

A REPORT CARD ON THE WASHINGTON D.C. METROPOLITAN AREA TECHNOLOGY ECONOMY



**CENTER FOR INFORMATION
TECHNOLOGY AND THE GLOBAL
ECONOMY**

**KOGOD SCHOOL OF BUSINESS
AMERICAN UNIVERSITY**

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Executive Summary

The Washington D.C. metropolitan area (or DC area for short) has had a long tradition of providing IT products and services to the Federal government which is one of the largest consumers of IT in the world. During the 1990s the DC area successfully expanded beyond this core market and became a thriving center for Internet, e-commerce, telecommunications and bio informatics business activity. Like other technology centers the DC area was affected by the downturn in the technology sector in the years 2001 and 2002. The Center for Information Technology and the Global Economy (CITGE) undertook the task of systematically analyzing data on the area's technology economy and comparing to two other notable technology centers – Silicon Valley and Boston. The study was motivated in part by conflicting reports about the robustness of the area's technology economy. Another motivation for the study was to broker a dialog between universities, venture capitalists, entrepreneurs, state and local governmental agencies to build for the future together.

The study examines five important types of capital that we deem essential for a technology cluster – financial capital, infrastructural capital, intellectual capital, human capital and social capital. The report card for the DC area contains both positive and negative grades. The DC area does remarkably well (scores A's) in human and infrastructural capital, holds its own in intellectual capital (a B+), but lags Silicon Valley and Boston in financial and social capital (scores a B). These are good grades that any region can be proud of, but there is room for improvement in order to sustain and grow the region's technology economy. The study also suggests a few areas for debate – the role of Federal contracting, research productivity, emphasis on “soft” infrastructure and leveraging international connections.

CITGE hopes that this report serves as a catalyst for collaborative action to build on the platform of the earlier era and grow the DC area's technology economy in the years ahead.

Introduction

During the 1990s, the Washington, DC metropolitan area (referred to as DC area or DC metro) successfully diversified its economy – moving away from its dependence on government services and toward a vision of the region as a high-tech center. A 2001 Brookings Institution study suggested that the area has some advantages that can help it build an economy based on advanced technological and professional services. Certainly the DC area has the makings of a competitive high-tech economy, with its abundance of high-energy professional talent and world-class institutions (America Online and The National Institutes of Health come to mind).

Over the last few years, however, misfortune has targeted the area most cruelly. The Pentagon disaster, anthrax, a plunging stock market, violent snipers and the threats of war and terrorism have tested the area's mettle and thrown what previously seemed a promising high-tech future into doubt. The question is, is the DC area up to the task of fully building and sustaining itself as a high tech Mecca? Is the homeland security business enough to pull the area out of the tech slump? Or are the setbacks too great and is the DC area high-tech economy headed down a slow slide to the bottom?

To help answer this question, the Center for Information Technology and the Global Economy (CITGE) at The American University's Kogod School of Business looked for examples of regional knowledge economies that managed to "make it" despite severe setbacks. We were struck by an example from a bygone era.

Cremona, a small town in Italy, has been famous for producing the best violins in the world for hundreds of years. Cremona's proud heritage of craftsmanship and innovation – built by names such as Antonio Stradivari, Nicolò Amati, and Giuseppe Guarneri – has survived the plague, countless wars, and the Spanish inquisition. Although during the Renaissance creativity and genius thrived as never before (or maybe since), violinmakers could depend on no reliable system of money, no standard system of weights and measures, no safe, dependable system of transportation. Yet Cremona's violin making industry thrived, and their unsurpassable beautiful, playable instruments were sold all over the world. Drastic changes in social structure, famine, disease (plague cost Italy almost one-fourth of its population between 1630 and 1660), and wars all over Europe built, destroyed, and rebuilt economies and society. Yet not only did Cremona continue making violins, it constantly improved upon techniques of production to give the world masterpieces that have never been replicated.

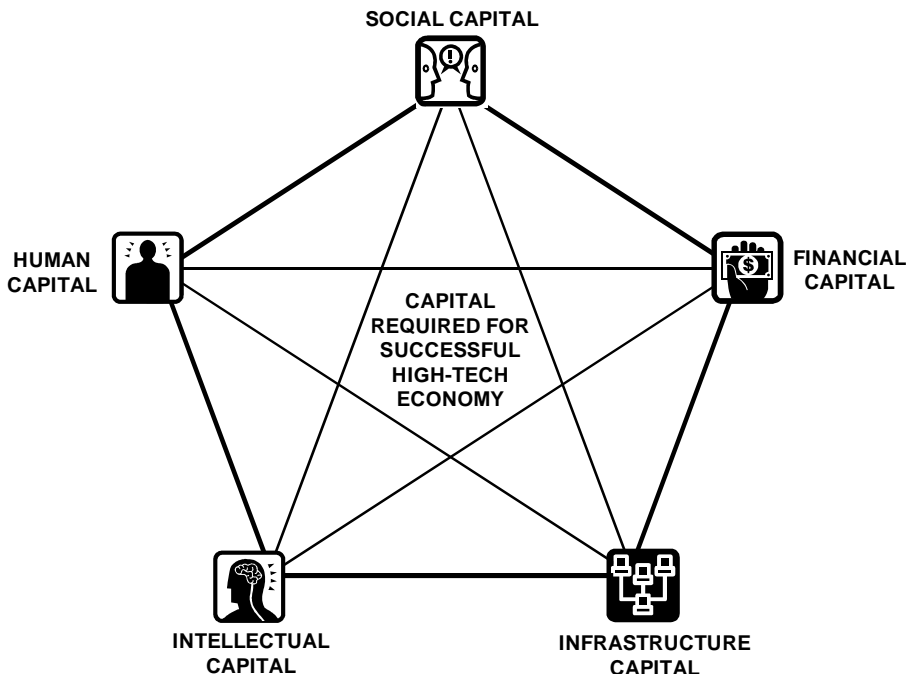
We believe Cremona has lessons to teach DC as it attempts to become a competitive, sustainable center of innovation. Cremona had strong talent, endurance during tough times, and the flexibility to adapt to dramatic change. Its master craftsmen pursued the perfection of the violin in the face of hardships beside which the dot-com busts, accounting scandals and even terrorist attacks surely pale. Realizing the DC area's vision of an enduring high-tech economy will take the same kind of creativity, innovation, and persistence displayed by the violinmakers of Cremona.

The CITGE Study

CITGE studied three leading US high-tech centers – Silicon Valley (California), the Boston Metro area (Massachusetts), and the DC Metro area (DC and surrounding suburbs and counties in Virginia and Maryland), to compare features and qualities needed to sustain innovation and adaptability in high-tech industries. These three metropolitan areas are significant population centers in the U.S. The D.C. area is home to 5.6 million people, while Silicon Valley and Boston are slightly larger with populations of 7 million and 5.8 million respectively. The DC area or DC metro includes the District of Columbia, the Northern Virginia counties of Arlington, Fairfax, Fauquier, Loudon, Prince William, Spotsylvania, Stafford as well the suburban Maryland counties of Anne Arundel, Calvert, Charles, Montgomery, Howard, Prince George’s and St. Mary’s. For the purposes of this study, high technology included mostly information technology businesses ranging from bio-informatics, telecommunications, computer software, IT services, web-based retailers etc. but excluded more engineering and manufacturing oriented businesses like aerospace or industrial control systems.

Based on extant research on technology economies and informed by historical examples of the guild-based economies, CITGE identified five types of “capital” – i.e., types of resources – a region must have to build and maintain a high-tech cluster. These capitals form the basis for the CITGE High-Tech Economy Pentagon. The five capitals are mutually reinforcing. They are subject to increasing returns and connect in both virtuous and vicious cycles (good leads good and bad leads bad). If one capital is in abundance in a region, the other capitals will follow there. The reverse is also true: as capitals become

CITGE HIGH-TECH ECONOMY PENTAGON



disproportionately located in a region, the lesser-endowed areas may never catch up. And some of these capitals – human, for example – are relatively more difficult to accumulate.

Financial Capital

Few can dispute the need for financial capital for any business, particularly in the high-tech industry. Financial capital – in the form of private wealth, equity markets, foreign investors, and (most important for a high-tech economy) venture capital – is often thought of as the most mobile factor of production, and in fact shows a strong tendency toward localization.

Venture capital investment is a bottom-line indicator of market-driven investment in entrepreneurial ventures with high growth expectations. It is a main factor in an area's ability to create new enterprises and grow employment, as it spurs growth at the critical early stages of a company's development. Typically, areas with high growth potential will attract more venture capital. A recent study by the National Venture Capital Association (NVCA) quantified the way venture capital investment can snowball into greater economic health for an area: companies backed by venture capital generate twice the sales, pay three times the federal tax, and invest more (\$44 for every \$1,000 of assets) in research and development than companies without such investment.¹ Venture capitalists are contemporary versions of the Medicis who bankrolled the surge of creativity during the Renaissance.

Infrastructure Capital

For its high-tech industry to grow and prosper, a region must provide a host of services to support the money and ideas that flow there. In addition to basic facilities such as airports, roadways, telecom and computing infrastructure, companies need lawyers to write their articles of incorporation, marketing people to develop brochures and advertising, accountants, auditors and banking facilities. It was infrastructure that made Amazon choose Seattle and Gateway to relocate to California.

Intellectual Capital

The chief characteristic of high-tech industries is their continual development of new processes, new products and new business models. A region's chances for high-tech success are improved by the presence of academic research and development. R&D yields new product innovations that add to the knowledge base of the regional economy. It is a key driver of economic growth. In addition to patent activity, R&D funding and the absolute number of technology firms and quality educational institutions, we also looked at serial entrepreneurs, who constitute a special form of intellectual capital. The more the serial entrepreneurs in an area, the greater is the intellectual capital of the region.

¹ NVCA presented the results of this study on Capitol Hill, June 26, 2002 (source: *Washington Post*).

Human Capital

In the high-tech sector the most precious resource walks home in the evening – not unlike the Renaissance, which depended as much on the stock and quality of craftsmen and artisans as on the treasury of the Medici.

To assess human capital – the quality of an area’s people – we looked at both static and dynamic factors. Information on education levels is relatively easy to come by, but does not paint a complete picture. So we also evaluated domestic migration patterns, international migration, foreign-born population, and workforce education levels, as well as the number of jobs in each area. An area that gains more people than it loses is one whose economy is attractive enough to both retain its current residents and attract outsiders. Finally, areas whose residents have achieved higher levels of education are likely to have more participants in the high tech knowledge economy creating new products, services and companies.

Social Capital

In his classic work *Democracy in America*, the French historian Alexis de Tocqueville pointed out America’s strength in creating grassroots-level organizations that foster community and encourage commerce. Social capital refers to an area’s stock of informal networks and associations, which indirectly but very powerfully contribute to business formation. Informal organizations give human capital the opportunity to form the relationships and learn the new information that increases an area’s knowledge base and its chances for entrepreneurial start-ups. The rise of the networked economy, with its strategic alliances and joint ventures, makes social capital increasingly important to the ecology of high-tech business.

Key Findings

To borrow from Mark Twain, reports of the DC area’s death as a high-tech center have been exaggerated. We find that the DC area has several strengths that create optimism for its vision of itself as a leading US high-tech cluster, as shown in the region-grade table below:

REGION	FINANCIAL CAPITAL	INFRASTRUCTURE CAPITAL	INTELLECTUAL CAPITAL	HUMAN CAPITAL	SOCIAL CAPITAL
Silicon Valley	A	A	A	B+	A
DC Area	B	A	B+	A	B
Boston Metro	B+	B	A	B+	B+

In several respects, the DC area’s future looks brighter than that of Boston. But Silicon Valley is far ahead of both the DC area and Boston along most of the dimensions we studied. For the DC area to mirror Cremona in its ability to nurture ideas, attract investment and withstand the forces of change, it will need to increase its social capital,

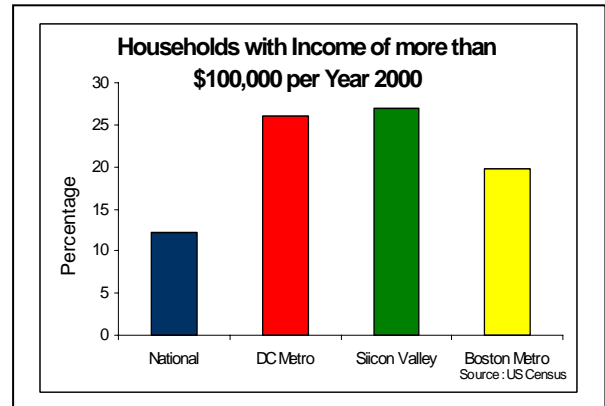
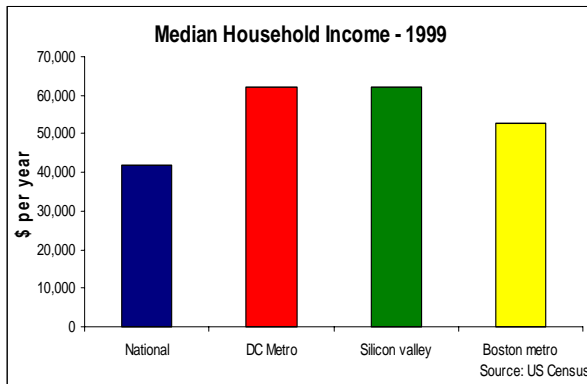
maintain its technological infrastructure and improve its ability to provide for world-class research and development.

Financial Capital

The DC area is at a disadvantage to Boston and Silicon Valley in terms of financial capital for building a high-tech economy. It lags far behind Silicon Valley on the dimensions we studied – strength of local companies, venture capital investment, foreign direct investment and number of initial public offerings – and leads Boston in foreign direct investment and household income. Silicon Valley clearly merits an “A” in this capital, Boston a B+ and the DC area gets a passable B grade.

Household Income

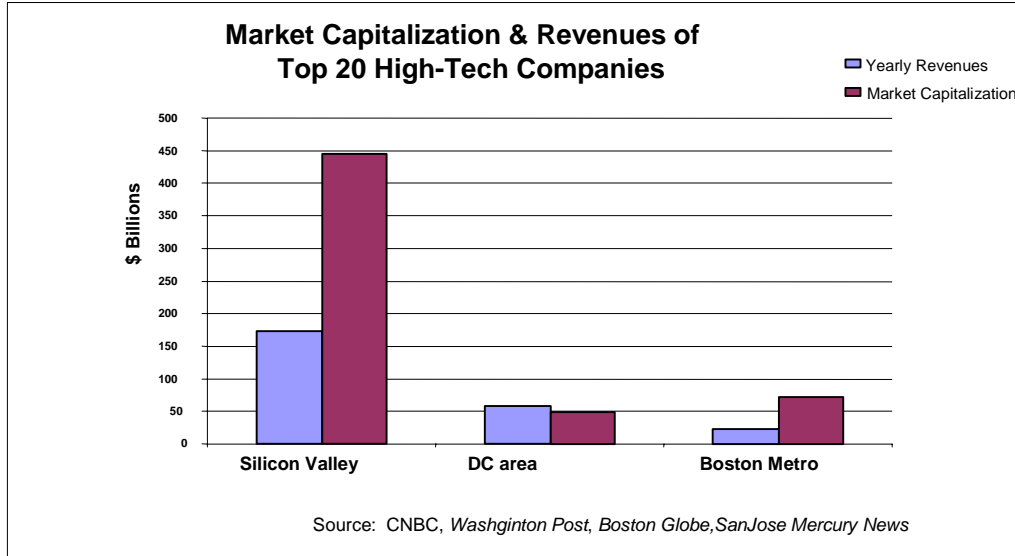
The success of an area’s high-tech economy depends in part on the financial resources of its residents. To determine the financial well-being of our target areas’ residents, we looked at income across three dimensions: per household (an average of incomes for all households in the area), per capita and median household (indicating the point at which incomes of half of the families are higher and half are lower). Based on per-household and per capita income, the DC area compares favorably to Silicon Valley and does better than the Boston area. 26 percent of DC households and 27 percent of Silicon Valley households earn more than \$100,000 per year (the national average is 12.3 percent, according to the 2000 US Census). In terms of per capita income, DC area and Silicon Valley residents earn nearly \$10,000 above the national average (DC area – \$30,350, Silicon Valley-\$30,769, Boston-\$26,856 and US average-\$21,587).



Financial Strength of Local Companies

Silicon Valley companies demonstrate their might in terms of both revenues and stock prices. While the revenues of DC Metro’s top 20 companies – mostly telecom and biotech – stack up favorably compared to Boston’s, their market capitalization is lower, due to large amounts of debt and tough economic conditions. However DC metro is a powerhouse in the federal IT contracting business garnering nearly \$9 billion worth of

federal IT services business in 2001 with 20 firms accounting for nearly \$7.9 billion of contracting revenues².



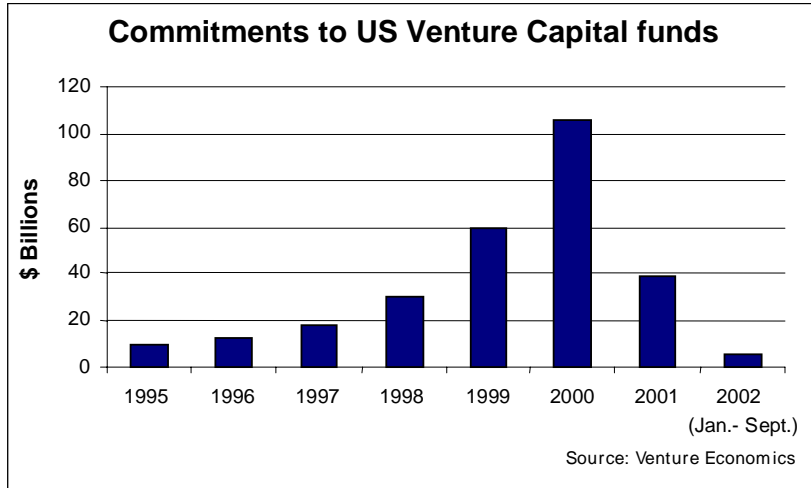
Venture Capital

Venture capital investment is critically important to an area’s financial capital. Silicon Valley receives more than twice as much venture capital as a share of its economy than Boston Metro. This is clearly because the San Francisco area remains the technological innovation capital of the globe, with a strong presence in a host of high-tech sectors, including biotech, Internet, telecom, computers and devices. Other top-ranking metros, including Washington, DC, are much more specialized, with a strong presence in only one or two high-tech industries. Venture capital is also drawn to places with strong university engineering and science programs, like those in Silicon Valley. While the DC area may tout its biotech specialization, it does not rank in the top five locales for biotech-related investment. And while venture capital investment has recently been falling for all three metros, our study suggests that a large amount of uninvested money is out there, waiting for good high-tech projects to emerge.

Venture Capital Commitments: Overall Decline

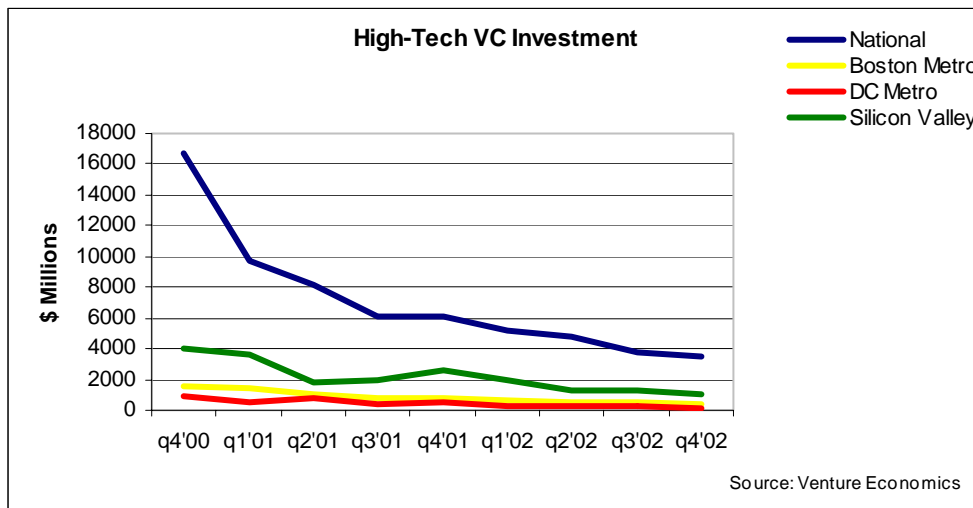
Until recently, nationwide venture capital commitments for all industries had been rising steadily, culminating in more than \$100 billion in 2000. Since then, however, commitments have fallen sharply, totaling only \$39 billion in 2001. Even though the final figures are not in, much improvement is not expected for 2003.

² Source: Brookings Institute Study, 2001



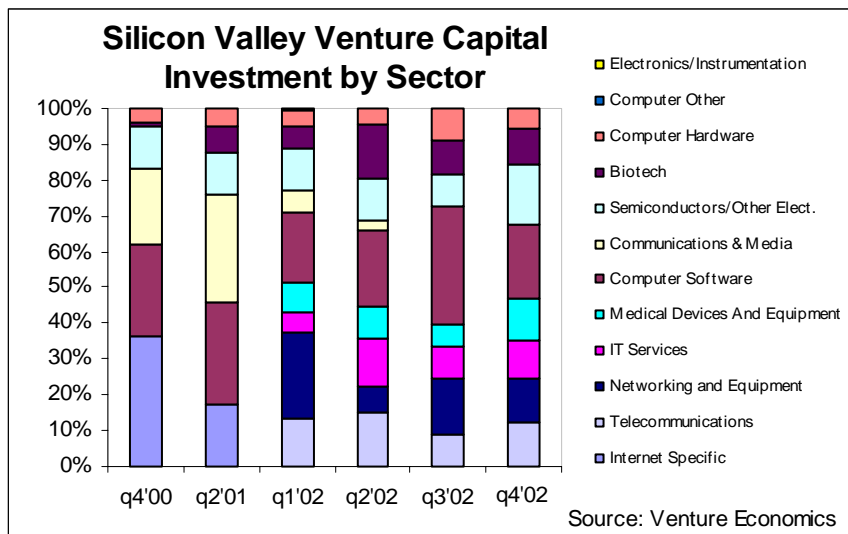
In the US high-tech sector, VC investments have also been declining since late 2000, dropping from \$18 billion to less than \$6 billion in late 2002. The total national VC investment in high tech stood at less than \$4 billion in the third quarter of 2002 as compared to \$18 billion at the end of 2000.

The picture for Silicon Valley, Boston and DC also shows declining high-tech VC investment. In Silicon Valley, high-tech VC dollars stood at \$6.5 billion in late 2000, but fell to less than \$2 billion by early 2002 and stood at less than \$1.1 billion in the fourth quarter of 2002. Boston high-tech VC investment reached \$1.5 billion in late 2000, but by early 2002 stood at only \$400 million (although this number represented an increase after five quarters of consistent decline). The VC money in Boston stood at \$335 million in the fourth quarter of 2002. The D.C. area started from a smaller base of venture capital than Boston or Silicon Valley in the early 1990s but grew rapidly from \$390 million in 1995 to nearly \$5.5 Billion in 2000. The downturn in DC numbers are especially grim: total VC investment in high tech, which stood at \$900 million in late quarters of 2000, fell to a low \$150 million by early 2002, and stood at only \$189 million in the fourth quarter of 2002 – a bad omen for DC’s high-tech companies.



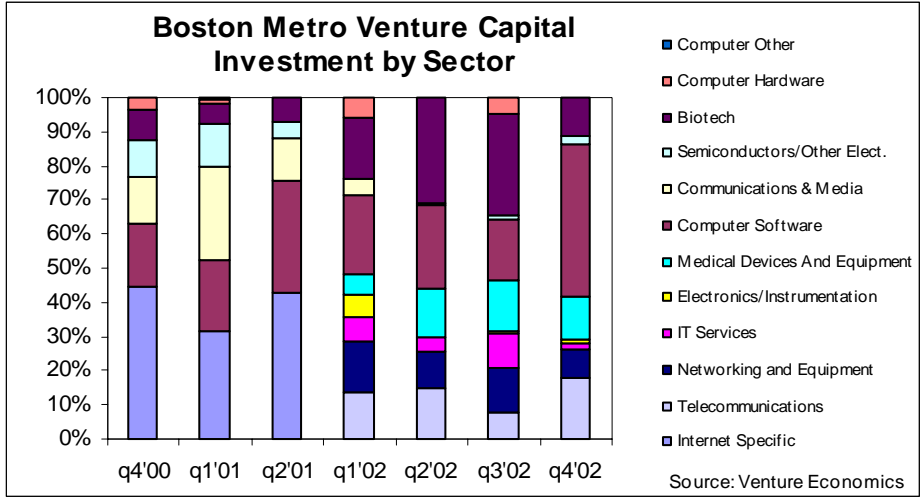
Venture Capital Commitments by Sector

Comparing investment in various sectors provides clues to what the venture capitalists perceive to be each metro’s strengths and weaknesses. In Silicon Valley, the Internet-specific and computer software sectors account for more than 60 percent of total high-tech VC investments. In the fourth quarter of 2002, the Internet-specific and computer software sectors had less than 35 percent of these funds. The biotech sector share has steadily increased, while communications and media have taken the hardest hit. Computer hardware’s share has increased over the quarters. Because of the presence of big semiconductor companies, the semiconductor sector has consistently received close to 10 percent of the high-tech money, although in late 2002 its share rose to more than 15 percent.

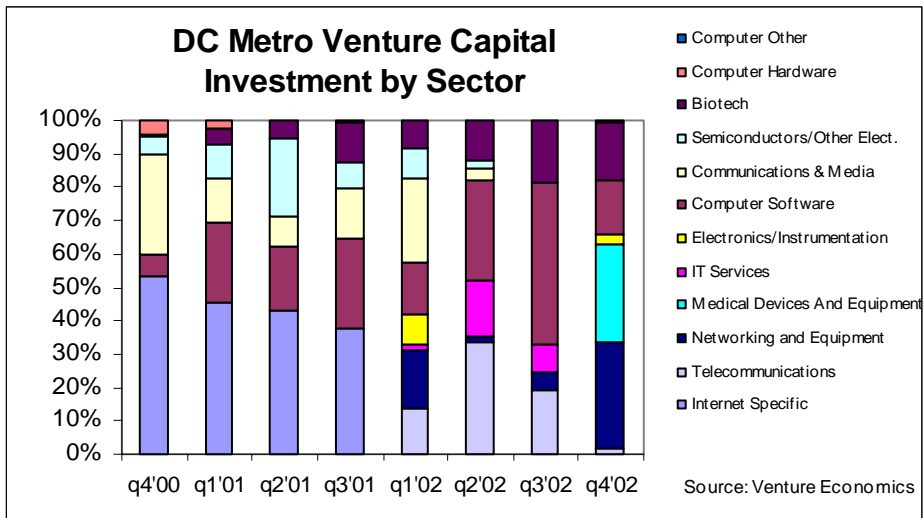


The Internet-specific sector also received the greatest share of high-tech VC money in Boston, although that share decreased from over 45 percent in late 2002 to 30 percent in early 2002 and stood at just 23 percent in the fourth quarter of 2002. The computer software sector’s share has shown a steady increase from 20 percent in late 2000 to 45 percent in the fourth quarter of 2002 after dipping to 18% in the third quarter. Biotech dropped from about 30 percent in the third quarter of 2002 to 12% in the fourth quarter. The communications/media and semiconductors sectors have been gradually shrinking. Hardware made a comeback in the third quarter of 2002, perhaps due to select VC deals in that segment but diminished in the fourth quarter.

By late 2002, investments in telecom had decreased to almost half of what they were in earlier in the year in the third quarter but regained its share to 18% by the end of the fourth quarter. IT services showed a steady increase, to about 10 percent of total investment till the third quarter but sharply reduced to 2% in the last quarter. Medical devices and equipment also showed an upward trend, taking a 13 percent share in the fourth quarter of 2002. Networking and equipment maintained its share of about 9 percent.

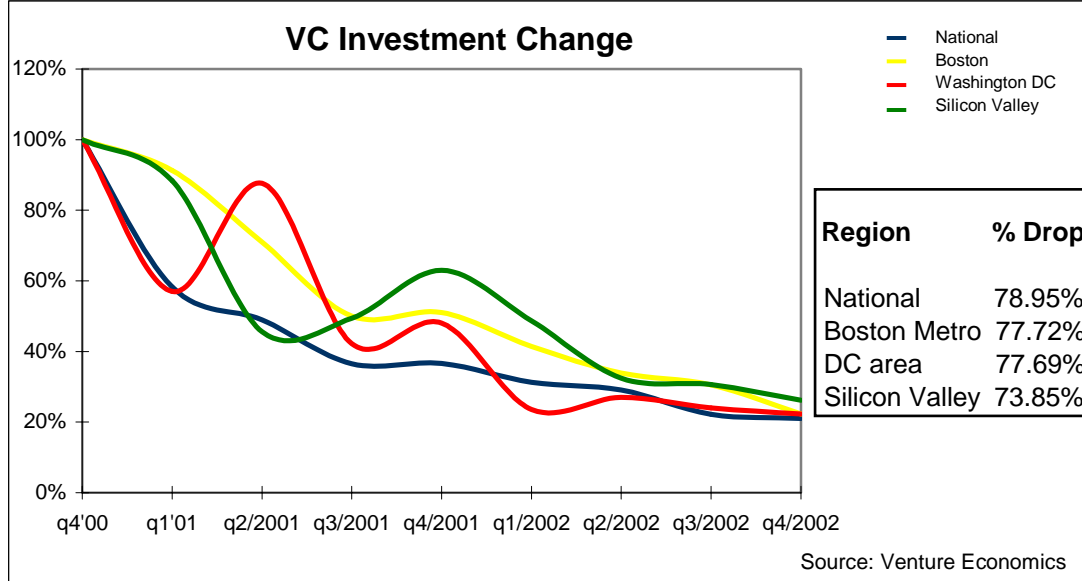


DC metro’s Internet-specific sector has shown a constant decline in share of high-tech VC money, falling from a high of 50 percent in 2000 to less than 30 percent by late 2002. In early 2001, computer software looked like it might become the darling of the venture capitalists, but by the end of that year its share had slipped significantly. In third quarter 2002, however, it had regained its standing and stood at almost 49 percent of VC investment, dipping back to 16% in the fourth quarter. The communications sector’s share was under 30 percent in early 2002, down from a high of 50 percent, and continued to slide in the fourth quarter of the year. In 2001, the biotech sector appeared to be growing, taking more than 30 percent of the area’s high-tech VC investment. However, despite the hype this sector receives in DC, its 2002 share was only 19 percent. Telecom’s share decreased further in the latter part of the 2002 to stand at just 2 percent. DC expected a boost from homeland security initiatives given its traditional strength in securing federal contracts. During the 1990s the DC area garnered nearly 60% of federal increases in spending according to Stephen Fuller’s 2001 study for the Brookings Institution. However as of late 2002 this expected boost has been less forthcoming than anticipated and has not brightened the overall financial picture for the DC area.



VC Investment: Normalized Curve

When data for the three metros are compared across metros and over time, the greatest drop in high-tech VC investment appears to have occurred in Boston and DC – however, investment in all three areas continues to slide.



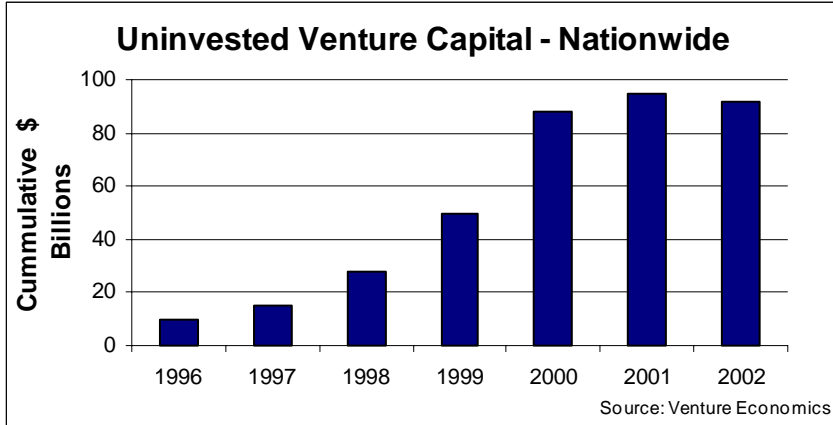
From quarter to quarter, DC shows abrupt changes in investment amounts. And the absolute dollars flowing into DC are low, not only compared to Silicon Valley and Boston, but to the US as whole. The area is clearly less stable than Boston and Silicon Valley when it comes to holding VC money. Boston has had the best record of sustaining VC investment.

Region	2000	2001				2002			
	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
National	16659.1	9711.2	8149.8	6087.5	6094.2	5203.4	4844.9	3696	3506.7
DC area	847.9	483.5	743	357.9	490.5	199.9	229.3	204	189.2
Silicon Valley	4060.3	3587.4	1851.1	2006.1	2556.9	1976.4	1319.1	1243	1061.8
Boston Metro	1501.2	1370.4	1065.9	750.6	765.6	622.1	508.2	459	334.5

Source: Venture Economics

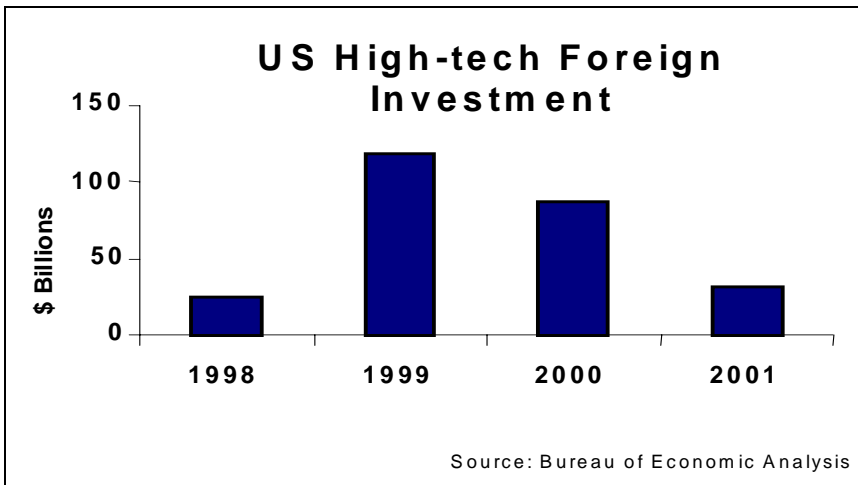
VC Story: Silver Lining

The drop in venture capital investment is not all bad news. There is still a lot of money out there – it’s just looking for good high-tech projects. In 2001, uninvested VC capital stood at close to \$90 billion, because promising projects had been lacking for three straight years.

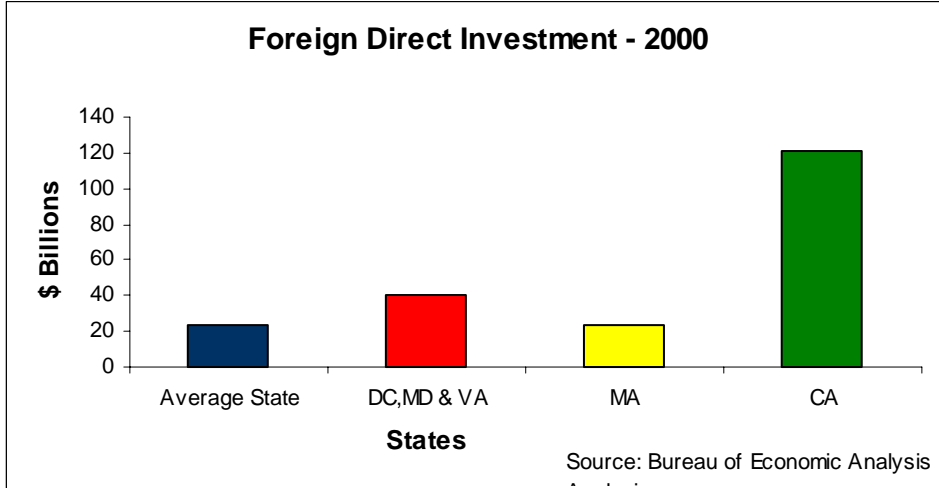


Foreign Direct Investment

In 1999, foreign investors saw a great investment opportunity in the US high-tech sector, when they poured close to \$120 billion into US high-tech companies, out of \$300 billion in total foreign direct investment (FDI). A slowdown began in 2000, with foreign high-tech investment shrinking to less than \$100 billion. Only \$40 billion was invested in high tech in 2001 – a complete meltdown. The computer and electronics sectors lost share in the total high-tech FDI from 2000 to 2001. Broadcasting and telecom have also recently lost share.

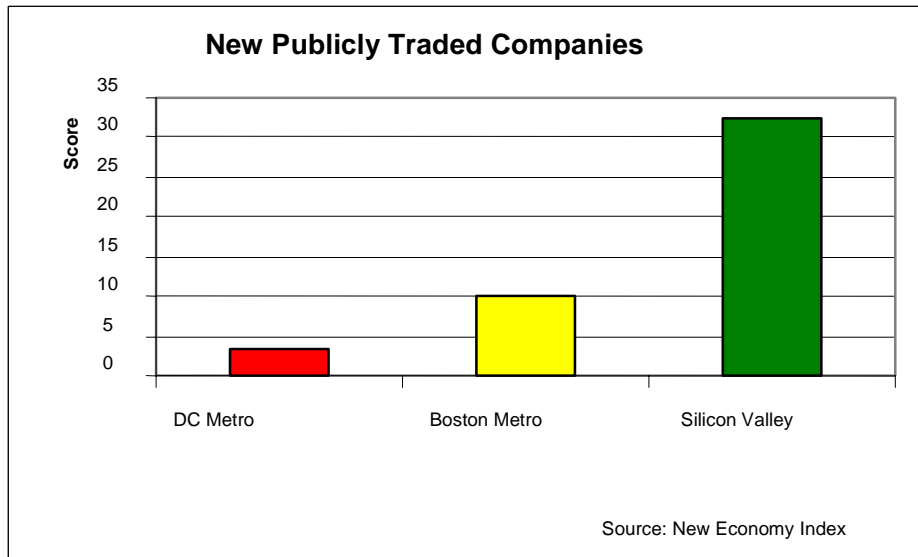


In 2000, California received more than \$120 billion of the \$300 billion in total US FDI. DC attracted just above \$40 billion, while Massachusetts received about \$23 billion – the only measure by which the DC area appears to have an edge over Massachusetts. Even in terms of FDI as percentage of state product, California beat the two other states by a good 2 to 3 percentage points, suggesting that it is a more “global” state than the other two. All three areas have significantly larger pools of FDI than the “average” U.S. state – national statistics suggest that a typical state begets \$23.52 Billion annually in FDI.



Initial Public Offerings (IPOs)

Over the last two decades, financial markets have embraced entrepreneurial dynamism. The number of annual IPOs priced and filed rose by 50 percent between the 1960s and the 1990s, and is still quite high, despite a sharp drop in 2000 (from 1,095 in 1999 to 489). IPOs indicate the degree to which an economy is producing companies that have long-term and substantial growth potential. Silicon Valley is producing a large number of start-ups with growth potential, giving it a good score on the IPO indicator. DC scores low on IPOs, suggesting that its economy is not as entrepreneurial as it needs to be.



Infrastructure Capital

Development of a high-tech economy depends not only on the people and money that can be attracted to an area, but also on the infrastructure available to support them. To compete for high-tech companies, an area must possess a competitive technological (Internet and telecom) infrastructure, adequate business services, available and affordable real estate and convenient, flexible air travel options. Silicon Valley provides the best infrastructure of the three regions, but the DC area has much more to offer than Boston. We awarded “A” grades to the DC area and Silicon Valley and a “B” to Boston.

Technological Infrastructure

On five important parameters, Silicon Valley ranks higher than the DC area and much higher than Boston in technological infrastructure.

Technological Infrastructure				
Area Rank				
Region	Online Population¹	Broadband Telecom²	Commercial Internet Domains³	Internet Backbone⁴
Silicon Valley	1	1	1	10
DC area	4	10	5	13
Boston	15	18	33	20

¹ The percentage of adults with internet access at work or at home
² The number of broadband competitors per zip code area.
³ The number of domain names (“. Com”) per number of businesses.
⁴ Total capacity of all internet backbone links to other metropolitan areas as share of employment.
 Source: Metropolitan New Economy Index April 2001

In addition, Metropolitan New Economy Index April 2001 ranks Silicon Valley as the “Most Wired” in the US, followed by the DC area (fourth) and Boston (twelfth).

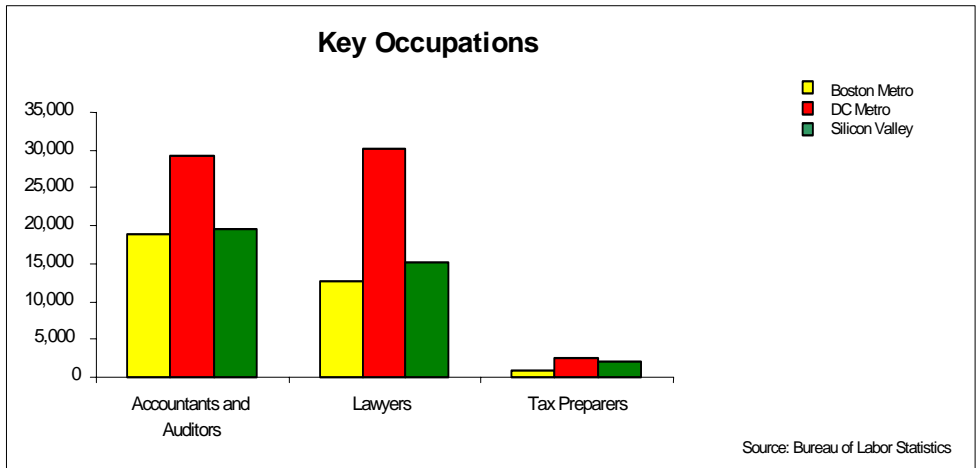
Business Services

Another important aspect of infrastructure capital is the availability of related business services, which act as catalysts to the development of a high-tech economy. On this dimension, the DC area (based on the District of Columbia alone) is strongly placed compared to Boston and Silicon Valley, with almost double the number of total occupations in Boston and one-third more than Silicon Valley.

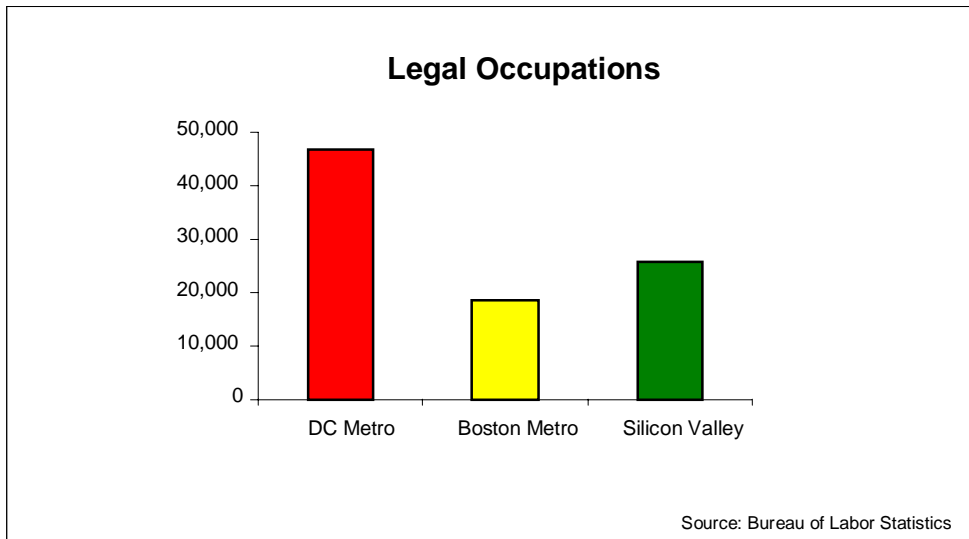
Business and Financial Operations Jobs	
2000	
<u>Region</u>	<u>No. of Jobs</u>
DC	175,190
Silicon Valley ¹	115,640
Boston	91,980

¹ San Francisco and San Jose
Source: US Bureau of Labor Statistics

In three key occupations – accountants/auditors, lawyers, and tax preparers – DC also outranks both Boston and Silicon Valley.



The total number of legal occupations tells the same story, with DC boasting 2.5 times the number of occupations as Boston and 1.8 times that of Silicon Valley.



Real Estate Prices

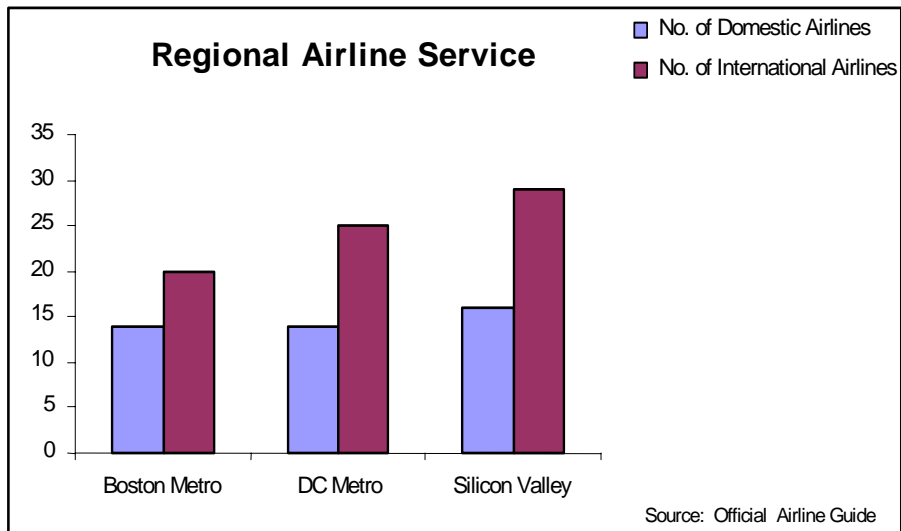
High-tech companies looking for real estate will find the DC area a fairly good deal. Although office space is somewhat less available in the DC area than the other regions, lease rates are relatively inexpensive, especially compared to Boston. Rates in Silicon Valley are also relatively good, but San Jose real estate prices are nearly as high as Boston's.

Region	Office asking rates (in \$ per sq. ft)	Office Availability Rates
Silicon Valley	30.20	19.90%
Boston Metro	37.67	15.20%
DC area	30.63	10.40%

Air Transport Infrastructure

Air transportation infrastructure is imperative for the growth of a high-tech economy. In addition, high-tech executives travel more than average business travelers. On this dimension, the Silicon Valley fares best. But the DC area is very well positioned compared to Boston, with more international and domestic airlines, more daily non-stop domestic and weekly international flights and more US destinations, providing greater flexibility and connectivity for business travelers, both nationally and internationally.

The DC area and the Silicon Valley both have three airports; Boston has just one. In 2002, 473 domestic flights took off from Boston each day, compared to 1,141 from DC. Boston had 426 international flights per week; DC had 483. Boston serves 64 domestic and 23 international destinations, compared to DC's 95 and 28.



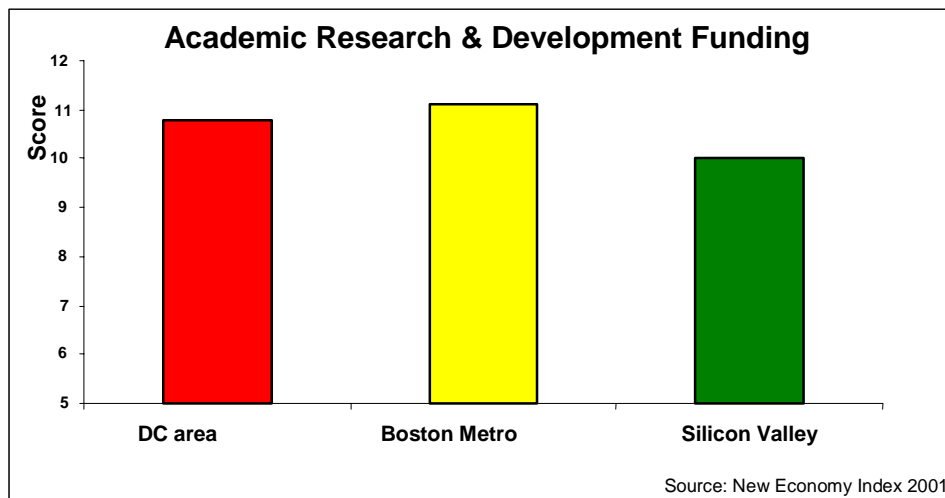
Intellectual Capital

An area's intellectual capital while related to its workforce's education level is a conceptually distinct pool of capital that fuels innovation and business formation in a region. In order to gage this we looked at a variety of different factors ranging from quality of academic institutions to serial entrepreneurs. The DC area has a high degree of intellectual capital, with important academic R&D being conducted at prestigious institutions. However, the region lags behind Boston and especially Silicon Valley in terms of patents, colleges and universities, and serial entrepreneurs. We awarded Silicon Valley and Boston with A's and gave the DC area a B+ in this category.

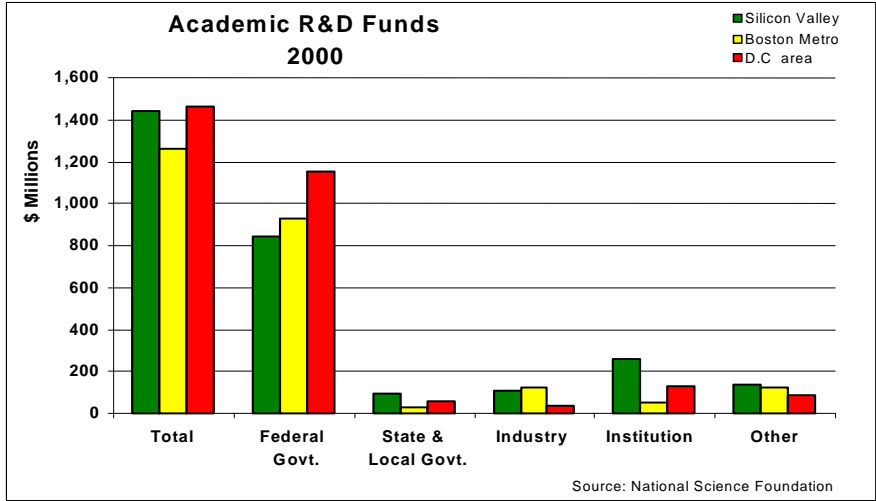
Academic Research and Development

Research and development, which yields new product innovations and adds to the knowledge base of industry and the marketplace as a whole, is a key driver of economic growth, especially in a high-tech economy. Data on R&D conducted by businesses in metros are largely proprietary, but data on academic R&D are available. Metropolitan areas that have academic institutions performing large amounts of R&D, particularly R&D that is funded by industry, are more able to attract and grow technology companies. While it has become almost a cliché to talk about the importance of MIT and Stanford to the economies of Boston and Silicon Valley, it is true that these research universities play critical roles in fueling their regions' high-tech economies.

While Silicon Valley must surely rank high in corporate R&D, it lags behind both Boston and DC in academic R&D funding. DC ranks high largely because of the Baltimore presence of Johns Hopkins, the leading academic research performer in the nation.

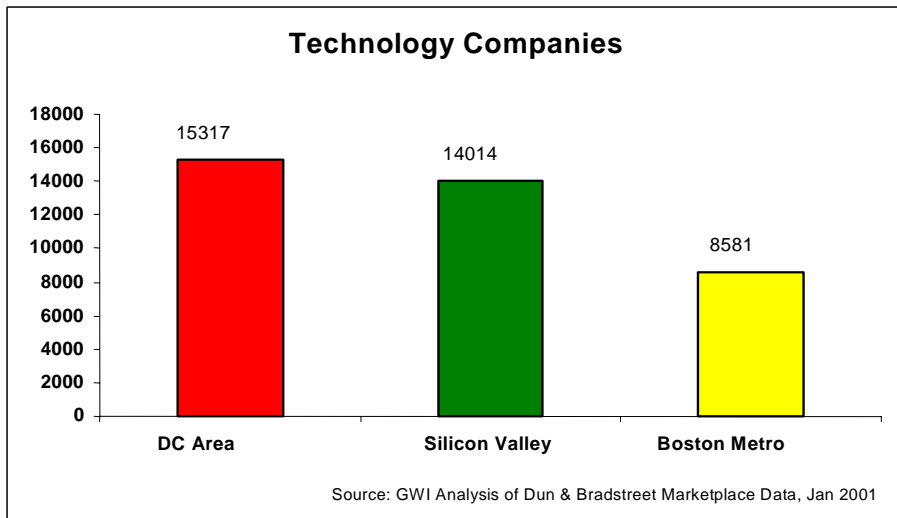


Industry funded academic R&D is key to the development of new products and services. DC lags behind both Silicon Valley and Boston on this dimension, and according to the New Economy Index ranks seventh in the nation in industry-funded research. It is the leader, however, in capturing federal government funding.

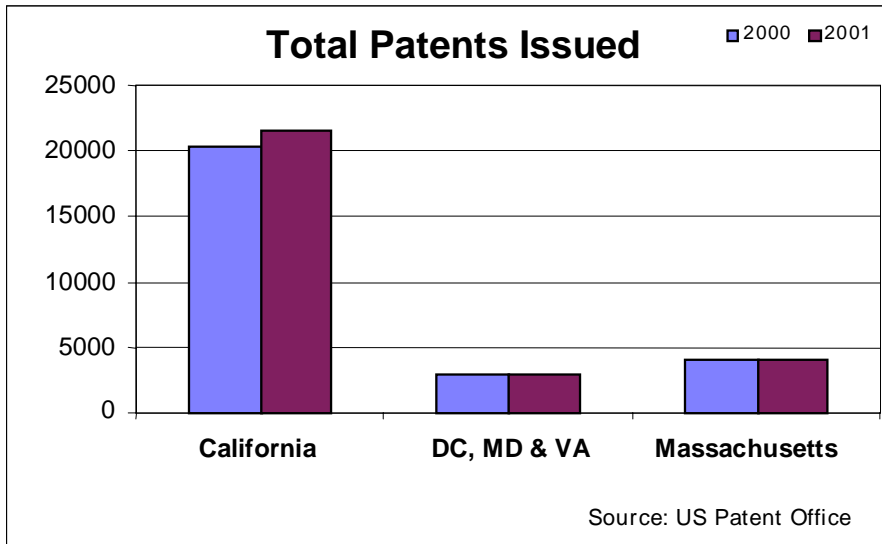


Patents

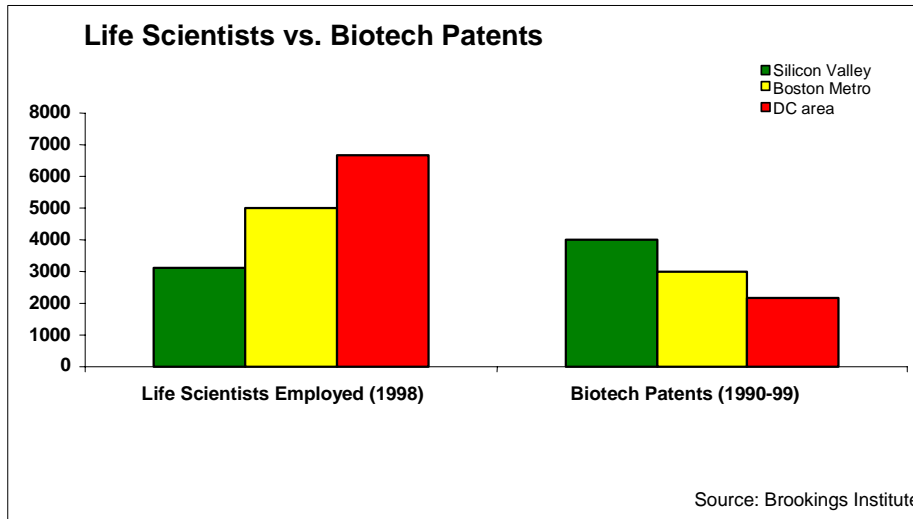
Many high tech sector executives and policy makers argue that patent applications are imprecise even inappropriate indicators of innovation – the argument being that few high tech firms bother to file patents for their innovations. Nevertheless as technological innovation has become more important, patents issued in the US have increased, from 58,000 in 1984 to more than 159,000 in 1999. Patent data across are also affected by the placement of corporate headquarters since R&D facilities tend to be co-located with them. Patent data continue to, albeit less accurately perhaps, reflects the capacity of firms in a region to develop new products and processes. As of January 2001, technology companies had more employees in the DC area than in the Silicon Valley and Boston regions. It is interesting to note that Silicon Valley which is often thought to be the home of small companies has more employees in fewer companies than in the DC area.



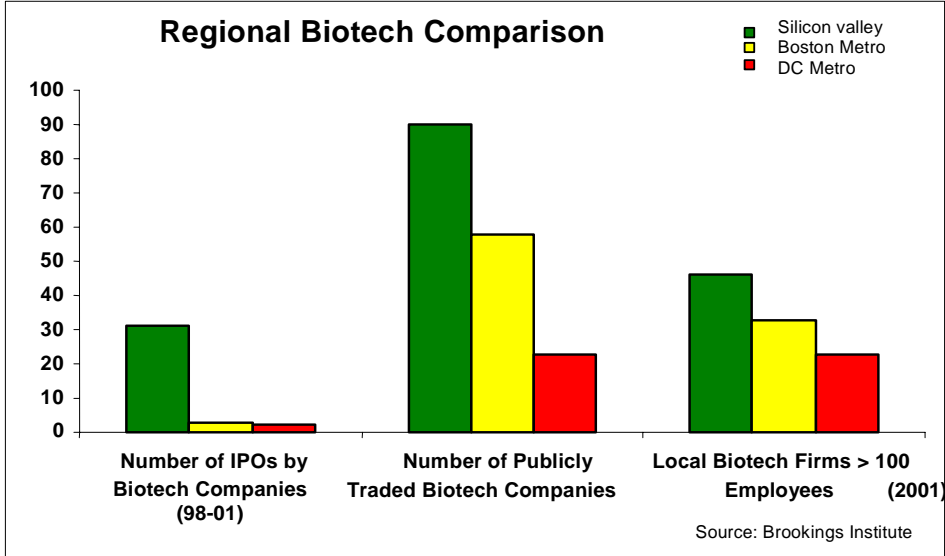
However, California leaves Massachusetts and the DC area far behind when it comes to obtaining patents on new products.



Because the DC area has more life scientists than the other two regions, due mainly to the presence of NIH and major biotech companies, it might be expected that patents in this field would rank high compared to those locations. However, DC actually lags both Boston and Silicon Valley in registered biotech patents.

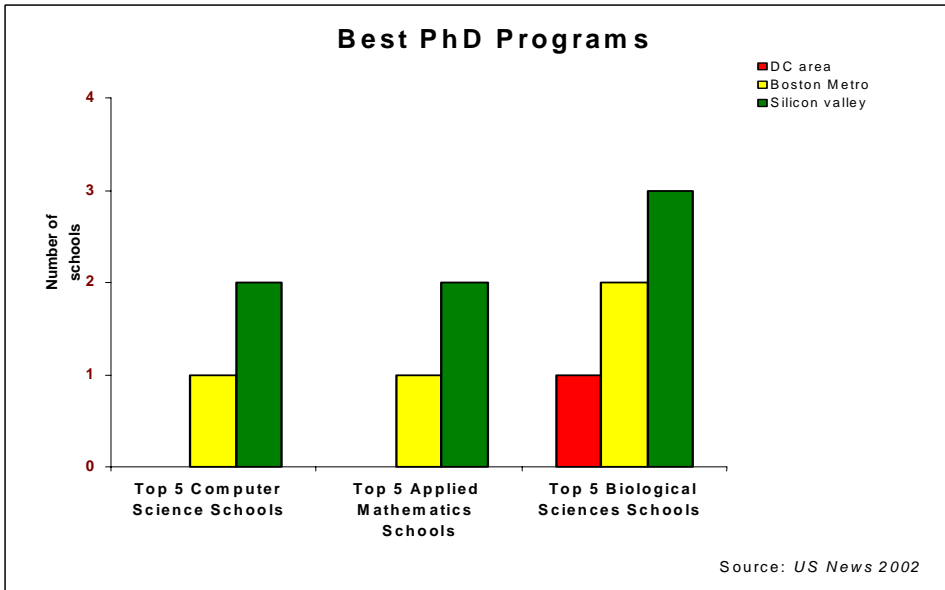


One reason for this surprising inverse proportion is that biotech companies in the DC area have not been very successful at raising public money over the last three years, as evidenced by the small number of DC-area biotech IPOs. Silicon Valley leads the pack with 90 publicly funded biotech companies to Boston's 55 and DC's 25.



Colleges and Universities

The number and quality of schools granting advanced degrees in key high-tech fields (computer science, applied mathematics, and biological sciences) is also important to an area’s intellectual capital. The three metropolitan areas have nearly the same number of institutions granting MS and PhD degrees (10 in DC and 8 in both Boston and Silicon Valley). However, only one DC school ranks in the Top 5 in its field, compared to four in Boston and seven in Silicon Valley.



Serial Entrepreneurs

Serial (or repeat) entrepreneurs are the rare people who have the ability to create two or more successful companies. Serial entrepreneurs constitute a special form of intellectual capital. Serial entrepreneurs have a track record that attracts talent and capital more easily than “first time” entrepreneurs. Because they are experienced, they do not need a steep learning curve – hence, their companies also take off faster. For example, Steve Jobs (Apple Computer, NeXT Computer Inc.) and James H. Clark (Silicon Graphics, Netscape) have repeatedly built successful companies. As a result, the more serial entrepreneurs a region has, the higher its rate of innovation will be – a critical factor in building a high-tech economy.

Silicon Valley has by far produced the most serial entrepreneurs of the three regions – almost triple that of DC and Boston (which have about the same number). This wide disparity suggests that people in Silicon Valley are more innovative and have a larger appetite for risk. The following table shows the number of well-known serial entrepreneurs in these areas:

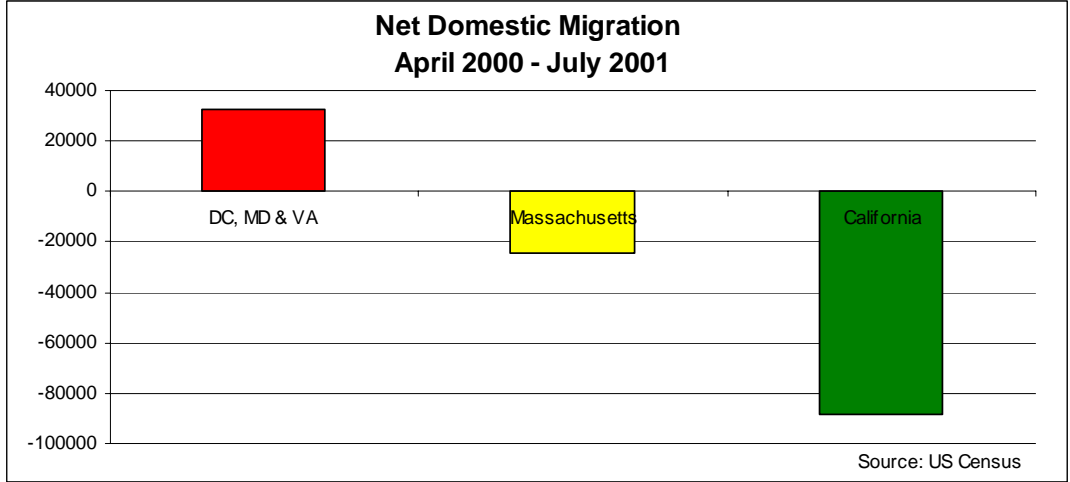
REGION	NUMBER OF SERIAL ENTREPRENEURS
Silicon Valley	28
DC Metro	9
Boston Metro	9

Human Capital

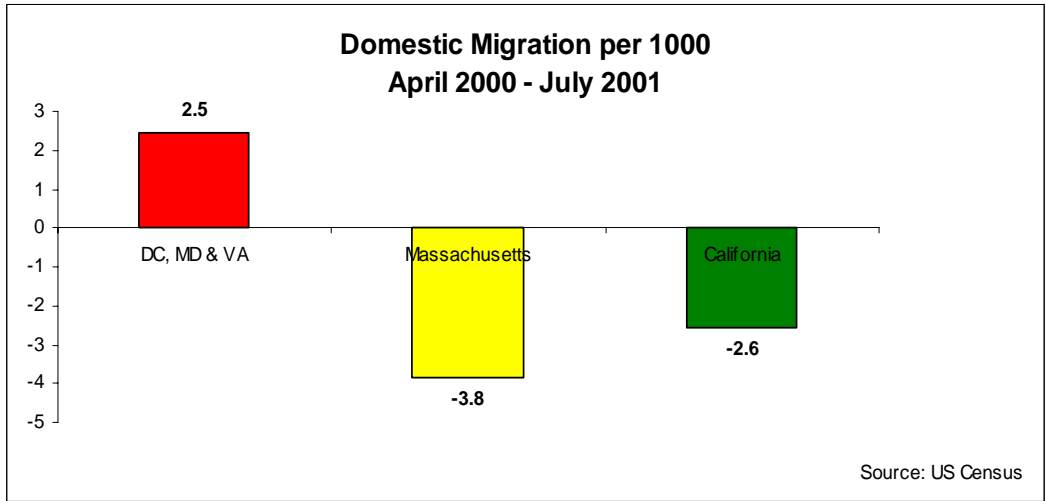
A region’s human capital is defined as the number and skill level of the people in the area. The human capital dimension is the DC area’s greatest strength. While Silicon Valley leads in several measures of human capital, DC performs well in some of the most important ones: domestic migration, attracting international workers, workforce education and high-level occupations. The DC area handily scores an “A” for human capital; Silicon Valley and Boston come in with solid B+s.

Domestic Migration

The number of people moving in and out of a metro region each year is a fairly good indicator of whether the area’s economy acts as a magnet for retaining its talented workforce. If an area’s net domestic migration (net of people moving in and out but staying within the US) is positive, it is apparently attractive enough not only to retain its existing residents but also to draw outsiders. From April 2000 to July 2001 – in the midst of an economic downturn – DC, Maryland and Virginia had positive net migration, while California and Massachusetts lost people, a testament to the attractiveness of the DC area.



The picture is even more telling when we look at domestic migration as a percentage of population. DC, Maryland and Virginia gained 2.4 people per 1,000 residents. Massachusetts is losing people faster than California.

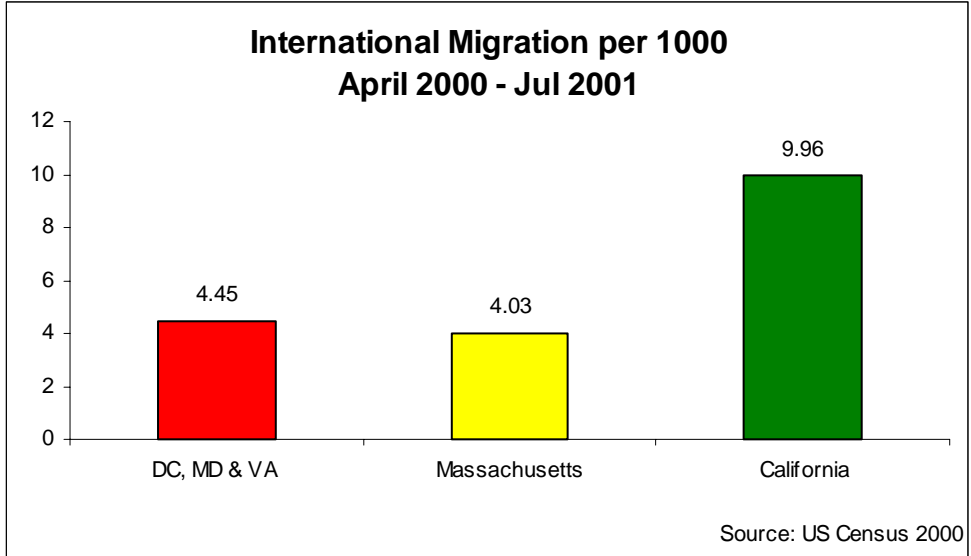


International Migration

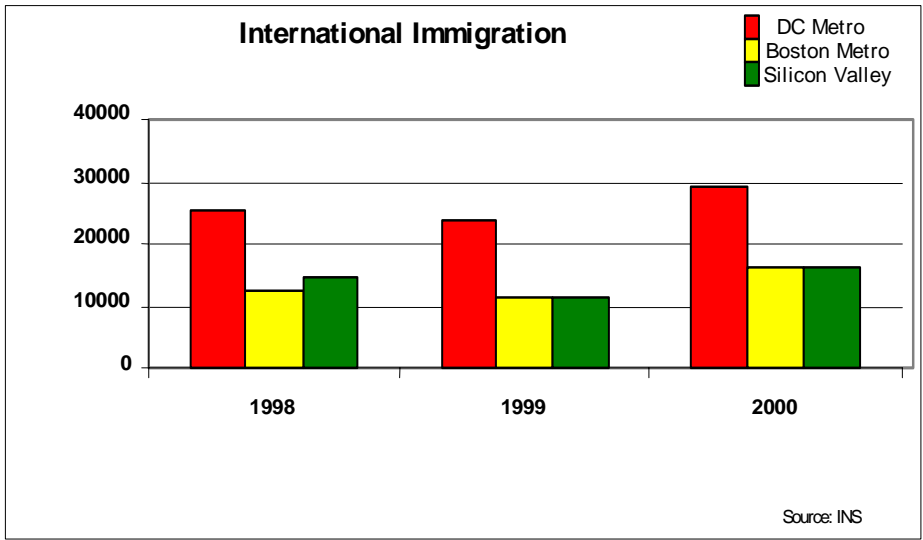
The number of immigrants from other countries can be another good indicator of an area’s human capital for high-tech industry. Many highly educated foreigners immigrate to the US for high-paying jobs in the high-tech sector.

Immigration

The number of people from foreign countries who immigrate to an area can mean many things. Compared to Massachusetts and the DC region, California has heavy international migration as a percentage of residents – as much as twice that of the other areas.



California is a huge state with many industries and metro regions. It is clearly well situated to attract people from other countries, in many industries and cities. Many of these people come to take high-tech jobs. The picture for the DC area is slightly different. While its rate of international immigration per 1,000 is lower, it has still attracted a significant, consistently increasing number of foreigners over the last three years, most of them young (25-45) and working in high-tech fields. Its international immigration compares favorably to that of Massachusetts, as well.



Foreign-born Population

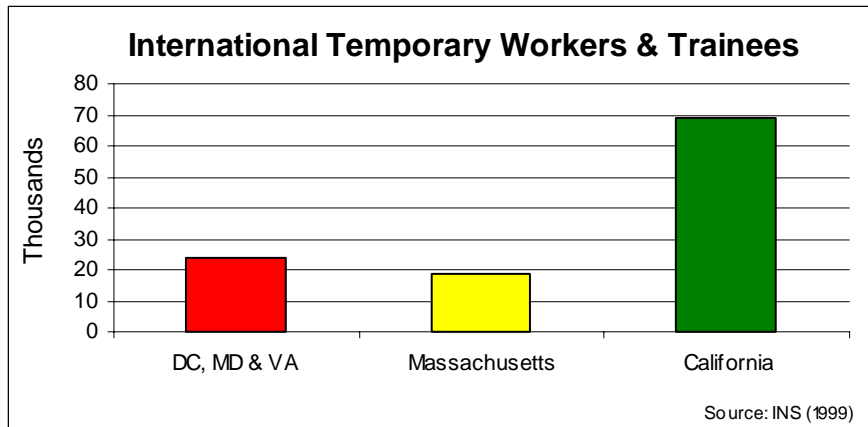
The number of foreign-born residents in an area adds robust diversity of talent and entrepreneurial mien to a region’s labor pool. On this measure, Silicon Valley far outstrips DC and Boston. In 2000 Silicon Valley’s foreign-born population was close to 27 percent, while DC and Boston had almost half this proportion – 13 percent.¹

International Business Visitors

A good benchmark year for comparison is 1999 which was a record year for international business travel. California had more than 700,000 international business visitors in 1999, suggesting that it is a bigger hub for global business than the other two areas. DC, Maryland and Virginia had about 200,000 international business visitors and Massachusetts had about 100,000. In terms of international business visitors per 1,000, California still comes out on top.³ *Caveat emptor:* The visitor data is gathered from the Immigration and Naturalization Service and does not account for visitors who might say fly into New York or Los Angeles and then drive to Boston or Silicon Valley.

International Temporary Workers

The entry of international temporary workers to an area indicates its ability to attract qualified technical human capital to fuel growth in the tech sector. In 1999, more workers and trainees flowed into California from other countries than into Massachusetts or the DC area. However, Massachusetts ranked highest in international temporary workers per 1,000 residents.⁴



Workforce Education

Educated workers are important to a high-tech economy. Clearly, the principal factor determining where high-tech firms locate is an adequate supply of skilled labor. But the presence of an educated workforce also boosts incomes, which creates a virtuous cycle for creating and maintaining a superior economy. In 2000, the per-capita incomes of metro areas with the most educated populations grew 1.8 percent in real terms per year, while those with the least-educated populations grew only 0.8 percent per year.

In addition, entrepreneurs are more likely to have higher levels of education. Thus, the more educated workers an area has, the more entrepreneurial activity it is likely

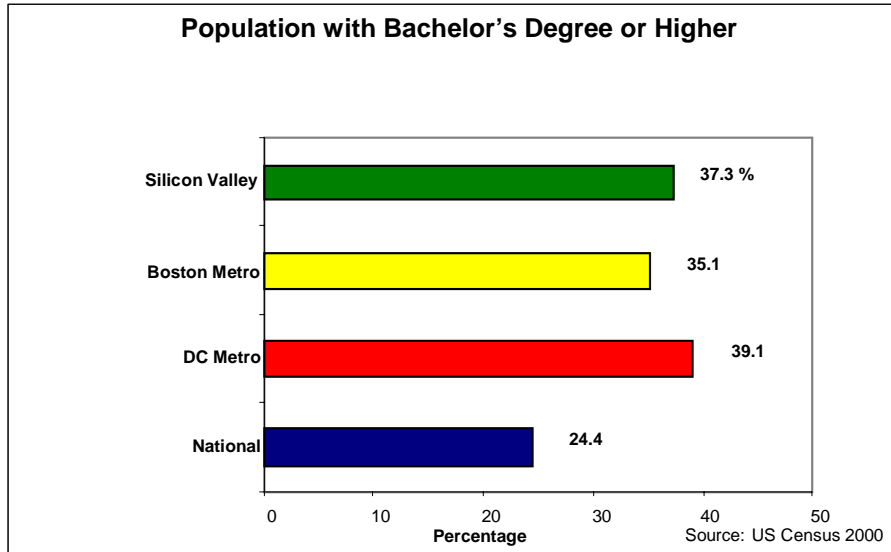
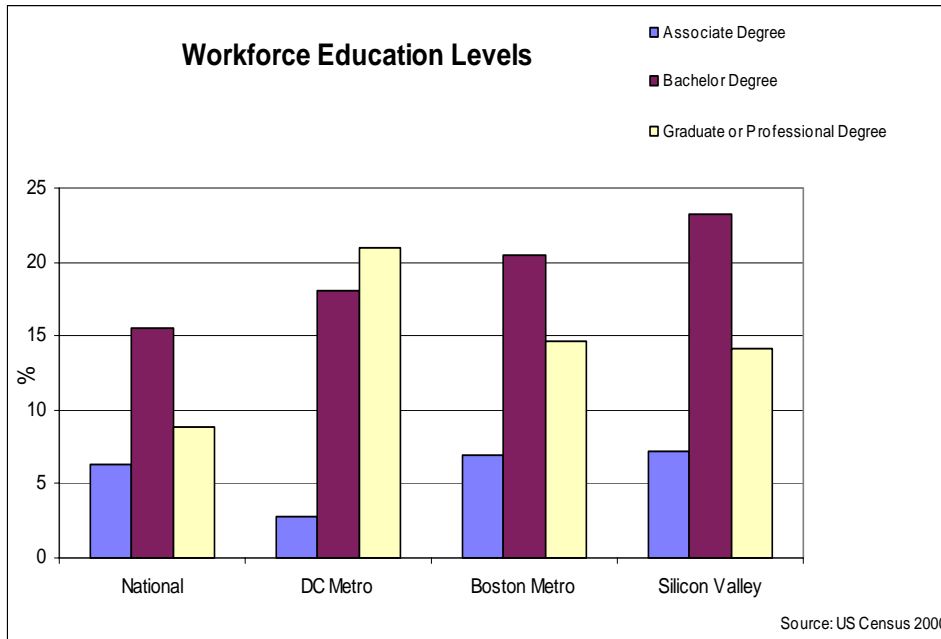
¹ Source: US Census 2001

³ Source: INS.

⁴ Source: INS.

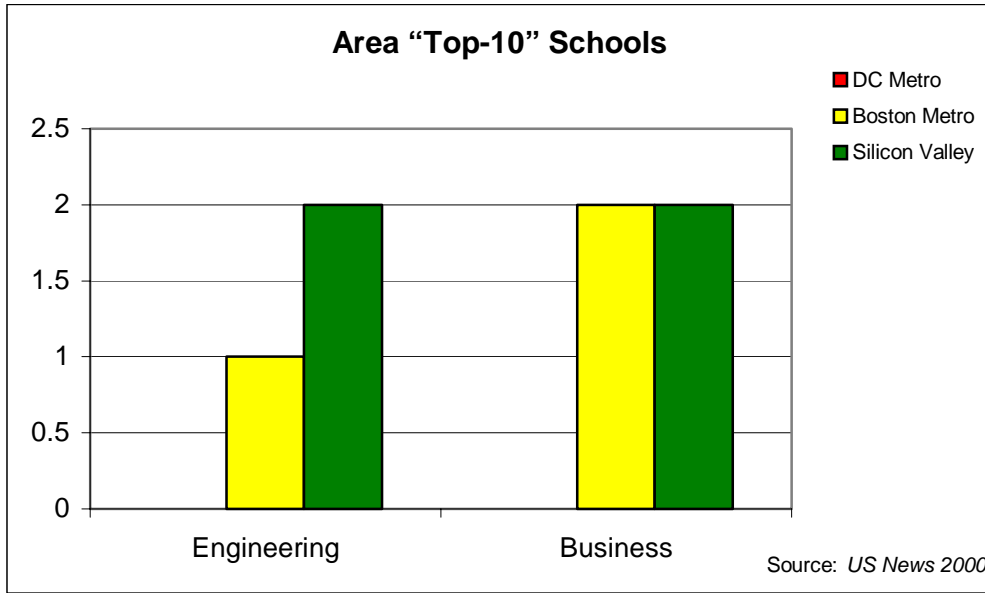
to experience. The more entrepreneurial start-ups in a region, the more successful its high-tech economy.

While Silicon Valley and Boston score higher in percent of population holding bachelor's degrees, DC has the highest percentage of people holding graduate and professional degrees. It also has the highest percentage of people holding bachelor's degrees or higher.



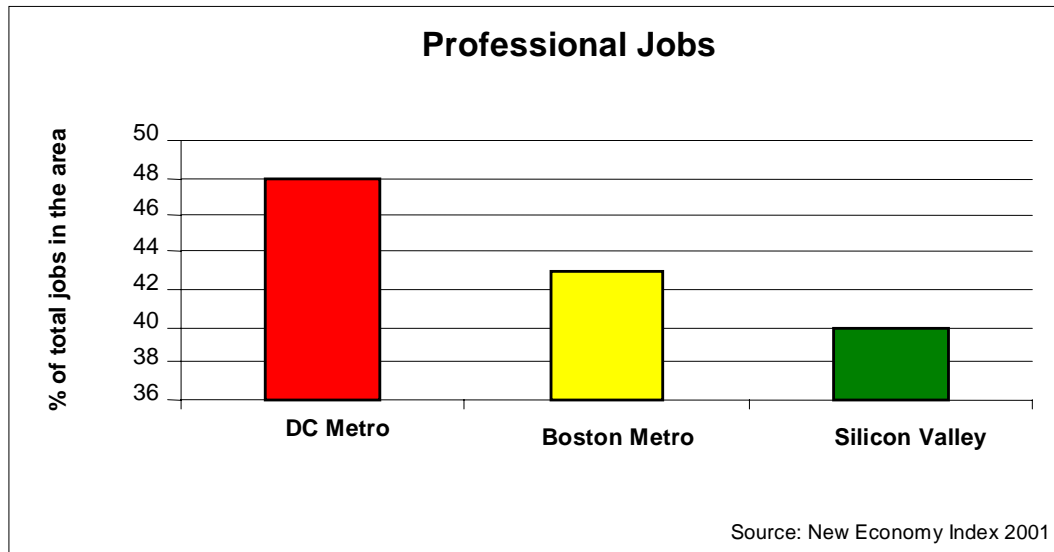
In all three metro regions, some of the country's best engineering and business schools turn out bright graduates year after year. Silicon Valley and Boston boast the top

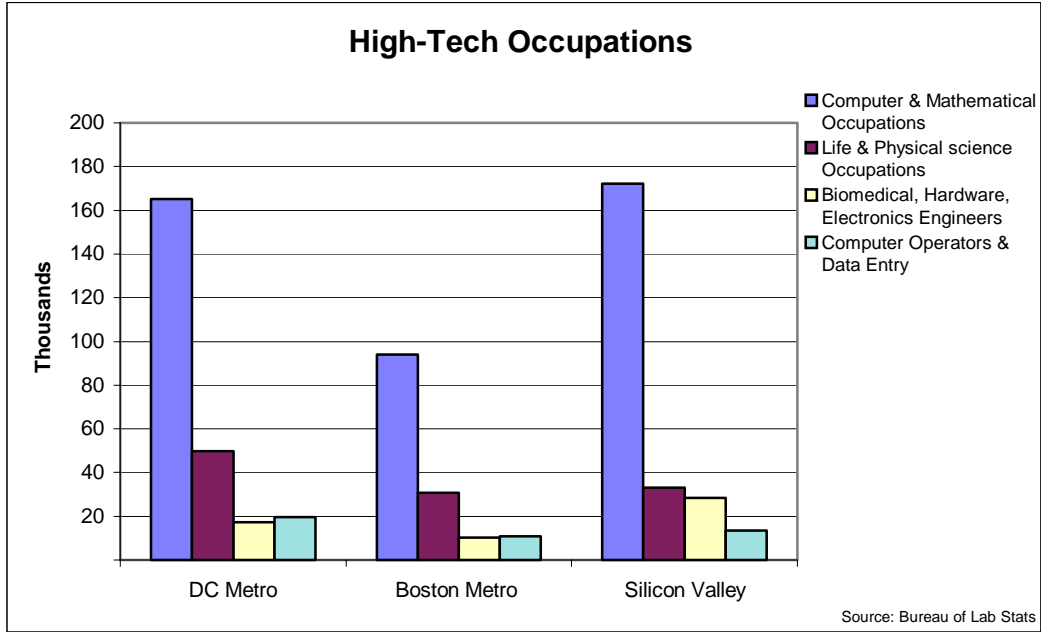
schools in both these disciplines. DC Metro also has a number of very good schools, but none in the Top 10.



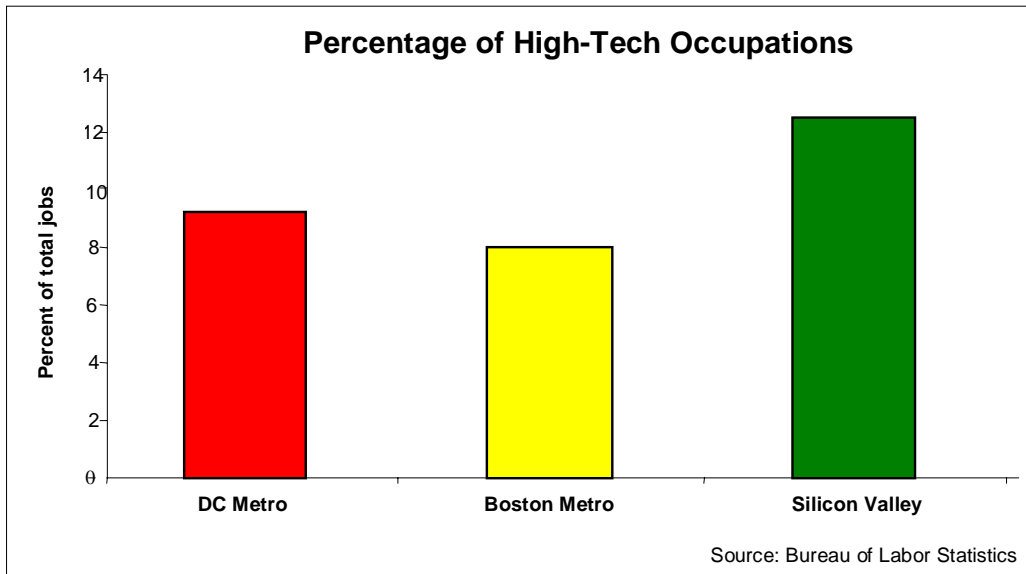
Managerial, Technical, and Professional Jobs

Based on the ranking done by the Progressive Policy Institute (New Economy Index 2001), DC ranks way ahead of Silicon Valley and Boston in percentage of managerial, technical and professional jobs. Even in absolute numbers, DC is just marginally behind Silicon Valley in computer and mathematical occupations. DC leads in Life Sciences because of the presence of the National Institutes of Health (NIH) and other major institutions.





The high-tech portion of these managerial, technical and professional jobs is of course most important to a high-tech economy. As a percentage of population, DC has more such jobs than Boston, but fewer than Silicon Valley.



Social Capital

Social capital refers to features of social organization, such as networks, association and trust that facilitates coordination and cooperation for mutual benefit. Social capital is a powerful resource that develops from productive social ties. A group’s ability to work jointly can translate directly to investment or growth potential.

Well-functioning partnerships, consortia and networks are forms of social capital. Capital is located both in the sharable resources held by individual institutions in a network and in the overall structure – the relationship – among the institutions. Networks grow and change over time, increasing the social capital they provide to an area. As individuals gain confidence in the reliability of others, trust develops. A small academic network may ultimately be extended to members of the political and business community. Small cooperative ventures may grow into more ambitious undertakings as parties learn how to collaborate productively and develop reputations for trustworthiness.

To determine our three study regions’ level of social capital in the high-tech area, we compared the number and diversity of high-tech social organizations, the total membership in these organizations, the average age and percentage of new organizations and the number of networking events per month. Based on the number and membership of organizations in these regions, we developed a “networking index” to indicate the relative level of involvement of each region’s high-tech workforce in social networks.

In our assessment Silicon Valley earns a clear “A” grade in this category; Boston gets a solid B+ but the DC area lags with a passing “B” grade.

Number and Diversity of Organizations

Our research into the number of organizations whose details about membership are publicly available showed the following:

Area	Number of Organizations
Boston	55
Silicon Valley	150
DC	45

Organization diversity is another key indicator of a region’s social capital. The greater the variety of technologies discussed by technical organizations, the more flexible the region will be in adapting to the changing nature of technology and business. The more diverse an area’s organizations, the greater the chance the area will overcome a downturn in a particular sector or technology.

Silicon Valley's organizations are highly diverse. Many of them are related to networking and support; others are associated with women's networking and support, Windows NT technology, wireless, Linux technology, Java technology, CAD technology, database technology, etc. Boston Metro's organizations also display a high degree of diversity. The majority of the organizations in Boston pertain to venture finance; others pertain to Internet technology, interactive advertising, women's networking, Lotus Notes technology, Macintosh technology, semiconductors, etc. In the DC area, the distribution is not fine grained. Most of the organizations are related to networking and support; some are technology related or pertain to biotech and marketing.

Membership in Technology Associations

We estimated the total number of association members based on the average number of members of organizations whose membership details were publicly available, multiplied by the number of organizations in an area. Silicon Valley led the three areas on this dimension with approximately 110,000 members. The DC area has a little over 62,000 members, surpassing Boston's 45,000.

Age of Organizations

The average age of technical organizations is about the same for all three regions (13 years for Silicon Valley and DC, 14 years for Boston.) Most of these organizations are longstanding. About 11 percent of DC area organizations are less than two years old, compared to 6 percent for Silicon Valley. This is a good sign as it shows that new organizations are continuing to form and are forming at a higher speed than in Silicon Valley. Boston has not introduced any new organization in the last two years.

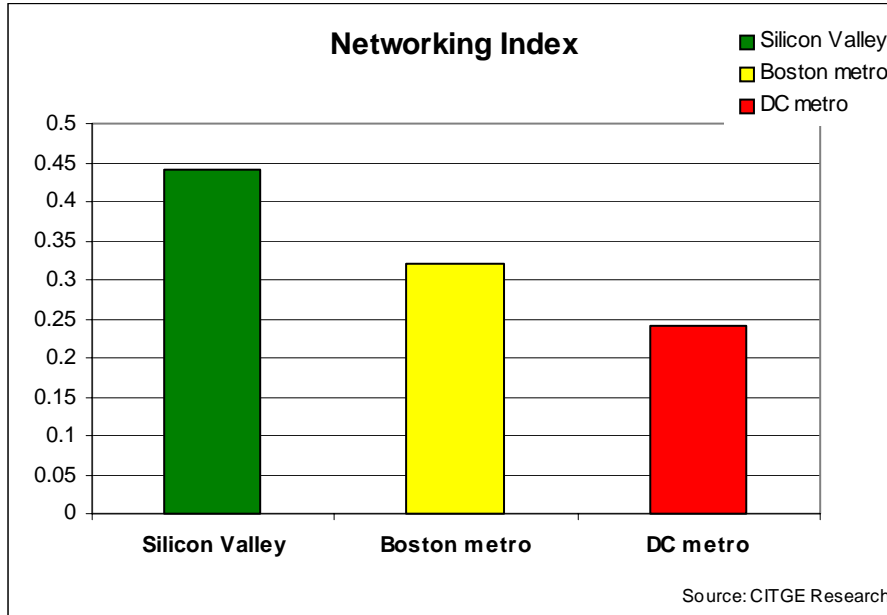
Number of Networking Events

While the Silicon Valley's associations are about the same age as the DC area's, they are far more active, as evidenced by the number and type of events and sessions they organize. Silicon Valley led the other two areas with about 350 events every month, compared to Boston's 90 monthly meetings and the DC area's 71.

More frequent meetings lead to a greater flow of ideas among members. They also lead to a continuity of dialogue, which can help in the formation of small groups that might ultimately start new ventures.

Networking Index

To provide a simple measure of social capital, we devised a "networking index." This index is arrived at by dividing the number of members in an area's technological associations by the number of people in that area's high-tech workforce. It indicates the degree to which the area's workforce is involved in networking activities. The Silicon Valley has the highest networking index; the DC area has the lowest.



Implications and Conclusions

“The New Economy” was a popular term during the technology boom of the late 1990s – the phrase conjured up images of twenty-something CEOs changing the world before the markets close at 4:00. We have all found that the world does not change overnight and that even modest value creation requires more sweat than chutzpah. In the course of this study, we were struck by how similar the “new economy” is to the “very old economy” – to guild-like communities in small geographic regions that labored under difficult and uncertain circumstances and fashioned a changing economic order. Building a long-lasting regional technology economy has, is and will always be arduous and perhaps equally difficult to predict. Nevertheless, our study does suggest that while the DC region has experienced a slow down, it is hardly out of the high-tech game. In the spirit of Andy Grove’s caution “only the paranoid survive,” we would like to suggest some important implications for the DC metro area.

- Federal contracting is a Faustian bargain:** Government contracting has always played a large part in the DC high-tech economy. DC’s high-tech successes have been fueled in large part by the largest spender on IT: the US federal government. With the government as their major client, firms like BTG and SAIC built successful, well-run, profitable businesses. But while the more fiercely competitive economies of Silicon Valley and Boston create new opportunities, the DC economy seems to be playing a zero-sum game: local companies compete amongst themselves for every dollar the government intends to spend. This has several deleterious effects. First, unlike companies in Silicon Valley and Boston, DC firms are not looking to increase their scale and scope by expanding internationally. Second, innovation dissemination is weaker here than in the other two areas – in part due to the proprietary nature of work performed for the government. Third, government spending is no replacement for venture capital. Venture capitalists, often derided as “vulture capitalists,” perform

an important function, albeit in an error-prone manner – they weed out good ideas from bad and fire bad management, thereby imposing a Spartan market discipline on companies. Regardless of the size of the federal purse, the DC area must make it a priority to boost the venture capital in the area. It must be noted that the DC area accrues significant benefits from Federal contracting – e.g., Silicon Valley experienced swings in unemployment from a low of 1.7% to 8.7% while the DC area moderated between 2% to 3.7% in the last six business quarters⁵.

- **Does the DC area have a research productivity problem?** Our data suggests that while there is plenty of research activity in the area, innovation productivity is lower than in Boston and Silicon Valley. Research productivity is notoriously difficult to measure since R&D is inherently subject to fits and starts with periods of apparent inactivity punctuated by bursts of creative thinking. Indeed, a recent study by the Greater Washington Initiative of 127 organizations records some impressive numbers – over 80,000 professionals, most with advanced degrees working on areas as diverse as biotechnology, photonics to forensics. But perhaps Maryland, Virginia and DC should consider pooling their respective research resources to develop ways to speed up the innovation cycle – to get ideas from lab bench to store shelves faster. This would mean more venture capital would flow to the area; more companies would get off the ground generating more employment for the area’s residents.
- **Policymakers need to emphasize “soft” infrastructure.** Much government attention and resources are focused on traditional infrastructure issues in the DC area – roads, real estate and railroads. However, DC’s infrastructure, at least as concerns a high-tech economy, is quite strong – on par with if not better than both Silicon Valley and Boston. Policymakers should turn their attention to other issues relevant to building and sustaining DC as a high-tech center, such as encouraging the formation of social capital, building a “brand” for the DC area through public relations efforts and incentivizing serial entrepreneurship. Our understanding of the ecology of high-technology economies suggests that small things can have disproportionate impact. This is good news for public officials since they are currently operating under severe budgetary constraints. The tough part is finding the will to act and navigating the *realpolitik* of enacting policy.
- **The DC area should better leverage its location and international connections.** While the high-technology industry has American parentage, it has become increasingly global, with investors, engineers and companies fluidly moving across time zones. Areas that are international magnets stand to benefit from this trend. DC’s location as the center of the US federal government makes it a prime candidate for foreign capital investment and various other sources of international funding. Our data suggests that DC is a natural magnet for international visitors, qualified immigrants and international investors. Exploiting this advantage could help the DC area and its high-tech businesses offset the low level of venture capital operating in the region and increase the area’s competitiveness vis-à-vis Silicon Valley and Boston.

⁵ Source: Bureau of Labor Statistics

- **The DC area must address its social capital deficit.** In another knowledge economy, Michelangelo spent considerable time with the Florentine guild of artisans, exchanging tips and techniques on hewing marble – implicitly recognizing the benefits of social capital while simultaneously adding to it. Today’s high-technology economies have the same traits. At the Home Brew Computer Club in Silicon Valley, recent H1-B visa-holding programmers interact with the likes of Steve Jobs and Jim Clark to discuss advances in programming techniques. But compared to Boston and Silicon Valley, DC’s social capital deficit is significant. The competitive atmosphere in the region (the “zero-sum” game) puts the region at a severe disadvantage in terms of cross-fertilization of ideas and opportunities to create new entrepreneurial relationships. The area faces an urgent need for corrective action along this dimension, to promote greater, more beneficial interaction among the DC area high-tech workforce, centered on specific technologies and the creative process.

After several months of study and analysis, our prognosis for the DC area’s high technology economy is one of guarded optimism. The surge begun in the 1990s will not die away – there are too many smart people here to write the next chapter in the area’s economic history, and sufficient resources to help them do it. But it should not be left to chance. The area’s technology community needs to come together to address the future – Cremona-like – with passion, innovation and a never-say-die attitude. Common Cremonians with uncommon zeal built and dominated their industry for three centuries. The DC area can do it, too.

Acknowledgements

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