



TENNESSEE WORKFORCE DISRUPTION INDEX

Future Impacts of Automation, Age Demographics and Education
within the Tennessee Workforce

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INTRODUCTION

This report discusses jobs that have a high probability of workforce disruption due to automation and technological advances. We illustrate the workforce vulnerable to automation in Tennessee counties, Tennessee regions and across the Southeast region.

Due to technological developments, algorithms can do many tasks that were once viewed as uniquely human such as writing news articles, driving cars and diagnosing illness. The labor market as we know it is on the verge of a paradigm shift—as machines once overcame human physical limitations during the Industrial Revolution, artificial intelligence has the potential to not only overcome unambiguous and uncreative tasks but also less routine tasks currently performed by individuals in the labor force.

In similar spirit to the Institute for Emerging Issues' recent "FutureWork Disruption Index for North Carolina,"¹ this report is built upon the foundational research of Oxford University's Carl Frey and Michael Osborne.² Through analysis of occupational tasks, Frey and Osborne forecast the probability of automation for over 700 occupations.

For Tennessee, we evaluate the 320 jobs with a high probability (70 percent probability or higher) of automation³ — jobs that are most vulnerable to replacement by technology capital. These jobs employ 1.4 million Tennesseans, representing 50 percent of Tennessee's current workforce.

1.4 MILLION TENNESSEE JOBS HAVE A HIGH PROBABILITY OF AUTOMATION, REPRESENTING 50 PERCENT OF TENNESSEE'S CURRENT WORKFORCE.

Automation is creating an accelerating shift in our workforce. As "the second machine age"⁴ drives restructuring of workforce tasks and reallocation of jobs, trends in educational attainment and age demographics significantly impact a community's future workforce composition. This report provides a regional index⁵ of projected vulnerability to workforce disruption, taking into consideration the interaction of these three trends. The primary component of the disruption index score is lost wages due to predicted workforce automation, representing 50 percent of the score. Twenty-five percent of the index score is influenced by a region's share of population that is of working age and the pressure placed on that population to support dependents.

¹"FutureWork Disruption Index for North Carolina." Institute for Emerging Issues, NC State University, February 1, 2016. <https://iei.ncsu.edu/disruptionindex/>.

²Frey, Carl Benedick, and Michael A. Osborne. "The Future of Employment: How Susceptible Are Jobs to Computerisation?" University of Oxford, September 17, 2013. http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

³ Appendix C provides the list of 320 occupations with 70 to 100 percent probability of automation.

⁴Brynjolfsson, Erik, and Andrew McAfee. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: W. W. Norton & Company, 2014.

⁵The methodology and inspiration of this index are based on the "FutureWork Disruption Index for North Carolina" (Institute for Emerging Issues 2016)

High dependency ratios may influence a more rapid shift towards automation among the business community due to lack of business access to sufficient working age labor. Working populations already under this relative demographic pressure may in turn experience a heightened degree of disruption from job automation. Educational attainment, representing the remaining 25 percent of the index score, can improve a community's ability to adapt and impact the changes automation creates.

While automation will create change across Tennessee and particularly in communities with highly vulnerable workforces, the negative connotations we commonly associate with disruption and change may not be realized. We discuss the economic value technological advances have historically generated. Automation can complement labor to improve productivity and incomes. To realize and capture the value of automation, businesses, communities and regions must realize this future workforce pattern and prepare for the benefits of disruption.

KEY FINDINGS

- 1.4 million Tennessee jobs have a high probability (70 percent probability or higher) of replacement by automation. This represents 50 percent of Tennessee's current workforce. Vulnerable jobs as a share of total employment ranges from 35.7 percent in Bledsoe County to 59.6 percent in Sevier County. (Map 1)
- Lower-wage occupations are more vulnerable to replacement by automation. The average hourly wage of jobs with a 70 percent probability of automation is \$14.56, five dollars lower than the average hourly wage for all jobs. (Table 1)
- If automation occurred in the occupations with at least a 70 percent probability of automation, 37 percent of the wages of workers in Tennessee could be lost. (Map 3)
- Rural counties are more vulnerable to the disruptive effects of automation. Of Tennessee's 17 urban counties, only three—Hamblen, Loudon, and Bradley—are ranked in the most vulnerable two-thirds of Tennessee counties. (Map 2)
- Tennessee regions most vulnerable to future workforce disruption are Northwest Tennessee and Upper Cumberland. The Northern Middle and Greater Memphis regions are least vulnerable. (Map 6)
- Within the Southeast states, Tennessee is ninth most vulnerable to future workforce disruption, where a rank of 1 represents high vulnerability and a rank of 12 represents low vulnerability. Virginia is the least vulnerable state (#12); Mississippi is the most vulnerable state (#1). (Map 7)

THE PROBABILITY OF JOB AUTOMATION

An estimated 47 percent of the nation's employment in 2010 was highly susceptible to replacement by "computer capital," as outlined by Frey and Osborne.⁶ Through application of their probability structures, we estimate 1,400,914 Tennessee jobs in 2015 are highly susceptible to computerization, representing 50 percent of the state's workforce.

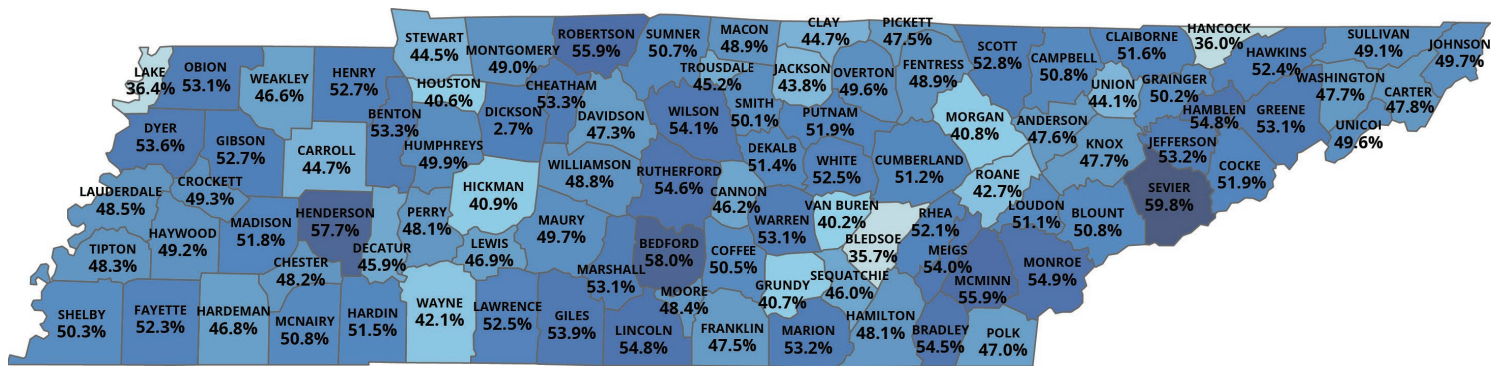
⁶Frey and Osborne. "The Future of Employment"

North Carolina found similar results, estimating 1.88 million employees, or 48 percent of the North Carolina workforce, are highly susceptible to replacement by automation (occupations with at least a 70 percent probability of automation and employing over 10,000).^{7 8}

Map 1 illustrates the percentage of jobs within each Tennessee county with a high probability of replacement through technological advances. Vulnerable jobs as a share of total employment ranges from 35.7 percent in Bledsoe County to 59.6 percent in Sevier County.

1,400,914 TENNESSEE JOBS IN 2015 ARE HIGHLY SUSCEPTIBLE TO COMPUTERIZATION.

MAP 1: PERCENT OF 2015 JOBS THAT HAVE A 70 PERCENT OR HIGHER PROBABILITY OF AUTOMATION



The job classifications highly susceptible to automation represent a large portion (45 percent) of all job categories and half of Tennessee’s current workforce. Table 1 provides the distribution of occupational classifications and Tennessee workforce by probability of technological disruption. Jobs with an intermediate probability (30 to 69 percent probability) of automation support 543,863 jobs, representing 19 percent of Tennessee’s workforce. Occupations with the lowest probability of replacement by automation (0 to 29 percent probability) employ 753,078 Tennesseans, representing 27 percent of the state’s workforce.

⁷Institute for Emerging Issues, “FutureWork Disruption Index for North Carolina”
⁸The methodology of this report does vary slightly from North Carolina’s evaluation-including differences in index components and the removal of a 10,000 statewide employment threshold for an occupation to be considered vulnerable to automation. CERT’s detailed methodology is available at the end of this report.

**TABLE 1: COMPARISON OF WORKFORCE
BY PROBABILITY OF AUTOMATION^{9 10}**

Probability of Replacement by Automation	Number of Occupations (% of Total)	Number of Employees (% of total)	Avg. Hourly Wage	Lowest Occupational Avg. Hourly Wage	Highest Occupational Avg. Hourly Wage	Percent of Employees with Avg. Annual Wage Over \$55,000	Percent of Employees with Avg. Annual Wage Under \$30,000
0% to 29%	247 (31%)	753,078 (27%)	\$31.39	\$9.57	\$116.95	55%	6%
30% to 69%	146 (19%)	543,863 (19%)	\$16.37	\$8.61	\$54.50	7%	42%
70% to 100%	320 (41%)	1,400,914 (50%)	\$14.56	\$8.38	\$43.07	6%	58%
Occupations with No Assigned Probability	73 (9%)	109,046 (4%)	\$28.43	\$9.71	\$96.63	9%	2%
Total	786 (100%)	2,806,900 (100%)	\$19.56	\$8.38	\$116.95	19%	41%

Jobs with high probabilities of replacement by automation, characterized as “routine cognitive and manual jobs,”¹¹ generally have lower wages—58 percent of employees in these occupations earn less than \$30,000 annually. The average hourly wage of this workforce (\$14.56) was 12 percent lower than the average wage for jobs with an intermediate probability (30 to 69 percent probability) of automation, and 116 percent lower than the average wage for jobs with a low automation probability (0 to 29 percent probability). Only 6 percent of employees with high probabilities of automation have an average annual wage above \$55,000. Meanwhile, 55 percent of employees with a low probability of automation earn more than \$55,000 annually.

LOWER-WAGE OCCUPATIONS ARE MORE VULNERABLE TO REPLACEMENT BY AUTOMATION.

⁹Walden, Michael L. “North Carolina’s Future Job Market and Policy Responses.” NC State University, July 2015. <https://iei.ncsu.edu/wp-content/uploads/2016/01/Walden-IEI-White-Paper-futurejobs-July2015.pdf>

¹⁰By matching the probabilities of automation developed by Frey and Osborne to updated SOC occupational codes, there are 713 occupations that have an applicable probability of being replaced by automation. There are 73 occupations (employing 109,046 Tennesseans) without a corresponding probability assigned by Frey and Osborne. Appendix C provides the list of 320 occupations with 70 to 100 percent probability of automation.

¹¹Michael Walden, “North Carolina’s Future Job Market and Policy Responses.”

What types of jobs have a high probability of automation? Table 2 displays the distribution of highly vulnerable jobs across broad occupation groups. On a more detailed level, Table 3 provides the top 25 occupations (by Tennessee employment) with a high vulnerability to automation. Details for all occupations with a high probability of automation are included in Appendix C.

Occupational sectors employing greater than 10 percent of Tennessee's 1.4 million jobs vulnerable to automation:

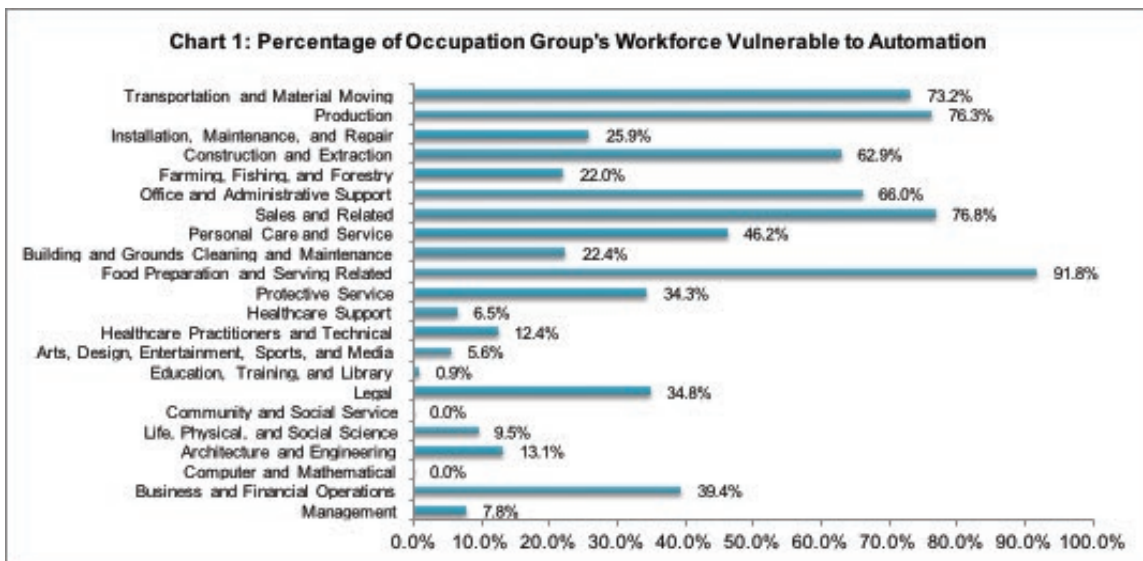
- Office and administrative support occupations employ 21.6 percent of Tennessee's workforce that has a high probability (70 percent probability or higher) of automation. Vulnerable occupations with high employment in Tennessee include office clerks (53,806 jobs); secretaries and administrative assistants not in the legal, medical or executive fields (49,329 jobs); bookkeeping, accounting and auditing clerks (31,441 jobs); shipping, receiving and traffic clerks (18,396 jobs); and receptionists (18,008 jobs).
- Food preparation and service occupations employ 16.6 percent of Tennessee's workforce that has a high probability of automation. Vulnerable jobs employing high numbers of Tennesseans include combined food preparation and serving workers (65,405 jobs), waiters and waitresses (53,007 jobs), restaurant cooks (23,900 jobs) and food preparation workers (18,783 jobs).
- Sales occupations employ 15.4 percent of Tennessee's workforce vulnerable to automation. Vulnerable jobs employing high numbers of Tennesseans include retail salespersons (89,873 jobs); cashiers (74,748 jobs); and sales representatives for wholesale and manufacturing, non-technical and non-scientific (22,572 jobs).
- Transportation and material moving occupations employ 14.0 percent of Tennessee's workforce vulnerable to automation. Vulnerable jobs employing high numbers of Tennesseans include laborers and freight, stock and material movers (90,239 jobs), and heavy and tractor-trailer truck drivers (50,101 jobs).
- Production occupations employ 13.9 percent of Tennessee's workforce vulnerable to automation. Vulnerable jobs employing high numbers of Tennesseans include team assemblers (62,203 jobs); inspectors, testers, sorters, samplers and weighers (12,996 jobs); and packaging and filling machine operators and tenders (11,154 jobs).

TABLE 2: COMPARISON OF VULNERABLE JOBS TO ALL JOBS, BY MAJOR OCCUPATION GROUP (2015)

SOC Code (2-digit)	Major Occupation Group	Employment in Vulnerable Occupations	Employment in All Occupations	Vulnerable Jobs as a Share of Total Jobs	Share of 1.4 Million Vulnerable Tennessee Jobs
11	Management Occupations	12,020	155,055	7.8%	0.9%
13	Business and Financial Operations Occupations	41,523	105,472	39.4%	3.0%
15	Computer and Mathematical Occupations	16	49,777	0.0%	0.0%
17	Architecture and Engineering Occupations	5,734	43,690	13.1%	0.4%
19	Life, Physical, and Social Science Occupations	1,523	16,028	9.5%	0.1%
21	Community and Social Service Occupations	0	30,527	0.0%	0.0%
23	Legal Occupations	4,684	13,460	34.8%	0.3%
25	Education, Training, and Library Occupations	1,267	145,813	0.9%	0.1%
27	Arts, Design, Entertainment, Sports, and Media Occupations	1,620	29,086	5.6%	0.1%
29	Healthcare Practitioners and Technical Occupations	22,915	185,542	12.4%	1.6%
31	Healthcare Support Occupations	4,975	76,720	6.5%	0.4%
33	Protective Service Occupations	22,455	65,384	34.3%	1.6%
35	Food Preparation and Serving Related Occupations	231,971	252,683	91.8%	16.6%
37	Building and Grounds Cleaning and Maintenance Occupations	19,462	86,915	22.4%	1.4%
39	Personal Care and Service Occupations	34,642	75,039	46.2%	2.5%
41	Sales and Related Occupations	215,910	281,024	76.8%	15.4%
43	Office and Administrative Support Occupations	302,403	458,121	66.0%	21.6%
45	Farming, Fishing, and Forestry Occupations	1,675	7,607	22.0%	0.1%
47	Construction and Extraction Occupations	54,103	86,014	62.9%	3.9%
49	Installation, Maintenance, and Repair Occupations	30,917	119,412	25.9%	2.2%
51	Production Occupations	194,410	254,850	76.3%	13.9%
53	Transportation and Material Moving Occupations	196,667	268,681	73.2%	14.0%
Total		1,400,914	2,806,900	49.9%	100.0%

Chart 1 identifies the percentage of each group’s workforce that has high likelihood of automation. The five occupational groups outlined above also represent the top five occupational groups with the greatest share of vulnerable jobs: food preparation and serving occupations (91.8 percent of the jobs in this occupation group), sales occupations (76.8 percent), production occupations (76.3 percent), transportation and material moving occupations (73.2 percent), and office and administrative support occupations (66 percent).

CHART 1: PERCENTAGE OF OCCUPATION GROUP’S WORKFORCE VULNERABLE TO AUTOMATION



**TABLE 3: TOP 25 OCCUPATIONS (BY EMPLOYMENT) WITH
A 70 PERCENT OR GREATER PROBABILITY OF AUTOMATION**

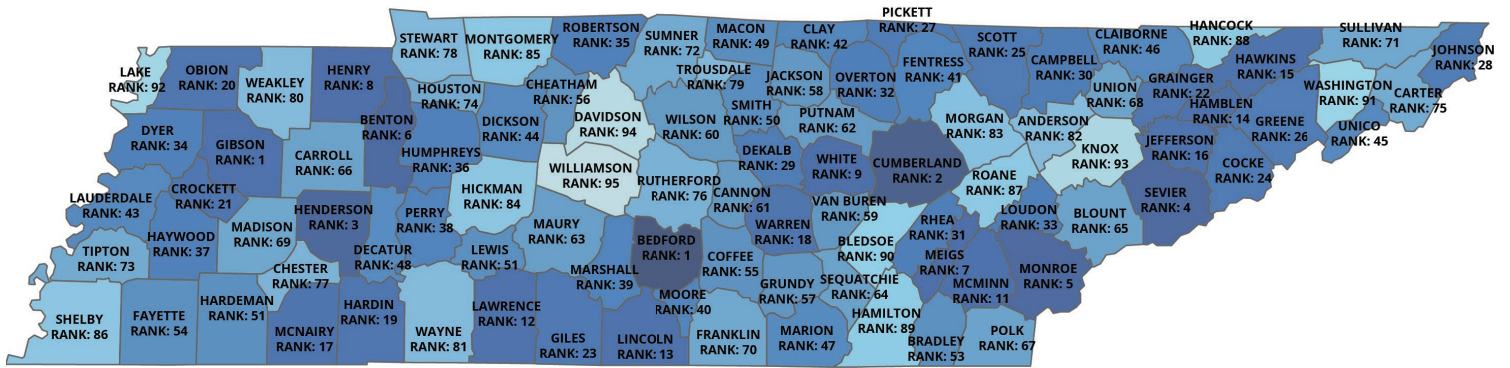
SOC Code	Occupation	TN Employment, 2015	Avg. Hourly Wages, 2015
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	90,239	\$12.54
41-2031	Retail Salespersons	89,873	\$12.21
41-2011	Cashiers	74,748	\$9.32
35-3021	Combined Food Preparation and Serving Workers, Including Fast Food	65,405	\$8.74
51-2092	Team Assemblers	62,203	\$15.01
43-9061	Office Clerks, General	53,806	\$14.36
35-3031	Waiters and Waitresses	53,007	\$8.99
53-3032	Heavy and Tractor-Trailer Truck Drivers	50,101	\$19.68
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	49,329	\$14.82
43-3031	Bookkeeping, Accounting, and Auditing Clerks	31,441	\$17.07
35-2014	Cooks, Restaurant	23,900	\$10.49
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	22,572	\$27.97
33-9032	Security Guards	22,304	\$12.16
39-9021	Personal Care Aides	21,349	\$9.16
13-2011	Accountants and Auditors	19,855	\$32.12
35-2021	Food Preparation Workers	18,783	\$9.25
43-5071	Shipping, Receiving, and Traffic Clerks	18,396	\$14.48
53-7051	Industrial Truck and Tractor Operators	18,102	\$14.54
43-4171	Receptionists and Information Clerks	18,008	\$12.78
47-2061	Construction Laborers	16,235	\$13.88
37-3011	Landscaping and Groundskeeping Workers	15,535	\$12.09
35-2011	Cooks, Fast Food	14,903	\$8.38
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	12,996	\$16.28
29-2052	Pharmacy Technicians	12,164	\$14.18
51-9111	Packaging and Filling Machine Operators and Tenders	11,154	\$14.39

DISRUPTION INDEX FOR TENNESSEE COUNTIES

Map 2 illustrates the likelihood of Tennessee’s counties to experience disruption resulting from the forecasted automation of jobs, high dependency ratios and lower educational attainment.

We predict that workforces with a high share of earnings vulnerable to computerization will experience greater disruption (Map 3). We predict communities with high dependency ratios may experience increased rates of automation due to lack of business access to working age populations (Map 4). Educational attainment is incorporated as a change agent that can improve or prevent a region’s ability to manage and align with automation (Map 5).

MAP 2: DISRUPTION INDEX FOR TENNESSEE COUNTIES



RURAL COUNTIES ARE MORE VULNERABLE TO THE DISRUPTIVE EFFECTS OF AUTOMATION.

COUNTY CONSIDERATIONS

Williamson, Davidson and Knox are the three counties that are least vulnerable to disruption. *Bedford, Cumberland and Henderson* are the three most vulnerable counties. See Appendix A for county index data and scores.

The counties near metro areas tend to be less susceptible to disruption. Of the 17 counties that TNECD has identified as urban,¹² only three of these counties—*Hamblen, Loudon and Bradley*—are ranked in the most vulnerable two-thirds of Tennessee’s counties.

Bedford, Sevier and Henderson, respectively, had the highest percent of their wages vulnerable to automation, which led to high rankings in the vulnerability index (1st, 4th, and 3rd). Over 10,600 (58 percent) of Bedford County’s jobs have a high probability of automation. Over 25,100 (60 percent) of Sevier County’s jobs have a high probability of automation. Over 4,500 (58 percent) of Henderson County’s jobs have a high probability of automation.

Hickman County is vulnerable to lose 31 percent of its wages to automation—which is the 5th lowest of Tennessee’s counties. A low percent of vulnerable wages and a low dependency ratio result in relatively low vulnerability. Yet, of its population age 25 to 64, only 17 percent have an associate’s degree or higher—which could make retraining its workforce for new occupations with more advanced skills difficult.

¹²TNECD identified 17 counties as urban: *Anderson, Blount, Bradley, Carter, Davidson, Hamblen, Hamilton, Knox, Loudon, Madison, Montgomery, Rutherford, Shelby, Sullivan, Sumner, Washington, and Williamson*. Definition based on the percentage of a county’s population living within urbanized areas as outlined by the U.S. Census Bureau.

Roane County had the second lowest percent of its wages vulnerable to automation. The wage disparity between the occupations with over 70 percent probability of automation (an average hourly wage of \$13.63) and occupations with under 70 percent probability of automation (an average hourly wage of \$25.18) could have attributed to the county's low vulnerability. The average hourly wage of Roane County for all occupations is \$20.24, yet only 33 percent of its workers make more than that.

Robertson County has the sixth highest percent of its wages vulnerable to automation of Tennessee's counties—yet it has a more favorable dependency ratio (24th lowest) and educational attainment of an associate's degree or higher (24th highest), pushing it toward the less vulnerable ranks.

A high dependency ratio in Cumberland County, ranked second most vulnerable of Tennessee counties, drives the county's high vulnerability score. A high share of individuals under age 15 and over age 65, relative to the population typically considered within the workforce (age 15 to 64) may create vulnerability in a future of automation.

Some of Tennessee's counties have low occupational diversity, which may contribute to a more favorable vulnerability index score where jobs are concentrated in non-vulnerable occupations. Yet counties face a number of difficulties as a result of a lack of diversity and low employment, and it may prove more difficult for these counties to upskill their workforces. Lake, Hancock and Bledsoe counties appear to be outliers for these reasons.¹³

Lake County: Employment is concentrated in a few occupations. Expected lost wages in the county rank second lowest of all the counties at 29 percent, indicating low vulnerability. However, for Lake County this results from low employment and low wages for all jobs; loss of any jobs could be very disruptive in comparison to communities with greater and more diverse industry presence.

The occupation with the highest employment is correctional officers and jailers, representing 7.4 percent of the county's employment. Lake had the lowest dependency ratio of Tennessee's counties—a favorable indicator—but also the lowest educational attainment of an associate's degree (9 percent of the county's population age 25 to 64).

Hancock County: The two occupations with the highest employment in Hancock County are elementary school teachers and teacher's assistants, representing 10.2 percent of the county's employment. Of Hancock County's population age 25 to 64, only 15 percent have an associate's degree or higher. Hancock also had the highest unemployment rate of Tennessee's counties in 2015.

Bledsoe County: The two occupations with the highest employment in Bledsoe County are correctional officers and jailers and police and sheriff's patrol officers, representing 12.0 percent of the county's employment. Of Bledsoe County's population age 25 to 64, only 17 percent have an associate's degree or higher.

¹³See *Limitations and Other Considerations*.

IF AUTOMATION OCCURRED IN THE OCCUPATIONS WITH AT LEAST A 70 PERCENT PROBABILITY OF AUTOMATION, 37 PERCENT OF THE WAGES OF WORKERS IN TENNESSEE COULD BE LOST.

In a recent article, “A World Without Work,” Derek Thompson describes the economic and social depression realized in Youngstown, Ohio with the off-shoring of steel manufacturing in the 1970s, and imagines the same disruptions occurring through automation.²¹ “A decline in wages as a share of economic output is indicative of a shift towards declining importance of human labor,” Thompson argues. Others alternatively argue that labor’s declining share of output is exaggerated; labor’s declining share results not from replacement of human labor but rather from increases to production taxes, as well as the rapid depreciation of capital and rising costs of technology replacement/repair.²²

Technological advances have historically produced sentiments of unease. Another article in The Atlantic referenced writer Thomas Mortimer, who in 1772 over concerns with the sawmill “decried ‘those [machines]’ which are intended almost totally to exclude the labor of the human race ... [which] if introduced into our dockyards etc. would exclude the labor of thousands of useful workmen.”²³ A letter to President Herbert Hoover described “that industrial technology was a ‘Frankenstein monster’ that threatened to upend manufacturing, ‘devouring our civilization.”²⁴ The Monthly Labor Review of the Bureau of Labor Statistics offers similar perspective, referencing a 1927 statement from the Secretary of Labor in issues from 2016 and 1965:

“In the long run, new types of industries have always absorbed the workers displaced by machinery, but of late, we have been developing new machinery at a faster rate than we have been developing new industries... At the same time we must ask ourselves, is automatic machinery, driven by limitless power, going to leave on our hands a state of chronic and increasing unemployment? Is the machine that turns out wealth also to create poverty? Is it giving us a permanent jobless class? Is prosperity going to double aback on itself and bring us social distress?”²⁵

History demonstrates that a shift toward heightened technological demands of the business community does not likely coincide with declining demand for labor. Automation of workplace tasks will displace workers, but not replace workers.²⁶ Rather than eliminating labor, automation is likely to reshape the distribution of jobs. New jobs will be created and individuals will shift toward existing jobs requiring the unique abilities, knowledge and high-level skills that our future workforce will demand. “Humans will still be necessary in the economy of the future, even if we can’t predict what we will be doing.”²⁷

²¹Thompson, Derek. “A World Without Work.” *The Atlantic*, July 2015. <http://www.theatlantic.com/magazine/archive/2015/07/world-without-work/395294/>

²²Jones, Michael. “Yes, robots will steal your jobs, but don’t worry, we’ll get new ones.” *The Conversation*, February 12, 2016. <http://theconversation.com/yes-robots-will-steal-our-jobs-but-dont-worry-well-get-new-ones-54143>

²³Rosen, Rebecca J. “In Praise of Short-Term Thinking.” *The Atlantic*, September 3, 2015. <http://www.theatlantic.com/business/archive/2015/09/jobs-automation-technological-unemployment-history/403576/>

²⁴Thompson, “A World Without Work.”

²⁵Atkinson, Rob. “Technology may disrupt occupations, but it won’t kill jobs.” *Monthly Labor Review*, February 2016. <http://www.bls.gov/opub/mlr/2016/article/pdf/technology-may-disrupt-occupations-but-it-wont-kill-jobs.pdf>

²⁶Bessen, James. “Some Predict Computers Will Produce a Jobless Future. Here’s Why They’re Wrong.” *Washington Post*, February 18, 2014. <https://www.washingtonpost.com/news/the-switch/wp/2014/02/18/some-predict-computers-will-produce-a-jobless-future-heres-why-theyre-wrong>

²⁷Michael Jones, “Yes, robots will steal your jobs, but don’t worry, we’ll get new ones.”

The redistribution of jobs across industries has shifted dramatically in the last century, according to a U.S. Bureau of Labor Statistics analysis of jobs in 1910 and 2015.²⁸ For example, the professional services industry has risen from a meager 3.0 percent to 28.9 percent of all employment, whereas manufacturing has declined from 32.4 percent to 8.7 percent of all employment. The domestic service industry exemplifies another significant shift, accounting for 8.5 percent of employment in 1910 and no longer exists in 2015 industry structures. Michael Walden forecasts six areas for new job creation: “household management, repair/maintenance of new technology, global interaction, logistics/data management/analysis, aged assistance, education/re-training and artisanship.”²⁹

McKinsey & Company explores shifts the current machine age may create. Through evaluation of 2,000 work activities prevalent across 800 occupations, their research shows “45 percent of work activities could be automated using already demonstrated technology.”³⁰ Rather than portraying a future where all of a job’s activities are replaced by computers, the McKinsey analysis reports that for a majority of job classifications only 30 percent of tasks can be replaced through automation in the near and medium term. The disruptive changes automation creates will induce not job loss, but instead “necessitate significant job redefinition and a transformation of business processes.”³¹

Through the complementary effects of human skill and technological speed and precision, the productivity of individual jobs and organizations will rise. The favorable impacts automation and robotics can have on productivity, incomes, consumption, standards of living and leisure time are recognized in the 2016 Economic Report of the President.³² While replacing some jobs, David Autor argues “automation also complements labor, raises output in ways that leads to higher demand for labor, and interacts with adjustments in labor supply.”³³ The modern age of automation and information will complement the labor force, improving earnings and productivity of individuals, businesses and regional economies.³⁴ Citi GPS suggests that we face a productivity paradox—that technological progress and innovation are rampant yet it is not seen in productivity statistics due to limitations in the current measurement of productivity.³⁵

²⁸U.S. Bureau of Labor Statistics, U.S. Department of Labor. “Employment by Industry, 1910 and 2015.” *The Economics Daily*, March 3, 2016. <http://www.bls.gov/opub/ted/2016/employment-by-industry-1910-and-2015.htm>

²⁹Michael L. Walden, “North Carolina’s Future Job Market and Policy Responses.”

³⁰Chui, Michael; Manyika, James; and Mehdi Miremadi. “Four Fundamentals of Workplace Automation.” *McKinsey Quarterly*, November 2015. <http://www.mckinsey.com/business-functions/business-technology/our-insights/four-fundamentals-of-workplace-automation>

³¹Chui, Michael; Manyika, James; and Mehdi Miremadi. “Four Fundamentals of Workplace Automation.”

³²Economic Report of the President 2016.

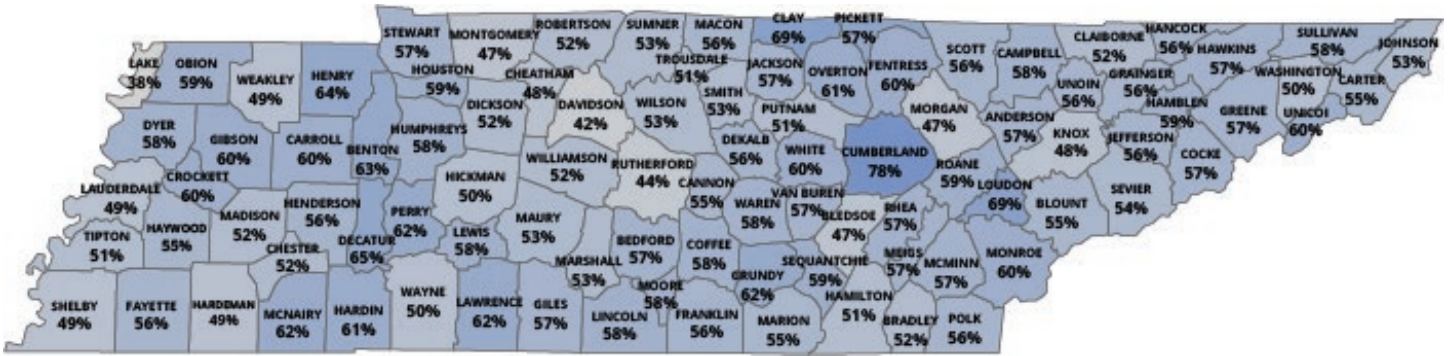
³³Autor, David H. 2015. “Why Are There Still So Many Jobs? The History and Future of Workplace Automation.” *Journal of Economic Perspectives*, 29(3): 3-30. <http://www.aeaweb.org/articles.php?doi=10.1257/jep.29.3.3>

³⁴Carnevale and Rose, *The Economy Goes to College*.

³⁵Citi GPS, *Technology at Work v2.0*.

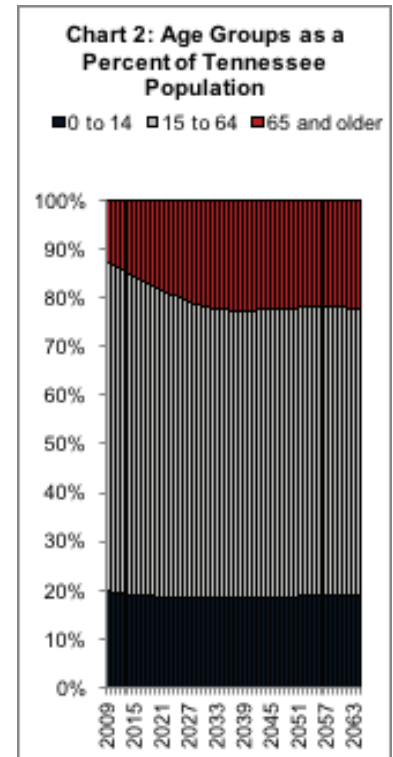
AGE DEMOGRAPHICS (#2)

MAP 4: DEPENDENCY RATIOS IN TENNESSEE'S COUNTIES



The trend of automation will impact the population within working age (age 15 to 64), and the population within working age may impact the trend of automation. A region’s dependency ratio, one component of the disruption index score, reflects the share of population that is typically in the workforce (age 15 to 64) relative to the population age 14 and under and age 65 and older.

In communities where retirements, migration and other phenomena result in comparatively small working age populations, businesses may have a greater incentive to adopt robotics and other technologies that automate workforce tasks at a faster rate. Availability of labor is a top site selection priority, with availability of skilled labor considered important by 82.1 percent of corporate respondents and availability of unskilled labor considered important by 52.5 percent of respondents, in an annual survey by *Area Development Magazine*.³⁶ Retirements in particular create high-skill job vacancies, and the accelerated rates of retirement currently driven by the baby boomer cohort represent a highly disruptive trend for organizations.



Meanwhile, in regions where the working age population represents a small share of total population, the workforce is under relatively high pressure to financially support dependents below age 15 and above age 64. A measure of pressure on the productive population, high dependency ratios may indicate few job-holders relative to the number of dependents within a population resulting in lower wages and tax revenues that support dependents through school, healthcare and other support systems. Where automation influences job loss and reorganization across the nation, disruptive impacts may be intensified for workforces that are already under this distress, relative to communities in which the working age population represents a higher share. Alternatively, communities with a robust working age population may be able to more fluidly manage and adjust to job transformation resulting from technological shifts.

³⁶“29th Annual Survey of Corporate Executives,” *Area Development Magazine*, Q1 2015. <http://www.areadevelopment.com/Corporate-Consultants-Survey-Results/Q1-2015/annual-corporate-executive-business-expansion-survey-287775.shtml>

Forecasts demonstrate the national and Tennessee labor markets will experience rising dependency ratios, significantly driven by the aging of the nation's population. Though forecasted demographic profiles are outside the scope of this index, which encompasses current age demographics of regions, it is important to understand the implication of predicted trends. The Manufacturing Institute and Deloitte forecast retirements will create 2.7 million manufacturing job vacancies nationwide in the ten years from 2015 to 2025, representing 22 percent of the sector's workforce.³⁷ Additionally, lowered birth rates among the millennial generation point toward future workforces which are smaller in size.³⁸ In this forecasted future, a declining number of available workers may increase business tendency to automate job tasks.

Tennessee population forecasts, illustrated in Chart 3,³⁹ demonstrate this demographic trend in the state. The working age population is projected to grow at a slower rate than the total population. From 2009 to 2012, Tennessee's working age population represented 67 percent of the state's population. This share is projected to decline to 60 percent by 2028, where it will remain through 2064. Meanwhile, Tennessee's senior population age 65 and older represented 13 percent of the state's population in 2009, and is forecasted to increase to 21 percent by 2028, where it will remain through 2064.

Automation and relative declines to regional working age populations may not necessarily coincide with adverse economic trends. In 2005, Alan Greenspan predicted the baby boomer generation retirements would result in "an inevitable slowing in the growth of gross domestic product per capita relative to the growth of output per worker. As the ratio of workers to population declines, so too must the ratio of output to population, assuming no change in the growth of productivity." However, in the wake of baby boomer retirements and declining fertility rates, automation could aid in the productivity and income growth of a shrinking workforce through education, innovation and entrepreneurial activity. In the case that automation complements a shrinking workforce to boost productivity and workers' incomes, we may see the negative connotations of disruption are muted and instead reallocation and opportunity are intensified.

While automation may serve as the agent necessary to boost productivity despite declines to working age populations, authors of *Technology At Work v2.0* caution the "race between demography and automation" are not "purely one-dimensional."⁴⁰ While at an aggregated level automation may mitigate a future decline in working age populations, trends of retirement and automation may not likely overlap for individuals: "those losing their job to a robot, will not necessarily land an equivalent job of someone who just retired."⁴¹ It is at this point where the need for education and re-skilling of the current and future workforce becomes apparent.

³⁷Giffi, Craig; Dollar, Ben; Drew, Michelle; McNelly, Jennifer; Carrick, Gardner; and Bharath Gangula. *The Skills Gap in U.S. Manufacturing: 2015 and Beyond*. The Manufacturing Institute and Deloitte, 2015. <http://www.themanufacturinginstitute.org/-/media/827DBC76533942679A15EF7067A704CD.ashx>

³⁸Astone, Nan Marie; Martin, Steven; and Peters, Elizabeth H. "Millennial Childbearing and the Recession." *Urban Institute*, April 2015. <http://www.urban.org/research/publication/millennial-childbearing-and-recession>

³⁹CERT analysis of population forecasts produced by the University of Tennessee's Center for Business and Economic Research (CBER).

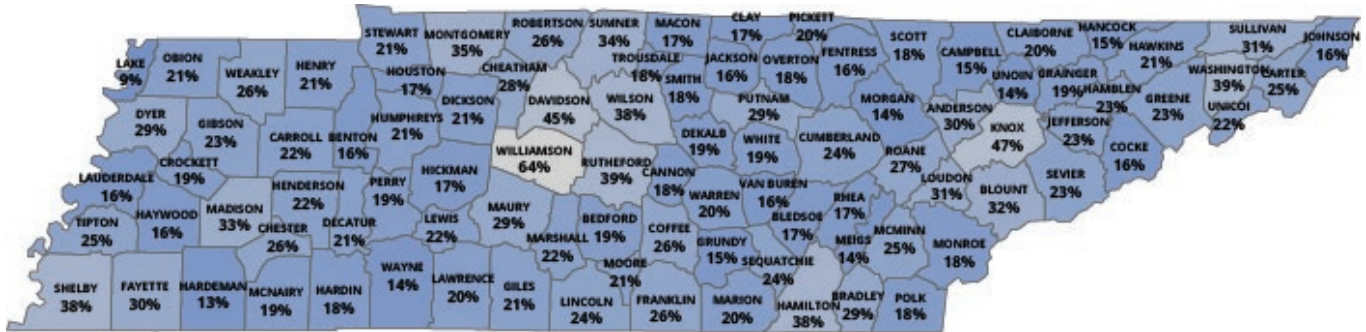
⁴⁰Citi GPS, *Technology at Work v2.0*.

⁴¹Citi GPS, *Technology at Work v2.0*.

EDUCATIONAL ATTAINMENT (#3)

MAP 5: PERCENT OF THE POPULATION AGE 25 TO 64 WITH AN ASSOCIATE'S DEGREE OR HIGHER IN TENNESSEE'S COUNTIES

Counties near metro areas tend to have higher educational attainment.



Automation and relative declines to working age populations may not necessarily coincide with adverse economic consequences. Education, innovation and other characteristics of a community's workforce may prepare the population to complement and take advantage of automation. Within the scope of this index, we argue that educational attainment will improve or prevent the ability of a workforce to manage and align with automation.

As information technologies alter the workforce landscape, new demands are placed on present-day employees. Jobs least vulnerable to automation require higher levels of creativity, intelligence, interaction and critical thinking skills. Education enables individuals, businesses and regions to participate in shifting technological opportunities, allowing individuals "to create and capture value" in the present age where "there's never been a worse time to be a worker with only 'ordinary' skills and abilities to offer."⁴² The Center on Education and the Workforce (CEW) describes the complementary relationships between technology, education and labor:

"Today, for every task surrendered to automation, new opportunities are generated for exploiting the technology's capabilities. Moreover, the more flexible and powerful the machinery, the more employees, work teams, and organizations must increase their skills to fully deploy its technical capabilities. These more flexible and powerful technologies work best in combination with more flexible and highly skilled workers to deliver quality, variety, customization, convenience, brand consistency, speed, and innovation at the lowest cost."⁴³

In discussing policy solutions for future workforce disruptions, Michael Walden explains human capital development is necessary for economic growth. Jobs requiring higher education are less susceptible to automation; higher education translates to higher earnings; and therefore a sufficiently educated workforce is essential for regional economic growth.⁴⁴ Citi GPS remarks, "Policymakers will need to leverage [education] in preparation for the effects of accelerated technological change."⁴⁵

⁴²Brynjolfsson and McAfee, *The Second Machine Age*

⁴³Carnevale and Rose, *The Economy Goes to College*.

⁴⁴Michael L. Walden, "North Carolina's Future Job Market and Policy Responses."

⁴⁵Citi GPS, *Technology at Work v2.0*.

This recommendation is influenced by a client survey conducted by Citi Research, in which “investment in education” was reported as the number one policy suggestion for offsetting the risks of automation—the authors also reference the need for public spending “on a structural basis, rather than only during downturns.”⁴⁶ Michael Walden remarks that while some individuals and communities will experience economic gain, for others “occupations and livelihoods will be destroyed,” is at “re-training, re-skilling and re-purposing workers will be the crucial element in addressing this reality.”⁴⁷

Tennessee’s Drive to 55 initiative aligns education with forecasted employer demand for postsecondary skills, creating a competitive advantage for Tennessee employees and employers. Increased education will allow Tennesseans to adapt and capitalize on the opportunities presented by workplace automation. Through education and automation, employers will be well-equipped to increase productivity, revenues and competitiveness through use of technological improvements and a high-skill workforce. While growing employer demand for “intellectually challenging and highly skilled jobs” will influence Tennesseans to seek higher levels of education,⁴⁸ the Tennessee Promise, Reconnect and the Labor and Education Alignment Program (LEAP) generate additional incentive for the Tennessee workforce to participate in postsecondary education programs.

TENNESSEE’S DRIVE TO 55 INITIATIVE ALIGNS EDUCATION WITH FORECASTED EMPLOYER DEMAND FOR POSTSECONDARY SKILLS, CREATING A COMPETITIVE ADVANTAGE FOR TENNESSEE EMPLOYEES AND EMPLOYERS.

DISRUPTION INDEX FOR TNECD REGIONS⁴⁹

- The Northwest region of Tennessee is the most vulnerable to disruption due to automation. Northwest has the highest percentage of expected lost wages, which is the most influential factor of the index. Northwest is vulnerable to lose 41 percent of wages from occupations with high probabilities of automation. Northwest has the second highest dependency ratio and the second lowest percent of population age 25 to 64 with an associate’s degree or higher. The region’s most vulnerable county is Benton County; Lake County is least vulnerable.

⁴⁶Citi GPS, *Technology at Work v2.0*.

⁴⁷Michael L. Walden, “North Carolina’s Future Job Market and Policy Responses.”

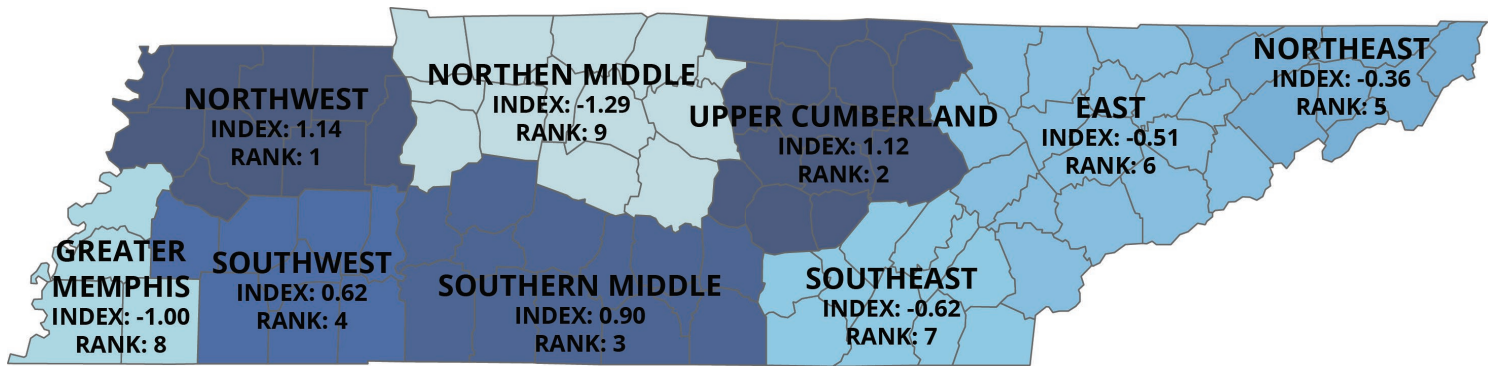
⁴⁸Carnevale and Rose, *The Economy Goes to College*.

⁴⁹Appendix B provides region-level data.

See *County Considerations* on pages 7-8 for discussions on several counties listed within the ECD regions.

- The Upper Cumberland region is the second most vulnerable to disruption. Upper Cumberland's expected lost wages is the third highest among Tennessee's regions, but it also has the highest dependency ratio and the lowest percent of population age 25 to 64 with an associate's degree or higher. Upper Cumberland's most vulnerable county is Cumberland County, and its least vulnerable county is Putnam County.
- The Southern Middle region is the third most vulnerable to disruption. Southern Middle's percentage of expected lost wages is the second highest among Tennessee's regions. It has the third highest dependency ratio and the third lowest percent of population age 25 to 64 with an associate's degree or higher. Southern Middle's most vulnerable county is Bedford County, and its least vulnerable county is Hickman County.
- The Southwest region is the fourth most vulnerable to disruption. Southwest's percentage of expected lost wages is the fourth highest among Tennessee's regions. It has the fifth highest dependency ratio and the fourth lowest percent of population age 25 to 64 with an associate's degree or higher. Southwest's most vulnerable county is Henderson County, and its least vulnerable county is Chester County.
- The Northeast region is the fifth most vulnerable to disruption. Northeast's percentage of expected lost wages is the seventh highest, but it has the fourth highest dependency ratio and the fifth lowest percent of the population age 25 to 64 with an associate's degree or higher. Northeast's most vulnerable county is Hawkins County, and its least vulnerable county is Washington County.
- The East region is the sixth most vulnerable to disruption. The East region has the fifth highest percentage of expected lost wages, the sixth highest dependency ratio, and the seventh lowest percent of the population age 25 to 64 with an associate's degree or higher. East's most vulnerable county is Sevier County, and its least vulnerable county is Knox County.
- The Southeast region is the seventh most vulnerable to disruption. The Southeast region has the lowest percentage of expected lost wages, but the seventh highest dependency ratio and the sixth lowest percent of the population age 25 to 64 with an associate's degree or higher. Southeast's most vulnerable county is Meigs County, and its least vulnerable county is Bledsoe County.
- The Greater Memphis region is the No. 2 least vulnerable to disruption. Expected loss wages in Greater Memphis are also middle-of-the-road in comparison to other regions. Greater Memphis has the second lowest dependency ratio and the second highest (eighth lowest) percent of population with an associate's degree or higher. Greater Memphis's most vulnerable county is Lauderdale County, and its least vulnerable county is Shelby County.
- The Northern Middle region is the least vulnerable to disruption. Expected lost wages in the Northern Middle region is middle-of-the-road in comparison to the other regions, but it has a significantly lower dependency ratio and a significantly higher percent of population with an associate's degree or higher. Northern Middle's most vulnerable county is Robertson County, and its least vulnerable county is Williamson County.

MAP 6: TNECD REGION INDEX



DISRUPTION INDEX FOR STATES IN THE SOUTHEAST ⁵⁰

Tennessee ranks the ninth most vulnerable state in the Southeast for workforce disruption due to automation, where a rank of 1 represents high vulnerability to workforce disruption, a rank of 12 represents low vulnerability.

- Tennessee trails the least vulnerable states of Virginia, Georgia and North Carolina.
- Virginia is the least vulnerable state in each of the three component indicators.
- Tennessee is vulnerable to lose 37 percent of wages from occupations with high probabilities of automation. Tennessee ranks sixth in the Southeast for share of wages vulnerable to automation, where a rank of 1 represents high share of lost wages. Mississippi has the greatest share of wages vulnerable to automation.
- Tennessee's dependency ratio ranks seventh highest in the Southeast. Florida has the highest dependency ratio.
- 33 percent of Tennessee's population age 25 to 64 holds an associate's degree or higher, which ranks sixth highest in the Southeast. West Virginia has the lowest educational attainment.

⁵⁰The Southeast is defined by the U.S. Bureau of Economic Analysis to include Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

MAP 7: SOUTHEAST STATES INDEX

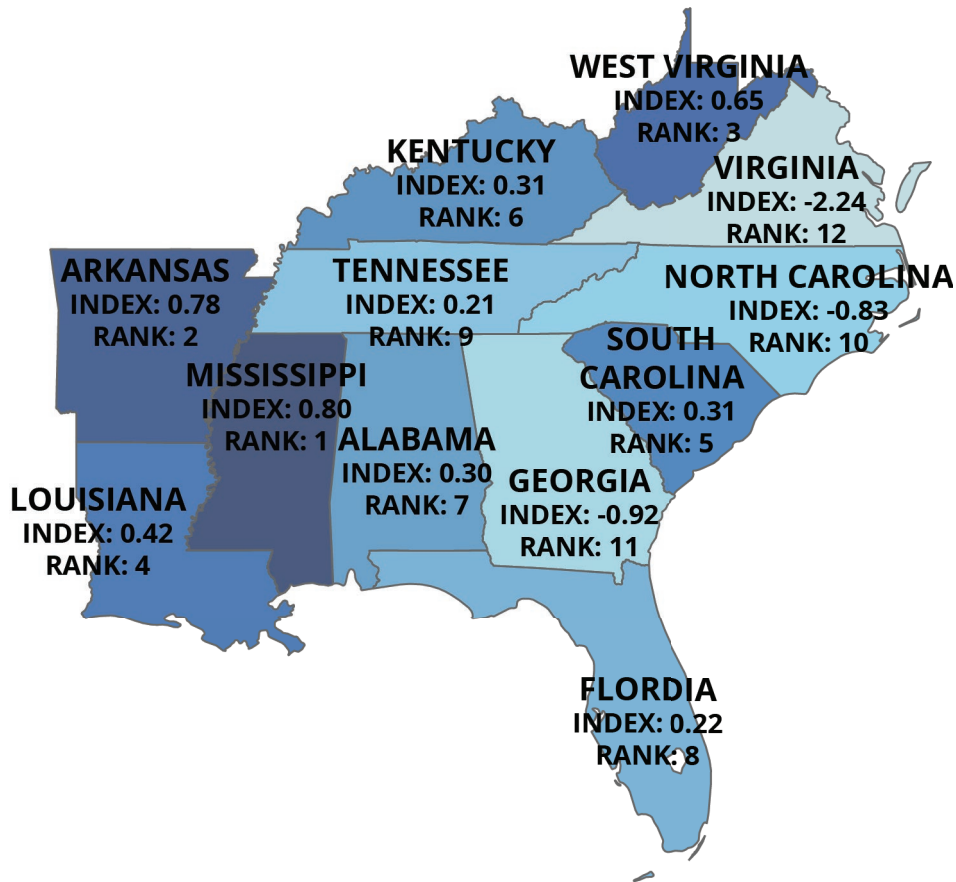


TABLE 4: SOUTHEAST STATES INDEX

Location	Index Value	Rank (1= highest vulnerability)	1/2 of Index Value		1/4 of Index Value		1/4 of Index Value	
			Expected Lost Wages	z-score	Dependency Ratio	z-score	Associate's Degree or Higher	reverse z-score
Alabama	0.30	7	37%	0.46	52%	0.03	33%	0.26
Arkansas	0.78	2	37%	0.35	55%	1.40	29%	1.01
Florida	0.22	8	36%	-0.09	56%	1.78	38%	-0.73
Georgia	-0.92	11	33%	-0.91	49%	-1.26	37%	-0.62
Kentucky	0.31	6	37%	0.53	51%	-0.31	32%	0.48
Louisiana	0.42	4	38%	0.64	51%	-0.61	29%	1.00
Mississippi	0.80	1	39%	1.05	53%	0.45	31%	0.66
North Carolina	-0.83	10	33%	-1.01	51%	-0.35	39%	-0.95
South Carolina	0.31	5	38%	0.64	53%	0.26	36%	-0.31
Tennessee	0.21	9	37%	0.43	51%	-0.23	33%	0.18
Virginia	-2.24	12	29%	-2.50	48%	-1.74	46%	-2.20
West Virginia	0.65	3	37%	0.40	53%	0.58	28%	1.21

⁹Citi GPS, Technology at Work v2.0.

⁵²Institute for Emerging Issues, "FutureWork Disruption Index for North Carolina

WITHIN THE SOUTHEAST STATES, TENNESSEE IS NINTH MOST VULNERABLE TO FUTURE WORKFORCE DISRUPTION.

LIMITATIONS AND OTHER CONSIDERATIONS

- The index only considers occupations with at least a 70 percent probability of replacement by automation. Job loss due to automation is possible for occupations with less than 70 percent probability of replacement by automation.
- The repercussions of job loss due to automation within a community are difficult to predict and are expected to vary depending on a number of factors—occupational skills, present industries, and workforce training responses to automation.
- Automation could lead to the ‘reshoring’ of manufacturing supply chains closer to home in critical geographical hubs—“with North America gaining the biggest advantage from this development.”⁵¹ Tennessee could have an infrastructural advantage by taking advantage of its central location.
- Counties with low employment and low wages could have been falsely identified as less vulnerable, yet their ability to cope with the shifting occupational training necessary may prove difficult because of already low educational attainment. Though for the counties with low wages for all occupations, even if jobs do not become automated as quickly in these communities, the low wage may fall even further behind as wages grow to accommodate the skill requirements necessary for a more technologically-readied workforce.
- Communities with a large share of wealthy retirees could be less fragile than the dependency ratio suggests.⁵² A community with a large portion of wealthy retirees could add to the financial stability of a community. This may be a significant advantage for communities where jobs lost through automation are not replaced by new job opportunities.
- Counties with a large population of workers commuting to other counties for work could have been falsely identified as less vulnerable to automation. County commuting patterns are not taken into account within this analysis. Significant or negligible job loss in neighboring counties or counties within reasonable commute times is not taken into consideration when computing a county’s vulnerability to automation, despite that commute patterns may significantly impact the economic well-being of a county’s residents.

METHODOLOGY

There are three factors that compose the index:

1. Expected Lost Wages due to Automation (50 Percent)

This index component represents the wages of individuals employed in 320 job categories that are most susceptible to automation. Lost wages in a community correlate with other economic distress indicators—unemployment, personal income, and poverty rates of communities—with disruptive implications for resident populations.

Expected lost wages were calculated by compiling the occupations with a 70 percent probability of automation, then dividing the sum of the 2015 employment multiplied by the average hourly wages for each of the occupations with higher than 70 percent probability of automation by the sum of the 2015 employment multiplied by the average hourly wages for all occupations.

$$\frac{\sum \text{Vulnerable Occupations (2015 Employment of Vulnerable Occupation)} * (\text{Average Hourly Wage of Vulnerable Occupation})}{\sum \text{All Occupations (2015 Employment of Occupation)} * (\text{Average Hourly Wage of Occupation})}$$

The higher the expected lost wages, the more vulnerable an area is to future workforce disruption because a larger percent of the wages of workers has the potential to be lost.

2. Dependency Ratio (25 Percent)

A region's dependency ratio reflects the share of population that is of working age, and is a measure of pressure on the working age population. The ratio compares the populations that are more likely to be dependent on the financial support of others (age 14 and under and age 65 and over) to the working age population (age 15 to 64). In regions with relatively small working age populations, automation may be introduced more rapidly and to a greater extent than in regions with sufficient labor availability to support business demand. Additionally, for workforces currently under relatively high pressure to support dependents, the future replacement of work through automation may create heightened disruptive consequences.

Dependency ratios were calculated by summing the populations age 14 and under and age 65 and over, then dividing by the population age 15 to 64.

The higher the dependency ratio, the more vulnerable an area is to future workforce disruption.

3. Percent of the Population Age 25 to 64 with an Associate's Degree or Higher (25 Percent)

A region's educational attainment may impact its ability to take advantage of, and benefit from, technological advances. As jobs become automated, a shift in occupational opportunities in the job market could arise—education could be the competitive advantage for a community to advance with this shift in jobs. The lower the percent of the population age 25 to 64 with an associate's degree or higher, the more vulnerable an area is to future workforce disruption.

Data was standardized by computing z-scores, which shows a data point's relationship to the average of a group of data points: $z\text{-score} = (\text{Value} - \text{Average of All Values}) / \text{Standard Deviation of All Values}$

A z-score was calculated for expected lost wages and dependency ratio, and a reverse z-score was calculated for percent of the population age 25 to 64 with an associate's degree or higher for the areas of comparison. A higher z-score for expected lost wages and dependency ratio implies more vulnerability of disruption due to occupational automation. A higher reverse z-score for associate's degree or higher implies more vulnerability of disruption of occupations due automation.

TABLE 5: WEIGHT OF INDEX

Metric	Weight
Expected Lost Wages due to Automation	One-half (50%) of index
Dependency Ratio	One-fourth (25%) of index
Percent of Population Age 25 to 64 with an Associate's Degree or Higher	One-fourth (25%) of index

INDEX VALUE FORMULA

Index Value = $[(1/2) * z\text{-score of Expected Lost Wages}] + [(1/4) * z\text{-score of Dependency Ratio}] + [(1/4) * z\text{-score of Percent of the Population Age 25 to 64 with an Associate's Degree or Higher}]$

The higher the index value, the more vulnerable the area is to workforce disruption due to automation.

There were three types of areas of comparison: states in the southeast, ECD Regions, and Tennessee counties.

TABLE 6: DATA SOURCES

Source	Data
Economic Modeling Specialists Intl.	Employment Average hourly wages
U.S. Census Bureau 2014 Annual Estimates of the Resident Population for Selected Age Groups by Sex	Dependency ratio (calculated by authors)
U.S. Census Bureau 2010-2014 American Community Survey 5-Year Estimates	Percent of population age 25 to 64 with an associate's degree or higher

APPENDIX A: TENNESSEE COUNTY INDEX

Location	Index Value	Rank (1= highest vulnerability)	1/2 of Index Value		1/4 of Index Value		1/4 of Index Value	
			Expected Lost Wages	z-score	Dependency Ratio	z-score	Associate's Degree or Higher	reverse z-score
Anderson	-0.74	82	33%	-1.1	57%	0.2	30%	-0.9
Bedford	1.33	1	49%	2.3	57%	0.2	19%	0.5
Benton	0.90	6	42%	0.8	63%	1.2	16%	0.8
Bledsoe	-1.15	90	30%	-1.9	47%	-1.6	17%	0.7
Blount	-0.37	65	38%	-0.2	55%	-0.1	32%	-1.0
Bradley	0.00	53	42%	0.7	52%	-0.7	29%	-0.7
Campbell	0.46	30	40%	0.3	58%	0.4	15%	0.9
Cannon	-0.25	61	35%	-0.7	55%	-0.1	18%	0.6
Carroll	-0.37	66	33%	-1.2	60%	0.7	22%	0.2
Carter	-0.50	75	35%	-0.8	55%	-0.2	25%	-0.2
Cheatham	-0.07	56	42%	0.8	48%	-1.3	28%	-0.5
Chester	-0.62	77	35%	-0.7	52%	-0.6	26%	-0.4
Claiborne	0.16	46	41%	0.4	52%	-0.6	20%	0.3
Clay	0.24	42	34%	-1.1	69%	2.3	17%	0.8
Cocke	0.54	24	41%	0.5	57%	0.2	16%	0.9
Coffee	-0.06	55	38%	-0.1	58%	0.3	26%	-0.4
Crockett	0.63	21	42%	0.7	60%	0.7	19%	0.5
Cumberland	1.15	2	40%	0.4	78%	3.8	24%	-0.1
Davidson	-1.62	94	35%	-0.8	42%	-2.4	45%	-2.6
Decatur	0.11	48	35%	-0.7	65%	1.6	21%	0.3
DeKalb	0.47	29	41%	0.6	56%	0.1	19%	0.6
Dickson	0.17	44	41%	0.5	52%	-0.6	21%	0.3
Dyer	0.41	34	43%	1.0	58%	0.3	29%	-0.8
Fayette	-0.01	54	40%	0.4	56%	0.0	30%	-0.8
Fentress	0.29	41	38%	-0.2	60%	0.7	16%	0.8
Franklin	-0.43	70	35%	-0.7	56%	0.1	26%	-0.4
Gibson	0.74	10	44%	1.1	60%	0.8	23%	0.0
Giles	0.56	23	43%	0.9	57%	0.1	21%	0.2
Grainger	0.62	22	43%	1.0	56%	-0.1	19%	0.5
Greene	0.50	26	43%	0.9	57%	0.2	23%	0.0
Grundy	-0.17	57	32%	-1.4	62%	1.1	15%	0.9
Hamblen	0.71	14	44%	1.1	59%	0.5	23%	0.1
Hamilton	-1.08	89	35%	-0.9	51%	-0.9	38%	-1.8
Hancock	-1.03	88	27%	-2.6	56%	0.1	15%	1.0
Hardeman	0.03	51	39%	0.1	49%	-1.3	13%	1.2
Hardin	0.65	19	41%	0.5	61%	0.9	18%	0.6
Hawkins	0.70	15	44%	1.2	57%	0.3	21%	0.2
Haywood	0.39	37	40%	0.4	55%	-0.1	16%	0.8

Location	Index Value	Rank (1= highest vulnerability)	1/2 of Index Value		1/4 of Index Value		1/4 of Index Value	
			Expected Lost Wages	z-score	Dependency Ratio	z-score	Associate's Degree or Higher	reverse z-score
Henderson	0.96	3	47%	1.8	56%	0.1	22%	0.1
Henry	0.79	8	42%	0.8	64%	1.3	21%	0.3
Hickman	-0.94	84	31%	-1.7	50%	-1.0	17%	0.7
Houston	-0.49	74	31%	-1.6	59%	0.6	17%	0.7
Humphreys	0.40	36	41%	0.4	58%	0.4	21%	0.3
Jackson	-0.20	58	35%	-0.9	57%	0.2	16%	0.8
Jefferson	0.70	16	45%	1.4	56%	0.1	23%	0.0
Johnson	0.48	28	42%	0.8	53%	-0.5	16%	0.8
Knox	-1.49	93	35%	-0.9	48%	-1.4	47%	-2.8
Lake	-1.36	92	29%	-2.0	38%	-3.1	9%	1.7
Lauderdale	0.18	43	41%	0.5	49%	-1.2	16%	0.9
Lawrence	0.72	12	42%	0.7	62%	1.1	20%	0.3
Lewis	0.02	52	37%	-0.2	58%	0.4	22%	0.2
Lincoln	0.72	13	44%	1.3	58%	0.4	24%	-0.1
Loudon	0.44	33	39%	0.2	69%	2.3	31%	-0.9
Macon	0.06	49	38%	-0.2	56%	0.0	17%	0.7
Madison	-0.42	69	39%	0.1	52%	-0.7	33%	-1.2
Marion	0.15	47	39%	0.2	55%	-0.2	20%	0.4
Marshall	0.33	39	42%	0.8	53%	-0.5	22%	0.2
Mauzy	-0.29	63	39%	0.0	53%	-0.4	29%	-0.7
McMinn	0.73	11	45%	1.5	57%	0.3	25%	-0.3
McNairy	0.67	17	41%	0.6	62%	1.0	19%	0.5
Meigs	0.79	7	43%	0.9	57%	0.2	14%	1.1
Monroe	0.92	5	44%	1.2	60%	0.7	18%	0.6
Montgomery	-0.95	85	36%	-0.5	47%	-1.5	35%	-1.4
Moore	0.30	40	40%	0.3	58%	0.4	21%	0.2
Morgan	-0.83	83	32%	-1.5	47%	-1.5	14%	1.1
Obion	0.64	20	43%	0.9	59%	0.5	21%	0.3
Overton	0.45	32	39%	0.2	61%	0.8	18%	0.6
Perry	0.34	38	38%	-0.1	62%	1.1	19%	0.5
Pickett	0.49	27	38%	-0.1	67%	1.8	20%	0.4
Polk	-0.38	67	34%	-1.1	56%	0.1	18%	0.6
Putnam	-0.25	62	40%	0.2	51%	-0.8	29%	-0.7
Rhea	0.45	31	40%	0.4	57%	0.3	17%	0.8
Roane	-1.01	87	29%	-2.1	59%	0.6	27%	-0.5
Robertson	0.41	35	45%	1.3	52%	-0.6	26%	-0.4
Rutherford	-0.59	76	42%	0.8	44%	-2.1	39%	-1.9
Scott	0.52	25	42%	0.8	56%	0.0	18%	0.6
Sequatchie	-0.35	64	34%	-1.0	59%	0.6	24%	-0.1
Sevier	0.93	4	48%	2.0	54%	-0.3	23%	0.0
Shelby	-0.96	86	36%	-0.5	49%	-1.2	38%	-1.7

Location	Index Value	Rank (1-highest vulnerability)	1/2 of Index Value		1/4 of Index Value		1/4 of Index Value	
			Expected Lost Wages	z-score	Dependency Ratio	z-score	Associate's Degree or Higher	reverse z-score
Smith	0.06	50	39%	0.1	53%	-0.5	18%	0.6
Stewart	-0.68	78	31%	-1.6	57%	0.2	21%	0.2
Sullivan	-0.44	71	36%	-0.6	58%	0.3	31%	-1.0
Sumner	-0.48	72	38%	0.0	53%	-0.5	34%	-1.3
Tipton	-0.48	73	36%	-0.5	51%	-0.8	25%	-0.2
Trousdale	-0.69	79	33%	-1.3	51%	-0.8	18%	0.6
Unicoi	0.17	45	38%	-0.1	60%	0.7	22%	0.1
Union	-0.39	68	33%	-1.3	56%	0.0	14%	1.1
Van Buren	-0.21	59	34%	-0.9	57%	0.1	16%	0.9
Warren	0.66	18	43%	1.0	58%	0.3	20%	0.4
Washington	-1.29	91	34%	-1.1	50%	-1.0	39%	-2.0
Wayne	-0.72	81	32%	-1.4	50%	-1.1	14%	1.1
Weakley	-0.71	80	36%	-0.7	49%	-1.2	26%	-0.3
White	0.78	9	43%	1.0	60%	0.7	19%	0.5
Williamson	-1.72	95	35%	-0.7	52%	-0.6	64%	-4.9
Wilson	-0.23	60	42%	0.7	53%	-0.6	38%	-1.8

APPENDIX B: TENNESSEE ECD REGION INDEX

Location	Index Value	Rank (1-highest vulnerability)	1/2 of Index Value		1/4 of Index Value		1/4 of Index Value	
			Expected Lost Wages	z-score	Dependency Ratio	z-score	Associate's Degree or Higher	reverse z-score
East	-0.51	6	37%	-0.7	53%	-0.1	32%	-0.5
Greater Memphis	-1.00	8	37%	-0.9	49%	-1.2	36%	-1.0
Northeast	-0.36	5	37%	-0.9	55%	0.3	29%	0.0
Northern Middle	-1.29	9	37%	-0.8	47%	-1.8	41%	-1.8
Northwest	1.14	1	41%	1.3	58%	1.0	22%	1.0
Southeast	-0.62	7	37%	-0.9	53%	-0.3	31%	-0.4
Southern Middle	0.90	3	40%	1.1	56%	0.5	23%	0.8
Southwest	0.62	4	40%	0.8	55%	0.2	24%	0.7
Upper Cumberland	1.12	2	40%	1.0	59%	1.4	21%	1.2

APPENDIX C: OCCUPATIONS 70 PERCENT OR HIGHER PROBABILITY OF AUTOMATION

Of the occupations that are given a probability of automation by Frey and Osborne, 320 have a probability greater than or equal to 70 percent. Below is the list of occupations with Tennessee's employment and average hourly wages in 2015.

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.73	11-3011	Administrative Services Managers	6,993	\$36.00
0.96	11-3111	Compensation and Benefits Managers	403	\$43.07
0.75	11-9131	Postmasters and Mail Superintendents	352	\$33.69
0.81	11-9141	Property, Real Estate, and Community Association Managers	4,272	\$23.63
0.87	13-1021	Buyers and Purchasing Agents, Farm Products	168	\$27.25
0.77	13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	3,857	\$26.23
0.98	13-1031	Claims Adjusters, Examiners, and Investigators	3,406	\$27.15
0.98	13-1032	Insurance Appraisers, Auto Damage	164	\$28.38
0.97	13-1074	Farm Labor Contractors	17	\$17.16
0.94	13-2011	Accountants and Auditors	19,855	\$32.12
0.9	13-2021	Appraisers and Assessors of Real Estate	1,092	\$27.61
0.94	13-2031	Budget Analysts	655	\$32.78
0.98	13-2041	Credit Analysts	1,336	\$30.58
0.99	13-2053	Insurance Underwriters	1,513	\$32.01
0.98	13-2072	Loan Officers	6,673	\$31.37
0.93	13-2081	Tax Examiners and Collectors, and Revenue Agents	1,486	\$24.54
0.99	13-2082	Tax Preparers	1,303	\$22.19
0.99	15-2091	Mathematical Technicians	16	\$26.66
0.88	17-1021	Cartographers and Photogrammetrists	131	\$25.79
0.81	17-3012	Electrical and Electronics Drafters	589	\$26.39
0.75	17-3022	Civil Engineering Technicians	921	\$24.06
0.84	17-3023	Electrical and Electronics Engineering Technicians	2,472	\$25.74
0.81	17-3024	Electro-Mechanical Technicians	418	\$27.49
0.96	17-3031	Surveying and Mapping Technicians	1,203	\$19.89
0.97	19-4011	Agricultural and Food Science Technicians	505	\$15.57
0.91	19-4041	Geological and Petroleum Technicians	108	\$26.18
0.85	19-4051	Nuclear Technicians	315	\$33.21
0.77	19-4091	Environmental Science and Protection Technicians, Including Health	595	\$20.39
0.94	23-2011	Paralegals and Legal Assistants	4,170	\$23.95
0.99	23-2093	Title Examiners, Abstractors, and Searchers	514	\$17.52
0.76	25-4011	Archivists	70	\$22.15
0.99	25-4031	Library Technicians	1,197	\$14.40
0.98	27-2023	Umpires, Referees, and Other Sports Officials	266	\$16.43
0.72	27-3012	Public Address System and Other Announcers	261	\$9.56
0.89	27-3042	Technical Writers	703	\$29.01
0.74	27-4012	Broadcast Technicians	371	\$17.67

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.98	27-4013	Radio Operators	19	\$20.57
0.9	29-2011	Medical and Clinical Laboratory Technologists	4,215	\$28.42
0.92	29-2052	Pharmacy Technicians	12,164	\$14.18
0.91	29-2071	Medical Records and Health Information Technicians	5,331	\$16.51
0.71	29-2081	Opticians, Dispensing	1,204	\$16.14
0.78	31-9093	Medical Equipment Preparers	711	\$13.87
0.89	31-9094	Medical Transcriptionists	1,367	\$14.85
0.72	31-9095	Pharmacy Aides	950	\$10.62
0.86	31-9096	Veterinary Assistants and Laboratory Animal Caretakers	1,948	\$11.76
0.84	33-3041	Parking Enforcement Workers	113	\$13.67
0.95	33-9031	Gaming Surveillance Officers and Gaming Investigators	38	\$11.73
0.84	33-9032	Security Guards	22,304	\$12.16
0.81	35-2011	Cooks, Fast Food	14,903	\$8.38
0.83	35-2012	Cooks, Institution and Cafeteria	10,523	\$10.22
0.96	35-2014	Cooks, Restaurant	23,900	\$10.49
0.94	35-2015	Cooks, Short Order	4,036	\$9.40
0.87	35-2021	Food Preparation Workers	18,783	\$9.25
0.77	35-3011	Bartenders	6,712	\$9.60
0.92	35-3021	Combined Food Preparation and Serving Workers, Including Fast Food	65,405	\$8.74
0.96	35-3022	Counter Attendants, Cafeteria, Food Concession, and Coffee Shop	6,904	\$8.78
0.94	35-3031	Waiters and Waitresses	53,007	\$8.99
0.86	35-3041	Food Servers, Nonrestaurant	5,182	\$9.48
0.91	35-9011	Dining Room and Cafeteria Attendants and Bartender Helpers	5,353	\$9.20
0.77	35-9021	Dishwashers	9,023	\$8.72
0.97	35-9031	Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	8,241	\$8.86
0.94	37-1011	First-Line Supervisors of Housekeeping and Janitorial Workers	2,803	\$16.29
0.95	37-3011	Landscaping and Groundskeeping Workers	15,535	\$12.09
0.97	37-3012	Pesticide Handlers, Sprayers, and Applicators, Vegetation	149	\$15.71
0.77	37-3013	Tree Trimmers and Pruners	995	\$16.24
0.82	39-2021	Nonfarm Animal Caretakers	2,918	\$10.18
0.96	39-3011	Gaming Dealers	124	\$8.75
0.91	39-3012	Gaming and Sports Book Writers and Runners	72	\$10.56
0.97	39-3021	Motion Picture Projectionists	104	\$9.76
0.96	39-3031	Ushers, Lobby Attendants, and Ticket Takers	2,680	\$8.47
0.72	39-3091	Amusement and Recreation Attendants	4,470	\$9.24
0.8	39-5011	Barbers	270	\$10.80
0.95	39-5092	Manicurists and Pedicurists	463	\$12.21
0.79	39-5093	Shampooers	164	\$9.95
0.83	39-6011	Baggage Porters and Bellhops	557	\$9.92
0.91	39-7011	Tour Guides and Escorts	1,472	\$11.50
0.74	39-9021	Personal Care Aides	21,349	\$9.16
0.97	41-2011	Cashiers	74,748	\$9.32
0.83	41-2012	Gaming Change Persons and Booth Cashiers	194	\$10.82
0.97	41-2021	Counter and Rental Clerks	7,591	\$12.20
0.98	41-2022	Parts Salespersons	5,797	\$15.30

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.92	41-2031	Retail Salespersons	89,873	\$12.21
0.92	41-3021	Insurance Sales Agents	8,653	\$26.83
0.85	41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	22,572	\$27.97
0.98	41-9012	Models	48	\$14.86
0.97	41-9021	Real Estate Brokers	423	\$26.64
0.86	41-9022	Real Estate Sales Agents	1,635	\$19.47
0.99	41-9041	Telemarketers	4,306	\$11.65
0.94	41-9091	Door-to-Door Sales Workers, News and Street Vendors, and Related Workers	70	\$10.45
0.96	43-2011	Switchboard Operators, Including Answering Service	2,766	\$12.43
0.97	43-2021	Telephone Operators	191	\$17.34
0.95	43-3011	Bill and Account Collectors	10,930	\$15.52
0.96	43-3021	Billing and Posting Clerks	10,976	\$15.62
0.98	43-3031	Bookkeeping, Accounting, and Auditing Clerks	31,441	\$17.07
0.97	43-3051	Payroll and Timekeeping Clerks	3,515	\$18.13
0.98	43-3061	Procurement Clerks	1,302	\$18.66
0.98	43-3071	Tellers	10,288	\$12.33
0.98	43-4011	Brokerage Clerks	731	\$25.16
0.86	43-4021	Correspondence Clerks	208	\$15.74
0.97	43-4041	Credit Authorizers, Checkers, and Clerks	955	\$16.29
0.7	43-4061	Eligibility Interviewers, Government Programs	3,553	\$17.47
0.97	43-4071	File Clerks	2,470	\$12.80
0.94	43-4081	Hotel, Motel, and Resort Desk Clerks	5,677	\$9.36
0.94	43-4111	Interviewers, Except Eligibility and Loan	6,203	\$13.38
0.95	43-4121	Library Assistants, Clerical	1,109	\$12.46
0.92	43-4131	Loan Interviewers and Clerks	3,937	\$16.45
0.99	43-4141	New Accounts Clerks	702	\$16.62
0.98	43-4151	Order Clerks	4,626	\$14.34
0.9	43-4161	Human Resources Assistants, Except Payroll and Timekeeping	2,650	\$17.51
0.96	43-4171	Receptionists and Information Clerks	18,008	\$12.78
0.99	43-5011	Cargo and Freight Agents	2,410	\$19.88
0.94	43-5021	Couriers and Messengers	2,132	\$13.98
0.96	43-5032	Dispatchers, Except Police, Fire, and Ambulance	4,119	\$19.06
0.85	43-5041	Meter Readers, Utilities	1,196	\$17.76
0.95	43-5051	Postal Service Clerks	1,344	\$23.15
0.79	43-5053	Postal Service Mail Sorters, Processors, and Processing Machine Operators	2,189	\$24.10
0.88	43-5061	Production, Planning, and Expediting Clerks	8,527	\$24.69
0.98	43-5071	Shipping, Receiving, and Traffic Clerks	18,396	\$14.48
0.95	43-5111	Weighers, Measurers, Checkers, and Samplers, Recordkeeping	2,669	\$15.82
0.86	43-6011	Executive Secretaries and Executive Administrative Assistants	10,466	\$22.22
0.98	43-6012	Legal Secretaries	2,341	\$20.22
0.81	43-6013	Medical Secretaries	6,832	\$14.19
0.96	43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	49,329	\$14.82
0.78	43-9011	Computer Operators	2,091	\$18.83
0.99	43-9021	Data Entry Keyers	4,642	\$13.33

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.81	43-9022	Word Processors and Typists	380	\$14.79
0.98	43-9041	Insurance Claims and Policy Processing Clerks	4,833	\$18.19
0.94	43-9051	Mail Clerks and Mail Machine Operators, Except Postal Service	1,425	\$13.25
0.96	43-9061	Office Clerks, General	53,806	\$14.36
0.92	43-9071	Office Machine Operators, Except Computer	893	\$12.92
0.84	43-9081	Proofreaders and Copy Markers	143	\$16.29
0.94	45-2011	Agricultural Inspectors	279	\$20.28
0.95	45-2021	Animal Breeders	18	\$20.46
0.87	45-2099	Miscellaneous Agricultural Workers	157	\$14.77
0.83	45-3011	Fishers and Related Fishing Workers	16	\$22.20
0.77	45-3021	Hunters and Trappers	<10	Insf. Data
0.87	45-4011	Forest and Conservation Workers	305	\$12.93
0.76	45-4021	Fallers	163	\$16.72
0.79	45-4022	Logging Equipment Operators	659	\$13.91
0.97	45-4023	Log Graders and Scalers	71	\$16.39
0.82	47-2021	Brickmasons and Blockmasons	1,012	\$19.42
0.89	47-2022	Stonemasons	124	\$15.51
0.72	47-2031	Carpenters	6,981	\$17.09
0.87	47-2041	Carpet Installers	240	\$17.42
0.79	47-2042	Floor Layers, Except Carpet, Wood, and Hard Tiles	128	\$16.12
0.87	47-2043	Floor Sanders and Finishers	246	\$12.26
0.75	47-2044	Tile and Marble Setters	343	\$15.87
0.94	47-2051	Cement Masons and Concrete Finishers	2,174	\$15.98
0.88	47-2053	Terrazzo Workers and Finishers	35	\$16.85
0.88	47-2061	Construction Laborers	16,235	\$13.88
0.83	47-2071	Paving, Surfacing, and Tamping Equipment Operators	1,789	\$16.10
0.82	47-2072	Pile-Driver Operators	29	\$21.03
0.95	47-2073	Operating Engineers and Other Construction Equipment Operators	4,638	\$19.01
0.79	47-2081	Drywall and Ceiling Tile Installers	1,396	\$16.58
0.73	47-2121	Glaziers	750	\$15.45
0.83	47-2131	Insulation Workers, Floor, Ceiling, and Wall	549	\$15.16
0.75	47-2141	Painters, Construction and Maintenance	2,797	\$15.23
0.87	47-2142	Paperhangers	32	\$13.19
0.84	47-2161	Plasterers and Stucco Masons	148	\$16.76
0.9	47-2171	Reinforcing Iron and Rebar Workers	190	\$20.59
0.9	47-2181	Roofers	1,734	\$16.44
0.82	47-2211	Sheet Metal Workers	3,618	\$18.79
0.83	47-2221	Structural Iron and Steel Workers	1,056	\$20.83
0.83	47-3011	Helpers-Brickmasons, Blockmasons, Stonemasons, and Tile and Marble Setters	636	\$12.77
0.92	47-3012	Helpers-Carpenters	658	\$12.92
0.74	47-3013	Helpers-Electricians	1,856	\$13.96
0.94	47-3014	Helpers-Painters, Paperhangers, Plasterers, and Stucco Masons	172	\$12.15
0.72	47-3016	Helpers-Roofers	463	\$13.60
0.92	47-4031	Fence Erectors	271	\$13.67

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.87	47-4051	Highway Maintenance Workers	2,289	\$13.67
0.89	47-4061	Rail-Track Laying and Maintenance Equipment Operators	91	\$18.49
0.83	47-4071	Septic Tank Servicers and Sewer Pipe Cleaners	448	\$16.03
0.83	47-4091	Segmental Pavers	26	\$14.71
0.71	47-4099	Construction and Related Workers, All Other	518	\$18.81
0.8	47-5011	Derrick Operators, Oil and Gas	12	\$19.70
0.93	47-5013	Service Unit Operators, Oil, Gas, and Mining	69	\$17.32
0.85	47-5021	Earth Drillers, Except Oil and Gas	314	\$22.30
0.96	47-5051	Rock Splitters, Quarry	37	\$16.87
0.74	49-2011	Computer, Automated Teller, and Office Machine Repairers	2,481	\$16.82
0.93	49-2021	Radio, Cellular, and Tower Equipment Installers and Repairs	490	\$19.92
0.7	49-2091	Avionics Technicians	519	\$23.60
0.76	49-2092	Electric Motor, Power Tool, and Related Repairers	375	\$19.87
0.91	49-2093	Electrical and Electronics Installers and Repairers, Transportation Equipment	272	\$23.44
0.82	49-2098	Security and Fire Alarm Systems Installers	1,464	\$20.30
0.71	49-3011	Aircraft Mechanics and Service Technicians	1,760	\$27.80
0.91	49-3021	Automotive Body and Related Repairers	3,605	\$18.94
0.73	49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	5,890	\$20.64
0.75	49-3041	Farm Equipment Mechanics and Service Technicians	824	\$14.97
0.88	49-3043	Rail Car Repairers	64	\$26.43
0.79	49-3052	Motorcycle Mechanics	259	\$16.09
0.93	49-3053	Outdoor Power Equipment and Other Small Engine Mechanics	715	\$13.96
0.94	49-3091	Bicycle Repairers	217	\$11.24
0.7	49-3093	Tire Repairers and Changers	2,525	\$12.81
0.91	49-9011	Mechanical Door Repairers	548	\$15.80
0.72	49-9031	Home Appliance Repairers	666	\$15.54
0.86	49-9043	Maintenance Workers, Machinery	3,630	\$19.64
0.82	49-9045	Refractory Materials Repairers, Except Brickmasons	71	\$20.28
0.97	49-9061	Camera and Photographic Equipment Repairers	73	\$18.81
0.91	49-9063	Musical Instrument Repairers and Tuners	203	\$16.37
0.99	49-9064	Watch Repairers	43	\$16.28
0.94	49-9091	Coin, Vending, and Amusement Machine Servicers and Repairers	676	\$15.24
0.96	49-9093	Fabric Menders, Except Garment	<10	Insf. Data
0.77	49-9094	Locksmiths and Safe Repairers	304	\$16.01
0.89	49-9096	Riggers	260	\$18.28
0.9	49-9097	Signal and Track Switch Repairers	29	\$27.81
0.79	49-9098	Helpers—Installation, Maintenance, and Repair Workers	2,945	\$13.07
0.79	51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	284	\$24.92
0.73	51-2021	Coil Winders, Tapers, and Finishers	523	\$15.87
0.95	51-2022	Electrical and Electronic Equipment Assemblers	4,987	\$13.31
0.97	51-2023	Electromechanical Equipment Assemblers	794	\$14.45
0.82	51-2031	Engine and Other Machine Assemblers	1,553	\$17.06
0.93	51-2091	Fiberglass Laminators and Fabricators	454	\$13.14
0.97	51-2092	Team Assemblers	62,203	\$15.01

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.98	51-2093	Timing Device Assemblers and Adjusters	44	\$15.84
0.89	51-3011	Bakers	2,183	\$10.44
0.93	51-3021	Butchers and Meat Cutters	3,025	\$13.26
0.94	51-3022	Meat, Poultry, and Fish Cutters and Trimmers	2,069	\$11.02
0.91	51-3091	Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders	291	\$15.52
0.7	51-3092	Food Batchmakers	3,417	\$16.08
0.86	51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	2,554	\$17.36
0.91	51-4021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	1,909	\$13.78
0.93	51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	605	\$16.01
0.83	51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	948	\$18.49
0.78	51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	6,460	\$15.50
0.94	51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	375	\$16.42
0.95	51-4033	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	1,542	\$16.21
0.84	51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	913	\$16.50
0.98	51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	513	\$16.49
0.88	51-4051	Metal-Refining Furnace Operators and Tenders	748	\$18.60
0.87	51-4052	Pourers and Casters, Metal	227	\$16.64
0.93	51-4061	Model Makers, Metal and Plastic	341	\$16.26
0.9	51-4062	Patternmakers, Metal and Plastic	55	\$18.76
0.95	51-4072	Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	2,505	\$13.93
0.91	51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	2,206	\$14.68
0.84	51-4111	Tool and Die Makers	2,536	\$22.12
0.94	51-4121	Welders, Cutters, Solderers, and Brazers	6,860	\$17.72
0.91	51-4191	Heat Treating Equipment Setters, Operators, and Tenders, Metal and Plastic	465	\$17.60
0.84	51-4192	Layout Workers, Metal and Plastic	288	\$17.69
0.92	51-4193	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	496	\$12.74
0.88	51-4194	Tool Grinders, Filers, and Sharpeners	166	\$15.91
0.97	51-5111	Prepress Technicians and Workers	845	\$17.79
0.83	51-5112	Printing Press Operators	4,220	\$15.68
0.95	51-5113	Print Binding and Finishing Workers	830	\$14.68
0.71	51-6011	Laundry and Dry-Cleaning Workers	3,681	\$9.23
0.81	51-6021	Pressers, Textile, Garment, and Related Materials	664	\$11.03
0.89	51-6031	Sewing Machine Operators	3,426	\$12.16
0.97	51-6042	Shoe Machine Operators and Tenders	122	\$11.27
0.99	51-6051	Sewers, Hand	98	\$11.01
0.84	51-6052	Tailors, Dressmakers, and Custom Sewers	522	\$13.38
0.97	51-6061	Textile Bleaching and Dyeing Machine Operators and Tenders	113	\$12.32
0.95	51-6062	Textile Cutting Machine Setters, Operators, and Tenders	353	\$15.07
0.73	51-6063	Textile Knitting and Weaving Machine Setters, Operators, and Tenders	658	\$12.76
0.96	51-6064	Textile Winding, Twisting, and Drawing Out Machine Setters, Operators, and Tenders	485	\$12.04

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.88	51-6091	Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers	741	\$16.68
0.92	51-7011	Cabinetmakers and Bench Carpenters	1,454	\$13.79
0.87	51-7021	Furniture Finishers	155	\$13.50
0.96	51-7031	Model Makers, Wood	75	\$12.50
0.91	51-7032	Patternmakers, Wood	76	\$13.14
0.86	51-7041	Sawing Machine Setters, Operators, and Tenders, Wood	1,301	\$12.99
0.97	51-7042	Woodworking Machine Setters, Operators, and Tenders, Except Sawing	1,874	\$11.80
0.95	51-8011	Nuclear Power Reactor Operators	346	\$41.69
0.85	51-8013	Power Plant Operators	503	\$33.77
0.89	51-8021	Stationary Engineers and Boiler Operators	725	\$24.60
0.85	51-8091	Chemical Plant and System Operators	1,238	\$23.34
0.78	51-8092	Gas Plant Operators	152	\$25.35
0.71	51-8093	Petroleum Pump System Operators, Refinery Operators, and Gaugers	342	\$27.23
0.86	51-8099	Plant and System Operators, All Other	351	\$30.97
0.76	51-9011	Chemical Equipment Operators and Tenders	2,451	\$21.87
0.88	51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, Tenders	709	\$18.32
0.97	51-9021	Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	597	\$14.48
0.97	51-9022	Grinding and Polishing Workers, Hand	693	\$14.05
0.83	51-9023	Mixing and Blending Machine Setters, Operators, and Tenders	3,819	\$16.50
0.86	51-9032	Cutting and Slicing Machine Setters, Operators, and Tenders	1,830	\$14.68
0.93	51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	2,384	\$14.72
0.98	51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	12,996	\$16.28
0.95	51-9071	Jewelers and Precious Stone and Metal Workers	270	\$18.39
0.97	51-9081	Dental Laboratory Technicians	406	\$15.86
0.97	51-9083	Ophthalmic Laboratory Technicians	799	\$13.17
0.98	51-9111	Packaging and Filling Machine Operators and Tenders	11,154	\$14.39
0.91	51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	2,649	\$15.21
0.92	51-9123	Painting, Coating, and Decorating Workers	302	\$13.34
0.88	51-9141	Semiconductor Processors	99	\$16.92
0.99	51-9151	Photographic Process Workers and Processing Machine Operators	1,056	\$12.87
0.95	51-9191	Adhesive Bonding Machine Operators and Tenders	340	\$15.28
0.81	51-9192	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	316	\$12.59
0.93	51-9193	Cooling and Freezing Equipment Operators and Tenders	228	\$13.26
0.98	51-9194	Etchers and Engravers	140	\$15.79
0.9	51-9195	Molders, Shapers, and Casters, Except Metal and Plastic	1,153	\$14.15
0.94	51-9197	Tire Builders	712	\$19.37
0.92	51-9199	Production Workers, All Other	9,414	\$14.27
0.71	53-2022	Airfield Operations Specialists	213	\$21.43
0.89	53-3022	Bus Drivers, School or Special Client	9,469	\$11.60
0.98	53-3031	Driver/Sales Workers	8,087	\$14.72
0.79	53-3032	Heavy and Tractor-Trailer Truck Drivers	50,101	\$19.68
0.89	53-3041	Taxi Drivers and Chauffeurs	2,320	\$12.37

Probability of Automation	SOC Code	Occupation Description	TN Employment, 2015	Avg. Hourly Wages, 2015
0.96	53-4011	Locomotive Engineers	11	Insf. Data
0.93	53-4012	Locomotive Firers	0	\$0.00
0.91	53-4013	Rail Yard Engineers, Dinkey Operators, and Hostlers	30	\$21.34
0.83	53-4021	Railroad Brake, Signal, and Switch Operators	23	\$24.01
0.83	53-4031	Railroad Conductors and Yardmasters	25	\$24.77
0.86	53-4041	Subway and Streetcar Operators	110	\$24.79
0.83	53-5011	Sailors and Marine Oilers	960	\$18.58
0.97	53-6011	Bridge and Lock Tenders	32	\$22.10
0.87	53-6021	Parking Lot Attendants	2,205	\$9.68
0.83	53-6031	Automotive and Watercraft Service Attendants	2,362	\$10.21
0.9	53-6041	Traffic Technicians	481	\$24.85
0.9	53-6051	Transportation Inspectors	296	\$31.70
0.75	53-6061	Transportation Attendants, Except Flight Attendants	170	\$9.11
0.93	53-7011	Conveyor Operators and Tenders	3,901	\$15.50
0.9	53-7021	Crane and Tower Operators	753	\$20.47
0.92	53-7031	Dredge Operators	76	\$17.86
0.94	53-7032	Excavating and Loading Machine and Dragline Operators	1,298	\$17.08
0.93	53-7051	Industrial Truck and Tractor Operators	18,102	\$14.54
0.85	53-7062	Laborers and Freight, Stock, and Material Movers, Hand	90,239	\$12.54
0.93	53-7063	Machine Feeders and Offbearers	2,294	\$13.16
0.91	53-7071	Gas Compressor and Gas Pumping Station Operators	47	\$26.15
0.9	53-7072	Pump Operators, Except Wellhead Pumpers	193	\$16.70
0.84	53-7073	Wellhead Pumpers	13	\$26.69
0.93	53-7081	Refuse and Recyclable Material Collectors	2,665	\$12.46
0.72	53-7121	Tank Car, Truck, and Ship Loaders	191	\$17.79
Total for Occupations with 70 Percent or Higher Probability of Automation			1,400,914	\$14.56



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