Introduction

Discovering the City of Knowledge

In the second half of the twentieth century, a new and quintessentially American type of community emerged in the United States: the city of knowledge. These places were engines of scientific production, filled with high-tech industries, homes for scientific workers and their families, with research universities at their heart. They were the birthplaces of great technological innovations that have transformed the way we work and live, homes for entrepreneurship and, at times, astounding wealth. Cities of knowledge made the metropolitan areas in which they were located more economically successful during the twentieth century, and they promise to continue to do so in the twenty-first. Magnets for high-skilled workers and highly productive industries, cities of knowledge are, in fact, the ultimate post-industrial city.

Plenty of people know about the city of knowledge, but they do not call it by that name. It's a "high-tech capital" or a "science region"; it's Silicon Valley; it's Boston's Route 128.[1] Business leaders across the nation and globe want to become cities of knowledge and replicate their economic success. The allure of high-tech development does not diminish in economic downturns; even as the high-tech economy languished in a long and painful economic recession after the burst of the Internet bubble, CEOs and state and local politicians from Washington, D.C., to Albany to Shanghai continued to try and turn their metropolitan areas into the next high-tech boom town.[2] In doing so, these local leaders followed more than half a century of tradition. Ever since the growth of the Cold War defense complex and the consequent expansion of American scientific research and high technology sectors, cities, states, and regions have sought to imitate the magic formula that Silicon Valley and Route 128 seemed to have stumbled upon. Few have succeeded.[3]

Understanding why high technology thrived in certain places, and why these regions have proved so hard to replicate, requires looking at their evolution *historically* and *spatially*. In doing so, it becomes clear that these places are not simply high-tech regions that resulted from fortuitous combinations of capital and entrepreneurship. They are cities of knowledge: consciously planned communities that were physical manifestations of a particular political and cultural moment in history, and shaped by the relationship between the state and civil society in late twentieth-century America. The city of knowledge was a creation of the Cold War,

whose policies and spending priorities transformed universities, created vibrant new scientific industries, and turned the research scientist into a space-age celebrity. And it was a product of the suburban age, when economic realignments, demographic changes, and public subsidies transformed patterns of living, working, and economic opportunity. Suburbanization created ideal environments for science to grow and prosper, creating spaces where university, industry, and scientist could create new networks of innovation and production, away from the distractions and disorder of the changing industrial city. The Cold War made scientists into elites, and mass suburbanization reorganized urban space in a way that created elite places. The result of this intersection is that cities of knowledge did not just spring up anywhere, but rose up amid the larger landscape of the affluent postwar suburb.

The American research university was at the heart of this process, as economic development engine, urban planner, and political actor. Universities and their administrators were central to the design and implementation of cities of knowledge, and successful scientific communities often depended upon the presence of an educational institution that not only had extensive research capacity, but was also an active participant in state and local political power structures. The government-university relationship that emerged as a result of Cold War politics did not simply affect the "inside game"—the internal workings and research priorities of universities—but transformed the "outside game" of land management and economic development in the communities in which these institutions were located. This relationship was a two-way street in which federal programs influenced university choices, and academic institutions and traditions had an important effect upon the design and implementation of public policy.[4]

These intersections of policy and place, and the role of universities within this process, are evident in the highly particular industrial geography of high technology at the beginning of the twenty-first century—geographic patterns that endure in times of high-tech bust as well as high-tech boom. For most of the twentieth century, the places that provided desirable residential environments for high-tech workers were suburban in look, feel, and location.[5] High technology grew up as a world of office parks, freeway commutes, and proximity to residential subdivisions; high-tech workplaces looked more like college campuses than factories or downtown high-rises. This was more than a case of suburban "sprawl," however, for high-technology activities grouped together in distinct clusters—a pattern particularly evident in Silicon Valley, which one observer labeled a "remarkable petri dish of industrial innovation."[6]

High-technology location choices also take into account where educated workers prefer to live, and as a result, these sectors cluster in some

TABLE I.1
Decentralization, Density, and Income Levels of Some Leading Concentrations of High Technology Industry

Region	Distance from Region's 1950 Central Business District*	Population Density, 2000 Census (High-Tech Counties vs. 1950 CBD)	Median Household Money Income 1999 (High-Tech Counties vs. State Average)	Leading Research Universities in Area	Leading Universities Federal R&D Income, 1968 (National Rank)
Silicon Valley: San Mateo and Santa Clara Counties, San Francisco–San Jose, Calif.	32 miles	1,439.2 people per square mile *[City and County of San Francisco: 16,526.2]*	$72,577 *[California: $47,493]*	Stanford University	$41.1 million (2)
Route 128 Corridor: Middlesex and Norfolk Counties, Boston, Mass.	10 miles	1,703.6 people per square mile *[City of Boston: 12,172.3]*	$62,127 *[Massachusetts: $50,502]*	Massachusetts Institute of Technology (MIT) Harvard University	MIT $79.8 million (1) Harvard 39.2 million (3)
Eastside Seattle: King County, Seattle-Tacoma, Wash.	16 miles	817.0 people per square mile *[City of Seattle: 6,714.8]***	$53,157 *[Washington: $45,776]*	University of Washington	$27.9 million (10)
Silicon Hills: Williamson County, Austin, Tex.	18 miles	222.6 people per square mile *[City of Austin: 2,610.6]*	$60,642 *[Texas: $39,927]*	University of Texas at Austin	$10.3 million (40)

Sources: Distance from 1950 CBD to High-Tech Concentration is the driving distances from downtown districts to the following towns: San Francisco to Palo Alto; Boston to Waltham; Seattle to Redmond; Austin to Roundrock. Density figures from U.S. Department of Commerce, Bureau of the Census, *County and City Data Book 2000* (Washington, D.C.: Government Printing Office, 2002). Median household money income from U.S. Department of Commerce, Bureau of the Census, *City and County Quick Facts*, quickfacts.census.gov, (accessed 8 September 2003). Federal funding figures from national Science Foundation, *Federal Support of Research and Development at Universities and Colleges and Selected Nonprofit Institutions, Fiscal Year 1963*, NSF 69–33 (Washington, D.C.: Government Printing Office, 1968), 15–17.

*Central Business District, defined as the city with the largest population in the region according to the 1950 U.S. Census.

**Seattle is also part of King County and is included within the countywide figure.

of the most affluent, and economically homogeneous, places in the country. The connection between patterns of wealth and of high technology explain the infrequent exceptions to the suburban trend at the end of the twentieth century, which occurred after cities began to regain some of the wealth and middle-class residents they had lost to the suburbs decades earlier. Multimedia districts like Lower Manhattan's "Silicon Alley" and San Francisco's South of Market district—that grew during the 1990s Internet boom and shrunk significantly in the subsequent recession—emerged only after these city neighborhoods had become attractive to educated professionals. But changing urban economic dynamics have not been enough to trump the powerful connection between high technology and the suburb. Would-be Silicon Valleys, domestically and internationally, follow the model established by existing high-tech capitals and create homes for industry in largely affluent areas at the fringe (or beyond the fringe) of cities.[7]

American high-technology activities cluster in defined communities, simultaneously decentralized and proximate, diverse in function but not in socioeconomic composition. Communities of scientific production are places to live as well as work, home to a range of related and complementary production activities, cultural amenities, and services. In metropolitan areas with high concentrations of science-based industry, the rise of this kind of community has served to shift the focus of economic activity away from the central cities that dominated the regional economy up until the middle of the twentieth century and turned sleepy agricultural areas and bedroom suburbs into internationally influential concentrations of industrial production and commercial capital. By placing the history of high technology within the larger history of postwar urban and industrial change, we can trace the institutional and political origins of these fundamental—and inherently contradictory—geographic and socioeconomic characteristics and understand why they have been so economically important. This investigation shows how the process of high-tech growth was actually a process of city building. The suburbanization of science in the late twentieth century helped to *urbanize* American suburbs by making these places closer to classic definitions of cities in terms of their economic diversity and self-sufficiency.[8] No longer adjuncts to the central cities around which they grew up, the high-tech suburbs of the early twenty-first century are a new and influential kind of urbanism. They are not just amorphous "regions," but cities of knowledge.

Discovering the city of knowledge requires moving between the national scale and the local, identifying the complex interaction between public and private, and taking the story of high technology and giving it clearer

geographic dimensions. The development of the city of knowledge has been so hard to see because it stemmed from choices made not only in Washington, D.C., but at the local level as well. And the role of policy in this process is difficult to trace because it involved programs that did not dictate, but *encouraged*, certain institutional and industrial choices. This study traces these programs from inception to implementation, beginning with the Cold War politics of the late 1940s, moving through the local economic development efforts of the 1960s, and taking an intense look at the experience of three very different metropolitan areas and their research universities.[9] It finds that:

Cities of knowledge are products of Cold War spending patterns. The Cold War defense complex created new hierarchies of political influence and a giant new source of capital, both of which came with geographic strings attached and created fierce competition among regions and institutions for these funds. Cold War geopolitics prompted new political attention to science—not just the kind of research that could build better bombs, but also basic scientific exploration of the kind going on in universities. Scientists and university administrators became key political players in Washington, and unprecedented amounts of money began to flow to research laboratories and universities. In turning university science and industrial research into "big science," Cold War politics took an inherently elite and historically independent scientific sector and made it an increasingly public and governmental one, supported and shaped by national political priorities. It also reinforced long-standing hierarchies of scientific excellence, giving the vast majority of research money to a small pool of elite institutions that already had significant scientific capacity. Pork-barrel politics compounded this favoritism by steering the bulk of defense research and development dollars to certain regions of the country. For reasons both strategic and economic, deliberate and accidental, Cold War politics privileged a select number of places and institutions, leaving them much better situated to build economies of high-tech production.[10]

While institutional and regional favoritism might be a familiar story to students of Cold War history, its effect upon the intra-metropolitan geography of science has been little explored. However, there are some important connections. The patterns of national defense spending that funneled the majority of investments to certain regions of the country had the ancillary effect of shifting scientific activity to the suburbs because the Sunbelt states receiving the bulk of the funds were places experiencing rapid and largely untrammeled suburban growth. Federal defense spending—the "seed money" for later high-tech development—went to parts of the country where state and local leaders were particularly hospitable to the idea of this industry being located in the suburbs. Civil defense policies provided another connection between Cold War

defense spending and high-tech suburbanization. Concern about the vulnerability of central business districts during nuclear attack prompted officials to build in a number of powerful incentives into federal defense contracting policy that encouraged contractors to choose suburban locations over urban ones. The structure of these "industrial dispersion" policies, built around tax incentives and other private-sector encouragements, was quite similar to other federal mechanisms that indirectly encouraged postwar decentralization.[11] In this case, such subsidies explicitly targeted the expanding research-based industries that did business with the federal government. Although the civil defense concerns that prompted these incentives diminished in political and strategic importance over time, the preferences served as a federal endorsement of the idea that those sorts of industries should be decentralized and suburbanized and helped set in place enduring geographic patterns. The Cold War gave scientific institutions the money and clout to generate vibrant high-tech economies, and the geographic and institutional preferences embedded in Cold War defense contracting and research grant competitions contributed to the fact that these economies were more likely to emerge in suburban settings than urban ones.

Cities of knowledge are the product of university-centered economic development policies. As Cold War investments in research and development grew, state and local economic development policies began to increasingly orient themselves toward attracting clean, productive, and progressive businesses of science and technology. Because of its new wealth and research capacity, and its ability to act as a magnet for high-tech industries and workers, the research university became the economic development engine at the center of these efforts. Seeking in part to rectify the skewed economic geography of Cold War scientific research programs, by the early 1960s federal policy makers had created new public subsidies encouraging universities to expand their campuses and form collaborative partnerships with government and industry. States and localities complemented these programs with further incentives of their own. Many of these strategies centered on leveraging the power and resources of the university to create a very particular kind of industrial district, the research park. Through high architectural standards, extensive landscaping, and careful tenant selection, the research park mimicked the aesthetics and demographics of both the American college campus and the white-collar suburb.[12]

Although university-based economic-development strategies often aimed to shore up the declining economic fortunes of inner cities and poorer rural areas, and even though many prominent universities were in fact urban in location, the engagement of the university in economic development was crucial in mapping high-tech's exclusive and decentral-

ized-but-clustered industrial geography. These efforts promulgated an industrial model that was immensely well suited to a suburban setting, and that complemented the larger trend of industrial decentralization—a phenomenon that was itself heavily subsidized by public funds. Federal, state, and local governments provided tax breaks, infrastructure subsidies, and other persuasive mechanisms that pulled all kinds of firms out of central cities; public efforts to foster the growth of high-tech regions thus occurred amid a giant suburban building boom spurred in part by these federal incentives.[13]

The presence of these other policies indicates that science would have likely suburbanized to some degree, regardless of the geographic biases of Cold War defense spending and science-based economic development policy. The *degree* of this suburbanization, and the clustering of these institutions and firms in affluent places, however, are patterns that reveal the influence of science-based industrial development campaigns and the engagement of the university in these processes. By placing the university at the center of their high-tech development strategies, policy makers made an economic development model out of institutions that—despite often being located in cities—had long-standing preferences for low-rise, intensively landscaped campuses. And by making inherently exclusive and inward-looking institutions into agents of social and economic change, public policy reinforced the idea that communities of science should be places reserved for a highly trained and highly educated class of people.

Cities of knowledge are the product of local action. Federal policy built the framework for the city of knowledge, but the translation of this framework into real economic success depended on local implementation. And the preexisting social context at the local level, and the geographic and institutional preferences built into federal policy, had a massive effect on the ability of a region to win the high-tech economic development game. Areas with large defense industries and with the ability and willingness to develop modern research parks and desirable residential areas—like the suburban areas of the South and West—had huge competitive advantages. Regions receiving less defense money or with an aging and economically declining infrastructure—such as the large industrial cities of the Northeast and Midwest—faced huge hurdles in attracting high-tech industry. Geography wasn't everything, however. The centrality of the university in these kinds of economic development efforts meant that localities and regions fared much better if they had a wealthy, entrepreneurial, and politically savvy research university at their heart. These distinctions were lost on the designers and implementers of science-based economic development strategies. Policy makers instead approached this process as one of *imitation* that presumed universities

had similar economic development capacities, and cities and suburbs could be equally attractive to high-tech industries and their workers. The importance of the local political and economic context, and the drawbacks of this imitative strategy, become clear in the second half of this study, which takes an intensive, ground-level look at the experiences of three metropolitan areas and their leading research institutions.

Stanford University set a powerful early example of university-driven high-tech development and was widely imitated even though its success was due to rather extraordinary circumstances. Blessed with a massive endowment of undeveloped and economically desirable land, entrepreneurial administrators, and location near key defense facilities and amid one of the nation's more rapidly growing affluent suburban areas, Stanford built a research park adjacent to its campus that became, in the eyes of many government officials and university administrators, the gold standard for this kind of development. Stanford's development not only created even more rigorous criteria for architecture and landscape design that would blend into affluent suburban residential areas, but it also imbued the idea of the research park with a particularly Californian and Western architectural and landscape aesthetic—a look and feel that its imitators transposed in areas far removed from the Western habitat. At the University of Pennsylvania, in Philadelphia, local officials and university administrators used urban renewal funds as well as other sources of public money to attempt to transform a racially mixed and economically deteriorating urban neighborhood into a home for scientific industry and workers. Class and race often became conflated in the various attempts to develop scientific communities in these kinds of urban neighborhoods, where so many of the poor happens to be African American. The Penn example demonstrates that the racial and class politics of urban neighborhoods—not simply their physical infrastructure and location—created often insurmountable challenges to science-based development and were important reasons that Rustbelt cities like Philadelphia had such difficulty competing with Sunbelt suburbs for high-tech firms and personnel. The experience of the Georgia Institute of Technology, in Atlanta, demonstrates what happen when a region is advantaged by defense spending, and interested in creating suburban homes for high-tech industry and professional workers, but lacks a politically empowered and economically engaged research institution.

The experiences of Stanford, Penn, and Georgia Tech are more than merely case studies; these kinds of local-level processes formed a crucial second phase in the development of cities of knowledge and in the geography of American high technology. The experiences of these three places—a booming Western defense hub, a struggling Northeastern industrial city, and a rapidly growing and racially divided Southern metrop-

olis—vividly illustrate the unevenness of the high-technology playing field, and the way in which Cold War politics spurred tremendous opportunities for some places and closed off economic possibilities for others.[14]

Singling out three examples for in-depth exploration means, of course, leaving out others, and one city of knowledge that does not appear in this group is Boston, home to Harvard, MIT, and the East Coast high-tech region stretching along—and beyond—suburban Route 128. In many respects, 1950s and 1960s Boston demonstrated the processes of the city of knowledge at work: universities enriched by massive amounts of Cold War defense spending, research parks springing up at the outskirts of the metropolitan area, scientific professionals and firms flocking to the region to take advantage of its universities and research facilities. Yet Boston is in many regards an exceptional case and, because of this, a less apt fit for this kind of study. Taking one place that succeeded in its efforts to both become a top national research center *and* generate a high-tech economy—Stanford—and comparing it with two places that, despite valiant efforts, were not as successful—Penn and Georgia Tech—provides a more interesting comparison that reveals the importance of place and space. In addition, Harvard and MIT did not influence high-tech architecture, design, and university-centered land development practice to the same degree as Stanford. For reasons we will further explore, the universities of Boston were so uniquely privileged in the Cold War competition for scientific industry that the rules of economic development and economic competition that applied to other cities of knowledge (and would-be cities of knowledge) did not apply to them.[15]

The story of the city of knowledge is a revealing window onto the relationship between state and society in twentieth-century America. The choice of postwar policy makers to implement science policy through a loose and decentralized network of academic and industrial partners and interest groups, rather than through consolidated state power, was consistent with other aspects of U.S. welfare-state formation and economic policy—and a marked contrast to other industrialized nations. While an in-depth comparative analysis is not feasible here, it is worth noting that both Japan and Germany, two nations who rivaled (and at times surpassed) the United States in industrial and technical innovation during the late twentieth century, have had more visible and centralized science policy structures. However, these nations and others did not become home to geographic clusters of scientific activity on a par with Silicon Valley. The communities of this sort that now exist in other countries are the products of conscious imitation of American models rather than

being organic outcomes of national policy structures. The implication of this is that strong states may lead to strong national industrial policy, but they do not lead to cities of knowledge.[16]

The city of knowledge is a quintessentially American form, and is one that developed because of—not in spite of—the federalized and privatized American political system. The city of knowledge is, in fact, the product of the contradictions within this system, and within Cold War state-building policies in particular. The Cold War required a strong state, but American political traditions demanded a weak one. The solution was to empower universities and scientific industries to become agents and partners with the federal government, a choice that gave these local actors new influence over local economies and politics. It also created fiercely competitive dynamics among these partners, which in turn made institutions and industries more entrepreneurial and creative in devising strategies that could place them in favored positions economically and politically. While high-tech entrepreneurship is something often considered to have emerged in spite of government involvement, not because of it, the entrepreneurial drive of high-tech sectors and postwar universities may have stemmed in significant part from the competitive dynamics set up by the state.[17]

Examining these political and economic currents provides additional perspective on the question of how the United States implemented far-reaching, defense-driven policy agendas during the Cold War without becoming a "garrison state."[18] Through persuasion and partnership, the development of the Cold War science complex became a process in which federal decision makers, university administrators and scientists, and corporate research leaders all managed to have a voice. These power structures and policy networks enabled leaders to quietly and significantly increase the power and influence of the federal government while simultaneously condemning the idea of "big government" as dangerously communistic.[19]

Such political structures, involving institutions and industries with planning traditions that emphasized isolation and exclusivity, created a firm association between scientific activity and low-density, suburban working environments, and helped embed this association into the design and implementation of federal public policy. In doing so, Cold War research and economic development policies joined the ranks of a host of other public programs that "pulled" people and jobs out to the suburbs by creating economic incentives for the recipients of government money—whether they were states, cities, businesses, or homeowners—to behave in a particular way. While consumer preferences and market trends already favored urban decentralization and would have likely effected some decentralization even without this public intervention, gov-

ernment incentives accelerated and widened this process by making the automobile-dependent suburb a much more economically sensible location choice for families and employers. This same pattern of incentive-based policies and market influence marked the Cold War science complex and its component institutions, particularly the research universities that would become cores of significant concentrations of high-tech production. The outgrowth of these public-private collaborations was that these new suburban landscapes became home to an overwhelming proportion of the institutions and industries that made up the Cold War science complex.

Federal policies created a new political order in which scientific institutions were ascendant, and they built an institutional framework in which certain areas became the most economically attractive locations for scientific activity. They empowered and enriched certain institutions and certain places, reorienting the focus of American science and engaging universities in affairs of state and commerce like never before. In less than twenty years, the top American research universities went from being institutions with few financial or political ties to the federal government, to being entities crucial both to the federal defense complex and to state and local economic development campaigns. The way federal, state, and local governments contributed to this new spatial and economic order was not through large and centralized public programs, but through persuasive mechanisms that flew largely unnoticed below the political radar screen.

The political discourse around the American welfare state has long focused on what the federal government didn't provide its citizens (such as universal health insurance, wage subsidies, or family services like child care). By broadening the definition of "welfare" to include both means-tested and non-means-tested programs, and both public and private funding sources, new scholarship has demonstrated that the American welfare state is much more far-reaching and complex.[20] The case of the city of knowledge attests to how much the federal government *did* provide, and how these subsidies were disguised to such a degree that they often went unrecognized by their beneficiaries. These "strong-state-as-weak-state" policy frameworks—from basic research policy to economic development incentives to tax and infrastructure subsidies—allowed local actors to shape policy and tailor public funds to meet their own ends. Sometimes this worked, spurring explosions of science-based economic growth in certain regions; sometimes it did not. National policy intent and local policy implementation were equally important to the evolution of these communities and to the growth of the institutions and industries housed within them. This policy structure allowed a stronger state to masquerade as a weak one, and at the same time allowed local flexibility,

institutional entrepreneurship, and opportunities for innovation. The end result is a high-tech sector that has become a world leader in science and technology, but that seems to have collective amnesia when it comes to acknowledging the role of the federal government in its growth.

Uncovering the city of knowledge in the suburb reveals that the history of high technology has far more to do with government choices than is commonly realized, and it also shows how much local-level implementation of this policy matters. It explains why high technology is so often in the suburbs, and why this geography is so important to the history of technology and the history of American cities. For the influence of the city of knowledge goes well beyond high technology. At the outset of the Cold War, the notion that, in so many major metropolitan areas, more Americans would go to work in the suburbs than in the central city by the year 2000 would have seemed somewhat unbelievable. Today, the decentralized landscape of production, where millions of Americans go to work in office parks and lush "campuses" at the fringe of metropolitan areas, is so normal that most people rarely question how it came about. The historical and geographical dynamics underlying the development of the cities of knowledge help explain this. This story shows the complex interactions of policy, economics, and culture that spurred industrial suburbanization, and it also shows that this process was far more complicated and deliberately planned than is commonly supposed. The city of knowledge stands as a further example of a type of postwar urban development that, while often suburban in location and low-density in design, was not unplanned "sprawl." Instead, cities of knowledge were the products of careful and deliberate planning that involved both residential and industrial development. It also provides additional evidence of the profound influence of the Sunbelt and Pacific West in twentieth-century urban development patterns, and lends support to the argument that influence and imitation in postwar American city planning and development radiated from west to east rather than vice versa.[21]

"If the dominant figures of the past hundred years have been the entrepreneur, the businessman, and the industrial executive," wrote Daniel Bell in his 1973 treatise *The Coming of Post-Industrial Society*, "the 'new men' are the scientists, the mathematicians, the economists, and the engineers of the new intellectual technology."[22] This book is about how the rise of these "new men" became reflected in the American urban landscape, and traces the way in which federal public policy was instrumental in both the growth of high technology and the decentralization of high-tech industry and its workers. This is not a paean to the entrepreneurial brilliance of the Silicon Valley businessman—although it readily acknowledges the fundamental role individual innovation played in the growth of high-tech industry in the United States. Instead it places gov-

ernment and politics at the center of its narrative of how and why high-tech communities evolved the way they did. It was neither coincidence, nor a natural outgrowth of the market, that suburban landscapes became home to an overwhelming proportion of the institutions and industries that made up the Cold War science complex. The complex interactions between public and private created frameworks and incentives for high-technology production that moved the most rapidly growing sectors of the economy to the low-density, affluent fringe of the metropolis and redefined the American city for a post-industrial Information Age.