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# Georgia's High-Technology Industry and Innovation Capacity

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**Atlanta, GA**

**FRC Report No. 262**
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Georgia State University | ANDREW YOUNG SCHOOL OF POLICY STUDIES

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# I. Introduction

The high-technology sector is an important and strategic industrial cluster for long-term economic growth and is actively pursued by many state and local governments. High-technology industries are highly concentrated and specialized geographically in the United States in areas identified as "tech poles" by the Milken Institute (DeVol and Wong, 1999; DeVol et al, 2009). This report provides a systematic overview of the high-technology sector and its growth trend in the State of Georgia between 2000 and 2011. The analysis first examines the scale and growth of high-tech workers and entrepreneurs in Georgia in comparison to its peer states in the Southeast[1] (Section II) and then presents the industrial, demographic, and geographic details of the high-tech industry within the state (Section III). Particular attention is paid to immigrants given their over-representation as entrepreneurs (Hart and Acs 2011) and workers (Stephan and Levin, 2001) in the high-tech sector. Section IV discusses several additional indicators—patents, venture capital, STEM (Science, Technology, Engineering and Mathematics) graduates and level of research funding—to gauge Georgia's innovation capacity and competitiveness in the context of peer states. Policy options intended to foster high-technology development and increase innovation competitiveness in the state are discussed in Section V.

The majority of the results in this report are drawn from analysis of Decennial Census 2000 and American Community Survey 2007-2011 combined sample (referred to as 2011) microdata. Several other data sources are used to obtain different innovation measures. There exist different ways of defining high-tech industries. It can be defined by industry, by occupation, and by education and skill level. This study adopts the definition developed by Milken's high-technology economy report (DeVol et al 2009) which classifies the high-tech economy by the new North American Industry Classification System (NAICS) codes instead of old Standard Industrial Classification (SIC) codes. This characterization makes the distinction between high-tech manufacturing industries and high-tech service industries. A detailed list is provided in the Appendix.

[1] The southeastern states for purposes of this analysis are Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia.

## II. Georgia in the Regional and National Context

Georgia has a relatively sizable high-technology workforce as compared to peer states in the Southeast. There were 245,604 high-tech workers in Georgia in 2000, comprising 5.9 percent of the total workforce. This percentage is higher than the 5.4 percent average for all seven peer states combined, but lags behind Virginia (7.2 percent) as well as the national average (6.5 percent). In 2011, the high-tech workforce grew to 266,177 in Georgia, a growth rate of 8.4 percent. Now high-tech workers make up 5.5 percent of all workers which is a slight decrease from 2000. This trend of deceasing high-tech share seems to apply to peer states as well, but not nationally (an increase to 6.6 percent). While Virginia still has the highest high-tech share in 2011 (6.7 percent), Florida registered the largest growth rate of 11.2 percent during this decade (Table 1).

The high-technology sector tends to have a large share of self-employed workers, including both entrepreneurs, as well as those in unincorporated businesses, or as independent contractors. The past decade saw substantial growth of self-employed high-tech workers and high-tech entrepreneurs in Georgia, at 40.6 percent and 37.5 percent respectively. There are a total of 18,744 self-employed high-tech workers, including 9,961 high-tech entrepreneurs in Georgia in 2011, second only to Florida in the Southeast region (Table 2).

Immigrants make up an increasing share of the high-tech workforce in Georgia. In 2000, there were 27,193 immigrant high-tech workers, or 11.1 percent of the total high-tech workers in the state. In 2011, that number grew to 44,161, or 15.6 percent of all high-tech workers, exhibiting a growth rate of 62.4 percent. This share is lower than the national average at 19.9 percent, as well as lower than two of the Southeastern peer states: Florida (24.3 percent) and Virginia (19.5 percent). Among the high-tech self-employed workers, 19.4 percent were immigrants in 2000 and 14.9 percent are immigrants in 2010. Both immigrant and native-born high-tech self-employed workers experienced fast growth percentage-wise. This is especially true for the native-born population: of the 21,117 workers added during this decade, over half are self-employed.

The number of immigrant high-tech business owners grew from 741 to 1,584 and the number of native-born high-tech business owners grew from 6,501 to 8,377 in the last 10

**TABLE 1. HIGH-TECH WORKERS AND ENTREPRENEURS FOR GEORGIA & PEER STATES, 2000-2011**

| State | All Workers | High-Tech Workers | Share | High-Tech Self-Employed | High-Tech Entrepreneurs* |
|---|---|---|---|---|---|
| **----------2000----------** | | | | | |
| ***Georgia*** | ***4,135,552*** | ***245,604*** | ***5.9%*** | ***13,331*** | ***7,242*** |
| Alabama | 2,057,141 | 96,990 | 4.7% | 4,949 | 2,550 |
| Florida | 7,473,032 | 429,449 | 5.7% | 30,672 | 17,511 |
| Mississippi | 1,278,636 | 38,365 | 3.0% | 2,251 | 1,159 |
| North Carolina | 4,133,971 | 236,869 | 5.7% | 12,485 | 6,270 |
| South Carolina | 1,984,261 | 80,661 | 4.1% | 4,325 | 2,320 |
| Tennessee | 2,822,256 | 118,733 | 4.2% | 7,548 | 2,756 |
| Virginia | 3,693,614 | 267,458 | 7.2% | 11,615 | 6,004 |
| Total Peer States | 23,442,911 | 1,268,525 | 5.4% | 73,845 | 38,570 |
| Total US | 138,831,348 | 9,005,136 | 6.5% | 499,654 | 223,952 |
| **----------2011----------** | | | | | |
| ***Georgia*** | ***4,818,381*** | ***283,689*** | ***5.9%*** | ***18,744*** | ***9,961*** |
| Alabama | 2,258,850 | 118,815 | 5.3% | 5,705 | 2,621 |
| Florida | 9,260,979 | 535,666 | 5.8% | 46,318 | 26,321 |
| Mississippi | 1,359,451 | 42,710 | 3.1% | 2,790 | 1,273 |
| North Carolina | 4,788,999 | 303,946 | 6.3% | 16,918 | 8,393 |
| South Carolina | 2,262,068 | 105,170 | 4.6% | 5,979 | 3,035 |
| Tennessee | 3,122,995 | 153,047 | 4.9% | 9,157 | 3,344 |
| Virginia | 4,226,649 | 354,272 | 8.4% | 16,006 | 8,667 |
| Total Peer States | 27,279,991 | 1,897,315 | 7.0% | 102,873 | 53,654 |
| Total US | 156,421,146 | 10,363,424 | 6.6% | 640,425 | 298,849 |
| **----------2000—2011 Growth Rate----------** | | | | | |
| ***Georgia*** | ***16.5%*** | ***15.5%*** | | ***40.6%*** | ***37.5%*** |
| Alabama | 9.8% | 22.5% | | 15.3% | 2.8% |
| Florida | 23.9% | 24.7% | | 51.0% | 50.3% |
| Mississippi | 6.3% | 11.3% | | 23.9% | 9.8% |
| North Carolina | 15.8% | 28.3% | | 35.5% | 33.9% |
| South Carolina | 14.0% | 30.4% | | 38.2% | 30.8% |
| Tennessee | 10.7% | 28.9% | | 21.3% | 21.3% |
| Virginia | 14.4% | 32.5% | | 37.8% | 44.4% |
| Total Peer States | 16.4% | 49.6% | | 39.3% | 39.1% |
| Total US | 12.7% | 15.1% | | 28.2% | 33.4% |

SOURCE: Decennial Census (2000) and American Community Survey (2007-2011) Combined Sample.
NOTE: Entrepreneurs defined as self-employed workers in own incorporated businesses.

**TABLE 2. HIGH-TECH WORKERS AND ENTREPRENEURS BY IMMIGRANT STATUS, GEORGIA & PEER STATE**

| State | High-Tech Workers | | | High-Tech Self-Employed | | | High-Tech Entrepreneurs | | |
|---|---|---|---|---|---|---|---|---|---|
| | Immigrants | % of Total | Native | Immigrants | % of Total | Native | Immigrants | % of Total | Native |
| | | | | | 2000 | | | | |
| ***Georgia*** | ***27,193*** | ***11.1%*** | ***218,411*** | ***1,128*** | ***19.4%*** | ***4,696*** | ***741*** | ***10.2%*** | ***6,501*** |
| Alabama | 4,363 | 4.5% | 92,627 | 253 | 1.0% | 24,194 | 183 | 7.2% | 2,367 |
| Florida | 85,401 | 19.9% | 344,048 | 6,478 | 34.7% | 12,203 | 4,011 | 22.9% | 13,500 |
| Mississippi | 822 | 2.1% | 37,543 | 30 | 1.3% | 2,221 | 0 | 0.0% | 1,159 |
| N Carolina | 21,975 | 9.3% | 214,894 | 821 | 6.6% | 11,664 | 506 | 8.1% | 5,764 |
| S Carolina | 3,913 | 4.9% | 76,748 | 247 | 5.7% | 4,078 | 225 | 9.7% | 2,095 |
| Tennessee | 5,882 | 5.0% | 112,851 | 256 | 3.4% | 7,292 | 122 | 4.4% | 2,634 |
| Virginia | 40,137 | 15.0% | 227,321 | 1,364 | 11.7% | 10,251 | 980 | 16.3% | 5,024 |
| Total Peer States | 189,686 | 12.5% | 1,324,443 | 10,577 | 12.1% | 76,599 | 6,768 | 14.8% | 39,044 |
| Total US | 1,500,722 | 16.7% | 7,504,414 | 67,458 | 13.5% | 432,196 | 34,087 | 15.2% | 189,865 |
| | | | | | 2011 | | | | |
| ***Georgia*** | ***44,161*** | ***15.6%*** | ***239,528*** | ***2,791*** | ***14.9%*** | ***15,953*** | ***1,584*** | ***15.9%*** | ***8,377*** |
| Alabama | 7,880 | 6.6% | 110,935 | 187 | 3.3% | 5,518 | 68 | 2.6% | 2,553 |
| Florida | 129,970 | 24.3% | 405,696 | 12,284 | 26.5% | 34,034 | 7,023 | 26.7% | 19,298 |
| Mississippi | 1,523 | 3.6% | 41,187 | 16 | 0.6% | 2,774 | 0 | 0.0% | 1,273 |
| N Carolina | 36,596 | 12.0% | 267,350 | 1,492 | 8.8% | 15,426 | 827 | 9.9% | 7,566 |
| S Carolina | 6,350 | 6.0% | 98,820 | 455 | 7.6% | 5,524 | 320 | 10.5% | 2,715 |
| Tennessee | 11,329 | 7.4% | 141,718 | 683 | 7.5% | 8,474 | 288 | 8.6% | 3,056 |
| Virginia | 69,111 | 19.5% | 285,161 | 3,219 | 20.1% | 12,787 | 2,230 | 25.7% | 6,437 |
| Total Peer States | 306,920 | 16.2% | 1,590,395 | 21,127 | 17.4% | 100,490 | 12,340 | 19.4% | 51,275 |
| Total US | 2,058,485 | 19.9% | 8,304,939 | 110,633 | 17.3% | 529,792 | 56,297 | 18.8% | 242,552 |
| | | | | | 2000 - 2011 Growth Rate | | | | |
| ***Georgia*** | ***62.4%*** | | ***9.7%*** | ***147.4%*** | | ***239.7%*** | ***113.8%*** | | ***28.9%*** |
| Alabama | 80.6% | | 19.8% | -26.1% | | -77.2% | -62.8% | | 7.9% |
| Florida | 52.2% | | 17.9% | 89.6% | | 178.9% | 75.1% | | 42.9% |
| Mississippi | 85.3% | | 9.7% | -46.7% | | 24.9% | 0.0% | | 9.8% |
| N Carolina | 66.5% | | 24.4% | 81.7% | | 32.3% | 63.4% | | 31.3% |
| S Carolina | 62.3% | | 28.8% | 84.2% | | 35.5% | 42.2% | | 29.6% |
| Tennessee | 92.6% | | 25.6% | 166.8% | | 16.2% | 136.1% | | 16.0% |
| Virginia | 72.2% | | 25.4% | 136.0% | | 24.7% | 127.6% | | 28.1% |
| Total Peer States | 61.8% | | 20.1% | 99.7% | | 31.2% | 82.3% | | 31.3% |
| Total US | 37.2% | | 10.7% | 64.0% | | 22.6% | 65.2% | | 27.7% |

SOURCE: Decennial Census (2000) and American Community Survey (2007-2011) Combined Sample.

years in Georgia. Among the peer states, only Florida has a larger immigrant (7,023) and native-born (13,500) high-tech entrepreneur presence and Virginia has a slightly larger immigrant (2,230) high-tech entrepreneur presence than Georgia. Even when the population sizes of these states are considered, Florida and Virginia are still ranked higher than Georgia in their respective shares of the immigrant and native-born labor forces who are high-tech entrepreneurs for both observation years. It is worth noting that such shares remain fairly consistent for the native-born population over the past decade, but declined considerably for the immigrant population which did not keep pace with their overall fast growth.

## III. Georgia's Industrial, Demographic, and Geographic Details

Zooming in to the state of Georgia, detailed analysis further demonstrates the industrial (Table 3), demographic (Table 4), and geographic patterns (Table 5) of the state's high-tech workforce. Industry-wise, the top industries in terms of employment are wired telecommunications carriers (19.8 percent), computer systems design and related services (17.6 percent), and architectural, engineering and related industries (13.6 percent) for year 2000. In 2010, computer systems design and services has become the largest high-tech industry in the state, employing 21.9 percent of the total high-tech workforce. Examples of businesses in this category include computer facilities management services, computer hardware or software consulting services, computer systems integration design services, custom computer programming services, and software installation services. Medical and diagnostic laboratories experienced substantial growth over the last decade, nearly doubling its employees and now making up 15.2 percent of the state's high-tech workforce. Other major industries include wired telecommunications carriers (13.6 percent) and architectural, engineering and related (14.8 percent). Location Quotient, or LQ, is calculated as the share of state workforce in an industry divided by share of US workforce in an industry and is used to measure the relative concentration in Georgia compared to the United States as a whole. If LQ is larger than 1, it suggests that the particular industry is more concentrated in Georgia when compared to the share of this sector nationally. Six industries have above national concentration in Georgia for year 2011 (shaded in table): software publishers (1.05), wired telecommunication carriers (1.58), other telecommunication services (1.44), other information services (1.35), data processing, hosting and related services (1.37) and computer systems design and related (1.17). Semiconductor and other electronic component industry experienced decline in their employment base and also lost its relative concentration over the decade, from 1.32 in 2000 to 0.99 in 2010.

Immigrants from India make up the largest share among high-tech immigrant workers in Georgia, whose share were 13.9 percent in 2000 and 20 percent in 2010. Germany remains as the second largest sending country of high-tech immigrants through the decade, at 8.2 percent in 2000 and 5.2 percent in 2010. Immigrants from several countries, including Jamaica, China, Korea, Nigeria and the Philippines increased their high-tech workforce share

## TABLE 3. DETAILED HIGH-TECH (HT) INDUSTRIES AND LOCATION QUOTIENTS (LQ) FOR GEORGIA

| | | 2000 | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|
| NAICS Code | High-Tech Industry | GA | % of HT | US | LQ | GA | % of HT | US | LQ |
| 3254 | Pharmaceutical and medicine | 5,014 | 1.8% | 423,909 | 0.40 | 6,474 | 2.1% | 514,914 | 0.41 |
| 3333 | Commercial and service industry machine | 3,210 | 1.2% | 184,510 | 0.58 | 3,372 | 1.1% | 120,247 | 0.91 |
| 3341 | Computer and peripheral equipment | 11,169 | 4.0% | 510,732 | 0.73 | 6,234 | 2.0% | 298,557 | 0.68 |
| 3345 | Communications, audio and video equipment | 4,784 | 1.7% | 295,356 | 0.54 | 5,464 | 1.7% | 261,658 | 0.68 |
| 334M1 | Semiconductor, other electronic component | 12,657 | 4.6% | 321,151 | ***1.32*** | 6,917 | 2.2% | 225,996 | 0.99 |
| 334M2 | Navigational/measuring/medical/control | 12,903 | 4.6% | 1,155,562 | 0.37 | 9,180 | 2.9% | 822,805 | 0.36 |
| 33641M2 | Aerospace products and parts | 2,687 | 1.0% | 283,463 | 0.32 | 6,397 | 2.0% | 407,080 | 0.51 |
| 3391 | Medical equipment and supplies | 12,730 | 4.6% | 529,772 | 0.81 | 14,759 | 4.7% | 624,008 | 0.77 |
| 5112 | Software publishers | 1,862 | 0.7% | 65,960 | 0.95 | 2,908 | 0.9% | 89,628 | ***1.05*** |
| 5121 | Motion pictures and video | 7,556 | 2.7% | 420,968 | 0.60 | 10,671 | 3.4% | 505,137 | 0.69 |
| 51331/5171 | Wired telecommunications carriers** | 54,938 | 19.8% | 1,132,428 | ***1.63*** | 42,456 | 13.6% | 874,357 | ***1.58*** |
| 5133Z517Z | Other telecommunication services** | 21,019 | 7.6% | 479,710 | ***1.47*** | 18,680 | 6.0% | 421,431 | ***1.44*** |
| 5181 | Internet service providers* | NA | NA | NA | NA | 529 | 0.2% | 18,485 | 0.93 |
| 5182 | Data processing, hosting, and related services* | NA | NA | NA | NA | 5,400 | 1.7% | 128,061 | ***1.37*** |
| 5141Z/5191ZM | Other information services** | 8,116 | 2.9% | 300,349 | 0.91 | 1,388 | 0.4% | 33,398 | ***1.35*** |
| 5413 | Architectural, engineering and related services | 37,820 | 13.6% | 1,429,041 | 0.89 | 46,363 | 14.8% | 1,768,695 | 0.85 |
| 5415 | Computer systems design and related services | 48,751 | 17.6% | 1,411,884 | ***1.16*** | 68,649 | 21.9% | 1,909,121 | ***1.17*** |
| 5417 | Scientific R&D | 7,729 | 2.8% | 554,243 | 0.47 | 9,430 | 3.0% | 681,590 | 0.45 |
| 621M | Medical and diagnostic laboratories | 24,831 | 8.9% | 864,344 | 0.96 | 47,581 | 15.2% | 1,812,915 | 0.85 |
| All High-Tech Workforce | | 277,776 | | 10,363,382 | 0.90 | 312,852 | | 11,518,083 | 0.88 |
| Total Workforce | | 4,135,552 | | 138,831,348 | | 4,818,381 | | 156,421,146 | |

SOURCE: Decennial Census 2000 and American Community Survey 2007-2011 Combined Sample.

NOTES: *5181 & 5182 (Internet service providers & Data processing, hosting and related services) were not available in 2000. ** Some NAICS codes changed between 2000 and 2007

**TABLE 4. GEORGIA'S HIGH-TECH IMMIGRANT WORKERS BY COUNTRY OF ORIGIN**

| 2000 | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|
| **Rank** | **Country of Origin** | **Number** | **Share** | **Rank** | **Country of Origin** | **Number** | **Share** |
| 1 | India | 4,346 | 13.9% | 1 | India | 9,567 | 20.0% |
| 2 | Germany | 2,555 | 8.2% | 2 | Germany | 2,503 | 5.2% |
| 3 | Vietnam | 1,673 | 5.4% | 3 | Jamaica | 2,190 | 4.6% |
| 4 | Mexico | 1,535 | 4.9% | 4 | China | 2,167 | 4.5% |
| 5 | England | 1,190 | 3.8% | 5 | Korea | 1,711 | 3.6% |
| 6 | Jamaica | 1,084 | 3.5% | 6 | Vietnam | 1,514 | 3.2% |
| 7 | Canada | 1,038 | 3.3% | 7 | Nigeria | 1,459 | 3.1% |
| 8 | China | 1,009 | 3.2% | 8 | Canada | 1,350 | 2.8% |
| 9 | Korea | 998 | 3.2% | 9 | Philippines | 1,233 | 2.6% |
| 10 | Nigeria | 986 | 3.2% | 10 | Mexico | 1,164 | 2.4% |
| Total Immigrants | | 31,254 | | Total Immigrants | | 47,738 | |

SOURCE: Decennial Census (2000) and American Community Survey (2007-2011) Combined Sample.

over the decade while those from Vietnam, England and Mexico declined in number and share (Table 5).

The 159 counties of Georgia are grouped into 42 aggregated work areas by the Census. Table 5 lists the geographic distribution of high-tech workers across the counties or county groups in the state by workers' place of work. Location Quotients (LQ) are calculated as a ratio of the high-tech share in a county in comparison to the high-tech share of the state to illustrate relative concentration. Gwinnett County has the highest high-tech LQ of 1.97 in 2000, but decreased its high-tech concentration to an LQ of 1.61in 2010, and its share of the state total also declined from 14.4 percent to 12.7 percent. Fulton County maintained around 31.4 percent of the state's high-tech workers through the decade and its LQ of 1.68 remains constant as well. Despite absolute growth, Cobb County experienced a slight decrease in share from 12.2 percent to 11.8 percent and in relative concentration from 1.57 to 1.53. The same pattern holds for DeKalb County and Newton/Rockdale Counties. To the contrary, Dawson/Forsyth/Pickens Counties almost doubled their high-tech workforce over the last decade, now having a high-tech concentration 1.39 times of the state average. While the several core Atlanta counties remain home to over half of the high-tech workers, the fast growth of several surrounding counties in the high-tech sector is worth noting.

## TABLE 5. GEORGIA'S HIGH-TECH WORKERS BY PLACE OF WORK COUNTY/COUNTIES

| | | 2000 | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|
| **County/Counties**** | **PWPUMA** | **HT Workers** | **All Workers** | **LQ** | **% of GA** | **HT Workers** | **All Workers** | **LQ** | **% of GA** |
| Catoosa, Dade, Walker | 100 | 669 | 35,857 | 0.31 | 0.3% | 1,390 | 36,898 | 0.61 | 0.5% |
| Gordon, Murray, Whitfield | 200 | 1,455 | 92,180 | 0.26 | 0.6% | 2,396 | 90,416 | 0.43 | 0.9% |
| Fannin, Gilmer, Habersham, Lumpkin, Rabun, Towns, Union, White | 300 | 1,534 | 59,496 | 0.42 | 0.7% | 2,740 | 71,125 | 0.62 | 1.0% |
| Banks, Franklin, Hart, Jackson, Stephens | 400 | 903 | 48,955 | 0.30 | 0.4% | 1,613 | 52,211 | 0.50 | 0.6% |
| Clarke, Madison, Oconee | 500 | 3,132 | 79,623 | 0.65 | 1.3% | 3,191 | 85,535 | 0.61 | 1.2% |
| Hall | 600 | 1,898 | 68,175 | 0.46 | 0.8% | 2,791 | 77,303 | 0.59 | 1.1% |
| Bartow, Paulding | 700 | 2,637 | 47,731 | 0.91 | 1.1% | 2,247 | 61,591 | 0.59 | 0.9% |
| Dawson, Forsyth, Pickens | 800 | 3,668 | 56,823 | ***1.06*** | 1.6% | 7,036 | 82,179 | ***1.39*** | 2.7% |
| Barrow, Walton | 900 | 825 | 28,506 | 0.48 | 0.4% | 1,310 | 40,081 | 0.53 | 0.5% |
| Butts, Crawford, Lamar, Monroe, Pike, Upson | 1000 | 679 | 31,354 | 0.36 | 0.3% | 678 | 32,840 | 0.33 | 0.3% |
| Fulton | 1100 | 73,735 | 720,781 | ***1.68*** | 31.4% | 82,762 | 799,547 | ***1.68*** | 31.6% |
| DeKalb | 1200 | 29,839 | 313,707 | ***1.56*** | 12.7% | 25,282 | 308,927 | ***1.33*** | 9.7% |
| Cobb | 1300 | 28,562 | 298,035 | ***1.57*** | 12.2% | 31,006 | 329,081 | ***1.53*** | 11.8% |
| Clayton | 1400 | 2,632 | 97,457 | 0.44 | 1.1% | 2,965 | 97,827 | 0.49 | 1.1% |
| Gwinnett | 1500 | 33,926 | 283,445 | ***1.97*** | 14.4% | 33,308 | 336,468 | ***1.61*** | 12.7% |
| Newton, Rockdale | 1600 | 3,428 | 50,941 | ***1.11*** | 1.5% | 3,823 | 65,449 | 0.95 | 1.5% |
| Henry | 1700 | 1,198 | 34,717 | 0.57 | 0.5% | 1,811 | 55,915 | 0.53 | 0.7% |
| Carroll, Douglas | 1800 | 2,627 | 67,315 | 0.64 | 1.1% | 3,153 | 80,601 | 0.63 | 1.2% |
| Cherokee, | 1900 | 1,917 | 40,335 | 0.78 | 0.8% | 3,346 | 59,762 | 0.91 | 1.3% |
| Coweta, Fayette, Spalding | 2000 | 4,648 | 86,889 | 0.88 | 2.0% | 5,213 | 103,827 | 0.81 | 2.0% |
| Chattooga, Floyd, Haralson, Polk, | 2100 | 1,707 | 69,836 | 0.40 | 0.7% | 2,709 | 71,334 | 0.62 | 1.0% |
| Elbert, Greene, Hancock, Lincoln, Morgan, Oglethorpe, Taliaferro, Warren, Wilkes | 2200 | 863 | 33,803 | 0.42 | 0.4% | 670 | 32,074 | 0.34 | 0.3% |
| Richmond | 2300 | 4,300 | 108,577 | 0.65 | 1.8% | 5,515 | 118,635 | 0.75 | 2.1% |
| Columbia, McDuffie | 2400 | 965 | 33,984 | 0.47 | 0.4% | 1,199 | 42,094 | 0.46 | 0.5% |
| Burke, Emanuel, Glascock, Jefferson, Jenkins, Screven, Washington | 2500 | 512 | 45,542 | 0.18 | 0.2% | 611 | 33,139 | 0.30 | 0.2% |
| Baldwin, Jasper, Johnson, Laurens, Putnam, Wilkinson | 2600 | 1,311 | 53,580 | 0.40 | 0.6% | 1,112 | 52,171 | 0.35 | 0.4% |
| Bibb | 2700 | 3,265 | 85,179 | 0.63 | 1.4% | 3,223 | 82,414 | 0.63 | 1.2% |
| Houston, Jones, Peach, Twiggs, | 2800 | 1,648 | 55,934 | 0.48 | 0.7% | 3,842 | 81,076 | 0.77 | 1.5% |
| Harris, Heard, Meriwether, Talbot, Troup | 2900 | 1,436 | 47,552 | 0.50 | 0.6% | 1,713 | 48,921 | 0.57 | 0.7% |
| Muscogee | 3000 | 2,306 | 102,281 | 0.37 | 1.0% | 4,083 | 107,637 | 0.62 | 1.6% |

*Table 5 continues next page…*

**TABLE 5 (CONTINUED). GEORGIA'S HIGH-TECH WORKERS BY PLACE OF WORK COUNTY/COUNTIES**

| | | 2000 | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|
| **County/Counties**** | **PWPUMA** | **HT Workers** | **All Workers** | **LQ** | **% of GA** | **HT Workers** | **All Workers** | **LQ** | **% of GA** |
| Chattahoochee, Crisp, Dooly, Macon, Marion, Schley, Sumter, Taylor, Webster | 3100 | 945 | 53,363 | 0.29 | 0.4% | 865 | 50,134 | 0.28 | 0.3% |
| Bleckley, Dodge, Montgomery, Pulaski, Telfair, Toombs, Treutlen, Wheeler, Wilcox | 3200 | 598 | 35,773 | 0.27 | 0.3% | 539 | 37,339 | 0.23 | 0.2% |
| Appling, Bulloch, Candler, Evans, Jeff Davis, Tattnall, Wayne, | 3300 | 1,195 | 60,006 | 0.33 | 0.5% | 1,083 | 64,821 | 0.27 | 0.4% |
| Chatham | 3400 | 3,727 | 91,888 | 0.67 | 1.6% | 4,879 | 102,394 | 0.77 | 1.9% |
| Chatham | 3500 | 582 | 35,204 | 0.27 | 0.2% | 1,489 | 45,317 | 0.53 | 0.6% |
| Bryan, Effingham, Liberty, Long, McIntosh | 3600 | 964 | 46,281 | 0.34 | 0.4% | 1,693 | 54,732 | 0.50 | 0.6% |
| Camden, Glynn | 3700 | 1,567 | 56,629 | 0.45 | 0.7% | 1,680 | 62,780 | 0.43 | 0.6% |
| Atkinson, Bacon, Brantley, Charlton, Clinch, Coffee, Pierce, Ware | 3800 | 742 | 52,205 | 0.23 | 0.3% | 1,091 | 52,104 | 0.34 | 0.4% |
| Ben Hill, Berrien, Cook, Irwin, Lanier, Tift, Turner, | 3900 | 749 | 48,185 | 0.26 | 0.3% | 751 | 43,947 | 0.28 | 0.3% |
| Dougherty, Lee | 4000 | 2,085 | 58,795 | 0.58 | 0.9% | 2,394 | 56,098 | 0.69 | 0.9% |
| Baker, Calhoun, Clay, Colquitt, Early, Mitchell, Quitman, Randolph, Stewart, Terrell, Worth | 4100 | 969 | 43,859 | 0.36 | 0.4% | 540 | 42,266 | 0.21 | 0.2% |
| Decatur, Grady, Miller, Seminole, Thomas | 4200 | 1,030 | 43,451 | 0.39 | 0.4% | 765 | 39,687 | 0.31 | 0.3% |
| Brooks, Echols, Lowndes | 4300 | 1,512 | 54,176 | 0.46 | 0.6% | 1,367 | 59,633 | 0.37 | 0.5% |
| GA Total | | 234,890 | 3,858,405 | | 100.0% | 261,874 | 4,248,330 | | 100.0% |
| US Total | | 9,005,136 | | | | 10,363,424 | | | |

SOURCE: Decennial Census 2000 and American Community Survey 2007-2011 Combined Sample.

NOTE: LQ = (PWPUMA HT Workers/GA HT Workers) / (PWPUMA All Workers/GA All Workers). LQ values >1 are highlighted.

## IV. Georgia's Innovation Capacity

Several indicators are frequently used to gauge the innovation capacity of an area which include number of patents, amount of venture capital, Ph.D. graduates in STEM, and R&D funding from various sources. As Table 6 shows, a total of 1541 patents were filed in Georgia in 2000 consisting of 214 design patents and 1312 utility patents. This number is lower than Florida (3129) and North Carolina (2196) among the peer states. Patents per 10,000 people are calculated to take into account the population size in each state. Georgia has a value of 1.88 for this measure, following North Carolina (2.73) and Florida (1.96). Georgia's total patents increased to 2194 in 2010 with 257 design and 1905 utility patents, still lagging behind Florida and North Carolina on total numbers, but surpassed Florida in terms of patents per 10,000 persons.

Venture capital[2], an important source of capital for high-tech start-ups, shrank substantially nation-wide after the recession from $105 billion in 2000 to $23 billion in 2010.[3] Venture capital firms are highly concentrated, with over 75 percent in the top nine metropolitan areas, and over 50 percent in the top three (San Jose/San Francisco, Boston, and New York) (Chen, Gompers, Kovner, & Lerner, 2010). The Atlanta Consolidated Statistical Area (CSA) had only two percent of main offices for venture firms in 2005, while San Jose/San Francisco has 21.6 percent. For Georgia, its venture capital volume was over $2 billion in 2000, second only to Florida and Virginia. In 2010 it declined to 338 million and was surpassed by North Carolina and Virginia. One way of getting at the issue of scale across different states is to use "VC (Venture Capital) Intensity," (VC/GDP) instead of just VC amount. In 2000, Georgia is second to Virginia only on this measure (7.724 versus 12.687) and in 2010 Georgia (0.781) lagged behind North Carolina (0.940) and Virginia (0.918).

[2] Based on data measuring "cash-for-equity investments by the professional venture capital community in private emerging companies in the U.S." This does not include debt, buyouts, recapitalizations, secondary purchases, IPOs, or private investments in public entities. For a complete definition of venture capital in this data, see "MoneyTree™ Report Definitions and Methodology" (PriceWaterhouseCoopers & National Venture Capital Association, 2013)

[3] 2000 was the peak year for venture capital, being both the height of and the end of the "Internet bubble" of 1999-2000. To put this in perspective, 1998 VC was around $21.5 billion, 1999 was around $54.9 billion and 2001 was close to $41 billion. Then there was steady growth until the "Great Recession" of 2008, when funding dropped back to pre-bubble levels.

## TABLE 6. INNOVATION MEASURES, GEORGIA & PEER STATES, 2000-2010

| State | 2000 Patents: Design | Utility | Total | Per 10,000 | Venture Capital 2000 | VC Intens.† 2000 | STEM PhDs 2000 | 2006 R&D Expenditures*: State | Academic | Total | % Academic | R&D Intens.‡ 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Georgia*** | ***214*** | ***1312*** | ***1541*** | ***1.882*** | ***2,270,678,400*** | ***7.724*** | ***453*** | ***10,620,188*** | ***1,302,570,000*** | ***1,313,190,188*** | **99.2%** | **3.45** |
| Alabama | 58 | 337 | 395 | 0.888 | 278,525,600 | 2.401 | 277 | 7,269,319 | 601,881,000 | 609,150,319 | 98.8% | 3.83 |
| Florida | 491 | 2605 | 3129 | 1.957 | 2,691,072,800 | 5.592 | 567 | 42,329,624 | 1,522,099,000 | 1,564,428,624 | 97.3% | 2.14 |
| Mississippi | 29 | 184 | 213 | 0.749 | 23,499,900 | 0.358 | 125 | 2,744,882 | 369,143,000 | 371,887,882 | 99.3% | 4.33 |
| N Carolina | 340 | 1845 | 2196 | 2.729 | 1,829,815,700 | 6.499 | 603 | 14,344,310 | 1,709,877,000 | 1,724,221,310 | 99.2% | 4.56 |
| S Carolina | 97 | 531 | 629 | 1.567 | 415,211,000 | 3.597 | 193 | 22,427,746 | 524,034,000 | 546,461,746 | 95.9% | 3.66 |
| Tennessee | 156 | 782 | 963 | 1.693 | 458,303,800 | 2.581 | 286 | 5,355,000 | 742,923,000 | 748,278,000 | 99.3% | 3.17 |
| Virginia | 136 | 1141 | 1284 | 1.813 | 3,320,944,400 | 12.687 | 493 | 11,579,623 | 946,886,000 | 958,465,623 | 98.8% | 2.56 |
| Total Peer States | 1,307 | 7,425 | 8,809 | 2 | $9,017,373,200 | | 2,544 | 106,050,504 | 7,719,413,000 | 7,825,463,504 | 98.6% | |
| Total US | 11,284 | 85,068 | 97,011 | 3 | $105,032,882,500 | | 19,787 | $1,022,475,684 | $47,750,592,000 | $48,773,067,684 | 97.9% | |

| State | 2010 Patents: Design | Utility | Total | Per 10,000 | Venture Capital 2010 | VC Inten.† 2010 | STEM PhDs 2010 | 2009 R&D Expenditures*: State | Academic | Total | % Academic | R&D Intens.‡ 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Georgia*** | ***257*** | ***1,905*** | ***2,194*** | ***2.285*** | **$338,426,000** | ***0.781*** | ***739*** | ***6,662,887*** | ***1,565,574,000*** | **1,572,236,887** | **99.6%** | **3.99** |
| Alabama | 87 | 444 | 538 | 1.133 | $600,000 | 0.003 | 339 | 12,929,167 | 761,982,000 | 774,911,167 | 98.3% | 4.66 |
| Florida | 670 | 2,978 | 3,724 | 1.993 | $239,383,100 | 0.308 | 1,173 | 66,513,756 | 1,663,542,000 | 1,730,055,756 | 96.2% | 2.40 |
| Mississippi | 24 | 145 | 172 | 0.582 | | | 187 | 9,731,915 | 416,804,000 | 426,535,915 | 97.7% | 4.61 |
| N Carolina | 271 | 2,636 | 2,922 | 3.102 | $428,556,300 | 0.940 | 973 | 51,404,202 | 2,160,505,000 | 2,211,909,202 | 97.7% | 5.36 |
| S Carolina | 124 | 517 | 652 | 1.425 | $26,715,000 | 0.152 | 255 | 28,599,885 | 611,539,000 | 640,138,885 | 95.5% | 4.06 |
| Tennessee | 105 | 925 | 1,037 | 1.647 | $67,776,500 | 0.245 | 397 | 3,881,687 | 832,991,000 | 836,872,687 | 99.5% | 3.39 |
| Virginia | 131 | 1,587 | 1,726 | 2.178 | $409,316,300 | 0.918 | 664 | 17,929,519 | 1,088,367,000 | 1,106,296,519 | 98.4% | 2.74 |
| Total Peer States | 1,412 | 9,232 | 10,771 | 1.677 | $1,172,347,200 | | 3,988 | 190,990,131 | 9,101,304,000 | 9,292,294,131 | 97.9% | |
| Total US | 12,612 | 107,792 | 121,179 | 3.952 | $23,382,326,600 | | 27,001 | $1,210,113,524 | $54,935,457,000 | $56,145,570,524 | 97.8% | |

SOURCES: For *Patents:* TAF database maintained by the U.S. Patent and Trademark Office. For *VC Funding:* MoneyTree™, PricewaterhouseCoopers & National Venture Capital Association; data provided by Thomson Reuters. For *STEM PhDs:* NSF/NIH/USED/USDA/NEH/NASA, Survey of Earned Doctorates, 2010. For *State R&D Expenditures:* National Science Foundation, National Center for Science and Engineering Statistics. (2012). State Government Research and Development: Fiscal Year 2009. Detailed Statistical Tables NSF 12-331. Retrieved August 7, 2013, from http://www.nsf.gov/statistics/ nsf12331. For *Academic R&D Expenditures*: Fiscal Year 2009 Detailed Statistical Tables NSF 11-331. Retrieved September 17, 2013, from http://www.nsf.gov/statistics/nsf11313.

NOTES: * Calculated from quarterly data. † VC Intensity = (VC/GDP)*1,000. ‡ R&D Intensity = (R&D/GDP)*1,000.

Ph.D. students enrolled in the state's STEM discipline and programs can be an important source of high-tech workforce and innovation. In 2000, Georgia produced 453 STEM Ph.D.s as compared to Florida's 567, North Carolina's 603 and Virginia's 493. The same general pattern holds for 2010, though Georgia expanded STEM Ph.D. graduates (739) now surpasses Virginia (664). Overall, given the density of research institutions in Georgia, which is tied for eleventh in the percentage of doctoral degree-granting institutions[4], its level of STEM graduates are relatively high in the region.

Research & Development (R&D) funding is important for innovation-related activities. The National Science Foundation collected statistics from 2006 and 2009[5] for the Southeastern states including state agency expenditures on R&D from federal and state fund sources and public and private college and university R&D expenditures. In 2006, these institutions in Georgia spent a total of $1.3 billion on R&D, of which over 99 percent was spent by public and private universities (National Science Foundation, 2011; National Science Foundation, 2012). Of the peer states, it is worth noting that Florida spent $1.6 billion on R&D with somewhat less (98.8 percent) through academic institutions. In general, Georgia is slightly more dependent on its colleges and universities for its R&D efforts than many of its peer states. An R&D intensity index similar to the venture capital intensity index (R&D/State GDP) shows the relative level of investment as a percent of each state's overall economy. This index shows Georgia in the middle of the pack, ahead of states such as Florida, Virginia and Tennessee but behind all of the other states. Most notably, North Carolina, an economy and population similar in size to Georgia's, spends over $600 million more on R&D.

[4] Based on data from the Carnegie Foundation for the Advancement of Teaching, http://classifications. carnegiefoundation.org, Georgia has only seven doctoral-degree granting institutions classified as DRU (Doctoral/Research Universities), RU/H (Research Universities High Research Activity) or RU/VH (Research Universities very high research activity).

[5] Within R&D expenditures "federal, state and other" refers to the fund source for spending that flows through state agency budgets and "academic" refers to R&D funding from a variety of fund sources that flows through public and private universities and colleges (Yamaner, 2013).

## V. Conclusion and Discussion

This report describes the landscape of the high-tech industry in the state of Georgia between 2000 and 2010 and compares it to other peer states in the Southeastern region. It also presents the demographic, industrial, and geographic distributions of this sector within the state. Several indicators on the state's innovation capacity are presented as well. While Georgia's high-tech sector experienced steady growth over the last decade, its share in the overall economy and growth rate still lags behind the national average. Immigrants, especially those from India, make up increasing shares among the state's high-tech workforce and entrepreneurs.

Six industries have above-national concentrations in Georgia including software publishers, wired telecommunication carriers, other telecommunication services, other information services, data processing, hosting and related services and computer systems design and related. Semiconductor and other electronic component industry experienced a decline in their employment base and also lost its relative concentration over the decade. Geographically, the core Atlanta counties of Fulton, DeKalb, Gwinnett and Cobb remain home to over half high-tech workers, but the fast growth of several surrounding counties like Dawson, Forsyth, and Pickens in the high-tech sector is worth noting. Georgia is producing competitive numbers of patents and STEM graduate students, but its federal and state R&D funding, as well as venture capital flow, has declined over the last decade.

The high-tech industry is highly clustered in the United States (Mayer and Cortright, 2001). Cities and regions act as incubators of creativity and innovation as the economic, social, and policy context can shape the entrepreneurial environment and facilitate or inhibit high-tech growth (Lee, Florida, and Acs, 2004). Industrial intensity, unemployment rate, and market access, among others factors, have been identified as important determinants of regional variations in firm formation (Armington and Acs, 2002). A creative and diverse social environment, one that is open, tolerant, and creative, attracts human capital and produces high level of innovation and entrepreneurship on state (Qian and Stough, 2011) and metro levels (Hackler and Mayer, 2008). Our research also shows that the supporting professional, management, and other producer service industries such as financial and technical services are strong predictors of high-tech agglomeration on the metropolitan area level (Liu, Painter and Wang, 2013).

Business climate factors such as tax rates and incentives, compensation costs, land and office space costs, energy costs and capital costs have been traditionally recognized as important determinants of high-tech business location. In order to nurture Georgia's comparative advantage in this sector, we also need to pay attention to other amenities including a skilled workforce, close proximity to excellent universities and research institutions, density of related industries, availability of venture capital and research funding, quality of life, and the general cost of living.

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## APPENDIX A. LIST OF NAICS CODES FOR HIGH-TECH INDUSTRIES

**High-Tech Manufacturing Industries**

| | |
|---|---|
| 3254 | Pharmaceutical and medicine manufacturing |
| 3333 | Commercial and service industry machinery manufacturing |
| 3341 | Computer and peripheral equipment manufacturing |
| 3342 | Communications equipment manufacturing |
| 3343 | Audio and video equipment manufacturing |
| 3344 | Semiconductor and other electronic component manufacturing |
| 3345 | Navigational/measuring/medical/control instruments manufacturing |
| 3346 | Manufacturing and reproducing magnetic and optical media |
| 3364 | Aerospace products and parts manufacturing |
| 3391 | Medical equipment and supplies manufacturing |

**High-Tech Services Industries**

| | |
|---|---|
| 5112 | Software publishers |
| 5121 | Motion picture and video industries |
| 517 | Telecommunications |
| 518 | Internet service providers, web search portals, and data processing services |
| 5191 | Other information services |
| 5413 | Architectural, engineering and related services |
| 5415 | Computer systems design and related services |
| 5417 | Scientific R&D services |
| 6215 | Medical and diagnostic laboratories |

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