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Why are manufacturers struggling to hire high-skilled workers?

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The authors examine the apparent lack of high-skilled workers for the U.S. manufacturing sector by focusing on the educational attainment and wage compensation of manufacturing workers and their nonmanufacturing counterparts over the period 1990–2007.

The educational attainment of the manufacturing work force has been converging with that of the nonmanufacturing work force.

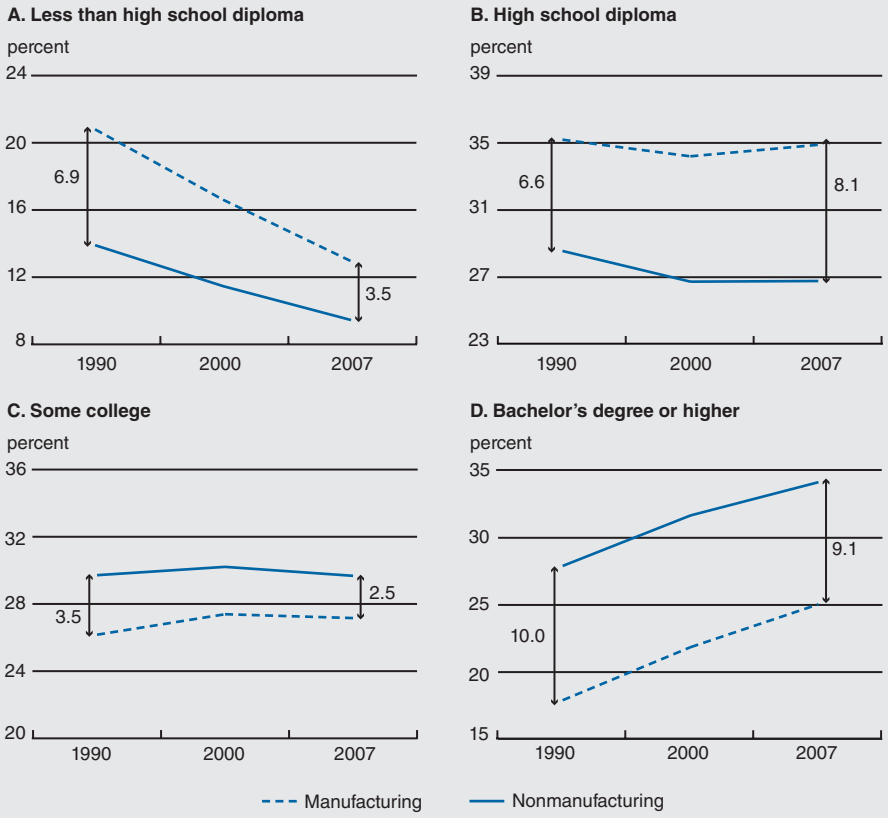
U.S. manufacturers are often disappointed with the supply of high-skilled workers available to them, especially from the pool of younger candidates. Manufacturers and their trade associations have actively responded to this apparent shortage by heightening their recruitment efforts, marketing the manufacturing sector's prospects, and improving their skills certification and training programs. If manufacturing employers are indeed faced with an unduly short supply of high-skilled workers, this is puzzling given the falling levels and shares of manufacturing employment in the U.S. To further understand this reported labor shortage, we look at trends in "upskilling," or improvements in average skill levels, of the overall U.S. work force. We examine whether the manufacturing sector (compared with the nonmanufacturing sector) has sought and employed more high-skilled workers versus low-skilled workers over time. In addition, we analyze how wage premiums in the manufacturing sector relative to the nonmanufacturing sector have changed over the past two decades. Having to provide higher wage premiums usually indicates tightening labor markets, so we look at whether these premiums for manufacturing labor have been increasing in relative terms over time. Finally, we touch on other challenges that manufacturers may be facing in hiring high-skilled workers.

Upskilling

In the U.S., manufacturing's share of payroll jobs has been contracting since the middle of the twentieth century, with accelerating declines over the past three decades. A shrinking manufacturing sector in the U.S. suggests that workers would be readily available, since many existing workers have been displaced on account of plant closings and other retrenchment decisions. However, what may be true for the overall manufacturing work force may be less true for high-skilled segments of it. That is, both technological change and heightened global competition may be affecting low-skilled manufacturing workers to a greater extent. Meanwhile, the demand for high-skilled workers has also been tightening across the entire U.S. economy; thus, manufacturing employers must likely compete with nonmanufacturing employers for these workers.

In recent decades, the U.S. work force has been upskilling. As documented by various researchers,[1] upskilling across the U.S. work force over the past century is evidenced by rapid growth in educational attainment, particularly by the increased numbers of high school and college graduates. Researchers continue to debate the reasons behind the continued broad-based upskilling in recent decades. But a strong impetus for upskilling across the U.S. work force appears to have arisen from employers' growing

1. Share of work force, by educational attainment and industry



NOTES: The numbers between the manufacturing and nonmanufacturing work force series in each panel indicate their percentage point differences. The data are for workers aged 25 and older.

SOURCES: Authors' calculations based on data from the U.S. Census Bureau, 1990 *Census of Population and Housing, Public Use Microdata Samples*, 1% sample; and 2000–07 *American Community Survey*.

2. Average hourly wages, by educational attainment and industry

	1990			2000–07			% change from 1990 to 2000–07		
	Mfg	Nonmfg	Total	Mfg	Nonmfg	Total	Mfg	Nonmfg	Total
Less than high school diploma	15.25	13.77	14.25	14.85	14.16	14.31	–2.6	2.8	0.5
High school diploma	18.12	15.91	16.56	18.55	16.85	17.24	2.3	6.0	4.1
Some college	21.53	18.55	19.26	23.03	20.41	20.88	7.0	10.0	8.4
Bachelor's degree	29.54	24.87	26.00	34.90	30.97	31.69	18.1	24.5	21.9
Master's degree or higher	37.08	32.27	33.41	46.66	43.21	43.86	25.8	33.9	31.3

NOTES: Nominal average wages are deflated by the U.S. Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U) to 2007 U.S. dollars. The data are for workers aged 25 and older. Mfg indicates manufacturing. Nonmfg indicates nonmanufacturing.

SOURCES: Authors' calculations based on data from the U.S. Census Bureau, 1990 *Census of Population and Housing, Public Use Microdata Samples*, 1% sample; and 2000–07 *American Community Survey*.

demand for high-skilled employees—particularly for those who are facile with technological advancements.[2]

To examine the educational attainment of manufacturing workers, we draw on the 1990 U.S. Census's 1% *Public Use Microdata Sample* (PUMS), as well as the annual *American Community Survey* (ACS) over the period 2000–07, both from the U.S. Census Bureau. Educational attainment of workers correlates fairly well with measured skill levels. Although some may argue there are many manufacturing skills that do not reflect formal education, especially those involving on-the-job training, we find that educational attainment correlates strongly with wages in both manufacturing and nonmanufacturing sectors.[3] Accordingly, as measured by years of schooling completed, educational attainment and its changes over time can serve as reasonable proxies for skill levels and high-skilled-work-force growth in manufacturing.

In general, manufacturing continues to have a reputation for employing those with lesser educational attainment. This is confirmed by the 1% PUMS and ACS data: Compared with the nonmanufacturing work force, the manufacturing work force has greater shares of those with only a high school diploma, as well as those who have not completed high school (see figure 1, panels A and B). Nonetheless, the educational attainment of the manufacturing work force has been converging with that of the nonmanufacturing work force at both ends of the educational attainment spectrum over the past two decades. For the manufacturing work force, the share with less than a high school diploma falls from 20.8% in 1990 to 12.9% in 2007; for the nonmanufacturing work force, this share drops from 13.9% in 1990 to 9.4% in 2007 (figure 1, panel A). Thus, it is clear that this share for the manufacturing sector falls much faster over this period. For the manufacturing work force, the share of those with a bachelor's degree or higher rises from 17.9% in 1990 to 25.0% in 2007; this share also goes up from 27.9% to 34.1% over the same period for the nonmanufacturing work force (figure 1, panel D). Thus, the spread between the college graduate share in manufacturing and this share in the nonmanufacturing sector drops from 10.0 percentage points to 9.1 percentage points over the 1990–2007 period, indicating a convergence between the two sectors' work forces through upskilling.[4]

Wage pressures

Beyond the increasing broad demand for high-skilled workers across the manufacturing and nonmanufacturing sectors alike, is there further evidence to suggest that manufacturing employers strain to acquire such workers? In the economics literature, manufacturing has been shown to consistently offer a wage premium

3. Manufacturing wage premiums, by educational attainment

	1990		2000		2007	
	Premium (dollars)	% of nonmfg wage	Premium (dollars)	% of nonmfg wage	Premium (dollars)	% of nonmfg wage
Less than high school diploma	1.11*	8.09	–0.10*	–0.66	0.29*	2.11
High school diploma	1.21*	7.59	1.22*	7.24	0.55*	3.32
Some college	1.42*	7.63	1.22*	5.98	0.67*	3.32
Bachelor's degree	2.70*	10.86	1.71*	5.51	1.45*	4.69
Master's degree or higher	2.25*	6.96	–1.24*	–2.83	–0.92*	–2.06

*Significant at the 1% level.

NOTES: All wage premiums are in 2007 U.S. dollars. Wage premiums are measured by the manufacturing employment regression coefficients for each of the educational attainment levels. Regressions also control for gender, experience, and U.S. Bureau of Economic Analysis (BEA) region. For information on BEA regions, see www.bea.gov/regional/docs/regions.cfm. The data are for workers aged 25 and older. Nonmfg indicates nonmanufacturing.

SOURCES: Authors' calculations based on data from the U.S. Census Bureau, 1990 *Census of Population and Housing, Public Use Microdata Samples*, 1% sample; and 2000–07 *American Community Survey*.

(relative to the nonmanufacturing sector). However, such wage premiums do not necessarily imply tight labor markets. Previous studies have explained the manufacturing wage premium as being (alternatively) a byproduct of unionization; compensation for less desirable working conditions; and "efficiency wages," or overcompensation to workers to ensure they will not shirk their responsibilities. Given that wage premiums have been historically typical of the manufacturing sector, somewhat stronger evidence may be needed to indicate tightening labor markets over time.

Actually, aggregate evidence of late has shown a countertrend or at least an easing of the wage premium in U.S. manufacturing. Over the past two decades, manufacturing wages have been rising less rapidly in the U.S. work force: From 1990 through 2007, average annual hourly wage increases (net of overtime) in the private nonmanufacturing sector have cumulatively outpaced those in manufacturing by amounts ranging from 5% (e.g., retail and wholesale trade and other services) to 23% (e.g., finance, insurance, and real estate).[5]

We focus on changing wage differences between the manufacturing and nonmanufacturing sectors in figure 2. To account for different skill levels, we compare the average hourly wages of the manufacturing and nonmanufacturing sectors for individual workers categorized by their educational attainment. The average hourly wage for manufacturing workers at all education levels is higher than that for nonmanufacturing workers in both periods we consider. In 1990, the largest wage gap between manufacturing workers and nonmanufacturing workers was for individuals with a master's degree or higher, with this difference equaling almost $5 per hour. In 2000–07, individuals with only a bachelor's degree had the largest gap: Manufacturing workers earned about $4 more an hour than their nonmanufacturing counterparts. In each educational attainment category, the wage spread converged from 1990 to 2000–07, with the wages of the nonmanufacturing sector outpacing those of the manufacturing sector. Manufacturing workers having less than a high school diploma experienced actual real wage declines from 1990 to 2000–07, while nonmanufacturing workers with the same level of educational attainment eked out small gains. In higher educational attainment categories, average wages grew in both sectors, though nonmanufacturing wages rose more rapidly. Nonmanufacturing workers with some college saw wage gains of 10%, versus gains of 7% for their manufacturing counterparts. Among those with only bachelor's degrees, nonmanufacturing wages jumped 24.5%, compared with 18.1% for manufacturing wages.

To further examine wage premiums paid by manufacturing employers with more statistical controls, we run ordinary least squares regressions on observations of individual workers in the manufacturing and nonmanufacturing sectors, with hourly wage[6] as our dependent variable. In doing so, we account for each worker's human capital—both education and experience—along with gender and geography of the workplace. To proxy for worker skill level, we segment our observations of all private sector workers into five mutually exclusive categories of educational attainment: 1) less than a high school diploma, 2) a high school diploma, 3) some college, 4) a bachelor's degree, and 5) a master's degree or higher. We run separate regressions for each year (1990, 2000, and 2007) and education level, and distinguish manufacturing workers from nonmanufacturing workers.

In figure 3, we report the manufacturing wage premium as the dollar amount per hour, as well as its percentage of the average hourly wage for nonmanufacturing workers having the same level of education. With a few exceptions, we find that the estimated wage effect of being in the manufacturing sector is positive and statistically significant.[7] In 1990, this wage effect is worth between 6.96% and 10.86% of the average wage of nonmanufacturing workers. By 2007, the wage effect reduced to being worth between –2.06% and 4.69% of the nonmanufacturing sector's average wage. Manufacturing wage premiums for workers with

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some college or a bachelor's degree generally remain superior to those of others. Most importantly, contrary to what we might expect to find if the manufacturing labor markets were tightening, the manufacturing wage premium has tended to decline over time for workers of nearly all educational attainment levels.

Other factors making hiring challenging

We find a persistent, albeit declining, wage premium for U.S. manufacturing workers. Given this finding, how might we understand the apparent tightness in U.S. manufacturing labor markets, particularly for high-skilled workers? For one, U.S. manufacturers face extraordinary competition for high-skilled labor from offshore manufacturing employers, as well as domestic nonmanufacturing employers. In addition, manufacturing firms may face a number of challenges in recruiting talent from the pool of available workers, which the feasible wage premium may not be able to overcome. Prospective workers may be discounting employment opportunities in the U.S. manufacturing sector, since they perceive it as being in decline, with its employees all too often being subject to temporary job interruptions, underemployment, and layoffs. Also, as the numbers of potential manufacturing employees are falling, the costs of offering traditional or legacy training programs are rising for manufacturing firms. When manufacturing job numbers were very high, local schools, unions, and employers could more easily gather a sufficient number of students to make the scale of their training operations affordable.[8] With the waning of such training programs, manufacturing is losing another valuable avenue for its firms to acquire new workers.

Conclusion

According to our analysis, continued manufacturing wage premiums do not adequately explain the apparent labor tightness that manufacturers have experienced. Wage premiums actually shrunk from the early 1990s to the late 2000s, even for those workers with higher educational attainment. One possibility is that declining manufacturing job prospects may be self-reinforcing, leading to a negative image among prospective employees. If so, the pool of available workers at any given educational attainment may be inferior to that in previous times. Accordingly, U.S. manufacturers may need to increase their efforts in marketing their prospects and improving their skills certification and training programs to gain more qualified candidates.

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[1] See, e.g., Daniel Aaronson and Daniel Sullivan, 2002, "Growth in worker quality," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 174, February.

[2] See, e.g., David H. Autor, 2009, "Explaining trends in wages, work, and occupations," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 261, April; and David H. Autor, Frank Levy, and Richard J. Murnane, 2002, "Upstairs, downstairs: Computers and skills on two floors of a large bank," *Industrial and Labor Relations Review*, Vol. 55, No. 3, April, pp. 432–447.

[3] According to our calculations based on ACS data, the correlation between real hourly wages and educational attainment for manufacturing and nonmanufacturing workers is 0.40 and 0.33, respectively, over the period 2000–07.

[4] For both manufacturing and nonmanufacturing sectors, we also look at their shares of those with only a high school diploma and those with some college (figure 1, panels B and C), but all these shares stay relatively flat over the 1990–2007 period.

[5] Federal Reserve Bank of Dallas, 2008, *Opportunity Knocks: Selling Our Services to the World—2007 Annual Report*, exhibit 9, top panel, p. 24, available at www.dallasfed.org/fed/annual/2007/ar07.pdf.

[6] This is generated by dividing deflated annual income by (weeks worked times usual hours worked per week).

[7] In order to further refine skill differences, we isolate wages and experience of workers in specific occupations over the period 2000–07. On average, over all occupations, we find that the manufacturing sector paid a wage premium of $0.68 per hour, almost 2.78% of the average hourly nonmanufacturing wage.

[8] There are some ongoing initiatives that attempt to address this problem. See, e.g., http://institute.nam.org/page/edu_workforce_skills_cert.