Production in the Innovation Economy

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2 Skills and Skill Gaps in Manufacturing

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Production workers are at the core of the manufacturing work force, just as they have always been. In 2011 blue collar jobs accounted for over 40 percent of all manufacturing employment. Without these employees products would simply not get out the door. But the importance of these jobs extends beyond this obvious point. A great deal of research, not to mention the experience of leading firms, demonstrates that the skills, ideas, and commitment of blue collar workers are central to obtaining the levels of quality and productivity needed to succeed in today's hypercompetitive economy. Furthermore, these production jobs have long been the path to middle-class lives for people with relatively modest levels of education. Consider that in 2011 a U.S. manufacturing production worker with just a high school degree earned \$17.29 an hour and equivalent employees in all other industries earned \$15.87 (Lemieux 2006).[1] The goal of this chapter is to understand the nature of production jobs and to shed light on some puzzles and controversies that have arisen regarding them. In chapter 3 we take up policy solutions to the challenges that we identify.

The two main puzzles on which we focus in this chapter turn on issues regarding skill. There is a great deal of uncertainty regarding just what capacities firms are looking for in their production workforces. What mix of hard skills—math, reading, writing, computers—is needed, and how important are capacities such as the ability to work in teams or to solve unexpected problems? There is a great deal of speculation, as well as several well-respected research efforts, but a comprehensive study of the manufacturing sector per se has yet to be undertaken. The second puzzle concerns whether manufacturing firms are able to find what they need. Numerous reports of shortages coexist with other reports of unemployed people lining up for jobs when they are announced. Firms complain that they cannot find the workers they want, but the main signal that economists look at—wages—has remained flat in the face of supposedly rising demand and limited supply. Just what is going on? Are there shortages, and, if so, in what kind of firms and for what skills?

To answer these questions we base much of this chapter on two sources of data: an original nationally representative survey of 885 American manufacturers that we conducted in 2012 and a wide-ranging set of face-to-face interviews with manufacturing firms in a variety of regions around the country. See appendix 2.1.[2] The details of the survey and the interviews are provided in the appendixes to this chapter. We believe that they provide a unique and valuable insight into the workforce issues confronting American manufacturers.

Two key features of our survey are important to understand up front. First, the survey was directed to establishments and not to firms. This is not a meaningful distinction for a firm that has only one location, but consider, at the other extreme, General Motors. If GM happened to be in our sample we would have interviewed a plant and not the corporate headquarters. We adopted this approach because we believed that the respondent, typically the plant manager, would be far more knowledgeable about the issues that concern us than would someone buried in corporate headquarters. For many questions we asked about the establishment and not the firm as a whole. However, when it came to questions about skill, shortages, and hiring practices, we built on previous research we have conducted and focused on what we termed *core workers,* who were defined as the occupational groups most central to production (Osterman 1994, 2000). We targeted this group because it would not be sensible to ask a question about hiring or skills and expect any reasonable answer to apply to blue collar, administrative, or managerial employees in the aggregate.

To preview our results, we find that there is widespread demand for basic hard skills such as reading, writing, math, and computers, but that the demand for more advanced levels of these skills is modest. Interpersonal skills such as the ability to work in teams and to get along with colleagues are quite important, whereas demand for problem-solving abilities and initiative is somewhat less so. When it comes to the skill shortage debate we focus on long-term vacancies, and our results indicate that the majority of manufacturers do not face significant obstacles in accessing skilled production workers. At the same time, we do find persistent long-term vacancies among a subset of manufacturing establishments. The most consistent predictors of these extended vacancies are demands for advanced math and reading skills. Low wages and frequent product innovation are also contributing factors.

General characteristics of the manufacturing workforce

Before discussing some of the specific issues regarding skill requirements and skill gaps, it is helpful to describe some of the basic characteristics of the U.S. manufacturing workforce.

From a demographic point of view, contrary to some conventional wisdom, the manufacturing workforce is not consistently older than the rest of the workforce across all age categories. That said, about 17 percent is approaching retirement. This will prove important when it comes to thinking about hiring needs. In addition, the percentage of the youngest workers trails that of other industries. See table 2.1 for comparisons.

The manufacturing workforce contains a variety of occupational categories. Not surprisingly the largest occupational group is production workers, followed by managers, engineers, and scientists. Note that the U.S. Census Current Population Survey (CPS) data do not distinguish skill levels within each group (table 2.2).

With regard to education, we are interested in both the level and the rate of change. In other words, what are the education levels of the manufacturing workforce compared to workers in other industries, and how does the rate of change in education levels compare to the rest of the economy?

We use data for twenty-five- to thirty-year-olds to answer these questions because these are new hires and, as such, best capture trends in skill and education that represent the future of the industry. Comparing

Table 2.1
Age Distribution, Manufacturing, and the Rest, 2010–2011 (Percentage)

	Manufacturing	Not Manufacturing
25–34	23.3	29.7
35–54	59.1	53.2
55+	17.5	19.9

Source: Authors calculations based on Current Population Survey, May Outgoing Rotation Group (CPS ORG) data. See http://data.nber.org/morg/annual.

Table 2.2
Occupational Distribution, Manufacturing (Percentge)

	2000–2001	2010–2011
Management, business, financial	13.9	16.0
Computer, math, life, physical, social sciences	4.7	4.8
Architecture and engineering	6.9	8.1
Production, installation, repair	47.6	42.5
Other	26.8	28.4

Source: Authors calculations based on CPS ORG data.

Table 2.3
Education Distribution, Manufacturing Mechanics, Installation/Repair/Production Workers, Ages 25–34 (Percentage)

	2000–2001	2010–2011
High school dropout	14.0	12.7
High school graduate	37.3	32.3
Some college	17.2	16.7
AA degree	8.0	8.7
College degree or more	23.4	29.4

Note: "Some college" can be anything from one course in a community college to all courses except graduation from a four-year college.

Source: Authors' calculations based on CPS ORG data.

the education distribution for manufacturing workers for 2010–2011, it is clear that the manufacturing workforce is less well educated than is the workforce in the rest of the economy (table 2.3). At the same time, we can also see that there is indeed some evidence that the education level of the manufacturing workforce is increasing more rapidly than the average for nonmanufacturing industries (see table 2.4).

Skills and shortages

The national discussion regarding the manufacturing workforce has centered on two questions: (1) what are the skills that production workers need to help manufacturers thrive and (2) do sufficient numbers of employees possess these skills to meet employers' needs? In this section we will review the state of knowledge and the open questions regarding each of these issues. This will set the stage for the findings that flow from the national survey and our fieldwork.

Table 2.4
All Nonmanufacturing Distribution, All Occupations, Ages 25–34 (Percentage)

	2000–2001	2010–2011
High school dropout	9.7	8.3
High school graduate	25.9	23.2
Some college	20.0	18.0
AA degree	9.1	10.9
College degree or more	34.3	39.3

Source: Authors' calculations based on CPS ORG data.

Skills

Historically, manufacturing was a sector in which unskilled but strong and hardworking people could earn a decent living. Of course, there have always been higher level blue collar craft and repair jobs, but the bulk of employees could do well with basic skills and a strong work ethic. Today there is a general perception, which extends well beyond manufacturing, that the diffusion of information technology as well as organizational innovations such as quality programs and self-managed teams has raised the bar for what is expected of employees. In manufacturing this view is reinforced by perception that unskilled work has moved overseas and that what remains in the United States are sophisticated, highly automated factories and production sites. In this view individuals who do not meet the new, higher expectations will be trapped in lower paying service work (Dietz and Orr 2006).

This said, there is uncertainty about what the actual skills are that employees need. Most of the discussion about skill requirements relies on educational attainment, but education is a noisy proxy for concrete skills. In addition, there is a fundamental identification problem associated with using education as a proxy of skills. If we observe that, say, the education level of a group of incumbent workers in a given occupation is rising, does this reflect an increase in the skill demands of the job, or is it a reflection of an increase in the educational level of the available workforce due to any number of possible reasons—such as the consumption value of education or an educational "arms race"—that are unrelated to actual job requirements?

In short, when it comes to understanding skills we want to know what skills are needed, whether skill requirements are accelerating, and what we can say about the existence and characteristics of any mismatch between the supply of and demand for skills. Our survey results provide some of the first detailed evidence on these questions with regard to manufacturing establishments.

The current state of understanding regarding skill requirements, leaving aside the research that uses education as proxy for skill, is fairly thin. Representative of the view that skill demands are high and accelerating is recent work by David Autor, Frank Levy, and Richard Murnane (ALM) that examines the impact of the diffusion of information technology on skill requirements (Autor, Levy, and Murnane 2003). This work centers on the distinction between routine and nonroutine skills. The argument is that computers increasingly perform routine tasks that can be programmed, hence substituting for human labor that previously did this work. The research points to a variety of jobs that are nonroutine (i.e., not programmable), both at the high end (managers, brain surgeons) and the low end (hotel room cleaners, home health aides). ALM find that from 1960 to 1998 the share of work in the economy that was nonroutine interactive and nonroutine analytical rose and the share that was nonroutine manual, routine manual, and routine cognitive fell.[3] In general they find these trends occurred across all industries. They also find that much of the shift takes place within education groups. In addition, the pattern is largely due to the adoption of computers and not to other forms of capital investments. However, the data are not presented in a way that enables one to determine the percentage of work that the authors believe fall into each category.

This set of findings points to a shift in the demand for skill and contributes a new model to explain this shift. Although it is clear that the computerization processes that ALM describe have altered the labor market, what is less clear is the magnitude of the shifts and whether this transformation is the type of discontinuous change that would drive gaps between the supply and demand for skills.

Other researchers have examined skill changes and found them to be either modest or manageable with current workforce capabilities. Michael Handel finds a steady growth in skill demands but not any evidence of acceleration in recent decades. For example, Handel concludes that "overall, it seems that rather basic levels of math, corresponding to two years of ordinary high school instruction, are sufficient for most jobs"(Handel 2010).

In their book *Teaching the New Basic Skills*, Richard J. Murnane and Frank Levy provide a case study of hiring at Honda Motors in Ohio in the early 1990s (Murnane and Levy 1996). Honda hired only one in ten applicants, but the hard skill demands were very low. The company used only simple math tests—at a high school level or less—in its screening process, and it did not even use past manufacturing experience as a selection criterion. Ultimately Honda was more concerned about attitude, ability to work in teams, and flexibility than previously acquired hard skills.

Roberto Fernandez studied these issues in the context of a technological change in a food processing factory (Fernandez 2001). The factory totally redesigned its production process in order to implement continuous processing and control systems. Fernandez collected numerous direct measures of skill changes, and these do show generally increased skill demands in the new jobs, although the increases are not radical. However, and this is very important, the firm kept its old workforce and retrained them despite the fact that the average education level at the plant was below twelfth grade. The fact that existing workers could be successfully retrained to use modern production technologies casts some doubt on the existence of the skill shortage problem.

As is apparent, there has been a substantial amount of research on the trajectory of skill demands in manufacturing but these investigations have not converged on a consistent story. Our survey is intended to bring clarity to this debate as well as address the question, described in the next section, of whether skill demands have accelerated and moved jobs out of the reach of many Americans.

Mismatch and shortage?

Has the demand for skill increased in a way that has outrun what today's blue collar workforce can deliver? Have jobs suddenly become so demanding that most candidates for production jobs are not qualified? In short, is there a skill shortage facing America's manufacturing firms? Here too there is considerable uncertainty and controversy.

A great deal of concern has been expressed about a skills shortage in manufacturing. In 2005, the National Association of Manufacturers endorsed a study by Deloitte that asserted "today's skill shortages are extremely broad and deep . . . impacting more than 80 percent of the companies surveyed. . . . [S]kill shortages are having a widespread impact on manufacturers' abilities to achieve production levels, increase productivity, and meet customer demands" (Deloitte and The Manufacturing Institute 2005). In 2011 another NAM/Deloitte report indicated that 74 percent of the firms surveyed said that shortages or skill deficiencies in skilled production workers "harmed their ability to expand operations or improve productivity" (Deloitte and The Manufacturing Institute 2011).

Numerous newspaper articles reporting from different parts of the country have echoed these worries as they quote firms complaining about difficulties in hiring. One typical headline from Indiana reports that "hundreds of manufacturing jobs go unfilled," and in another story the mayor of Chicago states that six hundred aircraft maintenance positions are going begging (Kavilanz 2012; Emanuel 2011).

The widespread nature of these complaints commands attention, and in fact these concerns were echoed in some, though far from the majority, of our own interviews with firms. This said, there are several stumbling blocks in the way of believing that shortages are in fact a major problem. First, with unemployment at high levels it is hard to believe that potential employees cannot be found. This observation is given additional weight by the success of manufacturing in ramping up production in the past two years. From October 2010 to October 2012, U.S. employment of manufacturing production workers grew by 4.0 percent, and overall manufacturing employment grew by 3.5 percent. Total private sector employment grew by 3.7 percent over this time period (BLS Current Employment Survey).[4] If labor shortages were a major obstacle, then it seems unlikely that manufacturing employment growth would keep pace with overall employment growth.

More worrisome to the shortage argument is the fact that manufacturing wages have not risen disproportionately for more highly skilled or educated production workers. Simple supply and demand economics implies that when a factor is in short supply, its price will rise. It is well understood that there are frictions in the labor market that slow adjustments and that these frictions are due to factors such as the lack of homogeneity of the "product," barriers to mobility, and the institutional characteristics of the labor market. That said, it is hard to believe that wages will not rise over a reasonable period of time if shortages represent a serious obstacle to profitability. We can look at a variety of datasets to get a handle on manufacturing wage trends. In the Bureau of Labor Statistics (BLS) Current Employment Survey, average hourly wages in the manufacturing sector rose by 6.9 percent from 2008 to 2011, as compared to 6.7 percent for average hourly wages across all private sector industries. Thus, overall manufacturing wages do not appear to have spiked.

Of course, one might worry that aggregate manufacturing wage data are too crude and do not distinguish among levels of skill. To address

Table 2.5
Average Hourly Wages by Selected Manufacturing Occupations

	2008	2011	Percent Change
Production occupations	$15.87	$16.74	5.5
Machinists	18.17	19.51	7.4
Industrial engineering technicians	22.89	24.42	6.7
Mechanical engineering technicians	23.74	24.92	5.0
Industrial engineers	35.47	37.56	5.9

Source: BLS Occupational Employment Statistics.

these concerns, we can examine the BLS Occupational Employment Statistics (OES) and the Census's CPS. Using the OES, we can compare wages from several detailed occupations within manufacturing. Although the OES is not well suited to comparisons over time for many occupations (particularly fast-changing information technology positions), the manufacturing positions we have chosen are relatively well defined and have not undergone radical redefinitions in recent years. Table 2.5 contains the change in average hourly wages for overall production workers and machinists compared to three higher skill categories of employees: industrial engineers, industrial engineering technicians, and mechanical engineering technicians. These three occupations represent the types of higher paid, higher skill workers that are often thought to be in short supply.

We can see from these data that wage growth in the higher skilled occupations does not appear to be any more rapid on average than that among the less skilled job categories.

CPS data can also shed light on manufacturing wage trends. Figure 2.1 shows the wage premium for workers who hold an associate's degree (AA) from a community college, expressed as a ratio of wages for degree holders compared to high school graduates. The wage premia are presented for manufacturing workers and nonmanufacturing workers.

We can see from the chart that although there is year-to-year variation in the return to an AA, the manufacturing wage premium has not been rising relative to the nonmanufacturing premium. If anything, the manufacturing premium has shown a relative decline in recent years.

These wage data, along with the successful expansion of manufacturing output and hiring, raise questions about the shortage argument. Spot shortages might arise from time to time in any market, but this is

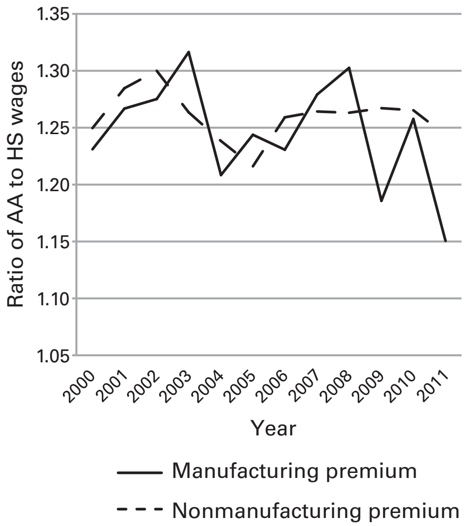

Figure 2.1
Community college wage premium by industry sector. *Source:* Current Population Survey, May ORG.

to be expected. The serious question is whether in general manufacturing is facing a hiring crisis. Although our initial analysis provides grounds for healthy skepticism, given the widespread complaints—including those we turned up in some of our fieldwork—it is not prudent to simply dismiss the shortage argument out of hand. We will use our own survey results to explore this issue more carefully and will in fact identify specific circumstances in which shortages are a real concern.

Survey evidence

Given the broad uncertainty regarding what skills manufacturers require, a substantial portion of our survey was devoted to this topic. Our overall approach was to ask very specific questions about the activities and capabilities required of core employees. Our view is that by being as concrete as possible we are able to move beyond the broad generalities that characterize much of the popular discussion.

We did, nevertheless, ask a few opinion questions about the trajectory of skill change. Of the respondents, 7.1 percent said that skill requirements had increased a great deal in the past five years, and 34.4

percent said that they had increased somewhat. The remainder indicated that there had been no change (48.2 percent) or that requirements had declined (10.1 percent). These data add additional support to the view that although skill demands have gradually increased over time, the perspective that we are in a period of sudden discontinuous new demands is something of an exaggeration. A more concrete question aimed at understanding the skill-related challenges facing firms was how many weeks it takes a new hire to attain an acceptable level of proficiency. This is a complicated question because the reply is a function of the skills demanded in the job and the nature of the hiring process. However, the question does provide some insight into the challenges facing managers. In response, the median establishment reported that a new hire was up to speed in three months, and less than 10 percent of establishments reported that it takes more than six months. On the whole, these time periods seem manageable.

All this said, it is important to drill down beyond generalizations to examine skills in a more concrete way. In the discussion that follows, the data represent yes-no answers to questions that took the form of asking, "does the core job require . . .?" The questions were grouped into six categories: reading skills, writing skills, mathematical skills, computer skills, interpersonal skills, and problem-solving skills. Multiple questions were asked for each category.

We began by asking about basic skills and then turned to more advanced job requirements. For reading we defined basic skills as the ability to read basic manuals, we defined writing as the capacity to write short notes, and for math it was the ability to add, subtract, multiply, divide, and handle fractions. We asked an additional question regarding the frequency of computer use. Table 2.6 shows the results.

Table 2.6
Basic Skill Demands (Percentage)

Establishments requiring basic reading for core jobs	76
Establishments requiring basic writing for core jobs	61
Establishments requiring basic math for core jobs	74
Establishments requiring basic reading, writing, and math skills for core jobs	43
Establishments reporting that usage of computers at least several times a week is part of the core job	63

Source: PIE Manufacturing Survey.

These results certainly do suggest that basic skills are important in most firms, but one can also read them to suggest that there is a large segment of employers that do not require the full range of basic reading, writing, and math skills, or regular computer usage. It would indeed be surprising if these employers were facing difficulties in recruiting, but we will hold off on this question until we explore the demand for more advanced skills.

As noted, we measured six bundles of more advanced skills: reading, writing, mathematics, computer skills, interpersonal skills, and problem solving or initiative. Within each of these, depending on the group, we asked between two and five specific questions. For example, for computer skills one of the questions was whether the job required the ability to use computer-aided design or computer-aided manufacturing programs, and for the math questions one item was whether the job required probability or statistics. For interpersonal skills, one of the questions was whether it is important to be able to work effectively in teams, and for the set of initiative questions one item was whether the employee needed to be able to initiate new tasks without guidance from management. A full list of all the skill questions and the distribution of answers is provided in appendix 2.2.

In table 2.7 we show for each of the advanced hard-skill bundles the percentage of establishments that requires at least one additional advanced skill, as well as the percentage that requires two or more.

These data on advanced skills contain a number of interesting results. First, although demand for reading and math is comparable at the basic level, reading is in greater demand among advanced skills. Advanced math and computer skills are both very important, but fewer than half of manufacturing establishments require at least

Table 2.7
Establishments Requiring Advanced Skills by Number of Additional Skills Required (Percentage)

	At Least One Additional Skill	Two or More Additional Skills
Advanced reading	53	25
Advanced writing	22	4
Advanced math	38	12
Advanced computer	42	23

Source: PIE Manufacturing Survey.

one advanced skill in these skill bundles. With regard to the 38 percent of establishments that do require advanced math skills, it should be kept in mind that the level of additional math that is expected (beyond the basic skills described previously) is in reality not out of reach. In breaking down this bundle, 32 percent of respondents said that employees should be able to use algebra, geometry, or trigonometry, whereas for statistics and probability the figure was 14 percent, and for calculus it was 7 percent.

Another point that comes out of the data presented in table 2.7 is that requirements for advanced skills are often limited to particular advanced skills. As we can see by the reductions in the percentages requiring two or more skills, it is not the case that establishments that require one advanced skill in, say, math, are equally likely to require multiple advanced skills in that same area. This would imply that firms have very specific needs for certain advanced skills. These specific needs may be more amenable to training than would broad-based requirements for competency across many advanced skills.

Table 2.8 presents the results for two characteristics that are often referred to as "soft skills": cooperation and teamwork. Here the message is clear: the typical manufacturing firm places substantial weight on these behavioral traits, which in turn suggests that the widespread discussion about the importance of soft skills has a strong basis in reality.

We also asked about two additional bundles of skills that fall somewhere between hard skills and soft interpersonal skills. The first bundle is the ability of employees to operate on their own and to show initiative. The second bundle is the ability to spot and to address quality problems. These questions and the fraction of establishments that indicated that the capacities are very important are shown in table 2.9.

It is striking that well under half of the surveyed establishments feel it is very important for their core workers to display the self-starting

Table 2.8
Interpersonal Skill Demands (Percentage)

	Percent Responding "Very Important"
Cooperation with other employees: very important	81
Ability to work in teams: very important	65

Source: PIE Manufacturing Survey.

Table 2.9
Demand for Problem Solving and Initiative (Percentage)

	Percent Responding "Very Important"
Ability to initiate new tasks without guidance	35
Ability to independently organize one's time	46
Ability to critically evaluate options	36
Ability to solve unfamiliar problems	39
Ability to evaluate the quality of output	71
Ability to take action if quality is unacceptable	76

Source: PIE Manufacturing Survey.

or initiative traits described in table 2.9. Although the percentage totals obviously rise if we include respondents who indicated that these characteristics are "somewhat important," these results nevertheless imply real limitations on reinforcement of personal initiative that is often thought to be at the heart of developing an advanced manufacturing system.

A final skill question that we asked was directed toward the ability to learn new skills. When asked about the importance of the ability to learn new skills, 50 percent of respondents replied that this capacity is very important for their core employees. An additional 39 percent indicated that it is moderately important.

It is possible to read the overall thrust of these patterns from several perspectives. First, in general it is clear that, as many people have observed, we are well past the era in which a strong back is the primary capacity needed for manufacturing work. The majority of manufacturing establishments require basic reading and mathematics, and many go beyond this in their expectations. The second way of reading these data is to observe that the range of skills that are required, both at the basic and advanced levels, would seem to be well within the reach of a strong high school graduate and, without question, a holder of a community college degree or certificate. These data do not support the idea of across-the-board skill demands that are unattainable for potential production workers with high-school or sub-baccalaureate training.

The final observation points to the importance of moving beyond a discussion of the central tendency in these results and instead observing that there is diversity in skill demands across establishments. Of particular interest are establishments that have relatively high skill requirements for their core employees. For example, consider the following bundle of skill needs: establishments whose employees use computers at least several times a week, who require that their employees have some level of math beyond the basics, and who require that their employees be able to read more than basic instruction manuals. The needs and experiences of this particular subset are likely to diverge from the average. In our survey data, only 21 percent of establishments fit this description. Although these establishments are not typical, they are likely to be the ones with the most advanced technology that may be at most risk of having difficulty finding appropriate employees—though, again, it is important to emphasize that even in this situation the skills are well within the reach of community college graduates. In our subsequent discussion of skill shortages we will more rigorously characterize the distribution of skill demands and relate it to labor market issues.

Vacancies

Much of the discussion concerning the manufacturing workforce has centered on whether firms are facing significant difficulties obtaining an appropriate workforce. One interpretation of this discussion, and one that may be significant, is that these concerns are forward looking and point to the problems that firms will confront as the baby boom wave retires. Related to this are concerns regarding attracting young people into the manufacturing field. While these worries about the future will be addressed in chapter 3, the issue we take up here is whether firms today are having problems identifying and hiring the employees they need.

We asked employers the general question of whether in the past two years it had become more difficult to recruit core employees, and 41 percent indicated that it had. Just what "difficult" means is, of course, in the eye of the beholder. A more objective measure is the time it takes to identify an appropriate candidate. The median time was four weeks, and more than 90 percent of establishments reported that they were able to identify a candidate in twelve weeks or less. Once a candidate is identified, establishments seem to have little difficulty in actually hiring the person, with the average acceptance rate being 86 percent and the median 95 percent.

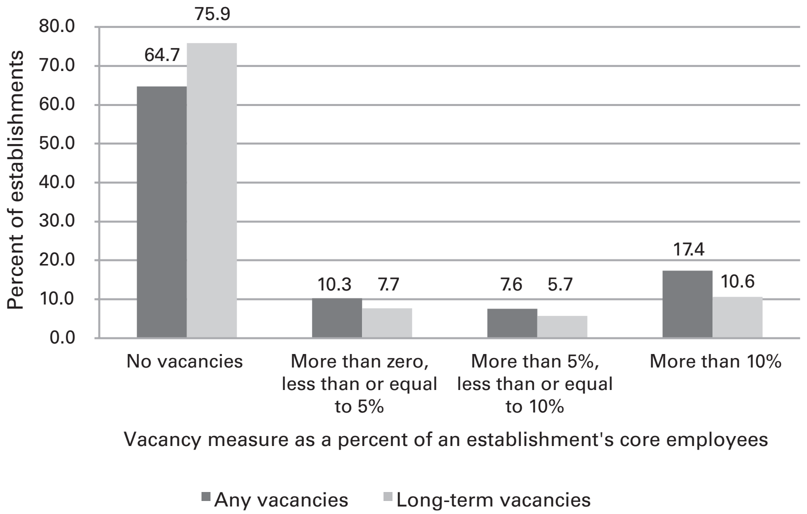

Figure 2.2
Vacancies. *Source:* PIE Manufacturing Survey.

To understand where the problem with hiring might lie and what the characteristics are of firms that face challenges, we asked two questions about vacancies. First, we asked about the number of current vacancies, and second, about the number of long-term vacancies in which jobs remained unfilled for three months or more. The distribution of the replies is shown in figure 2.2.

Similar to the survey responses on skills, these data show some clear, broad patterns and at the same time display diversity. The strong majority of manufacturing establishments simply do not have a problem recruiting the employees that they need, and this should be no surprise given the current state of the job market and wage data trends. Sixty-five percent of establishments report that they have no vacancies whatsoever, and 76 percent report that they do not have any long-term vacancies. There is, however, a subset of establishments that report problems in the form of extended vacancies. Overall, 24 percent of establishments report some level of long-term vacancy, and 16 percent report higher levels of long-term vacancies equal to or greater than 5 percent of their core employee workforces. There is no way of knowing if these are the firms whose complaints we hear in the public discussion because it is actually in the interest of all employers, regardless of their situation, to beat the drums for more investments in producing a manufacturing workforce. However, we will pay special attention to these establishments with extended vacancies because we have a general concern with any significant labor market frictions that might harm workers and hold back economic growth.

Are vacancies a problem for the establishments that are experiencing them? In general, the answer concerning long-term vacancies is that for a subset of establishments they are a moderate problem. When we asked the entire sample whether "lack of access to skilled workers is a major obstacle to increasing financial success," 16.1 percent reported that this was a major obstacle. Notably, this percentage is lower than the percentages reporting that weak demand, taxes, or regulation were major barriers to financial success. Again, however, the central tendency is misleading. Among those establishments who reported no long-term vacancies, only 10.6 percent reported that access to a skilled workforce is an obstacle to their success. Among establishments with some long-term vacancies, the response increased to a strikingly high 33 percent. Among establishments with 5 percent or more long-term vacancies, it was 41 percent.

Explaining vacancies

What distinguishes establishments that are suffering from long-term vacancies from others? This question is important for several reasons. First, some might argue that these firms should simply be left to struggle through their problems, and in general it is reasonable to argue against intervening to help companies deal with every difficulty they face. This, after all, is the essence of a market-driven system. However, if the firms that have difficulty attracting the workforce they need are in some ways "advanced" or "cutting edge" then we might be more worried because, in some sense, they represent the future and a case can be made for nurturing them.

What can we say about the characteristics of establishments that report the existence of long-term vacancies that they cannot fill? In answering this question we focus on three sets of variables that relate to three different categories of explanations: (1) the general characteristics and human resources policies of the establishment, (2) the skill requirements of the establishment, and (3) the competitive strategy of the establishment. In examining these we distinguish among establishments with no long-term vacancies, those whose percentage of long-term vacancies are in the upper third of the distribution of all

Table 2.10
Establishment Characteristics and Vacancies

	No Long-Term Vacancies	In the Upper Third of the Distribution of Establishments with Any Long-Term Vacancies	Report that Obtaining a Skilled Workforce Is a Major Obstacle to Financial Success
Mean number of total employees	.65	.37	.60
Mean hourly wage	$16.56	$18.62	$17.79
Prefer to promote (obtain skills) from within (Percent)	62	49	50

establishments with any long-term vacancies, and those establishments who report that obtaining skilled workers is major obstacle to their financial success. There is considerable overlap between the last two groups but it is worth distinguishing between them because the upper-third cutoff is potentially arbitrary.

Table 2.10 examines establishment size, wage levels, and the firm's policy regarding training internally versus hiring in the external market. Smaller organizations typically have less well-developed human resource functions. In addition, on average they pay less than do larger establishments and may offer less secure employment. Finally, they may have fewer contacts in their communities that aid in attracting employees. We also present data on wage levels because these clearly have an impact on the relative ease of recruitment and hiring. Finally, some employers seek to hire the skills they need on the external market whereas others hire "trainable" people and then develop them internally. We asked respondents to characterize their organization's philosophy along this dimension, and it is reasonable to expect that these alternative approaches may be correlated with challenges in attracting the workforce that the establishment seeks.

The establishments with long-term vacancies are smaller, are more reliant on the external labor market, and pay more. There is, of course, a paradox here: the establishments having difficulty seemingly want more skilled employees yet appear to rely less on internal resources in obtaining them. A partial resolution to this paradox is establishment size: smaller establishments often operate on tighter margins and have more limited internal systems for skill development.

The wage pattern is a reminder that we are examining correlations. We saw previously in the national data that in the aggregate manufacturers have not disproportionately raised wages for production workers. At the same time, it makes sense that the subset of manufacturing establishments that are having difficulty recruiting have raised wages somewhat. From table 2.10 we do not yet have a sense of whether the correlation between long-term vacancies and higher wages will remain positive once we take into account other factors, such as the relative levels of skills demanded. We will explore this in the following in a multivariate regression framework.

Table 2.11 examines the relationship between skill and long-term vacancies. A reasonable expectation is that establishments that seek relatively high skills or scarce skills are those that experience vacancies. The results in table 2.11 provide general support for this expectation, but, perhaps more important, it helps us distinguish the kinds of skill demands that pose challenges.

The central message of these patterns seems clear: establishments that experience difficulties with long-term vacancies are those that seek a skill that is unique in their area, and are also those that seek employees with reasonably advanced levels of math and computer skills. For establishments in the upper third of the distribution of long-term vacancies, advanced reading requirements are also associated with higher levels of long-term vacancies. In general, most of the interpersonal or problem solving–initiative skills do not vary consistently with vacancies. We will further explore these relationships in a multivariate framework.

One feature of the foregoing discussion is that it is done on a variable-by-variable basis. It is important to understand the patterns when the variables are considered simultaneously; that is, it is important to execute a more sophisticated statistical model. We have employed models with two different dependent variables: long-term vacancies as a percentage of core employment and a binary indicator variable for establishments that report high levels of long-term vacancies (defined as greater than 5 percent of core employees). We use a standard regression model with the first dependent variable and a logistic regression model with the second. As explanatory variables we use indicators for establishment size, an indicator for low wages, a measure of the firm's preference for internal hiring and promotion, several measures of the competitive strategy of the establishment, indicators for increasing and decreasing production, and a range of measures of the skill demands of the establishment. We also control for industry using industry-fixed effects based on disaggregated two-digit industry (NAICS) codes. A summary of the results is shown in table 2.12, and the full results are shown in appendix 2.3.

Table 2.11
Skill Demand and Vacancies

	No Long-Term Vacancies	In the Upper Third of the Distribution of Establishments with Any Long-Term Vacancies	Report that Obtaining a Skilled Workforce Is a Major Obstacle to Financial Success
Job requires unique specialized skills not used by other firms in the area (percent)	23	43	39
Mean number of additional math skills employees require	.45	.83	.88
Mean number of additional computer skills employees require	.69	1.25	1.26
Mean number of additional reading skills employees require	.80	1.16	.82
Mean number of additional writing skills employees require	0.27	0.2	.17
Percent indicating ability to learn new skills is a very important core job capacity	49	51	54
Percent indicating ability to cooperate with other employees is a very important core job capacity	82	76	86
Percent indicating ability to work in teams is a very important core job capacity	64	59	70
Percent indicating that the ability to evaluate the quality of output is very important	70	72	72

Table 2.11
(continued)

	No Long-Term Vacancies	In the Upper Third of the Distribution of Establishments with Any Long-Term Vacancies	Report that Obtaining a Skilled Workforce Is a Major Obstacle to Financial Success
Percent indicating that the ability to take appropriate action if quality is unacceptable is very important	75	82	75
Percent indicating ability to solve unfamiliar problems is very important	38	60	53
Percent indicating ability to initiate new tasks without guidance is very important	36	37	43
Percent indicating ability to independently organize one's time is very important	46	63	50
Percent indicating ability to critically evaluate options is very important	37	33	41

The most consistent finding from this exercise is that there is a strong relationship between certain skill measures and long-term vacancies. In our first model, establishments that require a unique skill not readily found in their region have higher percentages of long-term vacancies. Likewise, establishments that demand advanced math and reading skills experience higher levels of long-term vacancies. In the model measuring the presence or absence of any levels of long-term vacancies above 5 percent of core workers, the indicator for advanced math remains significant at the 95 percent level, and the indicator for advanced reading is significant at the 90 percent level. Although advanced computer skills are not significant predictors of long-term vacancies in these models, if a measure of the number of advanced

Table 2.12
Results of OLS and Logit Models of Long-Term Vacancies

	Dependent Variable	
Independent Variables	Long-Term Vacancy (Percent)	Long-Term Vacancy Indicator
Advanced reading	.012*	.049
	(.006)	(.027)
Advanced math	.017*	.065*
	(.007)	(.027)
Advanced computer	.007	.025
	(.006)	(.027)
Advanced writing	-.003	.007
	(.008)	(.029)
Unique skill demand	.016*	.038
	(.007)	.026
Ability to learn unfamiliar tasks	-.005	.015
	(.006)	(.025)
Cooperation is important	-.001	-.007
	(.009)	(.035)
Work in teams is important	.005	-.011
	(.007)	(.029)
Low wage indicator	.150**	.102
	(.034)	(.112)
Frequent product innovation	.014*	.064
	(.007)	(.028)
Preference for internal promotion	-.003	-.025
	(.006)	(.024)
Number of observations	698	696
R^2 / Pseudo R^2	.110	.133

Note: Results for logit/indicator model are marginal effects.
* = significant at 5 percent level;
** = significant at 1 percent level.
Source: Author's calculations based on PIE Manufacturing Survey. See text for details.

computer skills required is used, then these skill demands become significant as well (results not shown). In both models, establishments in the ten to nineteen employee size category have a greater chance of experiencing high levels of long-term vacancies than larger establishments (the effect is significant at the 95 percent level in the logit model and at the 90 percent level in the base model). In the first model, an indicator for low wages relative to other area employers is a highly significant predictor of percentage vacancies. A measure indicating that an establishment frequently engages in product innovation also has a significant positive relationship with long-term vacancy levels in both specifications, although other innovation and quality variables are not significant. In neither specification are soft skills, such as cooperation or ability to work in teams, a factor.

As a final topic, we asked the establishments why they thought that they were experiencing difficulties in recruiting core employees. We offered a series of possible explanations, asked the respondents to indicate which played any role, and then asked them which were the first and second most important explanations for the long-term vacancies. The results are shown in table 2.13 for establishments with 5 percent or more core vacancies. The patterns are fundamentally similar for establishments that experience any level of core vacancies.

The explanations are grouped into four categories: skills, character, aspects of the firm, and insufficient labor supply (in the questionnaire the items were randomly spaced and not clustered). These results are interesting for what they do and do not show. First, it is clear that skill concerns are very important. Second, it is apparent that so-called character issues are much less so. Despite all the rhetoric about failed drug tests and bad character, these factors are listed infrequently as the top reason for recruiting problems. What is also interesting is when the respondents simply listed concerns without ranking them, 35 percent of those reporting long-term vacancies did cite drug tests and 59 percent cited character (skills continued to dominate with 89 percent citing a lack of specific skills). One interpretation, albeit speculative, is that character concerns are easy instinctive responses, but when respondents are forced to rank issues and consider which problems are truly pressing, they fade in importance. In any case, these patterns support the earlier analysis of long-term vacancies: for the minority of establishments that have this problem, skill issues loom large.

Table 2.13
Two Most Important Reasons for Significant Long-Term Vacancies (Percentage)

	First Most Important Reason	Second Most Important Reason
Candidates lack sufficient general skills (reading, math, etc.).	8.48	5.9
Candidates lack sufficient specific skills for your industry.	41.4	17.8
Candidates fail drug test.	1.9	4.7
Candidates have poor attitude or character.	2.4	21.5
Poor social or interpersonal skills	2.0	1.6
Wages not attractive to qualified candidates	10.7	5.9
Insufficient resources for recruiting	8.4	5.9
Working conditions are difficult (hot, dirty, etc.).	1.5	3.5
Too few candidates apply.	5.5	13.1

Columns do not add up to 100 percent because of the "other" category.

Conclusion

Understanding what skills modern manufacturers demand and whether shortages of these skills among production workers hold back economic growth have been contentious topics of debate in recent years. We have sought through our research to shed light on these subjects by gathering new empirical data that capture skill requirements through very concrete and specific questions. In terms of skills, math and reading stand out as the most widespread requirements, but it is important to recall that for the majority of establishments the level of skills demanded is quite basic. Computer skills are also important, although they are not as consistently prominent in our data. Some soft skills, such as cooperation and teamwork, are also widely sought by employers.

Our results indicate that for the majority of manufacturers, no significant barriers exist to accessing the skilled workers they demand. However, it is at the same time worth noting that for a minority of manufacturing establishments—about 16 percent of our sample—long-term vacancies among core production workers are at levels that are potentially troubling. For these employers, demand for advanced math and reading skills appears to be the most significant predictor of long-term vacancies. Although they may be important in other contexts, soft skills and character issues do not appear to play a large role in skill shortages as measured by long-term vacancies. In addition to core hard skills, our data also suggest that low wages and frequent product innovation may contribute in certain cases to higher levels of extended vacancies.

Appendix 2.1

As part of this research effort, an original national survey was administered to manufacturing establishments. In addition, we conducted numerous in-person interviews with manufacturers, community colleges, trade associations, and other relevant parties in various geographic locations.

Survey methodology

Starting in October 2012, the survey was mailed out to 2,700 manufacturing establishments with at least ten employees. Manufacturing establishments were randomly selected from Dun & Bradstreet's database. The random sample was drawn on a stratified basis to make it representative of the frequency of different establishment sizes by employment level based on 2010 data from the U.S. Bureau of the Census's County Business Patterns survey. The sample was also trimmed to exclude SIC codes for the baking, printing, and publishing industries (which are sometimes included in the broad manufacturing category).[5]

The survey administrators called each firm in the sample to identify the individual who would be the most appropriate respondent. As an incentive and as compensation for response time, a $10 bill was included with each survey packet. The target respondents were either plant managers or human resources staff with knowledge of operations. The survey specifically asked respondents to answer questions about "core" workers. These were defined as the workers who were most critical to the production process. Examples of a core worker include manufacturing associate, fabricator, assembler, production technician, and process operator.

The response window for the survey was closed on January 3, 2013. By the end of the response period, 885 establishments completed and returned the survey, 427 establishments declined to participate, 1,230 did not respond, 126 establishments were determined to be ineligible for the survey, and 32 surveys were returned due to incorrect addresses. Eleven of the 885 completed surveys contained missing or zero responses for the total number of core workers and were not included in the analysis. Excluding the ineligible establishments, the incorrect addresses, and the surveys with incomplete core worker totals, the total response rate was 34.5 percent. Reasons for deeming an establishment ineligible include that the establishment did not actually engage in manufacturing; the establishment only carried out manufacturing activities outside of the United States; or the establishment said that it had less than the cutoff level of ten employees for survey participation.

The actual employment size breakdown and the regional breakdown of respondents compared to the target levels from County Business Patterns is as shown in table A2.1a and A2.1b.

Table A2.1a
Employment Size Breakdown: Sample versus County Business Patterns

	Percent of Total Employment for Established ≥ 10 Employees	
Establishment	Target	Respondent
1–9 employees	0	4.1
10–19 employees	6.2	10.8
20–99 employees	26.9	33.8
100–249 employees	22.9	22
250–499 employees	15.9	15.6
500+ employees	28.1	13.8

Source: PIE Manufacturing Survey and County Business Patterns (2010).

Table A2.1b
Regional Breakdown: Sample v. County Business Patterns

Census Region	Dun & Bradstreet Percent	Respondent Percent
Northeast	20.4	22.1
Midwest	39.0	42.1
South	20.4	16.8
West	20.2	19.0

Source: PIE Manufacturing Survey and Dun & Bradstreet.

Although the responding establishments roughly track the targets, small establishments are overrepresented and large establishments are underrepresented among the actual respondents. In statistical analyses we employ establishment size weights to correct for these deviations.

From a geographic perspective, the percentage of actual respondents from the Northeast and the West Census regions are not significantly different than the percentages of establishments in these regions in the original Dun & Bradstreet sample (see table A2.1b). However, establishments located in the Midwest are somewhat overrepresented, and establishments in the South are somewhat underrepresented. We have not adopted weights to address these deviations because they are relatively small in magnitude and most of our arguments do not rest on regional differences. When appropriate, we control for region or breakout regional results.

We conducted a slightly more formal bias analysis using size, geographic, and industry data. We used a linear probability model to regress an indicator for completing the survey on indicators for the various establishment size categories, indicators for geographic region, and indicators for two-digit SIC codes.[6] The results are consistent with the previous discussion. The largest size categories of establishments were significantly less likely to respond. As noted, we have corrected for this via weights. Establishments in the South were 5 percent less likely to respond than their New England counterparts. Other geographic differences were insignificant. Out of the twenty two-digit industry SIC codes, only two were significant at the 5 percent level.

In-person interview methodology

We conducted on-site interviews of manufacturers, educational institution staff, and trade association staff in a variety of locations in order to ground our analysis and flesh out our hypotheses. In North Carolina, from January 9 to January13, 2012, we interviewed people from six firms, two universities, three community colleges, and two industry associations in the biopharma-biomanufacturing industry. The interviews were semistructured and were oriented toward discussion of skill requirements for production workers and the challenges (or lack thereof) in hiring skilled workers. In Ohio, we conducted similar interviews focusing on the metal-working firms located in the state’s northeast region. During the week of October 23, 2012, we interviewed people from seven firms and one community college, with a subsequent follow-up interview with individuals from a second community college via phone. In Rochester, we targeted the region's optics manufacturers and conducted interviews with people from six firms, two community colleges, and two trade associations. In Michigan we visited McComb Community College in October 2012, and in Springfield we visited the Regional Employment Board as well as several employers and community colleges in November 2012.

Appendix 2.2: Skill demands

Appendix Table 2.2A.
Skill Question Responses

	Percent Answering Yes or Selecting Option
Does the job require reading:	
Basic instruction manuals	75.9
Complex technical documents or manuals	39.2
Any document that is longer than five pages	35.2
Articles in trade journals, magazines, newspapers	10.7
Does the job require:	
Preparing bills, invoices, etc.	18.1
Writing short notes, memos, reports, or requests	61.2
Writing anything at least one page long or longer	21.8
Writing anything at least five pages long or longer	4.5
What is the frequency of computer use:	
Everyday	50.6
A few times per week	12.2
Less often	11.1
Never	26.1
Does this job require (applies only to establishments that do not report "never" requiring computer use):	
Use of word processing software	38.3
Use of spreadsheet or database software	60.5
Computer-aided design (CAD) or computer-aided manufacturing (CAM) skills?	39.3
Use of other engineering or manufacturing software	40.0
Ability to write computer programs	25.6
Performing Internet searches and/or using the World Wide Web to gather information or seek solutions	45.2

Appendix Table 2.2A.
(continued)

	Percent Answering Yes or Selecting Option
Does this job require mathematical operations involving:	
Addition and subtraction	94.5
Multiplication and division	85.9
Fractions, decimals, or percentages	78.0
Using algebra, geometry, or trigonometry	31.8
Probability or statistics	14.1
Calculus or other advanced mathematics	7.3
How important is cooperation with other employees:	
Very important	81.1
Moderately important	18.2
Not very important	0.5
Not at all important	0.0
Not applicable	0.2
How important is the ability to work in teams:	
Very important	64.6
Moderately important	26.7
Not very important	7.6
Not at all important	0.2
Not applicable	0.9
How important is the ability to solve unfamiliar problems:	
Very important	39.1
Moderately important	44.0
Not very important	14.3
Not at all important	1.9
Not applicable	0.8
How important is the ability to learn new skills:	
Very important	50.1
Moderately important	39.2
Not very important	9.5
Not at all important	1.0
Not applicable	0.2
How important is the ability to initiate new tasks without guidance from management:	
Very important	35.0
Moderately important	45.8

Appendix Table 2.2A.
(continued)

	Percent Answering Yes or Selecting Option
Not very important	16.9
Not at all important	1.5
Not applicable	0.9
How important is the ability to independently organize time or prioritize tasks:	
Very important	46.0
Moderately important	38.2
Not very important	13.4
Not at all important	1.7
Not applicable	0.7
How important is the ability to critically evaluate different options:	
Very important	35.9
Moderately important	38.6
Not very important	19.9
Not at all important	4.4
Not applicable	1.2
How important is the ability to evaluate quality of output:	
Very important	70.6
Moderately important	25.1
Not very important	3.5
Not at all important	0.3
Not applicable	0.5
How important is the ability to take appropriate action if quality is not acceptable:	
Very important	76.2
Moderately important	21.4
Not very important	1.8
Not at all important	0.3
Not applicable	0.3

Source: PIE Manufacturing Survey.

Appendix 2.3: Regression tables

Table A2.3 contains the complete regression results for the two models referred to in the text. The first column contains results from an ordinary least squares regression with long-term vacancies as a percentage of core workers as the dependent variable. The second column contains a logit model with an indicator for the presence of high levels of long-term vacancies (> 5 percent of core workers) as the dependent variable. Both models include industry-fixed effects based on two-digit NAICS codes. We also conducted the analyses using three-digit fixed effects (not shown). The results were very similar, although advanced math skills become significant only at the 10 percent level due to collinearity between specific industries and demands for math skills.

Table A2.3
Complete Results of OLS and Logit Models of Long-Term Vacancies

	Dependent Variable	
Independent Variables	Long-Term Vacancy (Percent)	Long-Term Vacancy Indicator
Advanced reading	.012*	.049
	(.006)	(.027)
Advanced math	.017*	.065*
	(.007)	(.027)
Advanced computer	.007	.025
	(.006)	(.027)
Advanced writing	-.003	.007
	(.008)	(.029)
Unique skill demand	.016*	.038
	(.007)	.026
Ability to learn unfamiliar tasks	-.005	.015
	(.006)	(.025)
Cooperation is important	-.001	-.007
	(.009)	(.035)
Work in teams is important	.005	-.011
	(.007)	(.029)
Low wage indicator	.150**	.102
	(.034)	(.112)
Frequent product innovation	.014*	.064*
	(.007)	(.028)
Preference for internal promotion	-.003	-.025
	(.006)	(.024)

Table A2.3
(continued)

Independent Variables	Dependent Variable: Long-Term Vacancy (Percent)	Long-Term Vacancy Indicator
10–19 employees	.033	.200*
	(.018)	(.100)
20–99 employees	.004	.119
	(.017)	(.099)
100–249 employees	-.010	.026
	(.017)	(.103)
250–499 employees	-.006	.093
	(.018)	(.101)
500+ employees	-.012	.044
	(.018)	(.104)
Production has increased over last five years	.003	.001
	(.008)	(.033)
Production has decreased over last five years	-.002	-.053
	(.009)	(.038)
Currently provide formal training to core employees	-.006	-.023
	(.006)	(.026)
Ability to evaluate quality of output is very important	-.004	-.011
	(.008)	(.031)
Ability to take appropriate action if quality is not acceptable is very important	.014	.043
	(.008)	(.035)
Number of points respondent allocated to the importance of new products out of 100	-.0003*	-.001*
	(.0001)	(.0007)
Number of points respondent allocated to the importance of quality out of 100	.0001	.0002
	(.0002)	(.001)
NAICS two-digit industry fixed effects	X	X
Number of observations	698	696
	.110	.133

Note: Results for logit/indicator model are marginal effects.
* = significant at 5 percent level;
** = significant at 1 percent level.
Source: Author's calculations based on PIE Manufacturing Survey. See text for details.

Notes

1. These figures come from our calculations using the Census Outgoing Rotation Group data. These data are also used in some of the tables presented in the chapter. The wage data that follow are taken from the Outgoing Rotation Groups (ORGs) (i.e., the Current Population Surveys [CPSs] of April and August) in which wage data are collected for that point in time. These wage data are considered to be more accurate than the wages calculated from the March CPS, which asks about earnings over the prior year and for which the wage has to be calculated by dividing annual earnings by annual hours worked, both of which are recalled with some error. In the ORG data we eliminated allocated wages as well as wages that are reported below $1 an hour in 1979 dollars. See Thomas Lemieux, "Increasing Residual Wage Inequality: Compositional Effects, Noisy Data, or Rising Demand for Skill?" *American Economic Review* 96, no. 3 (June 2006): 461–498, for a discussion of processing these data.

2. Subsequent to writing this chapter, more replies were received and hence future publications will have a modestly higher sample size.

3. In their empirical implementation of this idea ALM use the 1977 and 1991 *Dictionary of Occupational Titles*, which provides (imperfect) data on the skill content of occupations. There are many serious criticisms of these data but for the purposes of their research there was nothing better available. They append occupational skill measures to Census data for several years ending in 1998.

4. BLS Current Employment Survey. Current Employment Survey, Series CES3000000006, CES3000000001, and CES0500000001.

5. The Standard Industrial Classification (SIC) codes that were excluded from the survey sample are:

2051 (bread, cake, and related products)
2759. (commercial printing, n.e.c.)
2711. (newspaper publishing and printing) 2721. (periodicals publishing and printing)
2731. (book publishing and printing)
2732. (book printing)
2741. (misc. publishing)

6. We conducted this bias analysis with SIC rather than NAICS codes because for the nonrespondents in the sample only SIC codes were available.

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