Regional Spotlight

Technology vs. the Middle Class

Over the last 50 years, technological change helped eradicate midwage jobs. Can we do better in the age of AI?

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The views expressed in this article are not necessarily those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

A pressing concern cited by researchers and policymakers alike is that the middle class has fallen behind—or at least, it's not what it once was. Over the last 50 years, wage inequality has worsened, and the share of income held by the middle class has fallen.[1] The rapid onset of automation, made possible by advances in information technology, coincided with this period of decline, making automation by computers and computerized robots an important area of study for researchers trying to understand why our middle class is facing challenges. The current rise of artificial intelligence (AI) technologies brings new relevance to this research. Now is the time to take a closer look at how technological advancement can change the skills we demand from our workforce, and how these changes have previously held back midwage workers.

In this article, I explain how technological change during the last several decades shifted the dynamics of midwage work for the United States. I then focus on the three states of the Philadelphia Fed's district to show how these dynamics played a role in our region. Lessons from this research may help policymakers

address the newest technological leap forward, AI.

Technology and Job Polarization: 1980 to the Information Age

New technologies create demand for certain skills and therefore for the workers who have those skills. For example, the demand for skilled typists only came about after the invention of the typewriter. The mechanical typewriter helped businesses save time and money, and this need paved the way for an explosion in the typist profession in the first half of the 20th century.[2] Eventually, however, new inventions replace the old, weakening demand for previously sought-after skills. In recent decades, for example, the invention of the desktop computer and eventual ubiquity of typing rendered the typist profession almost obsolete. Understanding how technology has impacted the demand for skills is important for explaining the shifts in midwage occupations over the past several decades.

A substantial body of economic research has solidified our understanding of how technological change has impacted the demand for skills and exacerbated *job polarization* in the United States since the 1980s.[3] Thanks, in part, to technological advances, there has been stronger job growth in high- and low-wage occupations than in midwage occupations.

We can better understand the connection between technology, skills, and job polarization if we take a closer look at the tasks required by an occupation. Each task requires certain skills. Some of these tasks are routine—that is, these tasks follow a repeated series of steps. Other tasks are nonroutine and are not easily described by a set of rules. Many prominent midwage jobs of the mid-20th century, such as office clerks and machine operators, relied on routine tasks. Automation rendered many of these tasks obsolete. However, these new automation technologies couldn't accomplish *nonroutine* tasks associated with the highest- and lowest-wage occupations. For example, a lawyer must exercise expert judgement that computers aren't able to replicate. Nor can computers employ the interpersonal skills and flexibility required of a good waiter. As a result, we have seen job growth in high- and low-wage occupations but a decline in the middle. The result is what economists call a more *polarized* labor market.

*See **Four Kinds of Tasks***

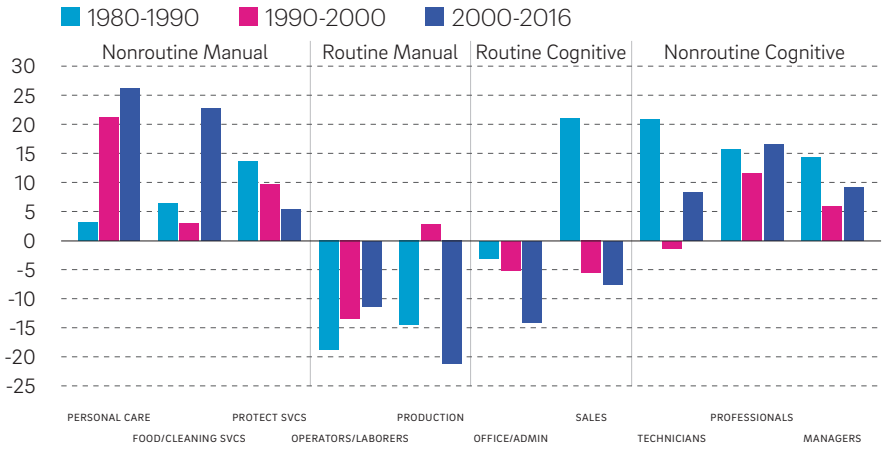
A main finding from the research showcases changes in employment share across 10 major occupation categories (Figure 1).[4] The first three categories comprise nonroutine manual occupations, often low-wage and with limited

FIGURE 1

The U.S. Labor Market Has Become More Polarized

Since 1980, job growth in traditionally midwage occupations has slowed compared to low- and high-wage occupations.

Percent change in share of U.S. employment, by occupational category, 1980–1990, 1990–2000, and 2000–2016



Data Source: U.S. Census Bureau's American Community Survey (ACS)

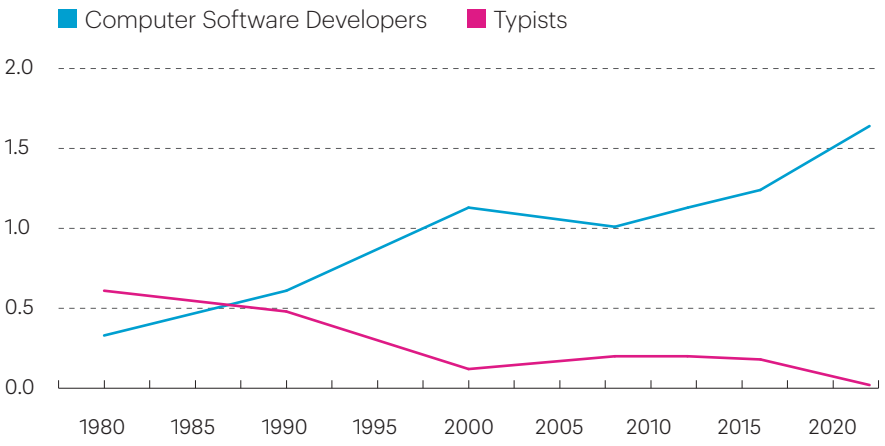
Note: Results replicated based on Autor (2015) and Autor (2019). The sample includes the working-age (16–64) civilian noninstitutionalized population in nonagricultural employment. Employment is measured as full-time equivalent workers.

FIGURE 2

Thanks to Computers, Typists Lost Their Prominence in the Labor Market

But it's been a great time to be a software developer.

Share of employment, typists and software developers, 1980–2022



Data Source: U.S. Census Bureau's American Community Survey (ACS)

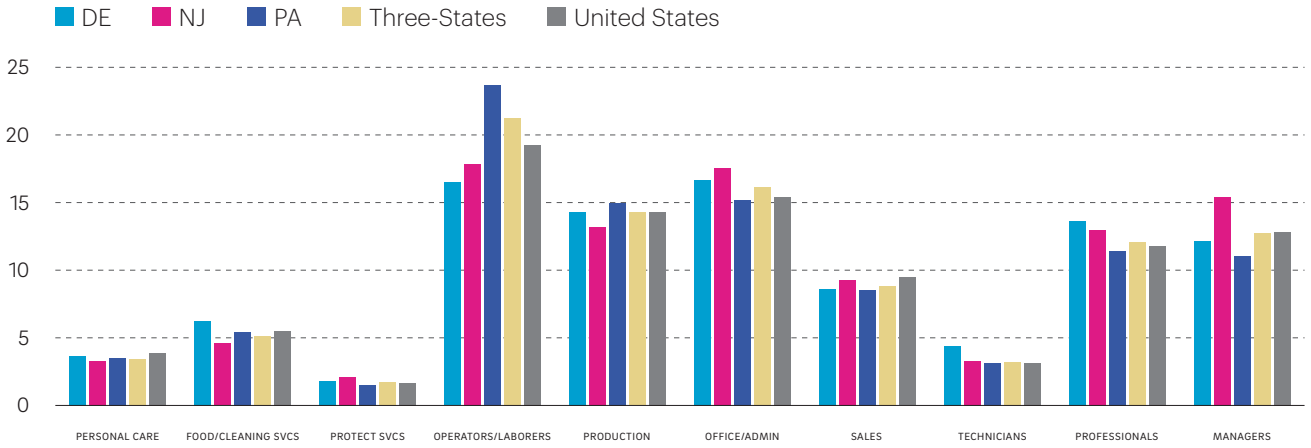
Note: The sample includes the working-age (16–64) civilian noninstitutionalized population. Employment is measured as full-time equivalent workers.

FIGURE 3

Blue-Collar Manual and Administrative Occupations Were Overrepresented in the Third District in 1980

This may explain why the region saw a bigger loss of middle-class jobs in subsequent decades.

Share of employment by occupational category, U.S. and the three states of the Third District, 1980



Data Source: U.S. Census Bureau's American Community Survey (ACS)

Note: The sample includes the working-age (16–64) civilian noninstitutionalized population in nonagricultural employment. Employment is measured as full-time equivalent workers.

educational or training requirements. The next four categories are midwage routine occupations that require training or specialized expertise but often do not require a college degree. The last three categories feature high-wage nonroutine cognitive occupations that often require substantial training or experience and at least a college degree. Since 1980, the share of workers in traditionally midwage occupations has contracted while the shares within low- and high-wage categories have grown.

As our society changes, so too does our mix of occupations. Change itself is not surprising nor necessarily alarming. In fact, this changing mix can create new opportunities for some workers. Although new technologies may render some occupations obsolete, they can also increase demand for existing occupations or bring about new types of work.[5] For instance, typists were replaced by new computer technologies, but this same period of technological advancement triggered rising demand for software developers (Figure 2).

But this period of automation has created both winners and losers. The "losers"—occupations prone to automation—were routine jobs that enabled workers to join the middle class, whereas the "winners"—occupations growing in demand and not subject to this same automation—were nonroutine jobs at the low and high ends of the wage spectrum.

This bifurcation of the labor market has contributed to rising wage inequality.[6] Workers with a college degree—and thus access to high-wage nonroutine cognitive occupations—have seen their earnings increase because technology has more often augmented rather than replaced their jobs. Spreadsheets, for example, made many accountants and other analysts more productive, and more-productive workers (usually) earn more money.[7] Meanwhile, workers without a college degree have seen their earnings stagnate partly because technology has replaced many routine midwage jobs. Many of these workers were unable to transition into higher-wage work and have entered lower-paid occupations because of degree or credential requirements at the high end.[8] This partly explains why we've seen growing wage inequality and an eroded middle class.[9]

Job Polarization in the Third District

Each region of the United States hosts a unique mix of occupations. This mix reflects each region's advantages, such as proximity to natural resources, transportation infrastructure, and early industrial development.

How was the Federal Reserve's Third District positioned in 1980 in terms of the 10 broad occupational categories discussed above? Were midwage occupations overrepresented in the District? Did this leave the region's workers particularly vulnerable to automation? When we compare the United States with the three states of the Third District, we see similar employment patterns emerge in these 10 broad categories, but midwage occupations were indeed overrepresented in the three-state region (Figure 3). In 1980, Pennsylvania was home to much larger shares of the operator and laborer occupations associated with the region's strong manufacturing base, such as machine operators and production checkers, graders, and sorters. Office and administrative occupations such as secretaries, stenographers, and general office clerks were also more represented in the region than in the United States, with a higher share of these workers in New Jersey and Delaware, perhaps because of the region's proximity to business-rich New York City and Philadelphia. Overall, the three-state region may have been more vulnerable to a weakened middle class given its concentration of blue-collar manual jobs and administrative work.

When we examine the change in employment share for the three-state region, the pattern that emerges is similar to what we see in the United States (Figure 4, top panel): The share of

employment rose in high- and low-wage occupations but fell substantially in the middle.

Although this job polarization mirrors what we see for the United States, three of the four midwage categories saw a bigger drop in the three states than in the entire country. Operator and laborer occupations experienced their greatest decline between 1980 and 1990: a 26 percent loss in the share of employment, compared with 19 percent in the United States. Office and administrative occupations experienced their largest loss later: 18 percent between 2000 and 2016, compared with 14 percent in the United States. Production occupations suffered slightly more than in the United States across each period. Sales occupations grew more between 1980 and 1990 in the three states than in the United States but follow a similar pattern of loss in the subsequent two periods. Personal care occupations, as well as managers and professionals, experienced higher relative growth in the three states compared with the United States, perhaps due to the region's concentration of education and medical institutions.

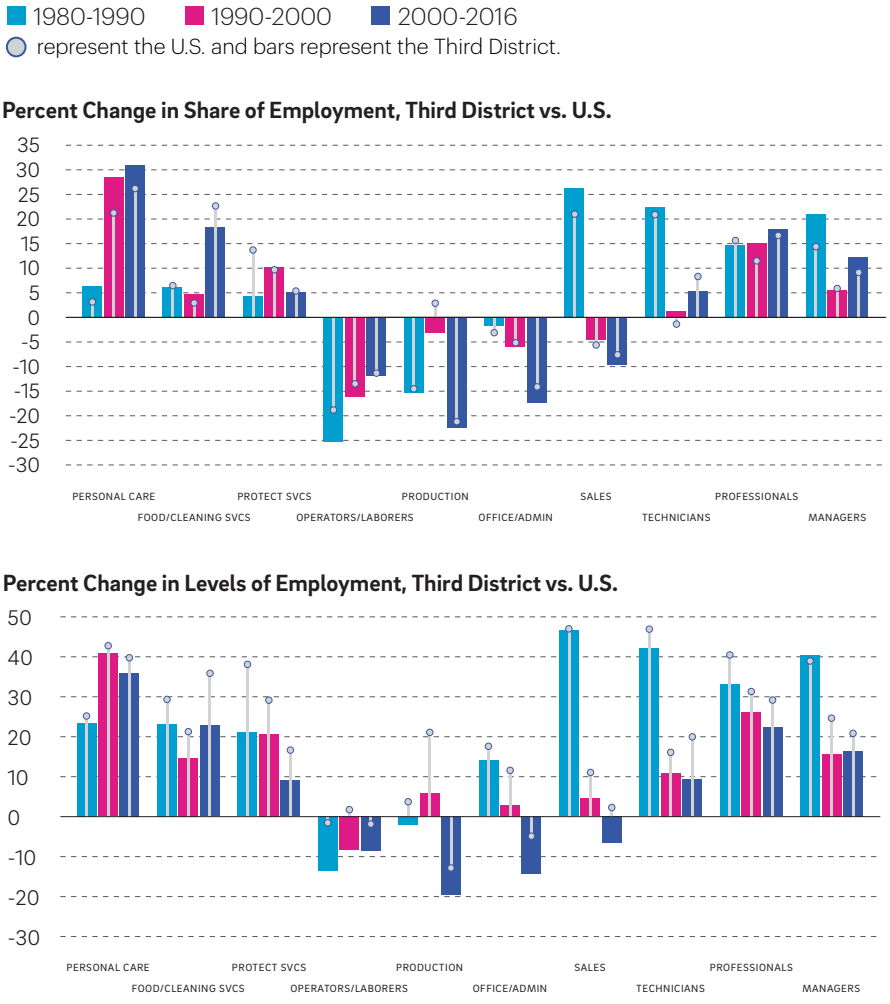
To elucidate whether these changes in share translated to actual declines in employment or slower relative growth, we examined similar results in terms of employment level (Figure 4, bottom panel). Within each of the four midwage categories, the three-state region experienced employment losses at some point. Overall, the three-state region experienced more employment loss or slower employment growth across nearly every category and period in comparison to the United States.

FIGURE 4

Job Polarization Also Occurred in the Third District

But the Third District experienced larger changes than the U.S., especially in operators and laborers and office and administrative occupations.

Percent change in share and levels of employment in the three states of the Third District and the U.S., by occupational category, 1980–1990, 1990–2000, and 2000–2016.



Data Source: U.S. Census Bureau's American Community Survey (ACS)

Note: The sample includes the working-age (16–64) civilian noninstitutionalized population in nonagricultural employment. Employment is measured as full-time equivalent workers.

To further examine employment change, let's compare the United States to each state's overall change in level of employment for the four midwage categories in terms of their 1980 share (Figure 5). Pennsylvania suffered worse employment changes, even when compared with states with a similar 1980 concentration of these occupations. Pennsylvania had among the highest employment losses in operators and laborers and production occupations, as well as slower growth in office and administrative and sales occupations compared with most other states between 1980 and 2016. New Jersey also fared poorly: It was one of a handful of states to *lose* office and administrative jobs, and it experienced one of the largest losses in overall production employment. As in the United States, the three Third District states have seen a hollowing out of their midwage work, but they seem to have suffered even greater employment losses in these occupations, especially those occupations overrepresented in the region compared with the United States in 1980.

We can make another observation from this comparison. Higher shares of operators and laborers and of office and administrative occupations in 1980 correspond to a higher level of employment loss in each of these categories. However, this pattern differs in the production and sales categories. Although we still need to disentangle other economic forces that influence these relationships,[10] this finding points to the potential for regions with higher shares of certain at-risk occupations to experience more job loss. Future researchers may want to take a closer look at the regional factors that lend themselves to these varied employment changes. Doing so would help us understand job polarization at a localized level and the factors that may make a community more resilient.

FIGURE 5

Pennsylvania Suffered More Job Loss or Slower Growth, Even When Compared to States With a Similar Concentration of These Occupations

New Jersey also fared poorly in comparison to other states.

Percent change in level of employment for four midwage occupational categories, U.S. and Third District states, 1980–2016; the X axis is percent share of employment in 1980; the Y axis is percent change in employment from 1980 to 2016

Data Source: U.S. Census Bureau's American Community Survey (ACS)

Note: The sample includes the working-age (16–64) civilian noninstitutionalized population. Employment is measured as full-time equivalent workers. Nevada has been excluded for charting purposes. Its values (share of employment in 1980; percent change in employment) are Operators and Laborers (11; 242); Office and Administrative (14; 216); Production (12; 165); and Sales (11; 264).

AI's Implications for the Future

New technologies can create a paradigm shift in the demand for workers with certain skills. Just such a paradigm shift is upon us with the rise of AI. Although AI is still in its early stages of deployment, recent advancements, most notably generative AI, have grabbed the public's attention thanks to their ability to automate nonroutine tasks. For instance, drafting an email and optimizing the distribution of assignments to team members were once nonroutine cognitive tasks not easily replicated by machines (and core tasks of managers). Generative AI may soon accomplish these and other nonroutine tasks with a simple prompt.

Although generative AI and its deployment may differ from previous technologies, the findings I present in this article can help us imagine some of the risks and opportunities for our labor market.

We know that technological shifts *can* contribute to job loss and wage inequality. Understanding the tasks—and thus the occupations—likely to be replaced rather than augmented by AI is important if we are to assist those workers who are likely to be harmed by these changes. Although it's too early to be definitive, preliminary research suggests that nonroutine cognitive jobs may be most at risk of automation, especially scientific occupations with little face-to-face interaction, such as researchers, software engineers, and data scientists. (Many of these workers fall into the broad occupational categories of technicians and professionals.)[11] Ironically, software developers may experience a pattern of decline similar to what typists experienced in the 20th century (Figure 2). If this happens, will these workers successfully transition into better jobs (that is, jobs that require more expertise and provide higher pay)? Or will they fall into lower-expertise, lower-wage work?

This future is unknown and, importantly, undecided. Just as no one could have predicted the rise of the software developer before the invention of the computer, and the typist before the typewriter, so too can we only guess at what new types of work will arise in the coming decades. AI might add new types of work, or it could augment rather than replace many types of work. In his 2024 working paper, Massachusetts Institute of Technology professor of economics David Autor indeed asserts this as a possibility—and an opportunity—for policymakers to address concerns about the middle class. New AI technologies *could* help more workers rise to higher-paying jobs that require more expertise if these technologies pair well *with* workers to augment their skills and knowledge—and improve their productivity—without the worker needing higher credentials or needing to develop full expertise on their own (which may otherwise take years). For example, a primary task of software developers is writing computer code. If demand for these skills remains and computer-coding skills are made more accessible to a broader set of workers by AI, could more of these workers transition to higher-paid work? If so, this may raise encouraging possibilities for the middle class.

Conclusion

The occupations that make up our labor market will keep evolving. Technological change is a major factor driving this evolution. The question policymakers must ask is, what decisions can be made to ensure that new technologies help a broad range of working Americans? Automation weakened the country's and the Third District's middle class by putting midwage workers at a disadvantage. The resulting automation-induced loss of midwage occupations contributed to higher wage inequality. Regions with higher concentrations of certain midwage workers, such as the states of the Third District, may have been more disrupted by these changes. If policymakers heed the task framework and lessons learned over the last several decades, their AI-related policies might strike the balance between mitigating risk and embracing the opportunities of AI.

Four Kinds of Tasks

In studying the impacts of automation, economists often divide tasks into four categories. An occupation can often be described by which of these tasks it relies on. By employing this conceptualization, we discern patterns in the types of occupations most impacted by automation.

Routine Cognitive Tasks
Office, administrative, and sales occupations, such as bank tellers and office clerks. These jobs require literacy, memory, attention, logical reasoning, or information processing, but they generally follow explicit rules or procedures.

Routine Manual Tasks
Operators, laborers, and production occupations, such as machine operators and construction laborers. These jobs require physical strength, agility, or manual dexterity and follow explicit rules or procedures.

Both types of routine occupations have been subject to replacement in the era of automation.

Nonroutine Cognitive Tasks
Technicians and professional and manager occupations, such as teachers and lawyers. These jobs require abstract problem-solving, intuition, persuasion, or creativity. A college degree and often a postgraduate degree or training is required.

Nonroutine Manual Tasks
Personal care and food and cleaning service occupations, such as waiters and health aides. These jobs require situational adaptability, visual and language recognition, and in-person interactions. Often they do not require formal education beyond a high school diploma or extensive training.

Automation has augmented rather than automated some of these occupations.

NOTES

1 See Kochhar (2024).

2 See Hoke (1979).

3 See, for example, Acemoglu and Autor (2011) and Autor, Levy, and Murnane (2003).

4 See Autor (2015).

5 See Lin (2011).

6 See, for example, Acemoglu and Restrepo (2022).

7 See, for example, Krueger (1993) and Akerman et al. (2015).

8 See, for example, Cortes et al. (2017).

9 There are other factors contributing to job polarization and wage inequality. Other lines of research include unionization patterns, minimum wage policy, and globalization.

10 For instance, there may be important differences in how the Great Recession or an aging workforce affected a region's employment patterns.

11 See Eloundou et al. (2024).

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