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Economic Growth and Linkage with Silicon Valley

The Cases of Austin and Boston

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What creates growth in a local economy? Answers to this question have varied markedly over the last forty years. Theories popular in the 1960s and 1970s, for example, saw the economic growth of cities as determined by input-output linkages among firms. Although now passé, this thinking recognized that a city's endowment of production factors—in particular, the stock of labor and physical capital—was a necessary condition for the production of goods in a local economy, as well as for its growth.

These theories gave way in the 1980s to the revolutionary concept that *knowledge* (i.e., a city's stock of ideas), rather than labor and physical capital, is the prime engine of economic growth.¹ This idea prompted policy makers and analysts to associate local economic development with the exchange of ideas among educated workers living in a city. Indeed, a pioneering study in 1991 found that raising the average education level of a U.S. metropolitan area by one year increases total factor productivity by 2.8 percent, after controlling for other variables that affect productivity.² These findings support the suggestion that local firms operating in cities with a large pool of scientists and engineers can innovate more readily, secure more patents, and therefore enjoy more rapid rates of technical progress and productivity growth.

Nowhere is this more evident than in the U.S. cities that have emerged as high-tech centers. High technology and the shift to a knowledge-based economy have transformed not only traditional economic sectors, but many local economies as well,

most notably Silicon Valley in California and Route 128 in Massachusetts (the San José and Boston metropolitan areas, respectively). The dominance of Silicon Valley as a high-tech industry center is well documented. Patents indicate the level of innovation within a city, and companies in San José generate more patents than any other U.S. metropolitan area. Indeed, San José companies generated 49 percent more patents than those in second place Boston in 1999 (the last year for which this information is available from the U.S. Patents Office), and 93 percent more patents than third-ranked Chicago.

Although patents are a good indicator of innovations, such a measure may be biased by city size. That is, one might expect that larger cities will produce more patents than smaller ones just because their industrial base is larger. A better indicator for comparing innovativeness among large and medium-size cities is the number of patents per 1,000 full-time, college-educated workers, i.e., those with a higher probability to be working for high-technology (skilled or knowledge-intensive) industries. In 1999, Austin reported 8.3 new patents per 1,000 full-time, college-educated workers; Boston reported 6.2; and San José, 18.5. We suggest that Austin's success as an innovation center—and its subsequent strong economic growth—is due in great part to its ability to capture a large share of the flow of ideas and knowledge emerging from Silicon Valley.

In this new economic geography, young high-tech cities like Austin grow not only because of their capacity to develop their own stock of ideas, but also because of their capacity to import ideas from other regions, especially those with a large accumulation of knowledge such as Silicon Valley.

Knowledge Flows Between High-Tech Cities

Location decisions by high-tech industries determined which metropolitan areas grew the fastest during the boom years of the 1980s and 1990s. The U.S. economic geography began to show an uneven distribution of educated workers as intellectual and innovation-based industries became concentrated in a handful of cities with a high agglomeration of high-tech industries.³ The combination of a large supply of educated workers with a sizeable number of highly innovative firms proved the engine of growth for these selected cities (including San José, Austin, and Boston), where linkages among skilled workers provide the conduit for knowledge diffusion and therefore local economic growth.

San José's superior innovation performance has been attributed, in part, to the rich business and social networks in the Silicon Valley region. In this area, individuals move easily between firms and continue to meet at trade shows, industry conferences, seminars, and social activities organized by local business organizations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, new enterprises are conceived, and networks are developed.

The abundant knowledge networks in Silicon Valley do not stay within the geographical boundaries of the region, however, but spill over to other metropolitan areas. The flow of ideas between high-tech cities accelerated in the 1990s with the boom in telecommunications infrastructure (e.g., the Internet).

In this new economic geography, young high-tech cities like Austin grow not only because of their capacity to develop their own stock of ideas, but also because of their capacity to import ideas from other regions, especially those with a large accumulation of knowledge such as Silicon Valley.⁴ An indicator of the close exchange of ideas between San José and Austin can be found in the increasing availability of direct flights between these two high-tech regions. American Airlines made news in the fall of 1992 when it began direct flights

from Austin to San José. In what have come to be known as "nerd birds," these direct flights now number three per day and claim the highest laptop-per-passenger ratio in the airline industry.

A Tale of Two Cities and Their Relationship to Silicon Valley

The Route 128 high-tech industry in Boston, on the other hand, is often viewed less as a complement to Silicon Valley and more as a competitor. Much of what has been written about the relationship between Route 128 and Silicon Valley emphasizes the rivalry between these leading high-technology regions. One popular theory depicts this competition in the context of two opposing styles of management.⁵ Silicon Valley is characterized by a network of closely knit small companies. Route 128, on the other hand, has come to be dominated by a few self-sufficient large corporations.

In contrast to Boston, Austin's per capita innovative capacity has been enhanced by cooperative relationships between its high-tech industry and that of Silicon Valley. The strength of this relationship can be observed in three trends: the dominance of the computer cluster in both of these high-tech centers; the stronger presence of high-tech branch plants in Austin, with headquarters in Silicon Valley, than in Boston; and the steady flow of college-educated workers between Austin and San José.

Furthermore, Austin has established an industrial structure that complements that of Silicon Valley. Route 128 is known as a high-tech center for the biotechnology, financial, and insurance sectors. Silicon Valley, in contrast, is home to innovators in electronics and software. The list of Silicon Valley's specializations is long—software, communication equipment, data storage, to name a few—and includes the products (e.g., semiconductors, computers) that make up much of the Austin high-tech industry. Employment data in the top ten high-tech industries in Boston, San José, and Austin show that the computer cluster (semiconductors, computer parts, and computer system design) accounts for

more than 40 percent of high-tech employment in manufacturing and services in the cases of Austin and San José, but for only 16 percent in the case of Boston (see table 1). Indeed, the semiconductor industry is *the* top high-tech industry in San José and Austin, generating about 65,000 and 28,000 jobs in these cities, respectively, in 1997. In contrast, high-tech services,⁶ such as financial and insurance businesses, are the top high-tech employers in Boston, with 26 percent of high-tech employment in the city.

How many of the largest high-tech firms in Austin and Boston have headquarters in

Silicon Valley? This may be another good indicator of the strength of business linkages with Silicon Valley. In Austin, computer-related companies such as Dell Computer, Motorola, IBM, Advanced Micro Devices, Solectron, Applied Materials, and 3M list among the top ten private employers. Three of these ten companies have headquarters in Silicon Valley, illustrating the close bond between Austin and Silicon Valley (see table 2). In contrast, financial service companies such as Fidelity Investments, John Hancock, and State Street Corporation are among the top

The semiconductor industry is the top high-tech industry in San Jose and Austin. In contrast, high-tech services, such as financial and insurance businesses, are the top high-tech employers in Boston.

Table 1
Top High-Tech Industries in San José, Austin, and Boston
(1997)

	<i>Employment</i>	<i>Percentage of total high-tech employment</i>
San José		
semiconductor & other electronic component mfg	64,795	23
communications equipment mfg	36,058	12.8
computer and peripheral equipment mfg	32,876	11.7
navigational, measuring, etc. instruments mfg	28,054	9.9
software publishers	22,708	8.1
computer systems design & related services	19,195	6.8
architectural, engineering, & related services	17,601	6.2
Austin		
semiconductor and other electronic component mfg	27,641	33.8
insurance carriers	11,365	13.9
architectural, engineering, & related services	7,651	9.4
computer systems design & related services	6,631	8.1
industrial machinery mfg	4,532	5.5
computer & peripheral equipment mfg*	3,750	4.6
manufacturing & reproducing magnetic and optical media*	3,750	4.6
Boston		
other financial investment activities*	37,500	13.5
insurance carriers	36,684	13.2
navigational, measuring, etc. instruments mfg	34,208	12.3
architectural, engineering & related services	30,137	10.9
computer systems design & related services	25,464	9.2
managment, scientific, and technical consulting services	19,986	7.2
semiconductor & other electronic component mfg	19,102	6.9

Source: U.S. Economic Census, 1997.

* In this case, industry-level employment denotes the mid-point value obtained from a specified employment range. For certain industries, the Economic Census only reports a range of employment levels rather than actual estimates.

The strong movement of workers—especially those with a college education who are working in full-time jobs—between Austin and San José, reflects the close complementarity in the high-tech industries of these two regions.

Table 2
Corporate Headquarter Locations of the Largest Private High-Tech Employers in Austin and Boston

Austin		Boston	
<i>Corporation/Company</i>	<i>Headquarters</i>	<i>Corporation/Company</i>	<i>Headquarters</i>
Dell Computer Corp.	Round Rock, TX	Fidelity Investments	Boston, MA
Motorola, Inc.	Schaumburg, IL	John Hancock	Boston, MA
IBM Corp.	Armonk, NY	State Street Corp.	Boston, MA
Advanced Micro Devices	Sunnyvale, CA	Massachusetts Financial Services	Boston, MA
Solelectron Texas	Milpitas, CA	New England Financial	Boston, MA
Applied Materials	Santa Clara, CA	Thomson Financial Services	Boston, MA

Sources: Greater Austin Chamber of Commerce, 2000; D. Modicamore, G. Perkins, M. Renehan, and C. Frye, "The Largest Private Employers in Boston, 2001," Policy Development and Research Department, Report #545.

ten high-tech employers in the Boston area and all are headquartered in Boston.

The Austin high-tech industry, more than that of Boston, depends on the flow of college-educated workers from Silicon Valley. Indeed, in 2002, the *Austin American-Statesman*, using IRS data, showed that San José ranked second as place of origin for new migrants to Austin in the 1990s. Even more interesting, the article also noted that the second most popular destination of people leaving Austin was San José (Phoenix was first).⁷ A better way to see knowledge networks among high-tech cities is to observe migration flows of full-time, college-educated workers because they have a higher probability of working for a high-tech company. Data from the 2000 *Census of Population* shows that full-time, college-educated workers from San José account for 0.9 percent of all full-time, college-educated workers in Austin, but they account for only about half this number, or 0.5 percent, in Boston. The strong movement of workers—especially those with a college education who are working in full-time jobs—between Austin and San José, reflects the close complementarity in the high-tech industries of these two regions.

Austin also shares with Silicon Valley a high demographic diversity and a less

diversified high-tech industry. For instance, data from the *Austin Index*,⁸ an online resource from the Bureau of Business Research, shows that in 2000, Hispanics accounted for 26 percent and 22 percent of total population in Austin and Silicon Valley, respectively, but for only 7 percent in the Boston/Route 128 region. Moreover, as noted in an article from the Federal Reserve Bank of Boston, Silicon Valley hosts jobs in only 60 percent of high-tech industries, while Boston high-tech employment is spread much more evenly across almost the entire list of such industries.⁹

Conclusions

Austin's extraordinary growth in the high-tech sector since the 1980s is at least partly due to the development of a high-tech industry that *complements* that of Silicon Valley. Could Austin's high-tech success be cloned in other regions? For new high-tech cities to succeed, they must tap into the stock of knowledge available in established high-tech regions with a larger endowment of knowledge, such as Silicon Valley. What is the best way for cities to import this knowledge? The case of Austin shows that one successful way to do it is to attract branch plants of high-tech firms located in established high-tech

cities. This is not necessarily the only policy alternative, as the case of Boston shows. Route 128 illustrates a more self-contained successful high-tech industry, one more reliant on a few large corporations than on the knowledge flows among many smaller high-tech firms. Nevertheless, the success story of Austin provides one model for economic growth based on the growth and maintenance of knowledge networks among regional high-tech centers.

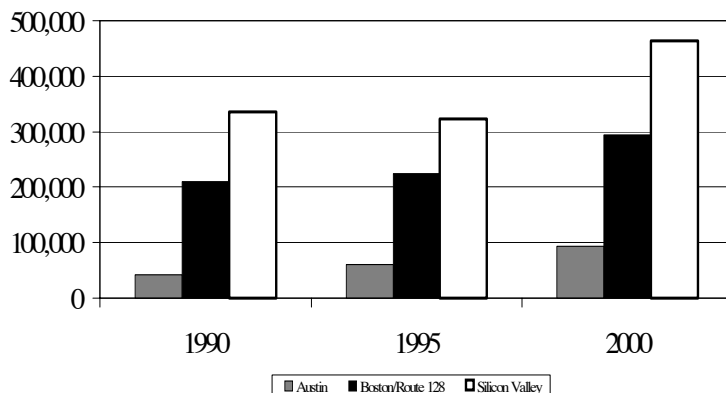
Notes

1. Paul Romer, "Increasing Return and Long Run Growth," *Journal of Political Economy*, 94: 1002-37, 1986.
2. J. E. Rauch, "Productivity Gains From Geographic Concentration of Human Capital: Evidence from Cities." *NBER Working Paper No. 3905*. Cambridge, MA: National Bureau of Economic Research, 1991.

3. High-tech industries are defined as those with twice the U.S. proportion of technology-oriented workers (TOW).
4. E. L. Echeverri-Carroll and W. Brennan, "Are innovation networks bounded by proximity?" In L. Suárez Villa, M. M. Fischer, and M. Steiner (eds.), *Networks, Innovation, and Competitiveness*, Berlin: Springer Verlag, 1999.
5. A. L. Saxenian, *Regional Advantages—Culture and Competition in Silicon Valley and Route 128*, Cambridge, MA: Harvard University Press, 1994.
6. Banks, securities firms, and insurers are classified as high-tech services because they employ a large proportion of computer scientists and analysts. These professionals manage customer transactions, back-office operations, and security redundancies, all with sophisticated information technologies that have transformed the financial world in the last decade.
7. B. Bishop and M. Lisher, "Austin Boom in '90s Part of Creative Shift in U.S.—Migration of Talented, Highly Paid Workers Creating New Landscape," *Austin American-Statesman*, August 4, 2002.
8. <http://www.utexas.edu/depts/bbr/austindex/>.
9. D. P. Yu "Focus on high-tech—What's in a name? Gauging high-tech activity." *Regional Review*. The Federal Reserve Bank of Boston, 2003/4. ♦

What is the best way for cities to import this knowledge? The case of Austin shows that one successful way to do it is to attract branch plants of high-tech firms

High-Tech Employment in Selected U.S. High-Tech Regions 1990, 1995, 2000



Source: U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*; compiled by Bureau of Business Research, University of Texas at Austin.

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