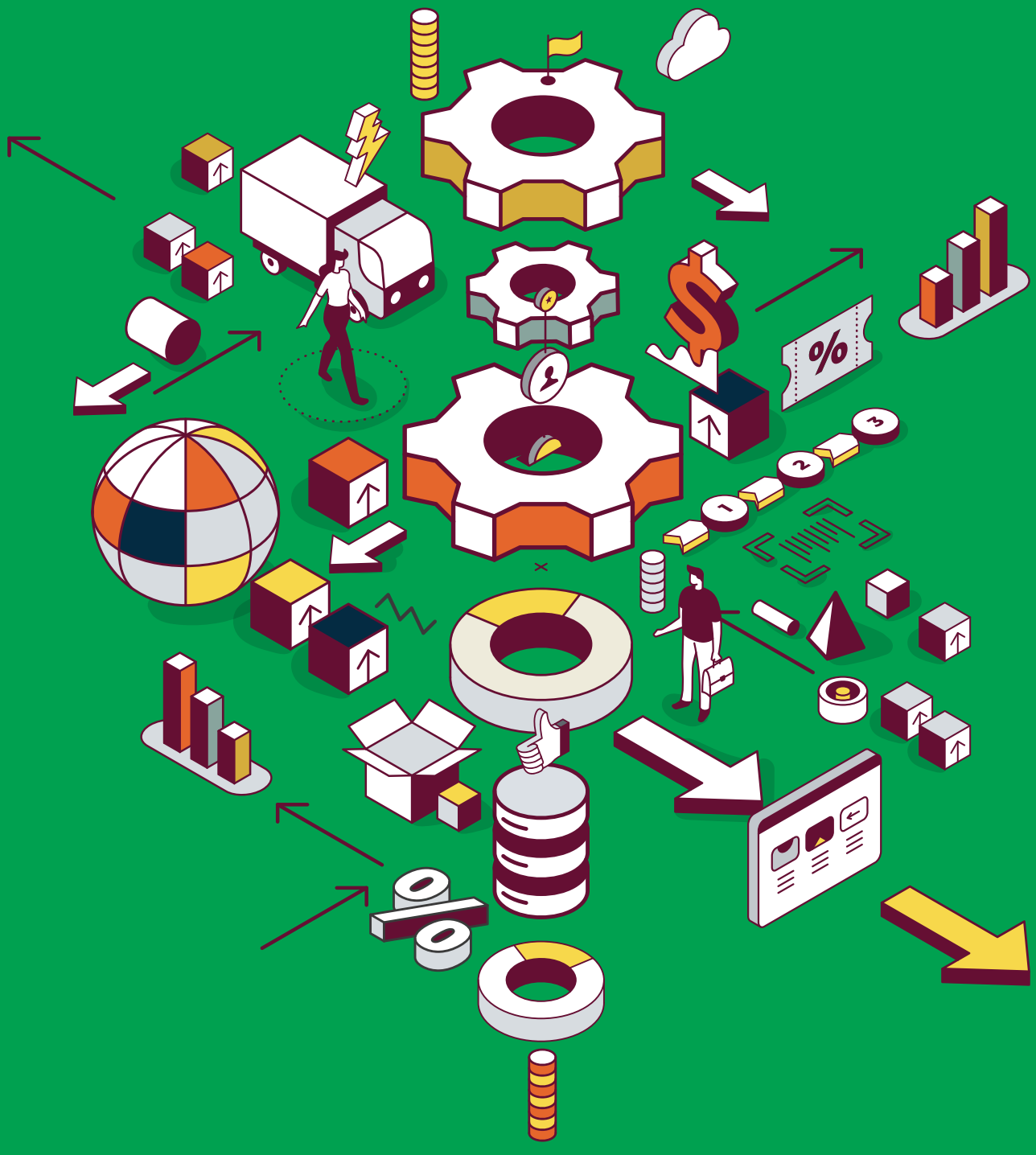
Finding Good Jobs in Manufacturing

There is a new wave of energy and investment in American manufacturing. Demand for American-made goods is growing, and job openings in manufacturing have expanded by more than 65% since 2020. In April 2022, there were more than 1 million jobs available in manufacturing.



WHERE ARE THE GOOD MANUFACTURING JOBS?

MANUFACTURING WAGES IN THE UNITED STATES

Ben Armstrong | MIT Industrial Performance Center Report | August 2022

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EXECUTIVE SUMMARY

American manufacturing has experienced a new wave of energy and investment. In the wake of the COVID-19 pandemic, market demand for U.S. manufacturers has grown, and new policies like the CHIPS and Science Act have dedicated new public investment to the future of domestic production. Despite this momentum, manufacturers have faced a persistent challenge as they seek to grow: recruiting and retaining the next generation of manufacturing workers.

In response, educational institutions, as well as state and local governments, have focused on building a pipeline of skilled manufacturing workers that can meet industry demand. Three key stakeholders in building this pipeline are i) workers and career counselors, ii) training institutions, and iii) manufacturing firms. Each faces a central question about their respective roles in the labor market:

FOR WORKERS AND CAREER COUNSELORS: where are the jobs with the highest wages and best opportunities for upward mobility?

Although real manufacturing wages have been flat, some manufacturing occupations and manufacturing industries offer high-wage job opportunities with upward mobility. Production jobs requiring more technical skills and training, as well as positions operating precision equipment, typically pay more than jobs in assembly departments or more typical machine operator roles. By industry, jobs in engineering-intensive sectors like aerospace, chemicals, and semiconductor manufacturing pay far more than comparable jobs in less engineering-intensive industries.

FOR TRAINING INSTITUTIONS: what skills can we provide that help workers enter higher-paying jobs?

Wages for manufacturing jobs vary widely, and training institutions can focus workforce development programs on the skills required to fill the highest-wage positions. However, some of these high-wage positions value additional training differently than others. The manufacturing roles with the highest "education premium," or additional wages for workers with years of training beyond high school, are assembly workers and positions in chemicals and semiconductor manufacturing, where production workers with more than a high school degree make on average 20% more than those with a high school degree or less. High-impact training programs might also help students transition into higher-wage positions or industries within manufacturing.

FOR MANUFACTURING FIRMS: what wages, training, and technology should employers offer to recruit and retain a competitive workforce?

Prevailing wages by occupation, industry, and education level can offer employers a partial guide to understanding how to compete for manufacturing workers. However, an employer's wage strategy might depend on other factors, such as expected turnover, skill needs, and performance incentives. Firms that expect high turnover might offer higher wages without significant opportunities for upward mobility. An alternative employer strategy is to emphasize opportunities for skill development, wage growth, and performance-based bonuses.

PART I: MOTIVATION

Over the past decade, there has been slow but steady growth in U.S. manufacturing jobs. American factory employment grew by approximately 12% between 2010 and 2019, the first such expansion in since the 1970s. Demand for U.S. manufacturing jobs accelerated after the onset of COVID-19, when shortages of critical supplies galvanized business and government sentiment around strengthening U.S. manufacturing capabilities. Public policy investment has followed with the passage of new state and federal subsidies for manufacturers looking to expand manufacturing capabilities in critical sectors.

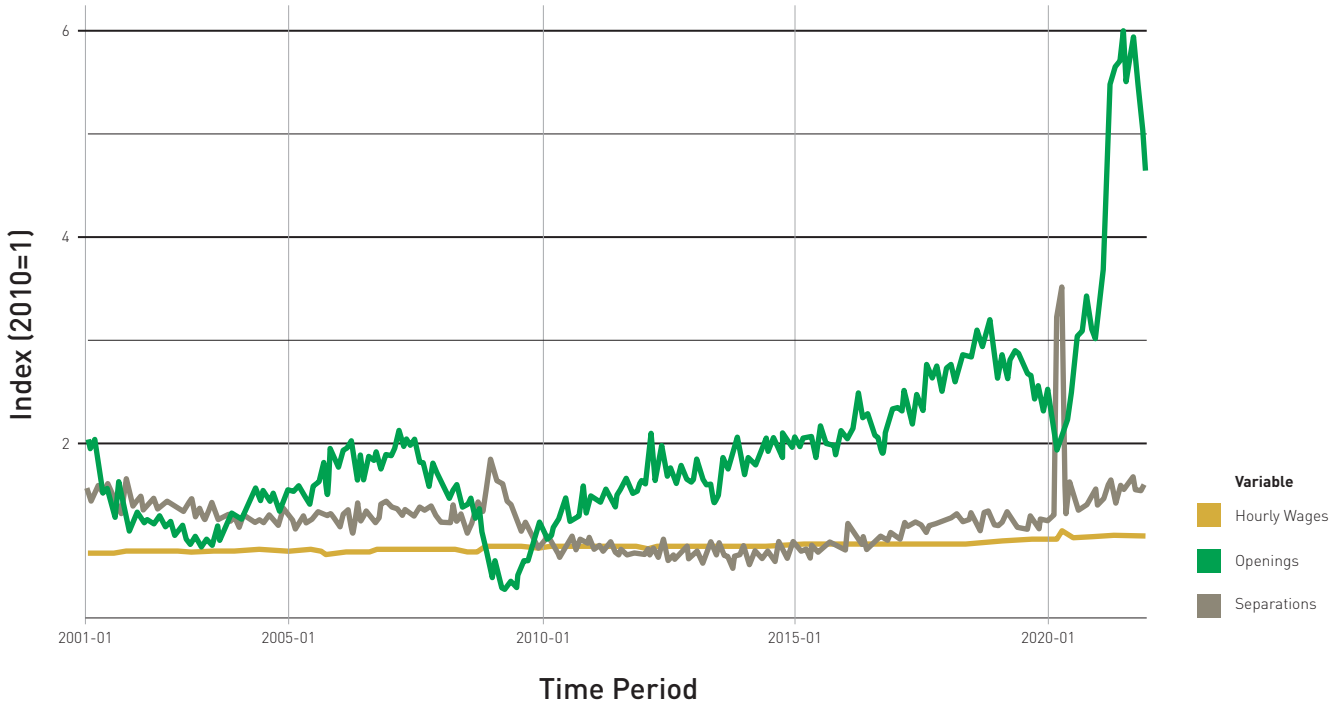
Although these are reasons to be bullish about the prospects of American manufacturing, there are significant barriers to rebuilding domestic manufacturing capabilities. Principal among them is recruiting and retaining a skilled manufacturing workforce.

ADDRESSING WORKFORCE CHALLENGES IS KEY FOR U.S. MANUFACTURING COMPETITIVENESS

The manufacturing workforce challenge has three key symptoms. First, the number of job openings in manufacturing has been growing dramatically. Between 2010 and 2019, as manufacturing employment was expanding, job openings were growing even faster. Manufacturing job openings in 2019 were triple what they were in 2010. And manufacturing job openings in 2021 were double what they were in 2019. Notably, the growth in job openings has far outpaced the growth of job separations, or the number of people leaving their manufacturing jobs. This pattern suggests that the demand for U.S. manufacturing work has been growing faster than U.S. manufacturers can hire (see Figure 1).

Figure 1

Job Openings in Manufacturing

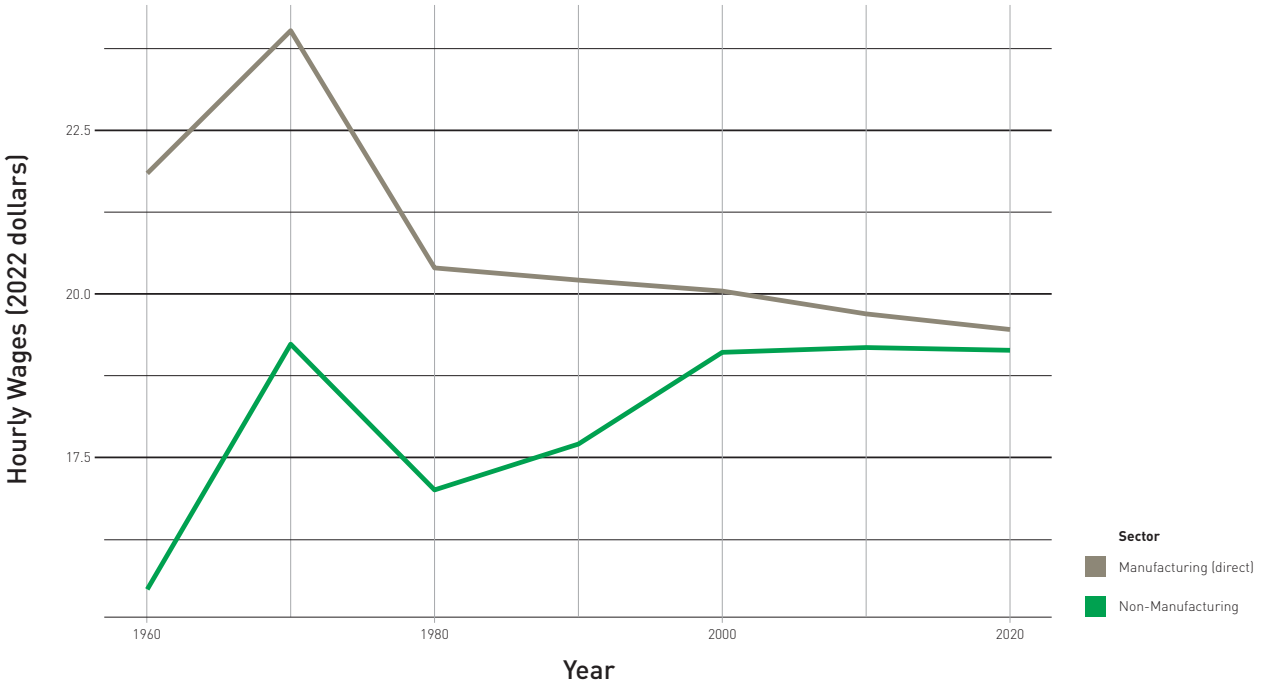


The second symptom is increasing turnover among manufacturing employees. Between 2010 and 2022, the share of manufacturing workers quitting their jobs has more than doubled. The growth in turnover rose steadily before the pandemic, accelerating after 2020. The growth in manufacturing turnover matters because manufacturing employers – particularly small and medium enterprises – invest in on-the-job training. In interviews, manufacturing employers consistently report that it takes between one and three years before a production worker becomes fully self-sufficient in their role. Given this commitment, an increase in turnover can prove costly for employers that invest in training their production workers with less confidence that those workers will remain in their roles long enough to be self-sufficient.

The third symptom is slow wage growth for manufacturing workers without a college degree. Although some manufacturing workers have experienced wage growth since 2000, particularly college-educated engineers and front-office workers, there has not been substantial inflation-adjusted wage growth for production workers without a college degree. From one perspective, it might appear that slow wage growth in manufacturing is a positive sign for the competitiveness of U.S. manufacturers, which have faced increasing competition from low-wage markets like China and Vietnam in the past two decades. However, slow wage growth has also contributed to manufacturers' challenges of recruiting and retaining a production workforce.

Figure 2.

The Shrinking Manufacturing Wage Premium

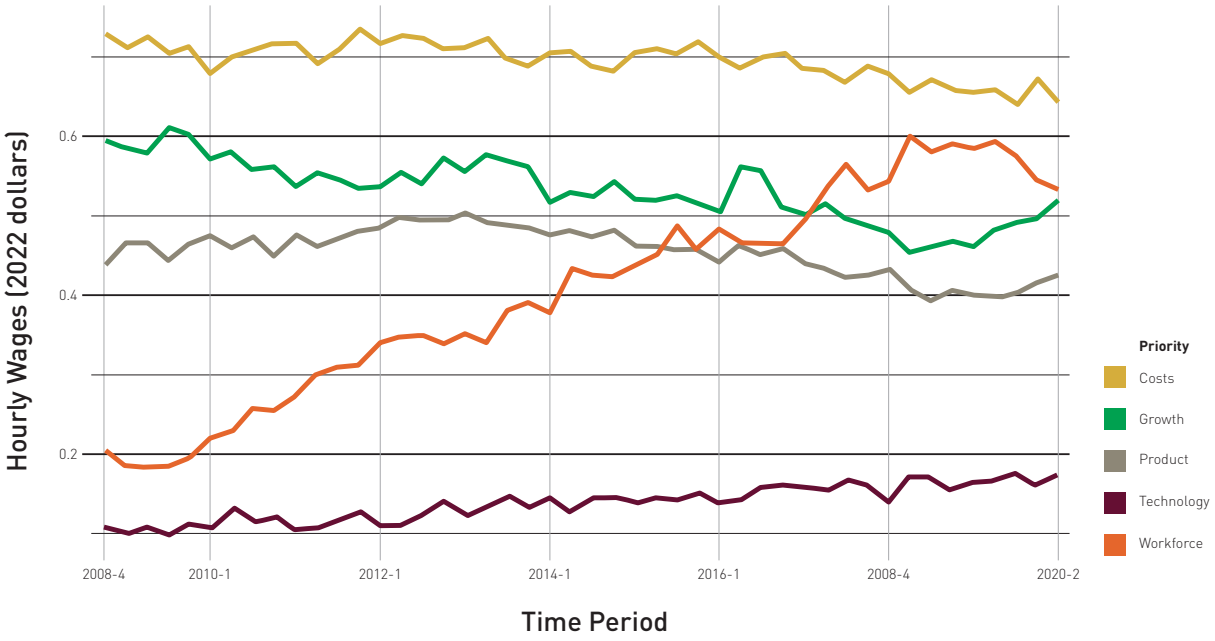


In 1960, a factory job paid 41% more on an hourly basis than a job outside manufacturing for workers without a college degree. The wage premium for factory jobs has steadily decreased, reaching a level of only 1.7% by 2020 (see Figure 2). The shrinking manufacturing wage premium helps explain why recruiting and retaining talent has become so challenging. It is not only that manufacturing jobs are perceived as dull, dirty, and dangerous, as advocates of manufacturing jobs often assert. It is also that manufacturing jobs do not offer the same bonus over rival jobs that they once did.

Many manufacturers have recognized the workforce challenge and are trying to address it. Among small and medium manufacturing firms, workforce issues have been a growing priority when compared to other critical challenges like keeping costs low and identifying growth opportunities. In survey data from the national Manufacturing Extension Partnership network, workforce issues were a top-three priority among only 20% of firms in the 2008-2009 period. Before the pandemic, in 2018-2019, a majority of responding firms ranked workforce challenges among their top priorities (see Figure 3). Large manufacturers have ranked workforce issues as a similarly high priority. Before the onset of the COVID-19 pandemic, in the third quarter of 2019 the National Association of Manufacturers' survey of its members found that attracting and retaining a quality workforce was the top concern facing large U.S. manufacturers.[i]

Figure 3.

SME Manufacturer Priorities



TRAINING IS A CENTRAL INGREDIENT TO ADDRESSING WORKFORCE CHALLENGES.

Policymakers, manufacturing advocates, and educational institutions have responded to workforce challenges by designing new programs and campaigns to recruit a new generation to become manufacturing workers. These campaigns frequently emphasize the excitement of new and advanced manufacturing jobs in contrast to the "dull, dirty, and dangerous" manufacturing jobs of the past. They offer training that promises to provide the skills to match young and eager workers with firms looking to hire and promote. The theory behind these programs is that the supply of manufacturing workers has not met firms' demand because there is not enough information available about the quality of manufacturing jobs – or affordable training options to prepare prospective workers to thrive in manufacturing careers.

Model programs include the Alliance for Working Together in Ohio, which provides high school manufacturing technology programs to excite regional students about manufacturing; Ivy Tech manufacturing programs in Indiana, which provide specialized training in advanced technology sectors; and Apprenticeship SC in South Carolina, which connects trainees with regional employers so they can begin working while they continue to develop industry-relevant skills in the classroom.[ii] The new MassBridge initiative in Massachusetts combines elements of these types of training efforts: *recruiting* students into manufacturing careers; *launching educational* curricula to prepare students for advanced manufacturing jobs; and *coordinating with industry* to ensure that the manufacturing skills these programs provide meet the needs of Massachusetts employers.

A COLLECTIVE APPROACH CAN MAKE WORKFORCE TRAINING EFFICIENT AND SCALABLE.

The evidence supporting workforce training in manufacturing is mixed. Some SME manufacturers have been critical of community college manufacturing training programs, claiming that they do not provide the skills that their employees need to succeed. For example, in some cases community college programs have emphasized the skills to operate advanced technologies, while only a small share of local firms actually have those technologies. Firms looking to hire are more interested in providing training tailored to their production processes and their current equipment.

When workforce programs at the national level have been evaluated, the results have been unimpressive. Trainees who have experienced workforce development assistance through federal programs like WIOA or TAA have not had significantly better workforce outcomes than individuals who have not participated in these programs.

However, there are both theoretical and practical reasons to invest in collective workforce training programs that build a pipeline of talent for many firms in a region. The main theoretical reason is that workforce training is best provided as a public good. Economists show that when training is left to employers, firms will underinvest in workforce training, which can result in a workforce that is not equipped to drive productivity gains and innovation within an industry.[iii] Firms underinvest because if firms make full investments in private training, then competing firms could poach the skilled workers that the investing firm had trained. It could even make sense for the competing firm to offer the skilled worker even higher pay than the original firm could afford because the competing firm did not make any investment in training.

Also, although employers are generally aware of the skills that they need to fill roles, manufacturing firms are not training experts. In interviews, firms frequently report an informal on-the-job training process that requires experienced production workers to take time away from their tasks to train junior colleagues. This process detracts from the firm's productivity compared to a training program where experienced instructors provide similar training in a purely educational setting.

There is also recent empirical evidence that collective training programs can help address firms' challenges recruiting and retaining workers without a college degree. A series of studies have detailed the effectiveness of the "sector partnership" training model in which industry groups partner with educational non-profits to set workforce development curricula that develop skills in common to multiple employers in a particular region. The educational non-profit recruits workers into the training program, provides career counseling, and places the trainee in a job. After the trainee is placed in the job, the educational non-profit continues to meet with the employer and the trainee to ensure that the employee is thriving in their role and the employer is satisfied.[iv] At this point, the role of the non-profit is not to provide new skills, but to serve as a social service organization to ensure that the trainee is showing up to work on time, able to manage family challenges, and can perform reliably in their job. Interviews with manufacturing employers indicate that this social service role is critical to employee retention, and many firms take on these functions themselves, even with limited Human Resources operations.

COORDINATION IN TRAINING IS NECESSARY, BUT MUST TARGET GOOD JOBS AND HIGH-IMPACT INDUSTRIES TO BE EFFICIENT.

The sector partnership model provides a framework for developing training that serves employees and employers, but it is not immediately clear how to implement such a model successfully in a regional manufacturing ecosystem. On what jobs should the training program focus? Which employers should it recruit to participate? How will the training program make the case to prospective manufacturing workers to participate?

Three baseline assumptions can help guide the answers to these questions. First, workers will be more likely to participate in training programs that prepare them for higher-wage jobs and upwardly-mobile careers. Thus, manufacturing training programs should identify manufacturing occupations that pay comparatively high wages with opportunities for wage growth over time.

Second, some manufacturing occupations and industry will reward additional training and skill development more than others, and training programs should aim to deliver the highest "wage premium" – the percent difference in wages between someone with training and someone without training – for their graduates. A controlled way of estimating the wage premium for different training programs would be to compare an individual's wages before and after training in the same role at the same firm. However, since individuals might not return to their same position or firm after training, the available data to understand the impact of training are far messier. A simple estimate with available data would compare the wages for workers in the same occupation with and without training beyond a high school degree.

Third, manufacturing employers will be most likely to hire from training programs that can place graduates in positions with high or growing demand. Although it is difficult to determine the exact occupations where jobs are particularly hard to fill, it is clear which manufacturing occupations have grown over time in each industry. A training program might focus on occupations in industries where the share of jobs for that occupation is increasing.

The next section introduces data on the manufacturing labor market – including manufacturing wages, wage premia, and the skill composition of manufacturing occupations – that can assist training programs in answering these questions.

PART II: LABOR MARKET DATA

Policymakers and commentators typically refer to "manufacturing" as a single industry and "manufacturing jobs" as a monolith, but manufacturing occupations and industries vary widely in their growth rates, wage rates, and skill requirements. There is not one prevailing wage for manufacturing work, but different wages for different occupations in different industries in different regions. To inform training programs aiming to target high wage jobs, as well as industries where demand for those jobs is growing, data in this section compare the labor market for different jobs in different industries for individuals with different levels of education.

This report examines the differences in hourly wages for manufacturing workers by occupation, industry, experience, education, and geography. The purpose of this analysis is to understand the factors that differentiate higher-paying manufacturing jobs from lower-paying ones. The data behind the analysis are from the American Community Survey, which gathers income, occupational, and other social information from a 1% sample of the population each year. The analysis focuses on a five-year period (2017-2021) to include more individuals in the sample and gain more confidence in the wage estimates.[v]

The analysis groups occupations and industries into categories based on previous manufacturing and labor market research. It uses five primary categories for manufacturing workers, which are derived from David Dorn's categorization of American occupations (based partly on the Census occupational categories). The categories are "assemblers," "operators" of production equipment, "technicians," "precision" production workers, and "engineers." There is of course variation within these categories, but the occupational classification in the Census (as well as in Dorn's work) aims to group occupations with similar tasks in each of these categories. The industries included in the analysis are based on NAICS codes, typical industry categories, and are based on the eight strategically important industries from MIT's *Made in America* study, as well as several select additions that correspond to other segments of the NAICS categorization. The twelve focus industries are "aero," "auto," "chemicals," "chips," "computers," "electrical," "food," "machines," "metals," "pharma," "textiles," and "wood_paper." For more details, see www.benarmstrong.work/data.

WAGES FOR FACTORY WORKERS VARY WIDELY. WORKERS PERFORMING TECHNICAL AND PRECISION TASKS MAKING THE HIGHEST WAGES.

Manufacturing wages roughly divide into three tiers based on tasks and wages. The lowest-tier jobs, which typically require the most manual and repetitive tasks are assembly and operator roles. These occupational categories include specific roles like "lathe, milling, and turning machine operatives" and "molders and casting machine operators" in the "operator" category, and "assemblers of electrical equipment" and "production checkers, graders, and sorters in manufacturing" in the "assemblers" category. Jobs like these earn the lowest median wages of $17.88 per hour for assembly workers and $18.43 per hour for operator jobs. These wages vary slightly by age and education. The lower 25% of assembly workers make below $13.13 per hour and the upper 25% of assembly workers make above $24.42 per hour. Jobs in this tier comprise approximately 23% of the manufacturing workforce (14.4% operators, 9% assemblers). The majority of workers in these categories have a high school degree or less. Approximately 69% of assembly workers in manufacturing have a high school degree or less, and 74% of operators in manufacturing have a high school degree or less.

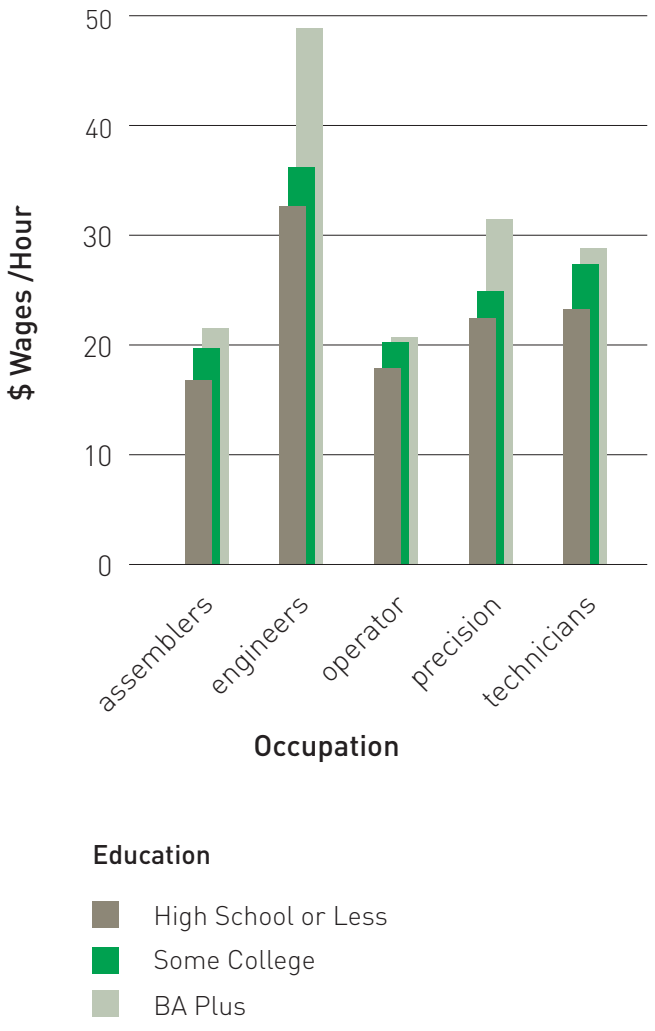
The middle-tier manufacturing jobs are technician and precision roles, which have median wages that are several dollars higher per hour than typical assembly and operator roles. Sample "precision production occupations" include "machinists," "tool and die makers and die setters," and "production supervisors or foremen," whereas technician roles include "engineering technicians" and "programmers or numerically controlled machine tools," for example. The median hourly wage for precision workers is $23.72, and the median hourly wages for technicians is $25.71. The lowest-paid 25% of technicians make below $19.17 per hour, and the highest-paid 25% of technicians make more than $33.91 per hour. Precision workers make up 10% of the manufacturing workforce, and technicians make up 2.2% of the manufacturing workforce. Technicians and precision production workers are more likely to have advanced education than operators and assembly workers. Less than two in three (64%) precision production workers have a high school degree or less, and less than half (46%) of technicians have a high school degree or less.

The highest-tier manufacturing jobs, which are not consistently considered production jobs, are engineering roles, which include various occupations such as "aerospace engineers" and "industrial engineers," as well as "computer systems analysts and computer scientists."

Although engineering roles are typically associated with a college degree holders, a sizable minority (23%) of engineers in manufacturing industries have less than a college degree. Among engineers with only some college, the median wage is $36.21 per hour, more than double the median wage of an assembly worker. Lower-wage engineers (bottom 25%) with some college education make below $26.95 per hour, and the highest-wage engineers with some college (upper 25%) make more than $46.93 per hour. Engineers are approximately 10% of the manufacturing workforce.

Figure 4.

Education Premium for Manufacturing Jobs



THE "EDUCATION PREMIUM" IN MANUFACTURING IS HIGHEST FOR TECHNICIAN AND ASSEMBLY POSITIONS.

There is an education premium, or higher wages associated with higher levels of education,for each of the five categories of manufacturing jobs (see Figure 5).The highest education premia in percentage terms are in assembly jobs, where workers with more than a high school degree but less than a college degree make 17% more per hour than workers with only a high school degree. Workers in technician roles with more than a high school degree but less than four years of college also make substantially more – 16% more per hour – than technicians with a high school degree or less. Workers with "some college" in engineering, operator, and precision production jobs also earn an education premium over their colleagues with a high school degree or less. Engineers with "some college" earn 9% more; precision production workers earn 11% more; and operators earn 13% more per hour.

In assembly, operator, and technician jobs, the wage gap between workers with "some college" and a college degree or more is smaller than the wage gap between workers with "some college" and a high school degree or less. For these roles, the advantage of a college degree appears smaller than the advantage of having some additional education beyond high school. For precision production and engineering roles, however, the opposite is true. The wage premium of a college education in these roles is substantial: engineers with a college degree earn 35% more than engineers with just "some college," and precision production workers with a college degree earn 26% more per hour than their peers with "some college."

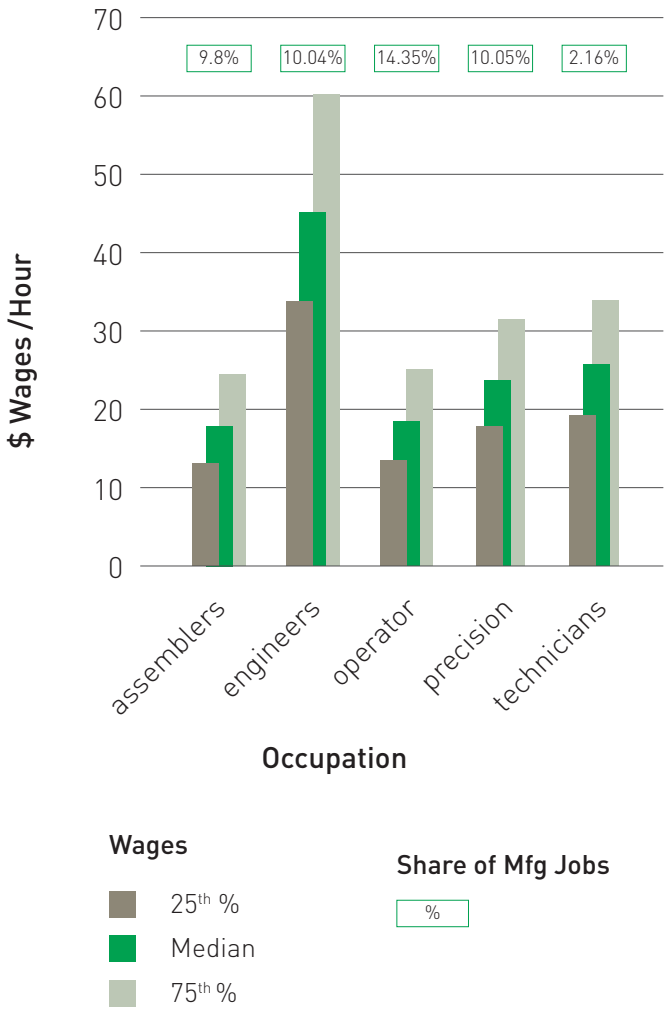
There are three potential explanations for the varying education premia by occupation. One reason why manufacturing workers with some college earn more than workers with a high school degree or less is because employers value their additional educational experience, and the workers are in turn able to demand higher wages. However, the skills associated with higher education may not be the only reason why there is an "education premium" for manufacturing occupations. In interviews with employers, many report training workers with a high school degree to develop specific skills on the job that employers say community colleges cannot teach.

A second potential reason why workers with "some college" might earn more is if these workers are more likely to be older and perhaps have more work experience. However, the median age of manufacturing workers with a high school degree or less is *older* across all five occupational categories. Assemblers with some college, for example, have a median age of 43 compared to a or less. Operators with some college have a median age of 42 compared to a median age of 46 among those with a high school degree or less. Given that workers with "some college" are younger *and* earning more than their counterparts with a high school degree or less suggests that the education premia in Figure 5 could be under-estimates.

The third potential explanation for the education premia is that the manufacturing industries more likely to hire workers with education beyond high school are also industries with higher market wages. In this case, the education premia would reflect an "industry premium" more than a benefit of specific skills. As the next section will show, some industries do indeed offer higher education premia than others, but even within manufacturing industries, workers with more education tend to earn higher median wages than workers with less education.

Figure 5.

Manufacturing Wages by Education Level

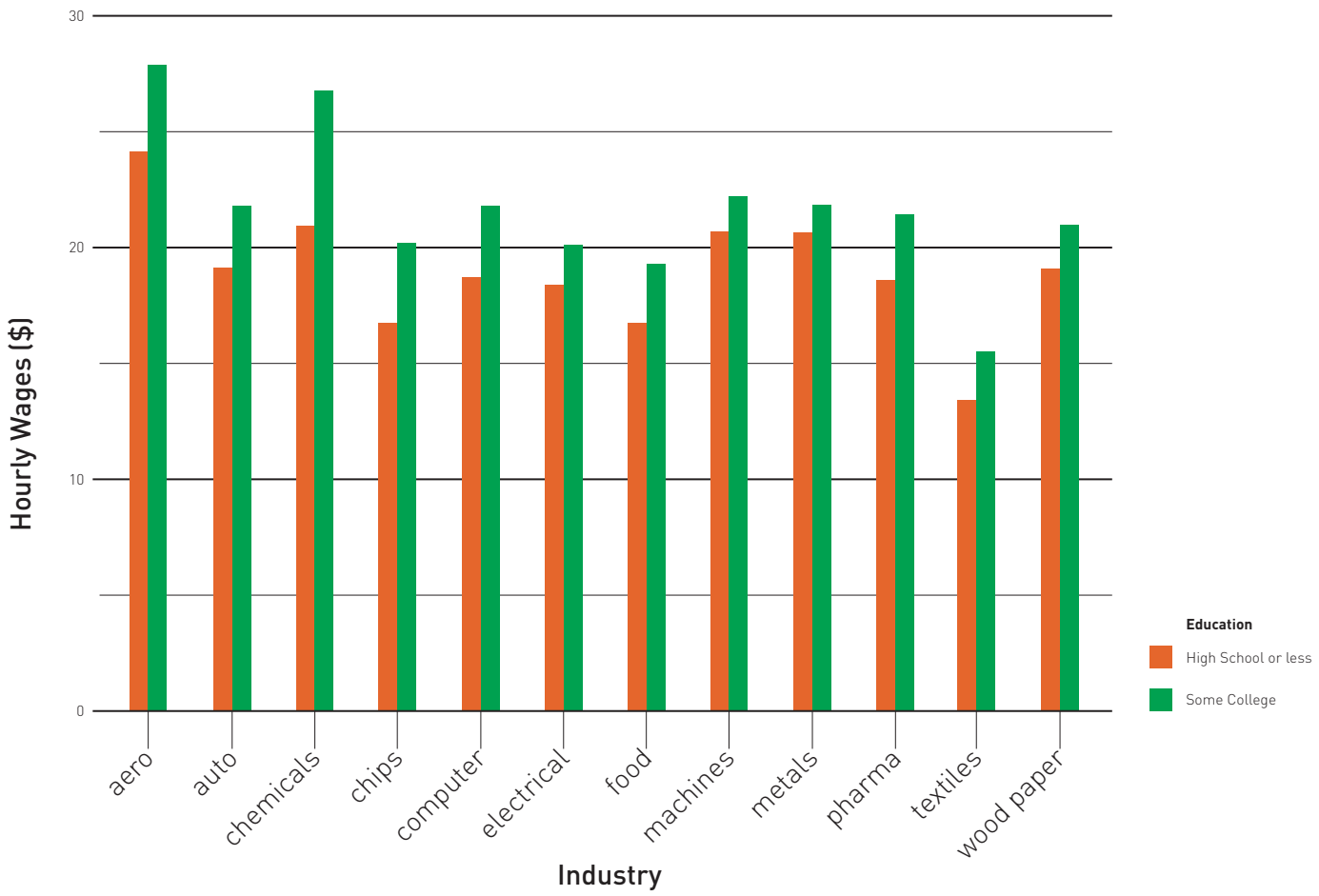


MANUFACTURING INDUSTRIES LIKE CHEMICALS AND COMPUTERS MANUFACTURING STAND OUT FOR THEIR HIGH EDUCATIONAL PREMIUM, AS WELL AS THEIR HIGH MEDIAN WAGES ACROSS MANUFACTURING OCCUPATIONS.

Workers with more education earn higher wages within each of the key twelve manufacturing industries in the study. The educational premium within industries like chemicals manufacturing (where the educational premium is more than 26%) and chips (semiconductor) manufacturing (where the educational premium is more than 20%) are far higher than the educational premium of individual occupations and other industries, such as metals, where workers with more advanced education earn only 6% more than workers with a high school degree or less.

Figure 6.

Manufacturing Wages by Industry and Education Level



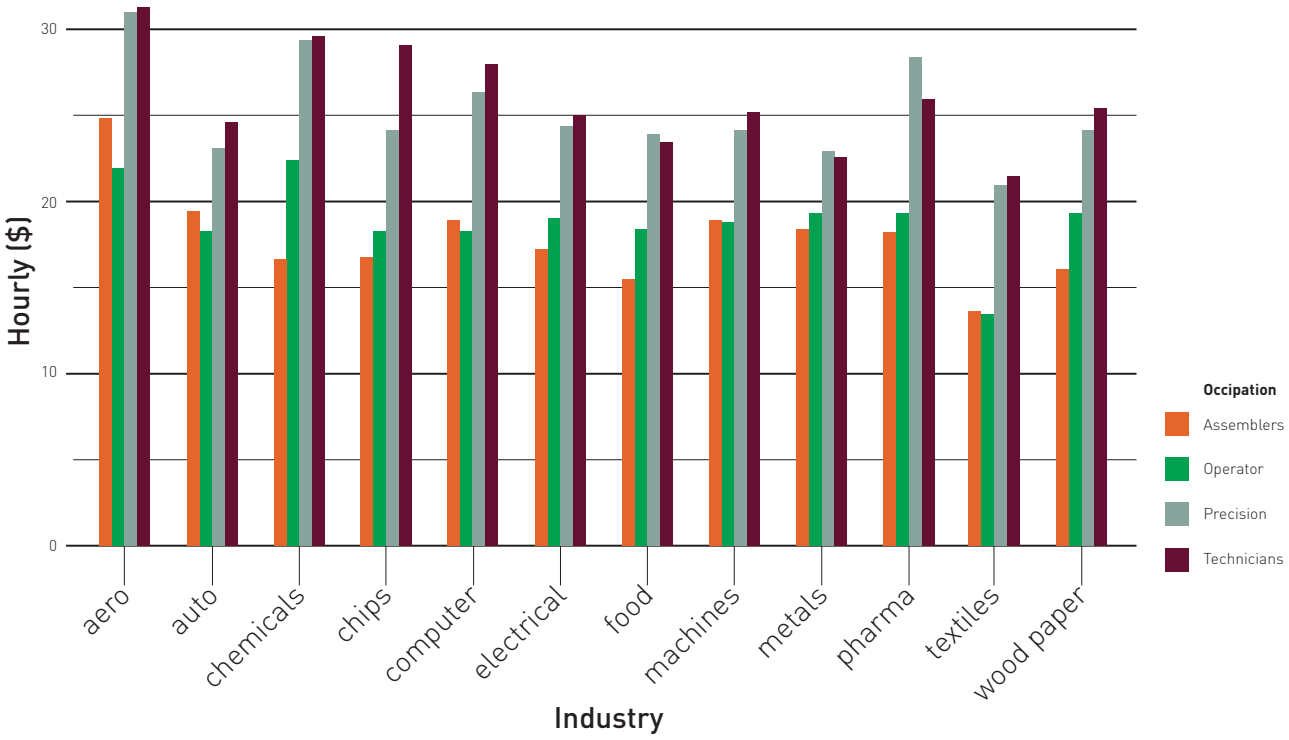
MANUFACTURING WORKERS IN INDUSTRIES LIKE AEROSPACE, CHEMICALS, AND MICROELECTRONICS MAKE FAR HIGHER WAGES THAN THE MEDIAN MANUFACTURING WORKER IN THEIR RESPECTIVE OCCUPATIONS.

Manufacturing workers' wages vary sharply by the industry in which they are employed. Figure 7 illustrates the median wage for manufacturing occupations (excluding engineers) across twelve key industries. The figure highlights the gap between lower-tier and middle-tier manufacturing occupations, which is frequently greater than $5 per hour, as well as the differences between (and within) industries. The figure shows that some of the highest-wage operator and assembly positions have parallel wages with some of the lowest-wage precision production and technician positions.

A dramatic illustration is the gap between manufacturing workers in aerospace (the highest-wage industry) and manufacturing workers in textiles (the lowest-wage industry). Although assembly workers are typically in the lowest-wage tier of manufacturing workers, the median wage of an assembly worker in aerospace is $24.83 per hour, which is higher than a median precision production worker or a technician in the textiles industry, who make $20.95 and $21.47 per hour respectively.

Figure 7.

Manufacturing Wages by Occupation and Industry



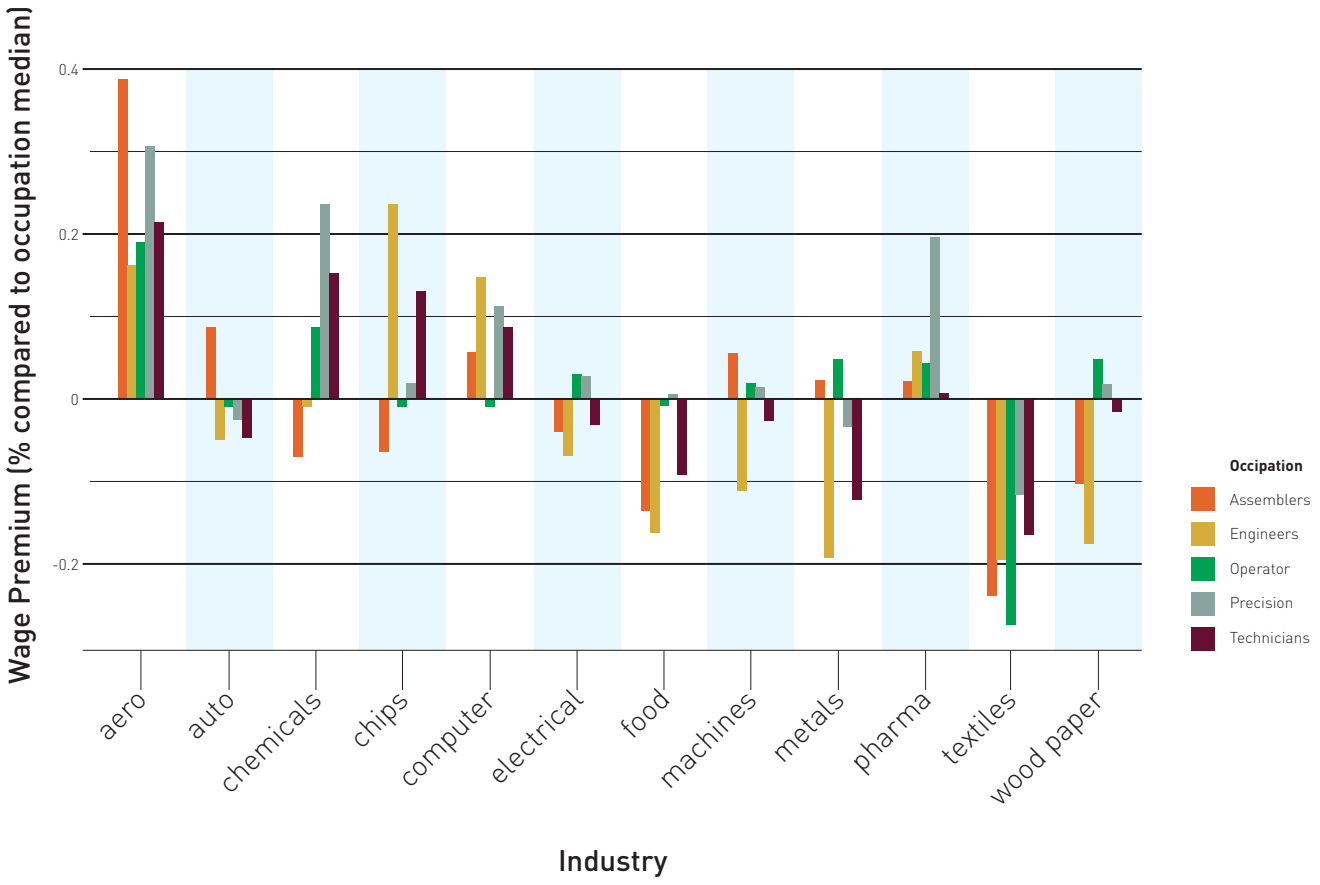
MANUFACTURING OCCUPATIONS IN SOME INDUSTRIES STAND OUT FOR THEIR WAGE PREMIUM.

Figure 8 shows how individual manufacturing occupations within each industry compare to the median wage for that industry. The bars above the 0.0 horizontal line represent an occupation in an industry with a median wage above the expected median wage in the industry as a whole. For example, the upward pointing blue bar on the right side of the figure indicates that precision production workers (as indicated in blue) in pharmaceutical manufacturing make approximately 20% more per hour than the median hourly wage for precision production workers.

In other industries where the wage premium is generally high, like chemicals manufacturing, some occupations do not earn a wage premium. Assembly jobs in chemicals manufacturing, for example, make less than the median wage for assembly workers. These additional data illustrate how occupation *and* industry wage data can reveal more than either occupational wages or industry wages do on their own. Figure A.1 shows the wage range of occupations in select industries.

Figure 8.

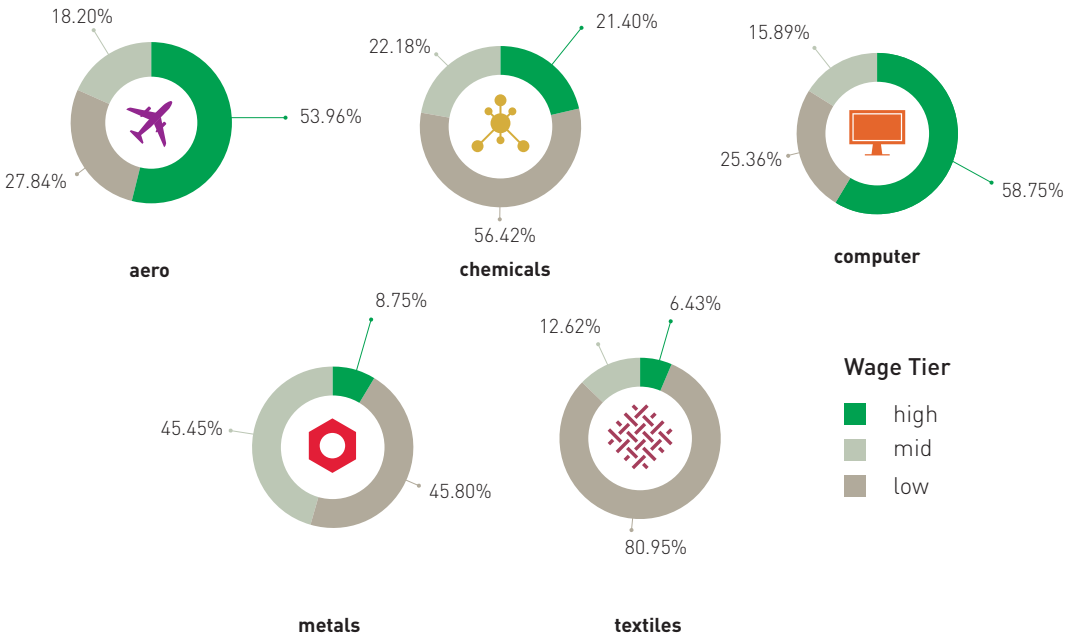
Wage Premium for Occupation Categories by Industry



THE HIGHEST-WAGE MANUFACTURING SECTORS ARE ALSO THE MOST ENGINEERING-INTENSIVE SECTORS, INCLUDING AEROSPACE AND COMPUTER MANUFACTURING

The composition of occupations within each manufacturing sector varies sharply. Recall that engineers comprise 10% of manufacturing employment overall, whereas low-wage production occupations comprise 23.4% (middlewage production occupations amount to 12.2% of all manufacturing occupations). Four of the twelve manufacturing sectors – aerospace, semiconductor, computer, and pharmaceutical manufacturing – have a disproportionately large share of engineers compared to occupations in the middle-wage and lower-wage tiers. In six manufacturing sectors – automotive, chemicals, electrical, food, textiles, and wood and paper manufacturing – more than half of the manufacturing workers in the three tiers are assembly workers and operators in the lowest-wage tiers are disproportionately large. For two sectors – machine and metals manufacturing – middle-wage occupations including technicians and precision production workers are disproportionately represented, although not nearly as concentrated as engineers are in aerospace, semiconductor, or computer manufacturing, for example.

Figure 9.
Share of Manufacturing Jobs by Wage Tier

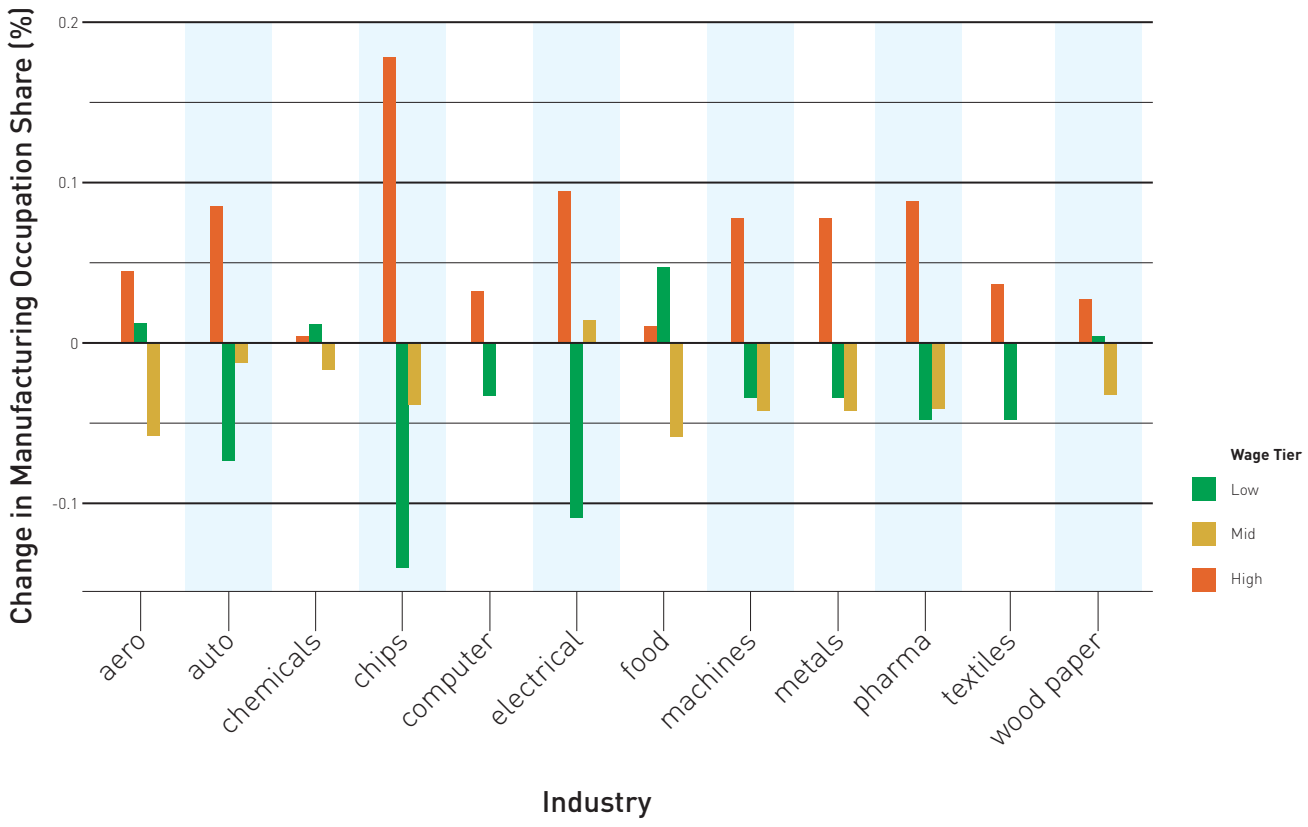


DEMAND FOR ENGINEERING ROLES IS INCREASING AND DEMAND FOR LOWER TIER MANUFACTURING OCCUPATIONS IS DECREASING.

In many industries, the composition of occupations has changed significantly in the past twenty years. Between 2000 and the period of focus in this study (2017-2021), the share of engineers grew in each of the twelve manufacturing sectors with the share of engineers growing fastest in the semiconductor manufacturing sector. Demand for the lowest-wage tier occupations decreased in most manufacturing sectors.

Figure 10.

Demand for Manufacturing Occupations by Industry

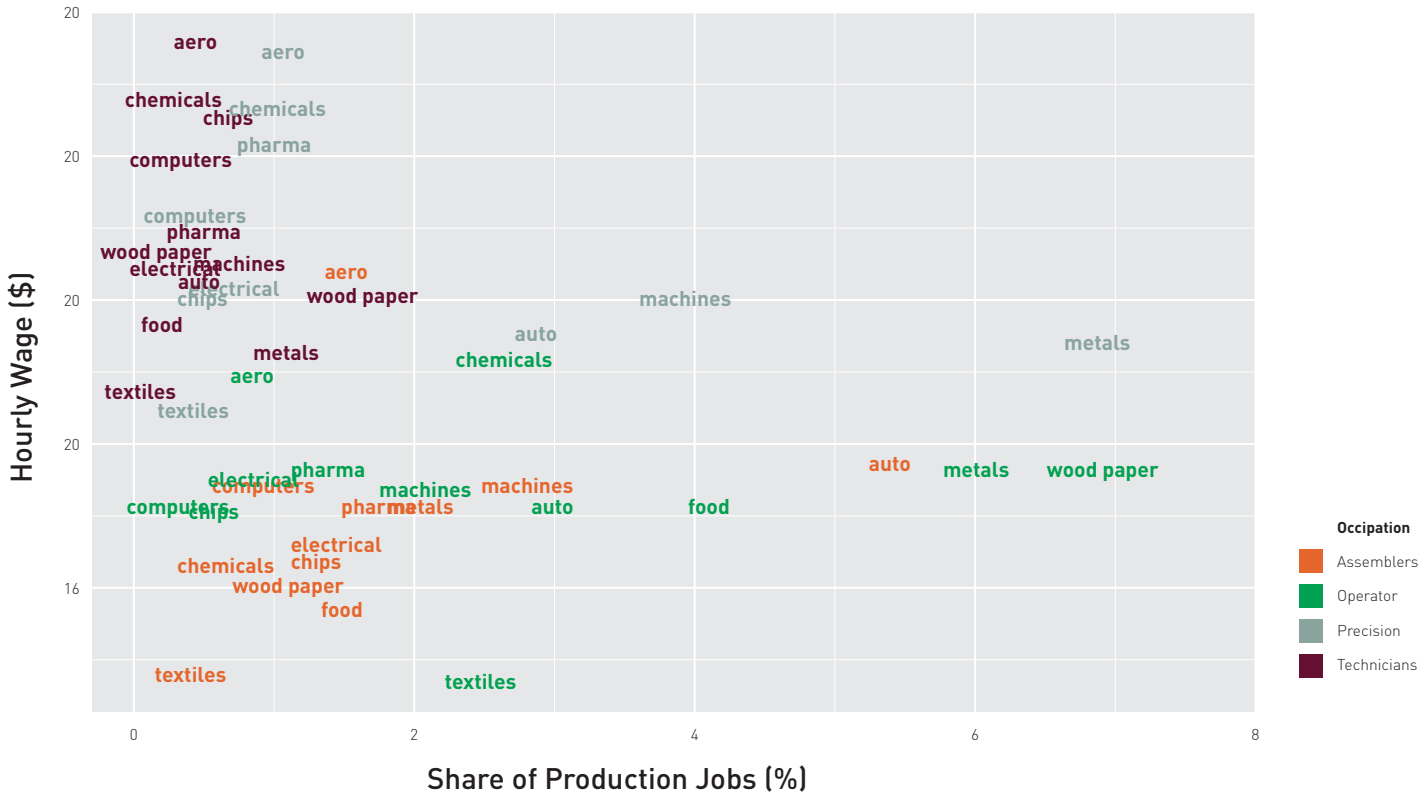


MANY OF THE HIGH-WAGE MANUFACTURING JOBS ARE COMPARATIVELY SCARCE, ALTHOUGH SOME MIDDLE-TIER JOBS IN METALS, MACHINE, AND AUTO MANUFACTURING ARE MORE WIDELY AVAILABLE.

Figure 11 plots manufacturing occupations in the twelve industries according to their median wages and their share of production jobs overall. High-wage jobs that are in abundance in the labor market would show up in the upper-right portion of the figure. Jobs with low wages and comparative abundance would be in the lower right portion of the figure. The figure helps put the high-wage industries and occupations in context. The middle-wage tier of production occupations – precision production and technician jobs – are concentrated in the upper left of the figure. These jobs are comparatively high-wage, but also comparatively scarce. There are no jobs that stand out in the upper right portion of the figure, but jobs in the middle and middle-right include precision production roles in automotive, machine, and metals manufacturing, as well as operator roles in chemicals manufacturing. These jobs pay more than $22.50 per hour and comprise more than 2% of the production workforce.

Figure 11.

Manufacturing Wages and Job Availability

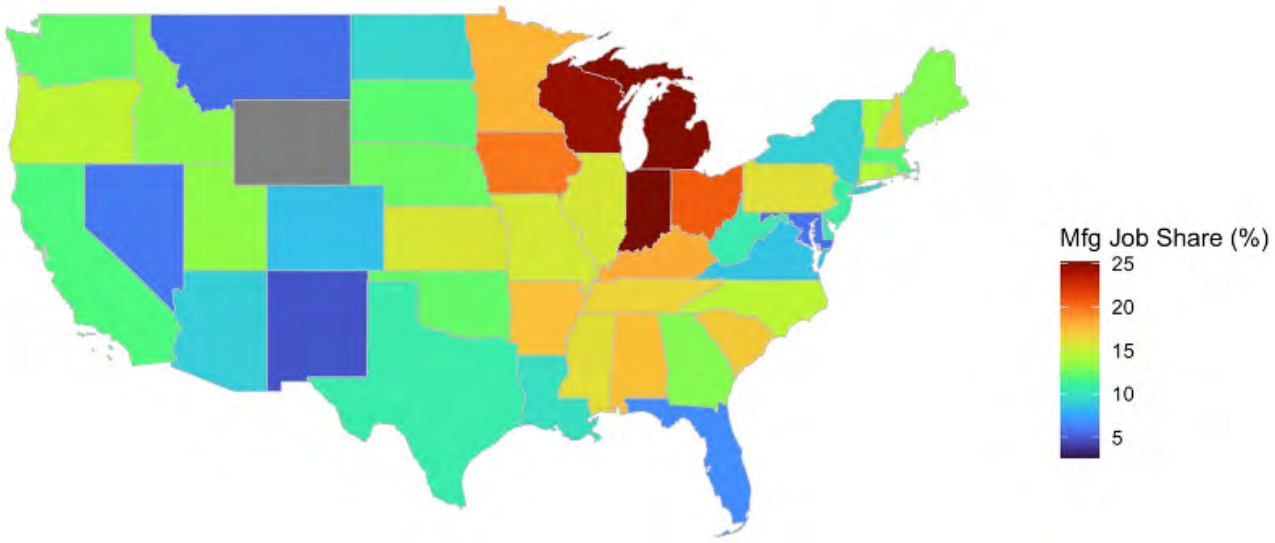


THE AVAILABILITY AND WAGES OF MANUFACTURING JOBS VARY BY GEOGRAPHY.

In the United States and throughout the world, manufacturing jobs and industries have clustered in some regions more than others. Historically, the concentration of certain manufacturing activities has been linked to natural resources and infrastructure (e.g. proximity to lakes, canals, and railroads) or individual entrepreneurs who established businesses in one region, and related businesses blossomed nearby (e.g. William Shockley and the semiconductor industry in Silicon Valley). Although these factors remain important for explaining the clustering of manufacturing activities, the concentration of manufacturing activities has been increasingly associated with the available skills in a region, as well as the associated educational and research institutions. As the maps below indicate, the concentration of manufacturing jobs in advanced technology industries like aerospace and computer production are not the same places where manufacturing jobs overall are most concentrated.

Figure 12.

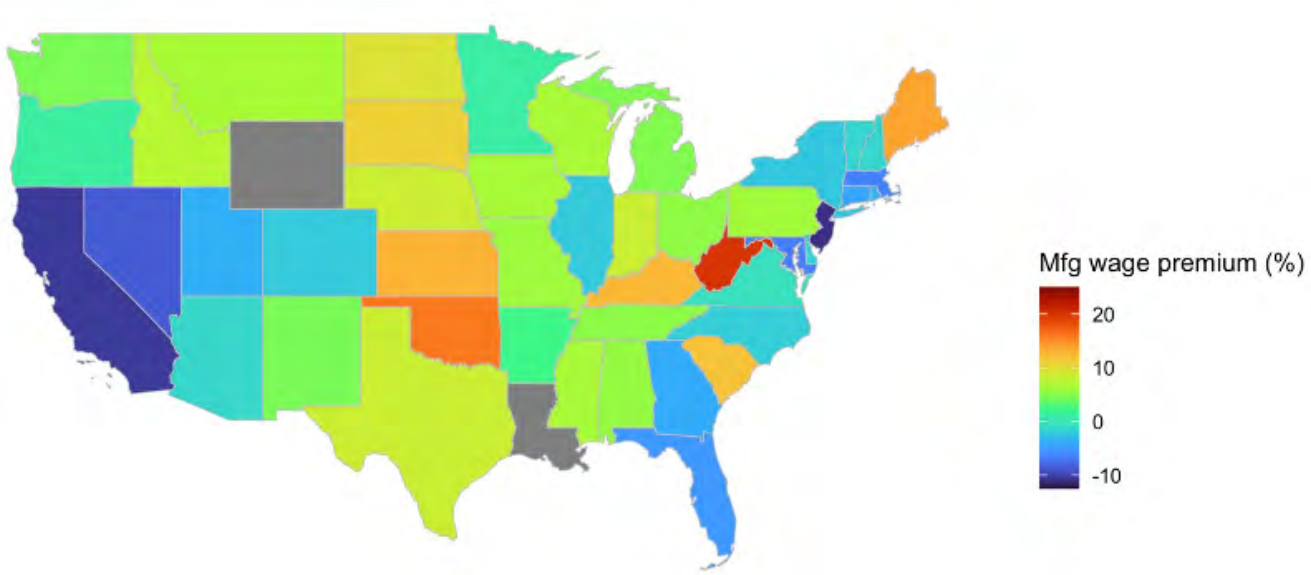
Manufacturing Job Share by State



Manufacturing regions in this section can be generally divided into three categories. The first category includes "manufacturing belt" states, primarily along the Great Lakes, but also stretching down into the southern half of the United States. These states span from Minnesota, Wisconsin and Michigan across to Pennsylvania down to Arkansas on the west and South Carolina in the east. This group of states is characterized by a higher-than-average concentration of manufacturing jobs (as much as a quarter of overall jobs in the upper midwest). In these states, manufacturing workers without a college degree are likely to earn a positive wage premium (higher wages in manufacturing than alternative industries). However, in these states, the share of advanced industries that pay the highest wages (e.g. aerospace, chemicals, semiconductor, computer, and pharmaceutical production) are the lowest in these states.

Figure 13.

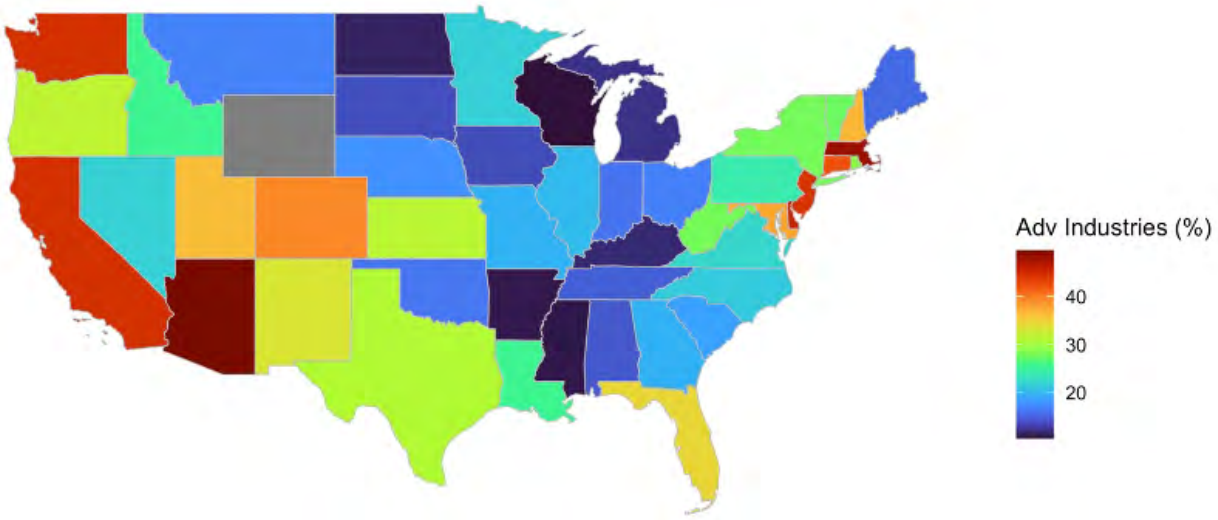
Manufacturing Wage Premium by State



The second category of states are emerging manufacturing regions. These states, which include North and South Dakota, Iowa, Nebraska, Kansas, and Oklahoma, have a share of manufacturing jobs near the median for the United States. However, these states have higher-than-average wage premia for manufacturing. Manufacturing workers without a college degree still earn in excess of 10% higher wages than workers with comparable educations in other industries. One potential explanation for the higher wage premium in these regions is that they have a comparatively high share of workers in technician and precision production roles, which pay higher than typical production jobs for manufacturing workers without a college degree. These regions have a comparatively low share of high-wage, advanced technology manufacturing industries.

Figure 14.

High-wage Manufacturing Industries by State

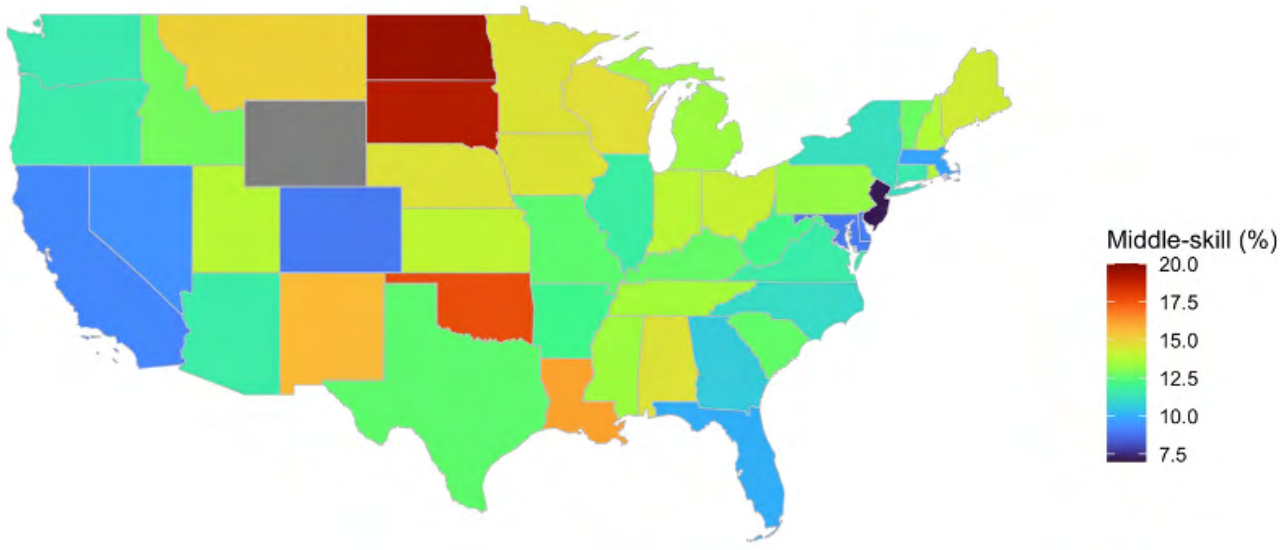


The third group of states includes places with a high share of advanced manufacturing industries, but comparatively low manufacturing wage premia. These states include Massachusetts, Connecticut, and New Jersey in the Northeast, as well as Florida in the Southeast, and California, Colorado, Arizona, and Washington in the west. These states stand out for their high concentration of engineering-intensive industries including aerospace, computer, semiconductor, and pharmaceutical manufacturing. However, for manufacturing workers without a college degree, many of these states – with the potential exception of Washington – have low wage premia for manufacturing. In Massachusetts, California, and New Jersey, for instance, manufacturing workers without a college degree earn less on average than workers with comparable education in other industries. Moreover, despite having a high share of high-wage, advanced technology industries, these states do not have a high concentration of middle-skill technician and precision production roles in manufacturing. One potential explanation for this phenomenon is that the highest- wage manufacturing industries in these places have a concentration of college-educated engineers, which are only becoming more represented in the highest-wage fields.

Although these three categories do not capture all American manufacturing, they help explain how the best job opportunities in manufacturing for individuals without a college degree might be in places like Iowa, South Dakota, and Oklahoma, whereas the best job opportunities for advanced technology manufacturing – particularly for those with a college degree – could be in coastal states where these industries are concentrated.

Figure 15.

Middle-skill Manufacturing Jobs by State



PART III. ANALYSIS

The overall wage premium for manufacturing jobs has been shrinking, but there remain many high-wage job opportunities in manufacturing. Four key factors help explain where higher-wage job opportunities are in manufacturing – and how individuals might access them. Education, occupation, industry, and geography all play a role in shaping why one manufacturing workers might earn $15, while their friend earns $30. Job-seekers and career counselors must weigh the benefits of each as they navigate potential career paths in manufacturing.

THE EDUCATION PREMIUM: THERE ARE HIGHER WAGE GAINS FOR SWITCHING POSITIONS THAN GAINING EDUCATION AND RETURNING TO THE SAME ROLE.

Manufacturing workers with higher education (beyond a high school degree) consistently earn more than manufacturing workers with less education in comparable roles and industries. However, the wage premium that a machine operator with some college (e.g. a two-year associate's degree) earns over a machine operator with just a high school degree is pretty small – just $20.26 per hour compared to $17.88 per hour, or 12%. There appears to be greater opportunity for upward mobility if increased education enables manufacturing workers to move from jobs in lower-wage tiers (e.g. operators, assemblers) to jobs in higher-wage tiers (e.g. precision production, technician, or even engineering roles). The wage increase from moving from an operator role with just a high school degree to a precision production role with some college is much more significant – from $17.88 to $24.90, or a 39% increase in hourly wages.

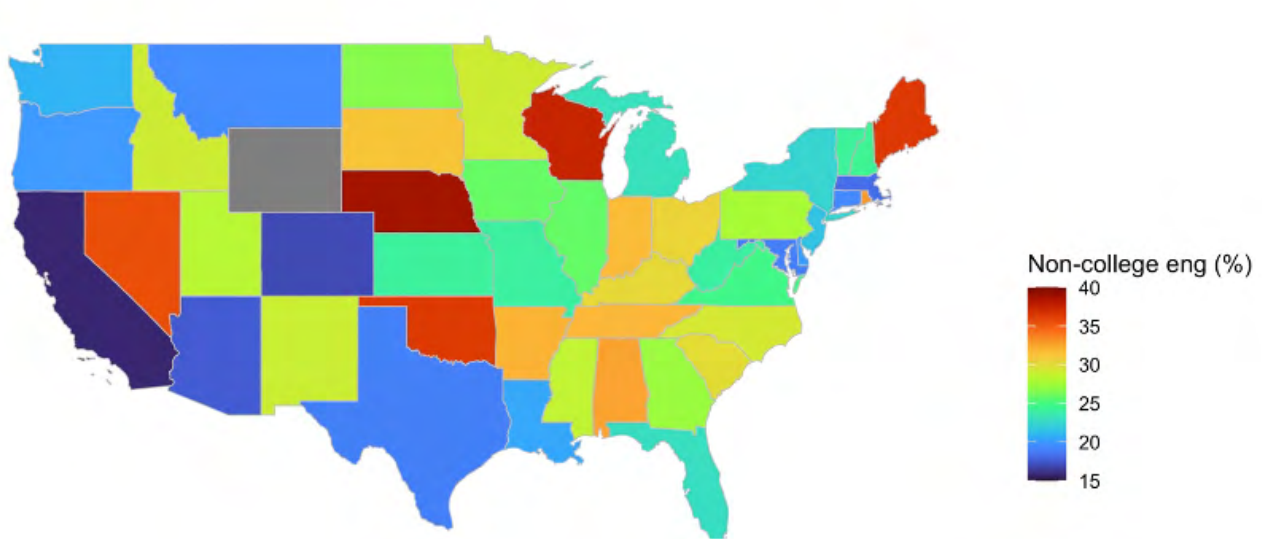
THE OCCUPATION PREMIUM: THERE ARE OUTSIZED WAGE INCREASES ASSOCIATED WITH JUMPING FROM ONE WAGE TIER TO THE NEXT, PARTICULARLY TO THE HIGHEST-WAGE ENGINEERING TIER.

Manufacturing wages differ significantly between the three occupational tiers with an outsized jump between middle-tier occupations in the precision production and technician categories and higher-tier engineering occupations. Engineering positions for individuals without a college degree pay far higher than any other manufacturing role. For instance, engineers with some college experience make 32% more on an hourly basis than technicians with similar education (the next highest-paying manufacturing role).

Although the availability of non-degreed engineering positions can vary by firm and by industry, the earnings potential of engineering roles – as well as the growing

Figure 16.

Share of Engineers in Manufacturing without a College Degree



demand for engineers in manufacturing – suggests that job-seekers and career counselors should search for paths to move into engineering positions in manufacturing. Currently, more than 1 in 5 engineers in manufacturing do not have a four-year college degree. In some states, the share of engineers without a college degree is even higher. Figure 16 shows that the share of engineers without a college degree is highest in the manufacturing belt of states stretching from the Great Lakes into the south, where manufacturing employment as a share of overall jobs is highest. But it is important to note that the share of non-college engineers varies widely by place – and presumably by industry. In places like Massachusetts and California, where high-wage advanced industries are most concentrated as a share of manufacturing employment, engineers without a college degree are comparatively scarce: approximately 15% of the manufacturing workforce. At the high end, in places like Wisconsin, more than one-third of engineers do not have a college degree.

THE INDUSTRY PREMIUM: MANUFACTURING JOBS IN HIGH-WAGE INDUSTRIES ARE SCARCE AND SOMEWHAT GEOGRAPHICALLY CONCENTRATED. NEXT-BEST OPPORTUNITIES ARE IN INDUSTRIES WITH AVAILABLE MIDDLE-SKILL ROLES.

Judging from the industry-level data, it might seem like a no-brainer for job-seekers and career counselors to focus on opportunities in high-wage industries like aerospace, chemicals, or computer manufacturing. Jobs in these industries are comparatively high wage, but they are also comparatively scarce. And when they are available, they are concentrated in states along both coasts without an abundance of other manufacturing opportunities. There is a case for industrial policy that can expand the availability of jobs in these industries that pay well and have the potential to contribute to innovation. However, for the current labor market, job-seekers need at least a Plan B should these jobs not be available.

Manufacturing jobs with comparatively high wages and availability include precision production roles in industries like automotive, machine tool, and metals production. These positions make near the median wage for precision production workers ($22-25 per hour), but they are among the most common middle-wage jobs in manufacturing. In metals and automotive manufacturing, for example, engineering and middle-wage positions are stable or growing, whereas lower-wage positions are decreasing, suggesting that these jobs could increase in availability over time.

THE GEOGRAPHY PREMIUM: STATES WITH ABUNDANT MANUFACTURING OFFER DIFFERENT OPPORTUNITIES THAN STATES WITH CONCENTRATED HIGH-WAGE INDUSTRIES.

The states with high concentrations of manufacturing jobs have a comparatively small share of the highest-wage, most engineering-intensive industries. By contrast, states like Massachusetts and California are home to a concentration of advanced manufacturing jobs, but those jobs – at least for workers without a college degree – do not offer a significant premium over non-manufacturing careers. For manufacturing job-seekers without a college degree, there would need to be a reasonable path to enter high-wage industries and earn a wage premium for manufacturing careers in Massachusetts, California, or similar states to make sense. By contrast, manufacturing careers in the upper midwest and parts of the U.S. South continue to pay a premium over non-manufacturing careers. The challenge in these states, however, is that the availability of job opportunities in higher-wage industries could be comparatively limited.

PART IV. RECOMMENDATIONS

Data on manufacturing jobs at the occupation, industry, or state level offer a high-level picture of different career paths in manufacturing. But perhaps the most important variation in manufacturing jobs comes at the employer level. Some employers in high-wage industries will offer low-quality jobs without opportunities for upward mobility, and other employers in comparatively low-wage industries will offer terrific opportunities for upward mobility and high earning potential. Asking potential employers four sets of questions about the job opportunities they offer can provide additional data – beyond the wage level of the available job – indicating whether the current job opportunity could translate into a fruitful career:

1. HAS THE EMPLOYER PROMOTED WORKERS WITHOUT A COLLEGE DEGREE TO BECOME TECHNICIANS OR ENGINEERS?

An employer with a history of promoting workers without a college degree into high-wage technician or engineering roles shows prospective workers that there could be a path from entry-level manufacturing positions to higher-wage opportunities. Whereas many employers might report that they would prefer to promote high-performing workers internally, it is important to understand how common this practice is for a prospective employer. If an employer likes the idea of promoting entry-level workers, but does not have concrete examples, then the likelihood of upward mobility could be low.

2. HOW DOES THE EMPLOYER RECOGNIZE AND REWARD NEW SKILLS AND HIGH PERFORMANCE WITHIN THE MANUFACTURING WORKFORCE?

Some employers value educational degrees and certifications, requiring additional education for employees to move into higher-wage roles. Other employers track the skills that employees acquire on the job. Acquiring new skills can translate into new work opportunities. Performance reviews also vary by employer. Whereas some employers prefer subjective measures, rating performance based on peer reviews and supervisor perceptions, other employers track data from machining centers and other sensors throughout the factory floor. Understanding how an employer measures performance can help a job-seeker understand what would be required to thrive in the prospective workplace.

3. HOW MANY ENGINEERS DOES THE COMPANY EMPLOY COMPARED TO ASSEMBLERS, OPERATORS, AND OTHER POSITIONS?

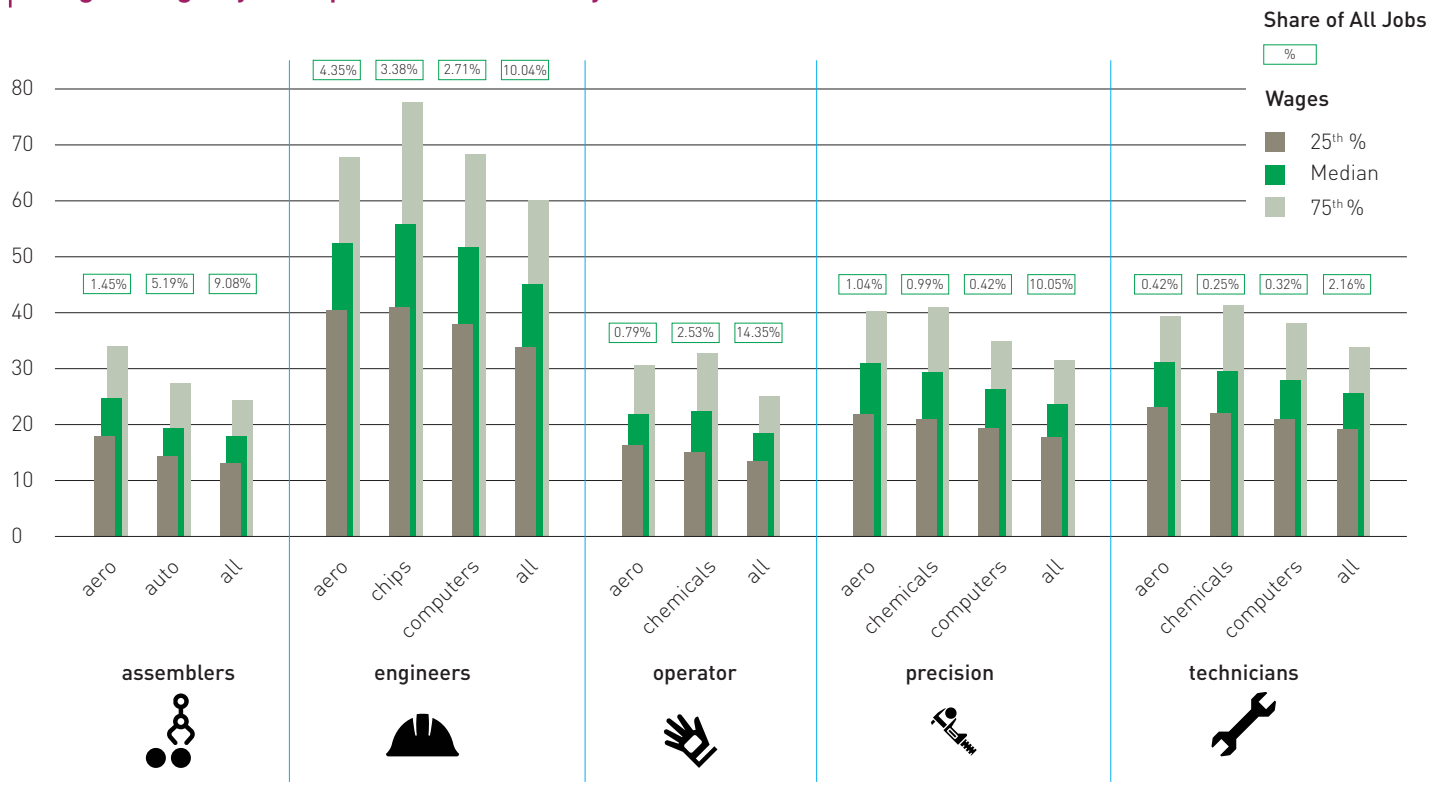
What types of roles is the company planning to hire in the coming years? Multiple factors influence a worker's opportunities for upward mobility within a firm. An employer's willingness to promote from within the firm is part of the equation. But the availability of higher-wage jobs within the firm is another important variable. Firms focusing on hiring higher-skill workers will also be more likely to provide opportunities for upward mobility (assuming they are open to promoting internally).

4. HOW DOES THE COMPANY'S PRODUCTION TECHNOLOGIES COMPARE TO ITS COMPETITORS?

Manufacturers that invest in advanced technology and automation tend to be more competitive in their industries, hire more workers, and can increase wages for more skilled workers.[vi] Job postings that require digital skills typically pay higher than job postings with no such digital skill requirements. But the presence of advanced technologies and automation does not guarantee that the prospective job will be higher wage or higher quality. If an employer is focused on automation, a job-seeker could ask about opportunities for workers to be involved in integrating and updating the technology. For workers involved in the implementation of technology on the factory floor, there could be additional opportunities for wage growth and upward mobility.

Figure A.1.

Wage Range by Occupation and Industry



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