

Crash and reboot: Silicon Valley high-tech employment and wages, 2000–08

On the whole, high-tech industries in Silicon Valley declined sharply in employment and wages from 2000 to 2004 but increased gradually in both respects from 2004 to 2008; though the industry mix changed during the 8-year period, Silicon Valley remains the world's leading high-tech hub

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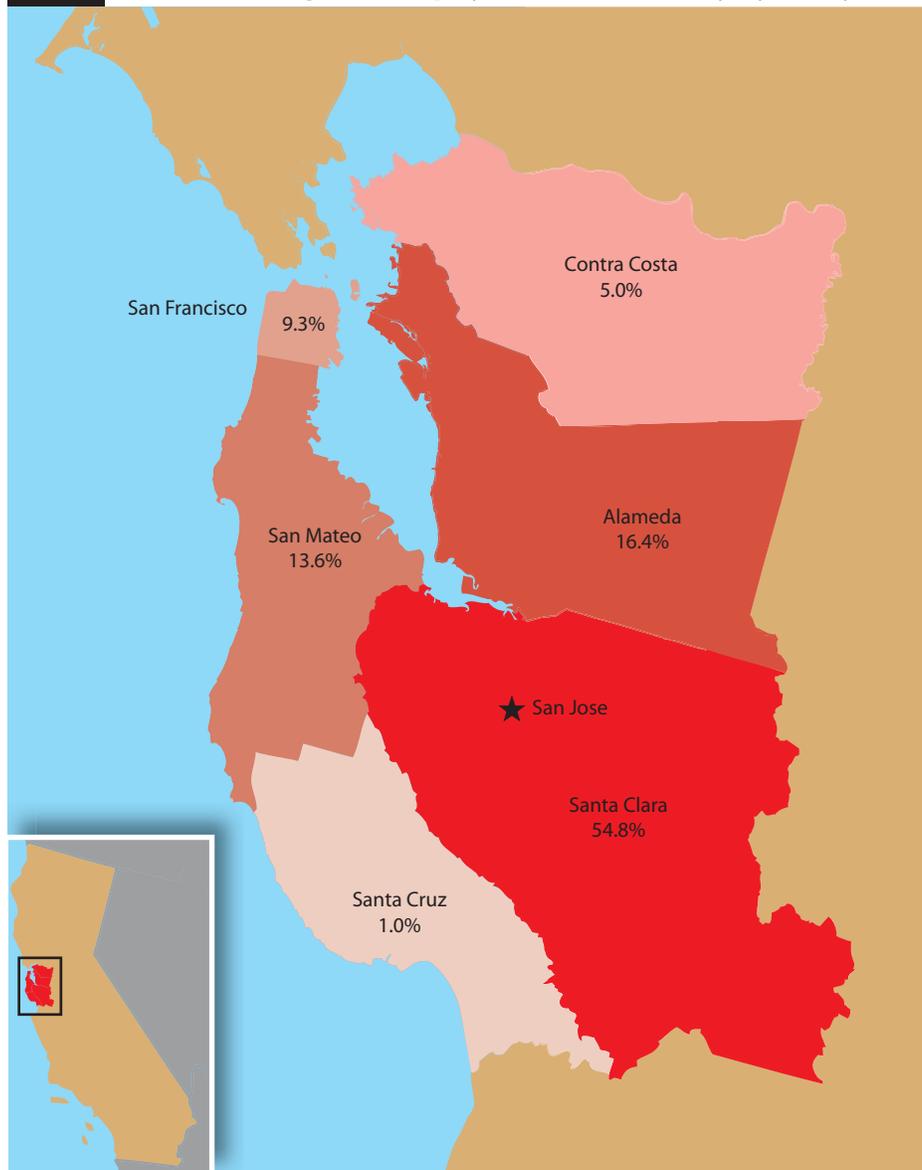
Silicon Valley is the largest and most influential high-tech center in the world and leads all other metropolitan regions in the United States in the breadth and scope of economic activity it creates through technological innovation.¹ Since the 1960s, when technology firms that were engaged in semiconductor manufacturing, computer design, and computer programming and services began to symbiotically cluster in the southern portion of the San Francisco Bay Area, Silicon Valley has become the most famous high-tech industrial cluster in the world. The network of people, firms, universities and research institutions, and government agencies has provided an ideal habitat for high-tech firms to be born and to grow; the products of these high-tech firms have improved business processes and models, generated economic growth, and improved standards of living around the globe.²

This article examines trends in Silicon Valley high-tech employment and wages during the 2000-to-2008 period, which encompasses the peak of the dot-com era, the ensuing dot-com bust, and a resurgence of high tech. It also discusses the factors affecting the decline and growth of specific Silicon Valley high-tech industries, such as increased global and domestic competition and higher demand from health-care indus-

tries. Next, the analysis examines trends in high-tech wage distribution and generation. The performance of high-tech industries in Silicon Valley is compared with the performance of those in the rest of the Nation. Finally, the analysis assesses the extent to which the clustering or geographic concentration of Silicon Valley high-tech industries has increased or decreased over the 8 years since the peak of high-tech industry performance.

The word “silicon” in the term “Silicon Valley” refers to the key ingredient of semiconductors, which formed the technical basis for the computer-based high-technology economic climate that appeared and grew in strength in and around San Jose, California, in Santa Clara County. This area attracted venture capitalists, computer technologists, and entrepreneurs, resulting in a regional agglomeration of high-tech industries that spread into neighboring Bay Area counties (specifically, Alameda, Contra Costa, San Francisco, San Mateo, and Santa Cruz). These industries have made Silicon Valley synonymous with dynamic, technology-driven growth and created a large and diverse base of high-paying jobs across the region. (See map 1.) Silicon Valley continues to be at the cutting edge of innovation. According to the U.S. Patent and

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MAP 1. Distribution of high-tech employment in Silicon Valley, by county, 2008

Trademark Office, in 2008, 11 of the 20 U.S. cities with the most registered patents were in Silicon Valley.³

From the mid-1990s to 2000, Silicon Valley's new Internet sector, along with its related high-tech industries, rapidly grew, due in large part to widely available venture capital. The amount of venture capital pumped into Silicon Valley between 1995 and 2000 was about \$65 billion, nearly one-third of total national venture capital investment during the period. The capital that came into Silicon Valley created a new wave of growth there.⁴ Approximately 172,000 high-tech jobs were created during this 5-year period. The infusion of venture capital and speculation in stocks led to huge runups in individual

stock prices and in entire stock markets, such as the NASDAQ, on which many high-tech corporations are listed, and created the "dot-com bubble."⁵ On March 10, 2000, the NASDAQ reached a peak of 5,132.52. As the enormous gap between valuation and performance became apparent, Internet stocks collapsed, with Silicon Valley at ground zero of the crash.⁶ By December 2000, the NASDAQ had dropped by more than 50 percent and stood below 2,500. After the dot-com bubble burst, Silicon Valley underwent a transformation. Reeling from massive hits to market capitalizations, many high-tech firms trimmed jobs or went out of business entirely. Others left the area and set up offices in less expensive locales.⁷

From 2000, when high-tech employment and wages peaked, to 2008, Silicon Valley's high-tech industries lost more than 108,400 jobs, or 19.9 percent of their employment.⁸ High-tech industries in the rest of the Nation lost 6.2 percent of employment. In addition, real wages fell by 13.5 percent among Silicon Valley's high-tech industries, while high-tech wages grew by 1.3 percent in the rest of the Nation. The loss in employment and

real wages in Silicon Valley, however, was not the result of a continuous decline. The 2000-to-2008 period is marked by two distinct phases. During the first phase—2000 to 2004, a period during which the crash of dot-com stocks occurred—real wages and high-tech employment declined precipitously. The decline in high-tech employment lasted for 4 consecutive years and erased nearly a decade of growth. High-tech employment declined in the rest of the Nation as well, but losses were more acute in Silicon Valley, where jobs disappeared at a faster rate. During the next phase, 2004 to 2008, most of Silicon Valley's high-tech industries "rebooted" and experienced a modest expansion in employment and wages. Manufacturing indus-

tries, which had been decimated following the dot-com crash, saw employment levels finally stabilize; however, Silicon Valley high-tech employment did not recover to the peak level reached in 2000. (See chart 1.)

Using employment and wage data drawn from the database of the Bureau of Labor Statistics' Quarterly Census of Employment and Wages program, this article examines employment and wage trends in the Silicon Valley high-tech sector from 2000 to 2008, dividing the data into the two periods mentioned earlier. Average annual employment data are computed, and average annual wages are calculated by dividing total annual wages by employment. Real wages are used throughout the wage analysis and benchmarked to 2000 dollars by deflating nominal wages with the San Francisco-San Jose-Oakland average Consumer Price Index. The periods covered include the recession beginning in March of 2001 and ending in November 2001, as well as some of the most recent recession, which started in December 2007.

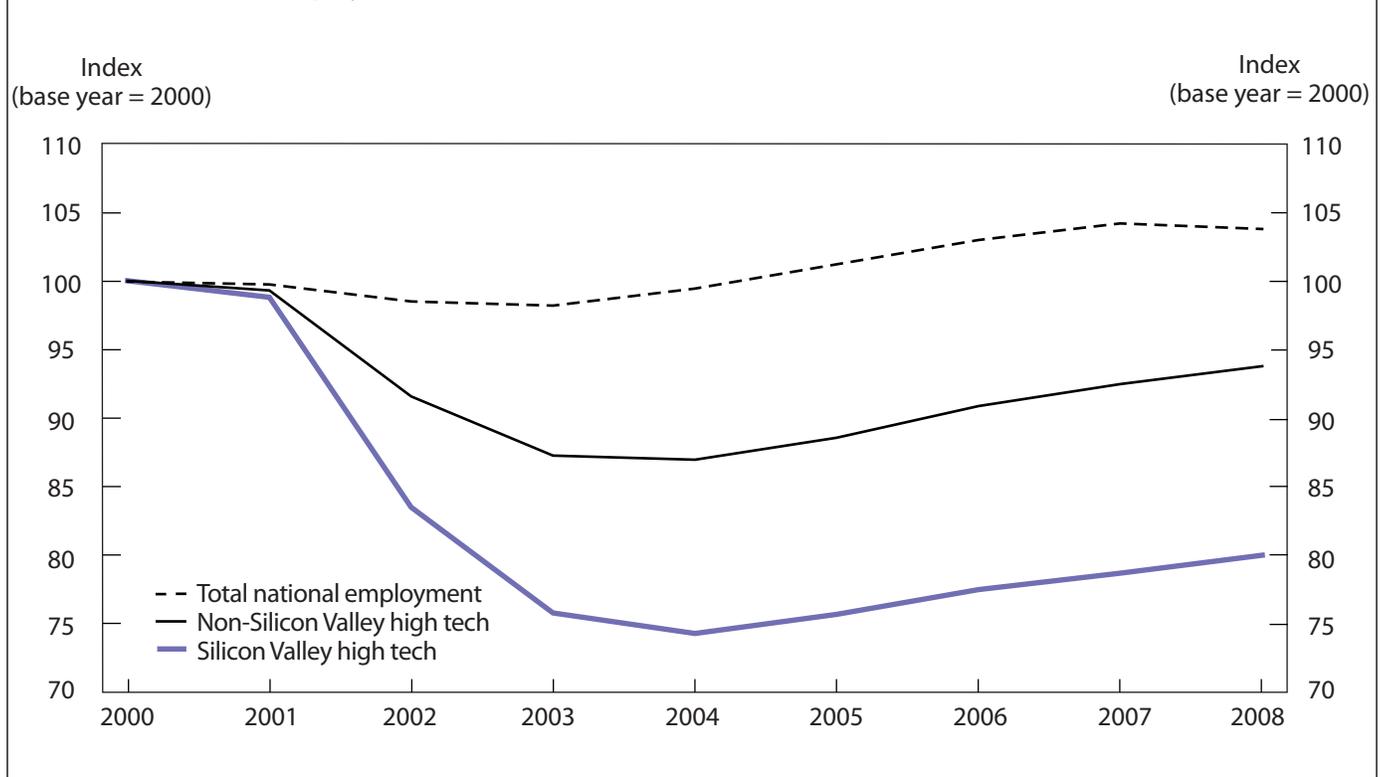
For this article, 11 "industries" have been identified as "high tech" through the use of the 2007 North American Industry Classification System (NAICS)⁹ codes. (The word "industry" is used in a general sense here, because the industries that were analyzed vary with regard to the

number of digits they are assigned under NAICS.) An industry is considered high tech if "technology-oriented workers" within the industry, as identified by occupational staffing patterns, account for 25 percent or more of total jobs within the selected industry.¹⁰ Because of revisions made to some of the NAICS codes for the 2007 version of NAICS, employees in the three subsectors of Internet services, telecommunications, and data processing, hosting, and related services have been aggregated under one industrial classification for this article. The employment and wage data reported in this article cover all sectors of the economy, sectors which comprise Federal, State, and local governments, and private organizations. Statistics on total wages generated are in nominal dollars, and statistics on average annual wages are indexed to the year 2000.

After the dot-com crash: 2000–04

Silicon Valley high-tech employment. Following the crash of dot-com stocks in 2000, Silicon Valley's landscape of technology and its economic future were drastically altered. Despite such a massive hit to the market capitalizations and financial projections of high-tech firms, employment in Silicon Valley was stalwart through the

Chart 1. Index of Silicon Valley high-tech employment, non-Silicon Valley high-tech employment, and total national employment, 2000–08



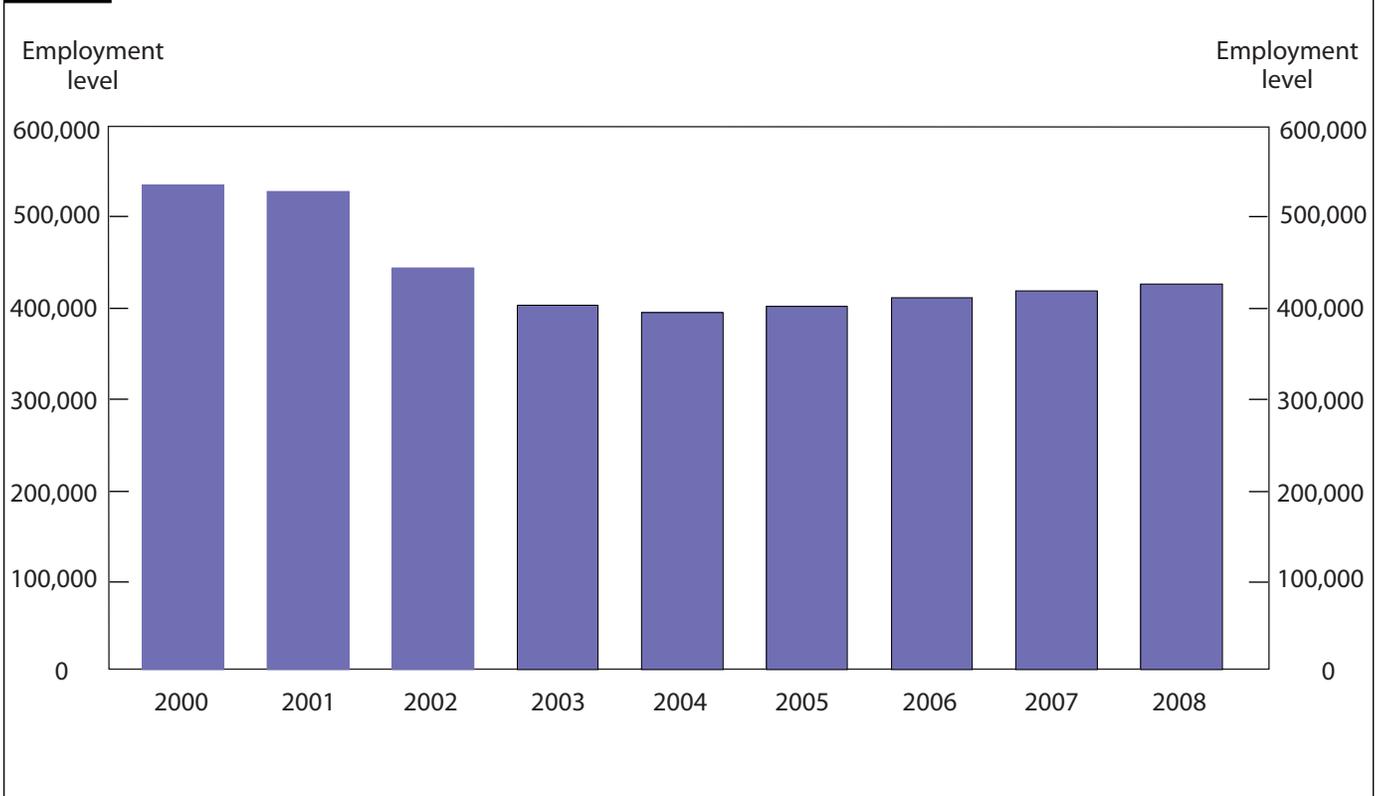
end of 2000 and into the early part of 2001. In Santa Clara County, the heart of Silicon Valley, the unemployment rate stood at 2.4 percent in December 2000. Then, the aftershocks of the stock market crash—combined with the onset of economic recession and greatly reduced venture capital financing—resulted in a sudden contraction of the Silicon Valley economy; by late 2001 Silicon Valley had entered into a deep recession.¹¹ Businesses, which had accelerated spending in preparation for the Y2K switchover, found themselves with almost all the equipment they needed for some time. As orders for new technology and computing equipment fell, demand for programming and services also waned.¹² As a result of all these factors, as well as increased foreign and domestic competition, Santa Clara County’s unemployment rate jumped to 7.0 percent by December 2001. Some high-tech companies responded by relocating certain phases of production or moving out of Silicon Valley altogether to areas with lower commercial rents and housing costs. The future of Silicon Valley as a crucible of innovation appeared in doubt.¹³

The downturn in employment for Silicon Valley high tech lasted from late 2001 through 2004. High tech’s share of total Silicon Valley employment dropped from

17.2 percent in 2000 to 14.4 percent in 2004. During this 4-year period about 140,400 jobs were lost in high-tech industries in Silicon Valley, a decline of 25.8 percent. About 60 percent of the job losses occurred in 2002, after the national recession had ended. (See chart 2.) In addition, many of the job losses occurred not only in the Internet startups that were associated with the dot-com crash, but in the long-established, bedrock high-tech industry groups of computer and peripheral equipment manufacturing (henceforth referred to simply as “computer manufacturing”), and semiconductor and other electronic component manufacturing (hereafter referred to as “semiconductor manufacturing”). While not as severe as the losses in Silicon Valley, the decline in employment in high-tech industries was 13.0 percent in the rest of the Nation during the 2000-to-2004 period; as was the case in Silicon Valley, elsewhere in the country the majority of job losses occurred in 2002.

Silicon Valley high-tech wages. Average annual wages in Silicon Valley’s high-tech sector fell sharply along with employment following the dot-com crash.¹⁴ After adjustment for inflation, average annual wages in Silicon Valley high-tech industries dropped by 15.8 percent (from

Chart 2. Silicon Valley high-tech employment, 2000–08



\$120,064 to \$101,057) from 2000 to 2004.¹⁵ Outside Silicon Valley, the drop in average annual wages in high-tech industries was far more subdued: the decline was only 1.2 percent. (See table 1.) This difference—15.8 percent compared with 1.2 percent—greatly reduced the wage differential between high-tech workers in Silicon Valley and those in the rest of the Nation. In 2004, average annual wages for high-tech workers in Silicon Valley were 60.5 percent higher than for those outside the Valley. Though still a considerable gap, this was markedly less than the gap of 88.4 percent in 2000.

The combination of lower average wages and lower employment levels in high-tech industries in Silicon Valley resulted in lower total wages. During the year 2000, high-tech industries in Silicon Valley generated \$65.4 billion in wages—1.4 percent of total wages earned in the country and 12.8 percent of all high-tech wages in the Nation. High-tech industries accounted for 34.5 percent of all wages paid in Silicon Valley in 2000. From 2000 to 2004, wages paid in high-tech industries in Silicon Valley fell by 31.1 percent—in nominal terms—to \$45.0 billion. As a result, the share of total national wages emanating from Silicon Valley high tech decreased to 0.9 percent and Silicon Valley’s share of total high-tech wages fell below 10 percent by 2004. The share of Silicon Valley wages that was produced by high-tech industries fell to 26.9 percent. Just as average annual wages for high tech declined at a slower rate outside Silicon Valley, total wages for high tech in the rest of the Nation declined at a more restrained rate—5.6 percent—than did total wages for high tech in Silicon Valley.

The relatively larger declines in Silicon Valley’s average annual high-tech wages and total high-tech wages can be explained by the Valley’s larger share of employment in computer and semiconductor manufacturing, which experienced large declines following 2000. In comparison with Silicon Valley, the rest of the Nation had a much greater share of workers in the comparatively stable architectural, engineering, and related services industry group (henceforth referred to simply as “architecture and engineering”).

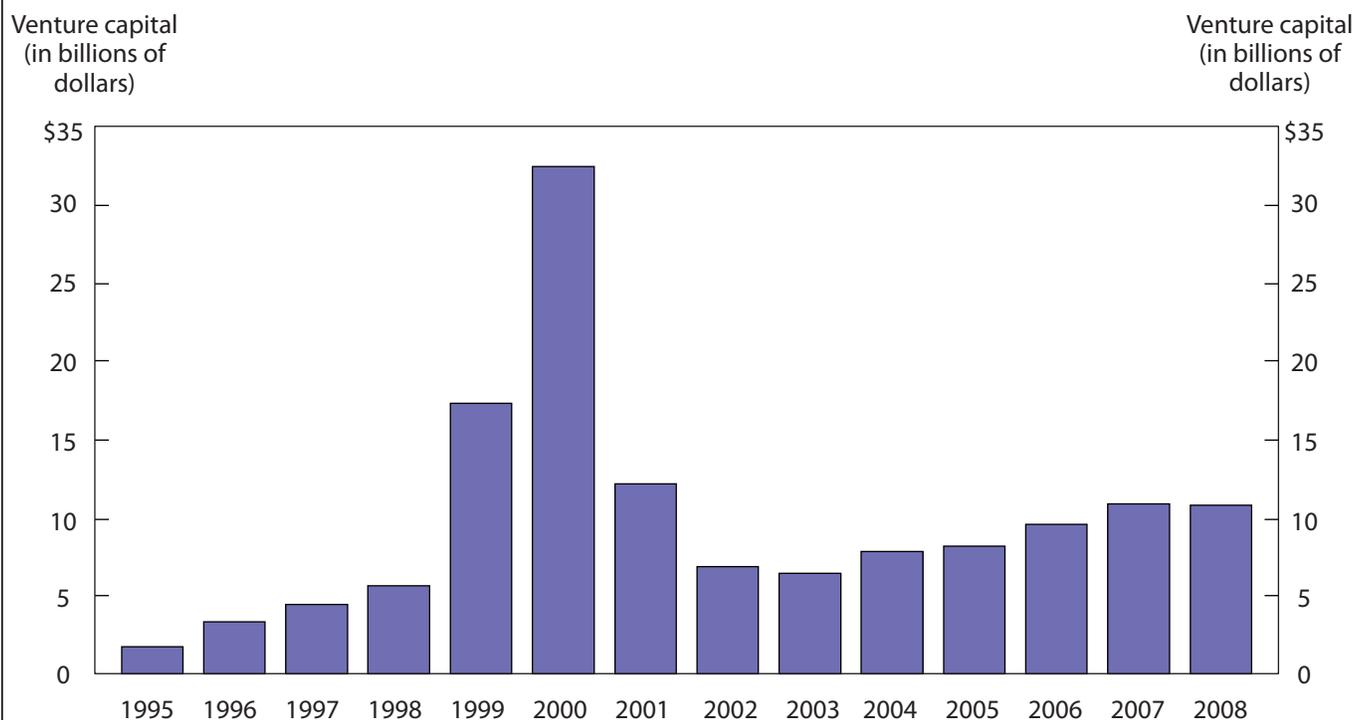
Silicon Valley reboots: 2004–08

Silicon Valley high-tech employment. After 2004, high-tech employment in Silicon Valley experienced 4 years of steady, continuous growth. The stable growth across most high-tech industries during this period stands in stark contrast to the boom and bust in high tech in the years preceding and following the 2000 peak. (See chart 2.) The rebooting of Silicon Valley following 2004 was driven by several factors. Despite absorbing a loss of more than 140,000 jobs since 2000, the region held on to much of its core talent and industry strengths.¹⁶ From 2004 to 2007, technology companies benefited from a generally strong economy. Robust consumer spending, coupled with increased business investment in new technology, also helped to boost high-tech employment.¹⁷ In addition, venture capital financing, which had decreased substantially from 2000 to 2003, increased, though not nearly to the peak level seen in 2000. (See chart 3.) Some of this new financing went towards a new breed of Internet startups, which spurred the evolution of Web 2.0.¹⁸ Another factor that buoyed employment after 2004 was the demand for products from nascent industries like biotechnology, nanotechnology, and clean or green technology.¹⁹

Employment in Silicon Valley’s high-tech sector expanded by more than 31,900 jobs, or 7.9 percent, between 2004 and 2008. This growth rate was nearly identical to that of high-tech employment outside of Silicon Valley during these 4 years. (See table 2.) The share of total Silicon Valley jobs accounted for by employment in high-tech industries grew slightly, from 14.4 percent in 2004 to 14.8 percent in 2008. Although the increase in employment was more subdued than during the dot-com boom, Silicon Valley firms experienced strong growth in sales, revenues, and profits. Between 2003 and 2004, profits rose by 170 percent for the largest 150 companies in Silicon Valley; the next year, 2005, saw profits grow by 18 percent for the largest 150 companies.²⁰ These increases in profitability, though, did not translate into vigorous job growth. During the 2000-to-2004

Table 1. Wages in Silicon Valley high tech, non-Silicon Valley high tech, and the United States as a whole; 2000, 2004, and 2008

Area and industry	Real average annual wages (in year 2000 dollars)			Percent change		Total nominal wages (in billions of dollars)			Percent change	
	2000	2004	2008	2000–04	2004–08	2000	2004	2008	2000–04	2004–08
Silicon Valley high tech.....	120,064	101,057	103,850	-15.8	2.8	65.4	45.0	56.0	-31.1	24.3
Non-Silicon Valley high tech.....	63,714	62,979	64,539	-1.2	2.5	444.4	419.5	528.1	-5.6	25.9
United States (all sectors).....	35,331	35,874	36,438	1.5	1.6	4,588.8	5,087.6	6,141.8	10.9	20.7

Chart 3. Venture capital investments in Silicon Valley, 1995–2008

SOURCE: *MoneyTree Report*, PricewaterhouseCoopers and the National Venture Capital Association

period, companies learned to get by with fewer workers by increasing productivity through automation or by outsourcing functions to cut costs. Beginning in 2004, when the employment level of high-tech companies in Silicon Valley started to creep up again, employers put off hiring full-time workers until absolutely needed and favored higher skilled workers in the areas of research and innovation.²¹ Mergers and consolidation activity also dampened employment growth during the 2004-to-2008 period and knocked many company names off the list of Silicon Valley's largest 150 companies.²² The combination of productivity gains, job cuts from mergers, and the high cost of living in the region caused many Silicon Valley high-tech companies to focus their expansion efforts on other parts of the country.²³ It is noted, however, that the employment growth figures for Silicon Valley during the 2004-to-2008 period may be understated because they do not include self-employed contractors or consultants.²⁴

Silicon Valley high-tech wages. Like high-tech employment in Silicon Valley, average annual wages in nearly all of Silicon Valley's high-tech industries experienced growth

during the 2004-to-2008 period. Real wages grew by 2.8 percent (from \$101,057 to \$103,850).²⁵ Outside Silicon Valley, real average annual wages in high tech increased by 2.5 percent. (See table 1.) Already paid considerably more than high-tech workers in the rest of the Nation, Silicon Valley workers saw a widening in the difference between their wages and those in the rest of the Nation. By 2008, Silicon Valley high-tech workers were earning, on average, 60.9 percent more than non-Valley high-tech workers.

The slightly larger average wage growth in Silicon Valley can be explained partly by the lower rate of inflation experienced in the area during the 2004-to-2008 period. Also, many of the new jobs created after 2004 were high-skill jobs and jobs in industries with higher wages. In addition, stock options are included in the calculation of wages, and the period following 2004 was marked by strong gains for technology stocks.

During 2008, high-tech industries in Silicon Valley generated \$56.0 billion in nominal wages. Although this represents a 24.4-percent increase in comparison with the 2004 level, the shares of both total national wages (0.9 percent) and national high-tech wages (9.6 percent) accounted for by Silicon Valley's high-tech industries

Table 2. Employment in Silicon Valley high tech, non-Silicon Valley high tech, and the United States as a whole; 2000, 2004, and 2008

Area and industry	Employment			Net change		Percent change	
	2000	2004	2008	2000–04	2004–08	2000–04	2004–08
Silicon Valley high tech.....	544,387	403,994	435,958	-140,393	31,964	-25.8	7.9
Non-Silicon Valley high tech.....	6,975,252	6,071,746	6,544,599	-903,506	472,853	-13.0	7.8
United States (all sectors).....	129,879,584	129,278,176	134,809,551	-601,408	5,531,375	-0.5	4.3

were similar to the shares accounted for in 2004. Like total nominal high-tech wages in Silicon Valley, total nominal wages for high tech in rest of the Nation grew during the 2004-to-2008 period, expanding by 25.9 percent. Within Silicon Valley, high-tech industries accounted for 27.4 percent of total wages paid in 2008 compared with 26.9 percent in 2004.

Analysis of specific high-tech industries

Industry employment. To more clearly delineate the factors driving the changes observed in aggregate Silicon Valley high-tech employment, specific high-tech industries are analyzed for the 2000-to-2008 period. In general, goods-producing and service-providing industries displayed different patterns of growth. During the 2000-to-2004 period, both goods-producing and service-providing industries in Silicon Valley experienced steep employment declines: 29.3 percent and 23.2 percent, respectively. During the following 4 years, when aggregate high-tech employment in Silicon Valley recovered, goods-producing industries grew by only 0.2 percent while industries in services added 13.1 percent to their jobs base. This shift away from goods-producing high-tech employment towards service-providing high-tech employment mirrors the trend seen in high-tech outside of Silicon Valley as well as in the overall national economy.

All high-tech industries had significant representation in Silicon Valley throughout the 2000-to-2008 timeframe. In 2008, the level of employment ranged from 99,199 jobs in the computer systems design and related services industry group (henceforth referred to simply as the “computer systems design” industry group) to 9,053 jobs in the aerospace product and parts manufacturing industry group (hereafter referred to as the “aerospace” industry group). Although 9 of the 11 industries analyzed experienced employment declines, 2 industry groups—scientific research and development services (hereafter referred to as “scientific research”), and pharmaceutical and medicine manufacturing (henceforth referred to as “pharmaceuticals”)—exhibited employment

growth from 2000 to 2008. During this period, overall Silicon Valley high-tech employment fell by around 110,000 jobs to just under 436,000 jobs.

The interrelated industry groups of scientific research and pharmaceuticals were the only industries to experience job growth during both the 2000–04 period and the 2004–08 period. These industry groups added more than 2,700 jobs combined in the first 4 years analyzed and more than 6,400 jobs in the last 4 years analyzed. During both periods, employment growth in scientific research in Silicon Valley lagged behind the industry group’s employment growth in the rest of the Nation, while employment growth in pharmaceuticals in Silicon Valley outperformed pharmaceuticals’ employment growth in the rest of the country. (See table 3.) Biotechnology firms, which fall primarily under scientific research, benefited from a substantial increase in venture capital and government support in the earlier part of the decade.²⁶ In addition, biotechnology has been crucial in the development of medicines, which have fueled growth in the pharmaceutical industry.²⁷ Demand for both new drugs and new medical devices boosted medical and biotechnological research throughout the 8-year period.²⁸ The scientific research industry group includes not only research in the broad field of biotechnology, but also nanotechnology and green or clean technology. A separate analysis of green jobs estimates a 23-percent rise in Silicon Valley green jobs from 2005 to 2008.²⁹

Four of the industries analyzed declined during the 2000–04 period but experienced job growth in the 2004–08 period: the computer systems design industry group; the cluster of the three subsectors of Internet services, telecommunications, and data processing, hosting and related services (hereafter, this third subsector is referred to as “data processing”); the architecture and engineering industry group; and the computer manufacturing industry group. Employment in all of these industries, apart from architecture and engineering, fell at a higher rate locally than in the rest of the Nation during the first 4 years; however, these industries also recovered at a faster rate in Silicon Valley during the second 4-year period.

With the exception of architecture and engineering,

Table 3. Employment by industry in Silicon Valley and the rest of the Nation; 2000, 2004, and 2008

Industry	Employment in Silicon Valley			Net change		Percent change, Silicon Valley		Percent change, Non-Silicon Valley	
	2000	2004	2008	2000-04	2004-08	2000-04	2004-08	2000-04	2004-08
All industries.....	3,165,418	2,799,191	2,941,930	-366,227	142,739	-11.6	5.1	-0.2	4.3
High tech.....	544,387	403,994	435,958	-140,393	31,964	-25.8	7.9	-13.0	7.8
Computer systems design and related services	108,705	77,808	99,199	-30,897	21,391	-28.4	27.5	-11.4	26.6
Semiconductor and electronic component manufacturing.....	91,748	61,165	57,512	-30,583	-3,653	-33.3	-6.0	-33.4	-3.7
Internet services, telecommunications, and data processing, hosting, and related services.....	78,413	47,227	49,817	-31,186	2,590	-39.8	5.5	-22.8	-7.4
Computer and peripheral equipment manufacturing.....	58,328	38,315	42,869	-20,013	4,554	-34.3	11.9	-25.7	-18.5
Architecture and engineering services.....	49,680	39,274	43,352	-10,406	4,078	-20.9	10.4	3.0	13.8
Scientific research and development services.....	49,586	50,799	54,697	1,213	3,898	2.4	7.7	5.5	10.9
Electronic instrument manufacturing.....	39,948	30,543	27,550	-9,405	-2,993	-23.5	-9.8	-8.9	4.0
Software publishers.....	27,501	25,937	25,606	-1,564	-331	-5.7	-1.3	-12.0	12.7
Communications equipment manufacturing.....	20,601	11,663	11,578	-8,938	-85	-43.4	-7	-40.8	-13.7
Pharmaceutical and medicine manufacturing.....	10,667	12,190	14,725	1,523	2,535	14.3	20.8	4.5	.0
Aerospace product and parts manufacturing.....	9,210	9,073	9,053	-137	-20	-1.5	-2	-14.8	15.1

employment in every high-tech industry moved in the same direction—positively or negatively—in Silicon Valley as in the rest of the Nation between 2000 and 2004. The engineering services part of this industry group accounted for nearly two out of every three jobs it lost during this time. During the 2004–08 period, employment in architecture and engineering grew by 10.4 percent in Silicon Valley and by 13.8 percent in the rest of the Nation.

Computer systems design, which employed the largest number of employees in Silicon Valley throughout the period used for analysis, lost nearly 30,000 jobs from 2000 to 2004. This industry group provides computer systems design, expertise, and support not only for high-tech companies but for a broad range of professional and business-related industries. Employment in this industry was affected by the 2001 economic recession, which resulted in reduced businesses investment in information technology and the increased migration of system design employees and firms out of the area. In recent years, as businesses have increased their reliance on computer and information technology, they have turned to firms in the computer systems design industry group to meet their specialized needs.³⁰

The cluster of Internet services, telecommunications, and data processing experienced heavy job losses in both the telecommunications and Internet segments because of increased consolidation in the telecommunications industry and the failure of many Internet startups following the dot-com bust. Between 2004 and 2008, job losses in telecommunications began to subside, while Internet companies and web-search portals grew. Em-

ployment growth in the Internet services subsector was driven by a new breed of startups, which created many of the innovations in web 2.0 technology. In addition, many Internet companies benefited from venture capital financing.³¹

The two bellwether industry groups within high-tech manufacturing in Silicon Valley—computer manufacturing and semiconductor manufacturing—both were hit hard by job losses in the 2000-to-2004 period because of a substantial weakening in demand coupled with an increase in imports.³² These two complementary industry groups together accounted for more than 50,000 jobs lost during that time. A different pattern emerged during the 2004–08 period: computer manufacturing added nearly 5,000 jobs in the local economy, while outside of the area it continued to lose jobs; in contrast, semiconductor manufacturing continued to lose jobs both in Silicon Valley and in the rest of the country, primarily because of increased foreign competition.³³

In addition to semiconductor manufacturing, four other industry groups lost jobs in both the earlier and latter 4-year periods. Three of these industry groups were in the high-tech manufacturing arena—communications equipment manufacturing; navigational, measuring, electromedical, and control instruments manufacturing (hereafter referred to as “electronic instrument manufacturing”); and aerospace. Because of the precision involved in the manufacturing process, communications equipment and electronic instrument manufacturing have become highly automated in recent years.³⁴ The employment decline in communications equipment manufacturing was much less pronounced in

Silicon Valley than in the rest of the Nation during the 2004-to-2008 period; meanwhile, electronic instrument manufacturing grew in the rest of the Nation but fell by nearly 10 percent in the local area. Aerospace, which is the smallest high-tech industry in Silicon Valley in terms of employment, experienced a modest 1.5-percent decline during the 2000-to-2004 period. During this timespan, the aerospace industry group was undergoing a period of consolidation and contraction in the rest of the Nation, which resulted in a 14.8-percent national decline in employment for aerospace.³⁵ While the aerospace industry group resumed job growth in the rest of the Nation during the 2004-to-2008 period, Silicon Valley's employment in this industry group was basically unchanged. The last industry group that lost jobs during both periods analyzed was software publishers, which was affected by increased levels of offshore outsourcing. This trend appears to have reduced the number of lower paying software publishing jobs in Silicon Valley and the United States, though at the same time the number of higher paying software jobs increased in Silicon Valley and the country as a whole.³⁶ Employment in Silicon Valley's software publishers industry group declined at a little less than half the rate of software publishers in the rest of the Nation during the 2000-04 period; in the 2004-08 period, the number of jobs in this industry group decreased slightly in Silicon Valley but rose by nearly 13 percent in the rest of the Nation.

Employment concentration. Several Silicon Valley high-tech industries expanded between 2000 and 2004 as well as from 2004 to 2008 in terms of employment concentration and significance in the Silicon Valley economy. One statistical measure of the concentration of a local industry is the location quotient. The location quotient (LQ) is a ratio that compares a particular industry's concentration of jobs in a defined area with the industry's concentration of jobs in a larger area or base.³⁷ For example, LQs can be used to compare the proportion of the Silicon Valley workforce employed in high tech with the proportion of the national workforce employed in high tech.³⁸

An industry with an LQ greater than 1.0 employs a greater concentration of workers locally relative to the national concentration. The LQ for high tech in Silicon Valley was 3.0 in 2000 and 2.9 in both 2004 and 2008, indicating that high-tech employment was concentrated at about 3 times the national average throughout the 2000-08 period. (See table 4.) Another interpretation that can be elicited from these results is that the Silicon

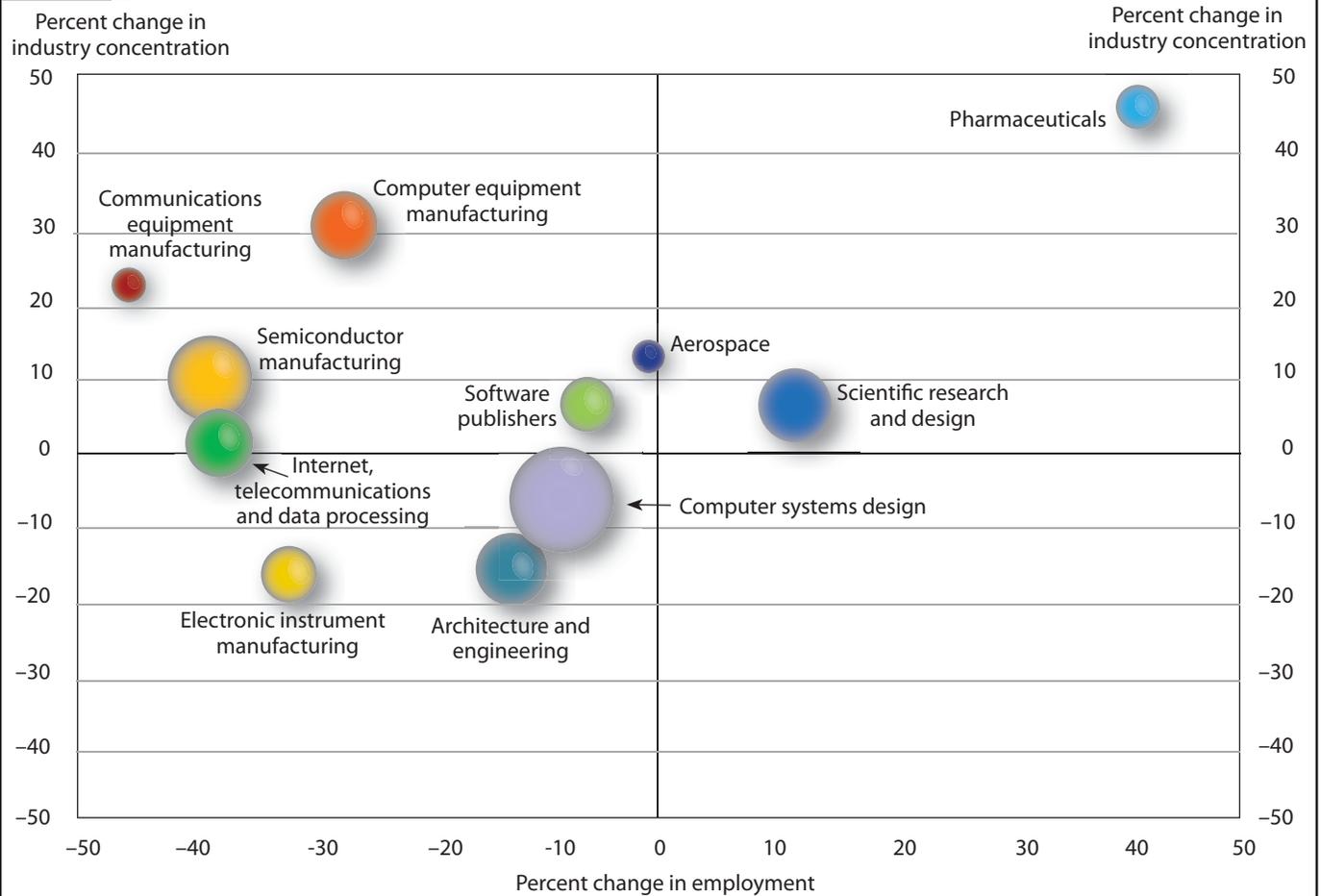
Valley high-tech cluster of industries has remained stable over time as measured by its concentration in the local economy relative to its concentration in the rest of the Nation. This result runs contrary to the arguments of those who say that, in recent years, high tech in Silicon Valley has lost some of its competitive edge compared with high tech in other regions.³⁹ In addition, although the Valley's overall high-tech LQ has remained stable, the majority of high-tech industries analyzed increased their relative concentration from 2000 to 2008. Between 2000 and 2004, 7 of the 11 high-tech industries increased their LQ; from 2004 to 2008, 4 industries increased their LQ; and over the entire 8-year period, 7 of the 11 high-tech industries increased their LQ.

Of the seven industry groups with LQs that increased between 2000 and 2008, five actually lost jobs over the 8-year period. LQs rose for manufacturing of computers, semiconductors, communications equipment, and aerospace products and parts, as well as for software publishers, even though job losses in these industry groups occurred in the local area. This demonstrates the increasing significance of these industries to the Silicon Valley economic base. Both the LQs and the employment of pharmaceuticals and of scientific research increased over the 8-year period. Note that the LQs range from a little under 1 for aerospace to more than 10 for computer manufacturing (in 2008). Ten of the eleven industries analyzed had location quotients greater than 1, indicating an above-average concentration of employment in the local area relative to the Nation as a whole.

Employment concentrations and trends can also be demonstrated visually by use of a bubble chart. (See chart 4.) The size of each bubble represents an industry's 2008 employment level; a larger bubble indicates more employ-

Industry	2000	2004	2008
All high tech.....	3.0	2.9	2.9
Computer and peripheral equipment manufacturing.....	8.3	8.4	10.7
Semiconductor and electronic component manufacturing.....	5.6	6.3	6.1
Software publishers.....	4.3	5.1	4.5
Scientific research and development services.....	3.7	4.1	3.9
Communications equipment manufacturing.....	3.4	3.7	4.2
Electronic instrument manufacturing.....	3.4	3.3	2.9
Computer systems design and related services..	3.4	3.1	3.1
Internet services, telecommunications, and data processing, hosting, and related services.....	2.0	1.8	2.0
Pharmaceutical and medicine manufacturing....	1.6	2.0	2.3
Architectural, engineering, and related services.	1.6	1.4	1.3
Aerospace product and parts manufacturing.....	.7	.9	.8

Chart 4. Percent changes in industry concentration¹ and employment, by high-tech industry in Silicon Valley, 2000–08



¹ As measured by location quotients.

NOTE: The size of each bubble represents the size of the industry as measured by employment in 2008.

ment. Industries in the upper-right quadrant grew both in employment and in relative concentration in Silicon Valley from 2000 to 2008 and thus are the “emerging leaders” of the area’s economy. Those in the upper-left quadrant, though having declined in terms of jobs, have grown as measured by relative concentration. These might be labeled the “survivors” from the original hardware-oriented Silicon Valley. In the lower-left quadrant are industries that have lost both employment and relative share. Most notable among these “sliders” is electronic instrument manufacturing. The lower-right quadrant is for industries that have gained in employment but have declined in relative concentration. None of Silicon Valley’s high-tech industries were found in the lower-right quadrant, a result which implies that industries which grew in Silicon Valley grew at a faster pace there than in the rest of the Nation.

Industry wages. Average annual wages fell sharply between 2000 and 2004 and grew modestly between 2004 and 2008 in Silicon Valley’s high-tech sector, mirroring the sector’s trends in employment in the Valley during these periods. Between 2000 and 2008, 4 of the 11 industries analyzed experienced an increase in real annual wages while 7 experienced wage declines. (See table 5.) During the final 4 years, however, the average wages of 8 of 11 industries advanced. In comparison, in the rest of the Nation, six of the industries had wage growth over the 8-year period and eight had wage growth from 2004 to 2008.

Of the 11 industries analyzed, 3 experienced growth in real wages in Silicon Valley during both the 2000–04 and 2004–08 periods. The three industries were aerospace, scientific research, and architecture and engineer-

Table 5. Real average annual wages (in year 2000 dollars), by industry; 2000, 2004, and 2008

Industry	Silicon Valley					Non-Silicon Valley				
	2000	2004	2008	Percent change, 2000–04	Percent change, 2004–08	2000	2004	2008	Percent change, 2000–04	Percent change, 2004–08
All industries.....	59,894	54,166	56,212	-9.6	3.8	34,718	35,463	36,011	2.1	1.5
High tech.....	120,064	101,057	103,850	-15.8	2.8	63,714	62,979	64,539	-1.2	2.5
Pharmaceutical and medicine manufacturing.....	122,044	124,147	111,929	1.7	-9.8	73,353	72,582	74,764	-1.1	3.0
Computer and peripheral equipment manufacturing.....	222,965	125,799	127,214	-43.6	1.1	78,257	79,023	82,241	1.0	4.1
Communications equipment manufacturing	120,745	100,080	107,154	-17.1	7.1	65,700	66,446	63,783	1.1	-4.0
Semiconductor and electronic component manufacturing.....	115,241	94,344	91,547	-18.1	-3.0	57,608	56,038	56,077	-2.7	.1
Electronic instrument manufacturing.....	102,561	89,878	98,358	-12.4	9.4	58,424	62,778	63,330	7.5	.9
Aerospace product and parts manufacturing	71,810	86,031	96,029	19.8	11.6	57,904	63,574	63,102	9.8	-7
Software publishers.....	158,090	126,415	132,925	-20.0	5.1	109,365	82,074	88,574	-25.0	7.9
Architectural, engineering, and related services.....	72,009	72,059	75,152	.1	4.3	53,975	55,374	58,473	2.6	5.6
Computer systems design and related services.....	118,607	102,428	102,995	-13.6	.6	71,599	68,279	68,575	-4.6	.4
Scientific research and development services	84,945	87,467	99,053	3.0	13.2	65,549	68,657	72,621	4.7	5.8
Internet services, telecommunications, and data processing, hosting and related services	104,638	116,620	116,248	11.5	-3	59,345	57,703	57,405	-2.8	-5

ing. Between 2000 and 2004, all three of these industry groups had wage growth in the rest of the Nation as well. During the 2004-to-2008 period, aerospace wages fell nationally but grew by 11.6 percent in Silicon Valley.

Within Silicon Valley, 5 of the 11 industries analyzed experienced wage declines in the earlier 4-year period followed by wage growth in the latter period. The largest 2000–04 decline occurred in computer manufacturing, in which average wages fell 43.6 percent from about \$223,000 per year to about \$126,000 per year. Two other industry groups experienced wage declines exceeding the average decline for all high-tech industries during the 4-year span: software publishers (a decline of 20.0 percent) and communications equipment manufacturing (a decline of 17.1 percent). Wages in these industry groups were affected by competition, both domestic and foreign, as well as by increased automation of manufacturing processes. Two of the industry groups—computer manufacturing and communications equipment manufacturing—did experience a modest rise in average wages outside of Silicon Valley. The wage declines that occurred in five industries between 2000 and 2004 were so severe that, by 2008, none of these industries had reached its average wage level seen in 2000.

During the 2000–04 period, wage trends in the Internet services, telecommunications, and data processing cluster and in the pharmaceuticals industry group ran contrary to trends observed in other high-tech industries in Silicon Valley and in the rest of the Nation: the

average wages of both sectors grew in Silicon Valley but declined in the rest of the Nation. During the 2004–08 period, wages for the pharmaceutical industry group fell in Silicon Valley but rose in the rest of the country, and wages in Internet services, telecommunications, and data processing fell slightly both in Silicon Valley and elsewhere in the country. The pharmaceuticals industry group and the Internet, telecommunications, and data processing cluster were among the three Silicon Valley high-tech industries to experience a decline in wages during the 2004-to-2008 period.

In Silicon Valley, semiconductor manufacturing exhibited declining average wages during both the 2000–04 and 2004–08 periods. Average wages in this industry declined in the rest of the country as well during the earlier 4-year period, but in the rest of the country they were slightly higher in 2008 than they were in 2004. With regard to total high-tech wages, a shift away from goods-producing industries and towards service-providing industries occurred between 2000 and 2008. The share of high-tech wages generated by service-providing industries grew from 50.8 percent in 2000 to 62.0 percent in 2008, primarily because of a fall in total wages in computer and semiconductor manufacturing. (See table 6.)

In 2000, total wages generated in Silicon Valley were \$189.6 billion. At that time, high-tech industries made up about 34.5 percent of all Silicon Valley wages. By 2004, Silicon Valley nominal wages had dropped to \$167.3 billion, of which 26.9 percent was in high-tech

Table 6. Total wages in Silicon Valley, by industry; 2000, 2004, and 2008

Industry	2000		2004		2008	
	Total annual wages (in billions of dollars)	Percent of Silicon Valley high tech	Total annual wages (in billions of dollars)	Percent of Silicon Valley high tech	Total annual wages (in billions of dollars)	Percent of Silicon Valley high tech
All industries.....	189.6	N/A	167.3	N/A	204.4	N/A
High tech.....	65.4	100.0	45.0	100	56.0	100.0
Computer and peripheral equipment manufacturing.....	13.0	19.9	5.3	11.8	6.7	12.0
Computer systems design and related services.....	12.9	19.7	8.8	19.5	12.6	22.6
Semiconductor and electronic component manufacturing....	10.6	16.2	6.4	14.1	6.5	11.6
Internet services, telecommunications, and data processing, hosting, and related services.....	8.2	12.6	6.1	13.5	7.2	12.8
Software publishers.....	4.3	6.7	3.6	8.0	4.2	7.5
Scientific research and development services.....	4.2	6.4	4.9	10.9	6.7	12.0
Electronic instrument manufacturing.....	4.1	6.3	3.0	6.7	3.3	6.0
Architectural, engineering, and related services.....	3.6	5.5	3.1	6.9	4.0	7.2
Communications equipment manufacturing.....	2.5	3.8	1.3	2.9	1.5	2.7
Pharmaceutical and medicine manufacturing.....	1.3	2.0	1.7	3.7	2.0	3.6
Aerospace product and parts manufacturing.....	.7	1.0	.9	1.9	1.1	1.9

industries. Total wages in Silicon Valley as a whole and total wages in Silicon Valley high-tech industries resumed growth after 2004. During 2008 the Silicon Valley economy generated approximately \$204.4 billion in wages, a 7.8-percent increase compared with the total in 2000, of which 27.4 percent came from high tech.

Among the 11 high-tech industries, the largest share of total annual wages in 2008 was in computer systems design (22.6 percent), followed by the Internet services, telecommunications, and data processing cluster (12.8 percent), computer manufacturing (12.0 percent), scientific research (12.0 percent), and semiconductor manufacturing (11.6 percent). These five industries accounted for 71.0 percent of all high-tech industry wages in 2008. During the same year, they accounted for 69.8 percent of Silicon Valley high-tech employment.

In 2000, these five industries had even more thoroughly dominated the high-tech industry scene in regard to wages and employment. The five combined accounted for 74.8 percent of total wages that year, with computer manufacturing making up the largest share of total wages, 19.9 percent. In addition, they accounted for nearly 387,000 jobs, or 71.0 percent of total Silicon Valley high-tech employment.

Eight of the eleven industries analyzed paid less in total annual wages in 2004 than they had paid in 2000. The only exceptions were scientific research and pharmaceuticals, both of which had growing employment bases, and aerospace, whose average wages experienced strong growth. The combined share of total annual wages for these three industry groups rose from 9.4 percent in 2000 to 16.5 percent in 2004. In contrast, computer

manufacturing experienced the largest drop in total annual wages in both nominal and percentage terms: wages fell from \$13.0 billion in 2000 to \$5.3 billion in 2004 (a decline of 59.2 percent) in this industry group.

From 2004 to 2008, total annual wages grew in every Silicon Valley high-tech industry. Computer systems design, the largest industry in Silicon Valley as measured by employment and total wages, experienced the largest growth in annual wages in both nominal terms (\$3.8 billion) and percentage terms (43.6 percent). Scientific research ranked second in both nominal growth (\$1.8 billion) and percentage growth (36.6 percent). The only industry in which total wages grew by less than 10 percent during the 2004-to-2008 period was semiconductor manufacturing (2.2 percent). Despite the acute drop in total wages for computer manufacturing and related industries that occurred after 2000, and the shift towards smaller high-tech industries, computer manufacturing, semiconductor manufacturing, and computer systems design still accounted for almost half of total wages in the Silicon Valley high-tech sector in 2008.

Analysis by county

Employment trends across Silicon Valley counties. Though it made up only 30.8 percent of Silicon Valley's total employment in 2008, Santa Clara County accounted for 54.8 percent of all of the Valley's high-tech employment that year. (See table 7.) In a majority of high-tech industries, Santa Clara accounted for at least half of the Valley's industry employment; in 5 of 11 industries, all of which were in manufacturing, Santa Clara had more

Table 7. High-tech employment in Silicon Valley, by county; 2000, 2004, and 2008

County	2000		2004		2008	
	Employment	Percent of total	Employment	Percent of total	Employment	Percent of total
Silicon Valley total.....	544,387	100.0	403,994	100.0	435,958	100.0
Santa Clara.....	311,941	57.3	217,980	54.0	238,747	54.8
Alameda.....	82,324	15.1	72,430	17.9	71,378	16.4
San Mateo.....	60,166	11.1	53,122	13.1	59,155	13.6
San Francisco.....	53,294	9.8	31,542	7.8	40,556	9.3
Contra Costa.....	28,727	5.3	23,839	5.9	21,928	5.0
Santa Cruz.....	7,935	1.5	5,081	1.3	4,194	1.0

Table 8. Average annual wages (in year 2000 dollars) for high tech in Silicon Valley, by county; 2000, 2004, and 2008

County	2000	2004	2008	Percent change, 2000-04	Percent change, 2004-08
Silicon Valley average.....	120,064	101,057	103,850	-15.8	2.8
San Mateo.....	139,487	110,713	111,915	-20.6	1.1
Santa Clara.....	137,779	112,868	115,302	-18.1	2.2
Santa Cruz.....	93,890	78,868	63,368	-16.0	-19.7
San Francisco.....	87,692	80,327	88,672	-8.4	10.4
Alameda.....	78,815	77,267	79,636	-2.0	3.1
Contra Costa.....	72,515	75,978	72,040	4.8	-5.2

than two-thirds of the industry's total employment: the 5 industries were the manufacturing of computers, communications equipment, semiconductors, electronic instruments, and aerospace products and parts. This trend—of Santa Clara accounting for a large percentage of industries' employment—was even stronger in 2000 and nearly as strong in 2004 than in 2008.

As would be expected, the distribution patterns of high-tech employment across Silicon Valley counties were driven primarily by the high-tech industrial mix in each county. Between 2000 and 2008, Santa Clara County suffered the largest percentage of job losses, 23.5 percent, mainly due to its larger concentration of employment in manufacturing. San Mateo County had relatively stable high-tech employment levels because of its larger concentration in growth industries like pharmaceuticals and scientific research. Over the 8-year period, the general trend was a shift of high-tech employment away from Santa Clara, Santa Cruz, and Contra Costa Counties towards San Mateo and Alameda Counties. San Francisco County lost the largest percentage (40.8 percent) of high-tech workers between 2000 and 2004, but recovered slightly more than 9,000 jobs between 2004 and 2008, primarily due to a resurgence of the computer systems design industry group.

Wage trends across Silicon Valley counties. Of the six counties in Silicon Valley, San Mateo and Santa Clara had the highest average annual wages throughout the

analysis period. (See table 8.) The higher wages in these counties are due mainly to the industrial mix in each county. San Mateo and Santa Clara had a larger concentration of jobs in higher paying high-tech industries such as software publishers, computer manufacturing, and pharmaceuticals. Between 2000 and 2004, when real annual wages shrank in most manufacturing industries, San Mateo and Santa Clara suffered the largest wage declines: 20.6 percent and 18.1 percent, respectively. Though Contra Costa was the only county to experience a rise in average wages between 2000 and 2004, it and Santa Cruz were the only counties to experience a decline in wages from 2004 to 2008. During this latter period, San Francisco County had the greatest wage growth (10.4 percent) of all the counties in Silicon Valley, and it experienced wage growth in nearly all of its high-tech industries.

FROM 2000 to 2008, SILICON VALLEY high-tech industries shed more than 108,400 jobs, or 19.9 percent of their total workforce, and real wages decreased by 13.5 percent. Among the area's high-tech industries, semiconductor manufacturing lost the most jobs (more than 34,000) and had the second-highest percentage decline, 37.3 percent. The percentage decline in communications equipment manufacturing was more substantial (43.8 percent). Bucking the trend, pharmaceuticals (38.0 percent employment growth) and scientific research (10.3 percent employment growth) were the only industries that had surpassed 2000

employment levels by 2008. In addition, these two industries were the only ones to have sustained growth throughout the 8-year period. Outside Silicon Valley, high-tech industries lost nearly 431,000 jobs but had a more modest 6.2-percent rate of decline in employment over the 2000–08 period. Real wages in non-Silicon Valley high-tech industries increased 1.3 percent.

Despite the loss in wages and relatively higher rate of employment decline in comparison with high-tech industries in the rest of the country, Silicon Valley high-tech industries remained prominent with regard to not only the number of jobs, but also the number of jobs paying

high wages. Silicon Valley high-tech workers were earning nearly 61 percent more than their counterparts in the rest of the Nation in 2008. In addition, from 2000 to 2008 most high-tech industries grew in concentration in Silicon Valley at a faster rate than they grew in concentration in the United States. In recent years, Silicon Valley's high-tech sector has had a resurgence, which has been led by biotech and Internet companies as well as a new investment boom in the emerging area of clean environment technology.⁴⁰ Silicon Valley thus continues to evolve while still remaining a breeding ground for technological advancement and ingenuity. □

Notes

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⁸ 2008 was chosen as the end year for the study because it was the most current year for which data were available. In addition, 2008 represented a year of growth for high tech in Silicon Valley (despite the recession), and during that year employment reached its highest level since 2000.

⁹ NAICS groups establishments into industries on the basis of the activities in which the establishments are primarily engaged.

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¹⁴ The wage data used in this article are average weekly wage figures that come from the Quarterly Census of Employment and Wages, 2000–08.

¹⁵ The average annual wage data that were used were deflated by use of the San Francisco-Oakland-San Jose Consumer Price Index for all Urban Consumers (CPI-U). All average annual wages are in 2000 dollars.

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¹⁷ Chris O'Brien and Jack Davis, "Valley steps up its rebound for second straight year," *San Jose Mercury News*, Apr. 10, 2006.

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²¹ Pui-Wing Tam, "Market Is Hot For High-Skilled In Silicon Valley," *The Wall Street Journal*, Feb. 28, 2006.

²² O'Brien and Davis, "Valley steps up its rebound."

²³ *Ibid.*

²⁴ Self-employed people—including independent contractors—are among those not covered under unemployment insurance and hence are not captured in the Quarterly Census of Employment and Wages. In addition, there is no way to disaggregate those who are self-employed and work in high-tech industries and those who are self-employed and work in other industries.

²⁵ These wage data were deflated by use of the San Francisco-Oakland-San Jose Consumer Price Index for all Urban Consumers (CPI-U).

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³³ Ibid.

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³⁵ John Tracy, "Drivers and Challenges for U.S. Aerospace Manufacturing," from *New Directions in Manufacturing: Report of a workshop*, National Research Council, 2004.

³⁶ "Offshore Outsourcing in an Increasingly Competitive and Rapidly Changing World," American Electronics Association, March 2004, p.4, on the Internet at www.aeanet.org/publications/IDMK_AeA_Offshore_Outourcing.asp (visited Jan. 8, 2010).

³⁷ Location quotients are calculated with the following equation:

$$LQ = \frac{\frac{E_{it}}{E_{it}}}{\frac{E_{it}}{E_{nt}}}$$

where l represents local employment, n represents national employment, i represents industry employment, and t represents total employment.

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