



# Cities on the Tech Frontier: Assessing Regional Competitiveness by Measuring the Concentration of Leading Edge Skills in the Local Workforce

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October 2023



***Skills can be the modern measure of regional economic competitiveness.***

## **The Geography of Skills at the Frontier of the Economy**

What drives regional economic growth in the knowledge economy? What is the best location for new and growing firms dependent on a highly skilled workforce? Where should educators, policy makers, and industry invest to advance their city's prospects as a rising tech hub? In an environment of rapid technology change, growing utilization of advanced artificial intelligence, and fluid work formats, conventional approaches to answering these questions miss many of the contours of regional competitiveness. Traditionally, a sector's regional competitiveness has been measured by the size and projected growth of the industry's workforce, with typical worker earnings used to impute output. However, these measures do not adequately capture the *quality* of the workforce. Skills are the yardstick of competitiveness in the human economy. A city might have a large tech workforce but, if that workforce is largely oriented toward legacy technologies, the city will soon find itself losing out to places with a greater investment in leading edge skills. But how can it track these dynamics before it has already lost its edge? Assessing the quality and competitiveness of the workforce requires innovative metrics of skill concentration.

In an analysis of regional skill concentrations, the Burning Glass Institute has identified several forces that offer insight into the likely shape of future growth. Utilizing real time labor market data, including the Burning Glass Institute's database of the career histories of over 65 million US workers and Lightcast's database of US job postings, we analyzed concentrations of the highest growth, highest value tech skills and occupations in order to understand which cities are out front, which are on the rise, and which are falling behind. Those concentrations vary widely across the nation, with some regions far better primed than their peers for investment at the frontier of America's tech- and data-enabled economies.

### **Frontier Skill Regions**

Typical analyses of regional workforces treat talent as a commodity whose inventory can be accounted through a simple measure of headcount. At best, these studies rely on educational attainment as a primitive proxy for quality. These analyses ignore the fact that workers are distinguished by the specific skills they bring. Instead, in assessing the competitiveness of America's tech workforces, we use skills as our yardstick.

Not all skills are created equal. Across the full range of skills within the tech workforce, there are some at the frontier of advances in technology. To identify these skills, we look at skills that are both highly valued by the labor market and have seen robust growth in demand. Then, we look at the share of tech workers in the region who possess these Frontier Skills.<sup>1</sup>

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<sup>1</sup> See Methodology section for additional details on the definition of Frontier Skills and tech occupations.

It isn't surprising that, among the cities with the greatest populations of tech workers, the usual suspects top the list of those with the greatest concentrations of Frontier Skills: the metropolitan statistical areas (MSAs) that encapsulate Seattle, San Jose, and San Francisco are in a league of their own, followed by other traditionally tech heavy MSAs that include Boston (MA), Austin (TX), San Diego (CA), and New York (NY).

Ultimately, size matters. The sheer volume of opportunities and talent lends a city critical mass that in turn assures continued commitment. Notably, reports of San Francisco's demise are greatly exaggerated. Even as headlines herald the city's decline, it still retains an enviable talent base. Simply put, the virtuous cycle of opportunity drawing talent and talent drawing opportunity is a juggernaut that's hard to shake, even as costs and troubles mount.

But it is worth noting that scale isn't determinative. Despite having one of the largest tech workforces in the country and despite having been crowned the victor in the contest for Amazon's HQ2 just a few years back, the Washington, DC MSA weighs in at only 21 out of 27 large tech workforce cities in terms of the concentration of Frontier Skills, eclipsed even by Detroit, Philadelphia, and Kansas City. Although DC has scale, its tech workforce is centered in government contracting and defense – sectors that are often tied to legacy technologies. This raises an important consideration for public officials and economic developers about which industries to prioritize: not only which sectors are best poised for growth but also which are most likely to enrich the talent soil, building the capability base of workers in ways that benefit the broader ecosystem.

Meanwhile, fast growing cities like Miami, Dallas, and Houston have yet to build tech workforce strength, ranking at 14, 22, and 26 respectively – raising questions about whether they can ever truly position themselves as future leaders.

The advantages of critical mass bear out in the competitive position of regions as well. The figure below reflects the relationship between the size of a city's tech workforce and the share of its tech workforce possessed of Frontier Skills, broken out by region. The positive relationship between the two bears out across regions but it is

worth noting that, propelled by Silicon Valley and its spillover, the West leads across the board. The Northeast is only a distant second, with the Midwest and South trailing further.

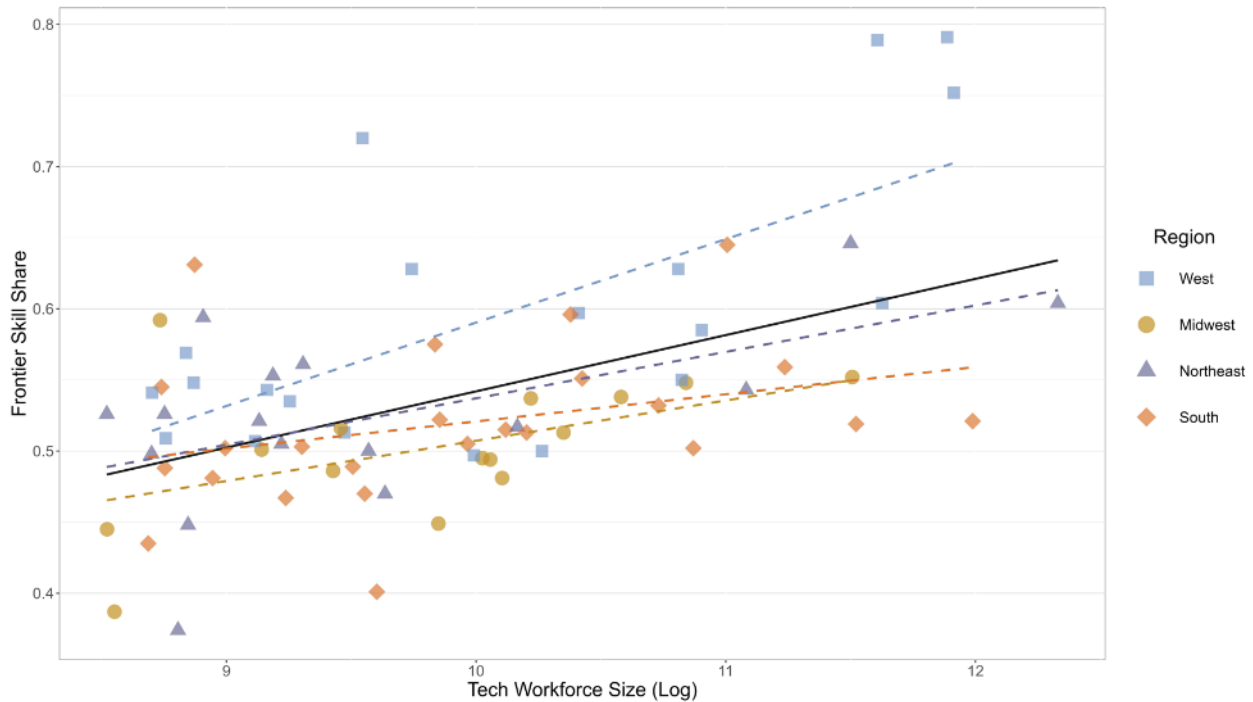


Figure 1: How Frontier Skill Concentrations Vary by Tech Workforce Size and Region

Among the next largest MSAs by tech workers, Provo-Orem (UT), Salt Lake City (UT), and Ogden-Clearfield (UT) rank first, third, and tenth, respectively, adding support to the claim Utah asserts of its “Silicon Slopes.”

Among metropolitan areas with medium-sized tech workforces, even a single employer or institution can change the contours of skill competitiveness. Fayetteville-Springdale-Rogers (AR) ranks second in the share of workers with Frontier Skills. It might seem surprising that a city in rural Arkansas would have a similar share of its tech workforce invested with Frontier Skills as Austin or San Diego, yet this MSA includes Bentonville, home to Walmart’s headquarters. In recent years, Walmart has invested heavily in developing its tech workforce as it has expanded e-commerce offerings and introduced tech-enabled innovations to its retail stores. What’s more, with Walmart as nucleus, Bentonville has attracted other major employers, including JB Hunt and Tyson Foods.

Northwest Arkansas’s ascendancy reflects another broader trend shaping the contours of America’s tech talent landscape. As a wide range of industries are increasingly tech-enabled and data-driven, a growing share of tech workers are employed outside the tech sector. In 2022, more than a third of software developers worked in industries other than Information and Professional & Technical Services.

Both Northwest Arkansas and Utah’s “Silicon Slopes” rank highly for Frontier Skill holders but they have very different employer profiles. Most of Fayetteville’s frontier tech skills are employed by Walmart, and a handful of others, whereas Frontier Skills are spread across a wider array of startups in the “Silicon Slopes.” Without a dominant employer in the “Silicon Slopes,” the region has developed a strong Frontier Skill concentration by anchoring in higher education, including the University of Utah, Utah State University, and Brigham Young

University. All three are doctoral granting institutions and ranked as either research intensive or high research activity institutions by the Carnegie Classification of Institutions of Higher Education.

The same pattern of Frontier Skill concentration being driven by a higher education engine plays out in metro regions like Boston-Cambridge and Raleigh-Durham. These university-driven ecosystems have long produced both the research and talent to build concentrations of Frontier Skills, especially in the technology sector. This highlights that there are different models for how cities can achieve success in building premier high-tech workforces and that there is no one-size-fits-all model for generating workforce competitiveness. Successful economic development strategies recognize that growing demand and enriching supply are inextricably linked and both demand-first and supply-first models work. Northwest Arkansas has built its advantage by being a nexus for innovative employers. Other regions, like Boston and Raleigh, have built through higher education and research stocks of talent that will likely drive investment, much as decades ago Silicon Valley set as its dynamo talent hubs like HP and Xerox PARC. It remains to be seen the extent to which new models of remote work challenge this model. We can already see some of these shifts bear out in which small cities are leading on Frontier Skill share. That list is dominated by lifestyle locations, including Santa Barbara, Santa Cruz, San Luis Obispo, Naples, FL, Bend, OR, and Palm Bay. Many of these are in some proximity to Silicon Valley or other tech hubs, possibly signaling the influence of hybrid work arrangements.

### Rankings by Share of Tech Workers with a Frontier Skill: Large MSAs (25k+ Tech Workers)

Rank	Metropolitan Statistical Area	Frontier Skill Holder Share
1	Seattle-Tacoma-Bellevue, WA	79.1%
2	San Jose-Sunnyvale-Santa Clara, CA	78.9%
3	San Francisco-Oakland-Berkeley, CA	75.2%
4	Boston-Cambridge-Newton, MA-NH	64.6%
5	Austin-Round Rock-Georgetown, TX	64.5%
6	San Diego-Chula Vista-Carlsbad, CA	62.8%
7	New York-Newark-Jersey City, NY-NJ-PA	60.4%
8	Los Angeles-Long Beach-Anaheim, CA	60.4%
9	Portland-Vancouver-Hillsboro, OR-WA	59.7%
10	Raleigh-Cary, NC	59.6%
11	Denver-Aurora-Lakewood, CO	58.5%
12	Atlanta-Sandy Springs-Alpharetta, GA	55.9%
13	Chicago-Naperville-Elgin, IL-IN-WI	55.2%
14	Miami-Fort Lauderdale-Pompano Beach, FL	55.1%
15	Phoenix-Mesa-Chandler, AZ	55.0%
16	Minneapolis-St. Paul-Bloomington, MN-WI	54.8%
17	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	54.3%
18	Detroit-Warren-Dearborn, MI	53.8%
19	Kansas City, MO-KS	53.7%
20	Baltimore-Columbia-Towson, MD	53.2%
21	Washington-Arlington-Alexandria, DC-VA-MD-WV	52.1%
22	Dallas-Fort Worth-Arlington, TX	51.9%
23	Pittsburgh, PA	51.7%
24	St. Louis, MO-IL	51.3%
25	Tampa-St. Petersburg-Clearwater, FL	51.3%
26	Houston-The Woodlands-Sugar Land, TX	50.2%
27	Sacramento-Roseville-Folsom, CA	50.0%

**Rankings by Share of Tech Workers with a Frontier Skill: Medium MSAs (5k-25k Tech Workers)**

Rank	MSA Name	Frontier Skill Holder Share	Rank	MSA Name	Frontier Skill Holder Share
1	Provo-Orem, UT	72.0%	25	Albany-Schenectady-Troy, NY	50.5%
2	Fayetteville-Springdale-Rogers, AR	63.1%	26	Huntsville, AL	50.3%
3	Salt Lake City, UT	62.8%	27	Birmingham-Hoover, AL	50.2%
4	Manchester-Nashua, NH	59.4%	28	Des Moines-West Des Moines, IA	50.1%
5	Ann Arbor, MI	59.2%	29	Providence-Warwick, RI-MA	50.0%
6	San Antonio-New Braunfels, TX	57.5%	30	Buffalo-Cheektowaga, NY	49.8%
7	Boise City, ID	56.9%	31	Riverside-San Bernardino-Ontario, CA	49.7%
8	Worcester, MA-CT	56.1%	32	Indianapolis-Carmel-Anderson, IN	49.5%
9	Rochester, NY	55.3%	33	Columbus, OH	49.4%
10	Ogden-Clearfield, UT	54.8%	34	Jacksonville, FL	48.9%
11	Charleston-North Charleston, SC	54.5%	35	Memphis, TN-MS-AR	48.8%
12	Oxnard-Thousand Oaks-Ventura, CA	54.3%	36	Omaha-Council Bluffs, NE-IA	48.6%
13	Fort Collins, CO	54.1%	37	Louisville/Jefferson County, KY-IN	48.1%
14	Las Vegas-Henderson-Paradise, NV	53.5%	38	Cincinnati, OH-KY-IN	48.1%
15	Trenton-Princeton, NJ	52.6%	39	Hartford-East Hartford-Middletown, CT	47.0%
16	Portland-South Portland, ME	52.6%	40	Richmond, VA	47.0%
17	Nashville-Davidson-Murfreesboro-Franklin, TN	52.2%	41	Oklahoma City, OK	46.7%
18	Bridgeport-Stamford-Norwalk, CT	52.1%	42	Cleveland-Elyria, OH	44.9%
19	Milwaukee-Waukesha, WI	51.6%	43	Allentown-Bethlehem-Easton, PA-NJ	44.8%
20	Charlotte-Concord-Gastonia, NC-SC	51.5%	44	Akron, OH	44.5%
21	Colorado Springs, CO	51.3%	45	New Orleans-Metairie, LA	43.5%
22	Albuquerque, NM	50.9%	46	Virginia Beach-Norfolk-Newport News, VA-NC	40.1%
23	Tucson, AZ	50.7%	47	Wichita, KS	38.7%
24	Orlando-Kissimmee-Sanford, FL	50.5%	48	Harrisburg-Carlisle, PA	37.4%

### Rankings by Share of Tech Workers with a Frontier Skill: Top 20 Small MSAs (<5k Tech Workers)

Rank	Metropolitan Statistical Area	Frontier Skill Holder Share
1	Santa Maria-Santa Barbara, CA	71.2%
2	Santa Cruz-Watsonville, CA	61.5%
3	San Luis Obispo-Paso Robles, CA	61.4%
4	Naples-Marco Island, FL	61.1%
5	Blacksburg-Christiansburg, VA	59.6%
6	Bend, OR	59.2%
7	Santa Rosa-Petaluma, CA	58.7%
8	Palm Bay-Melbourne-Titusville, FL	57.8%
9	Spokane-Spokane Valley, WA	56.4%
10	Reno, NV	54.5%
11	Lincoln, NE	54.4%
12	Eugene-Springfield, OR	53.7%
13	Utica-Rome, NY	52.2%
14	Iowa City, IA	52.1%
15	Janesville-Beloit, WI	51.9%
16	Champaign-Urbana, IL	51.8%
17	Syracuse, NY	51.5%
18	Columbia, MO	51.2%
19	Bloomington, IL	51.1%
20	Lakeland-Winter Haven, FL	50.5%

## Momentum Regions

America's tech workforce is dynamic, with the contours of employment and skill concentrations continuously shifting across regions. In recognition of this, we produced a separate ranking based on each region's momentum, as distinct from the current concentration of Frontier Skills in its workforce. The momentum rankings consider a weighted average of the growth of tech employment in the region and changes in the demand for Frontier Skills within new job openings.

Tech employment is measured using data from the US Census Bureau's American Community Survey to estimate the number of workers employed in tech occupations within each MSA in 2017 and in 2021. Growth is then measured through two metrics: (a) the percentage growth in the number of tech workers between the two periods and (b) the growth in the share of the local workforce employed in tech occupations between the two periods. Strong employment growth generally signals that a local economy can successfully create and attract new jobs.

Beyond a city's ability to create new jobs for tech workers, the skill requirements of the jobs being created also matters. Jobs that involve the use of Frontier Skills are more likely to be at the forefront of key technology



trends. If a region has a trend of increasing demand for frontier skills, it signals that the region is adding jobs that are likely to be and stay relevant.

Among major tech MSAs, the top four momentum spots were won by MSAs that also topped the overall Frontier Skill list. However, Pittsburgh (PA) and Kansas City (KS-MO), cities that ranked close to the bottom on the Frontier Skill Cities list, are near the top of the list for momentum, revealing these two as emerging tech hubs. Similar patterns bear out among MSAs with mid-sized tech workforces where several cities with thin concentrations of Frontier Skills nonetheless exhibit strong momentum. Notable examples are Las Vegas-Henderson-Paradise (NV), Memphis (TN), Cincinnati (OH), and Wichita (KS).

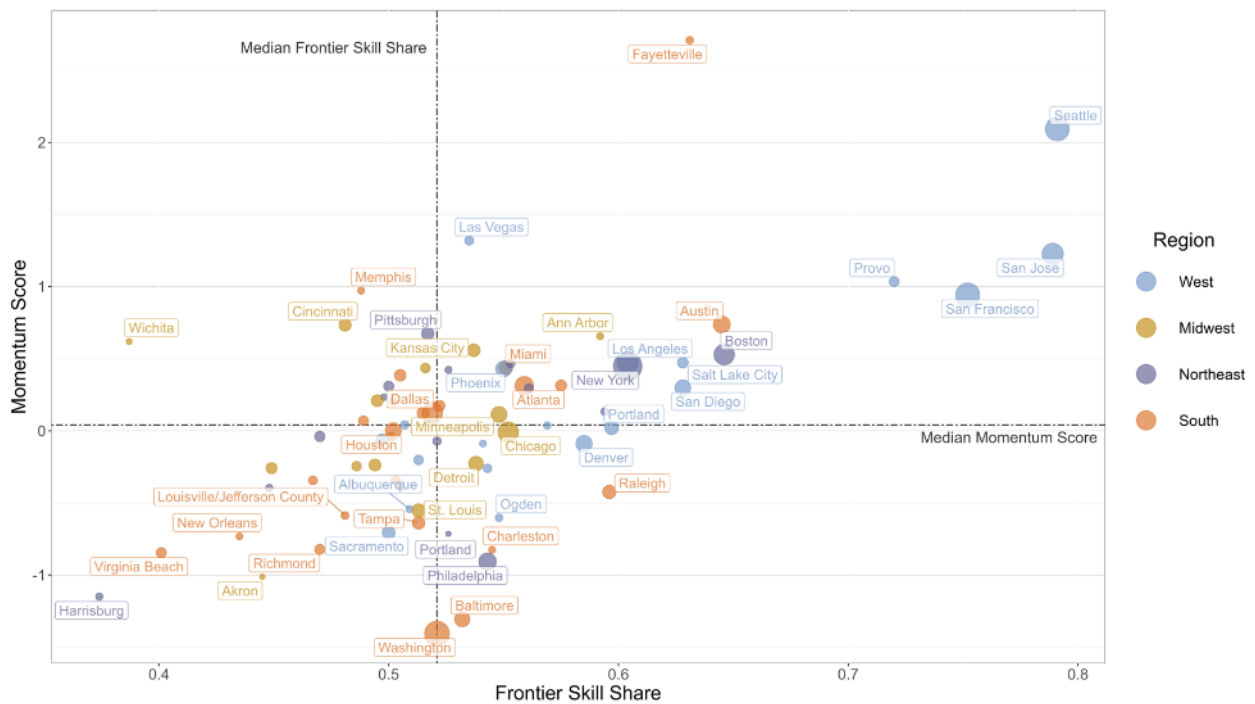


Figure 2: Comparing Frontier Skill Concentration and Momentum Across MSA's

But the opposite can also prove true. Among large tech workforce MSAs, San Diego-Chula Vista-Carlsbad (CA) and Portland-Vancouver-Hillsboro (OR-WA), which rank relatively high in terms of their existing Frontier Skill supply, have only middling momentum, indicating that they risk being overtaken if they don't work to attract more advanced technology jobs. Similarly, among medium-sized MSAs, some cities that rank high in current Frontier Skill supply show limited momentum. Examples are Manchester-Nashua (NH), Boise City (ID), Ogden-Clearfield (UT), Charleston-North Charleston (SC), Oxnard-Thousand Oaks-Ventura (CA), and Fort Collins (CO).

The combination of a region's current concentration of Frontier Skills and its momentum represents a powerful assessment of the competitiveness of its tech workforce, offering critical insights to industry, higher education, and government on how best to support workforce and economic development efforts and to build the local talent base.

### Rankings by Tech Worker Momentum: Large MSAs (25k+ Tech Workers)

Rank	Metropolitan Statistical Area
1	Seattle-Tacoma-Bellevue, WA
2	San Jose-Sunnyvale-Santa Clara, CA
3	San Francisco-Oakland-Berkeley, CA
4	Austin-Round Rock-Georgetown, TX
5	Pittsburgh, PA
6	Kansas City, MO-KS
7	Boston-Cambridge-Newton, MA-NH
8	Los Angeles-Long Beach-Anaheim, CA
9	New York-Newark-Jersey City, NY-NJ-PA
10	Miami-Fort Lauderdale-Pompano Beach, FL
11	Phoenix-Mesa-Chandler, AZ
12	Atlanta-Sandy Springs-Alpharetta, GA
13	San Diego-Chula Vista-Carlsbad, CA
14	Dallas-Fort Worth-Arlington, TX
15	Minneapolis-St. Paul-Bloomington, MN-WI
16	Portland-Vancouver-Hillsboro, OR-WA
17	Houston-The Woodlands-Sugar Land, TX
18	Chicago-Naperville-Elgin, IL-IN-WI
19	Denver-Aurora-Lakewood, CO
20	Detroit-Warren-Dearborn, MI
21	Raleigh-Cary, NC
22	St. Louis, MO-IL
23	Tampa-St. Petersburg-Clearwater, FL
24	Sacramento-Roseville-Folsom, CA
25	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
26	Baltimore-Columbia-Towson, MD
27	Washington-Arlington-Alexandria, DC-VA-MD-WV

### Rankings by Tech Worker Momentum: Medium MSAs (5k-25k Tech Workers)

Rank	Metropolitan Statistical Area	Rank	Metropolitan Statistical Area
1	Fayetteville-Springdale-Rogers, AR	25	Hartford-East Hartford-Middletown, CT
2	Las Vegas-Henderson-Paradise, NV	26	Des Moines-West Des Moines, IA
3	Provo-Orem, UT	27	Riverside-San Bernardino-Ontario, CA
4	Memphis, TN-MS-AR	28	Bridgeport-Stamford-Norwalk, CT
5	Cincinnati, OH-KY-IN	29	Fort Collins, CO
6	Ann Arbor, MI	30	Colorado Springs, CO
7	Wichita, KS	31	Columbus, OH
8	Salt Lake City, UT	32	Omaha-Council Bluffs, NE-IA
9	Rochester, NY	33	Cleveland-Elyria, OH
10	Milwaukee-Waukesha, WI	34	Oxnard-Thousand Oaks-Ventura, CA
11	Trenton-Princeton, NJ	35	Oklahoma City, OK
12	Orlando-Kissimmee-Sanford, FL	36	Huntsville, AL
13	San Antonio-New Braunfels, TX	37	Albany-Schenectady-Troy, NY
14	Providence-Warwick, RI-MA	38	Allentown-Bethlehem-Easton, PA-NJ
15	Worcester, MA-CT	39	Albuquerque, NM
16	Buffalo-Cheektowaga, NY	40	Louisville/Jefferson County, KY-IN
17	Indianapolis-Carmel-Anderson, IN	41	Ogden-Clearfield, UT
18	Birmingham-Hoover, AL	42	Portland-South Portland, ME
19	Nashville-Davidson-Murfreesboro-Franklin, TN	43	New Orleans-Metairie, LA
20	Manchester-Nashua, NH	44	Richmond, VA
21	Charlotte-Concord-Gastonia, NC-SC	45	Charleston-North Charleston, SC
22	Jacksonville, FL	46	Virginia Beach-Norfolk-Newport News, VA-NC
23	Tucson, AZ	47	Akron, OH
24	Boise City, ID	48	Harrisburg-Carlisle, PA

### Rankings by Tech Worker Momentum: Top 20 Small MSAs (<5k Tech Workers)

Rank	Metropolitan Statistical Area
1	Santa Maria-Santa Barbara, CA
2	Santa Cruz-Watsonville, CA
3	San Luis Obispo-Paso Robles, CA
4	Naples-Marco Island, FL
5	Blacksburg-Christiansburg, VA
6	Bend, OR
7	Santa Rosa-Petaluma, CA
8	Palm Bay-Melbourne-Titusville, FL
9	Spokane-Spokane Valley, WA
10	Reno, NV
11	Lincoln, NE
12	Eugene-Springfield, OR
13	Utica-Rome, NY
14	Iowa City, IA
15	Janesville-Beloit, WI
16	Champaign-Urbana, IL
17	Syracuse, NY
18	Columbia, MO
19	Bloomington, IL
20	Lakeland-Winter Haven, FL

# Building Regional Talent Strategies

Combining analysis of concentration and momentum suggests that a city's current station isn't destiny. Certainly, some regions have both a high concentration of Frontier Skills and strong momentum, including many of the stars of the digital firmament like Seattle, San Jose, and San Francisco. The high concentration and momentum these cities enjoy foretell continued success in growing employment and economic opportunity in the tech sector, at least for the time being. For all the talk of these high-cost hubs facing stiffening competition in an era of remote work, their place at the top seems secure. Key to their continued dominance is that these cities have been holding on to existing Frontier Skill workers. As shown in Figure 3 below, of those tech workers who were employed in Seattle, San Jose, or San Francisco between 2010 and 2019 and have had a job change since 2019, the majority stayed in one of those three cities. Only approximately 30 percent of the studied cohort moved to other MSAs.

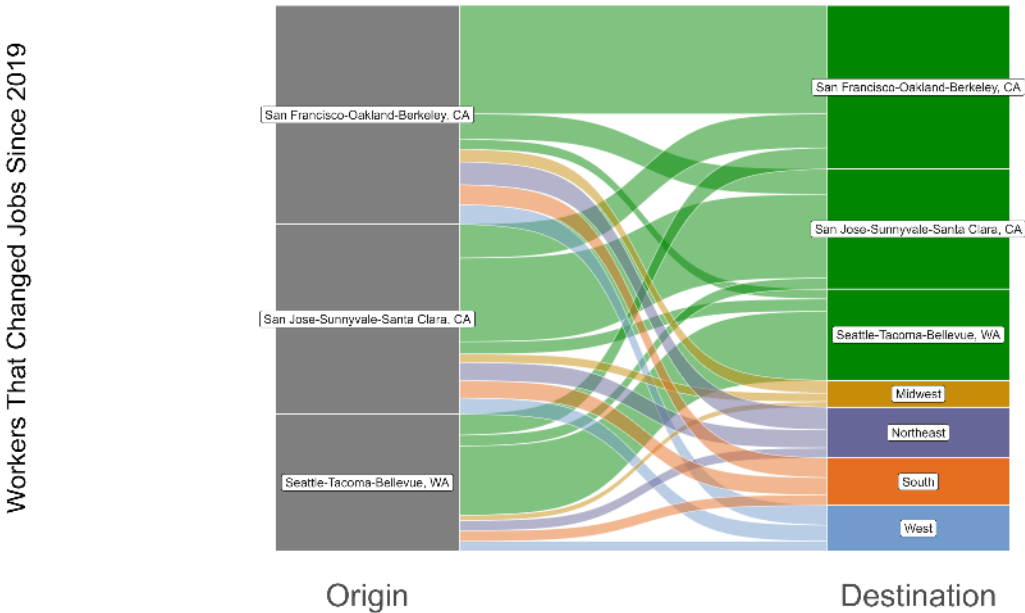


Figure 3: Where Workers from San Francisco, San Jose, and Seattle Who Have Recently Changed Jobs Went

Those who did relocate to a city other than Seattle, San Jose, or San Francisco were about equally likely to end up in the Northeast, South, or West, but relatively unlikely to settle in the Midwest. Notably, these results mirror those shown in Figure 2; the regions that drew in more workers from these three cities are the ones that tend to have higher Frontier Skill concentrations. The correlation of these two trends hints at how regional competitiveness is influenced by the migration patterns of existing talent. Yet, it would be a mistake to believe that talent migration is the only channel – or even the best channel – through which regions can build up their tech workforce. Investing in training and talent development remains a singularly powerful mechanism for advancing the talent base.

There are regions that have lower current concentrations of Frontier Skills and relatively low inflows of tech workers from West Coast powerhouses, but that nonetheless exhibit high momentum. Regions like Kansas City and Pittsburgh fit this mold. These regions show growth and promise in the tech sector driven by deliberate,

targeted efforts to build the local tech talent base in ways that capitalize on existing advantages. Kansas City has prioritized greater regional connectivity through its Google Fiber rollout and has seen growth in its technology sector in consequence. Pittsburgh has invested heavily in its education and healthcare sectors as it transitioned away from steel as the foundation of its economy. With significant employment growth in emerging sectors that pull on Frontier Skills, including innovations in software and robotics associated with the region's leadership in advanced manufacturing and autonomous vehicles, and with a powerful AI research & development at Carnegie Mellon University, Pittsburgh is a strong case study for how economic and workforce development strategies can shape an economy.

Regions with low concentrations of Frontier Skills and limited momentum can follow the playbook of places like Pittsburgh and Kansas City. A critical first step is to identify the skill base needed to advance sectors key to the region's success and to drive the local economy's comparative advantages, whether in or outside the tech sector. This analysis is key to developing a strategic plan linking talent development with economic development. Practically, such a plan could involve a wide array of actions. It may be investing in new research and development that drives technology adoption in existing economic sectors, or it may be identifying new targeted industries for economic development and industrial recruitment. Understanding the skills that mobilize a region and accelerate development is critical to aligning workforce and talent development with economic development. This may start with linking existing labor market and economic development analysis with an assessment of regional skills strengths.

Increasingly, a city's growth prospects lie in the strength of its talent base. As such, measuring the concentration of high-value, high-growth skills is critical to assessing economic competitiveness and future readiness. The same method we have applied here for understanding Frontier Skills in tech can be equally applied in any other sector. This must go beyond simplistic studies of industrial concentration. As this analysis of frontier tech skills has shown, measuring regional economic competitiveness and identifying future economic growth opportunities requires a clear view of the stock and flow of leading edge skills.

# Appendices

## Appendix – Tech-Related (O\*NET) Occupations

- Information Technology Project Managers
- Business Intelligence Analysts
- Information Security Analysts
- Blockchain Engineers
- Penetration Testers
- Database Administrators
- Statisticians
- Computer Programmers
- Telecommunications Engineering Specialists
- Web and Digital Interface Designers
- Digital Forensics Analysts
- Software Developers
- Web Developers
- Information Security Engineers
- Health Informatics Specialists
- Network and Computer Systems Administrators
- Document Management Specialists
- Software Quality Assurance Analysts and Testers
- Operations Research Analysts
- Computer Network Architects
- Computer Hardware Engineers
- Biostatisticians
- Computer and Information Research Scientists
- Computer Systems Engineers/Architects
- Video Game Designers
- Geographic Information Systems Technologists and Technicians
- Computer Occupations, All Other
- Data Warehousing Specialists
- Web Administrators
- Computer Systems Analysts
- Database Architects
- Clinical Data Managers
- Data Scientists

## Appendix – Frontier Skills (2022)

- Cloud-Native Computing
- Jest (JavaScript Testing Framework)
- Threat Modeling
- Scalability
- Amazon Web Services
- Amazon Redshift
- GraphQL
- Microservices
- Data Pipelines
- PyTorch (Machine Learning Library)
- Go (Programming Language)
- Cloud Security
- TypeScript
- Software Defined Networking (SDN)
- IT Security Architecture
- AWS Kinesis
- Front End Design
- Codebase
- Datadog
- Infrastructure Security
- Computer Architecture
- Google Cloud Platform (GCP)
- Kotlin
- Observability
- Terraform
- Apache Kafka
- Penetration Testing
- Security Engineering
- Application Programming Interface (API)
- Endpoint Detection And Response
- Gitlab
- Software Quality (SQA/SQC)
- Data Lakes
- Data Governance
- Vulnerability Management
- Code Review
- RESTful API
- ISO/IEC 27001
- Software Development
- Data Architecture
- Kubernetes
- Software Engineering
- CI/CD
- Software Design Patterns
- Cryptography
- Application Security
- Okta
- Adobe Experience Manager
- Systems Development
- Ansible



- Talend
- Serverless Computing
- Amazon DynamoDB
- Algorithms
- Application Deployment
- Full Stack Development
- Computer Science
- Internet Protocol Security (IP SEC)
- System Programming
- Deep Learning
- On Prem
- Object-Oriented Design
- Testability
- Code Coverage
- Event-Driven Programming
- Cloud Computing

# Tech Talent Regional Rankings Methodology

## Frontier Skills

We define “Frontier Skills” as skills that are on the frontier of tech skills in the labor market as evidenced by commanding a high wage premium while also experiencing robust growth in demand over the last two years. Wage premiums are the typical difference in advertised wage between a job posting that requests a skill and a similar job posting that does not request that skill; any differences in wage arising from variation in occupation, experience levels, and education levels are controlled for during the calculation of the wage premium. Skill growth refers to the change in likelihood of a skill appearing in a job posting between two years after controlling for any changes that result from the growing or shrinking of different occupations over time.

## Frontier Skill Holder Share

Using social professional profiles data, we are able to see skills as well as the location associated with each profile. The location of each profile is taken from the most recent job experience; if there is no location listed for the most recent job experience, the profile’s self-described location is used instead. Among profiles that have valid location and skills data and list a tech-related occupation as their most recent job experience, we calculate the percent that list at least one Frontier Skill within each MSA.

## Frontier Skill Usage

From job postings data, we can observe mentions of specific skills within each posting. For each MSA in each year, using that year’s set of Frontier Skills, we calculate the share of job postings that mention at least one Frontier Skill. To track the general trend in Frontier Skill Usage, we look at the average Frontier Skill usage share between 2017-2019 and compare it to the average Frontier Skill usage share between 2020-2022.

## Tech-Related Occupations and Skills

For these rankings, we define the tech sector on the basis of occupations. In particular, we use a hand-selected set of occupations that tend to emphasize programming and/or data skills. To focus in on *tech* talent rather than general talent within the tech sector, we also restrict the set of skills we use in the analyses to those that are most closely related to the selected tech occupations.

## Aggregate Scores and Rankings

The key results from the analyses are the aggregate scores and rankings based on the current Frontier Skill Holder Share and the “momentum” of tech talent in each MSA. The “Momentum Score” is an aggregated measure of the growth in tech labor supply and in relative share of the labor market as measured from American Community Survey (ACS) data downloaded from IPUMS. Because the units and scales of the different measures may differ drastically, we first normalize them by converting to z-scores (standard scores) before aggregating. Weights are then applied to each component and the aggregate score is calculated.

Rankings are created by ranking the Frontier Skill Holder Share and the Momentum Score in descending order within each MSA size grouping. Rankings should only be considered within MSA size groupings because the size of the tech labor market is correlated with differences in labor market structure and composition which preclude apples-to-apples comparisons.