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Trends among native- and foreign-origin workers in U.S. computer industries

The share of foreign-born workers in the U.S. information technology (IT) industry is much higher than their share of the labor force. In fact, foreign-born workers hold more than half the creative IT jobs located in metropolitan areas where IT innovation clusters are located. Nevertheless, except for in Silicon Valley, U.S.-born workers and workers born abroad to American parents still hold the highest proportion of creative IT jobs.

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The foreign-born labor force and its importance in the U.S. IT industry

The information technology (IT) industry plays a major role in the U.S. economy. In 2013, this industry accounted for a 9.4-percent share of U.S. business-sector value added and 5.7 percent of total employment.[1] Its major players are global companies (e.g., Microsoft, Apple, Oracle, Google/Alphabet, Facebook) that set trends and account for a large share of U.S. gross domestic product and exports. However, its importance is far greater than its direct output because IT is considered one of the "advanced industries" instrumental in fostering sustainable growth.[2] Moreover, IT supports (directly and indirectly) almost one-fourth of U.S. employment.[3]

Anecdotal evidence and scientific research highlight the importance of the foreign-born labor force in the U.S. IT industry. Silicon Valley success stories and executive appointments often involve foreign-born, highly skilled professionals emerging as IT industry leaders. These success stories are used as a contemporary illustration of the American Dream and help attract ambitious, young IT professionals from around the world to the United States. Outside the United States, there is a strong perception

that fortunes of many successful U.S. companies rest almost exclusively on foreign-born labor, with little credit given to the native-born labor force.

These perceptions and the importance of this industry as one of the main drivers of foreign trade and economic growth motivated us to assess the industry labor composition's magnitude and trends. This article helps provide an objective picture of native- versus foreign-born labor in the U.S. IT industry. Our analysis focuses on

1. whether there is evidence of displacement of native IT professionals,
2. occupational differences between native- and foreign-born IT workers, and
3. whether the relative shares of the two groups change as jobs have a higher creative content and are located in metropolitan areas identified as IT innovation clusters.

Definitions, data, and methods

Data for our study come from several integrated public-use microdata series (IPUMS-USA) samples.[4] The data are from 1980, 1990, and 2000 5-percent Census samples as well as American Community Survey (ACS) samples starting in 2001. Because ACS was not fully implemented until 2006, 2001–04 samples, although nationally representative, covered only about 0.4 percent of the U.S. population, while the remaining samples (2005–14) had 1-percent coverage. Our choice of data was motivated by the fact that they are comparable across years and data sources.

ACS data cover the 1980–2014 period. The ACS collects data by worker origin, enabling distinction between native born and foreign born, and also collects detailed occupation and industry information.

To select the IT professionals having creative IT jobs, we used occupation and industry variables from harmonized coding schemes, implemented in IPUMS on the basis of ACS occupation and industry variables used across various periods. Occupation information comes from a harmonized coding scheme based on the Census Bureau's 2010 ACS occupation classification scheme, modified to achieve consistent categories across time. Some categories were grouped because older categories included two or more occupations coded together that could not be split. Similarly, the industry variable classifies industries from all years since 1950 into the 1990 Census Bureau industrial classification scheme to achieve a consistent classification of industries. We chose the 1990 scheme as the standard in order to effectively accommodate the two most significant changes in industry codes: the changes from 1970 to 1980 and from 1990 to 2000.

We used Census Bureau "occupational crosswalks," which provide occupation and industry codes for double-coded items for each census year, in creating these variables. Our methodology was similar to the one described in a BLS working paper.[5]

Our analysis starts with the shares of the overall labor force—that is, the employed and the unemployed—composed of native-born workers and foreign-born workers and compares them with the shares of native- and foreign-born workers in the following IT professions:

- Computer scientists and systems analysts, network systems analysts, and web developers
- Computer programmers
- Software developers

- Computer support specialists
- Database administrators
- Network and computer systems administrators
- Computer hardware engineers
- Computer and information systems managers

We then focused our analysis on creative IT professions, which are defined as those

1. not involving repair, support, maintenance, or administration as their main tasks; and
2. found in the computers and related equipment industry and computer and data processing services industry; and
3. located in metropolitan areas identified as IT innovation clusters.

These professions are computer scientists and systems analysts, network systems analysts, and web developers; computer programmers; software developers; and computer hardware engineers. They involve designing solutions for IT systems to operate more efficiently; creating new IT products such as websites, computer programs, applications, or systems; or researching, designing, developing, and testing computer systems and components.[6] We placed computer and information systems managers in these categories because they plan, determine, and direct computer-related activities; establish IT-related goals; and pursue their implementation. In our opinion, occupations located in the metropolitan areas identified as IT innovation clusters are more likely to entail a significant share of creative content and thus are suitable for our analysis. Also, occupations located in the computer and data processing services and the computers and related equipment industries (manufacturing) within the IT innovation clusters would ensure that their content is highly likely to be creative because it is linked to designing and creating software and hardware products. Computers and related equipment industries as a whole would contain a large percentage of manufacturing jobs. However, the combined creative occupations and IT innovation cluster criteria ensure that workers involved in the development and design of new products—which include solving issues relating to incorporating new technologies in a feasible way in end products—are selected.

The metropolitan areas where IT innovative clusters are located were selected on the basis of having the largest number of patents filed for the computer hardware and peripherals and computer software subcategories.[7] These are

- San Jose–Sunnyvale–Santa Clara, CA, also known as Silicon Valley;
- Seattle–Tacoma–Bellevue, WA;
- Austin–Round Rock–San Marcos, TX;
- Portland–Vancouver–Hillsboro, OR–WA; and
- Raleigh–Cary, NC, also known as Research Triangle.

Because the annual estimates show a high degree of volatility, we chose, whenever necessary, to present and analyze 5-year averages for creative IT jobs located in IT innovation clusters.

Relatively more foreign-born workers in IT industry

Table 1 shows the proportion of native- and foreign-born workers (both employed and unemployed) in the U.S. labor force. The share of native-born workers has decreased by 10 percentage points from 1980 to 2014. The share declined 2.6 percentage points from 1980 to 1990, 3.2 percentage points from 1990 to 2000, and 4.2 percentage points from 2000 to 2014. Over the 34-year period, the average annual decrease was 0.4 percentage point. By contrast, the share of foreign-born workers was 2.5 times larger in 2014 than in 1980.

Table 1. U.S. civilian labor force, by nativity, 1980, 1990, and 2000–14 (numbers in thousands)

Year	Total	Native-origin labor force		Foreign-origin labor force					
		Number	Percent of total	Number	Percent of total	Naturalized citizens		Noncitizens	
						Number	Percent of total	Number	Percent of total
1980	105,749	98,701	93.3	7,048	6.7	3,395	3.2	3,653	3.5
1990	124,928	113,335	90.7	11,593	9.3	4,742	3.8	6,851	5.5
2000	138,831	121,520	87.5	17,312	12.5	7,268	5.2	10,043	7.2
2001	140,604	121,426	86.4	19,177	13.6	7,909	5.6	11,269	8.0
2002	143,062	122,709	85.8	20,353	14.2	8,492	5.9	11,861	8.3
2003	144,039	123,338	85.6	20,701	14.4	8,705	6.0	11,996	8.3
2004	145,466	124,226	85.4	21,239	14.6	8,966	6.2	12,273	8.4
2005	147,279	125,089	84.9	22,190	15.1	9,259	6.3	12,931	8.8
2006	152,216	128,626	84.5	23,591	15.5	9,950	6.5	13,641	9.0
2007	153,255	129,335	84.4	23,920	15.6	10,175	6.6	13,745	9.0
2008	157,471	132,837	84.4	24,634	15.6	10,653	6.8	13,982	8.9
2009	157,420	132,496	84.2	24,924	15.8	11,015	7.0	13,909	8.8
2010	157,032	131,515	83.8	25,517	16.2	11,325	7.2	14,192	9.0
2011	157,515	131,759	83.6	25,756	16.4	11,772	7.5	13,984	8.9
2012	158,880	132,940	83.7	25,940	16.3	12,008	7.6	13,932	8.8
2013	159,589	133,312	83.5	26,277	16.5	12,405	7.8	13,872	8.7
2014	160,528	133,798	83.3	26,730	16.7	12,753	7.9	13,977	8.7

Note: Because of rounding, percentages may not add up to 100.

Source: IPUMS-USA and authors' calculations.

The share of naturalized citizens increased steadily over the 1980–2014 period, recording an average annual increase of 0.2 percentage point. While having the same average annual increase, the share of noncitizens plateaued at or close to 9.0 percent from 2006 through 2010. Thus, while the share of native-born workers decreased, this 10-percent share decrease coincided with a 35.5-percent increase in the number of native-born workers from 1980 to 2014. This increase accounted for more than two-thirds of the 51.9-percent increase of the U.S. labor force over the same period. Also, a 1-percent annual average increase in the number of native-born workers started from a base of 98 million in 1980, compared with an 8.2-percent annual increase in the size of the foreign-born labor force, which started from a base of only 7 million in the same year.

Table 2 shows the trends observed in all IT occupations in the United States. We observe a decline of 16.6 percentage points from 1980 to 2014 in the share of native-born workers in IT occupations. The decrease from 2000 to 2014 totaled 6 percentage points, close to the 6.1-percentage-point decline recorded from 1990 to 2000 and larger than the 4.3-percentage-point decline recorded in the 80s. On an annual basis, the share of native-born

workers in the IT-related labor force decreased by 0.5 percentage point from 1980 to 2014 and 0.4 percentage point from 2000 to 2014.

Table 2. U.S. civilian labor force in computer occupations (all industries), by nativity, 1980, 1990, and 2000–14 (numbers in thousands)

Year	Total	Native-origin labor force		Foreign-origin labor force					
		Number	Percent of total	Number	Percent of total	Naturalized citizens		Noncitizens	
						Number	Percent of total	Number	Percent of total
1980	518.1	480.8	92.8	37.3	7.2	18.0	3.5	19.3	3.7
1990	1,133.0	1,003.1	88.5	129.9	11.5	65.8	5.8	64.0	5.7
2000	3,482.3	2,869.4	82.4	612.9	17.6	260.6	7.5	352.3	10.1
2001	3,782.5	3,064.8	81.0	717.7	19.0	309.2	8.2	408.5	10.8
2002	3,726.3	3,012.4	80.8	713.9	19.2	314.2	8.4	399.7	10.7
2003	3,631.0	2,913.3	80.2	717.7	19.8	326.9	9.0	390.8	10.8
2004	3,567.0	2,846.6	79.8	720.4	20.2	344.0	9.6	376.4	10.6
2005	3,594.5	2,837.0	78.9	757.5	21.1	347.7	9.7	409.8	11.4
2006	3,699.5	2,913.1	78.7	786.4	21.3	361.3	9.8	425.1	11.5
2007	3,778.2	2,977.1	78.8	801.1	21.2	394.5	10.4	406.6	10.8
2008	3,920.1	3,075.7	78.5	844.4	21.5	413.9	10.6	430.5	11.0
2009	4,035.6	3,159.7	78.3	875.9	21.7	439.8	10.9	436.1	10.8
2010	4,014.3	3,114.8	77.6	899.5	22.4	446.0	11.1	453.5	11.3
2011	4,119.6	3,193.9	77.5	925.7	22.5	481.7	11.7	444.0	10.8
2012	4,244.2	3,258.2	76.8	986.1	23.2	498.7	11.7	487.4	11.5
2013	4,416.9	3,381.5	76.6	1,035.5	23.4	521.5	11.8	514.0	11.6
2014	4,662.7	3,551.4	76.2	1,111.4	23.8	564.7	12.1	546.7	11.7

Note: Because of rounding, percentages may not add up to 100.

Source: IPUMS-USA and authors' calculations.

The 2000–14 decrease was accompanied by a steady increase in the share of IT-related workers who were naturalized citizens, totaling 4.6 percentage points. After jumping from 5.7 percent in 1990 to over 10 percent in the 2000s, the noncitizens' share was relatively stable, fluctuating between 10.1 percent and 11.5 percent, from 2000 to 2012. In 2013 and 2014, their share increased slightly, by 0.1 percentage point each year, above the previous high. Similarly, more foreign-born professionals were working in U.S. IT occupations. However, results of a paired *t*-test reveal a significant difference between the share of foreign-born workers in the U.S. labor force and their share in IT occupations ($t = -13.33$, p-value = 0). This difference should be considered along with the average annual increase of 33.6 percent in the size of IT labor force from 1980 to 2000 and of 2.4 percent from 2000 to 2014.

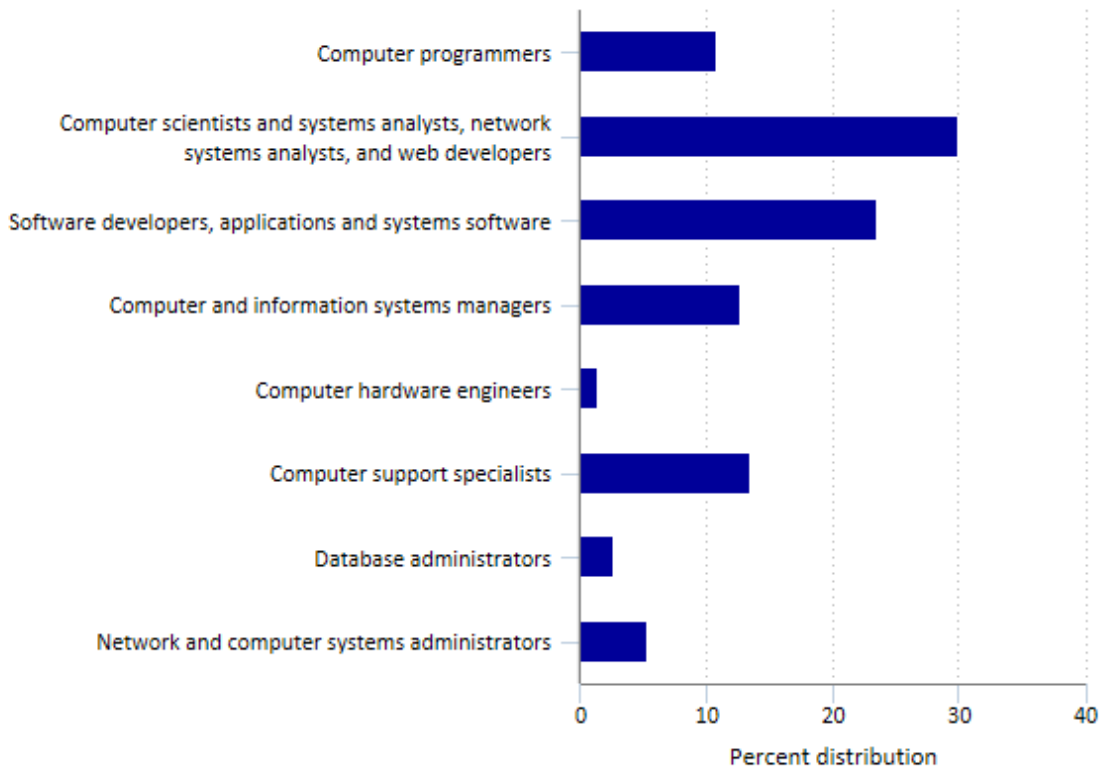
The share of foreign-born workers in IT occupations in 2014 was 7.1 percentage points higher than the share of foreign-born workers in the total U.S. labor force. Hence, the representation of the native-born labor force in IT occupations is lower than its share of the total labor force. However, native-born workers still account for more than three-fourths of the workers in IT occupations.

Given that the IT labor force had grown to about its current size by 2000, we consider the year 2000 to be when the IT industry reached maturity. However, we chose 2010 as a starting point for our analysis of the shares of the overall IT labor force, by profession and native-born versus foreign-born status, to focus on the recent period. We chose 2005 as the starting point for our analysis of creative IT jobs for two reasons: (1) we wanted to analyze the current period as accurately as possible, and (2) we needed to accommodate a small creative-IT sample and so we had to draw in data for a larger number of years.

Occupational specialization by place of origin

A snapshot of the occupational structure for all IT jobs in the United States, shown in figure 1, reveals that the largest share in 2010–14 was held by the computer scientists and systems analysts, network systems analysts, and web developers occupation, which accounted for 30 percent of IT jobs. The second largest category consisted of software developers, followed closely by support occupations (support specialists, database administrators, and systems administrators), with 22 percent. Managers and programmers were the next largest occupations. Hardware engineers represented the smallest occupational group in the U.S. IT industry.

Figure 1. U.S. civilian labor force in IT occupations (all industries), 2010–14 average

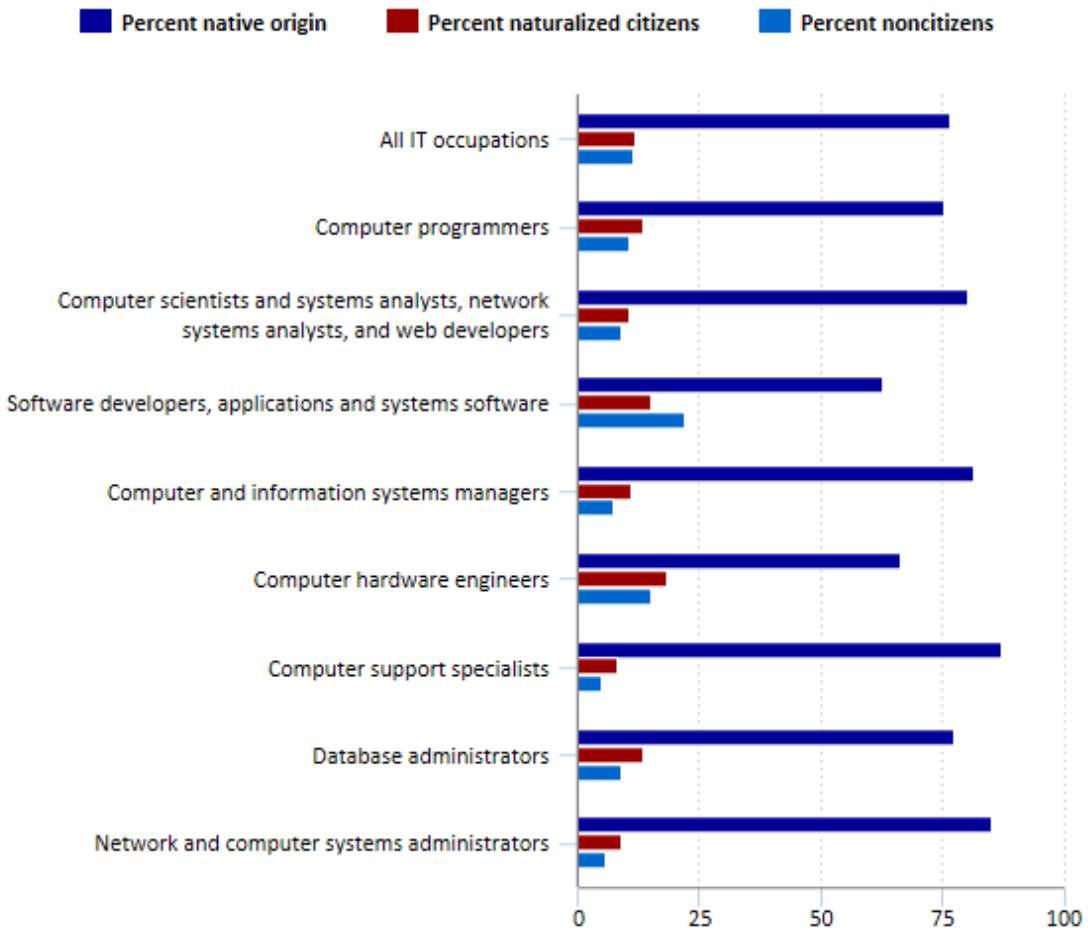


Note: Because of rounding, percentages may not add up to 100.
Source: IPUMS-USA and authors' calculations.

The place of origin of IT workers, shown in figure 2, differs by occupation. The native-born labor force was better represented in support and in network and computer systems administration occupations than in other IT occupations. Just over 87 percent of IT support workers and 85 percent network and computer systems

administration workers were of native born, compared with 77 percent of all IT workers. The share of native-born workers was slightly above their average share in management positions, too (by 4.9 percentage points) and in computer scientists and analysts and web developers jobs (by 3.7 percentage points). Native-born workers, however, were significantly less prevalent in software development and hardware engineering jobs. The shares of native-born workers in these two IT occupations were 14.1 percentage points and 10.4 percentage points, respectively, lower than their average share in all computer occupations.

Figure 2. Nativity of U.S. civilian labor force in IT occupations (all industries), 2010–14 average



Note: Because of rounding, percentages may not add up to 100.
Source: IPUMS-USA and authors' calculations.

In all but one occupation, the share of naturalized citizens was higher than that of noncitizens. The exception is software development, in which the share of naturalized citizens was larger by almost one third. The share of noncitizens was substantially smaller than that of naturalized citizens in administration, management, and support occupations. In these occupations, the native-born labor force had a higher share relative to its average share for all IT occupations.

Foreign-born workers in creative IT occupations

In 1990, 30 percent of the technology workforce of Silicon Valley was foreign born.[8] As noted earlier, however, a perception exists that the share of foreign-born IT workers is much larger.

To provide an objective assessment of the role of foreign-born workers, we hypothesized—on the basis of the occupational profile findings—that these workers are less numerous in support and maintenance activities (computer support specialists, database administrators, and network and computer systems administrators). We also hypothesized that they tend to concentrate in the creative IT occupations mentioned earlier in this article. Because of the need for effective leadership in ensuring success in high-tech startups, management jobs were considered occupations with a higher creative content.

Table 3 shows that the share of foreign-born workers is larger in IT jobs with higher creative content. The share of foreign-born workers was more than 28 percent each year from 2005 to 2014 (the most recent year we analyzed). Since 2005, the share in creative IT jobs was 7.7 to 9.7 percentage points higher than their share in all IT occupations. Among foreign-born IT workers, noncitizens held the highest share; their share exceeded that of naturalized citizens by at least 5.5 percentage points each year since 2005.

Table 3. U.S. civilian labor force in creative computer occupations in IT industries, by nativity, 1980, 1990, and 2000–14 (numbers in thousands)

Year	Total	Native-origin labor force		Foreign-origin labor force					
						Naturalized citizens		Noncitizens	
		Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total
1980	135.0	124.1	91.9	10.9	8.1	4.9	3.6	6.0	4.4
1990	315.1	273.9	86.9	41.2	13.1	18.5	5.9	22.7	7.2
2000	850.1	644.6	75.8	205.5	24.2	69.8	8.2	135.7	16.0
2001	973.4	723.3	74.3	250.1	25.7	97.3	10.0	152.8	15.7
2002	919.1	674.5	73.4	244.6	26.6	85.5	9.3	159.1	17.3
2003	904.0	655.3	72.5	248.7	27.5	97.6	10.8	151.1	16.7
2004	899.0	646.3	71.9	252.6	28.1	94.9	10.6	157.7	17.5
2005	894.0	636.1	71.2	257.8	28.8	97.7	10.9	160.1	17.9
2006	944.1	666.3	70.6	277.8	29.4	104.9	11.1	172.9	18.3
2007	968.2	693.6	71.6	274.7	28.4	110.5	11.4	164.2	17.0
2008	1,027.9	723.7	70.4	304.2	29.6	121.7	11.8	182.5	17.8
2009	1,018.5	708.9	69.6	309.6	30.4	128.2	12.6	181.4	17.8
2010	998.7	685.0	68.6	313.7	31.4	125.3	12.5	188.3	18.9
2011	1,055.7	719.9	68.2	335.9	31.8	138.9	13.2	197.0	18.7
2012	1,129.8	757.3	67.0	372.5	33.0	148.0	13.1	224.5	19.9
2013	1,164.7	779.2	66.9	385.4	33.1	157.1	13.5	228.4	19.6
2014	1,238.2	826.4	66.7	411.8	33.3	162.6	13.1	249.2	20.1

Note: Because of rounding, percentages may not add up to 100.

Source: IPUMS-USA and authors' calculations.

Trends were slightly different for IT workers in creative occupations compared with workers in all IT occupations. The 4.5-percentage-point decrease in the share of the native-born labor force in creative IT occupations from 2005 to 2014 was much larger than the 2.7-percentage-point decline in their share of all IT occupations over the same period. The share of noncitizens in creative IT occupations showed continuous increases and stayed above the share of naturalized citizens from 2005 to 2014. By contrast, for all IT occupations, the share of noncitizens was below that of naturalized citizens since 2009. The biggest increase in the numbers was, again, recorded by naturalized citizens, increasing by 62.4 percent from 2005 to 2014 for all IT occupations. Overall, the number of people employed in creative IT occupations grew by 38.5 percent from 2005 to 2014, compared with a 29.7-percent increase in all IT occupations in the same period. Foreign-born workers accounted for 44.7 percent of the increase in creative IT workers from 2005 to 2014.

Although the share of foreign-born workers in creative IT jobs was larger than their share in all IT occupations, native-born workers numbers are increasing. They have benefited by more than half the employment growth in the IT field. Moreover, their 29.9-percent labor force growth in creative IT occupations from 2005 to 2014 is above their 25.2-percent labor force growth in all IT occupations over the same period.

A closer look at the data reveals that the native-born workers in creative IT jobs had slightly lower average unemployment rates for most periods than their naturalized-citizen counterparts, even though the higher educational attainment of the native-born workers was significantly lower. (See table 4.) The even lower unemployment rates of noncitizens, which drive down the average unemployment rates for foreign-born workers, could have several contributing factors. Some people suggest strict visa requirements and diminished economic and social support to withstand unemployment spells may be a factor.

Table 4. Average unemployment rate and percent of U.S. civilian labor force with 4 or more years of college, creative computer occupations in IT industries, by nativity, 2000–14

Period	Native-origin labor force		Foreign-origin labor force					
					Naturalized citizens		Noncitizens	
	Average unemployment rate	Percent with 4 or more years of college	Average unemployment rate	Percent with 4 or more years of college	Average unemployment rate	Percent with 4 or more years of college	Average unemployment rate	Percent with 4 or more years of college
2000–04	6.2	65.8	6.1	88.0	8.7	NA	NA	NA
2005–09	4.2	67.6	3.2	90.8	4.2	87.2	2.6	93.2
2010–14	4.6	68.5	3.3	91.9	4.5	88.4	2.6	94.2
2000–14	5.0	67.3	4.2	90.2	5.8	86.2	3.2	92.7

Note: NA stands for not available.

Source: IPUMS-USA and authors' calculations.

Creative jobs in innovation-leading metropolitan areas

On the basis of a Brookings policy report, we defined innovation-leading metropolitan areas as those with patents in the computer software subcategory and computer hardware and peripherals subcategory.[9] As noted earlier, these areas are San Jose–Sunnyvale–Santa Clara, CA (Silicon Valley); Seattle–Tacoma–Bellevue, WA; Austin–Round Rock–San Marcos, TX; Portland–Vancouver–Hillsboro, OR–WA; and Raleigh–Cary, NC (Research Triangle), all home to major IT companies.

The employment trends we have already discussed are amplified in these metropolitan areas. As shown in table 5, the foreign-born labor force was larger than the native-born labor force in creative computer occupations in innovative IT clusters in 2012 through 2014. The largest increase is observed for noncitizens, whose number grew by 52.3 percent from 2005 to 2014, with their labor force share surpassing one-third since 2012. The number of naturalized citizens in creative computer occupations in innovative IT clusters increased 42.5 percent. The share of native-born workers declined in all but one year, falling from about 57.4 percent in 2005 to 47.1 percent in 2014, while their numbers were fairly constant.

Table 5. U.S. civilian labor force, creative computer occupations in IT industries in metropolitan areas with innovative IT clusters, by nativity, 1980, 1990, and 2000–14 (numbers in thousands)

Year	Total	Native-origin labor force		Foreign-origin labor force					
						Naturalized citizens		Noncitizens	
		Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total
1980	11.5	10.2	89.4	1.2	10.7	0.6	4.9	0.7	5.8
1990	31.1	24.6	79.0	6.5	21.0	3.0	9.5	3.6	11.5
2000	99.9	62.5	62.5	37.5	37.5	12.1	12.1	25.4	25.4
2005	120.5	69.1	57.4	51.3	42.6	18.1	15.0	33.3	27.6
2006	116.1	66.3	57.1	49.8	42.9	15.7	13.5	34.1	29.4
2007	123.3	71.8	58.3	51.4	41.7	19.6	15.9	31.8	25.8
2008	124.0	68.3	55.1	55.7	44.9	18.4	14.8	37.3	30.1
2009	136.2	74.4	54.6	61.8	45.4	24.0	17.6	37.9	27.8
2010	132.4	71.7	54.2	60.7	45.9	23.3	17.6	37.4	28.3
2011	144.3	76.0	52.7	68.3	47.3	25.4	17.6	42.9	29.7
2012	136.4	68.0	49.9	68.4	50.1	23.0	16.9	45.4	33.3
2013	140.1	68.0	48.5	72.1	51.5	25.6	18.3	46.5	33.2
2014	144.6	68.2	47.1	76.5	52.9	25.8	17.8	50.7	35.1

Note: Because of rounding, percentages may not add up to 100.

Source: IPUMS-USA and authors' calculations.

Silicon Valley stands out in the IT industry as the most dynamic metropolitan area in terms of number of patents and numbers and value of initial public offerings. As a result, we looked at region-specific statistics to see whether the same trends we observed for all metropolitan IT innovation clusters were also true for Silicon Valley.[10] The small number of observations caused much estimate variability, so we show 5-year averages for the 2005–09 and 2010–14 periods. (See table 6.)

Table 6. U.S. civilian labor force, creative computer occupations in IT industries in Silicon Valley, by nativity, 1980, 1990, and 2000–14 (numbers in thousands)

Period	Total	Native-origin labor force		Foreign-origin labor force					
		Number	Percent of total	Number	Percent of total	Naturalized citizens		Noncitizens	
						Number	Percent of total	Number	Percent of total
1980	6.2	5.3	85.5	0.9	14.5	0.4	6.8	0.5	7.7
1990	15.7	11.0	70.0	4.7	30.0	2.2	13.7	2.6	16.4
2000	38.6	15.7	40.8	22.9	59.2	7.9	20.3	15.0	38.9
2005–09	40.8	12.1	29.6	28.7	70.4	11.4	27.9	17.3	42.5
2010–14	50.6	14.7	29.1	35.9	70.9	14.6	28.9	21.2	41.9

Note: Because of rounding, percentages may not add up to 100. Data for 2005–09 and 2010–14 represent annual averages for these periods.

Source: IPUMS-USA and authors' calculations.

Silicon Valley has a different situation than other IT innovation clusters. In Silicon Valley, the native-born labor force decreased during the 2005–09 period before it partially rebounded during the 2010–14 period. The foreign-born labor force was larger than the native-born labor force during the 2005–14 period, and noncitizens composed more than 40 percent of the area's creative computer workers since 2005. This situation is entirely different than that for the other IT innovation clusters, in which the native-born labor force was the largest group, followed by noncitizens. In all areas combined, naturalized citizens were the third largest group, while their numbers in Silicon Valley were slightly below those of native-born creative computer workers since the 2005–09 period. These findings appear to be supported by statistics from other sources. In 1990, foreign-born workers made up 30 percent of the high-technology labor force, according to Claudia Bird Schoonhoven and Elaine Romanelli.[11] The 2016 *Silicon Valley Index* stated that "nearly 74 percent of all Silicon Valley employed computer and mathematical workers ages 25–44 are foreign born."[12]

Given the size of the Silicon Valley labor force in creative IT jobs and the differences we observed in the trends for all IT innovation clusters, our next goal was to see how trends for the other IT clusters compare with the ones observed in the Valley.

Data in tables 3 and 7 show that the evolution of the native-born labor force in metropolitan areas other than Silicon Valley with innovative IT clusters was similar to that for creative IT jobs in IT industries in the United States. While the decline in the share of the native-born labor force from 2005 to the 2010–14 period is significant, the native-born share did not fall below 60 percent. Noncitizens showed the strongest increases, with their share rising from 21.1 percent to 26.3 percent, which exceeded their 20-percent share in total U.S. creative IT jobs in IT industries. Naturalized citizens formed the smallest group with the smallest increase, rising 1.9 percentage points from 9.3 percent in 2005 to 11.2 percent during the 2010–14 period. Their 2010–14 share was about 2 percentage points below their share of total U.S. creative IT jobs in IT industries. Most of the labor force growth in the metropolitan areas other than Silicon Valley from 2005 to 2014 was among noncitizens.

Table 7. U.S. civilian labor force, creative computer occupations in IT industries in metropolitan areas other than Silicon Valley with innovative IT clusters, by nativity, 1980, 1990, and 2000–14 (numbers in thousands)

Period	Total	Native-origin labor force		Foreign-origin labor force					
		Number	Percent of total	Number	Percent of total	Naturalized citizens		Noncitizens	
						Number	Percent of total	Number	Percent of total
1980	5.3	4.9	93.9	0.3	6.1	0.1	2.7	0.2	3.4
1990	15.4	13.6	88.2	1.8	11.8	0.8	5.2	1.0	6.6
2000	61.3	46.7	76.2	14.6	23.8	4.2	6.9	10.4	16.9
2005–09	83.2	57.9	69.6	25.3	30.4	7.8	9.3	17.6	21.1
2010–14	89.0	55.6	62.5	33.3	37.5	10.0	11.2	23.4	26.3

Note: Because of rounding, percentages may not add up to 100. Data for 2005–09 and 2010–14 represent annual averages for these periods.

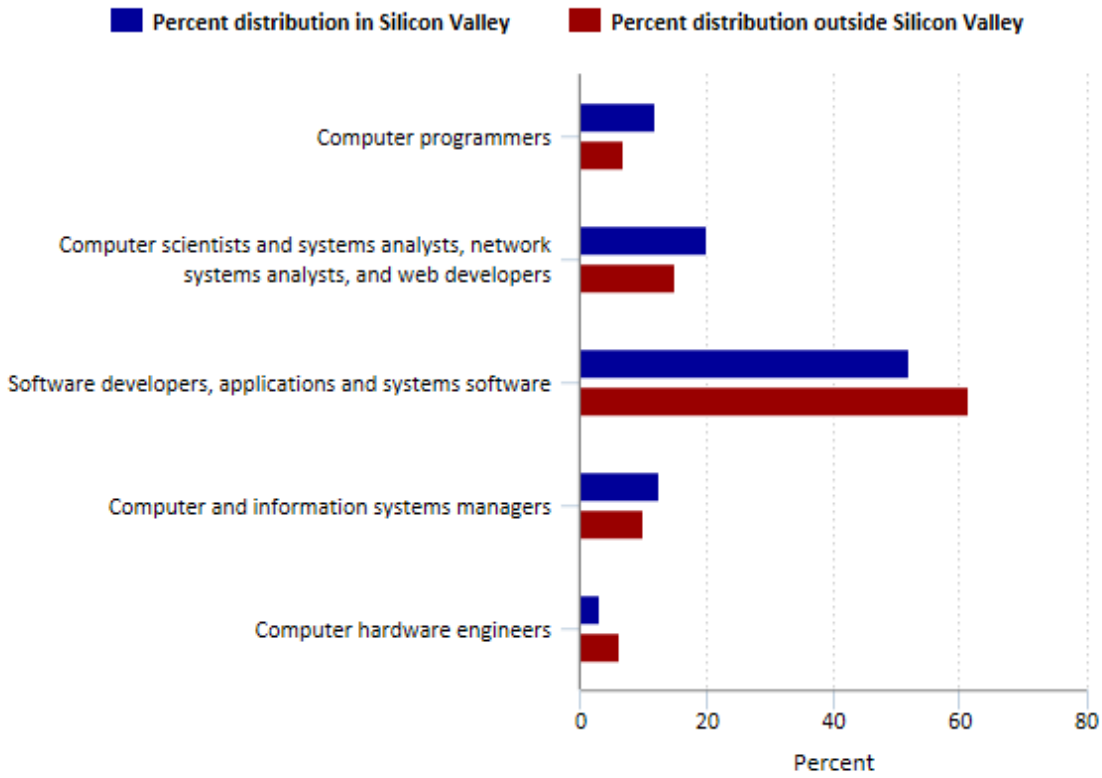
Source: IPUMS-USA and authors' calculations.

Occupational structure of IT professionals in creative IT industries

Given the differences we have observed between Silicon Valley and the other metropolitan areas identified as IT innovation leaders, we will now examine the job composition for the total United States, Silicon Valley, and other IT clusters for the 2005–09 and 2010–14 periods. We will look at which creative IT occupations have the largest share and how this share varies among native- and foreign-born workers.

There are striking differences between creative IT occupations in innovation clusters and IT occupations in the United States as a whole (see figures 1 and 3). While software developers ranked second in all U.S. IT occupations, they held the top spot in the creative IT occupations located in IT innovation clusters, accounting for over half of the creative IT labor force. Surprisingly, the computer scientists', system analysts', and web developers' share in Silicon Valley and other innovative IT clusters was much lower than that for all US IT labor force. But the largest difference was observed for hardware engineering jobs. Although they still formed the smallest group, their relative share in creative IT jobs was 3 to 6 times higher in the IT innovative clusters.

Figure 3. U.S. civilian labor force in creative IT occupations, IT industries, selected metropolitan areas, 2005–14 average



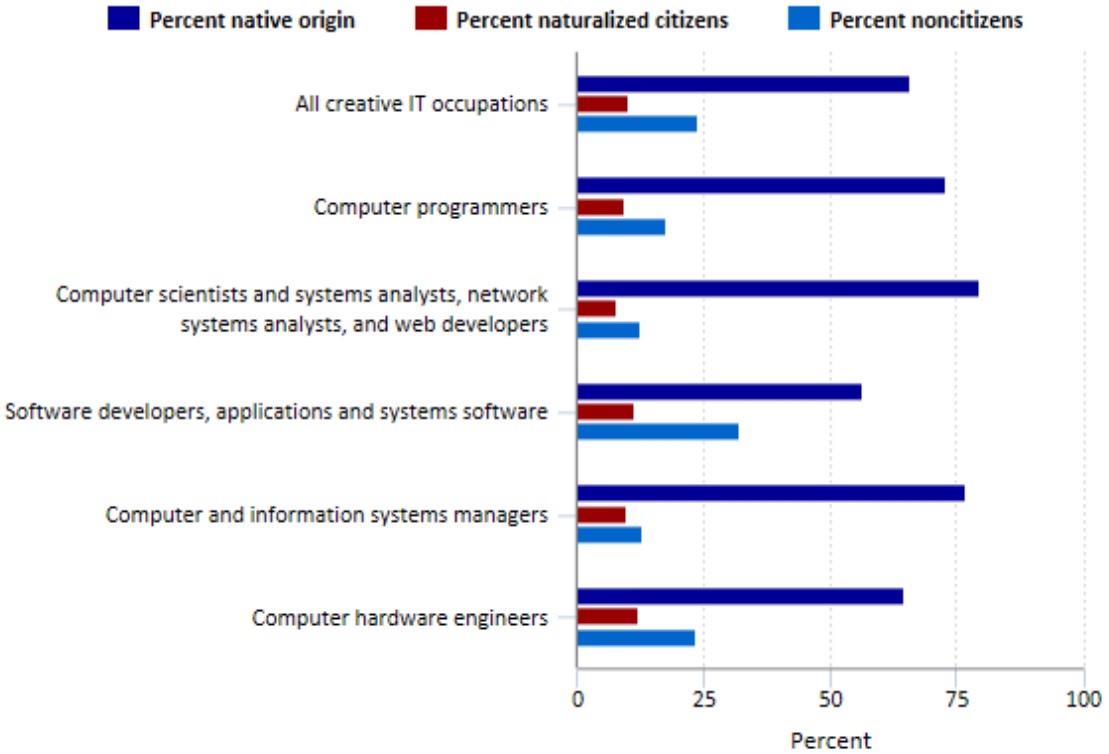
Note: Because of rounding, percentages may not add up to 100.
Source: IPUMS-USA and authors' calculations.

Software developers were the largest group, and computer scientists, system analysts, and web developers were the middle group (in terms of size) among creative IT occupations in Silicon Valley and in other metropolitan IT innovation clusters (see figure 3). Although the order of the remaining occupations was the same in Silicon Valley as in the other innovation clusters, their relative sizes show important differences. For example, the proportion of hardware engineers was twice as large in Silicon Valley, while both the proportion of programmers and the proportion of computer scientists, system analysts, and web developers was 5 percentage points lower than in the other metropolitan areas. A larger proportion of software developers in Silicon Valley accounted for the difference.

Given that the occupational rankings were the same for IT innovation clusters and the nation as a whole and, except for software developers and hardware engineers, no major differences were found in the proportions of different occupations, we recommend some caution in interpreting the remaining differences. Silicon Valley may tend to attach similar job descriptions to different occupations. For example, people called programmers elsewhere may be called software developers in the Valley. Similarly, some computer scientists, system analysts, and web developers may, in Silicon Valley, be called software developers because they are more involved in developing products than are peers in companies situated in the other metropolitan IT clusters. The differences in the names of the occupations may also be influenced by the H-1B visa requirement that applicants must demonstrate both that they will receive the prevailing wage for a specific occupation and that they meet the specialty occupation requirement.[13]

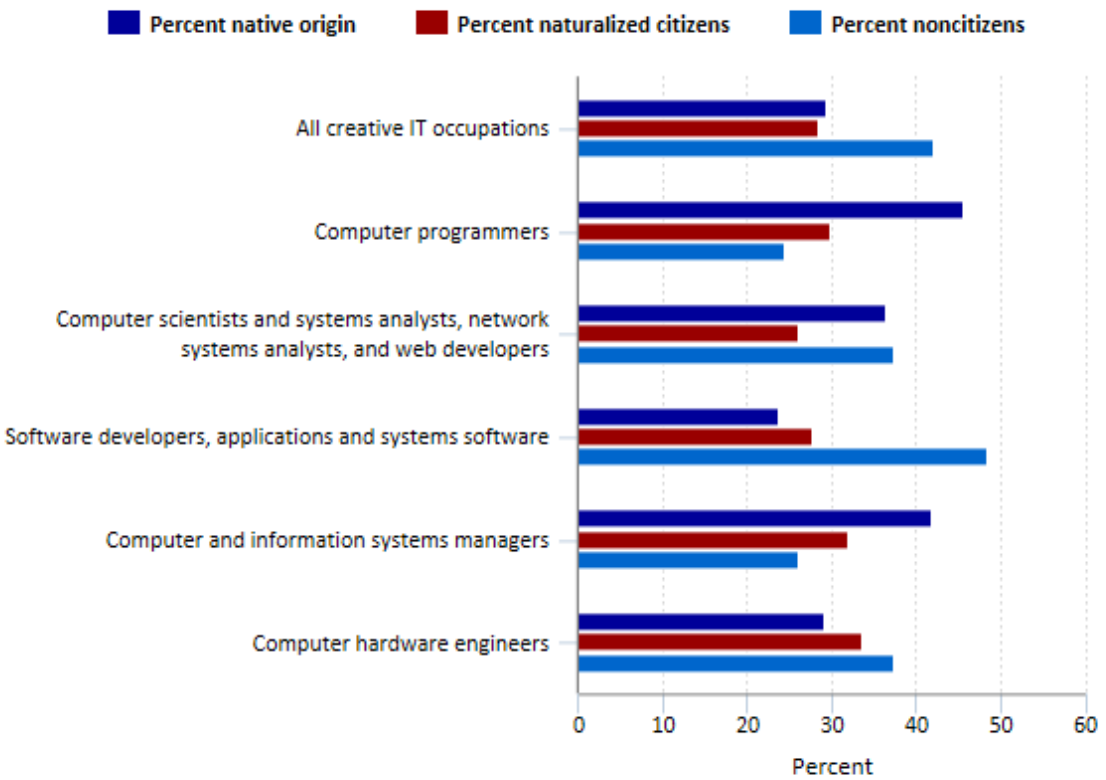
The occupation structure by citizenship status shows marked similarities between the structure of all U.S. IT occupations and the creative IT occupations located in the IT innovation clusters other than Silicon Valley (see figures 2 and 4). Despite a lower labor force share for native-born workers (65.9 percent in innovation clusters excluding Silicon Valley compared with 76.9 percent in the United States), their share was relatively higher for managers (11.0 percentage points higher than their share of all creative IT occupations in these innovation clusters) and computer scientists, system analysts, and web developers occupations (13.7 percentage points higher). For managers, this difference was more pronounced in Silicon Valley, where the proportion of native-born creative IT managers exceeds the proportion of native-born creative IT workers by 13.5 percentage points. (See figure 5.) Noncitizens' share was much larger than their average share in software development occupations and lower in all other occupations.

Figure 4. Nativity of U.S. civilian labor force in creative IT occupations in metropolitan IT clusters excluding Silicon Valley, IT industries, 2005–14 average



Note: Because of rounding, percentages may not add up to 100.
Source: IPUMS-USA and authors' calculations.

Figure 5. Nativity of U.S. civilian labor force in creative IT occupations in Silicon Valley, IT industries, 2005–14 average



Note: Because of rounding, percentages may not add up to 100.
Source: IPUMS-USA and authors' calculations.

Naturalized citizens showed a balanced profile—that is, they were about equally represented in each computer occupation—but had a slightly higher relative share in hardware engineering and software development jobs and a lower share in computer scientists, system analysts, and web developers occupations.

Although labor force composition in creative IT jobs in Silicon Valley by citizen status was different from elsewhere, with noncitizens being Silicon Valley's largest group, the Valley's occupational structural differences were similar to those for the other IT innovative clusters. Noncitizens were still more likely to hold software development jobs than other computer jobs. The major difference between Silicon Valley and other metropolitan IT clusters was that the lowest occupational share for noncitizens was in the valley's computer programmer jobs rather than in computer scientist and web developer jobs.

Native-born workers' share of total workers in creative IT occupations in Silicon Valley was similar to that of naturalized citizens. The native-born workers were highly concentrated in management and computer programmers jobs relative to their share (more than 12 percentage points higher), while their relative share in software development jobs was only 5.6 percentage points lower than their average in Silicon Valley. Like in other metropolitan IT clusters, naturalized citizens in Silicon Valley had a relatively balanced occupational profile. Their largest shares relative to their average were in hardware engineering jobs and managerial positions.

Conclusion

Despite perceptions that foreign-born workers are the main beneficiaries of the increase in IT occupations in the United States, data show that native-origin workers have benefited from at least 45 percent of the growth in most IT occupations. This finding also holds true when only creative IT occupations in IT industries are considered and even when only creative IT occupations in these industries located in IT innovative clusters are considered. Moreover, the similarities between the unemployment rates of the native-born labor force and the foreign-born labor force in creative IT jobs, despite the much higher educational attainment of the latter, may also show that foreign-born workers are not crowding out native-born workers.

It may be that the perceived role of foreign-born workers is mostly due to Silicon Valley trends, where the foreign-born labor force holds over 70 percent of the creative IT jobs. A closer look suggests that noncitizens, those in Silicon Valley as well as those in other innovation clusters, have a less balanced occupational profile than naturalized citizens, who have the most balanced profile—that is, were most evenly spread among IT occupations—of all citizen groups.

Occupational profiles for IT occupations show consistent patterns, even when the focus is narrowed to include only creative IT occupations located in metropolitan areas identified as IT innovative clusters. Noncitizens tended to have a large relative share of software development jobs and lower shares of all other IT occupations. Native-born workers were more likely to hold managerial positions, be computer scientists, system analysts, and web developers, or have computer programmer jobs. When all IT occupations in all industries were considered, native-born workers held 85 percent or more of network and system administrators and support jobs.

SUGGESTED CITATION

Adrian Otoiu and Emilia Titan, "Trends among native- and foreign-origin workers in U.S. computer industries," *Monthly Labor Review,* U.S. Bureau of Labor Statistics, December 2017, https://doi.org/10.21916/mlr.2017.32.

NOTES

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