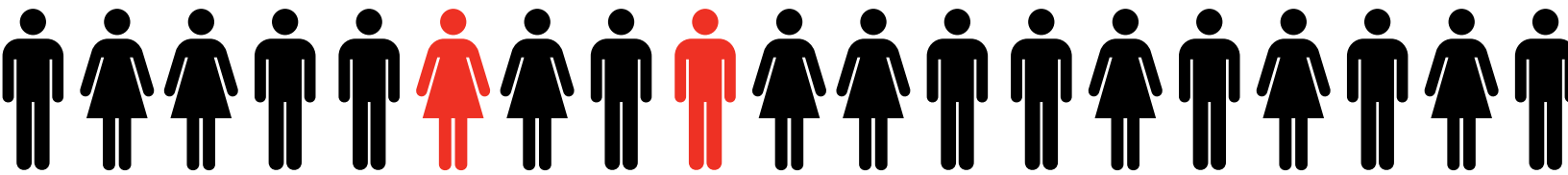
AARP FOUNDATION

An Assessment of Labor Force Projections Through 2018:

Will Workers Have the Education Needed for the Available Jobs?

Report Prepared for The AARP Foundation by The Public Policy Institute of California
May 2011



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Introduction

The impending retirement of the baby boom cohort could pose dramatic challenges for the U.S. labor force for at least two reasons. First, the boomers – adults born between 1946 and 1964 – are large in number. In 2008, boomers made up 34 percent of all adults in the United States, and 38 percent of all workers.[1] Second, boomers are relatively well educated. Many came into adulthood just as the nation was rapidly expanding postsecondary educational opportunities in relatively low-cost public institutions. For men, the GI bill was instrumental in encouraging greater postsecondary enrollment and the Vietnam War draft provided additional incentive for many male boomers to go to college (Cardand Lemieux, 2001; Bound and Turner, 2002). Further, it is likely that increasing labor market opportunities for women from factors as diverse as declining discrimination, changing attitudes, and contraceptive technology spurred them on to higher educational attainment as well (e.g., Goldin and Katz, 2002).

In this report we develop and analyze occupational and labor force projections to the year 2018, with a particular focus on the educational requirements of jobs, the educational attainment levels of workers, and the potential for imbalances to emerge between workforce needs and supplies. These projections are fairly short term because the analysis in this report is based, in part, on Bureau of Labor Statistics (BLS) occupational projections that extend only through 2018. Our focus is on broad levels of educational attainment, rather than specific types of degrees or areas of study. Our primary findings are:

- The U.S. economy will require more highly educated workers.
- The American population is becoming more educated, with the young adults showing gains relative to the generation immediately preceding them. According to the 2000 census, 16.4% of 25- to 29-year-olds had not graduated from high school. In 2008, 13.5% of 25- to 29-year-olds had not graduated from high school.
- The United States as a whole does not seem to be in peril of a substantial workforce skills gap, at least through 2018, although numerous states appear to face significant challenges and potential imbalances. This is due to more rapidly increasing shares of minority, and especially immigrant, populations that have less education.
- Despite overall improvements in educational attainment, the growth might not be in the areas of greatest economic demand and certain occupations might experience shortages.
- Projections of skill requirements by the Bureau of Labor Statistics appear to dramatically understate the level of educational attainment that employers demand and reward in the labor market.

Our findings depend on assumptions about the continuing trends of the recent past, including more upgrading of the educational attainment of non-traditional-aged students, and greater growth in the labor force participation of boomers even as they reach older ages. Our findings also depend on some particular facts that are driven by the period over which we do our projections. First, younger

[1] Authors' calculations are based on 2008 American Community Survey (ACS) data.

boomers are much more numerous than older boomers. In 2008, the oldest boomers were aged 62 and numbered 2.7 million. By 2018, most of those boomers will have retired. However, the youngest boomers (those aged 44 in 2008) numbered 4.6 million and will not have reached retirement age by 2018. Projections to 2030, when all of the boomers will be over the age of 65, could show different results with respect to national skill shortages.

Moreover, we focus on educational requirements in terms of the levels of education, but not the academic content of degrees, for two reasons. First, the skill requirements projections on which we base our analysis can be converted into the levels of education (by mapping occupational projections to the educational requirements of those occupations), but not to the academic content. And second, although we have data sources and methods to predict levels of educational attainment in the future, it is much more difficult to project the fields in which academic degrees will be achieved. This, as well as the short-term nature of our projections, is an important limitation that must be kept in mind in interpreting our findings.

Outline of the report

The report is organized into eight sections. First, we describe the occupational projections for 2018, which allows us to highlight the occupations expected to exhibit the greatest growth.

Second, we estimate the skill requirements – in terms of education levels – entailed by the expected occupational composition. We discuss a number of ways to do this estimation, and offer a lengthy discussion ("Insight") of BLS methods and our preferred methods.

Third, based on population projections, we estimate the educational composition that is likely to be supplied to the workforce over the same time horizon.

Fourth, we contrast the skill requirements with the population supplies to examine whether skill shortages are likely to arise. This section gives rise to two Insights[2] – likely state-level variations in skill shortages and some occupational shortages that may emerge. Possible policy responses, including at the state level, are also discussed.

Fifth, we identify the degree to which the skill upgrading of middle-aged adults and the increasing labor force participation of older adults will help prevent skill gaps from developing.

Sixth, we discuss some issues related to skill shortages.

Seventh, we offer some ideas about future research.

In the final section, we present Insights to highlight related issues in-depth.

[2] Insights are presented at the conclusion of the report.

1. Projected changes in the occupational makeup of the workforce

We rely on BLS projections to identify employment trends by occupation (Woods, 2009; Lacey and Wright, 2009).[3] These projections extend to 2018, and provide a straightforward way to predict future job growth and composition by occupation, including identifying the fastest-growing occupations.[4]

These estimates and projections were obtained from the occupational employment and worker characteristics data published by the Employment Projections Program at the Bureau of Labor Statistics.[5] The BLS data contain employment counts for 2008 with projections for 2018 at the six-digit Standard Occupational Classification (SOC) level. After aggregating occupation categories at the two-digit level (there are 22 two-digit occupations), we calculated the BLS projected change in occupational demand over the designated period.

Table 1.1 shows the occupation categories ranked by their growth rates in 2008 and 2018. Figure 1.1 ranks occupational categories by their growth rates while also showing the overall size of the category. Although relatively small occupational categories, healthcare and computer science occupations lead the way in terms of projected rates of employment growth. Agricultural and production occupations are the only occupations projected to decline between 2008 and 2018.

The BLS data reflect the number of *positions* in each occupation, rather than the number of total employees (i.e., people) required to fill these occupations. The two can differ because some people hold more than one job at a time. Moreover, the extent to which this happens likely varies by occupation. Occupations are differentiated by skill, and we know that the incidence of multiple jobholding varies by level of educational attainment.[6] For this reason, we adjust the projected occupation "counts" from the BLS to turn them into projections for the number of people required to perform these jobs (using Current Population Survey [CPS] data on multiple jobholding by education category).[7] As shown in Table 1.2, the fraction of people holding multiple jobs (or "moonlighting") generally increases with educational attainment. We use these fractions to adjust the BLS occupational counts, converting the projections into counts of people. Additional discussion of this adjustment is provided in Appendix A.

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3 In the BLS model labor force projections are derived from U.S. Census Bureau population projections, a macroeconomic model generating industrial composition forecasts, and a matrix providing occupational projections based on industry composition and levels (Bartsch, 2009).

4 These projections are also done by industry. However, since our goal is to project skill demands and supplies, and the BLS skill requirements on which we rely for some of the projections of demand are based on occupations, we focus on the occupational projections. In addition, occupations are typically thought about as distinguished by skill, whereas industries can include workers of many skills. Finally, other work on skill shortages (see Insight 4, on skill shortages and responses in other countries) is typically done in terms of occupations.

5 See BLS (2009), Employment Projections Table 1.6. "Occupational Employment and Job Openings Data, 2008-18, and worker characteristics, 2008." Note that this table excludes the military and institutionalized populations.

6 A more complete discussion of multiple jobholding and education appears later.

7 We use the January Supplement from the Current Population Survey for 2006 through 2008.

This conversion from positions to people results in an employment count, for 2008, of 146 million employed people. It closely matches BLS' own published employment results from the labor force statistics in the CPS, which are developed independently from the occupational employment projections.[8]

Table 1.1

BLS Occupational Employment Projections, 2008 and 2018

Rank	2-Digit SOC	Description	Occupational Employment (Jobs) (thousands) 2008	2018	Compound Annual Growth
1	31	Healthcare support occupations	3,982	5,130	2.6%
2	15	Computer and mathematical science occupations	3,540	4,326	2.0%
3	29	Healthcare practitioners and technical occupations	7,492	9,091	2.0%
4	39	Personal care and service occupations	5,044	6,075	1.9%
5	19	Life, physical, and social science occupations	1,461	1,738	1.8%
6	13	Business and financial operations occupations	6,834	8,044	1.6%
7	21	Community and social services occupations	2,724	3,172	1.5%
8	23	Legal occupations	1,251	1,439	1.4%
9	25	Education, training, and library occupations	9,209	10,533	1.4%
10	47	Construction and extraction occupations	7,811	8,829	1.2%
11	33	Protective service occupations	3,270	3,670	1.2%
12	27	Arts, design, entertainment, sports, and media occupations	2,741	3,074	1.2%
13	17	Architecture and engineering occupations	2,636	2,907	1.0%
14	35	Food preparation and serving related occupations	11,552	12,560	0.8%
15	37	Building and grounds cleaning and maintenance occupations	5,727	6,211	0.8%
16	43	Office and administrative support occupations	24,101	25,943	0.7%
17	49	Installation, maintenance, and repair occupations	5,798	6,238	0.7%
18	41	Sales and related occupations	15,903	16,883	0.6%
19	11	Management occupations	8,913	9,367	0.5%
20	53	Transportation and material moving occupations	9,825	10,217	0.4%
21	45	Farming, fishing, and forestry occupations	1,035	1,026	-0.1%
22	51	Production occupations	10,083	9,733	-0.4%
		All occupations	**150,932**	**166,205**	**1.0%**

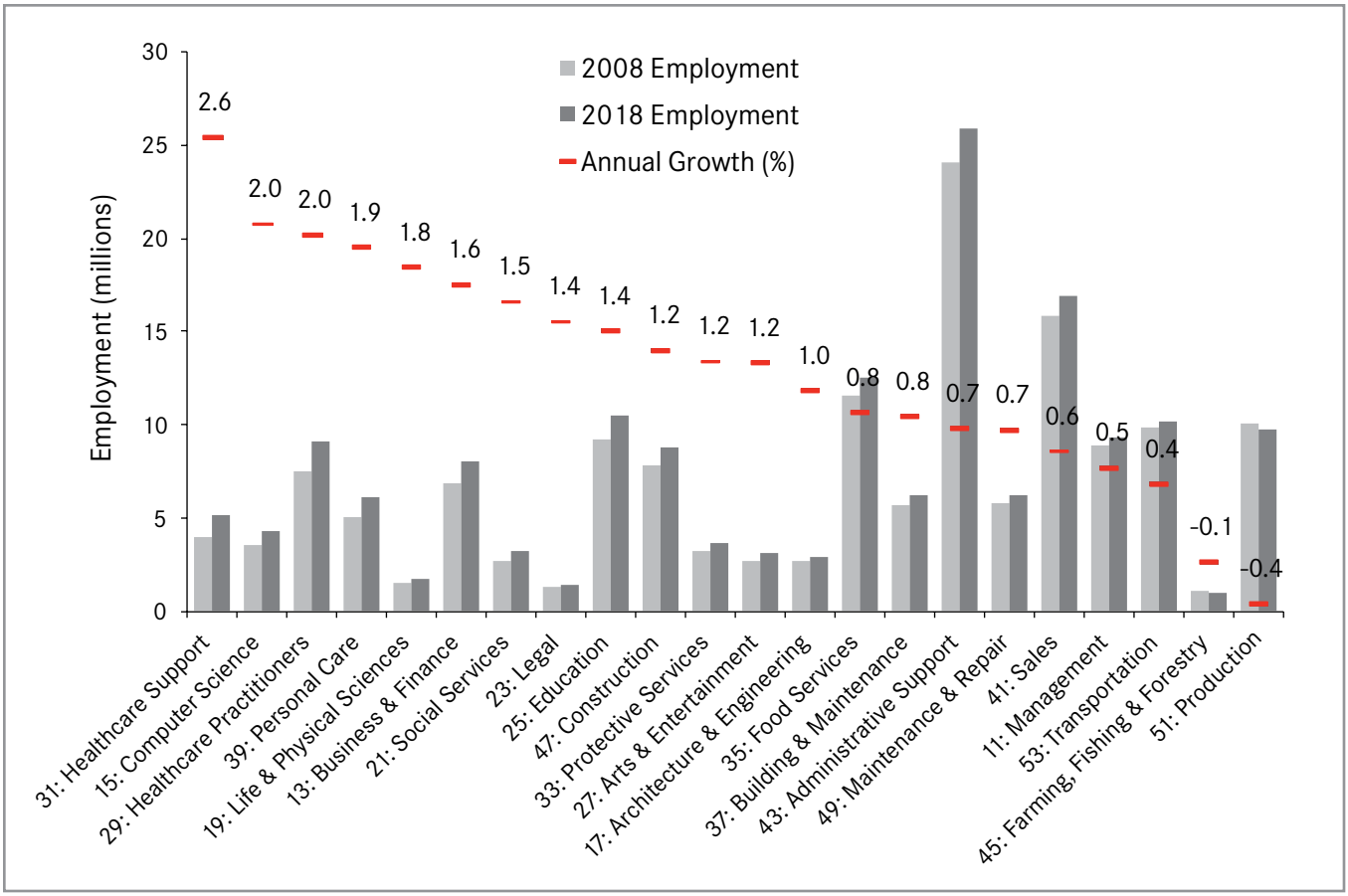
Note: Ranked by projected average annual growth.

Source: BLS Employment Projections.

[8] The BLS published employed population for 2008 is 145.4 million. See the following table from the "Labor Force Statistics from the Current Population Survey" : ftp://ftp.bls.gov/pub/special.requests/lf/aa2008/pdf/cpsaat8.pdf (accessed April 11, 2010).

Figure 1.1

BLS Occupational Employment Projections 2008 and 2018



Note: Ranked by projected average annual growth.

Source: BLS Employment

Table 1.2

Moonlighting Fraction by Education Category, 2006-2008

Education Category	Fraction of Individuals Holding More than 1 Job
High school degree or less	2.5%
Some college	4.6%
Associate's degree	5.5%
Bachelor's degree	5.4%
Master's degree	7.1%
Professional degree beyond bachelor's	5.2%
Doctorate	6.3%

Source: Current Population Survey, January 2006: Displaced Worker, Employee Tenure, and Occupational Mobility Supplement File.

Current Population Survey, January 2008: Displaced Worker, Employee Tenure, and Occupational Mobility Supplement File.

2. Education and skill requirements for the workforce in 2018

We use two primary approaches to project the education and skill requirements of future jobs and workers. The first relies on (but makes minor modifications to) the BLS occupational skills projections as reported by Lacey and Wright (2009). The BLS occupational skills classifications are based on a determination of training requirements, and range from short-term on-the-job training to a doctoral degree.[9] In the second approach, we project skill requirements based on a continuation of recent empirical labor force trends. Specifically, we use empirical data from the American Community Survey to identify trends in the educational attainment of workers aged 16 and over within 22 occupational groupings. Based on the patterns observed from 2000 and 2008, we project educational distributions within occupations to 2018 and apply them to the BLS projections of occupations.[10] This second approach is an alternative to the BLS method, and assumes that empirical employment practices are a good measure of workforce skill needs.

We note that it is because the BLS occupational projections extend to 2018 that our projections run only to that period. In both approaches, we project education requirements based on BLS occupational projections, and sum the projections across all occupations. The result is a set of projected education requirements for the entire workforce based on how our economy is changing (as reflected by occupational changes). As discussed later, we compare these projected requirements with projections of the supply of workers by educational attainment to identify any gaps or shortages.[11] We do not produce supply projections that are occupation-specific.

In addition to this core analysis, we assess the BLS classifications of skill requirements, in particular asking whether the BLS' skill classifications adequately capture true skill needs. We might well suspect not, given that the BLS skill requirements are more of a measure of the most common skills that workers need to qualify for an occupation. With this in mind, relying on the BLS skill requirements (and combined with projected changes in employment by occupation) might lead to underestimating the increase in skill needs - particularly when more skilled occupations are growing. We discuss this issue in Insight 1, which precedes the appendices at the end of this report.

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9 We adjust the BLS data to account for individuals holding more than one job, as noted in Section 1.

10 It is conceivable that these are not the ideal years to use, as during 2000 there was a very strong economy, and the economy started to weaken (in terms of a rising unemployment rate) during 2008. We are unaware of evidence suggesting that educational attainment within occupations is very sensitive to the business cycle. But additional research assessing the robustness of these findings by using different pairs of years to measure education might be useful. On the other hand, the National Bureau of Economic Research (NBER) business cycle dates (http://nber.org/cycles/cyclesmain.html) list March 2001 and December 2007 as the last two business cycle peaks, and these dates are fairly close to the 2000 and 2008 periods that we use.

11 We should note that both approaches are based on the perspective that the educational requirements of workers in particular occupations – whichever way we estimate them – imply that workers with less education would be less productive in these occupations. That is, we adopt the framework of the human capital model (Becker, 1964; Mincer, 1974) where education directly increases productivity, rather than the signaling model, where there is a fixed distribution of ability that is unaffected by schooling, and schooling serves only to "signal" to employers who has high ability (Spence, 1973). In the latter framework, there is really no sensible way to think about changing workforce demands for workers at different skill levels. However, the human capital perspective on education is by far the predominant view of the relationship between education, productivity, and earnings (Willis, 1986). For an alternative view, however, see Weiss (1995).

Projections of skill requirements based on BLS occupational projections and classifications of skill requirements

The BLS reports skill requirements for the occupations for which they do projections. The occupational forecasts distinguish between job openings due to growth and job openings due to replacement needs (Lacey and Wright, 2009).[12] There is an important distinction, which is sometimes a source of confusion, between projected demands for workers (or jobs) and projected job openings. Projected job openings can create an impression of very large demands for unskilled workers. For the purpose of assessing future workforce skill requirements, this is misleading because low-skilled workers move from job to job and from occupation to occupation at high rates. For example, filling one low-skilled job for one year may require multiple workers because these low-skilled workers may move on to other occupations, whereas filling one high-skilled job for one year may require only one worker because of much lower turnover rates. Assuming that employers anticipate this, they will project only one high-skilled job opening but more low-skilled job openings. But filling those jobs requires one worker of each type.[13] The projections we use are based on projected demands for workers, since we are ultimately interested in assessing how well the supplies of workers by skill level will meet the demands.

It is important to clarify what the BLS skill requirements mean. The BLS classifies occupations based on "training needed by most workers to become fully qualified." Specifically, occupations are classified into one of 11 categories according to the following principles (Lacey and Wright, 2009, p. 89):

(1) An occupation is placed into the category that best describes the education or training needed by most workers to become fully qualified in that occupation;

(2) If generally needed for entry into an occupation, postsecondary degrees take precedence over work-related training, even though additional skills or experience may be needed for a worker to become fully qualified in the occupation; and

(3) The length of time an average worker generally needs to become fully qualified in an occupation through a combination of on-the-job training and experience is used to categorize occupations when a postsecondary degree generally is not needed for entry into the occupation.[14] The BLS skill requirements categories include a combination of education requirements (for some occupations) and training or experience requirements (for others).

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[12] There is work underway at BLS to update and improve the measurement of skill requirements by occupation. See http://www.bls.gov/emp/edcatupdate.pdf (accessed October 29, 2010).

[13] See BLS, 2010. (accessed June 2, 2010). As an example, Table 3 in Lacey and Wright (2009) shows that between 2008 and 2018, BLS projects that 38.5 percent of all job openings will be in occupations at the lowest skill level (with short-term on-the-job training required, but that these low-skilled jobs will account for only 7.7 percent of the projected net change in employment. At the other end of the educational spectrum, 23 percent of all projected job openings will be in occupations that require at least a bachelor's degree, but these high-skilled jobs account for 77.5 percent of the projected net change in employment.

[14] Additional detail is given in Appendix B.

Alternative projections of skill requirements with the American Community Survey

The BLS data are not the only basis on which to estimate the skill requirements in occupational groups. We can also base such estimates on the observed educational distribution within occupations, using data from the Census Bureau's American Community Survey (ACS).[15] However, to make the results using the two data sources comparable the categories of skills used in both need to correspond. These are not the same: the BLS uses a combination of training and educational attainment to classify workers, while the ACS uses solely educational attainment. To come up with comparable distributions, we assign the skill set categories from each data source to a common set of educational attainment categories. The educational attainment categories we use are:

- High school degree or less;
- Some college;
- Associate's degree;
- Bachelor's degree;
- Master's degree;
- Professional degree beyond bachelor's; and
- Doctorate.

Since the decennial census and ACS only contain information regarding educational attainment, we need to convert the education/training variables seen in the BLS into measures of pure educational attainment. To do this we assign each grouping from the BLS into a new education category based on the implied level of education required for these occupations. Specifically, we assume that jobs requiring only on-the-job training are occupations that require a high school degree or less.

Table 2.1 shows assignments for each of the BLS training categories. The BLS classifications make it impossible to separate occupations that require a high school degree from those that require less education. Therefore we group all categories related solely to training into a single "High School Degree or Less" category. Likewise, we group those with a high school degree with those with less education in the ACS educational attainment categories. The full list of ACS categories and their assignment into the new categories is shown in Table 2.2.

Finally, the educational distribution in an occupation at a single point in time may miss changes in educational requirements over time. Consequently, in our projections based on ACS education data we apply trended estimates of the educational attainment shares within an occupational category that are available in the decennial census and 2008 ACS to the occupational employment projections for 2018 from the BLS.[16]

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[15] Data were accessed using the Integrated Public Use Microdata Series, IPUMS-USA, http://usa.ipums.org/usa/index.shtml (accessed October 29, 2010).

[16] One might argue that within-occupation changes in education should be forecasted from longer-term past trends. However, the nature of technology that likely drives these changes in education can differ over time, with some research suggesting that it can change quite quickly (Autor, et al., 2006). Thus, we think that longer-term changes in education within occupations could be misleading, although it would be worthwhile to explore the sensitivity of our conclusions to measuring using past differences computed over different periods.

These projections use the BLS projections of occupations, but apply trended projections of educational attainment for broad occupational groupings based on empirically observed trends as evidenced in the ACS.[17]

Projections of skill requirements

Table 2.3 shows BLS projections of skill requirements. Panel A is based on "positions," and is obtained directly from BLS projections without modification. Panel B shows our projections of workers filling those jobs, which adjusts for workers with more than one job. The projections indicate that the fastest growing occupations and the greatest increase in demand for additional workers are in occupations that will require some postsecondary education. The rate of growth in the demand for workers with some college is projected to be almost twice as great as for workers with lower levels of education. Despite this faster rate of growth, the BLS projections suggest that the vast majority of jobs have been and will continue to be in occupations that do not require any sort of postsecondary education. In 2018, 67.7 percent of all employment is projected to be in such occupations, a slight decline from the 69.1 percent in 2008.

Our alternative estimates and projections of employment by educational attainment, based on the decennial census and ACS, are shown in Table 2.4. The data reveal somewhat different patterns than those based on the BLS skill requirements, both in terms of the skill requirements of jobs currently held in the U.S. economy, and for projections of skill requirements for occupational changes to 2018. In 2008, only 37.5 percent of workers in the United States had a high school degree or less, whereas the BLS occupational requirements suggest that two of every three jobs required a high school degree or less (Table 2.3). While both the BLS- and ACS-based projections suggest that occupations with higher degree requirements will have the most rapid rate of growth, the difference in the magnitude of that growth is very large. The ACS-based projections indicate almost no change in the demand for workers with a high school degree or less, increasing by fewer than 200,000 workers between 2008 and 2018, while the BLS projection estimates an increase of 7.2 *million* for the same education group.[18]

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[17] To determine dynamic trends in occupational shares, we calculated compound average annual growth rates for educational attainment and occupation categories at the two-digit SOC level using the 2000 decennial census Public Use Microdata Sample (PUMS) and the 2008 ACS. (Both datasets were accessed using the Integrated Public Use Microdata Series, IPUMS-USA, http://usa.ipums.org/usa/index.shtml accessed October 29, 2010). We applied these growth rates to the 2008 ACS by educational attainment and occupation category to arrive at estimated levels of people in occupations for 2018. Instead of using these totals for the projections, we applied the shares by educational attainment and occupation category to the 2018 BLS population totals (adjusted from the occupational employment totals, as described above) to give us levels comparable to those projected by the BLS.

[18] Note that Table 2.4 indicates a decline in the demand for workers with professional degrees. What we observe is that from 2000 to 2008 the share of workers with these degrees in the two key occupation categories (legal and health) declined rather substantially, although the absolute numbers increased. This could be due to an increase in the employment of less-educated workers in these fields (for example, an increase in nurses that decreases the share of doctors). These within-occupation trends in education, coupled with our other forecast methods, account for the projected declines in the demand for workers with professional degrees. Recall, though, that we rescale projected 2018 employment to the BLS forecasts (rather than simply taking 2008 ACS employment by education and applying the 2000 to 2008 trends to arrive at 2018 levels). Absent this rescaling, the relative share in demand of workers with professional degrees would still decline, but the absolute number would increase. The difference arises because, although BLS projects that these will be among the fastest-growing occupations in the future (Table 1.1), they project the rates of growth to slow relative to the 2000 to 2008 period.

A key question that arises, then, is whether the ACS educational distributions reflect real demand for more highly skilled workers, or if workers in many occupations are over-educated. One way to identify if the much higher educational attainment levels as reported in the ACS reflect real demand is to examine the wages within those occupational categories. If employers pay larger wages to workers with higher levels of education within an occupational grouping, then we can take that as a sign of greater productivity and increased demand for such workers. Insight 1 provides just such an assessment. For reasons explained in that Insight, we conclude that the ACS data reflect real educational demands, and we therefore regard the projections based on the ACS data as much more reliable indicators of skill needs.[19]

[19] Finally, there is a potential caveat to some of these projections, given that some occupations require substantial non-education-related skills. Appendix C presents some evidence on occupations where non-educational requirements are more or less important, and discusses potential implications for our projections.

Table 2.1

BLS Occupational Skills Classification Assignment, Using Assignment of BLS Education or Training Categories to the ACS Educational Attainment Groups

BLS Skill Category	New Category
Short-term on-the-job training	High school degree or less
Moderate-term on-the-job training	High school degree or less
Long-term on-the-job training	High school degree or less
Work experience in a related occupation	High school degree or less
Postsecondary vocational award	Some college
Associate's degree	Associate's degree
Bachelor's degree	Bachelor's degree
Bachelor's or higher degree, plus work experience	Bachelor's degree
First professional degree	Professional degree beyond bachelor's
Master's degree	Master's degree
Doctorate	Doctorate

Source: Authors' reclassification of BLS skill categories.

Table 2.2

ACS-Decennial Census Educational Attainment Category Assignment

ACS Education Category	New Category
Less than high school	High school degree or less
High school graduate or GED	High school degree or less
Some college	Some college
Associate's degree	Associate's degree
Bachelor's degree	Bachelor's degree
Master's degree	Master's degree
Professional degree beyond bachelor's	Professional degree beyond bachelor's
Doctorate	Doctorate

Source: Authors' modification of ACS education categories.

Table 2.3

Skill Requirements Based on BLS Occupation Projections, 2008 and 2018

	Panel A: Occupational Employment						
		Jobs (thousands)				Distribution	
	Education/Skills Category	**2008**	**2018**	***Absolute change***	***Percent change***	**2008**	**2018**
1	High school degree or less	105,184	113,446	*8,262*	*7.9%*	69.7%	68.3%
	Work experience in a related occupation	14,640	15,837	*1,197*	*8.2%*	9.7%	9.5%
	Long-term on-the-job training	10,907	11,725	*818*	*7.5%*	7.2%	7.1%
	Moderate-term on-the-job training	24,778	26,768	*1,990*	*8.0%*	16.4%	16.1%
	Short-term on-the-job training	54,859	59,116	*4,257*	*7.8%*	36.3%	35.6%
2	Some college	8,685	9,839	*1,154*	*13.3%*	5.8%	5.9%
3	Associate's degree	6,005	7,152	*1,147*	*19.1%*	4.0%	4.3%
4	Bachelor's degree	24,620	28,196	*3,576*	*14.5%*	16.3%	17.0%
5	Master's degree	2,443	2,892	*449*	*18.4%*	1.6%	1.7%
6	Professional degree beyond bachelor's	1,966	2,314	*347*	*17.7%*	1.3%	1.4%
7	Doctorate	2,028	2,364	*337*	*16.6%*	1.3%	1.4%
	All education categories	**150,932**	**166,205**	***15,273***	***10.1%***	**100.0%**	**100.0%**

Source: BLS employment projections.

	Panel B: Demand for Workers						
		Workers (thousands)				Distribution	
	Education Category	**2008**	**2018**	***Absolute change***	***Percent change***	**2008**	**2018**
1	High school degree or less	91,200	98,360	*7,160*	*7.9%*	62.5%	61.2%
2	Some college	8,401	9,514	*1,113*	*13.2%*	5.8%	5.9%
3	Associate's degree	5,809	6,916	*1,107*	*19.1%*	4.0%	4.3%
4	Bachelor's degree	34,367	38,602	*4,235*	*12.3%*	23.5%	24.0%
5	Master's degree	2,364	2,797	*433*	*18.3%*	1.6%	1.7%
6	Professional degree beyond bachelor's	1,902	2,237	*335*	*17.6%*	1.3%	1.4%
7	Doctorate	1,961	2,286	*325*	*16.6%*	1.3%	1.4%
	All education categories	**146,005**	**160,713**	***14,707***	***10.1%***	**100.0%**	**100.0%**

Source: Authors' calculations based on multiple jobholders from the CPS and BLS employment projections.

Table 2.4

Alternative Projections of Educational Attainment Requirements Based on ACS/Decennial Census Trends

		Workers (thousands)				Distribution	
	Education Category	**2008**	**2018**	***Absolute change***	***Percent change***	**2008**	**2018**
1	High school degree or less	54,539	54,701	*162*	*0.3%*	37.5%	34.0%
2	Some college	35,182	39,560	*4,378*	*12.4%*	24.2%	24.6%
3	Associate's degree	12,144	15,879	*3,735*	*30.8%*	8.4%	9.9%
4	Bachelor's degree	28,038	32,822	*4,784*	*17.1%*	19.3%	20.4%
5	Master's degree	10,614	12,608	*1,994*	*18.8%*	7.3%	7.8%
6	Professional degree beyond bachelor's	3,059	2,816	*-243*	*-7.9%*	2.1%	1.8%
7	Doctorate	1,786	2,326	*541*	*30.3%*	1.2%	1.4%
	All education categories	**145,362**	**160,713**	***15,351***	***10.6%***	**100.0%**	**100.0%**

Note: Total workers in 2008 is from BLS (2008) "Household Data Annual Averages," Table 8. Shares in 2008 are calculated from the 2008 ACS. Total workers in 2018 is the same calculation as above; 2018 shares are calculated from authors' dynamic forecasting described in the text.

3. Population and educational attainment levels of the U.S. workforce in 2018

By our assessment, the BLS estimates of skills within broad occupational categories are not realistic in light of empirical evidence on employment practices of employers. Instead, we believe that our alternative projections based on trends observed in the ACS offer a more accurate version of the likely changes in employment demand in the United States from 2008 to 2018. Our alternative projections suggest negligible increases in demand for workers without postsecondary training, and substantial increases for those with such education. A key question that arises from the economic projections, then, is whether the skills of the U.S. population will match or tend to fall behind the changing demands of the economy. Specifically, is the American population changing in ways that make it unlikely for the economic projections to be realized?

To answer this question, we develop new population projections that include educational attainment. The U.S. Census Bureau provides population projections by race, ethnicity, gender, and age, but not by nativity (U.S.-born and foreign-born) or by educational attainment. The Census Bureau's projections extend to 2018 (and beyond) and are used by BLS to develop labor force projections. To produce educational attainment projections, we first develop a new set of population projections that includes nativity as well as race, ethnicity, gender, and age. Nativity is strongly associated with educational attainment, and therefore is essential for developing educational attainment projections.

Our projections of the population of the United States by educational attainment form the basis for our determination of the future supply of workers. Note that these population supply projections are not based on occupations, and do not include specific majors. Thus, we are able to compare these projections with our forecasts of workforce requirements by educational attainment across the entire population, but cannot identify specific occupations in our population supply projections.

One concern is that older workers – who are approaching retirement – are among the best-educated workers in the United States. Indeed, baby boomers nearing retirement are very slightly more likely to have graduated from college than young adults (Figure 3.1). This age pattern of educational attainment stands in stark contrast to the patterns in most other developed countries, where younger workers are generally the best-educated cohort (Organization for Economic Cooperation and Development, 2009). This is a reversal of the U.S. experience in earlier decades. Thus, projections regarding the supply of skilled workers hinge both on how quickly these more-educated older workers will exit the labor force, and on the education levels of younger cohorts.

United States population projections

Our population projections are derived from a standard cohort component model in which the population is aged across time using age, ethnicity, gender, and nativity cohorts. We consider five ethnic groups. Although we constrain our projections to be consistent with population projections produced by the Census Bureau, our projections include nativity, an important population characteristic that is highly predictive of educational attainment.

For each cohort, historical trends are used to generate future fertility, mortality, and migration rates. Our projections of these rates are, in the aggregate (that is, combining both the U.S.-born and foreign-born groups), very similar to those used by the Census Bureau in its "middle series" projections (Hollmann, Mulder, and Kallan, 2000) and in its latest projections (U.S. Census Bureau, 2008). In general, they show declining rates of mortality, mostly stable fertility rates at near replacement levels, and slight increases in international migration.

These fertility, mortality, and migration assumptions lead to modest increases in the population of the United States, with annual growth rates of just below one percent and absolute annual changes of about three million. By 2018, the entire U.S. population should reach about 335 million residents, up from 304 million in 2008. The composition of the United States will continue to change in three notable ways: first, the nation is becoming more ethnically diverse; second, the foreign-born population is growing more rapidly than the U.S.-born population; and third, Americans will continue to age. Figure 3.2 shows that by 2018 the share of the population that is non-Hispanic white will decline to about 60 percent with notable increases in the share of Hispanics and Asians. More than 30 percent of projected population growth between 2008 and 2018 is directly attributable to immigration, with children born to immigrants representing another sizable source of growth. Overall, the U.S.-born population will change at a relatively slow rate, and by 2018, 17 percent of all U.S. residents will be foreign-born (Figure 3.3). The fastest growing age groups will be those with baby boomers (Figure 3.4). In 2008, baby boomers were between the ages of 44 and 62, and by 2018 the leading edge will have already entered traditional retirement ages. Thus, the population in prime working ages is projected to grow more slowly than the overall population, and the amount of seniors is projected to grow more rapidly.

Despite the overall aging of the population, one notable change is that a younger age group will surpass one of the baby boom age groups as the most populous in the United States: by 2018, young adults ages 25 to 29 will number 23.3 million, compared to 22.1 million for 55- to 59-year-olds (the largest 5 year age group for the baby boomers). This cohort of young adults is very large for two reasons. First and most importantly, it is the echo of the baby boom; that is, it includes the large cohorts of children born to baby boomers. Second, it includes large numbers of immigrants, as most immigrants come to the United States as young adults. In 2018, we project that 18 percent of 25- to 29-year-olds will be foreign born.

Population projections by educational attainment

Educational attainment distributions are projected based on a continuation of historic trends for each of our population cohorts and are identified separately by race, ethnicity, gender, age, and nativity. We then apply these projected educational attainment distributions to our population projections. Our base year for the projections is 2008, with educational distributions derived from the American Community Survey. We develop projections for eight educational categories (doctorate, professional degree, master's degree, bachelor's degree, associate's degree, some college, high school graduate, and less than a high school graduate) but combine the latter two categories in most of our reporting to be consistent with the BLS education skills categories. Our education projections methodology depends on the age group. The methods are discussed in detail in Appendix D.

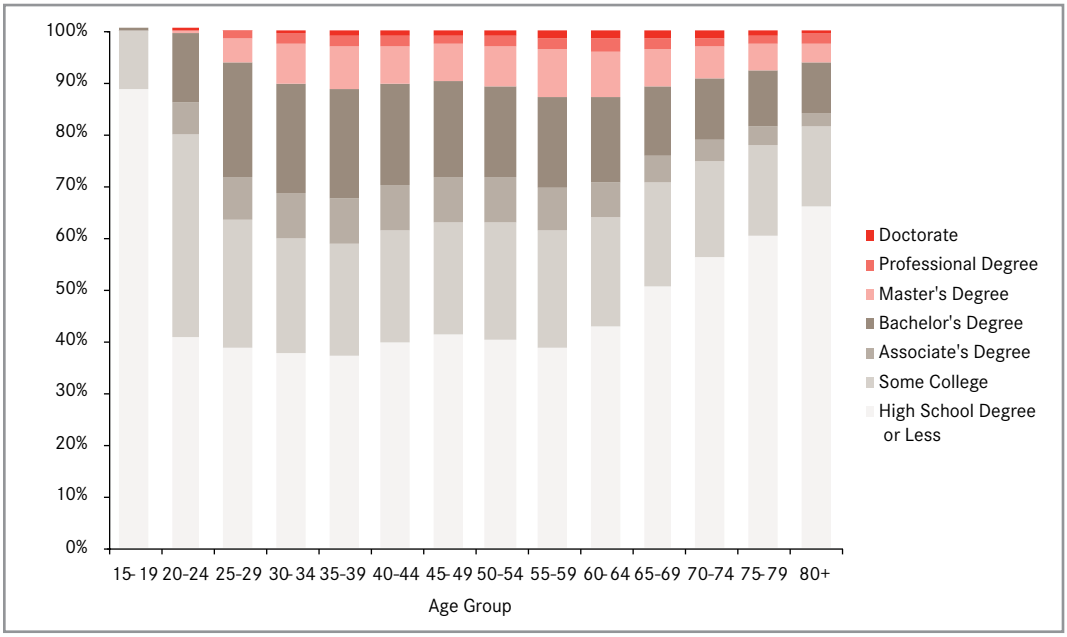
Population projections are not, of course, the same thing as labor force projections. Age-specific labor force participation rates are projected based on past levels for each demographic and education group. To predict the supply of workers ages 16 and over to 2018, we apply labor force participation rates to our population projections. We use labor force participation rates in 2008 from the American Community Survey for each of our population and education subgroups. The product is a new set of labor force projections that includes educational attainment for the labor force as well as all the other population characteristics noted above. Because labor force participation rates are greater for more highly educated people, the educational attainment levels of the workforce are slightly higher than those of the entire population, even controlling for age.

Our education projections show a continuation of recent and modest gains. Among the population ages 25 to 64, the share projected to have at least a bachelor's degree continues to increase, from 27 percent in 2000 to 29 percent in 2008 to 31 percent in 2018 (Figure 3.5). Although strong growth in less-educated immigrant populations is expected to continue, a substantial share of immigrants are college graduates. Strong intergenerational progress and notable increases in educational attainment for U.S.-born groups more than counteracts the demographic shifts towards groups that historically have relatively low levels of educational attainment. And not all the demographic shifts have a dampening effect on educational attainment. Although relatively small in number, U.S.-born and foreign-born Asians are the best-educated population groups in the United States (Table 3.1) and are projected to continue to experience strong rates of population growth (Table 3.2). Finally, we note that the young adults in their late 20s and early 30s have higher educational attainment levels in 2008 than in 2000. We project that this trend will continue to 2018, leading to greater overall gains in educational attainment (Figure 3.6). [20]

[20] Our projections of educational attainment levels are not directly comparable to Hussar and Bailey's "Projections of Education Statistics to 2018" produced by the National Center for Education Statistics (NCES) (2009). (http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2009062) NCES projects the number of degrees awarded each year. It does not project the number of degrees lost to the workforce through retirement or death, nor does it consider the role of international migration.

Figure 3.1

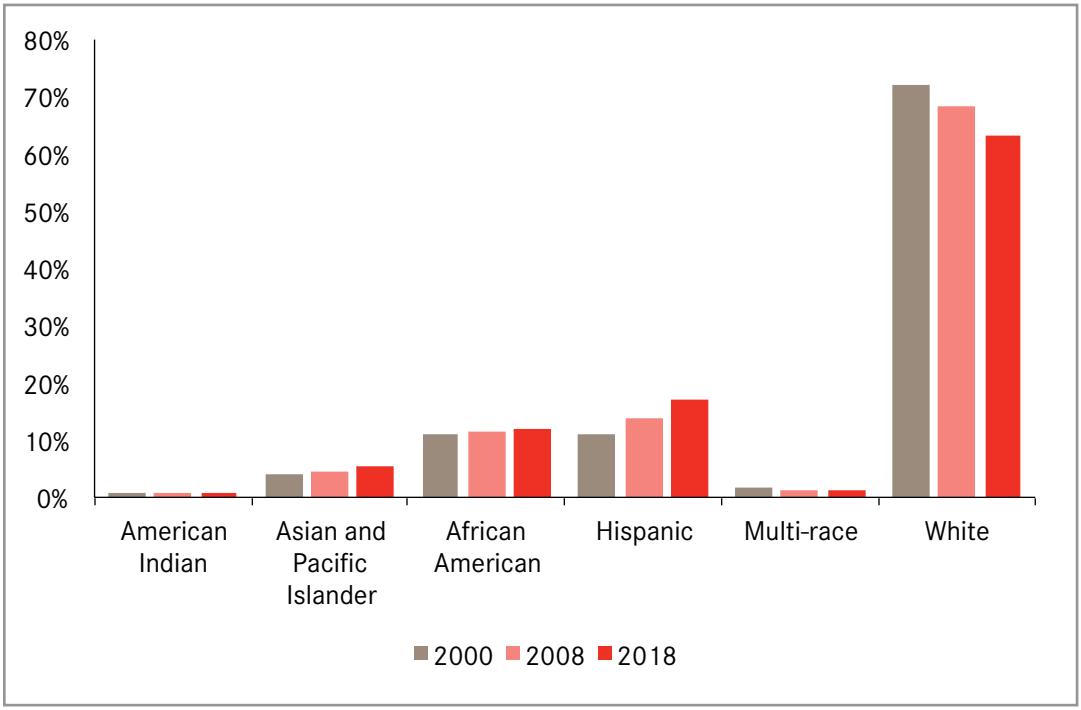
Educational Attainment of the U.S. Population by Age Group, 2008



Source: 2008 ACS.

Figure 3.2

Racial and Ethnic Composition of the U.S. Population, 2000, 2008, and 2018

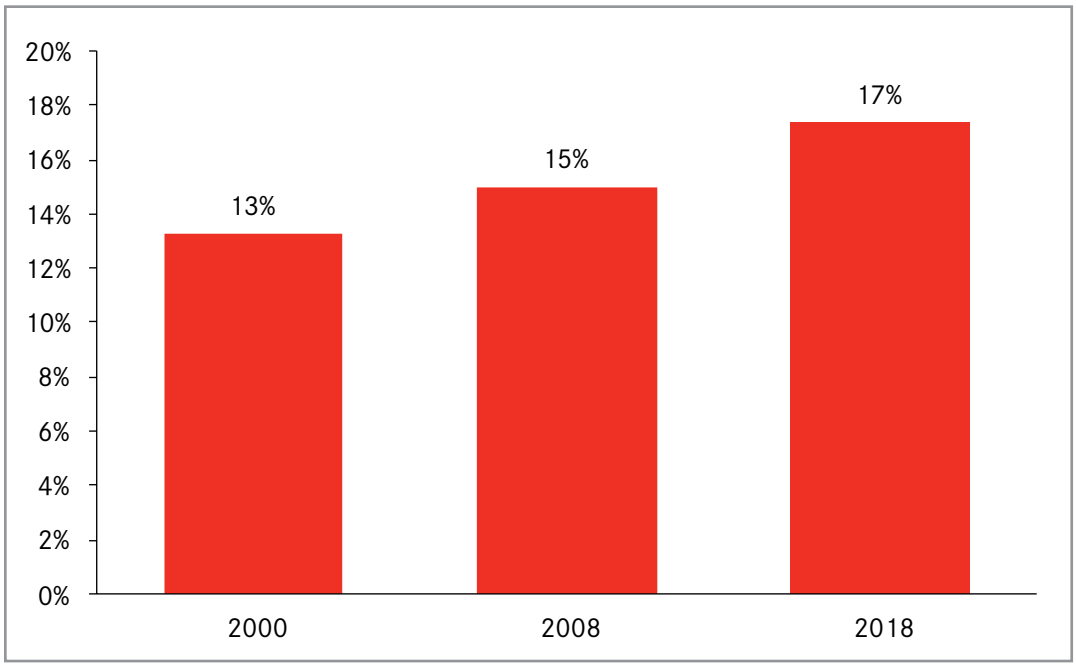


Sources: 2000 decennial census, 2008 ACS, and authors' forecast.

Note: Refers to the population ages 15 and over.

Figure 3.3

Percent of the U.S. Population that Is Foreign Born, 2000, 2008, and 2018

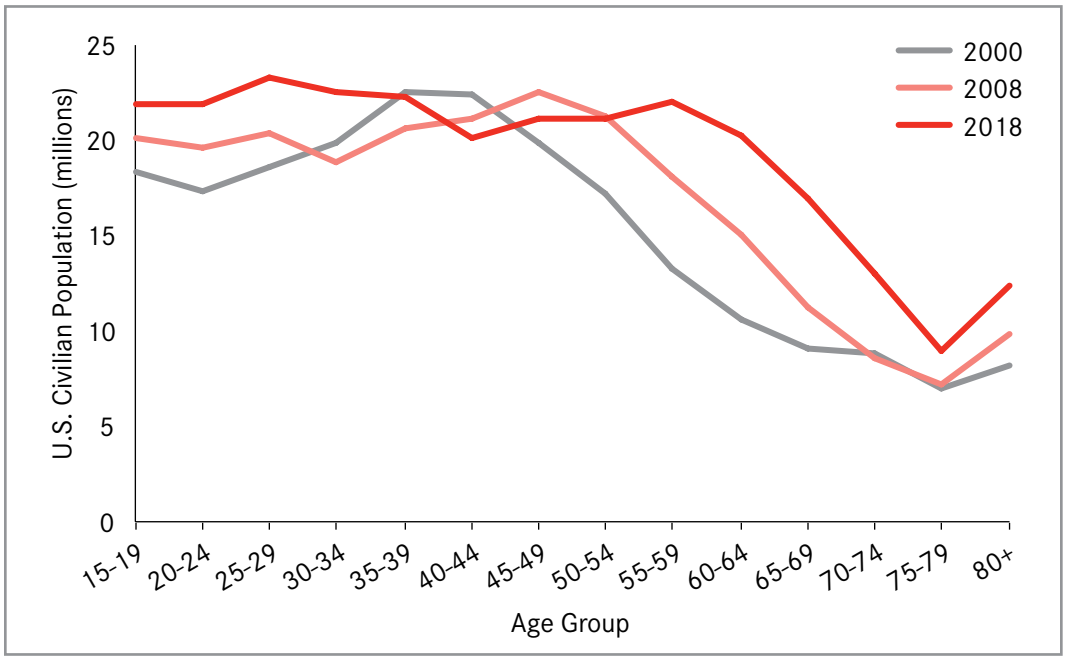


Note: Refers to population ages 15 and over.

Sources: 2000 decennial census, 2008 ACS, and authors' forecast.

Figure 3.4

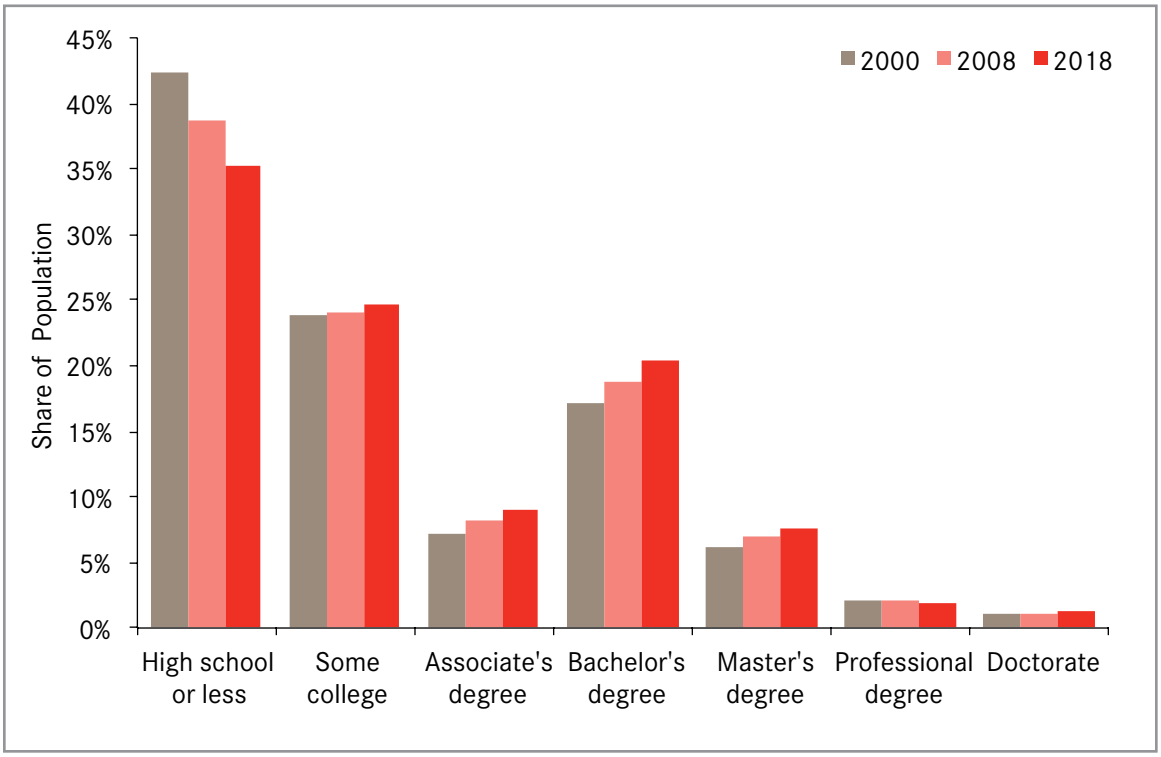
U.S. Population by Age Group, 2000, 2008, and 2018



Sources: 2000 decennial census, 2008 ACS, and authors' forecast.

Figure 3.5

Educational Attainment of U.S. Adults Ages 25 to 64, 2000, 2008 and 2018



Sources: 2000 decennial census, 2008 ACS, and authors' forecast.

Table 3.1

Educational Attainment of U.S. Population by Race and Ethnicity and Nativity, 2008

Foreign Born	Asian and Pacific Islander	African American	Hispanic	White
High school degree or less	28.8%	41.0%	74.5%	31.2%
Some college	12.3%	20.8%	11.4%	16.4%
Associate's degree	6.8%	10.2%	3.7%	8.3%
Bachelor's degree	30.7%	17.7%	7.2%	23.8%
Master's degree	14.4%	7.2%	1.9%	12.6%
Professional degree	3.4%	1.8%	0.9%	3.6%
Doctorate	3.6%	1.2%	0.3%	4.1%
Bachelor's degree or more	52.1%	28.0%	10.4%	44.1%
U.S. Born	**Asian and Pacific Islander**	**African American**	**Hispanic**	**White**
High school degree or less	17.5%	46.4%	47.7%	34.2%
Some college	19.6%	27.3%	25.9%	23.4%
Associate's degree	9.2%	8.1%	8.4%	9.2%
Bachelor's degree	33.9%	12.4%	12.5%	21.5%
Master's degree	11.8%	4.5%	4.0%	8.4%
Professional degree	6.0%	0.8%	1.0%	2.2%
Doctorate	2.0%	0.5%	0.4%	1.1%
Bachelor's degree or more	53.7%	18.2%	18.0%	33.2%

Note: Restricted to adults ages 25 to 64.

Source: 2008 ACS.

Table 3.2

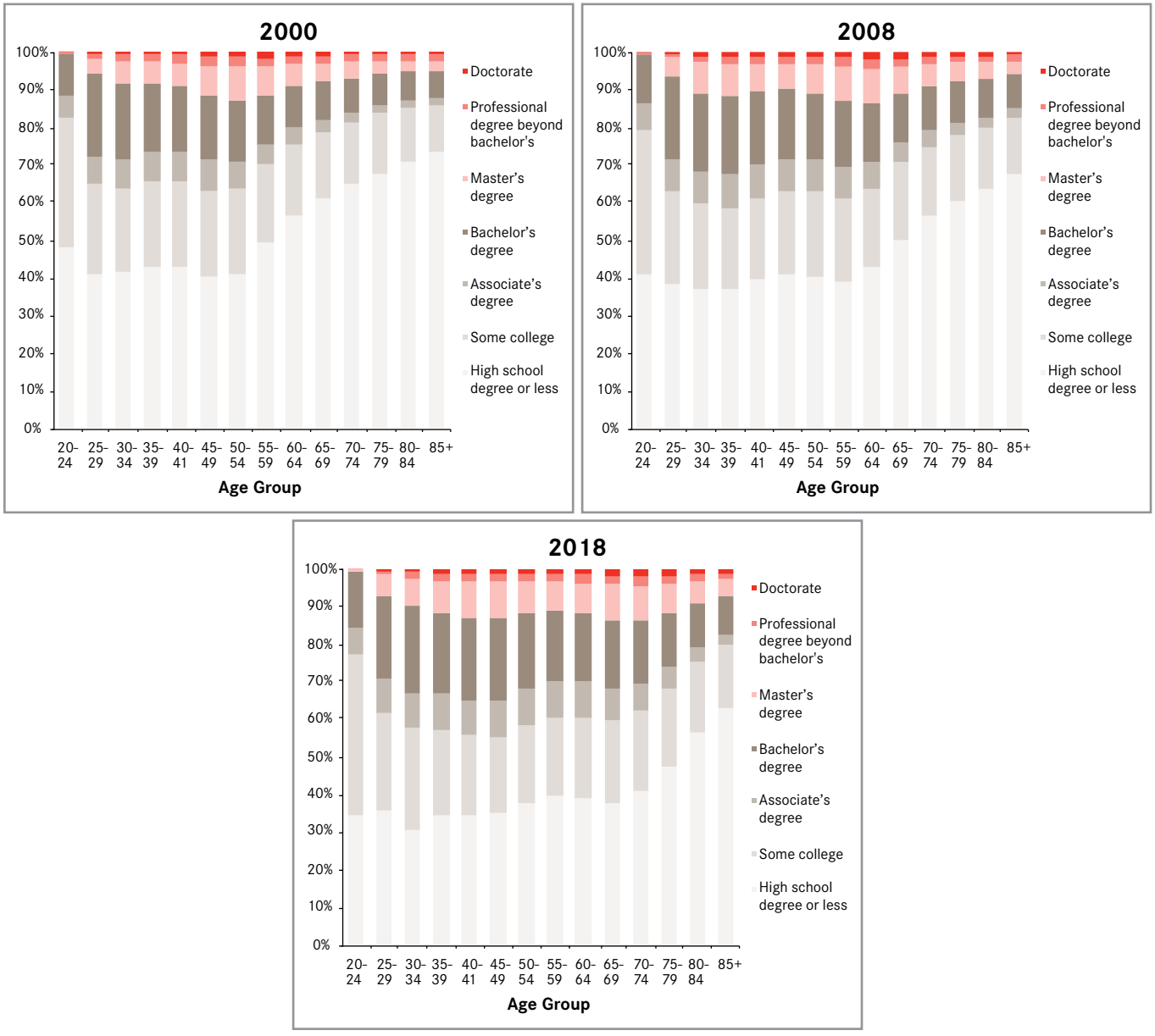
U.S. Educational Attainment and Population Share by Race and Ethnicity, 2000, 2008, and 2018

	Percent of Total Population		
Race/Ethnicity	**2000**	**2008**	**2018**
White	71.5%	67.5%	61.9%
Hispanic	11.2%	14.2%	17.4%
African American	11.0%	11.4%	12.6%
Asian and Pacific Islander	4.1%	5.0%	6.0%
	Education Distribution Within Race/Ethnicity		
	2000	**2008**	**2018**
White			
High school degree or less	38.8%	34.1%	30.3%
Some college	23.3%	23.1%	23.0%
Associate's degree	7.8%	9.1%	10.3%
Bachelor's degree	19.4%	21.6%	23.8%
Master's degree	7.3%	8.6%	9.1%
Professional degree	2.3%	2.3%	2.1%
Doctorate	1.1%	1.2%	1.3%
Hispanic			
High school degree or less	67.9%	63.2%	58.1%
Some college	16.5%	17.5%	19.6%
Associate's degree	4.6%	5.7%	6.7%
Bachelor's degree	7.1%	9.5%	11.5%
Master's degree	2.2%	2.8%	3.2%
Professional degree	1.4%	0.9%	0.5%
Doctorate	0.3%	0.4%	0.4%
African American			
High school degree or less	52.4%	45.8%	39.3%
Some college	25.0%	26.6%	29.2%
Associate's degree	6.6%	8.3%	9.7%
Bachelor's degree	10.8%	13.0%	15.1%
Master's degree	3.8%	4.8%	5.4%
Professional degree	0.9%	0.9%	0.8%
Doctorate	0.4%	0.6%	0.6%
Asian and Pacific Islander			
High school degree or less	31.6%	26.9%	20.7%
Some college	14.8%	13.5%	13.0%
Associate's degree	7.1%	7.2%	7.2%
Bachelor's degree	28.2%	31.2%	34.7%
Master's degree	11.4%	13.9%	16.8%
Professional degree	4.0%	3.8%	3.7%
Doctorate	2.9%	3.4%	3.8%
	Percent with Bachelor's Degree or Beyond by Race/Ethnicity		
Race/Ethnicity	**2000**	**2008**	**2018**
Asian and Pacific Islander	46.6%	52.3%	59.0%
African American	16.0%	19.3%	21.9%
Hispanic	11.0%	13.6%	15.6%
Multi-race	24.4%	27.5%	34.2%
White	30.1%	33.7%	36.4%

Notes: Decennial census 2000 and ACS 2008 data are used for historical trends. Data on the 2018 population is forecasted according to the Census Bureau methodology using decennial census 2000 as the base population. The sample only includes 25- to 64-year-olds.

Figure 3.6

U.S. Educational Attainment by Age Group, 2000, 2008, and 2018



Sources: 2000 decennial census, 2008 ACS, and authors' forecast.

4. Comparing the skill requirements and population projections to identify potential labor force skill shortages

Based on educational attainment, our population projections give us a measure of the future *supply* of workers while the projections of skill requirements by occupation give us a measure of the future *demand* for workers. Comparing these two projections allows us to identify potential imbalances between the future supply and demand for workers. In Table 4.1 and Figure 4.1, we compare our preferred educational attainment projections – based on the ACS and decennial census data – with the employment projections. We adjust our population projections to reflect labor force participation rates. Specifically, we apply labor force participation rates from 2008 to our population projections that include educational attainment. We use data from the ACS and disaggregate the labor force participation rates by education for each of our population subgroups.[21]

The supply shares by educational attainment are based on our population projections, and the demand shares are based on our alternative economic projections. For 2008, these shares are applied to published BLS data on the labor force and employed persons ages 16 and over.[22] Therefore, the difference between supply and demand in 2008 reflects unemployment. That is, the supply represents all workers in the labor force (both those employed and unemployed) while demand represents employed workers.[23]

In 2018, we calculate the supply shares by educational attainment using the population projections described in Section 3. We calculate demand shares by educational attainment using the dynamic alternative employment projections described in Section 2. The demand shares are applied to the total BLS data on projected employed persons, adjusted for moonlighting, which gives us the projected demand for employees by educational attainment. To calculate the supply of labor, we multiply the total employed persons by the 2008 ratio of the labor force to employed persons from the BLS data to get an estimate of the size of the aggregate labor force.[24] The population projection shares by educational attainment are then applied to the estimated labor force to give us our projected labor supply for 2018.

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[21] A concern has been raised regarding the measurement of labor force participation rates of older adults in the ACS (Alexander, Davern, and Stevenson, 2010). These measurement problems are very minor for the 2008 ACS.

[22] Labor force and employment figures for individuals ages 16 and over are from BLS. "Labor Force Statistics from the Current Population Survey": ftp://ftp.bls.gov/pub/special.requests/lf/aa2008/pdf/cpsaat8.pdf (accessed April 11, 2010). It should be noted that the employment figure of 145.4 million in 2008 is in line with our estimate of employed persons derived from the BLS occupational employment figures after applying the moonlighting rates described in Section 1, which we estimated at 146 million employed persons.

[23] We do not adjust our supply estimates or projections to account for unemployment. Thus, the unemployed are included in our estimates of the supply of workers but our demand is based on the number of workers holding jobs. As discussed earlier, we also adjust the BLS job projections to reflect demand for workers by taking into account multiple jobholding by some workers. Thus, the numbers in Table 4.1 reflect workers rather than jobs.

[24] The unemployment rate in 2008 was 5.8 percent, which is in line with historical national averages. For more information see BLS. (accessed April 10, 2010).

The primary finding based on our preferred alternative projections is that we do not see evidence of an impending shortage of skilled workers in the United States through 2018. For the most part, our projections of the supply of workers match up quite well with the demand for workers. We do see projected shortages for people with an associate's degree, and the projections point to some excess supply of less-educated workers (those with some college or a high school degree or less) who could be "bumped up" to fill the demand for workers with associate's degrees. At the same time, there is also a projected excess supply of workers with slightly more education (a bachelor's degree) who might fill jobs requiring only an associate's degree. We also see projected shortages for workers with a doctorate, but this is our smallest education group and it is probably the least precisely projected.

For purposes of comparison, the far right column in Table 4.1 and the grey bars in Figure 4.1 show demand estimates and projections based on our projections using BLS skill distributions. In contrast with the findings just discussed, these BLS-based estimates and projections of employment and worker demand imply that the supply of more highly educated workers has, and will continue to, far outstrip the demand for such workers; thus, one certainly gets no more evidence of skill shortages from using the BLS data. Differences between the BLS-based estimates and projections and those of our alternative preferred approach show most starkly in Figure 4.1. If the BLS numbers are correct, we might expect to see higher unemployment and greater underemployment of more highly educated workers in the United States. As noted earlier, we find no such evidence of underemployment reflected in earnings data. Similarly, labor force participation rates are higher and unemployment rates are lower for more highly educated workers. In the 2008 data, for example, unemployment rates of workers with a high school degree or less are more than twice as high as for workers who have attended some college or have an associate's degree (9.1 percent compared to 4.4 percent) and are more than three times as high as the unemployment rates for workers who have at least a bachelor's degree (2.8 percent).

Our finding of no overall shortage in skills, as measured by educational attainment, relies partly on three key assumptions. First, we project continued upgrading of educational attainment levels of older workers. Section 5 contains a more complete discussion of those trends. Second, we project that young adults will continue to experience improvements in educational attainment compared to the cohorts that preceded them. Specifically, we project that young adults in their late 20s and 30s in 2018 will be better educated than adults of the same ages in 2000. For example, in 2008, 30 percent of 25- to 34-year-olds had at least a bachelor's degree, compared to 28 percent in 2000. Our projection is that in 2018, 31 percent of 25- to 34-year-olds will have at least a bachelor's degree. In addition, we expect that labor force participation rates will continue to rise for more highly educated older adults and that past patterns in retirement will prevail for the baby boom as it reaches retirement ages. Section 5 has a discussion of retirement patterns as well.

One reason we might not see evidence of a skill shortage is that our projection horizon is too short. Our projections extend to 2018, but the majority of boomers (two of every three) will be younger than age 65 in 2018. In 2018, 6.1 million boomers with a bachelor's degree will be ages 60 to 64, compared to only 4.4 million boomers ages 60 to 64 and with a bachelor's degree in 2008. Extending the projections to 2030 would much more effectively capture the labor market implications of the aging baby boomers. In 2030, even the youngest boomers would be 66 years of age. Some speculation about the possible implications of extending projections to 2030 is discussed in Insight 2.

It is important to emphasize that our projections are national in nature and do not preclude the possibility of shortages in certain states. Earlier work for California shows that the state faces substantial workforce skill challenges (Neumark, 2005a; Neumark, 2005b; Johnson, 2005; Johnson and Sengupta, 2009; Johnson and Reed, 2007). In Insight 3, we identify states that could face challenges similar to those in California because of the projected changes in their demographic composition toward less-educated groups (as highlighted in Figure 3.7). And Insight 4 discusses some evidence on skill shortages in other developed countries.

Finally, our projections are based on broad education categories, and do not include training or education related to specific occupations. For example, we do not have projections based on school major or on certificates earned in career technical programs. Shortages could develop in certain occupations even if overall levels of educational attainment between population supply and economic demand appear to be well matched. Insight 5 discusses some occupation-specific concerns for the United States. Table 4.2 shows some occupations, measured at the three-digit SOC code, that have high projected growth rates and that, according to the ACS, have a high share of workers with at least a bachelor's degree. If shortages develop within certain occupations, these are the occupations that could be most vulnerable.

Table 4.1

Estimated and Projected Supply and Demand for Workers by Educational Attainment, 2008 and 2018

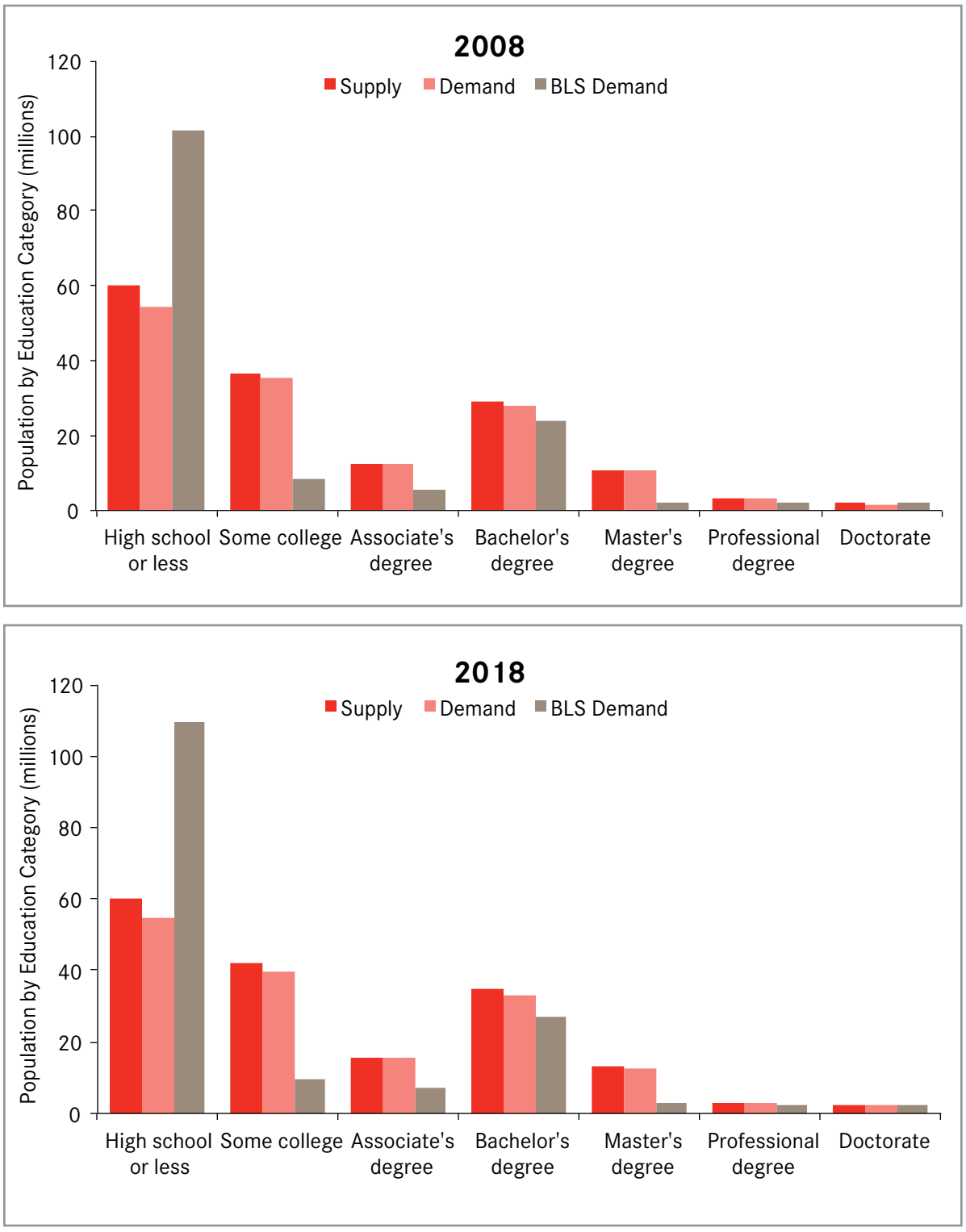
2008 Supply and Demand for Education by Education Category								
		Workers (thousands)			Share			BLS
	Education Category	**Supply**	**Demand**	***Diff***	**Supply**	**Demand**	***Diff***	**Demand**
1	High school degree or less	60,024	54,539	*5,485*	38.9%	37.5%	*1.4%*	69.7%
2	Some college	36,842	35,182	*1,660*	23.9%	24.2%	*-0.3%*	5.8%
3	Associate's degree	12,652	12,144	*507*	8.2%	8.4%	*-0.2%*	4.0%
4	Bachelor's degree	28,985	28,038	*947*	18.8%	19.3%	*-0.5%*	16.3%
5	Master's degree	10,856	10,614	*243*	7.0%	7.3%	*-0.3%*	1.6%
6	Professional degree beyond bachelor's	3,110	3,059	*51*	2.0%	2.1%	*-0.1%*	1.3%
7	Doctorate	1,817	1,786	*31*	1.2%	1.2%	*-0.1%*	1.3%
	All education categories	**154,286**	**145,362**	***8,924***	**100.0%**	**100.0%**	***0.0%***	**100.0%**
2018 Supply and Demand for Education by Education Category								
		Workers (thousands)			Share			BLS
	Education Category	**Supply**	**Demand**	***Diff***	**Supply**	**Demand**	***Diff***	**Demand**
1	High school degree or less	59,950	54,701	*5,248*	35.1%	34.0%	*1.1%*	68.3%
2	Some college	42,008	39,560	*2,448*	24.6%	24.6%	*0.0%*	5.9%
3	Associate's degree	15,509	15,879	*-371*	9.1%	9.9%	*-0.8%*	4.3%
4	Bachelor's degree	34,931	32,822	*2,109*	20.5%	20.4%	*0.1%*	17.0%
5	Master's degree	12,956	12,608	*348*	7.6%	7.8%	*-0.2%*	1.7%
6	Professional degree beyond bachelor's	3,084	2,816	*268*	1.8%	1.8%	*0.1%*	1.4%
7	Doctorate	2,143	2,326	*-183*	1.3%	1.4%	*-0.2%*	1.4%
	All education categories	**170,579**	**160,713**	***9,866***	**100.0%**	**100.0%**	***0.0%***	**100.0%**

Note: See text for detailed methods.

Sources: 2008 BLS Household Data Annual Averages (2008 worker demand), BLS Employment Projections, 2008 ACS, and authors' calculations.

Figure 4.1

Supply and Demand for Workers by Education Level, 2008 and 2018



Sources: BLS Employment Projections, 2008 ACS, and authors' calculations.

Table 4.2

Occupations with High Growth and a Majority Share of College Graduates, 2008 and 2018

Growth Rank	3-Digit SOC	Description	2008 BLS Population (workers, in thousands)	Annual Growth	2018 ACS Distribution		
					High School Or Less	Some College	Bachelor's Or Higher
1	151	Computer scientists and systems analysts	3,248	2.0%	6.2%	25.8%	68.0%
2	291	Health professionals	4,386	2.0%	2.7%	25.2%	72.1%
3	253	Other teachers and instructors	1,050	1.7%	11.7%	31.5%	56.8%
4	211	Counselors and social workers	1,844	1.7%	8.7%	21.5%	69.8%
5	131	Agents and business managers	3,863	1.6%	11.2%	29.2%	59.7%
6	132	Financial professionals	2,660	1.6%	6.5%	20.7%	72.8%
7	251	Postsecondary teachers	1,598	1.4%	16.1%	4.9%	79.0%
8	252	Primary and secondary teachers	4,293	1.3%	9.0%	10.9%	80.2%
9	172	Engineers	1,492	1.1%	4.2%	12.8%	82.9%

Notes: Thresholds for inclusion of occupations in this table include: more than 1 million workers in 2008 according to BLS; more than 50 percent bachelor's degrees or higher in 2018 according to the authors' calculations; more than 1 percent annual growth. SOC descriptions at the 3-digit level are not provided by the BLS, and are created by the authors based on lower-level occupation descriptions. Annual growth is the compound annual growth rate between the BLS 2008 and 2018 population numbers. The ACS distribution for 2018 uses the dynamic forecasting described in the text.

5. The role of middle-aged and older workers in alleviating skill shortages

Our findings that adults in the United States will have educational attainment levels that are well matched with economic demand depends on two critical trends: first, the continued skills acquisition of middle-aged workers; and second, the ongoing labor force participation of older workers.

Skills acquisition of middle-aged workers

Our projections and analyses of historic trends in skills (i.e., educational attainment) acquisition allow us to identify the extent to which middle-aged workers have continued to acquire new skills. We develop two primary measures of skills acquisition for adults of non-traditional school age: one uses a synthetic cohort approach (described in Appendix E), and the second is based on school enrollment rates of middle-aged adults using data from the American Community Survey.[25] We provide information on the share of any adults enrolled in any level of schooling, as well as restricting the sample to adults enrolled in schooling that is above their current educational attainment level.

Results based on our cohort analyses are shown in Figures 5.1 through 5.3. We project a notable upgrading of educational attainment levels based on recent historic patterns. Overall, among adults ages 40 to 64 in 2018 (ages 30 to 54 in 2008), we project that almost 1 million will have earned a bachelor's degree between 2008 and 2018, and an additional 1.2 million will have earned a master's degree (Figure 5.1).[26] Although these increases represent only a small share of the 104.9 million adults in this age range in 2018, they do represent a substantial share of the net increase in the supply of workers with these degrees.

Patterns of educational upgrading vary tremendously by nativity. Among U.S.-born adults, we project substantial increases in the number of middle-aged adults earning a master's degree (Figure 5.2), while among the foreign-born we project that the strongest increases will be in earning a high school degree (or GED) and in earning a bachelor's degree (Figure 5.3). These differences partly reflect the differences in educational attainment between the U.S.-born and the foreign-born, with the pool of foreign-born adults without a high school degree being quite large. However, the foreign-born patterns might also reflect immigration and emigration rates that differ by educational attainment, with less-educated immigrants more likely to return to their countries of origin and better-educated immigrants more likely to stay in the United States.

Enrollment in school among non-traditional-aged students is consistent with this educational upgrading. As shown in Figure 5.4, school enrollment declines with age. Among those ages 30 to 34 from 2006 through 2008, 5 percent are in undergraduate programs (including community colleges)

[25] We also examined data from the Integrated Postsecondary Education Data System, but have not reported those analyses due to apparent problems in age reporting in the data.

[26] The figures only go through age 64 because there is minimal upgrading at age 65 and over. (See Figure 5.4, discussed below.)

and 3 percent are in graduate programs.[27] For adults in their late 50s, less than 1 percent are in such programs. It is worth noting that the number of students enrolled is much larger than the number that eventually earns a degree. Other research shows that older students take longer and are less likely to earn a degree than younger students (Scott, Bailey, and Kienzl, 2006).

Labor force participation of older workers

Older workers might respond to changing labor market conditions by altering their retirement behavior. We examine decennial census and ACS data for recent older cohorts, estimating the level of employment or retirement at each age, as well as trends. Figure 5.5 shows that retirement rates are substantially lower for highly educated older adults than for those with less education. Moreover, retirement rates, which increased notably from 1970 to 1980 and remained near those levels for several decades, have recently declined. For older age groups, retirement rates are now lower than they were even in 1970.

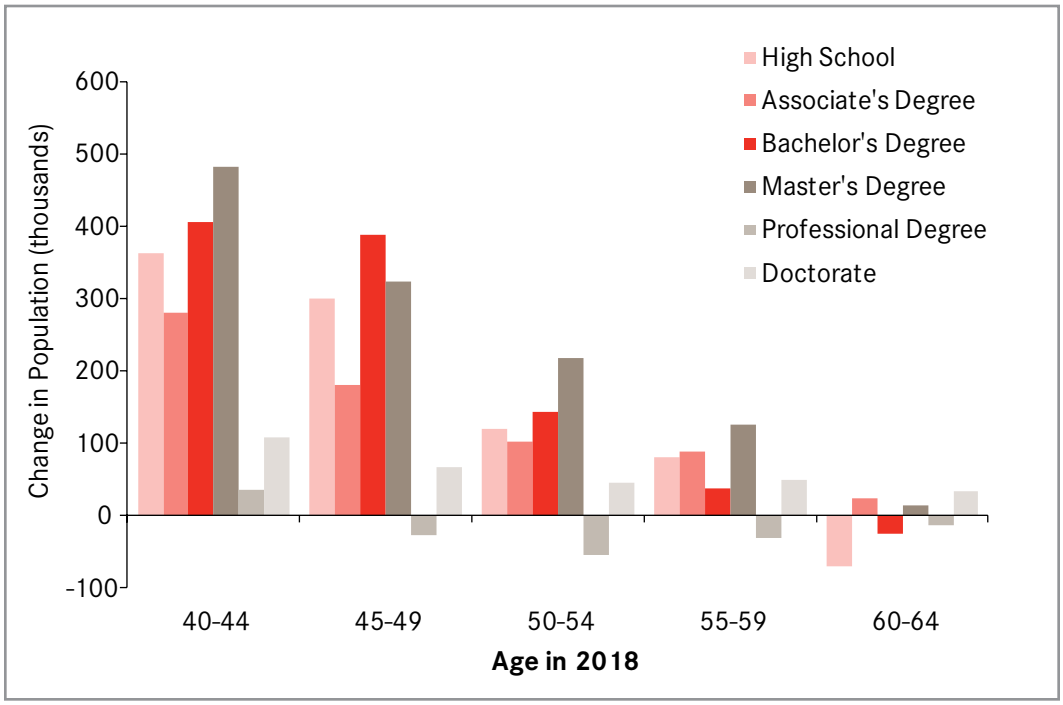
This decrease in retirement rates is consistent with other recent work speculating that the labor force participation of older individuals may increase modestly. In particular, Toossi (2009) suggests that a number of factors, including good health, the cost of health insurance, the shift from defined benefit to defined contribution pensions, and changes in Social Security, should all engender a shift toward increased labor force participation. However, these and other changes (for example, health insurance reform) could introduce considerable uncertainty.

Our projections of labor force participation rates for older adults allow recent patterns to continue. Specifically, we project greater rates of labor force participation for highly educated older adults than for those with less education. Because better educated cohorts are entering older adult age groups, our projected overall labor force participation rates are even higher in 2018 than they were from 2006 through 2008.

[27] This discussion is based on the restricted sample that only considers enrollment for adults in schooling that is above their current level of educational attainment. The numbers are slightly higher if we include adults enrolled in schooling that is at or below their current level of education, but the patterns remain the same.

Figure 5.1

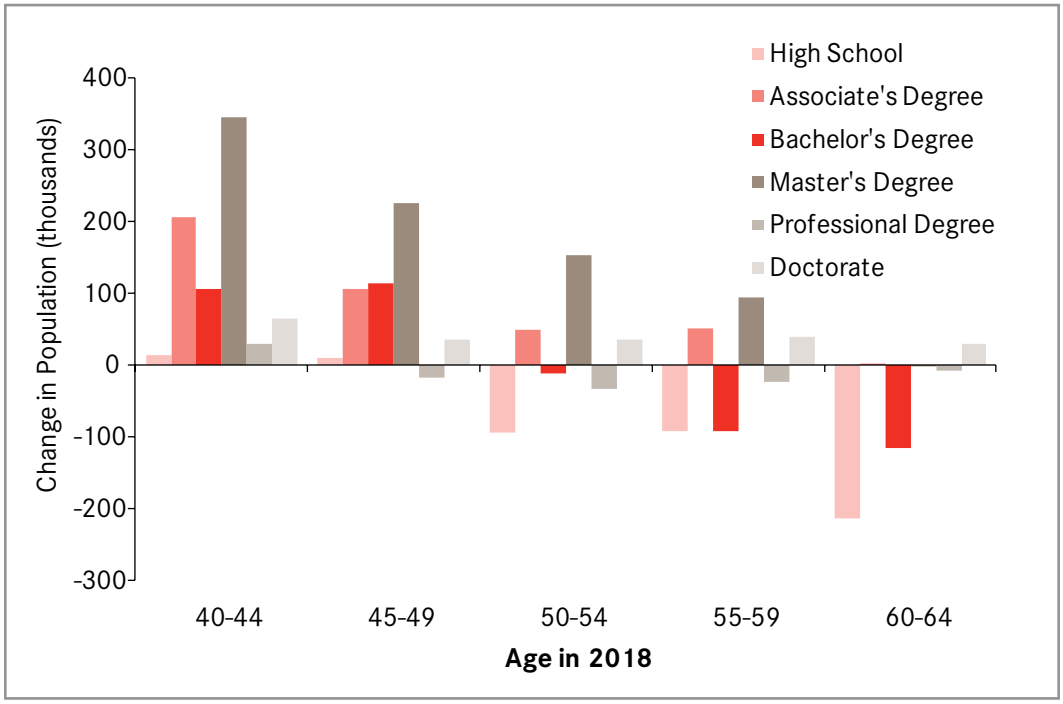
Projected Educational Upgrading from 2008 to 2018



Source: Authors' projections, 2008 -2018.

Figure 5.2

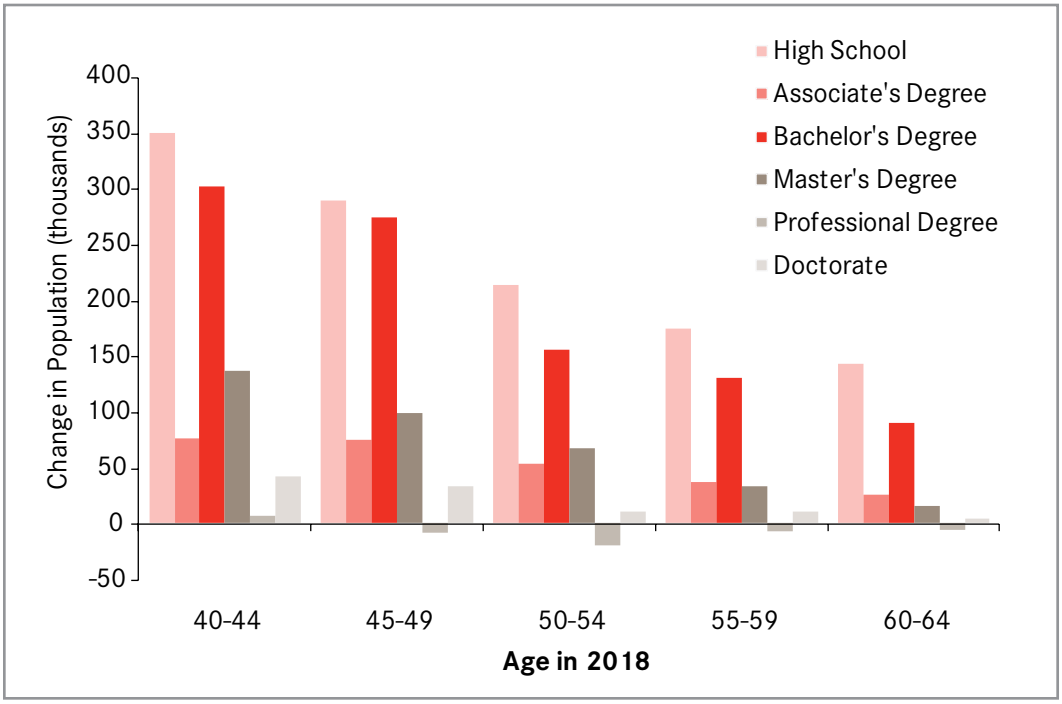
Projected Educational Upgrading of U.S.-Born Adults from 2008 to 2018



Source: Authors' projections, 2008-2018.

Figure 5.3

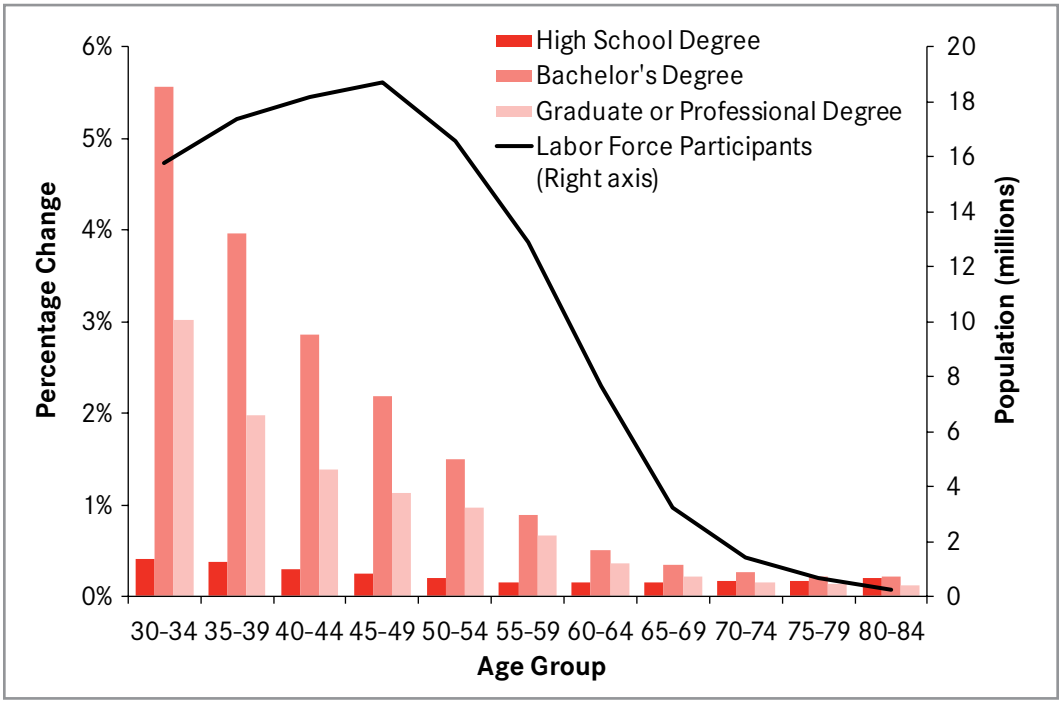
Projected Educational Upgrading of Foreign-Born Adults from 2008 to 2018



Source: Authors' projections, 2008-2018.

Figure 5.4

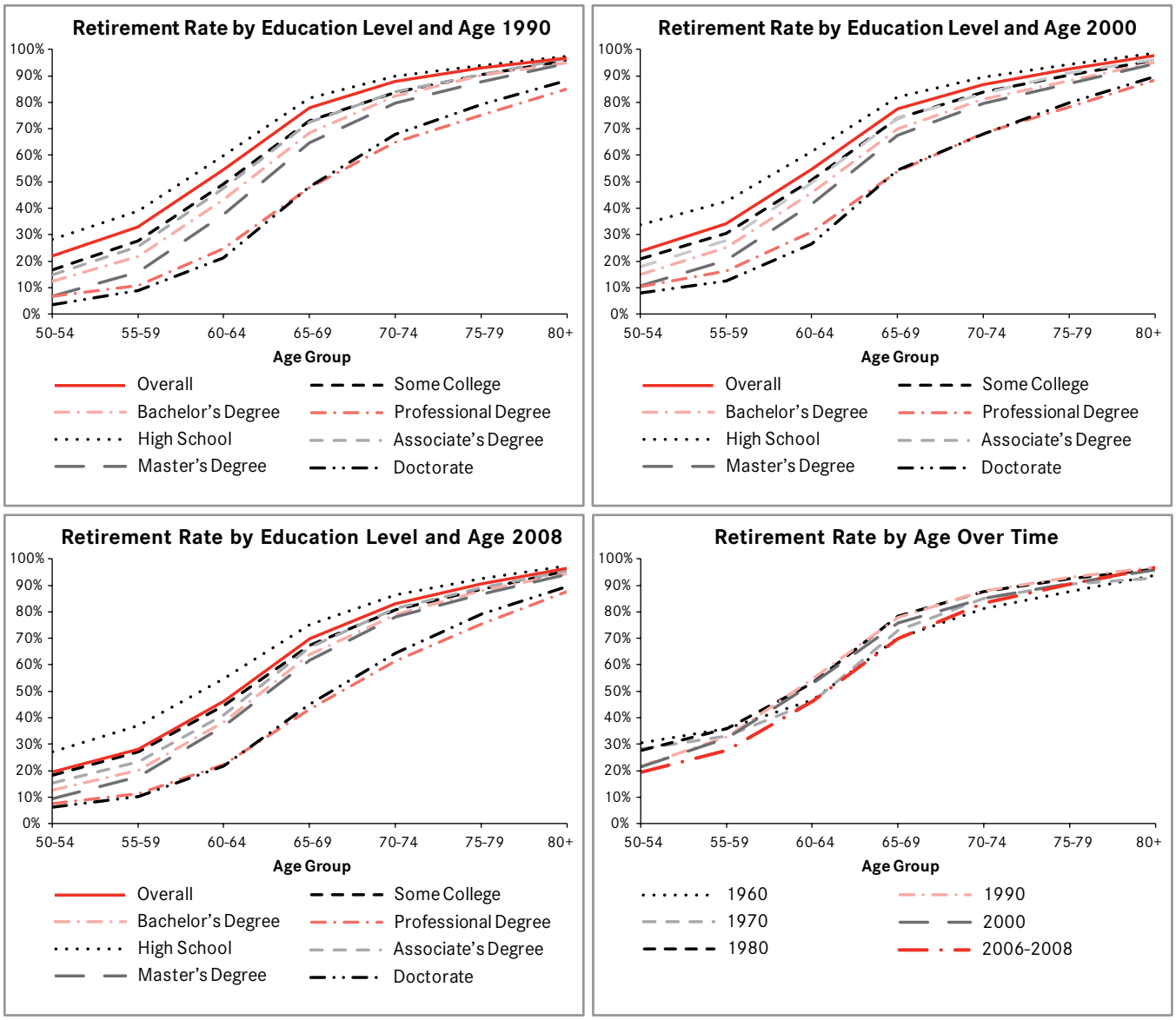
School Enrollment of Non-Traditional-Aged Students, 2006-2008



Source: American Community Survey, 2008-2018.

Figure 5.5

Retirement Rates by Education Level and Age for Older Adults, 1990, 2000, and 2008



Notes: Retirement is defined as those who are not actively participating in the labor force.

Sources: Decennial census and ACS, 1950-2008.

6. The meaning of skill shortages

The discussion to this point has focused on the potential for differences between projections of the employment needs or demands for workers at different educational levels, and the projected supplies. In everyday parlance, evidence of future demands outstripping supply would be referred to as "shortages." As it turns out, for the United States as a whole the evidence does not suggest serious skill shortages. However, as already noted, skill shortages may emerge in some states and/or in some occupations. And as we discuss below, it is possible that over a longer time horizon (for which we have not done projections in this report) skill shortages may surface.

Of course, in a market economy shortages are resolved by the market, and hence do not, literally speaking, emerge. This is especially true over the longer-run. In this section we flesh out what it means to think about skill shortages, and the potential scope for policy responses given this theoretical perspective that markets resolve shortages.[28]

Freeman (2006) suggests that in this context, the projected "shortages" of skilled workers should include the "changes in prices from long run equilibrium values that could have been avoided if market participants had foreseen the shifts in demand or supply better than they did" (pp. 1-2). In fact the problem is even more complex because adjustments to projected skill shortages are likely to be numerous. First, we should expect supply responses. For example, in reaction to price increases for more skilled labor, we would expect workers to acquire more skills. In addition, higher prices for skilled workers might entice them to re-enter the labor market (for instance, after childbearing) or to remain in the labor market longer than now occurs (for instance, delaying retirement). Second, we would expect demand responses. Whereas demand projections by skill assume "business as usual" with regard to the types of workers used in particular industries and occupations, if the price of skilled labor rises substantially, employers would likely move away from skilled labor and toward less-skilled labor. In the face of skill shortages, we might also expect more demand for skilled immigration (as well as more supply). In this case the extent of the response would depend on immigration policy.[29] And given that capital is more mobile than labor, if the skilled immigration were not forthcoming, U.S. firms would likely find ways to employ skilled workers overseas. This prospect appears to be more attractive with rising education levels in countries such as India and China. Of course, the same might apply to across-state variations within the United States. Employers in need of skilled workers might be deterred from operating in states with severe skill shortages. Thus, rather than use the term "shortages," it might be best to think of the projections in this report as indicating how demands and supplies for skilled workers would evolve in the absence of this entire set of responses.[30]

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[28] See Barnow, Trutko, and Lerman (1998) for discussion of some of these issues. Aside from the market's ability to correct labor shortages, Barnow, Trutko, and Lerman note that government may overreact to shortages and hence create countervailing problems. They state that government efforts to increase supplies to reduce shortages do have potential negative consequences for the wages of workers in the shortage occupations.

[29] Freeman (2006) presents evidence that this happened during the 1990s.

[30] Freeman (2006) provides a nice summary of these issues. He also discusses other problems with projecting skill needs that are beyond the scope of this report. Many of these have to do with the issue discussed above, that some of the responses to skill shortages lead to differences relative to the "independent" projections of skill demands and supplies.

What implications, then, would projected skill shortages have for policy? Does the preceding discussion simply imply that even in states where skill shortages might be severe, we need not be concerned because the shortages will never actually emerge and will be resolved by markets? Or are there steps policymakers should contemplate to ensure that markets respond strongly enough so that the projected relative growth in skill demands poses fewer costs? And should policymakers try to shape how markets respond to the strong growth in relative demand for skilled workers, so that their constituents reap more benefits and bear fewer costs from these changes?[31]

There are no hard-and-fast answers to these questions, and certainly for the purposes of this report, our goal is only to highlight some of the issues. We have organized the discussion around the likely ways in which workers and employers will respond to shortages (as redefined) in the preceding paragraphs.

The first point to recognize is that even if businesses respond to increases in the price of skilled labor by substituting less-skilled labor, this nonetheless implies real costs for companies.[32] In the simple neoclassical theory of the firm, businesses choose cost-minimizing input choices. Increases in the prices of an input (in this case, skilled labor) will increase employers' marginal costs and consumer prices, reducing overall labor demand. That does not necessarily imply that policy efforts to increase the supply of skilled labor, and hence avoid these cost increases for companies, would necessarily be preferable, since increasing skill levels also entails costs. Moreover, a policy intervention may not be called for, since one might simply rely on individual decisions regarding the acquisition of more skills to generate the "right" market response. However, to the extent that there are barriers to individuals or businesses making decisions regarding investments in higher skills, there may be scope for policy intervention. Especially when there are such barriers, it is possible that the cost of removing them so that there is a greater supply response of skilled workers is less than the costs entailed by more sharply rising prices for skilled workers and a more muted supply response.

Consider, first, the role of businesses investing in workers to increase skill levels via training. It is well known, going back to the work of Becker (1964), that firms have little incentive to invest in worker skills that lead to the accumulation of general human capital, of which schooling is surely the best example. Of course this might not be a concern, as individuals may be relied upon to make decisions about the right amount of investment in general human capital. However, there is a good deal of theoretical work (e.g., Acemoglu, 1997) showing that once one moves beyond simple models of competitive labor markets, underinvestment in training can occur. Similar results on underinvestment can hold for specific training (Balmaceda, 2005). This report is not the place to provide an assessment of these conjectures. Nor does this work necessarily predict how investment in training would respond to *changes* in the demand for high-skilled workers. It would be a mistake

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[31] One of our high school economics teachers used to insist, back in the midst of the oil price shocks of the mid-1970s, that there was no energy crisis, because prices would rise to equalize the supply and demand. But that does not imply that policy can play no role in determining the prices at which supply and demand are likely to balance out, as well as the distributional consequences of those price changes (both within the United States, and between the United States and other oil producers).

[32] Barnow, Trutko, and Lerman (1998) provide a nice discussion of firm responses to skill shortages, including many responses aside from substitution of less-skilled labor or other inputs (such as stepped up recruiting). Of course stepped up recruiting cannot increase the aggregate supply of skill.

to assume that the optimal amount of training necessarily occurs in response to the price signals conveyed through wages.[33]

With respect to investments in schooling, similar concerns arise. It is commonly argued that capital market constraints can deter investments in schooling by the young (e.g., Haskel and Holt, 1999).

Moreover, if there are positive unintended consequences from investments in schooling (for evidence, see Moretti, 2004), then social returns exceed private returns, and individuals may under-invest in schooling. Again, these types of arguments do not necessarily imply that schooling will not increase in response to a rise in wages for workers with more education. These arguments do, however, caution against assuming that markets bring forth the right level of skills. Moreover, we know from the projections discussed earlier in this report that part of the reason for the projected shortfall in the supply of educated workers stems from the growth of minority and immigrant populations, and that these groups likely face more severe capital constraints. The issue of capital market constraints is likely to be an important factor that could potentially deter some of the supply response.

It is reasonable to ask how much scope there actually is for schooling to respond to changes in the economic returns to education. We know that in the latter part of the 20th century, there were sharp increases in the returns to schooling (e.g., Goldin and Katz, 2007). Yet there is essentially no evidence that there was a supply response in terms of increased shares of workers with higher education. Indeed the most serious part of the run-up in schooling wage premia is attributed to the rising demand for educated workers in the face of a *decline* in the growth rate of educated workers (Blackburn, Bloom, and Freeman 1990; Goldin and Katz, 2007). According to Goldin and Katz, the decline in the growth rate of education is not principally due to the changing composition of the U.S. population, which experienced a rapid growth in immigration beginning in 1965. Rather, they attribute most of this decline to developments among the native-born (p. 155).

Indeed, in a discussion of the Goldin and Katz study, which is one of the most recent works to review the evidence on changes in the demand and supply of skilled workers, Gary Burtless noted explicitly the puzzling finding that male educational attainment has been declining while returns to education have been rising. Further, despite the run-up in returns to school, the amount of schooling among men ages 16 to 24 is the same now as it was in 1979 (discussion of Goldin and Katz, 2007, p. 166). Note that this apparent absence of a supply response is among *young* cohorts who *can* respond easily by staying in school. In contrast, we might expect less response among older cohorts who have already finished full-time schooling – a factor that would impede the extent to which skill levels among workers might rise in response to greater demand for more highly educated labor. On the other hand, there may be some scope for a supply response among older workers via the labor supply, rather than

[33] There may also be more idiosyncratic barriers to investment in particular fields. For example, consider supply responses in the two fields that are examined in Insight 5 – nursing and green jobs. The nursing industry has often been viewed as having some characteristics of a monopsonistic industry (e.g., Sullivan, 1989) where increased demand may not result in a sufficient increase in wages to call forth the needed supply response. In such a case, public policies increasing subsidies for training individuals for these occupations may be necessary. In green jobs uncertainty may deter training, and this uncertainty may even be exacerbated by government policy. Workers contemplating investing in retraining for green industries may have legitimate concerns that government subsidies for these industries may be withdrawn in the future (as has happened in the past for wind energy, e.g., Gipe, 1995), and hence may only engage in the retraining if there are subsidies.

additional investments in skill. For example, rising wage premia for more highly educated workers may induce older educated workers to remain in the labor force a bit longer, or induce educated women who may have left the workforce for childrearing to re-enter the labor market.

Despite the fact that education levels might be expected to rise in response to increases in demand for more highly educated workers, the possibility of such supply responses has received remarkably little attention in the research literature. This is true of research looking both backward and forward. For example, Katz and Murphy's (1992) analysis of changes in the wage distribution treats supply shifts as exogenous (i.e., not responding to changes in demand for workers at different skill levels) and finds that the facts apparently can be explained without resorting to supply responses. And Maestas and Zissimopoulos (2010) discuss future changes in the labor force participation of older workers without reference to supply responses – although to be fair they were not focused on changes in the relative prices of skilled and unskilled labor. Of course one important qualification is that at the state level, rather than the national level, there may be considerably more scope for supply responses, in part because internal migration in the United States is unrestricted.

The issues discussed to this point pertain to the question of the supply response among domestic workers. As Freeman (2006) emphasizes, though, in a global economy U.S. firms would also likely respond to skill shortages by hiring skilled workers in other countries. This would mitigate the cost increases entailed by any projected skill shortages. But state or federal policymakers might prefer to create high-wage, high-skilled employment at home, rather than import the products of workers from abroad, especially if part of the problem is barriers to investment in the skills of their workers. There are many reasons for governments to prefer a high-skilled to a low-skilled workforce, including a larger tax base, more technological progress, and fewer of the socioeconomic problems (and related government costs) associated with low-skilled workers. Indeed, there are some cases where a "market failure" cannot be identified that might hinder adjustments to skill shortages in a particular industry,[34] to the extent that the projections show that the supply of skilled workers will constrain future economic growth in high-skilled jobs – perhaps only in some states – there is still a potential case for policies that lead to higher educational attainment and skill levels overall than what one would otherwise expect. These policies could be based on a continuation of past trends, and the decentralized responses of individuals and firms to skill shortages.

In sum, then, our empirical analysis indicates that the demand for skilled labor *in some states* is likely to outstrip supply in the coming decade (and likely beyond) if there are no policy changes. Skill shortages are less likely for the *entire* United States, although they may be more of a problem over a longer time horizon. In the face of skill shortages, however, there will likely be changes. We might expect some supply responses in the domestic workforce, although there are reasons to believe the supply response may be limited. This may be in part because of barriers to human capital investment. We might also expect some changes with regard to the international division of labor, as U.S. firms meet their skill needs abroad. In light of these anticipated changes, and in light of some of the inherent advantages in turning low-paid, low-skilled workers into high-paid, high-skilled workers, to the extent that stronger demands for more highly educated workers do emerge, it would seem to behoove federal and especially state policymakers to seriously consider possible channels to

[34] For example, past research has suggested that the concentration of market power on the hiring side in nursing prevents wages from rising to attract enough nurses to the profession (see Hirsch and Schumacher, 2005).

increase the extent to which the workforce is able to supply the high levels of skills that are likely to be demanded in the future.

Barnow, Trutko, and Lerman (1998) discuss some potential policy responses to skill shortages including:

- Public-private partnerships to encourage students to enter shortage fields;
- Improved career information so that students choosing which fields to enter at least have some idea of the potential earnings and career prospects in those fields;
- An increased occupational focus of education, such as through school-to-work programs and career academies; and
- Subsidies or other institutional or legal changes to encourage company-sponsored training.

It is not the purpose of this report to assess these possible policy responses, to the extent that they might be needed (despite the absence of projected national shortages). Providing the most accurate information about future supply and demand conditions in different fields, as well as pay and benefits, could only help students and others facing educational and occupational decisions to make choices that are less likely to lead to shortages, and are more responsive to future market conditions.

7. Conclusions and implications

There is suggestive evidence that some states – in particular those with greater representation and expected population growth from less-educated demographic groups – could face some skill shortages. Although we do not find evidence at the national level of an impending and widespread shortage of highly skilled workers in our projections to 2018, we believe that policymakers should not be complacent about improving educational outcomes and worker skills, for a number of reasons.

First, shortages in certain occupations have already occurred and are likely to continue. Second, we expect certain states, including some of the nation's most populated states, to experience shortages of highly skilled workers, although it is possible that these state-specific shortages will be somewhat alleviated by the interstate migration that may occur in response to rising wages for skilled workers in states where they are in short supply. Third, it is important to keep in mind that our research focuses on the supplies of and demands for workers classified by educational degrees. We do not explicitly explore the academic content of the degrees likely to be demanded by employers and potentially provided by workers. It is possible that along these dimensions – for example, in nursing – shortages will emerge.

Finally, if we extend the projections to 2030, we might find greater challenges facing the entire nation as all the members of the baby boom generation will have reached traditional retirement ages by that time (see Insight 2). Thus, in the longer run the emergence of skill shortages is more likely. Indeed, there is other evidence (Carnevale, Smith, and Strohl, 2010) suggesting that skill shortages will emerge even in the time horizon covered in our study. Although our conclusions differ all forecasts have some uncertainty, and as a result we do not rule out the possibility that – even through 2018 – more severe skill shortages may occur than what we forecast.

Future research should expand on each of these topics – state-specific shortages and migration and other responses; particular occupations and education fields that might be in short supply; reconciling conflicting projections; and perhaps most important, exploring longer-term projections. This would help to better understand the possible skill shortages that could emerge despite our findings at present. We believe that more systematic study of how community colleges can better enable workers to make investments in skills to meet changing workforce demands is necessary. We outlined some largely anecdotal evidence suggesting that they are important in helping to meet these workforce demands, but there seems to be a general lack of solid evidence concerning how they do this and how they could improve.

Our research identified substantial upgrading of skills of middle-aged and even older workers. More research could be done to identify determinants for participation in such educational upgrading, to see what the effects are in terms of labor force outcomes, and to locate where this upgrading is occurring institutionally.

We also caution that our approach took the BLS projections as an accurate prediction of where the U.S. economy is headed in terms of the mix of occupations. (Of course, we do not believe the BLS projections of skills within occupations are well founded.) Our analyses based on the 2008 distribution of occupations shows substantial differences between the American Community Survey and the BLS. For example, managerial occupations and legal service occupations seem to be substantially underrepresented in the BLS 2008 occupational employment numbers relative to the

ACS. Both of these occupational categories disproportionately employ highly educated workers. In contrast, the BLS estimates for 2008 show greater numbers of workers in food preparation and serving occupations, jobs that tend to require relatively low levels of education. Future research should resolve these differences and could lead to alternative occupational projections.

Finally, improvements in worker skills and increases in educational attainment could spur economic growth and change the future path of our economy. Educational progress, across time and across generations, has proven to be a key determinant of economic wellbeing for individuals and for nations.

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Insight 1: Assessment of BLS skill requirements

The analysis in Section 2 suggests that the BLS skill requirements may fail to capture educational levels – and especially higher levels – that are needed in particular occupations. Of course nothing in that analysis demonstrates that these educational levels are *required*, but rather only that they are *represented*. The results from the analysis using the ACS data show much higher educational attainment levels within occupations compared to the BLS skill assessments and projections. Thus, the BLS skill requirements appear to understate considerably what we observe in practice. To try to shed more light on the question of what is required, we present some evidence on the wage premia paid for education levels that, on the one hand, are represented in given occupations but, on the other hand, may not be required according to the BLS skill requirements data.

To clarify, the question is not simply whether the BLS data fail to capture some skills needs, it is the reliability of using the BLS skill requirements data to project skill needs in an occupation. After all, the BLS data – as noted above – are intended to describe "the education or training that most workers need to become fully qualified in that occupation." This statement does not imply that higher educational levels are not sometimes required or that they are not valuable. To the extent that there are positive returns to education levels above those indicated as the skill requirement for an occupation in the BLS data, the BLS data will understate the skills needed in an occupation. The implication, of course, is that relying on the BLS skill requirements data to project skill needs could mask potential skill shortages that would be indicated based on skill needs exceeding those indicated by the BLS data.

Our approach examines education wage premia within occupations. It follows a tradition in the research literature on "over-education," where the standard human capital earnings function is augmented by measures of how much an individual is over-educated relative to the education level in his or her job. The idea is that if one is over-educated, the returns to the education that exceeds the education level in the job will be lower than the returns to the required level of education, indicating that the "extra" education is not as valuable.[35]

Hartog (2000) provides an extensive review of evidence suggesting that in many European countries over-education appears to be the norm, although the evidence for the United States (extending only through the mid-1980s) is more ambiguous. Of course there are a number of problems with trying to infer whether there is over-education by looking at returns to education above the required amount; the most obvious is that those who have more education than is the norm in their job may have lower innate ability (which is why they need more education to be employed in that job) than those with less education. There is some evidence consistent with this conjecture (Chevalier, 2003; McGuinness and Bennett, 2007).

In our case, we ask whether education-related wage premia in an occupation are lower when the education level exceeds skill requirements according to the BLS. Specifically, we take ACS data for 2008 that is used to construct the educational distributions displayed in Table 2.3, and estimate a

[35] Conversely, if one is under-educated, there is a penalty; but that is not our concern here, given that the issue is higher observed education in the ACS data than is indicated by the BLS skill requirements.

regression for earnings, with controls for the usual ingredients of earnings functions (marital status, age and its square, region, race, ethnicity, and sex), as well as a set of dummy variables corresponding to each education category beyond the lowest omitted group. We estimate this regression for each two-digit occupation.[36] Based on these regressions, we examine whether the economic returns to education levels above the highest education required for the occupation (according to the BLS) are smaller than for occupations where these education levels are required. We also test, statistically, the sharper hypothesis that the returns to these higher "unnecessary" levels of education are zero. For example, if the highest education category is not required, we test whether the wage premium associated with this category is equal to that for the education category that is one below; if there is more than one category above the BLS level, then we test whether the wage premia in each of these categories are higher. This sharp test seems most relevant to this report (as opposed to the general over-education question considered in other research). As long as the returns to "unnecessary" education are greater than zero, there is reason to believe that the education is to some extent required, even if it is not as important as for occupations where it is required.

One could object that if the regression model controls for all other differences in productivity, and there are no important compensating differentials across occupations (or they are captured in the intercepts), then the wage premium for education must be the same in all occupations. Otherwise workers would never work in the occupation paying the lower premium. As a result, we may fail to find evidence of lower returns to "unnecessary" education. However, in that case the employer would be paying a wage premium for a worker who is no more productive (or for whom the productivity premium is less than the wage premium), which the employer would never do. Thus, if one thinks markets work well enough that wages reflect these factors, the simple presence in an occupation of workers at a higher education level than indicated by the BLS skill requirements constitutes evidence against the over-education hypothesis. In other words, employers would not hire workers and pay them a wage premium unless they were in fact more productive. This implication is clearly rejected by the ACS education distributions displayed in Table I1.1, which show substantial representation of workers above the maximum required BLS education category (as assigned by us) for the two-digit occupation, based on the narrower occupations that make up the two-digit occupation.

Alternatively, one might object that employers "mistakenly" pay a premium for more highly educated workers. However, this is a view that does not comport with either the human capital or the signaling view of earnings differences associated with education. In either of these frameworks earnings premiums associated with higher education reflect higher productivity. The difference is whether education actually raises the productivity of some workers, or instead just helps employers distinguish more-productive from less-productive workers (which they need to do, for example, to assign workers to the appropriate tasks). Besides, the standard view of labor markets would suggest that employers would not persistently make the "mistake" of overpaying educated workers, since other employers would figure this out, pay them less, and drive down such an erroneous premium.

The results for the regression analysis are reported for each occupation in Table I1.2. The table shows the estimated returns to each level of schooling for two-digit occupations, relative to the omitted

[36] Consistent with the vast literature on economic returns to education, we use the log of earnings as the dependent variable in our regressions. In this case, the earnings differential associated with various levels of schooling measures approximately the percentage difference in earnings associated with those schooling levels.

high school degree or less category. The grey shading highlights the educational levels above those required according to the BLS. As shown in Table I1.2, the estimated returns to a bachelor's degree are lower in the occupations that BLS declares do not require that much education than in occupations in which the BLS states a bachelor's degree is required. However, for nearly every occupational grouping, wage returns are higher for more highly educated workers even if the BLS says such high levels of education are not necessary. For example, in the first panel, for SOC 11: management occupations, the estimated coefficients for master's, professional, and doctoral degrees are all above the estimated coefficient for a bachelor's degree, which is the BLS maximum. We conduct a statistical test to more rigorously summarize and evaluate the education wage premia we observe within occupations.[37] In every case but one (SOC 21: community and social services) we conclude that there is strong evidence of positive returns to education levels above those that the BLS states are required. In our view, the implication is that it is better to base projections for skill demands on observed (and projected) educational distributions of workers in each occupation, rather than on the BLS skill requirements.

[37] To provide this summary, we construct a joint test. In particular, for each occupation we report the results of the joint test of the hypothesis that there are no returns to education levels higher than the BLS required maximum. Thus, again in the first panel, we conduct a joint test of the hypothesis that the coefficients on the variables for master's, professional, and doctoral degrees are equal to the coefficient for a bachelor's degree. We do this joint test only for the education categories above the BLS maximum where the estimated individual coefficient is larger. For example, in the panel for SOC 53: transportation and material moving occupations, the estimated coefficient for a professional degree is below that for the BLS maximum bachelor's degree, so we leave this coefficient out of the joint test. We do this because a rejection of the joint test when the estimated return to education levels above the BLS required maximum is *lower* would not provide meaningful evidence of positive returns to higher levels of education. Thus, the degree of freedom differs panel-by-panel. Moreover, in some cases the BLS required maximum level of education is the highest level, in which case there is no joint test.

Table I1.1

ACS Education Distribution. 2008

2-Digit SOC	Occupation Descriptions	High School or Less	Some College	Associate's Degree	Bachelor's Degree	Master's Degree	Professional Degree	Doctorate	Share Above Highest BLS
11	Management occupations	19.8%	21.4%	7.8%	32.3%	15.2%	1.7%	1.7%	18.7%
13	Business and financial operations occupations	11.5%	18.4%	9.1%	44.0%	14.3%	1.9%	0.9%	17.1%
15	Computer and mathematical science occupations	6.9%	18.7%	10.5%	43.8%	17.7%	0.8%	1.7%	0.0%
17	Architecture and engineering occupations	9.8%	16.0%	11.7%	41.6%	16.9%	1.3%	2.6%	20.8%
19	Life, physical, and social science occupations	7.2%	9.8%	4.2%	33.2%	21.8%	3.4%	20.3%	0.0%
21	Community and social services occupations	10.0%	14.6%	5.8%	33.7%	30.8%	2.6%	2.4%	5.0%
23	Legal occupations	6.7%	10.5%	6.3%	13.5%	3.5%	54.0%	5.6%	5.6%
25	Education, training, and library occupations	8.5%	11.8%	4.8%	34.6%	31.7%	2.4%	6.2%	0.0%
27	Arts, design, entertainment, sports, and media occupations	14.6%	21.6%	8.9%	42.1%	10.7%	1.1%	1.1%	12.8%
29	Healthcare practitioners and technical occupations	7.8%	15.5%	22.7%	26.4%	9.0%	15.1%	3.6%	3.6%
31	Healthcare support occupations	43.1%	36.3%	11.0%	7.2%	1.3%	0.7%	0.2%	9.5%
33	Protective service occupations	30.4%	35.6%	12.4%	17.7%	3.3%	0.5%	0.2%	21.6%
35	Food preparation and serving related occupations	60.6%	26.9%	5.3%	6.4%	0.6%	0.1%	0.0%	39.4%
37	Building and grounds cleaning and maintenance occupations	72.2%	17.7%	4.3%	4.9%	0.7%	0.2%	0.0%	27.8%
39	Personal care and service occupations	47.8%	30.9%	7.5%	11.3%	2.0%	0.4%	0.1%	21.3%
41	Sales and related occupations	37.1%	29.1%	7.3%	21.8%	3.9%	0.5%	0.2%	4.7%
43	Office and administrative support occupations	37.2%	35.6%	10.3%	14.2%	2.3%	0.3%	0.1%	16.9%
45	Farming, fishing, and forestry occupations	78.5%	12.6%	3.4%	4.8%	0.5%	0.1%	0.1%	21.5%
47	Construction and extraction occupations	67.4%	21.2%	5.2%	5.1%	0.7%	0.2%	0.1%	32.6%
49	Installation, maintenance, and repair occupations	53.1%	28.4%	11.4%	6.0%	0.9%	0.1%	0.1%	7.1%
51	Production occupations	64.6%	22.1%	6.0%	6.1%	1.0%	0.2%	0.1%	13.3%
53	Transportation and material moving occupations	65.6%	22.7%	4.9%	5.8%	0.9%	0.1%	0.1%	1.1%

Notes: Grey cells represent the education levels above the highest BLS category reported for the occupation category. The 2008 ACS data include all employed persons age 16 and over.

Source: Authors' calculations using 2008 ACS data.

Table I1.2

Estimated Returns to Schooling, Comparisons Above and Below the Maximum BLS Required Skill Category, 2008

2-Digit SOC	Occupation Descriptions	Coefficients Relative to Lowest Category (High School or Less)						Joint Test	
		Some College	Associate's Degree	Bachelor's Degree	Master's Degree	Professional Degree	Doctorate	P-value	D.o.F.
11	Management occupations	0.165	0.171	0.465	0.630	0.702	0.775	<.0001	3
		(0.006)	(0.008)	(0.005)	(0.006)	(0.014)	(0.014)		
13	Business and financial operations occupations	0.114	0.099	0.379	0.596	0.620	0.670	<.0001	3
		(0.009)	(0.011)	(0.008)	(0.010)	(0.020)	(0.030)		
15	Computer and mathematical science occupations	0.102	0.074	0.293	0.403	0.404	0.481	na	na
		(0.012)	(0.013)	(0.011)	(0.012)	(0.031)	(0.022)		
17	Architecture and engineering occupations	0.075	0.117	0.400	0.547	0.419	0.663	<.0001	3
		(0.011)	(0.012)	(0.010)	(0.011)	(0.026)	(0.020)		
19	Life, physical, and social science occupations	0.056	0.091	0.294	0.406	0.422	0.541	na	na
		(0.025)	(0.029)	(0.020)	(0.021)	(0.032)	(0.022)		
21	Community and social services occupations	0.055	0.084	0.202	0.386	0.374	0.412	0.2522	1
		(0.014)	(0.017)	(0.012)	(0.013)	(0.023)	(0.025)		
23	Legal occupations	0.048	0.044	0.198	0.433	0.821	0.740	na	na
		(0.030)	(0.033)	(0.029)	(0.040)	(0.026)	(0.036)		
25	Education, training, and library occupations	0.036	0.095	0.458	0.673	0.746	0.926	na	na
		(0.009)	(0.012)	(0.008)	(0.008)	(0.014)	(0.010)		
27	Arts, design, entertainment, sports, and media occupations	0.137	0.129	0.328	0.426	0.533	0.507	<.0001	3
		(0.020)	(0.023)	(0.018)	(0.023)	(0.056)	(0.054)		
29	Healthcare practitioners and technical occupations	0.059	0.294	0.418	0.544	1.075	0.902	na	na
		(0.010)	(0.009)	(0.009)	(0.011)	(0.010)	(0.015)		
31	Healthcare support occupations	0.081	0.181	0.182	0.371	0.597	0.547	<.0001	4
		(0.008)	(0.011)	(0.014)	(0.030)	(0.038)	(0.068)		
33	Protective service occupations	0.204	0.278	0.376	0.550	0.497	0.679	<.0001	4
		(0.008)	(0.010)	(0.009)	(0.018)	(0.045)	(0.066)		
35	Food preparation and serving related occupations	0.097	0.235	0.242	0.279	0.127	0.447	<.0001	6
		(0.008)	(0.013)	(0.012)	(0.035)	(0.075)	(0.134)		
37	Building and grounds cleaning and maintenance occupations	0.107	0.121	0.149	0.282	0.129	0.238	<.0001	6
		(0.008)	(0.015)	(0.014)	(0.039)	(0.066)	(0.193)		
39	Personal care and service occupations	0.087	0.150	0.287	0.288	0.252	0.372	<.0001	5
		(0.011)	(0.017)	(0.014)	(0.032)	(0.070)	(0.156)		
41	Sales and related occupations	0.163	0.191	0.525	0.708	0.707	0.701	<.0001	3
		(0.005)	(0.008)	(0.006)	(0.011)	(0.029)	(0.045)		
43	Office and administrative support occupations	0.091	0.117	0.248	0.402	0.370	0.523	<.0001	4
		(0.003)	(0.004)	(0.004)	(0.008)	(0.023)	(0.035)		
45	Farming, fishing, and forestry occupations	0.092	0.190	0.292	0.497	0.145	0.863	<.0001	6
		(0.022)	(0.040)	(0.032)	(0.098)	(0.187)	(0.235)		

2-Digit SOC	Occupation Descriptions	Coefficients Relative to Lowest Category (High School or Less)						Joint Test	
		Some College	Associate's Degree	Bachelor's Degree	Master's Degree	Professional Degree	Doctorate	P-value	D.o.F.
47	Construction and extraction occupations	0.111	0.162	0.145	0.145	0.195	0.179	<.0001	6
		(0.006)	(0.011)	(0.011)	(0.029)	(0.056)	(0.112)		
49	Installation, maintenance, and repair occupations	0.120	0.172	0.190	0.290	-0.089	0.174	0.0003	3
		(0.006)	(0.008)	(0.011)	(0.027)	(0.069)	(0.122)		
51	Production occupations	0.153	0.198	0.287	0.427	0.234	0.493	<.0001	5
		(0.004)	(0.008)	(0.008)	(0.019)	(0.047)	(0.060)		
53	Transportation and material moving occupations	0.108	0.123	0.287	0.411	0.105	0.157	<.0001	1
		(0.005)	(0.010)	(0.010)	(0.024)	(0.064)	(0.104)		

Notes: Standard errors are shown in parentheses. Grey cells represent the education categories above the highest BLS category required for the occupation category. Occupation categories for which the entire range is shaded grey indicate that high school or less is the highest required BLS category. Each row reports the estimated coefficients on dummy variables for the indicated schooling categories, using 2008 ACS data. The dependent variable is log earnings, and the regressions are estimated for full-time (30 or more hours) and full-year (40 or more weeks) workers. The regression includes controls for race, ethnicity, sex, age and its square, and decennial census region. The test statistic reported is the p-value (and d.o.f.) for the test of no returns to education levels higher than BLS requirement, for the subset of higher education levels with point estimates larger than estimated return to BLS-required education level.

Source: Authors' calculations using 2008 ACS data.

Insight 2. Beyond 2018

Our projections do not extend beyond 2018 because the BLS projections end there. We can, however, make some determinations regarding likely workforce skill issues beyond 2018, especially with respect to the supply of highly educated workers. A key consideration in the future supply of such workers is the retirement of large numbers of relatively well-educated boomers. In 2018, the oldest boomers will be 72 years old and most of them will be retired. However, the youngest boomers will only be 54 years old and most of them will be working. By 2030, all of the boomers will have reached retirement ages, with the youngest boomers being 66 years old and the oldest reaching 84 years old.

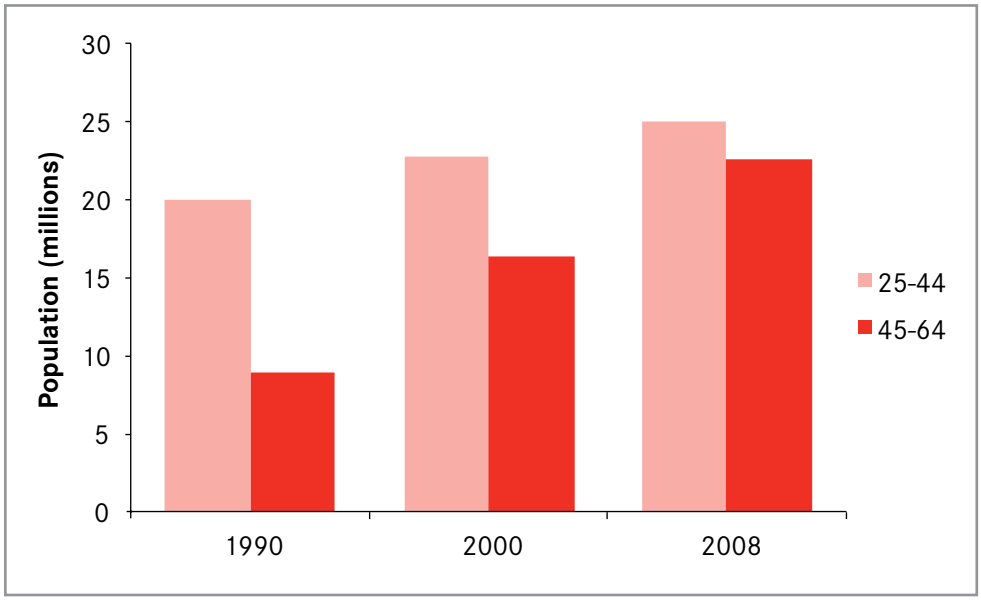
Figure I2.1 illustrates the demographic challenge facing the nation as this large cohort retires. The figure shows the number of older adults with at least a bachelor's degree, and compares those numbers with younger adults of similarly high levels of education. Over time, we see dramatic growth in the number of older adults with a bachelor's degree but only modest growth in the number of younger adults with the same education. This has important implications for the future supply of highly educated workers. In 1990 highly educated older adults – who were to retire over the next 20 years – were relatively few in number. Replacing those retirees was not a difficult task given their small numbers. Indeed, the cohort of well-educated younger adults that would replace these retirees was more than two times the size of the retiring cohort (comparing 25- to 44-year-olds in 1990 with 45- to 64-year-olds in that year). But this pattern has changed dramatically. By 2008, the number of older well-educated adults set to retire over the next 20 years had more than doubled, and was almost as large as the younger adult cohorts set to replace them in the labor force. Although this does not imply declining education levels in the workforce, it does imply difficulty meeting rising demands for educated workers, which is a reasonable expectation based on past trends (see below).

The impending retirement of this well-educated group is only partially included in our projections to 2018. As shown in Figure I2.2, the youngest of the impending retirement cohorts are larger in number, with 6.4 million 45- to 49-year-old college graduates (bachelor's degree or more) compared to 4.4 million 60- to 64-year-olds. By 2018, these younger boomers will be 54 to 59 years old and will not have reached traditional retirement ages. If we extend our projections to 2030, all boomers will have reached retirement age, including the more numerous younger boomers.

We suspect that projections of the U.S. economy to 2030 will show a continuation of current patterns, with greater rates of growth in industries and occupations that employ highly educated workers. Such a pattern is consistent with the long-standing trend in the United States of moving towards a more highly skilled economy. One certainty is that the aging of the boomer cohorts will drive up the demand for health care. Because health care occupations tend to have higher skill requirements than other occupations, the more rapid growth of this sector will contribute to greater demand for highly educated workers. Combined with the demographic supply forecasts to 2030, it is plausible that general skill shortages will be more evident if we extend the projections to 2030.

Figure I2.1

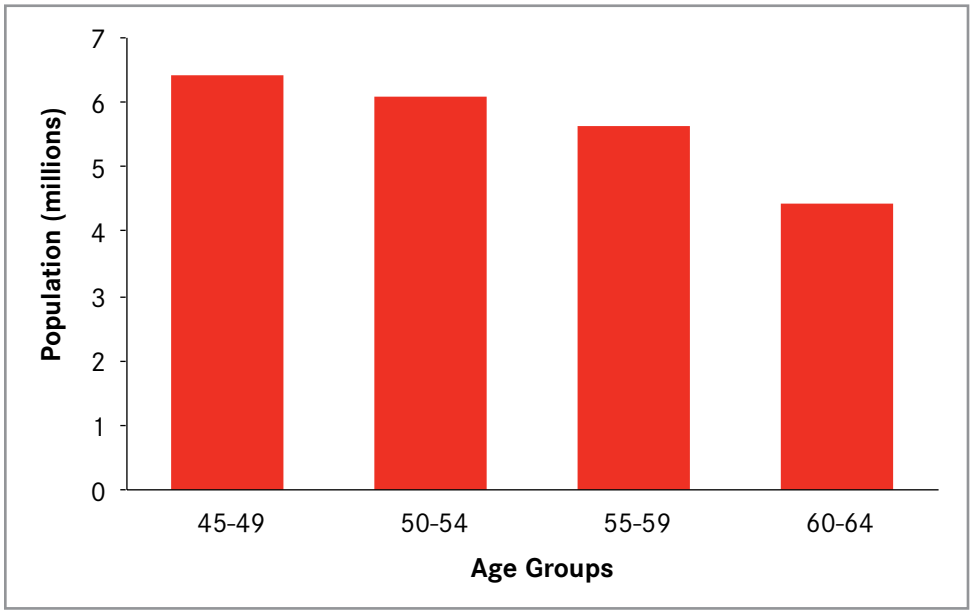
Number of Adults with At Least a Bachelor's Degree by Age Group (25-44 and 45-64), 1990, 2000, and 2008



Source: Authors' tabulations based on decennial census data for 1990 and 2000, and the American Community Survey for 2008.

Figure I2.2

Number of Older Adults with At Least a Bachelor's Degree by Age Group, 2008



Source: Authors' tabulations based on the American Community Survey for 2008.

Insight 3. Potential skill shortages facing the states

Although we do not find evidence of substantial skill shortages nationwide to 2018, many states could experience shortages of highly educated workers. As shown in Table I3.1, older adults nearing retirement ages are notably better educated than young adults in at least 20 states, including 3 of the nation's 4 most populous states: California, Texas, and Florida. As these older adults exit the labor force and enter retirement they will be replaced by younger cohorts with less education. And because these older cohorts are large in size, the absolute changes will be large as well.

In some of the states that face potential skill shortages the key driver is the changing demographic composition of the state. Large and growing populations of Hispanics, a group that historically has relatively low levels of educational attainment, are entering the labor force in greater numbers in these states, and they are replacing older, better-educated, mostly non-Hispanic cohorts that are reaching retirement ages. States that fit this profile include California, Texas, Florida, Arizona, Colorado, New Mexico, and Nevada. The importance of these demographic changes is illustrated by a simple exercise. In Table I3.2 we develop new estimates of the supply of workers for the nation, but substitute California's ethnic composition in 2018 for that of the entire United States. In other words, we ask and answer the question, would there be a national skill shortage if the country had California's demographic mix? The answer is yes; we find a deficit of 3.1 million workers with an associate's degree or higher, and an even larger surplus of workers with a high school degree or less.[38]

It is worth noting that nationwide, including in California, there has been strong intergenerational progress in educational attainment from first generation immigrants to their second generation children born in the United States, with far greater rates of high school graduation among the U.S.-born than among the foreign-born. College enrollment and graduation also show improvement across Hispanic generations, but remain far lower than among other U.S.-born groups (Reed,et al., 2005). One of the challenges in these states, then, is to target programs designed to improve college-going and college graduation among this population.

In other states with relatively well-educated older adults and less-educated young adults the differences between age groups are not due to international migration. In states in which resource extraction is a large sector of the economy (such as Alaska and Wyoming) the pattern might simply reflect the nature of the state economy, with relatively large numbers of blue-collar jobs attracting young adults with low levels of education.

Finally, in other states (such as Hawaii, Oregon, and Washington) college enrollment rates of high school graduates are quite low. Changes in the demographic composition of those states' populations are not substantial. Instead, older residents have migrated there from other states.

Some of the states facing an education skills shortage should be able to at least partially migrate their way out of this problem by attracting college graduates from other states or even abroad. Such dependence on migration flows, however, is risky. International migration, especially of

[38] Note that we do not account for unemployment in these estimates. The projected skills gap for more highly educated workers would be even greater were we to do so.

highly educated workers, is subject to the limits imposed by U.S. immigration policy. In general, international immigrants to America are not substantially more likely to have graduated from college than U.S.-born residents, and they are much more likely to have not completed high school. Interstate migration of college graduates could help close some of the gap, but the extent to which this might happen will depend on how much education premiums rise in states with growing skill shortages relative to other states.

Potentials for new skill acquisition vary across the states as well. One measure of such opportunities is the number of students served by community colleges. Insight 5 includes a discussion of this issue.

Table I3.1

Percentage of Adults with a Bachelor's Degree or Above by State, 2008

State (1)	Percentages with a Bachelor's Degree or Above: Total (2)	Latinos (3)	Ages 25-29 (4)	Ages 30-34 (5)	Ages 55-59 (6)	Ages 60-64 (7)	Cohort Differences (Sorted)	% Latino in State: 2005 (8)	2025 (9)
New Mexico	26%	14%	18%	26%	32%	35%	-23%	41%	48%
Alaska	28%	23%	23%	25%	30%	37%	-19%	5%	7%
Utah	30%	12%	25%	28%	33%	37%	-17%	7%	9%
Hawaii	32%	19%	25%	32%	38%	34%	-15%	9%	10%
Arizona	26%	10%	21%	26%	30%	31%	-14%	24%	32%
Colorado	38%	13%	32%	36%	40%	41%	-13%	15%	21%
Wyoming	23%	6%	19%	22%	28%	24%	-11%	7%	11%
Nevada	23%	9%	21%	23%	26%	27%	-9%	17%	25%
Oregon	30%	12%	24%	32%	33%	32%	-9%	7%	10%
California	31%	11%	27%	31%	33%	34%	-9%	36%	43%
Maine	25%	21%	20%	28%	28%	29%	-9%	1%	1%
Montana	30%	22%	28%	29%	36%	29%	-8%	3%	3%
Texas	27%	12%	24%	25%	29%	27%	-7%	31%	38%
Washington	32%	11%	28%	33%	34%	34%	-7%	7%	10%
Florida	28%	23%	24%	27%	29%	29%	-7%	17%	24%
Vermont	35%	21%	34%	37%	40%	37%	-6%	1%	2%
Idaho	26%	8%	21%	28%	27%	28%	-6%	8%	12%
South Dakota	27%	29%	27%	27%	25%	34%	-5%	1%	2%
Georgia	30%	13%	25%	30%	31%	29%	-5%	3%	4%
New Hampshire	36%	36%	32%	38%	37%	37%	-4%	2%	2%
Oklahoma	24%	11%	22%	25%	26%	23%	-2%	4%	6%
Virginia	36%	24%	34%	37%	36%	36%	-1%	4%	6%
South Carolina	26%	11%	26%	27%	27%	27%	-1%	1%	2%
Arkansas	21%	10%	19%	22%	23%	19%	-1%	1%	2%
Louisiana	22%	18%	22%	23%	24%	22%	-1%	3%	4%
Mississippi	21%	9%	20%	23%	23%	20%	0%	1%	1%
Alabama	24%	13%	24%	24%	26%	21%	1%	1%	1%
Kansas	32%	14%	31%	33%	34%	29%	1%	6%	9%
Nebraska	31%	8%	32%	32%	32%	31%	1%	4%	6%
Delaware	29%	15%	28%	32%	31%	28%	1%	4%	6%
Rhode Island	33%	14%	34%	35%	34%	33%	2%	9%	15%
Tennessee	25%	11%	24%	26%	24%	24%	2%	1%	2%
Maryland	38%	20%	36%	41%	38%	36%	3%	5%	7%
Indiana	25%	10%	26%	27%	26%	23%	4%	3%	4%
West Virginia	19%	29%	21%	20%	19%	18%	4%	1%	1%

State (1)	Percentages with a Bachelor's Degree or Above: Total (2)	Latinos (3)	Ages 25-29 (4)	Ages 30-34 (5)	Ages 55-59 (6)	Ages 60-64 (7)	Cohort Differences (Sorted)	% Latino in State: 2005 (8)	2025 (9)
Michigan	27%	17%	26%	30%	26%	26%	4%	3%	4%
North Carolina	28%	14%	27%	31%	29%	25%	4%	2%	2%
Missouri	28%	19%	28%	31%	29%	26%	4%	2%	3%
Wisconsin	28%	12%	29%	31%	28%	27%	5%	3%	4%
Kentucky	21%	11%	23%	24%	21%	21%	5%	1%	1%
Ohio	27%	20%	27%	30%	26%	25%	6%	2%	3%
Connecticut	39%	16%	39%	43%	38%	37%	7%	10%	15%
New Jersey	38%	17%	37%	42%	37%	35%	7%	14%	19%
Illinois	33%	12%	34%	36%	32%	30%	8%	12%	17%
North Dakota	29%	0%	29%	40%	29%	30%	10%	1%	2%
Minnesota	35%	18%	33%	41%	32%	31%	11%	2%	4%
Pennsylvania	29%	14%	33%	35%	30%	25%	13%	3%	5%
Iowa	27%	12%	33%	32%	27%	25%	13%	2%	3%
New York	35%	16%	38%	41%	33%	32%	14%	17%	22%
Massachusetts	42%	17%	46%	50%	42%	37%	17%	8%	14%
District of Columbia	52%	29%	63%	62%	44%	47%	34%	9%	12%

Note: The "Cohort differences" column is the difference in bachelor's degree attainment between younger and older cohorts ([Cols. 4+5] – [Cols. 6+7]).

Source: 2008 American Community Survey.

Table I3.2

Education Supplies and Demands If the United States Has California's Projected Ethnic Distribution, 2018

		Workers (thousands)			Share		
	Education Category	**Supply**	**Demand**	***Diff***	**Supply**	**Demand**	***Diff***
1	High school degree or less	67,589	54,701	*12,888*	39.6%	34.0%	*5.6%*
2	Some college	39,643	39,560	*83*	23.2%	24.6%	*-1.4%*
3	Associate's degree	13,946	15,879	*-1,933*	8.2%	9.9%	*-1.7%*
4	Bachelor's degree	32,430	32,822	*-392*	19.0%	20.4%	*-1.4%*
5	Master's degree	12,018	12,608	*-590*	7.0%	7.8%	*-0.8%*
6	Professional degree beyond bachelor's	2,794	2,816	*-22*	1.6%	1.8%	*-0.1%*
7	Doctorate	2,159	2,326	*-168*	1.3%	1.4%	*-0.2%*
	All education categories	**170,579**	**160,713**	***9,866***	**100.0%**	**100.0%**	***na***

Source: Authors' projections of supply and demand by education.

Insight 4: Skill shortages and policy responses in other developed countries

We have not undertaken original analyses of skill shortages in other developed countries. However, the existing research literature exhibits a fairly strong consensus regarding such shortages in certain occupations and the responses to these shortages.

Skill shortages in other countries

In other countries research on skill shortages is not based on long-run demand and supply projections, it is based on current and past data. As such, it is more likely to confound contemporaneous skill shortages that – depending on the timing of the research – may have to do with skill shortages at the peak of a business cycle, and less to do with longer-term underlying trends. Some of the evidence in other countries is organized more by occupation than by education, and it is the latter on which our analysis for the United States focuses.

Cohen and Zaidi (2002) provide a comprehensive look at skill shortages in the developed countries. They first summarize existing literature, based on a review of both academic studies and more popular reporting. The studies and articles covered do not, however, necessarily survey all of the relevant jobs, skill groups, or even countries. Nonetheless, the information may be useful – at a minimum – as corroboration of other more systematic evidence. Cohen and Zaidi's work is based largely on research done in the late 1990s, and as such it may say more about shortages at the peak of the economic cycle than about longer-term trends.

Table I4.1 presents the authors' findings in a tabular form. To the extent that it is possible to summarize the information, there are frequent references to shortages in information-related occupations (such as high-tech and software), technical training, and skilled and less-skilled manufacturing.

Cohen and Zaidi's second analysis attempts to be more systematic. Specifically, they assemble data on four indicators of skill shortages by occupation: average annual employment growth by occupation, 1995 to 1998; unemployment rate average by occupation, 1996 to 1998; average annual wage change by occupation, 1995 to 1998 (not available in most countries); and time required to prepare for an occupation based on educational qualifications. For each of these indicators they assign a rank of one to five, with a higher rank indicating the strongest shortage, and then average across these four indicators. These methods can be criticized on many grounds. First, the relationship between the indicators and a skill shortage is not always clear. For example, just because an occupation requires long training does not imply a shortage (although it likely implies a slower response in the short term

to increases in demand). Conversely, there may be shortages in occupations that require less training, as the authors acknowledge (p. 52). Second, some of the indicators should perhaps be weighted more heavily than others. And third, this classification system is clearly backward-looking, and may reflect the business cycle. These criticisms, however, should not be overstated. It is difficult to measure shortages, and Cohen and Zaidi do attempt a comprehensive set of measurements.[39]

Table I4.2 provides a summary of their rankings of occupations in terms of shortages, by country. We follow Cohen and Zaidi by listing occupations with average ranks of 3.75 or above (up to a maximum of 5) in the "most likely to have shortages" category. But to provide more information in the next column we also list occupations in the 3-3.74 range – i.e., in the top half of the ranking scale, but below this category 3.75 or higher.[40] Finally, we list the narrower occupations in the highest shortage category. All of the occupational classifications are based on ISCO-88 codes.

In the first column (which Cohen and Zaidi classify as facing the most severe shortages), the principal broad category that appears is "legislators, senior officials, and managers," which is sufficiently broad as to be relatively uninformative. In the second column, we see a consistent pattern of shortages in technical and professional occupations, and in some countries (Mexico, Portugal, and Singapore) skilled manual workers. The final column is perhaps more informative, as it lists occupations at a finer level of disaggregation. Here, we see a prevalence of estimated shortages among computer professionals, health professionals, engineers, and teachers. Viewed in this way the two tables, although garnering evidence in quite different ways, identify skill shortages in a somewhat similar set of fields.

An Organisation for Economic Co-operation and Development (OECD) (2009) report focuses more on skill shortages in terms of education and training, rather than occupation, and in that sense more closely parallels our analysis. However, it is still not forward-looking. The report tries to assess supply and demand imbalances for skilled workers in developed countries in two ways.

The first approach asks whether the representation of highly educated younger workers (ages 25 to 34) in skilled jobs in developed countries has tended to increase or decrease from 1998 to 2006. Specifically, the analysis looks at the representation of workers in this age range with postsecondary (or "tertiary") education in skilled jobs, defined as ISCO 1 (legislators, senior officials, and managers), 2 (professionals), and 3 (technician and associate professionals). The report first notes that, across all age groups, the representation of highly educated workers in skilled jobs has been stable over this period. However, it suggests that younger cohorts will be more sensitive to changes in supply and demand, so that variation in the proportion of highly educated younger workers in skilled jobs may provide a better barometer of skill shortages. The report finds that there has, overall, been a "marginal decrease in the proportion of young individuals who have succeeded in obtaining skilled jobs during this period" (OECD, 2009, p. 32). However, this varies a lot by country. Sweden, Poland, and Portugal have had marked decreases in the proportions of 25- to 34-year-olds with tertiary education in skilled

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[39] See Barnow, Trutko, and Lerman (1998) for additional discussion of how to measure skill shortages. Some of the definitions of shortages Barnow, Trutko, and Lerman discuss relate directly to the measures Cohen and Zaidi use.

[40] The exact definition of the rankings used by Cohen and Zaidi are not made explicit. They write "Ranks of 1 to 5 were assigned … A rank of 5 meant the labour market indicator was most favourable to the worker and most likely to indicate a labour shortage. For example, if employment grew an average of 4 percent or more per year … a rank of 5 was assigned … If employment declined, a rank of 1 was assigned" (p. 36).

jobs (ranging from –8 to –13 percent), while the reverse is true in Austria, Finland, Germany, and Switzerland, where increases have ranged from 4 to 9 percent (OECD, 2009, Chart A1.4).

The second approach focuses on those with "below-tertiary" (a high school degree or less) education. The idea is that as workers accumulate more experience they are more likely to move into skilled jobs as they age, even if they do not have a high educational attainment. Thus, in general, one expects to see an "age advantage" in terms of the presence of less-educated workers in skilled jobs. On the other hand, if educated workers are in short supply, one might expect employers to move less-educated young workers into skilled jobs more quickly. So if, among less than college-educated workers, there is a relatively large ratio of young people in skilled jobs to older people in skilled jobs, then there is more likely a skill shortage. Based on this evidence, there are two sets of countries that appear to have different manifestations of skill shortages (see Figure I4.1). First, in Hungary, the Slovak Republic, and Switzerland, older workers do not have any obvious advantage in terms of their presence in skilled jobs. Moreover, in Austria, Finland, Germany, and Israel, younger workers are actually overrepresented in skilled occupations, suggesting even sharper skill shortages. Of course a limitation of this type of analysis is that younger cohorts, even without tertiary education, may have stronger skills because of changes in the education system or the economy.

Figure I4.1 puts this evidence together in a revealing way.[41] The vertical axis is the difference between the representation of 25- to 34-year-olds and 45- to 54-year-olds who do not have tertiary educations but are in skilled jobs in 2006. The horizontal axis is the change in the proportion of 25- to 34-year-old workers with tertiary educations in skilled jobs from 1998 to 2006. Note that both of these measures are interpreted as proxies for the demand for skilled workers, although the first has more to do with skill needs of jobs less related to education, and the second has more to do with demand for educated workers. Thus, the upper-right quadrant captures those countries with increases in demand for skill along both dimensions, the lower-left quadrant captures countries with declines along both dimensions, etc. As a result, countries in the upper-right quadrant likely have the greatest skill shortages, and the opposite holds in countries in the lower-left quadrant. We see, therefore, that skill shortages appear to be particularly pronounced for Austria, Finland, and, Germany, and if anything there are some indications of declining demands for skill in Sweden, Poland, Portugal, and France.

Our view is that the evidence in the OECD study is more decisive than that in Cohen and Zaidi, although it is still backward- rather than forward-looking. Moreover, the Cohen and Zaidi evidence may tell us something about the occupations where shortages are more important. Of course, there may be a high correlation between recent, backward-looking skill shortages and projected future ones, so backward-looking evidence should certainly not be dismissed. However, we are not aware of much research that does the kind of forward-looking projections of skill shortages that we report for the United States.

There is a study from Canada (McMullin and Cooke, 2004) that examines interactions between demographic changes (aging, lower fertility, and longer life expectancy) and the shift from a resource-based to a knowledge-based economy. In Canada the population is projected to age because of the

[41] This largely reproduces Chart A1.5 from OECD (2009), with some modifications. In particular, we have dropped several countries with missing or incorrect data. We also center the quadrants on zero, rather than on the OECD average, although we show the OECD average and it is clear that this makes little difference in the qualitative conclusions.

baby boom, lower fertility, and longer life expectancy. In addition, young people are taking longer to complete their educations, and workers are ending their careers at younger ages (many earlier than age 60), which further increases the dependency ratio. McMullin and Cooke do not project economy-wide skill shortages, but they do argue that once one also takes into account the age structure of the workforces in specific industries and occupations, some localized, industry-specific shortages will emerge. For example, workers in health and education are older, posing more of a problem in these fields because of looming retirements coupled with an aging population that will increase the demand for health care. They also present some case study evidence showing how additional factors can affect whether shortages emerge, including the length of time required for training, the geographic mobility of workers, and working conditions that make it hard to attract or retain employees.

In summary, although there are a number of different types of evidence, each of which is subject to some criticism, there is fairly robust evidence of skill shortages in recent years by education and in highly skilled occupations or industries in many of the developed countries. To the extent that the evidence on occupations is regarded as solid, shortages are more apparent in health, technical, and professional fields. Recall, however, that the projections in this report are for education by degree, not for the fields in which educational degrees will be earned.

Policy responses

The discussion of responses to these skill shortages in the developed countries is a mix of advocacy for particular policy responses and the examination of responses already underway. We briefly discuss the first, and provide more detail on the second.

McMullin and Cooke (2004) suggest an array of policy responses including removing barriers to training and labor force participation and promoting immigration to target skills that are in short supply; higher labor force participation among underrepresented groups; and phased retirement and workplace flexibility that would encourage the participation of older workers. Lifelong learning and active aging are also recommended, including "training throughout working life and advancement opportunities for older workers" (p. iv). On the surface, most of these are sensible as they would either attempt to keep older, often skilled workers employed, or encourage skill formation at all ages. However, the study offers nothing in the way of concrete evidence about which policy responses would be most effective.

In terms of what is being done in Canada, most attention focuses on the system of immigration selection, which favors those in skilled occupations and with more education. The system is less explicit with regard to targeting specific occupations, although according to McMullin and Cooke having a verified employment offer helps, and there is a Provincial Nominee Program where "potential immigrants may apply in order to fill occupations identified by individual employers as in short supply" (p. 33). Occupations that appear to be singled out under this system include nursing and health care generally, and science and research more specifically, although these programs are limited and affect only a very small share of immigration – one percent, according to the authors

(p. 33). Canada also allows migration of temporary workers, of whom about one-third are skilled, and there appear to be plans to increase these numbers.

Green and Green (1999) provide a more historical overview of the goals of Canadian immigration policy. They discuss economic motives in general, and note that in the 1990s the government began to directly emphasize occupations that were in short supply in specific provinces, and gave priority to immigrants matching those occupations (p. 434). (There was a concurrent decline in the emphasis on the family component of immigration.) However, they argue that the most recent policies, adopted in the mid-1990s, moved away from filling precise occupation niches (p. 435) and toward emphasis on broader occupational classes. Nonetheless, skills remain important, and the authors quote a government document stating that "The proposed changes (in immigration policy) seek to improve the skills, flexibility and diversity of the Canadian workforce responding to Canada's new, emerging economy" (Citizenship and Immigration Canada, 1994).

There is also substantial evidence of using immigration to address labor shortages in European countries that is described by Doudeijns and Dumont (n.d.). To some extent, they focus on labor shortages overall; the summary that follows focuses more on immigration as a response to skill shortages.

There is fairly extensive discussion of efforts to alleviate skill shortages in information technology (IT). In Germany, the "Green Card" scheme has been used to recruit immigrants to this sector, via five-year permits for foreign workers. In addition, according to Doudeijns and Dumont, an immigration law reform in 2002 acted to ease the entry of highly skilled workers when they had job offers exceeding 75,000 Euros per year. A second mode of entry "selects skilled workers using a points system based on the Canadian model" (p. 14). In France, Ireland, the Netherlands, and the United Kingdom there are efforts at foreign labor recruitment. There is some emphasis on occupations currently in demand, including IT specialists, highly skilled workers, and workers in biotechnology, medicine, healthcare, and education.[42] Finally, the authors cite legislative changes in several OECD countries that enable foreigners to stay and enter the labor market after completing training, and this legislation largely focuses on skilled workers (see Table 2).

Some opposition to relying on immigration exists for the simple reason that immigrants may displace natives who could, in principle at least, be up-skilled to meet the new demands. For example, Doudeijns and Dumont cite the Irish Employment and Training Authority as claiming that youth unemployment may be rising due to employers' preference for work permit recruits (p. 7). However, our impression is that this concern has not been paramount. Nonetheless, there are clearly also efforts to increase training and education. A counter-argument (Green and Green, 1999) is that immigration is potentially cheaper, since the host country does not pay for the human capital "development." Moreover, it may be easier to target particular skill shortages by recruiting immigrants to meet those shortages (pp. 440-1), although there is the danger that skill gaps and shortages will not be accurately identified (Economic Council of Canada, 1991, p. 9).

A review of countries' responses to labor shortages in the IT sector (López-Bassols, 2002) reveals the use of both immigration and training as policy responses. López-Bassols notes that the main source

[42] Note that this material applies to immigrants from outside the European Union (the European Economic Area), as residents of European Union countries can freely migrate for work.

of IT workers country by country continues to be tertiary-level education, and there is evidence of increases in the supply of IT graduates (pp. 15-16). Thus, we should not overstate the importance of immigration, especially in light of the fact that the potential supply of immigrants may not be sufficiently large and many countries are competing for them.

Nonetheless, the author discusses many aspects of immigration policies intended to address the shortages. These include creating special programs for occupations with shortages (Germany, Canada, Australia), facilitating recruitment conditions and relaxing criteria for employment visas for highly skilled workers (Australia, Canada, France, Japan, New Zealand, Norway, United Kingdom), increasing non-wage incentives for skilled foreign workers (Australia), and allowing foreign students to change their status at the end of their studies (Germany, Switzerland, Australia, United States) (p. 18).

As more specific examples, López-Bassols (2002) reports that for the United Kingdom, "[o]f the 42,000 work permits granted in 1999 to non-EU nationals, 2,000 went to immigrants employed in IT occupations" (p. 20). The author also describes a "fast-track" work permit system in the United Kingdom that speeds up the recruitment of foreign workers by companies experiencing skill shortages. Similarly, in 2001 the Norwegian government started a program to simplify the recruitment of skilled workers and specialists from countries outside of the European Economic Area (p. 20).

In contrast, Sweden appears to rely more on training, although there is not enough evidence to assess how countries balance training and immigration in terms of supplies generated. López-Bassols describes an ambitious IT training program in Sweden that is focused on the unemployed and targets women, immigrants, and occupationally disabled people (p. 26).

The other field that is discussed fairly extensively is the health workforce, and in this case there are suggestions that neither immigration nor training can solve the problem, especially in the short term. A report by the OECD (2008) notes that raising domestic training can help increase the number of doctors and nurses, but this can have at best a limited impact in the short run given the duration of medical training. Immigration can also help, but at higher professional levels it can be problematic because immigrants may not have the requisite qualifications for the destination country. The study points out that this problem may be ameliorated by doing more to recognize and supplement the qualifications of immigrants (pp. 9-10). As a result, the OECD report calls for emphasizing efforts to improve retention of the existing workforce, attracting workers who have left health care to return to the field, increasing intake of medical students in restrictive systems, and moving to skill mixes (such as the use of advanced practice nurses and physicians' assistants) that would lessen the impact of shortages (pp. 10, 27-8). This latter point, of course, is something that one would expect to occur in the private sector in response to wage differentials that emerge due to shortages.

Some examples are also explored. On the immigration side, the OECD report cites increases in the immigration of foreign-trained physicians, coupled with temporary employment authorizations (p. 24); increases in nurse immigrants (p. 25); greater intake of medical students (France and Australia, pp. 27-8); special points for health professionals in permanent migration programs (Australia and New Zealand, p. 30); and government programs to better integrate foreign-trained health care professionals (Canada and Australia, p. 46). There is less explicit discussion of non-immigration responses, with the exception of the National Health Service in the United Kingdom that offers "back-to-practice courses, improved work-based learning, additional nursery facilities, and mentoring of

nurses returning to work" (p. 48). However, the report suggests that there is no evidence, at least yet, of an increase in nurses returning to the field.

Aside from immigration and education, as noted earlier, McMullin and Cooke (2004) call for active labor market policies such as job search assistance, public childcare, better retention of older workers, and lifelong learning – in particular, a shift away from bunching schooling and training at the beginning of life. There are some potential problems with the first and last of these. First, active labor market policies tend to focus more on the hard-to-employ, and more on rapid entry or re-entry in the labor market, rather than skill acquisition (p. 34). Second, it is not entirely clear what policy would encourage lifelong learning as the authors envision it. One thing that is known from theoretical research in economics is that the observed bunching of education and training at the early part of the life cycle is optimal for individuals, both because the period over which the returns to education and training can be recouped is longer, and because the opportunity cost of training and education is lowest when skills (and therefore wages) are lowest (Ben-Porath, 1967). What this may imply is that subsidies to individuals at older ages would be necessary to encourage education and training later in life.

Policies to retain older workers is a more common refrain in the OECD countries (e.g., OECD 2000), although this is a more general response to population aging and rising dependency ratios than to skill shortages per se. In 2000 the European Union countries committed to implement legislation banning age discrimination by 2006 via the Employment Directive on Equal Treatment. That has occurred, although in most countries mandatory retirement is apparently still allowed (Hornstein, 2001, p. 82; O'Cinneide, 2005).

Table I4.1

Summary of Skill Shortages and Responses in Selected Countries, Through the Late 1990s

Country	Occupations	Sources of shortages	Responses
Australia	Professional (mining engineers, computing, nurses and health); skilled trades (toolmakers, boilermakers, sheet metal workers, chefs, cooks, hairdressers); services (childcare coordinators); information technology and communications	Spread of information technology	
Belgium	Technical professionals		Retraining
Canada	Human resource managers, systems analysts and computer programmers, machinists, tool and die workers for auto industry		Targeted immigration
Chile	High-tech workers	Constraints on technical training in education system; English deficiencies	
Germany	Software engineers		Immigration recruitment programs similar to U.S. H-1B visa program ("green card initiative")
Japan	Small-scale industries, manual laborers, highly skilled technicians		More work permits for descendants of Japanese abroad, more migrant workers
Portugal	Low- and medium-tech manufacturing (automotive and electronics)	Low penetration of personal computers and lack of computer knowledge	
South Korea	Labor-intensive and small- and medium-sized industries (clothing, construction, machine tools)		Inflow of foreign workers
Singapore	Banking, finance, accounting, investment management; information technology and computing; blue-collar jobs		Imported workers from neighboring countries for blue-collar work; foreign information technology workers
United Kingdom	Technical occupations requiring information technology or management skills		Sharp increases in earnings
United States	Management analysts, special education, dental hygienists, marketing, advertising and public relations managers, airplane pilots and navigators, purchasing agents and buyers, and mechanical engineers; skilled workers generally; aircraft and auto repair; telecommunications; high-level sales managers; nurses		

Note: Table includes entries for countries where shortages in particular occupations or industries are discussed.
Source: Summary of other studies and anecdotal evidence in Cohen and Zaidi, 2002, Chapter 4.

Table I4.2

Summary of Skill Shortages in Selected Countries, Through Late-1990s

Country	Most Likely to Have Shortages (3.75-5)	Ranking in Top Half of Distribution (3-3.74)	Narrower Occupations with Rankings of 3.75 or Above
Australia	Legislators, senior officials, and managers; professionals	Technicians and associate professionals	Computing professionals; business professionals; modern and traditional health associate professionals (except nursing)
Austria	Legislators, senior officials, and managers; professionals	Technicians and associate professionals	Government officials, CEOs, senior managers; business professionals
Belgium		Legislators, senior officials, and managers; professionals	Computing professionals; health professionals (except nursing); business professionals; legal professionals; social science and related professional
Canada		Legislators, senior officials, and managers; professionals; technicians and associate professionals	
Chile	Legislators, senior officials, and managers; professionals	Technicians and associate professionals	NR
Denmark	Legislators, senior officials, and managers	Professionals; technicians and associate professionals	Government officials, CEOs, senior managers; modern and traditional health associate professionals (except nursing)
Germany		Professionals; technicians and associate professionals	Computing professionals; business professionals; legal professionals; social science and related professional; modern and traditional health associate professionals (except nursing)
Greece	Legislators, senior officials, and managers; professionals	Technicians and associate professionals	Government officials, CEOs, senior managers; architects, engineers, and related professionals; health professionals (except nursing); business professionals; legal professionals
Italy	Legislators, senior officials, and managers; professionals	Technicians and associate professionals	Government officials, CEOs, senior managers; architects, engineers, and related professionals; health professionals (except nursing); college, university, and higher education teaching professionals; business professionals; legal professionals; computer associate professionals; modern and traditional health associate professionals (except nursing)
Japan		Professionals	Computing professionals; modern and traditional health associate professionals (except nursing)
Mexico	Legislators, senior officials, and managers; professionals; technicians and associate professionals; craft and related trades workers	Clerks; service workers and shop and market sales workers; plant and machine operators and assemblers; elementary occupations	NR

Table continues on page 74

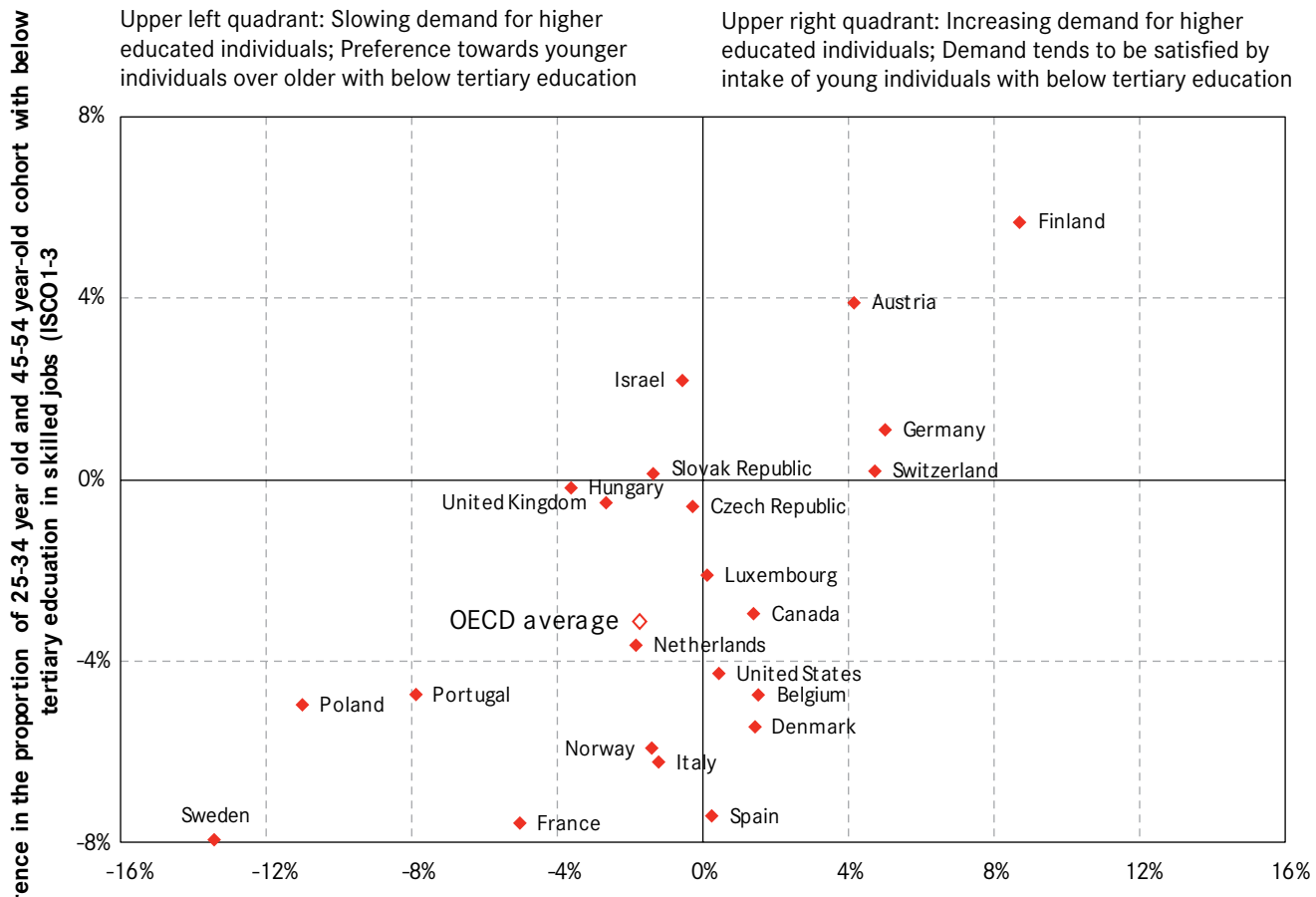
Country	Most Likely to Have Shortages (3.75-5)	Ranking in Top Half of Distribution (3-3.74)	Narrower Occupations with Rankings of 3.75 or Above
Portugal		Legislators, senior officials, and managers; professionals; technicians and associate professionals; craft and related trades worker; plant and machine operators and assemblers; elementary occupations	
South Korea	Professionals; technicians and associate professionals	Legislators, senior officials, and managers	NR
Singapore	Legislators, senior officials, and managers; professionals; technicians and associate professionals	Legislators, senior officials, and managers; professionals; technicians and associate professionals; clerks; service workers and shop and market sales workers	NR
Spain		Legislators, senior officials, and managers; professionals; technicians and associate professionals	Government officials, CEOs, senior managers; computing professionals; architects, engineers, and related professionals; health professionals (except nursing); college, university, and higher education teaching professionals; legal professionals
Sweden	Legislators, senior officials, and managers	Professionals; technicians and associate professionals	Government officials, CEOs, senior managers; health professionals (except nursing); business professionals; social science and related professionals
United Kingdom		Legislators, senior officials, and managers; professionals; technicians and associate professionals	Computing professionals; health professionals (except nursing); business professionals; legal professionals; modern and traditional health associate professionals (except nursing)
United States	Legislators, senior officials, and managers; professionals	Technicians and associate professionals	Government officials, CEOs, senior managers; computing professionals; architects, engineers, and related professionals; health professionals (except nursing); college, university and higher education teaching professionals; business professionals; legal professionals; modern and traditional health associate professionals (except nursing)

Note: Table includes entries for countries for which shortages in particular occupations or industries are discussed. Data needed to study the narrower occupations was not always available. For some countries some occupations are not covered. Spain is covered in the authors' empirical analysis, but none of the occupation groups are rated as having shortages. The occupational classifications are based on the ISCO-88 (viewed February 25, 2010).

Sources: Cohen and Zaidi (2002, Tables 5.6, 5.7); International Labour Organization (1988).

Figure I4.1

OECD Evidence on Skill Shortages in Developed Countries. 1998 and 2006



Source: OECD (2009). This figure is based largely on Chart A1.5, with some modifications discussed in the text.

Insight 5. Occupational shortages and policy responses

The analysis in the main report focuses on skill shortages by examining education levels. Although we use projections of *demand* by occupation, we project *supply* by education. There is ample discussion in reports from consultants, organizations, government bodies, and in the media about projected shortages of workers in particular industries or occupations, and there are policy responses to these shortages at a number of levels. This Insight discusses the most prominent examples of projected shortages by industry or occupation, and the policy responses to these shortages. We focus especially on two areas – green jobs and nursing.[43] In addition, we touch on the more generic capability of state higher education systems – in particular, community colleges – to be responsive to employer needs as they develop in the labor market. Finally, some new analysis is provided with regard to differences in lifelong learning by state, without attempting to do any detailed analysis about why these differences exist. Much of the material discussed in this Insight is not based on our own independent research, but instead tries to describe and summarize the conclusions and claims of others. In some cases the sources are organizations (such as those affiliated with community colleges or with nurses) that may have a vested interest in the outcome.

Green jobs

There is a plethora of studies projecting the need for workers in green jobs. One good example that seems fairly objective is by Global Insight (2008).[44] According to this study, the number of green jobs is projected to grow from about 750,000 in 2008 to more than 2.5 million in 2018 and nearly 3.5 million in 2028. The projected growth is based on the likely changes in how energy is generated, stemming both from rising prices of energy produced by fossil fuels (even absent policy changes), as well as important policy changes in the effort to reduce carbon emissions. This Insight is not the place to get into a number of questions that could be asked, including: the definition of green jobs; the validity of the forecasts and their uncertainty; and the extent to which training or retraining will be required to staff these green jobs. Regardless, there is abundant evidence that community colleges, often with

[43] Our emphasis on these two occupations (or industries, in the case of green jobs) is not based on systematic research on potential shortages by occupation, but rather on a subjective sense of potential shortages that receive a good deal of attention in the media. Nothing in this discussion is meant to imply that there will not be other specific occupations or industries where shortages emerge. Again, our projections are about potential shortages based on education, not occupation (or industry). Finally, note that Insight 4 presents some more systematic attempts to measure skill shortages and the occupations in which they occur. Although that Insight focuses on other countries, some evidence is reported for the United States (see Tables I4.1 and I4.2).

[44] The study by Global Insight defines green jobs as: "any activity that generates electricity using renewable or nuclear fuels, agriculture jobs supplying corn or soy for transportation fuel, manufacturing jobs producing goods used in renewable power generation, equipment dealers and wholesalers specializing in renewable energy or energy-efficiency products, construction and installation of energy and pollution management systems, government administration of environmental programs, and supporting jobs in the engineering, legal, research and consulting fields " (Global Insight, 2008, p. 5). Others, however, use broader definitions. For example: "Green jobs can be broadly defined as jobs that involve protecting wildlife or ecosystems, reducing pollution or waste, or reducing energy usage and lowering carbon emissions" (John J. Heldrich Center for Workforce Development, 2009, p. 1).

funding from state governments and the private sector, are launching programs to train workers for green jobs. Other state and federal efforts, as well, address the widely anticipated need for more workers in these industries.

Community colleges

There is extensive new activity at community colleges throughout the country to create and boost programs training workers for green jobs. In many cases this activity is supported by the private sector. Here are some examples.[45]

- At California's community colleges a $1 million gift from Southern California Edison for a "Green Jobs Education Initiative" provides scholarships for community college students to be trained or certified in green jobs. The initiative covers six key sectors: solar panel installation; water and wastewater management; transportation and alternative fuels; biofuels production and farming; environmental compliance; and sustainability planning. The support is targeted at students with financial need (California Community Colleges Chancellor's Office, 2010).

- In Michigan the Charles Stewart Mott Foundation granted $250,000 to promote green workforce development through a "Michigan Community College Learning and Action Network." Among other things, this includes an "employment 'pipeline' approach to build strong partnerships between community colleges and regional green sector employers …" (Charles Stewart Mott Foundation, 2010).

- IBM is working with Metropolitan Community College in Omaha, Nebraska to create a "green data-center management degree." General Electric has donated a small wind turbine to Mesalands Community College in New Mexico and plans to hire graduates from its new wind energy technician program. And Johnson Controls is building a solar education farm for Milwaukee Area Technical College where students can learn photovoltaic installation and design (Kimes, 2009).

- In the San Francisco Bay Area a consortium of community colleges has established the New Energy Workforce (NEW) Initiative, working to "respond strategically to industry's current and emerging energy workforce needs" (Feldbaum, n.d., p. 25). The emphasis is on photovoltaic design and installation, a hybrid auto technician program, wind generation, etc.

- The National Science Foundation has funded a collaborative called the Consortium for Education in Renewable Energy Technology (CERET). CERET is based at Wisconsin's Madison Area Technical College, with the goal of increasing the number and expertise of renewable energy teachers and students at two-year colleges and secondary schools (Feldbaum, n.d., p. 26).

State legislation

Keaton, Sundeen, and Leiker (n.d.) describe many types of state legislation in support of green jobs training. These include working groups and task forces (Colorado, Connecticut, California, Minnesota, Vermont, Virginia); curriculum development in secondary and postsecondary institutions (Colorado, Connecticut, Florida, Kentucky; workforce development/job corps-related initiatives (Iowa, Michigan, New Mexico, Washington, District of Columbia); training centers and programs

[45] Numerous other examples are given in Keaton, Sundeen, and Leiker (n.d.) for Colorado.

(California, Michigan, Ohio); grants and bonds for agencies and partnerships to train (California, Maryland, North Carolina, Vermont, Pennsylvania); and collaborative efforts with educational institutions, energy companies, and energy institutions/agencies, (Illinois, Kansas, Oregon, Michigan). For example, in California the Green-Collar Jobs Act of 2009 (California, Green Collar Jobs Act, 2009) requires the state's Workforce Investment Board to establish a "Green Collar Jobs Council" to consult with public and private groups and develop "a comprehensive array of programs, strategies, and resources to address the workforce needs that accompany California's growing green economy and to establish, among other programs, green job training programs for eligible individuals …"[46]

Federal efforts

In 2007 (effective in 2008) the federal government enacted a previously proposed Green Jobs Act as part of a larger energy bill (The Energy Independence and Security Act, which included the Green Jobs Act as Title X) to encourage research into and training for green jobs.47 The act includes charging BLS to create a program to collect labor market data and track skills, and to establish workforce training initiatives; training grants for nonprofit partnerships that include employers and labor to train and educate workers; competitive grants to states for research to identify job openings in renewable energy and energy efficiency sectors, assess workers, and provide referrals to qualified job seekers; and competitive grants to states for renewable energy and energy efficiency workforce development programs. This last provision is part of $500 million for competitive grants for green jobs training included in the American Recovery and Reinvestment Act, under which the Department of Labor is giving grants to local and state Workforce Investment Boards and local One Stop Career Centers to help develop a green workforce (Apollo Alliance, et al., 2008).

Nursing

Shortages are also widely projected for nursing (see, e.g., American Hospital Association, 2001; Buerhaus, Staiger, and Auerbach, 2000,2004; Kaiseredu.org, 2008). Consistent with some of the material for the other countries discussed in Insight 4, one major contributor to the projected nursing shortage is the aging of the nursing workforce, which is driven by the diminished entry of women into nursing in recent decades. Based on forecasts assuming no changes in the rate at which future cohorts will enter nursing, the aging of the nursing workforce suggests that its absolute size will remain approximately the same as in 2000 (Buerhaus, Staiger, and Auerbach, 2000), along with the substantial aging and growth of the general population. (These same conclusions are echoed in American Association of Community Colleges [AACC] [2002], which also emphasizes worker dissatisfaction.) Illustrating the sensitivity of such forecasts to assumptions about the entry of future cohorts, a follow-up study (Buerhaus, Staiger, and Auerbach, 2004) pointed to some evidence of increased entry of young workers into nursing, as well as the re-entry of older women, the growth in the number of immigrant nurses, and an uptick in the entry of men. Nonetheless, the Bauerhaus, et al study reports little evidence of mitigation of the nursing shortage. Again, we emphasize that our

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[46] See ftp://leginfo.public.ca.gov/pub/09-10/bill/asm/ab_1351-1400/ab_1394_cfa_20090908_204403_asm_floor.html (viewed March 17, 2010).

[47] See http://www.greenforall.org/files/faq-greenjobsact07.pdf (viewed June 2, 2010).

research did not entail projections of occupation-specific shortages. Nonetheless, as with green jobs, responses to this perceived projected shortage are occurring at many levels.[48]

Community Colleges

According to statistics published by the AACC (2002), community colleges play a leading role in the production of the nursing workforce. Sixty percent of U.S.-educated registered nurses (RNs) who entered the occupation in 2000 received an associate's degree in nursing (ADN), and 79 percent of these ADN recipients graduated from community colleges. This report also lists the states that experienced gains and losses in per capita nurses over the 1996 to 2001 period, although there is no analysis tying these gains or losses to community college efforts.

A somewhat unsystematic review of on-line sources did not uncover as much explicit activity on the part of community colleges to increase the training of nurses, which may stem from both the expense of nursing programs and a lack of applicants. In addition, there is a sense that the problem stems in part from a shortage of nurse educators and other troubles associated with the education of nurses. There are efforts to address these difficulties, although the research literature cited above tends to focus less on the shortage of educators as the source of the problem (and see Gooden, 2003).[49] For example, AARP, the AARP Foundation, and the Robert Wood Johnson Foundation (as part of the Center to Champion Nursing in America), are working with teams in many states to build teaching capacity, to revamp curricula, to help students move more easily from associate degree to bachelor degree programs, and to ease the clinical placement process (Reinhard and Cleary, 2010). Reinhard and Cleary report that these efforts have led to a 47 percent increase in nursing student enrollment in the last half of this decade.

On the other hand, there is considerable evidence of state efforts that have been channeled through community colleges to address the nursing shortage. For example, the Kansas Board of Regents in 2006 awarded grants to 20 public higher education institutions in the state – 13 of which are community or technical colleges – to boost nursing education in Kansas. This was part of a $30 million initiative to increase the state's nursing capacity (with $22 million coming from state appropriations) (Kansas Board of Regents, 2006). Similarly, in 2005 the state of California committed $90 million over five years to increase the capacity for nursing education (in partnership with California community colleges and private entities) and to expand nursing education at the University of California and California State University (California, Office of the Governor, 2005). And as a third example, the state of Connecticut has taken many steps (more discussed below) to address the nursing shortage, including assistance to community-technical colleges in support of nursing

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[48] For a listing of a great deal more research on the nursing shortage and policy responses, see Kaiseredu.org (2010). (viewed March 16, 2010). For a state-by-state list of reports on nursing shortages, see American Association of Colleges of Nursing (AACN) (2010), (viewed March 16, 2010).

[49] On the other hand, there are numerous reports that suggest that nursing schools are turning away many students because of faculty shortages, although the AACN appears to be a principal force behind the dissemination of these studies. See, e.g., Arizona Hospital and Healthcare Association (2008) (for Arizona); Connecticut Hospital Association (2007) (for Connecticut); and Florida Center for Nursing (2010) (for Florida)., all viewed March 16, 2010.)

education.[50] Examples of other states that have implemented policies focused on increasing nursing educational capacity are Colorado, Nebraska, Georgia, Illinois, Minnesota, Texas, and Vermont.[51]

Other state and federal efforts

In addition to the efforts described above to boost nursing education – which are not restricted to community colleges – many states have devoted funds to attracting more nursing students via scholarships and loan forgiveness programs (Vu, 2008; AACN, 2006). There are also policy efforts to address the nursing shortage in other ways. For example, Connecticut has made it easier for nurses to renew state licenses, and for those licensed elsewhere (Washington, DC, Puerto Rico, and other U.S. commonwealths) to get licensed in the state (Kasprak, 2007).

Federal efforts to address the nursing shortage include the 2002 Nurse Reinvestment Act and the Nursing Workforce Development Programs (administered by the Health Resources and Services Administration). These programs include a fund to repay student loans of nursing graduate students who remain in teaching, a scholarship/loan forgiveness program for students who work in nursing shortage areas, and grants to support training and education programs for geriatric nursing (American College of Nurse Practitioners, n.d.; American Nurses Association, 2007). Some of these programs were singled out as recipients of stimulus funds under the American *Recovery* and Reinvestment Act of 2009.

Community colleges as "first responders" to occupational shortages

In the case of both green jobs and nursing, the above discussion highlights the prominent role of community colleges in meeting workforce needs. To some extent this role is natural, as community colleges emphasize career and technical training relative to liberal arts or pre-professional education. It is therefore logical that both government and private efforts seeking to increase supplies of workers in particular fields will turn to community colleges. More generally, however, there is some evidence that community colleges, including private two-year colleges, are especially attuned to local labor market needs. They are likely to be the institutions that are most adept at responding to shortages of skilled workers in various fields – whether that shortage is national or local.

Some examples in the field of green jobs illustrate the proactive role played by community colleges in identifying and responding to local labor market needs. For instance, the growth of the solar energy industry in the San Francisco Bay Area led to City College of San Francisco and West Valley College conducting the Bay Region Solar Industry Workforce Study. This study "identified solar firms in the Bay Area including their geographical concentration, size, and major sectors; key solar occupations that are most relevant to community colleges; and employer challenges in recruiting, hiring, and retaining their workforce and future employment growth projections" (Feldbaum, n.d., pp. 25-6). In Pennsylvania, Bucks County Community College (2010) has established a Green Jobs Academy as a collaborative effort of college and private industry. And in California, a program run by the state's community colleges, called Economics and Workforce Development, seeks to identify skill gaps in

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[50] These are simply examples and not meant to be comprehensive. It is easy to find discussions of similar initiatives in many states.

[51] See American Association of Colleges of Nursing, (n.d.). (viewed March 16, 2010).

green industries, to specify the training requirements, and to document how the community college system should respond (Lindstrom, 2007).

More systematic research on community and private two-year colleges highlights the connections between these institutions and local labor markets. Person and Rosenbaum (2007) emphasize the potentially important role played by community colleges, and occupational colleges in particular, in the workplace preparation of lower-skilled adults. They point out that nearly half of those who enter postsecondary education do so at community and two-year colleges. Moreover, these colleges have an occupational focus and collaborate with local employers and government.

Person and Rosenbaum's research explores the role of two-year postsecondary institutions in creating links between school and work. To some extent, their work focuses on differences between private occupational colleges and public community colleges, which is potentially informative about what the latter institutions might do better. Qualitative evidence from interviews of program chairs points to a number of dimensions where labor market connections are taken more seriously at the private occupational colleges, even if there are formal responsibilities for labor market linkages at the public community colleges. These include greater contact and integration between faculty/teaching and career services, increased involvement with advisory committees of local employers, fewer bureaucratic obstacles to changing curricula to respond to new developments, more individualized and intensive job placement efforts, and a mission more focused on workforce training rather than on general education and transferring to four-year colleges.

Somewhat earlier research by Brewer and Gray (1999) focuses only on community colleges and is generally consistent with these conclusions. Of course this research is dated, based on information collected in the mid-1990s. The study examines both survey evidence and detailed case studies, looking at the various ways in which community college faculty build and draw on connections to the workplace. The focus is only partially on responsiveness to local labor market needs and conditions. The authors also examine the career content of work, which is less germane to our inquiry. There are two main findings relevant to this report. First, Brewer and Gray conclude that faculty build links to the labor market when these connections involve relatively low effort, but they are less likely to be involved in linkages that require greater effort. Second, however, all of the labor market connection activities are more common for the vocational faculty, which is what we would expect. For example, faculty quite frequently use business applications in the classroom, but are much less likely to give students assignments requiring interaction with local businesses, government, or organizations, which Brewer and Gray believe is because the latter types of activities require much more planning and preparation. Similarly, there is low incidence of faculty personally developing new internship, apprenticeship, or cooperative education programs (1999, p. 408), but a high incidence of faculty talking to students about career concerns, trying to find out what skills employers need, and helping with student placement, although the authors characterize these efforts as ad hoc.

Leigh and Gill (2007) provide a more data-driven analysis of this question. In particular, looking across both individual community colleges in California as well as community college districts (which may contain multiple colleges), they compare the distributions of occupation-specific skills (based on a classification of each course taken) with the distributions of short-term projections of labor demand for those same occupations. They then calculate a Duncan Index, which ranges from zero to 100 and captures the "match" between skills learned and skills needed. Zero is the lowest, implying that 100 percent of students' courses would have to be in different occupations for the distributions

to match, and 100 is the highest, meaning that the match is exact. They compute the index by school and by district, concluding that the match is generally quite high (a mean of 60.1). When it is lower for a particular institution, that is often because the school is part of a multi-college district in which schools specialize. This analysis is somewhat limited in a couple of respects. First, it is not clear that demands for workers in an occupation require occupation-related coursework. And second, it is not necessarily the case that the "demands" reflect opportunities for the students enrolled in community colleges. Given these difficulties, it might be more informative to study how community college coursework changes as projected occupational demands change.

In neither Brewer and Gray's nor Leigh and Gill's work is there any comparison to the private occupational colleges that Person and Rosenbaum research. However both studies do suggest that community colleges are somewhat attuned to the local labor market, with the Brewer and Gray study indicating that the activities are not intensive. One might be tempted to conclude, from the specific examples cited earlier regarding green jobs, that community colleges have become more responsive. But there is no basis for comparison with how community colleges responded in the past to similar emerging industries, nor is there information on the success of the recent efforts to respond to the demand for workers in green jobs.

Nonetheless, based on all of the evidence, it does seem sensible to think about relying fairly heavily on community colleges to meet the specific occupational shortages that are likely to emerge. In contrast, tone might need to rely on the overall postsecondary education system – including but not limited to community colleges – to meet the growing demands for educated workers generally.

To gain some sense of which states are perhaps better equipped to use community colleges to respond to skill shortages, Table I5.1 lists in the first column the share of each state's labor force participants enrolled in community colleges. The states are ranked in order, with California at the top with 132.4 students enrolled per 1,000 labor force participants, compared with a low of 8.5 in Alaska. The overall enrollment rate may be a little misleading, however, if the full-time vs. part-time enrollment composition varies much by state. However, as shown in columns 3 and 4, using a full-time equivalent measure (which adjusts for part-time status) we get very similar results, with the rankings exhibiting a correlation of 0.95.

Community college enrollments can provide an incomplete picture. First, some states may rely more on community colleges for traditional undergraduate education. This is certainly true in California where the community colleges are important feeders of transfer students to the University of California. For example, California's "Master Plan for Higher Education" requires that the state public universities have more upper division students than lower division enrollees in order to accommodate transfer students. Thus, high community college enrollments do not necessarily indicate a high degree of retraining of adults. Columns 5 and 6 of Table I5.1 report enrollment rates of 45- to 64-year-olds in postsecondary institutions at the bachelor's level or below. As the table shows, this ranking is quite different, although it is still positively correlated (with correlations of 0.2 to 0.3) with the community college enrollment measures.[52]

And finally, we should point out that the older-adult enrollment measures do not necessarily provide a better measure of how states' educational systems may respond to skill shortages. Even if community colleges serve many students at traditional undergraduate ages, the greater

[52] The correlations would be higher if not for Alaska, which is ranked last on community college enrollments, and first in postsecondary enrollments. The correlations are about 0.08 higher excluding Alaska.

responsiveness of community colleges to the labor market may still mean that states with high enrollments of young people in community colleges may better adapt to changing skill needs. Regardless, the states that rank high on *both* measures – community college enrollments overall and adult postsecondary enrollments – are likely to be better poised to respond to emerging workforce skill needs. Such states include California, Arizona, New Mexico, Washington, Oregon, Iowa, Michigan, and North Carolina. In contrast, South Dakota, New Hampshire, Montana, Pennsylvania, West Virginia, and North Dakota have low enrollments measured in both ways.

Table I5.1

Community College and Older Adult Post-Secondary Enrollments by State, 2007-2008 Academic Year

State	Community College Enrollments per 1000 Labor Force Participants	Rank	Full-Time Equivalent Community College Enrollments per 1000 Labor Force Participants	Rank	Enrollment Rate of 45-64 in Postsecondary Education, Bachelor's Program or Less	Rank
	(1)	(2)	(3)	(4)	(5)	(6)
California	132.4	1	51.0	2	2.2%	2
Arizona	127.9	2	41.6	6	2.1%	6
New Mexico	122.6	3	46.4	3	2.1%	4
Wyoming	119.1	4	51.9	1	1.4%	37
Illinois	107.8	5	38.1	8	1.6%	24
Nebraska	95.2	6	32.6	14	1.5%	30
Kansas	90.3	7	35.9	9	1.7%	20
Washington	85.3	8	35.5	11	1.9%	11
Oregon	85.1	9	32.9	13	1.7%	18
Iowa	84.2	10	44.5	4	1.8%	16
Texas	81.1	11	35.8	10	1.5%	29
Mississippi	75.8	12	44.2	5	1.4%	34
Michigan	74.5	13	33.0	12	1.9%	10
North Carolina	66.8	14	38.9	7	1.8%	13
Kentucky	65.4	15	24.4	23	1.4%	39
Virginia	64.9	16	26.6	22	1.8%	12
Minnesota	62.4	17	30.9	16	1.4%	36
Arkansas	62.3	18	28.0	19	1.5%	32
Oklahoma	61.6	19	29.6	18	1.7%	23
Maryland	61.5	20	26.7	20	2.2%	3
South Carolina	58.0	21	29.8	17	1.4%	41
Alabama	57.8	22	31.1	15	1.1%	49
New Jersey	53.9	23	26.6	21	1.3%	43
Utah	53.3	24	18.5	37	2.0%	8
Wisconsin	52.7	25	21.0	32	1.4%	33

Table continues on page 84

State	Community College Enrollments per 1000 Labor Force Participants	Rank	Full-Time Equivalent Community College Enrollments per 1000 Labor Force Participants	Rank	Enrollment Rate of 45-64 in Postsecondary Education, Bachelor's Program or Less	Rank
	(1)	(2)	(3)	(4)	(5)	(6)
Hawaii	52.1	26	21.4	30	2.1%	5
Colorado	50.2	27	20.0	35	1.8%	17
Delaware	49.2	28	24.3	25	2.0%	9
Ohio	48.8	29	22.7	27	1.5%	31
Georgia	48.2	30	24.3	24	1.8%	15
Florida	48.2	31	24.2	26	1.7%	22
Missouri	48.0	32	22.0	29	1.5%	27
Louisiana	47.2	33	20.6	34	1.2%	46
Rhode Island	45.2	34	19.2	36	1.7%	21
New York	44.0	35	22.4	28	1.4%	42
Tennessee	43.0	36	21.2	31	1.4%	35
Indiana	39.2	37	16.3	40	1.6%	26
Massachusetts	39.2	38	17.3	39	1.4%	38
Connecticut	39.1	39	16.0	41	1.7%	19
North Dakota	38.3	40	21.0	33	0.9%	50
West Virginia	36.7	41	18.1	38	1.2%	48
Pennsylvania	33.7	42	15.4	42	1.4%	40
Montana	31.2	43	13.5	44	1.3%	45
Maine	30.0	44	13.6	43	1.6%	25
Vermont	28.3	45	8.9	48	1.5%	28
New Hampshire	27.6	46	11.1	46	1.2%	47
Idaho	26.6	47	11.0	47	2.0%	7
South Dakota	16.0	48	13.0	45	1.3%	44
Nevada	14.9	49	5.6	49	1.8%	14
Alaska	8.5	50	1.0	50	2.7%	1
Correlation with Col. (2)				0.953		0.296
Correlation with Col. (4)						0.204

Notes: Community college enrollment data are from the Integrated Postsecondary Education Data System Data Center (IPEDS), provided by the National Center for Education Statistics. It covers unduplicated enrollment for the 2007-2008 academic year. For calculating community college enrollments per 1,000 labor force participants, we use the number of enrolled students, taken from IPEDS, and divide them by the number of individuals in the labor force ages 18 to 64, derived from the 2007 American Community Survey (ACS) Public Use Microdata Sample (PUMS). For calculating the state enrollment rates for individuals ages 40 to 64, we use the 2008 ACS data and take the number of 40- to 64-year-olds enrolled in either community colleges or bachelor's programs and divide them by the population in that age range.

Appendix A. Adjustment for multiple jobholding

In developing adjustments for multiple jobholding, we treat multiple job holders as having two jobs, and do not distinguish those with three (or more) jobs. Based on the Current Population Survey (CPS) data, 7.9 percent of multiple job holders have three or more jobs, so ignoring this has negligible effects. The self-employed are treated symmetrically in these calculations. They are included in the BLS projections (2009) (viewed June 9, 2010) and are covered in the CPS multiple jobholding question. Thus, there is no problem regarding the treatment of the self-employed in the adjustment for multiple jobholding.

A comparison of the occupational "positions" and our imputed employment levels from the BLS are shown in Table A1. Since the moonlighting rate tends to increase with education, occupations requiring more education and training will thus see a larger difference between the level of occupational employment and the number of people holding those occupations. To illustrate this relationship, Figure A1 shows the share of workers who hold multiple jobs (which comes from applying moonlighting rates by education to the educational distribution of workers in each occupation) versus the share of the occupational category with a bachelor's degree or higher. From this, it is clear that occupations that require higher education see a greater number of positions held per employee due to the increased moonlighting rates.[53]

[53] The shares of education are derived using 2008 American Community Survey (ACS) data.

Table A1

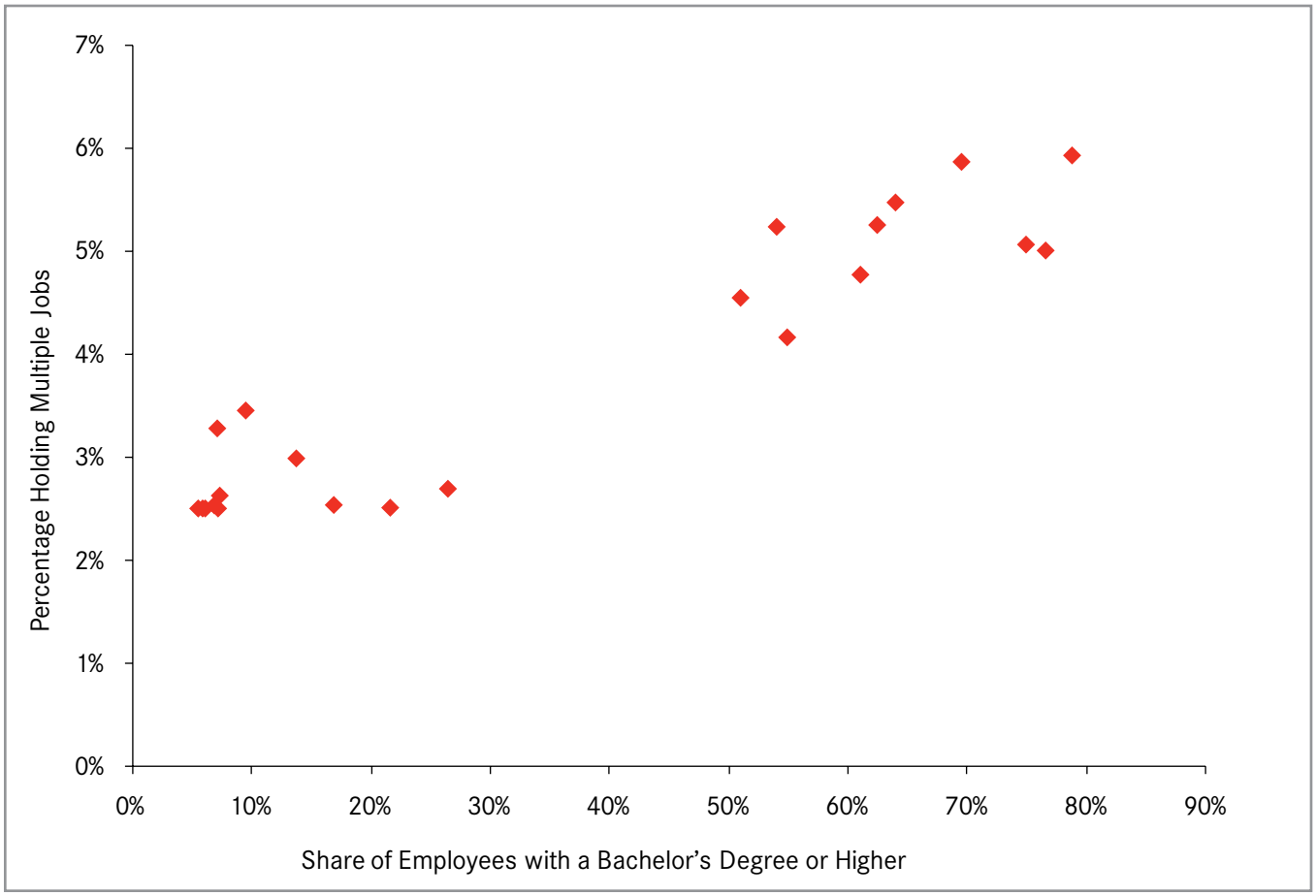
BLS Occupation Employment by Two-Digit SOC Category (Adjusted for Workers With More Than One Job), 2008

2-Digit SOC	Occupation	Occupational Employment (thousands)		Percent Difference
		Jobs	Workers	
11	Management occupations	8,913	8,525	-4.3%
13	Business and financial operations occupations	6,834	6,523	-4.6%
15	Computer and mathematical science occupations	3,540	3,357	-5.2%
17	Architecture and engineering occupations	2,636	2,504	-5.0%
19	Life, physical, and social science occupations	1,461	1,379	-5.6%
21	Community and social services occupations	2,724	2,573	-5.5%
23	Legal occupations	1,251	1,191	-4.8%
25	Education, training, and library occupations	9,209	8,765	-4.8%
27	Arts, design, entertainment, sports, and media occupations	2,741	2,631	-4.0%
29	Healthcare practitioners and technical occupations	7,492	7,119	-5.0%
31	Healthcare support occupations	3,982	3,849	-3.3%
33	Protective service occupations	3,270	3,190	-2.4%
35	Food preparation and serving related occupations	11,552	11,270	-2.4%
37	Building and grounds cleaning and maintenance occupations	5,727	5,588	-2.4%
39	Personal care and service occupations	5,044	4,898	-2.9%
41	Sales and related occupations	15,903	15,486	-2.6%
43	Office and administrative support occupations	24,101	23,505	-2.5%
45	Farming, fishing, and forestry occupations	1,035	1,010	-2.4%
47	Construction and extraction occupations	7,811	7,620	-2.4%
49	Installation, maintenance, and repair occupations	5,798	5,614	-3.2%
51	Production occupations	10,083	9,825	-2.6%
53	Transportation and material moving occupations	9,825	9,583	-2.5%
	All occupations	**150,932**	**146,005**	**-3.3%**

Notes and sources: 2008 Current Population Survey January Supplement was used to calculate education-specific ratios of persons with multiple jobs. These ratios were then applied to BLS Employment Projections jobs to calculate the number of workers holding jobs.

Figure A1

Scatter Plot of Multiple Jobholding Rate vs. Education, by Occupation, 2008



Sources: Authors' calculations using 2008 CPS January Supplement, 2008 BLS employment counts, and 2008 ACS.

Appendix B. Additional detail on BLS skill requirements

The BLS data contain information regarding the most common skills required to perform in a given occupation. For each SOC, the BLS identifies the "most significant source of education and training category,"[54] which combines education and training measures into a single category. Certain categories only identify "work-related training"[55] while not specifying education (e.g., "short-term on-the-job training"). As noted in the main text, postsecondary awards take precedence over work-related training in the BLS approach. We understand this to mean that education above a high school degree is not required in those occupations that BLS identifies as requiring no more than work-related training. The BLS develops these classifications using educational attainment data from the ACS, skills information from the Occupational Information Network (O*NET), and other qualitative information from occupational experts to assign occupations into these categories. Since a single education/training category is assigned to each occupation, these data group all employees in an occupation into a single mold. The BLS acknowledges that there is a distribution of educational attainment and training for employees within a given SOC. The BLS method only identifies what "best describes the education or training that most workers need to become fully qualified in that occupation."[56]

[54] See Employment Projections Table 1.6: "Occupational Employment and Job Openings Data, 2008-18, and worker characteristics, 2008," available at www.bls.gov (accessed April 11, 2010).

[55] For detailed descriptions of these categories, see "Occupational Variable Data Definitions." at http://www.bls.gov/emp/ep_nem_definitions.htm (accessed October 29, 2010).

[56] For a detailed description of how the BLS develops its education and training categories, see www.bls.gov (accessed April 11, 2010).

Appendix C. Non-educational training requirements

As noted in the main text, some occupations require substantial non-education-related skills. To provide some evidence on the importance of this problem, we explore the extent to which the ACS educational profiles within occupations, as measured at the three-digit level, match up with BLS categories on education and training. We do this by aggregating the more detailed occupations that make up the three-digit occupations and computing the shares in each skill requirements (BLS) or education (ACS) categories. As shown in Table C1, the two measures – not surprisingly – are not entirely consistent. In some occupations, especially those where BLS indicates that high levels of educational attainment are required, the ACS is in strong agreement. For example, the BLS training requirements indicate that all postsecondary teachers will need at least some college education, and the ACS shows that 97.4 percent of postsecondary teachers in 2008 had this level of education. On the other hand, there are some occupations where the agreement is weak. For instance, the BLS classifications suggest that one-third of real estate and other sales persons should have at least some college education, but the ACS shows that three-fourths of all people in this occupational category had at least some college. Overall, the correlation between the ACS education levels and the BLS category is quite high (with a correlation coefficient of 0.73 between the "any college" shares in the two sources). In addition, there are occupations where it is clear that most of the jobs require skills related to training or work experience, according to the BLS. Our methods are based on educational specifications, and some of these jobs may require high levels of skills but not much education. For occupations such as these our methods are likely less reliable. Note, however, that there is not a clear bias in one direction or the other. That is, one should not assume that just because some occupations have a fairly high degree of "non-educational" skill requirements, that he or she should project particularly fast-growing demands for workers in those occupations (making shortages more likely, all else being the same). Moreover, in some of the occupations that BLS identifies as requiring long-term on-the-job training (but no college education), we find substantial shares of workers with at least some college. For example, BLS data suggest that 52 percent of law enforcement workers need long-term training, and we find that 78 percent of these workers have attended at least some college. This suggests that in some occupations, college vocational courses (including those in community college programs that lead to certificates) might substitute for long-term training.

Table C1

Comparison of BLS Skill Requirements with ACS Education Distributions, by Detailed Occupation, 2008

		2008 BLS Population					2008 ACS Population		
3-Digit SOC	Description	Population (thousands)	Some On-the-Job Training	Long-term On-the-Job Training	Work Experience in a Related Occupation	Any College	High School Or Less	Any College	ACS Difference in College Share
412	Retail salespersons	8,524	100.0%	-	-	-	50.2%	49.8%	49.8%
353	Food service staff	6,153	100.0%	-	-	-	50.5%	49.5%	49.5%
472	Construction specialists	5,871	48.4%	51.6%	-	-	69.5%	30.5%	30.5%
434	Clerks and customer service	5,546	98.5%	-	1.5%	-	36.1%	63.9%	63.9%
537	Heavy machinery operators	4,472	99.0%	1.0%	-	-	72.6%	27.4%	27.4%
291	Health professionals	4,386	-	-	-	100.0%	2.4%	97.6%	-2.4%
119	Process managers	4,366	-	22.0%	29.7%	48.3%	23.7%	76.3%	28.0%
439	Computer operators and specialists	4,297	99.4%	-	-	0.6%	34.3%	65.7%	65.1%
252	Primary and secondary teachers	4,293	-	-	-	100.0%	4.7%	95.3%	-4.7%
436	Secretaries and administrative assistants	4,235	57.4%	-	36.7%	5.9%	33.4%	66.6%	60.7%
533	Private and public transportation drivers	4,069	100.0%	-	-	-	64.5%	35.5%	35.5%
435	Postal service and freight workers	4,013	100.0%	-	-	-	51.7%	48.3%	48.3%
131	Agents and business managers	3,863	-	25.6%	0.3%	74.1%	15.2%	84.8%	10.7%
372	Household and building cleaners	3,859	100.0%	-	-	-	73.9%	26.1%	26.1%
433	Billing and accounting clerks	3,816	100.0%	-	-	-	34.1%	65.9%	65.9%
151	Computer scientists and systems analysts	3,248	-	-	-	100.0%	7.0%	93.0%	-7.0%
499	Maintenance and repair workers	2,889	65.4%	23.0%	-	11.6%	53.8%	46.2%	34.5%
352	Cooks	2,886	68.9%	31.1%	-	-	71.7%	28.3%	28.3%
399	Personal aides	2,798	91.1%	-	-	8.9%	47.5%	52.5%	43.6%
519	Production workers and specialists	2,711	96.1%	0.9%	-	3.0%	63.9%	36.1%	33.1%
132	Financial professionals	2,660	15.5%	-	-	84.5%	8.2%	91.8%	7.3%
292	Health technicians	2,598	12.3%	2.2%	-	85.5%	18.9%	81.1%	-4.4%
311	Nursing, psychiatric, and home health aides	2,365	40.6%	-	-	59.4%	51.0%	49.0%	-10.4%
411	First-line sales managers	2,139	-	-	100.0%	-	34.8%	65.2%	65.2%
514	Machinists	2,097	53.6%	24.3%	0.8%	21.3%	67.2%	32.8%	11.6%
111	Executives and general managers	2,088	-	-	-	100.0%	15.6%	84.4%	-15.6%
414	Sales representatives, wholesale and manufacturing	1,925	-	-	100.0%	-	21.4%	78.6%	78.6%
512	Engine and other machine assemblers	1,903	100.0%	-	-	-	68.3%	31.7%	31.7%
211	Counselors and social workers	1,844	18.6%	-	-	81.4%	9.8%	90.2%	8.9%
493	Mechanics and transportation technicians	1,658	8.4%	25.4%	-	66.2%	61.2%	38.8%	-27.4%
251	Postsecondary teachers	1,598	-	-	-	100.0%	2.6%	97.4%	-2.6%
413	Sales agents	1,555	10.5%	-	37.0%	52.5%	17.5%	82.5%	30.0%
259	Teacher assistants and other education workers	1,532	83.6%	-	-	16.4%	27.9%	72.1%	55.7%
172	Engineers	1,492	-	-	-	100.0%	4.8%	95.2%	-4.8%
113	Administrative and other managers	1,479	-	-	16.9%	83.1%	15.0%	85.0%	1.9%
431	First-line sales managers and support workers	1,422	-	-	100.0%	-	27.2%	72.8%	72.8%
339	Protective service workers	1,386	96.8%	-	3.2%	-	43.4%	56.6%	56.6%
319	Medical therapists and assistants	1,346	83.8%	-	-	16.2%	31.1%	68.9%	52.8%
419	Real estate and other salespersons	1,343	57.4%	-	9.0%	33.6%	25.1%	74.9%	41.3%
359	Dining and kitchen workers	1,312	100.0%	-	-	-	72.8%	27.2%	27.2%
373	Grounds maintenance workers	1,271	100.0%	-	-	-	73.3%	26.7%	26.7%
333	Law enforcement	1,240	38.1%	52.4%	8.8%	0.6%	21.8%	78.2%	77.6%
253	Other teachers and instructors	1,050	-	-	23.6%	76.4%	15.7%	84.3%	7.9%

Notes: Table includes only 3-digit occupation categories with greater than one million workers, as calculated by the BLS.SOC descriptions at the three-digit level are not provided by the BLS, and were created by the authors based on lower-level occupation descriptions.

Sources: 2008 BLS employment counts and the 2008 American Community Survey.

Appendix D. Education projections

We employ three methods for developing one set of education projections, using both a cohort approach and a period approach depending on the age group.

For adults ages 30 and over in 2008 we use a dynamic cohort approach. In this method we follow cohorts across time so that educational attainment in 2018 is based on 2008 levels for the cohort. Adjustments are made based on historic patterns of change in educational attainment observed for similarly aged cohorts from 2000 to 2008. Specifically:

$$p_{e,x,i,s,n,2018} = p_{e,x-10,i,s,n,2008} + (p_{e,x,i,s,n,2008} - p_{e,x-8,i,s,n,2000})$$

where p equals the proportion of adults of educational category e within age group x, ethnicity i, gender s, nativity n, and year (2000, 2008, or 2018).

This approach allows for continuing improvements in educational attainment across age-specific cohorts, and also allows us to examine the degree to which older workers continue to acquire new educational skills. We include the following seven educational attainment categories: doctorate, professional degree, bachelor's degree, associate's degree, some college but no degree, high school degree, and not a high school graduate.

For younger cohorts, those under age 30, historic patterns of change in educational attainment for the age group are allowed to continue at the same pace. Using the same notation as above:

$$p_{e,x,i,s,n,2018} = p_{e,x,i,s,n,2008} + (p_{e,x,i,s,n,2008} - p_{e,x,i,s,n,2000}).$$

This approach assumes that for each of our population subgroups under age 30, changes in educational attainment observed for an age group from 2000 to 2008 will continue from 2008 to 2018.

Finally, for adults ages 80 and over we use a cohort approach but do not allow for any changes in educational attainment. Again using the same notation as above:

$$p_{e,x,i,s,n,2018} = p_{e,x-10,i,s,n,2008}.$$

Appendix E. Synthetic cohort approach to predict acquisition of skills by middle-aged workers

In this method, we examine changes in educational attainment reported by adults identified by birth cohort and population subgroup, with the subgroups identified by ethnicity, nativity, and gender (characteristics that do not, for the most part, change over time). We project these trends from 2008 to 2018 based on patterns of change observed from 2000 to 2008 (as described in section 3). If there was no international migration and no mortality, these educational changes across time would provide a completely accurate measure of new levels of education acquired by these cohorts. Because mortality rates are not high for adults under age 60 and international migration rates are relatively low for middle-aged adults, we feel comfortable that our synthetic cohorts reflect true longitudinal changes. We report findings separately by nativity because of notable differences between the U.S.-born and foreign-born, but also because the U.S.-born cohorts are much less likely to be affected by international migration. We use the term "education upgrading" to refer to an increase in the educational attainment level.

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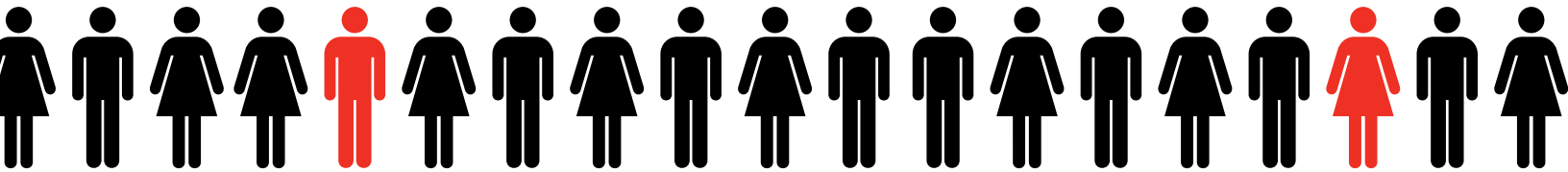

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