

# Chicago Fed Letter

## Explaining trends in wages, work, and occupations

by David H. Autor, professor, Massachusetts Institute of Technology, and faculty research associate, National Bureau of Economic Research

The inequality of labor market earnings in the U.S. has increased dramatically in recent decades. However, closer examination of the data reveals two distinct periods of rising inequality: 1973–89 and 1989–2005. The first period was one of diverging wages throughout the distribution, while the second period was one of polarizing wage growth.

It is widely recognized that inequality of labor market earnings in the United States has increased dramatically in recent decades. Over the course of more than three decades, wage growth was

weak to nonexistent at the bottom of the distribution, strong at the top of the distribution, and modest in the middle. While real hourly earnings of workers within the bottom 30% of the earnings distribution rose by no more than 10 percentage points between 1973 and 2005, earnings of workers at the 90th percentile rose by more than 40 percentage points.<sup>1</sup>

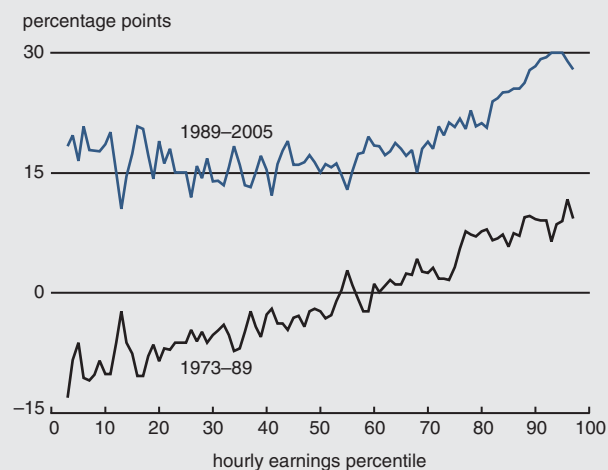
What is less widely known, however, is that this smooth,

monotonic growth of wage inequality is a feature of a specific time period—and that this time period has passed.<sup>2</sup> Figure 1 shows that, consistent with common perceptions, the growth of wage inequality over the period 1973–89 was strikingly linear in wage percentiles, with sharp falls in real wages at the bottom of the distribution and modest increases

at the top.<sup>3</sup> Yet, starting in the late 1980s, the growth of wages *polarized*, with strong, ongoing wage growth in the top of the earnings distribution (at or above the 70th percentile) and modest growth in the lower tail of the distribution (at or below the 30th percentile). Notably, the portion of the wage distribution that saw the least real earnings growth over the period 1989–2005 was the middle, roughly the group of earners between the 30th and 70th percentiles of the distribution.<sup>4</sup> Thus, the periods of 1973–89 and 1989–2005 represent two distinct periods of rising inequality: the first one of diverging wages throughout the distribution and the second of polarizing wage growth.

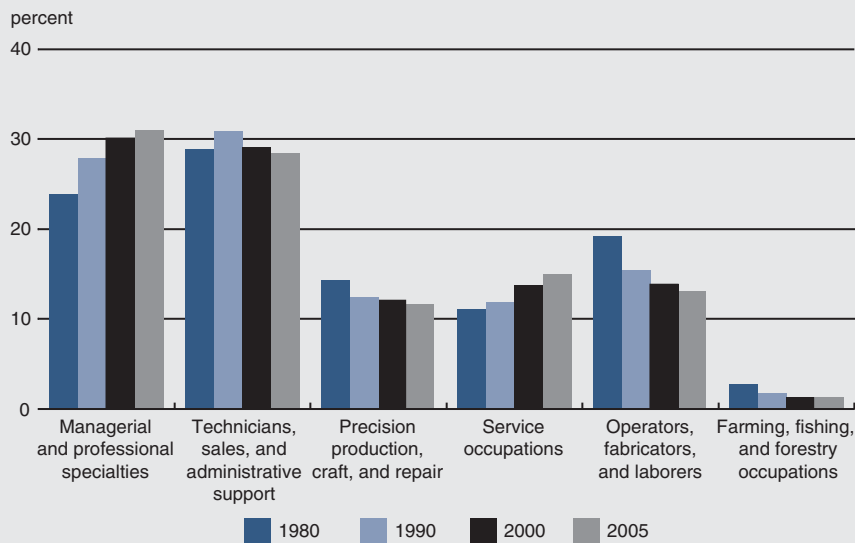
What explains the polarization of the last 15 years?<sup>5</sup> It is fair to say that the question has not yet received an entirely satisfactory answer. One potentially promising—though surely incomplete—explanation lies in the changing demand for job tasks spurred by the remarkable spread of computerization. The price of computer power has fallen by roughly one-third to one-half each year for several decades.<sup>6</sup> Processing tasks that were unthinkably expensive 30 years ago, such as searching the full text of a university's library for a single quotation, are now trivially cheap. This rapid, secular price decline creates enormous economic incentives for employers to substitute

1. Change in real hourly earnings, 1973–2005



SOURCES: Autor, Katz, and Kearney (2006); and author's calculations based on data from the U.S. Census Bureau, *Current Population Survey*, from Unicon Research Corporation.

## 2. Employment shares, by occupational group, 1980–2005



NOTES: Percent values show the occupational groups' shares of overall employment. For details on the six occupational groups, see the text.

SOURCES: Autor and Dorn (2008); and author's calculations based on data from the University of Minnesota, Minnesota Population Center, *Integrated Public Use Microdata Series*.

cheap computers for expensive labor in performing workplace tasks. Simultaneously, it creates significant advantages for workers whose skills become increasingly productive as computerization advances.

But what *are* the tasks that computers perform? One is immediately tempted to answer, "Everything." Indeed, it is hard to think of a quotidian activity—from checking the weather forecast to investing our retirement savings—that doesn't involve using a computer in one way or another. Yet, although computers are everywhere, they don't do everything—far from it. In fact, computers have a very specific set of capabilities and limitations. Ultimately, the ability of a computer to accomplish a task is dependent upon the ability of a programmer to write a set of procedures or rules to tell the machine what to do at each possible contingency. This means that computers are good at the things that people can program them to do—and inept at everything else.

For example, computer programs can play an unbeatable game of checkers and a nearly unbeatable game of chess. These games follow well-described rules and so are reasonably straightforward to program. In the workplace, computers accomplish countless data processing

and clerical activities, such as sorting, filing, calculating, storing, retrieving, and manipulating information. Similarly, computers now handle many of the repetitive assembly and monitoring tasks on the factory floor. I call these procedural, rule-based activities *routine* tasks.<sup>7</sup>

Yet, there are many essential tasks that workers perform daily for which programmers and engineers do not know the rules and therefore cannot program a computer to do. One such set of tasks is *abstract thinking*—e.g., developing a hypothesis, making a persuasive argument, creating a new idea or product, or motivating and managing a group of workers. These abstract thinking tasks require creativity, intuition, and insight. Though all of us have ideas and insights, the science of programming computers to do likewise is still in its infancy. Thus, for the moment, abstract thinking tasks require educated, creative, and clever people. Moreover, computerization likely raises the productivity of workers performing abstract tasks. For instance, lawyers accomplish faster and more thorough case research by tapping into legal databases. Engineers develop products more quickly when assisted by computer-aided design tools. Financial professionals handle much larger volumes of client money than was feasible in the paper-based era.

There is abundant evidence that the demand for highly educated workers has increased in the computer era, and it is likely that the complementarity between computerization and abstract work is part of the explanation.

But education-intensive, abstract tasks are not unique in their (partial) immunity from automation. A second group of tasks that have proven remarkably hard to computerize are so-called *manual* tasks. These are tasks that require on-the-spot flexibility and adaptability. Driving a truck through city traffic, waiting tables at a restaurant, and checking passengers' identification at the airport—these are all tasks that are easy for people but *hard* for computers. Why? Because they require complex and rapid interactions with unpredictable factors—erratic traffic, hungry restaurant patrons, and unfamiliar faces. Importantly, these manual tasks do not require high levels of formal education.

One can potentially glimpse the impact that computerization—more recently complemented by international outsourcing (i.e., moving jobs overseas to take advantage of lower production costs)—is having on job tasks by considering the changing occupational structure of U.S. employment. We can look at all U.S. employment across six major, and very broad, occupational groups: managerial and professional specialties; technicians, sales, and administrative support; precision production, craft, and repair; service occupations; operators, fabricators, and laborers; and farming, fishing, and forestry occupations. The highest skilled of these occupational groups is managerial and professional specialties, followed (by some distance) by technicians, sales, and administrative support. The four remaining groups—each averaging half the size of the first two—are demonstrably less education-intensive. Whereas in the year 2000, high school dropouts made up 2.2% of employment in professional/managerial jobs and 6.7% of employment in technical, sales, and administrative support jobs, they made up slightly over 20% of employment in the four remaining groups.

Growth has not been uniform across these six occupational groups. Figure 2 shows

that managerial and professional specialty occupations—the highest-skilled group—experienced consistent, rapid growth between 1980 and 2005, gaining 7.1 percentage points as a share of overall employment between 1980 and 2005—a 30% increase. By contrast, employment in the *middle-skilled* group of technical, sales, and administrative support occupations showed an inverse U-shaped pattern over this period, expanding from 1980 to 1990 and then contracting over the next 15 years to below its initial 1980 level (consistent with the growing substitution of technology for routine tasks). Most strikingly, employment shares in three of the four low-skilled occupations fell sharply in each decade. Between 1980 and 2005, farming, fishing, and forestry occupations contracted by more than 50% as a share of employment; operators, fabricators, and laborers contracted by 33%; and precision production, craft, and repair occupations contracted by 19%.

Standing in sharp contrast to these patterns of declining employment, however, is the experience of service occupations.<sup>8</sup> Despite being among the lowest-paid occupations requiring the least education in the U.S. economy, employment in service occupations expanded in each decade between 1980 and 2005, rising from 11.0% of employment in 1980 to 11.8% in 1990, to 13.7% in 2000, and to 14.9% in 2005. This 35% increase over the 25-year span is 6 percentage points larger than the gain in employment shares of managerial and professional specialties during the same period. In fact, service occupations are also the only major occupational group that is growing among non-college-educated workers (i.e., those with a high school diploma or lower education).

What is special about service occupations? The largest categories within the service occupations group are food preparation and service; health service support (a category that excludes registered nurses and other skilled medical personnel); and buildings and grounds cleaning and maintenance. These are low-paying jobs; in the year 2005, 75% of them had hourly wages below the overall hourly median. From the perspective of our conceptual framework, what distinguishes these

occupations is that each is highly intensive in *nonroutine manual tasks*—activities requiring interpersonal and environmental adaptability yet little in the way of formal education. These are precisely the job tasks that are difficult to automate with current technology because they are nonroutine. Moreover, these jobs are difficult to outsource because, in large part, they must be produced and performed in person (at least, at the moment).

Employment projections from the U.S. Bureau of Labor Statistics (BLS) support the view that low-education service jobs are likely to be a major contributor to U.S. employment growth going forward.<sup>9</sup> The BLS forecasts that employment in service occupations will increase by 5.3 million, or 19%, between 2004 and 2014.<sup>10</sup> The only major occupational category with greater projected growth is professional occupations, which are predicted to add 6 million jobs, a 21.2% increase.<sup>11</sup> Like all forecasts, these should be treated as tentative. Historically, the BLS has underpredicted the growing demand for professional and managerial occupations.<sup>12</sup>

## Conclusion

This process of employment polarization—in which job growth is concentrated among both highly education-intensive abstract jobs and comparatively low-education manual jobs—presents both challenges and opportunities for the U.S., as well as other industrialized economies. The rising productivity of highly educated workers is good news; the return on investments in higher education has perhaps never been greater. But the growing importance of manual and service tasks presents a challenge. The positive news about rising demand for in-person service occupations is that it will tend to increase the earnings of less educated workers. The less favorable news is that, even given rising demand, labor supply to services may be sufficiently elastic that wages stay low. Median real hourly wages in service jobs were \$8.86 in 1980, \$9.01 in 1990, \$10.24 in 2000, and \$10.28 in 2005 (all expressed in 2005 dollars).<sup>13</sup> These hourly wage rates imply annual, full-time earnings of approximately \$20,000 per year (of course, many service jobs do not provide

full-time, full-year earnings). This income level exceeds the U.S. Census Bureau's official poverty threshold for the year 2005 of \$19,806 for a family of two adults and two dependent children.<sup>14</sup> Yet, this is probably insufficient for families to make optimal investments in child rearing and education.

It appears a legitimate worry that the ongoing polarization of earnings levels among U.S. households will ultimately serve to thwart economic mobility among subsequent generations. Unfortunately, the impact of current economic inequality on future mobility cannot be judged until decades after the die is cast. Thus, investments in insuring the economic mobility of the next generation are necessarily precautionary—but perhaps a precaution worth taking.

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<sup>1</sup> A longer version of this article was prepared for the conference, *Strategies for Improving Economic Mobility of Workers*, held on November 15–16, 2007, co-sponsored by the Federal Reserve Bank of Chicago and the W. E. Upjohn Institute for Employment Research; it will be published in a forthcoming conference proceedings volume (to be published by the Upjohn Institute in 2009). The ideas in this article draw on several studies by me and my co-authors, including: David H. Autor, Frank Levy, and Richard J. Murnane, 2003, "The skill content of recent technological change: An empirical investigation,"

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<sup>2</sup> This observation was, to my knowledge, first offered in Lawrence Mishel, Jared Bernstein, and Heather Boushey, 2002, *The State of Working America, 2002–03*, Ithaca, NY: ILR Press.

<sup>3</sup> The public use files of the U.S. Census Bureau’s *Current Population Survey* and the Minnesota Population Center’s *Integrated Public Use Microdata Series* (IPUMS)—encompassing U.S. *Decennial Census* and *American Community Survey* data—are analyzed in figures 1 and 2. These files do not reliably cover the top several percentiles of the earnings distribution where the most dramatic increases in real earnings have occurred during these decades; see Thomas Piketty and Emmanuel Saez, 2003, “Income inequality in the United States, 1913–98,” *Quarterly Journal of Economics*, Vol. 118, No. 1, February, pp. 1–39. Including these top percentiles would reveal even greater growth at the top throughout the years studied.

<sup>4</sup> Note, however, that all percentiles of the distribution fared better in the second half of the time period (1989–2005) than in the first (1973–89), reflecting the acceleration of U.S. productivity growth commencing in the mid-1990s.

<sup>5</sup> See Maarten Goos and Alan Manning, 2007, “Lousy and lovely jobs: The rising polarization of work in Britain,” *Review of Economics and Statistics*, Vol. 89, No. 1, February, pp. 118–133; Goos and Manning coined the term “polarization” to describe this phenomenon.

<sup>6</sup> Ernst R. Berndt and Neil J. Rappaport, 2001, “Price and quality of desktop and mobile personal computers: A quarter-century historical overview,” *American Economic Review*, Vol. 91, No. 2, May, pp. 268–273.

<sup>7</sup> An alternative to codifying a highly complex task into machine instructions is to simplify the task by reducing the number of contingencies and discretionary steps that a machine will face.

<sup>8</sup> It is critical to distinguish *service occupations*, a relatively narrow group of low-education occupations that make up 13.4% of employment in 2000 (my calculation based on IPUMS data), from the *service sector*, a very broad category of industries ranging from health care to communications to real estate and making up 81% of non-farm employment in 2000 (according to the U.S. Bureau of Labor Statistics).

<sup>9</sup> U.S. Bureau of Labor Statistics, 2007, *Occupational Outlook Handbook, 2006–07 ed.*, Washington, DC, available at [www.bls.gov/oco](http://www.bls.gov/oco), accessed on October 21, 2007.

<sup>10</sup> The service employment measure used by the BLS’s occupational outlook indicates a service employment share that is several percentage points higher than my calculations in the text. My calculations are based on household data from the U.S. Census (via IPUMS), while the BLS numbers use *Current Employment Statistics* (CES). The service occupation in which the U.S. Census and CES data are most different is in food preparation and service, where my data show a 3.5% employment share and the CES data show a 7.4% employment share.

<sup>11</sup> The BLS category of professional occupations excludes managerial occupations and so is more disaggregated than the U.S. Census category of professional and managerial occupations. Combined growth in professional and managerial jobs is projected at 8.2 million jobs, or 18.8%.

<sup>12</sup> See John H. Bishop and Shani Carter, 1991, “How accurate are recent BLS occupational projections?,” *Monthly Labor Review*, Vol. 114, No. 10, October, pp. 37–43; and Richard B. Freeman, 2006, “Is a great labor shortage coming? Replacement demand in the global economy,” National Bureau of Economic Research, working paper, No. 12541, September.

<sup>13</sup> These are my calculations based on IPUMS data, deflated by the Personal Consumption Expenditures deflator.

<sup>14</sup> See [www.census.gov/hhes/www/poverty/threshld/thresh05.html](http://www.census.gov/hhes/www/poverty/threshld/thresh05.html).