Chapter 2: Middle Skill Workers in Today's Job Market

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I. Introduction: Why should we be concerned about the labor market for middle skill workers?

Over the past decade, policymakers and employers have been concerned that slower population growth combined with the retirement of the baby boom generation would lead to a shortage of skilled labor.[1] Even prior to the Great Recession, the concern was that an inadequate supply of skilled workers at both the top and middle of the distribution would hamper future economic growth by creating barriers for firms looking to locate or expand in the United States.[2] More recently, the worry is that the lack of skilled workers has made it difficult to fill jobs that are in high demand during the economic recovery, leading to slower than expected improvement in the labor market.[3] Of particular concern is the lack of workers able to fill "middle-skill" jobs that require some postsecondary education and training but less than a four-year college degree.[4]

[1] Barry Bluestone and Mark Melnik. "After the Recovery: Help Needed. The Coming Labor Shortage and How People in Encore Careers Can Help Solve it." Northeastern University, Kitty and Michael Dukakis Center for Urban and Regional Policy, April 2010; "Growing Talent: Meeting the Evolving Needs of the Massachusetts Life Sciences Industry." University of Massachusetts, Donahue Institute, November 2008; Robert Gavin. "State Expects to See Fewer Young Skilled Workers." The *Boston Globe.* November 1, 2008.

[2] "Recent Survey Finds Shortage of Skilled Workers." The *Business Times*, February 1, 2005; Kevin Kelley. "Tight Labor Market Barely Relaxes as Recession Looms." *Vermont Business Magazine*. November 1, 2001; and Navjeet Singh and Michael Goodman. "The Skills Gap: Labor Supply and Demand." Commonwealth Corporation, Research and Evaluation Brief. October 2005. Holzer, Harry and Robert Lerman. 2007. America's Forgotten Middle-Skill Jobs. Education and Training Requirements in the Next Decade and Beyond. Skills2Compete. Reed, Deborah. 2008. "California's Future Workforce Will There Be Enough College Graduates?" Public Policy Institute of California.

[3] Bloomberg Business. 2012. "Companies Say 3 Million Unfilled Positions in Skill Crisis: Jobs." July 25. Madigan, Kathleen. 2014. "How Some Companies are Bridging the Skills Gap." *Wall Street Journal*, May 15. Madigan, Kathleen. 2015. "Skills Shortage Is the Worst Since 2006, Small- Business Survey Says." *Wall Street Journal*, March 10. Rothwell, Jonathan. 2012. "Education, Job Openings, and Unemployment in Metropolitan America." The Brookings Institution. Congressional Budget Office. 2014. "The Slow Recovery of the Labor Market."

[4] Kochan, Thomas A., David Finegold, and Paul Osterman. 2012. "Who Can Fix the "Middle-Skills" Gap?" *Harvard Business Review*, December. Mary Jo Webster. 2014. "Where the jobs are: The new blue collar." *USA Today*,

This means having not only a sufficient ***number*** of workers but also a workforce with the right ***mix of skills*** to meet the diverse needs of the nation's economy.

The concern over having a sufficient ***number*** of skilled workers reflects the apprehension that when workers are in short supply, the rate at which employment and output can grow is constrained. For employers, slower employment growth means tighter labor markets that may require firms to find innovative ways to increase productivity in the face of rising labor costs. For policymakers, it means slower economic growth and tax revenues at a time when a greater share of the population will be retired and drawing support from public programs such as Social Security and Medicare. Additionally, firms may choose to increase productivity through greater automation or offshoring of production, raising concerns about the types of jobs that will be created and the possibility of lost opportunities for the nation's workers.

Indeed, the U.S. could possibly have a shortage of skilled workers in the not-so-distant future. According to the Census Bureau's most recent population projections, the U.S. population is expected to grow more slowly, to grow older, and to become more racially and ethnically diverse over the next several decades.[5] Current Census projections for 2020 show that the number of individuals aged 15 to 24 years who are slated to enter the labor force in the coming decade will just offset the number of individuals aged 55 to 64 years who are likely to leave the labor force as they retire.[6] In some regions of the country, such as New England, state projections actually show a decline in in the working age population due to fewer births, greater

September 30. Holzer, Harry. 2015. "Job Market Polarization and U.S. Worker Skills: A Tale of Two Middles." The Brookings Institution, April.

[5] Sandra L. Colby and Jennifer M. Ortman. 2014. "Projections of the Size and Composition of the U.S. Population: 2014 to 2060." Current Population Reports: P 25-1143. U.S. Census Bureau.

[6] U.S. Census Bureau. Table 9. Projections of the Population by Sex and Age for the United States: 2015 to 2060.

deaths, and little, if any, in-migration.[7] While in other regions, such as the South Atlantic, this population is growing more rapidly than the nation as a whole.[8]

Slowing labor force growth makes it all the more important to ensure that the nation's workforce will have the right ***mix of skills*** for the jobs that are likely to be generated in the future. The reduced role of the manufacturing sector, the increased importance of the professional service and knowledge sectors, advancements in technology, and the spread of globalization are evidence that the ways in which we "do work" have fundamentally changed.[9] As a result, employers are demanding that workers obtain more formal education and training—often requiring some type of postsecondary degree or certificate—in addition to greater technical proficiency and interpersonal skills than in the past. In addition, there has long been a concern that shortages sometimes develop and persist in specific industries or occupations, leading to inefficiencies in the U.S. economy.

However, it is unclear how large any potential labor mismatch might be and whether this issue is unique to particular regions of the U.S. or is pervasive across the nation. Even less well-documented is whether the looming shortages or mismatch that receive so much media attention are isolated to a few key industries or occupations or are expected to be more widespread. Finally, many scholars and practitioners point to a lack of "middle skill" workers, yet one can obtain vastly different estimates of shortages and mismatch based on how this group is defined.

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[7] For example, Maine, with one of the oldest populations in the nation, is projecting a 12 percent decrease between 2012 and 2022 in the number of working age individuals (age 25 to 54 years). http://www.maine.gov/economist/projections/index.shtml

[8] For example, North Carolina is projecting a 6 percent increase between 2012 and 2022 in the number of working age individuals (age 25 to 54 years).

[9] David Autor, Frank Levy, and Richard Murnane. "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics*, Vol. 118, No. 4. November 2003; and David Autor and Daron Acemoglu. "Skills, Tasks and Technologies: Implications for Employment and Earnings." *Handbook of Labor Economics* Vol. 4. Orley Ashenfelter and David Card, eds. Elsevier. 2010.

This report provides a framework for analyzing the potential mismatch between the supply of and demand for middle-skill workers over the next two decades. The goal is to understand the magnitude of the problem as well as the efficacy of alternative approaches aimed at addressing the skills gap, including the types of skills in which future investments in education and training may be warranted. Specifically, this research will explore several key questions:

- **How should we think about the demand for middle-skill workers?** What do we mean when we use the term "labor shortage" or "skills mismatch"? How do we define "middle skill" workers? How do we think about shortage or mismatch nationally versus regionally? Across industry sectors or occupations? In the short-term versus the long-term?
- **What has already been reported about the labor market for middle skill workers?** What evidence of labor market mismatch can be found in the economics literature? What has been reported about employer and industry concerns regarding shortages of qualified individuals for middle-skill jobs? Why do these two viewpoints often come to conflicting conclusions?
- **For what industry sectors and occupations do skills appear to be in short supply, either nationally or regionally?** What can be observed from current data and long-term future projections of employment demand and educational attainment? What do job vacancy data indicate regarding industry sectors and middle-skill technical occupations with persistently tight labor demand relative to supply? What types of skills appear to be in demand for entry level and for career advancement?
- **What actions, if any, should policymakers consider given the evidence?** What can be done in the short-term to address potential shortages in particular regions, industry sectors, or occupations within the skilled technical workforce? What do policymakers need to

consider in the long-term to alleviate a potential mismatch between skills demanded and skills of the population/labor force as the baby boom generation retires?

This report seeks to answer these questions by taking a more detailed approach than previous studies, exploring changes in the balance between labor supply and labor demand at multiple skill levels across the nation. Drawing on a wide range of data, we examine both historical trends as well as future projections in the supply of and demand for middle-skill workers. This approach eliminates the immediate effects of the Great Recession, which involves greater labor market slack than is the case at other points in the business cycle. Assessing whether there is a shortage of skilled labor before and after the trough of the downturn provides a better indication of the number of skilled workers that will be needed in the future as the economy recovers.

The report concludes with a discussion of several policy solutions aimed at addressing the potential skills gap in the region's workforce. Although the replacement of jobs lost during the Great Recession is of the highest priority, in the longer term the key issue will be whether workers have the right mix of skills to fill the jobs being generated by the U.S. economy. This suggests that the focus should be on providing workers with the skills they need to qualify for occupations that are likely to be in high demand in the future. Despite the labor market's sluggish recovery, it would appear that now is an excellent time to rethink how best to invest in our education and training programs. Keeping a long-term perspective on the potential consequences of a labor mismatch will be crucial in determining the future welfare of the nation and how its citizens will share in it.

II. Framework: How should we think about labor market imbalances for middle-skill workers?

There are several ways to characterize an imbalance between labor supply and demand, each giving rise to its own definition. In this report, the term ***"labor shortage"*** will be used to refer to a situation where we do not have a sufficient number of workers. We will use the term ***"skills mismatch"*** will be used to refer to a situation where we do not have a sufficient number of workers with a specific set of skills. Moreover, the set of "middle-skill" jobs has been loosely defined in a number of ways based on either the formal education levels of incumbent workers or the part of the wage distribution represented by the occupation. This section describes these concepts further as well as how they are typically measured.

A. What do we mean when we use the term "labor shortage" or "skills mismatch"?

In the popular press, the terms "labor shortage" and "skills mismatch" are often used to describe situations that reflect tight labor market conditions but not actual shortages or mismatches. For example, when labor is plentiful, employers become accustomed to hiring a particular caliber of candidates with specific training or level of experience. However, when the labor market tightens, the number of job applicants is likely to shrink and employers may have difficulty finding the same caliber of candidates. From the employers' perspective, a shortage or mismatch of workers exists. From the economists' perspective, the existence of a shortage is questionable because the job could be filled by another qualified, if not ideal, worker.

Indeed, there is no universally agreed upon definition of "labor shortage" or "skills mismatch"—even among economists. The most widely used definition identifies such imbalances in a dynamic sense as occurring "when the number of workers available (the supply) increases less

rapidly than the number demanded at the salaries paid in the recent past."[10] Even using this broad definition, economists will argue that most labor imbalances are temporary in nature, as markets will adjust—albeit perhaps slowly—to alleviate the gap. For example, when the demand for skilled labor exceeds supply, the economy will adjust as the wages of skilled workers increase relative to those of unskilled workers. In the short run, rising wages will encourage greater labor market participation and in-migration on the part of skilled workers to help alleviate the shortage. In the long run, higher returns to skilled labor will encourage individuals to obtain more education and training and create incentives for firms to find innovative ways to increase labor productivity.

However, under some conditions, an imbalance between labor supply and demand may persist for long periods of time. How might this occur? One possibility is if wages are constrained by wage controls, pricing regulations, competitive pressures, equity concerns, or imperfect information such that they cannot rise in response to an increase in labor demand.[11] Another possibility is if demand continually grows more rapidly than supply (Arrrow and Capron 1959). For example, technological advancements such as the widespread use of computers have been shown simultaneously to increase the demand for educated workers while replacing those who are less skilled through automation. Globalization has also led to increased demand for goods and services provided by skilled workers in the United States while displacing less-educated workers in production jobs through outsourcing to other countries. Conversely, supply-side constraints such

[10] David M. Blank & George J. Stigler, 1957. The Demand and Supply of Scientific Personnel. Cambridge, MA: National Bureau of Economic Research, no. 57-1, April.

[11] Other situations that might give rise to labor shortages include monosonistic labor markets and occupations with higher than average rates of return to education and training. Yet the first is likely to be a rare occurrence while the latter presents intractable measurement problems. The final situation that could arise would be that arising from a social demand problem whereby the labor supply is deemed insufficient to meet society's needs (e.g. having enough nurses) (Barnow, Trutko, and Piatak 2013). Yet this type of situation is outside the scope of this study.

as lengthy training requirements, licensing laws, or demographic shifts (e.g., slower population growth) may restrict the supply of skilled labor for long periods of time in key occupations such as nursing.

B. How do we define "middle skill" jobs and workers?

Although in theory there are many possible classification schemes that can be used to define "middle-skill," in practice there are two basic approaches that most researchers employ when quantifying the number of jobs and workers that fall into this category. Yet due to data limitations, few methods are able to be employed consistently across both jobs and workers to get a clear picture of how demand and supply match up.

To classify middle-skill *jobs*, researchers have used either a relative or absolute ranking to determine skill-level. Relative rankings classify occupations by skill level from lowest to highest and then use cut-offs at specific percentiles of the distribution to determine what falls into the "middle" (e.g. occupations falling into the 20^{th} to the 80^{th} percentiles). For example, Autor, Katz and Kearney (2006) sort (3-digit) occupations into percentiles by mean years of schooling in 1980 using data on incumbent workers in those jobs. Alternatively, Autor (2010) uses the average wage of workers in 1980 as a proxy for skill to classify occupations at the three-digit level and subsequently examine employment and wage trends.

Absolute rankings of middle-skill jobs use pre-defined skills criteria for specific jobs and then categorize occupations accordingly. For example, Autor et al. (2003) use data on task content from the Dictionary of Occupational Titles to classify jobs into a two-by-two matrix of routine versus non-routine and cognitive versus manual tasks. They classify middle-skill jobs as those involving routine cognitive tasks that are easily replaced by outsourcing or automation

such as telemarketing or bookkeeping. Alternatively, Holzer and Lerman (2007) define middle-skill jobs as those that generally require some significant education and training beyond high school but less than a bachelor's degree. These postsecondary education or training requirements can include associate's degrees, vocational certificates, significant on-the-job training, previous work experience, or generally "some college" without having earned a degree and typically fall into the clerical, sales, construction, installation/repair, production, and transportation/material moving major occupational groupings. Data on the education levels of incumbent workers or education requirements developed by the Department of Labor (O*NET) are then used to classify particular occupations as "middle-skill." For example, using data on the educational attainment of incumbent workers from approximately 485 occupations available in the American Community Survey, Modestino (2010) identifies 272 "middle-skill" occupations as those occupations in which more than one-third of the workers have some college or an associate's degree.

To classify middle-skill *workers*, researchers typically rely on the education level of the population or the workforce as a proxy for skill. This is largely due to data limitations as nationally representative demographic surveys that cover work and education experiences do not ask about their other types of training or particular skills acquired. In addition, although degree or field of study is collected for bachelor degree recipients, no such data is collected for associate's degrees. As a result, using education as a proxy can mask the variation in skill level *within* educational categories, such as experience (Lemieux 2006).

Finally, there is even less agreement as to how to classify middle-skill *technical* workers—the topic of Chapter 1 of this study. In that chapter, Jonathan Rothwell constructs a new

definition of middle-skill technical jobs as those that (1) require a high level of knowledge in a technical domain and also (2) do not require a bachelor's degree for entry.

III. Literature Review: What do we know about the labor market mismatch for middle-skill workers?

Some have pointed to recent labor market indicators suggesting that a potential mismatch already exists in the ***short-run*** between the skills of those looking for work and the needs of employers looking to fill vacant jobs. Typically, as the economy expands, the unemployment rate falls and the job vacancy rate rises—a relationship known as the Beveridge Curve.[12] This is exactly what happened in the years immediately following the 2001 recession (see Figure 1). However, in the wake of the Great Recession in 2009, as employers reported more vacant positions, the unemployment rate hardly budged. This resulted in a notable upwards shift in the Beveridge curve, such that the unemployment rate was now higher for a given vacancy rate than one would project from the pre-recession relationship (Diamond and Sahin 2014).

This shift has received a great deal of attention and started a debate regarding the nature of unemployment in the U.S. as some have interpreted it as a deterioration in the matching/hiring process in the economy.[13] On the one hand, the persistently high rate of unemployment coupled with a rising share of vacancies would seem to indicate some type of mismatch in the labor market. Indeed, Figure 2 shows that during this period, the share of workers with a college degree increased rapidly within middle- skill occupations. Yet on the other, the lack of wage growth

[12] As the economy expands, the unemployment rate generally falls, reflecting a decreased pool of excess workers. Simultaneously, the job vacancy rate is expected to increase as businesses seek workers to fill new and existing jobs.

[13] See, for example: "Evidence that factors other than weakness in overall demand for goods and services are boosting the unemployment rate comes in part from a shift in what is known as the Beveridge curve" (Congressional Budget Office, 2014, page 8).

observed even within industries and occupations with relatively strong demand would suggest otherwise. As a result, economists have been searching for ways to measure the degree to which the mismatch as evidenced by the shift in the Beveridge Curve might be due to ***cyclical*** (e.g. short-term or temporary adjustments) versus ***structural*** (e.g. long-term or sustained trends) forces. Unlike mismatch due to cyclical causes, structural mismatch will persist even as economic conditions improve, possibly warranting a change in labor market policies.

Aside from the short-term fluctuations associated with business cycle, significant demographic changes suggest that the supply of skilled workers may not keep pace with demand in the ***long-run.*** The retirement of the baby boomers—a well-educated group—will result in large numbers of skilled workers leaving the labor force. In addition, the population of native workers who are needed to replace those retiring has been growing more slowly over time such that net international migration is projected to be the dominant component of population growth by 2025.[14] This shift towards greater reliance of immigration as a source of population will alter the composition of the labor force in terms of educational attainment. Although the share of individuals with a bachelor's degree or higher is similar across immigrant and native populations, immigrants are more likely to be a high school dropout or to lack additional postsecondary education beyond high school such as an associate's degree such that these individuals often lack the formal education and English language skills that employers require. As a result, some suggest that there is likely to be a potential mismatch between the level of education and skill among the population and that which will be demanded by employers in the coming decades.[15]

[14] U.S. Bureau of the Census. Table 1. Projections of the Population and Components of Change for the United States: 2015 to 2060.
[15] Navjeet Singh and Michael Goodman. "Skills Gap: Where Are the Jobs?" Commonwealth Corporation, Research Evaluation and Brief. Vol. 4, No. 1. August 2006.

A. Academic Literature: Peer reviewed publications

Because it is inherently difficult to measure the imbalance between labor supply and demand as both forces are changing over time and the movement of one affects the movement of the other, there are several different approaches that can be used to quantify the level of structural mismatch. This typically involves constructing some sort of index using one of two basic methodologies. The first methodology is derived from the Beveridge Curve and consists of calculating the ratio of unemployment to vacancies (U/V) and comparing this measure across industries or occupations. In a perfectly balanced labor market, the U/V ratios should be very similar across industries or occupations—otherwise we could move some of the unemployed from one sector to fill jobs in another sector, thereby lowering the aggregate unemployment rate and increasing output. Thus the variation in U/V ratios across industries or occupations is often interpreted as a measurement of the degree of mismatch in the labor market.

Using this methodology, economists have estimated that between one-third and one-half of the increase in unemployment during the Great Recession can be attributed to structural factors related to labor market mismatch. Sahin et al. (2012) measure U/V ratios across both major industry groupings using vacancies from the JOLTS survey as well as major occupation groupings using online vacancies from HWOL. They find that mismatch across industries and occupations explains at most one-third of the total observed increase in the unemployment rate, and geographical mismatch due to a lack of mobility plays no apparent role. Canon, Chen, and Marifian (2013) calculate several alternative U/V indices and conclude that mismatch could explain up to 51 percent of the increase in unemployment during the Great Recession. Although Sahin et al (2012) emphasize that they find a greater role for cyclical factors, both papers suggest

a nontrivial role for structural mismatch as a contributing factor to the high and persistent rate of unemployment during the last downturn.

Yet there are significant limitations to measuring labor market mismatch using this method. First, these U/V ratios are often calculated using highly aggregated data for only the major industry and occupational groupings which encompass a wide range of skills. For example, within the construction industry one finds a wide range of occupations and related skills from manual construction workers with less than a high school degree to administrative assistants with some college or an associate's degree to executive with a bachelor's degree or higher. Similarly, within major occupation groupings such as office and administrative support occupations, one finds a wide range from tellers to executive assistants to copy editors. As such, U/V ratios constructed with aggregated data may fail to capture mismatch occurring within these major groupings.

Second, U/V ratios are often unable to identify underlying mechanisms that might be causing labor market mismatch, each with very different policy implications. For example, industry U/V ratios could diverge due to a structural skills gap, a lack of geographical mobility across regions, or temporary shocks to key industries—such as construction—that are related to the business cycle. In particular, many of these indices are constructed using relatively short panels of data, making it difficult to distinguish between the cyclical and structural components of the mismatch (Canon, Chen, and Marifian 2013). For example, Lazear and Spletzer (2012) show that although U/V ratios vary by industry, the industry-specific changes in the ratio are proportional before and after the recession, such that the overall level of industrial mismatch in 2011 that is the same as the level that prevailed before the recession.

Third, the Beveridge curve itself, upon which these U/V indices are based, is not necessarily a measure of the degree of labor market tightness. Rather, it measures the degree of efficiency in the labor market that can reflect a number of different factors aside from a skills mismatch. For example, changes in firm hiring practices regarding recruitment intensity and wages can shift the curve independent of structural factors such as barriers to moving across industries/occupations or the lack of sufficient worker skills to meet employer requirements (Rothstein 2012). Other researchers have similarly cast doubt on the importance of structural mismatch in explaining current economic conditions (Valletta and Kuang 2010; Dickens 2011; Daly, Hobijn, and Valletta 2011; Ghayad 2013; Capelli 2014). For example, Ghayad and Dickens find that the shift in the Beveridge Curve is almost entirely driven by long-term unemployment such that recently unemployed workers are just as readily employed as before.

The second methodology calculates supply/demand (S/D) ratios by skill level. Typically, demand is estimated by assigning skills to particular industries or occupations and then aggregating total employment (current plus vacancies) by skill level. Similarly, supply is estimated by assigning skills of the population or labor force and then aggregating across individuals either by region or across the nation. The difference between these two measures is interpreted as mismatch. Thus, an S/D ratio close to 1 would indicate that the supply and demand were closely balanced if not actually matched.

Using data from the 2006 Current Population Survey, Estevau and Tsounta (2011) rank major industry groups by the skill intensity of incumbent workers and then construct S/D ratios by state over time where supply is based on the skills of the working-age population and demand is based on industry employment levels. Controlling for cyclical factors using time dummies and state GDP growth, they conclude that structural mismatch may account for 20 to 30 percent of

the rise in unemployment during the Great Recession. Other researchers using variations of this methodology also find a significant role for structural mismatch (Rothwell 2012; Carnevale, Smith, and Strohl 2012; Manyika et al. 2011).

Not surprisingly, there are also a number of limitations with the S/D method. Due to data limitations, none of the current S/D ratios can directly measure either the demand for or the supply of a particular skill—instead they typically use the level of education as a proxy for skill.[16] This can produce misleading results on both the demand and supply sides. On the demand side, observed increases in the education level incumbent workers within a given occupation, may reflect either an increase in the skill demands of the job or simply a general increase in the educational attainment of the available workforce (Harrington and Sum 2010). As a result, high-skilled workers have moved down the occupational ladder, displacing lower skilled workers (Beaudry, Green and Sand 2013). Moreover, there is considerable heterogeneity in employer skill requirements by education even within detailed occupation categories, such that simply assigning one educational category to a given occupation would lead to misleading results (Modestino 2010).

Given the limitations of both methodologies described above, how can we credibly measure structural labor shortages or skills mismatch? As economists we look to evidence as to whether the labor market is clearing—both in the near term as well as the long-run. In the short-run, such evidence might include persistency high vacancy rates coupled with rising wages for new hires within narrowly-defined occupations and/or regional labor market areas. Yet even this

[16] Although it is now possible to obtain some measures of skill on the demand side (either from online job posting vacancies or by assigning O*NET skill requirements to particular occupations), there is no corresponding measure of the supply of skills in any nationally representation data set.

type of evidence can be seen as consistent with temporary imbalances due to mobility constraints, cyclical forces or other factors such as informational asymmetries. One would need to observe these trends over a longer period of time stretching beyond the business cycle to conclude that there are indeed structural forces at work.[17]

More recently, economists have been able to study changes in detailed employer requirements over the business cycle using new data from online job vacancy postings. Based on a database of 67 million online job ads, Figure 3 shows that the share of vacancies requiring a bachelor's degree or more rose by more than 10 percentage points from 2007 to 2010. At the same time, the share of postings requiring 5+ years of experience rose roughly 7 percentage points. Previous work examining this dynamic found that employers opportunistically raised education and experience requirements within occupations—and even within firms and job titles— in response to increases in the supply of relevant job seekers (Modestino et al. 2014, Hershbein and Kahn 2014). This growth in skill levels within occupations, colloquially known as *"upskilling,"* can account for roughly 30 percent of the total increase in employer skill requirements observed between 2007 and 2010.

Even more striking has been the considerable reversal in employer skill requirements, or *downskilling*, observed during the recovery and shown in Figure 3. Controlling for occupational trends and aggregate conditions, Modestino et al. (2015) find that a 1 percentage point reduction in the local unemployment rate is associated with 0.20 percentage point reduction in the fraction of jobs requiring a bachelor's degree and a 0.22 percentage point reduction in the fraction

[17] For example, Rothstein (2012) finds that unemployment levels among industries or groups that are often asserted to be the source of structural mismatch are not unusual once prior trends are taken into account. He also shows that aggregate, industry, and group-specific wages generally do not show the pattern of increases that would be consistent with structurally tight labor markets.

requiring 5+ years of experience. They also document similar trends in heretofore un-measurable dimensions of skill, including specialized skills (e.g. information security) and software skills (e.g. Adobe Dreamweaver), also shown in Figure 2. These results suggest that much of the observed increase in skill requirements within detailed occupations is correlated with the business cycle and are subject to reversion as the labor market tightens, suggesting that a significant portion of what is sometimes labeled as structural mismatch employment may actually be cyclical.

B. Employer Surveys and Industry Reports: Ground-level observations

A number of employer surveys and industry reports have highlighted potential labor market mismatches within certain sectors of the economy, particularly in manufacturing, healthcare, and construction.[18] For example, in an October 2011 survey of American manufacturers conducted by Deloitte Consulting LLP, respondents reported that 5 percent or 600,000 jobs remained unfilled because they could not find workers with the right skills. Of these manufacturers, 74 percent reported that work-force shortages or skills deficiencies in production positions such as machinists, craft workers and technicians were keeping them from expanding operations or improving productivity.[19]

What has changed? In manufacturing, the industry has shifted from high-volume, low-tech jobs to low-volume, high-tech jobs. As the industry shrank during the 1990s, it shed older workers with outdated skills for those that can work with precision machinery, computer modeling and high-tech tooling. This is an example of what Holzer (2015) refers to as the "new" middle of the labor market. He finds that that the traditional middle of the job market –

[18] Bloomberg Business. 2012. "Companies Say 3 Million Unfilled Positions in Skill Crisis: Jobs." July 25.
[19] Deloitte

composed primarily of construction, production and clerical jobs that require fairly little education – has indeed been declining rapidly. But another set of middle-skill jobs – requiring more postsecondary education or training - in health care, mechanical maintenance and repair and some services - is consistently growing, as are skill needs within traditionally unskilled jobs.

Compounding the problem is a demographic shift where a significant portion of the existing workforce consists of baby boomers nearing retirement with fewer younger workers to replace them. For example, at Boeing, 28 percent of the firm's 31,000 machinists are older than 55 and eligible for retirement.[20] Yet industry leaders say that it is difficult to attract younger workers to an industry that was once considered "dying" and "dirty" and machine shop classes have largely been cut from the high school curriculum as the focus has shifted towards college preparation. In addition, many of these newer middle-skills jobs, such as precision welding, require enough science and math knowledge such that manufacturing is now considered a STEM occupation.

Although manufacturers say the lack of skilled workers has pushed up wages, they argue that raising them too far would make outsourcing a more attractive option.[21] Last year, the Philadelphia Fed's survey of manufacturers asked employers what they were doing to address the skills mismatch. Almost two-thirds of manufacturers said they were increasing their recruitment efforts, while just over half reported they were training their existing staff. Only about a third reported that they were increasing salaries.

[20] Whoriskey, Peter. 2012. "U.S. manufacturing sees shortage of skilled factory workers." *Washington Post*, February 19.
[21] Whoriskey, Peter. 2012. "U.S. manufacturing sees shortage of skilled factory workers." *Washington Post*, February 19.

Instead of raising wages, some employers, such as those in the healthcare industry, are hoping to "upskill" their existing workforce. The idea being that these workers—typically housekeepers, clerks, low-skilled technicians and cafeteria workers—already have the soft skills and cultural fit that employers want, but simply lack the technical skills to move into middle-skill jobs within the company. [22]

The one sector where wages have been rising is in construction. Yet this trend seems to be limited to certain areas of the nation where house prices have risen rapidly or workers have opted to take better paying jobs in other sectors. For example, in Colorado, home builders reported having difficulty finding framers and carpenters in 2014 as production picked up with home prices rising over 20 percent during the past three years. Similar labor shortages were reported in North Carolina and southern Florida where home prices rebounded after the downturn. In addition, contractors reported losing skilled workers to fracking companies drilling in northeastern Colorado and North Dakota during the downturn. Other states, including Texas and Oklahoma, also report facing similar labor crunches in construction due to workers having switched to the oil and gas industry.[23]

Aside from these sectors, there are few, if any, reports of widespread skill shortages among employers---except perhaps among small employers. A survey of small businesses conducted by *The Wall Street Journal* and Vistage International in 2012 revealed that roughly 31 percent of the 811 small-businesses reported that they had unfilled job openings because they could not find applicants with the right skills or experience. And it wasn't just in

[22] Bloomberg Business. 2012. "Companies Say 3 Million Unfilled Positions in Skill Crisis: Jobs." July 25.
[23] Hudson, Kris. 2014. "Labor pains beset builders—Shortage of Skilled Workers Ripples Across Housing Market." *Wall Street Journal*, May 2.

manufacturing—about one-third of service sector employers and retail businesses also reported difficulty in hiring workers with the desired skills.[24] In February 2015, the National Federation of Independent Business reported that 89 percent of small-business owners said they were seeing few or no qualified applicants for their job openings with 29 percent saying they have job positions they cannot fill right now—the highest percentage since April 2006.[25] Although the percentage of small businesses raising wages has increased since the end of the Great Recession, it still remains low if there is indeed a skills gap. As of February 2015, the National Federation of Independent Businesses reports that only 20 percent of small business owners said they had raised compensation over the past three months and only 14 percent plan to raise compensation in the coming three months.[26]

More recently, consulting reports have started using online vacancy data to do more detailed analyses in conjunction with the usual surveys. A 2013 report by Accenture, Burning Glass Technologies, and Harvard Business School found that among middle-skill jobs, healthcare practitioners and technical workers, computer and mathematical positions, and technical sales and sales management positions were the most difficult to fill, based on duration and duplications rates of on-line job postings along with how much employers spend on recruiting sites and agents to fill positions. In the accompanying survey, 34 percent of firms surveyed indicated that they are able to find technically skilled people, but that they are deficient in other, harder-to-measure, skills for the job. In particular, 33 percent noted that while they

[24] Maltby, Emily and Sarah Needleman. 2012. "Small Firms Seek Skilled Workers but Can't Find Any." *The Wall Street Journal*, July 31.
[25] Madigan, Kathleen. 2015. "Skills Shortage Is the Worst Since 2006, Small-Business Survey Says." *The Wall Street Journal*, March 10.
[26] Madigan, Kathleen. 2015. "Skills Shortage Is the Worst Since 2006, Small-Business Survey Says." *The Wall Street Journal*, March 10.

could find skilled workers, many lacked the work ethic or ambition to be successful in the role. Many employers reported "upskilling" their credential requirements, with either a Bachelor's degree or more work experience, to find candidates with better soft skills.

In sum, these "on the ground" reports suggest that a significant portion of what employers deem a "skills mismatch" stems not just from a lack of formal education and training but also from a lack of soft skills that go beyond the usual "teamwork" and "communication" buzzwords. In addition, although the middle-skill applicant pool included such individuals even if they did not attend college in the past, as a greater share of individuals have enrolled in college over time, those without a college degree are perhaps less positively selected on the kinds of soft skills that employers are seeking.

C. How can we reconcile the academic literature with employer reports?

How can it be the case that employer surveys continue to report a skills mismatch while the economics literature repeatedly finds little or no evidence to support these claims? Setting aside strategic employer motivations to lobby for more public investment in education and training, there are a few plausible explanations.

First, there may be conceptual differences to reconcile. Economists think of skills as being quite portable with the exception of firm-specific human capital. Yet jobs have become more specialized over time such that training in even a detailed occupation such as a registered nurse does not mean that all nursing jobs are open to you. Registered nurses may specialize in pediatrics, critical care, cancer treatment, and a variety of other disciplines. Even less technical occupations may be subject to increasing specialization. For example, Figure 4 shows a job posting for a medical records coder that requires applicants to be certified as an AHIMA Certified Coding Specialist (CCS), have a Bachelors' degree in Medical Record Technology,

Health Services Administration, Nursing or Finance/Business, and also have five years coding experience. Although it may be the case that employers have become too "picky" in the wake of the Great Recession, nevertheless employers often require a very specific set of skills that is not captured by aggregate data on labor supply and demand used by economists.

Second, it may be the case that the employers responding to the surveys are the "squeaky wheels" of the labor market and do not represent the norm. Osterman and Weaver (2014) directly measure employer skill demands and hiring experiences using a nationally representative survey at the industry level. They find that demand for higher-level skills is modest at best and that three quarters of manufacturing establishments do not show signs of hiring difficulties.

Third, there may not be an actual skills mismatch but rather a coordination problem to solve. For example, a recent report by Burning Glass Technologies finds that in 2013 there were 33,923 medical coding graduates and 45,185 medical coding postings for new graduates. However, a recent survey of employers by Accenture found that 29 percent of healthcare employers named medical coders as one of their three hardest-to-fill roles. A closer look revealed that a shortage of workers with the required certification. Although there were 33,923 medical coding graduates in 2013, only about 20,000 individuals took and passed the medical coding certifications necessary to secure a full-time coding position. Osterman and Weaver (2014) also find in their study that firms with long-term vacancies either demand highly specialized skills. They conclude that policymakers should focus on market failures related to the interaction of supply and demand—such as disaggregation and communication/coordination failures—rather than simply focusing on inadequate labor supply.

IV. Current Data and Future Projections: For what industry sectors and occupations do skills appear to be in short supply, either nationally or regionally?

As discussed earlier, it is inherently difficult to measure the imbalance between labor supply and demand as both forces are changing over time and the movement of one affects the movement of the other. Moreover, we do not have adequate measures of actual skills (e.g. technical skills, computer skills, soft skills) on both the supply and demand side, so that we are left with education as a proxy. That said, it is still instructive to look at trends over time to detect changes in the magnitude or direction of any potential gap. Taken together, observable trends in educational attainment, employment, job vacancies, and wages can be used to paint a portrait of relative labor market conditions and highlight areas where potential imbalances might exist. Below we present data on both the stock and flow of labor supplied and demanded to the labor market. Although our projections of future labor supply and demand may be an indication of where future investments in human capital may be warranted, it is crucial to note that the future path of employment will be determined not only by the demands of employers and the skills of existing workers but also by future adaptations that we cannot anticipate. As such, our forecasts of future labor demand will be used only to place bounds on the problem and provide a context for our labor supply forecasts rather than to pinpoint the exact number of workers that will be demanded in the future.

A. <u>What does the current stock and flow of middle skills workers look like and how does it match up with labor demand?</u>

As a first step, we assess the trend in the current stock of middle-skill workers—defined here as individuals with some postsecondary education but less than a four-year college degree—relative to low-skill workers (those with a high school degree or less) and high-skill workers (those with a bachelor's or advanced degree). Data from the 3-year combined American Community Survey (ACS) indicate that the share of middle-skill workers has been increasing

steadily, rising 4.7 percentage point from 28.7 percent of the population in 2006 to 33.4 percent of the population in 2012 (see Figure 5). This is primarily due to a greater share of individuals having attended some postsecondary education rather than having completed an Associate's degree. In comparison, over the same period, the share of low-skill workers decreased by 7.5 percentage point while that of high-skill workers increased by 2.7 percentage points.

Next, we examine relative shifts in labor demand for middle-skill workers. Total demand by detailed occupation, as measured by employment plus vacancies, is allocated to "skill" categories based on the current distribution of educational attainment of workers as calculated from the 3-year combined 2012 ACS. Although not an ideal measure of skill, the ACS provides a consistent measure of educational attainment over time that can be applied to both the supply side (people in the labor force) as well as the demand side (jobs held by workers). That said, the ACS yields an observed distribution of skill that is jointly determined by a combination of supply and demand factors. Moreover, it is likely to underestimate the demand for entry level requirements. Figure 6 shows that between 2006 and 2012, labor demand appears to be decreasing for low-skill jobs (-5.4 percentage points), increasing for high-skill jobs (+6.6 percentage points), and holding steady in the middle at just under one-third of all jobs.

Given these relative movements in supply and demand across skill categories, what can we say about any potential imbalance in the labor market? To assess the relative tightness of labor market conditions for groups of varying skill, we compare wage trends for middle- and high-skill workers relative to those with only a high school degree. Prior to the Great Recession, employers appeared to be willing to pay a premium for middle- and high-skill workers despite there being a relatively larger pool of them (see Figure 7). Moreover, these premiums were growing over time, indicating that the demand for such workers has outpaced supply in the past.

However, wage pressures appear to have weakened since 2000, suggesting that the supply of such workers has been "catching up" with demand—even if it might not be perfectly in balance.

Indeed, if we do some basic calculations to construct the typical supply/demand (S/D) ratios such as those typically found in the economics literature, we find that any overall mismatch between the distribution of supply relative to labor is quite small. Figure 8 shows that prior to the Great Recession, there appeared to be a potential mismatch in the middle of the labor market that has since abated. In 2006, the share of middle-skill jobs (employment plus vacancies) in the labor force exceeded the share of middle-skill workers by 3.8 percentage points. By 2012, that imbalance had reversed itself such that relative supply of middle-skill workers supply exceeded demand by 2.1 percentage points. Yet it should be noted that in 2012 the labor market was still recovering from the Great Recession.

What can we say about the current "flow" of middle-skill workers and jobs? Over the past several decades, the share of employment accounted for by both industries and occupations has shifted over time—towards those that employ a high share of college-educated workers. For example, since 1990 the industrial composition of employment has shifted away from manufacturing and towards healthcare, education, and professional and scientific services while the associated mix of occupations has shifted away from production and towards management, education, healthcare and business and financial operations (Modestino 2010). Moreover, the share of middle- and high-skill workers increased *within* most major industry and occupation groups. One way we can measure the current imbalance between supply and demand within groupings is to look at vacancy rates by detailed occupations. Specifically, we examine job vacancy measures to determine which major occupation groups experienced the tightest labor

market conditions as of the most recent "peak" of the business cycle (2006)—and whether these conditions have persisted through the recovery (2012).

Table 1 shows that those major occupation groups with persistently high vacancy rates employ a relatively high share of both middle- and high-skill workers. These include occupation groups with "critical" vacancies as evidenced by having both a higher than average vacancy rate (number of vacancies as a percent of total employment) and vacancy share (number of vacancies as a percent of total vacancies). Critical vacancies are largely found in management, business and financial operations, computer and mathematical science, architecture and engineering, and healthcare practitioners and technical occupations. Contrary to conventional wisdom, these professional occupations—categories often labeled as "high-skill"—contain a significant percentage of middle-skill jobs.

Within these major occupation groupings, critical vacancies exist in detailed occupations that primarily employ middle-skill workers. For example, within the healthcare practitioner and technical occupation group, critical vacancies exist in detailed occupations such as medical and clinical laboratory technicians, surgical technologists, licensed practical and licensed vocational nurses, and medical records and health information technicians—jobs that employ a high share of workers with only some college or an associate's degree (see Table 2). Moreover most of these middle-skill occupations exhibit high and rising wages as well as projected growth through 2022.

In fact, middle-skill jobs are sprinkled throughout the broad occupation categories, suggesting that such workers are not contained in just a few easily identifiable sectors. Moreover, many of the jobs held by middle-skill workers appear to be complementary to those held by high-skill workers. For example, hospitals need both physicians as well as nursing and

other support staff—jobs not easily automated or outsourced. Engineering firms need both engineers as well as technicians. Businesses need both systems analysts as well as computer support specialists. Among all detailed occupations that exhibited "critical" vacancies, those that employed a greater share of middle- and high-skill workers had higher job vacancy rates both before and after the Great Recession (see Figure 9).

In sum, over the past several decades labor demand has shifted towards greater employment of middle- and high-skill workers within most industries and occupations. Prior to the Great Recession, rising wage premiums and supply/demand indices indicated a potential mismatch in the middle of the labor market. Yet those pressures seemed to have abated by 2012 due to a combination of rising educational attainment of the labor force as well as a massive decrease in aggregate demand associated with the Great Recession. Although it remains to be seen what the most current data reveal for 2014, some detailed occupations exhibited persistently higher than average vacancy rates both before and after the Great Recession suggesting that there may be a limited set of jobs that are difficult to fill in key sectors of the economy such as management, business and financial operations, computer and mathematical sciences, and healthcare.

B. How will the skills of new market entrants match up with demand?

In the previous section we noted that over the past several decades, the share of workers with a college degree had been rising ***within*** occupations. Indeed, recent media reports and surveys of job posting data suggest that employer requirements for education within occupations shifted during the Great Recession and subsequent recovery. In particular, it appears that a college degree is now required for a number of middle-skill occupations. For example, according to a survey by CareerBuilder in NOV/Dec 2013, almost one-third of employers said that their

educational requirements for employment have increased over the last five years and specifically that they are now hiring more college-educated workers for positions that were previously held by those without a Bachelor's degree.

Indeed, Table 3 shows that as of 2014 major occupation groups that employ a high share of middle- and high-skill workers have low unemployment relative to the number of vacancies, suggesting particularly tight labor markets. Major occupation groups with significantly less than one unemployed worker per job opening include computer and mathematical, architecture and engineering, and healthcare practitioners and technical support occupations. These occupations all have unemployment rates well below the national average and account for a relatively small fraction of the pool of unemployed. Yet most of the post-secondary degrees that have been recently completed (as of 2014) were in fields related to management and education, training, and library occupations. While graduates in management were likely to fare well, those in education were competing in a market where there were already 4 unemployed persons for every job.

In addition, looking within detailed occupations reveals substantial upskilling for some occupations that have historically been dominated by workers without a college degree, suggesting that entry level middle-skill workers face an ever-rising bar. For example, a recent report by Burning Glass Technologies found that 65 percent of online vacancies for Executive Secretaries and Executive Assistants now call for a bachelor's degree, but only 19 percent of those currently employed in these roles have a B.A. In other occupations, such as entry level IT help desk positions, BGT found that the skill sets indicated in job postings don't include skills typically taught at the bachelor's level, and there is little difference in skill requirements for jobs requiring a college degree from those that do not. Yet the preference for a bachelor's degree has

increased. This suggests that employers may be relying on a B.A. as a broad recruitment filter that may or may not correspond to specific capabilities needed to do the job.

Interestingly, upskilling appears to be less likely when there are good alternatives for identifying skill proficiency. For example, many health care and engineering technician jobs, such as Respiratory Therapists, show little sign of upskilling. It may be the case that these positions are resistant to the use of higher education as a proxy because they are governed by strict licensing or certification standards, well-developed training programs, or by measurable skill standards.

C. What does the future stock and flow of middle skills workers look like and how does it match up with demand?

Given the increase in skill requirements within occupations as well as the demographic changes on the horizon, it seems likely that the nation will face even greater labor supply constraints in the future. In this section, we make some basic calculations to indicate the size and scope of any potential future imbalance in the labor market, recognizing that the market will likely make adjustments to alleviate any shortfall. Specifically, we use a cohort component model to project the size and educational attainment of the population by five—year age groups by nativity and race/ethnicity over the coming decade (2012 to 2022) as new cohorts enter the labor force and older ones retire and then aggregate over groups to obtain estimates of the total labor force. We compare these supply simulations to projections of labor demand based on employment growth forecasts made by the U.S. Bureau of Labor Statistics through 2022 for each detailed occupation and then aggregate over occupations to the economy-wide level.

The nation's population of individuals aged 25 to 64 years is projected to shrink by 3.2 percent between 2012 and 2022.[27] In addition, the composition of the U.S. labor force will shift to include a greater share of minority and immigrant populations. The changing number and composition of the labor force illustrate two countervailing forces at work over the coming decades that will determine the supply of skilled labor United States. The first is the changing composition of the labor force across both nativity and racial groups as immigrants and minorities become an increasing share of the population. That is likely to place downward pressure on the educational attainment of the population as foreign-born and minority groups are typically less educated than the native white population. This will be ameliorated to some extent by the second force—rising educational attainment across age cohorts as younger cohorts become increasingly more educated than older cohorts—even within racial and ethnic groups. Given the changing composition of the population over the next two decades, what will the distribution of educational attainment look like? To account for both of these countervailing trends, we take the projected population broken down by age, nativity, gender, and race/ethnicity and "assign" educational attainment to both entering and current cohorts based on recent trends in educational attainment. We then sum the number of individuals over all cohorts by each education category to get the total number of workers aged 25 to 64 years that is "supplied" by each education level.

Projected labor supply estimates suggest that the share of both middle-skill and high-skill workers will increase slightly while that of low-skill workers will fall. If we restrict our analysis to those who are likely to participate in the labor force, these trends are even more apparent.

[27] U.S. Census Bureau. Table 9. Projections of the Population by Sex and Age for the United States: 2015 to 2060.

That is because labor force participation rates among those with less education are typically lower than those with any postsecondary education or training. Applying current labor force participation rates to each demographic group, we see that the future distribution of educational attainment among labor force participants will shift upward with fewer high school graduates and more bachelor's and advanced degree holders (see Figure 10). However, within the middle-skill category, while the share of labor force participants with some college increases, the share earning an associate's degree holds steady as degree completion rates in this category are extremely low.

How is the demand for workers of differing levels of skill likely to change over the coming decade? To examine this we take employment projections by detailed occupation from the Employment Projections Program of the U.S. Bureau of Labor Statistics (BLS). These projections are based on BLS In-Demand Industry Clusters, which reflect expected shifts in demand across industries during the decade. The shifts in demand are used to forecast changes in employment by detailed occupations, taking into account both new job growth as well as the need to replace retirees. It should be noted that historically, BLS has under-predicted the growing demand for professional and managerial occupations.

We then assign jobs to different levels of education using the current distribution of educational attainment for each detailed occupation. The distribution reflects the share of workers at each education level within each detailed occupation based on the 3 year Combined 2012 American Community Survey. For example, among licensed practical nurses, roughly 1 percent had less than a high school degree, 19 percent were high school graduates, 58 percent had some college, 17 percent had an associate's degree, 16 percent had a bachelor's degree, and 2 percent had an advanced degree. Thus, the roughly 921,000 jobs projected for licensed nurses

would be parsed out by education level according to that distribution. Unlike previous studies, this procedure allows us to capture the variation across education categories within occupations rather than assigning all jobs in an occupation to a single education level.

We then sum employment over all occupations by education level to get the total number of workers demanded by each category (less than high school, high school, some college, associate's degree, bachelor's degree, advanced degree). This is what we think of as "maintaining the status quo"—the distribution of workers that employers would demand if they were to fill both old vacancies and new job openings with workers who have the same level of education as those who hold those types of jobs now. As such, we consider this to be a lower bound on the demand for workers with postsecondary education and training. That is because by using the current education distribution, our measure will only capture how demand is likely to change given changes in employment across occupations with different educational attainment, holding the educational distribution of workers within those occupations constant at the levels that prevailed in 2012.

Our projections show that the distribution of labor demand across occupations of different skill levels will hold steady. However, a greater share of net new jobs due to growth and replacement will be high-skill, accounting for 37.2 percent of net employment (see Figure 11). Projections of future employment indicate rapid growth among major occupation groups that employ a high share of middle- and low-skill workers including healthcare practitioners and technical support, healthcare support, personal care and services, and construction and extraction (see Table 1). Moreover, job growth within these major occupation categories is concentrated in a few key areas—particularly for middle-skill workers. For example, middle-skill workers in the healthcare field will find the greatest opportunities exist for those trained as medical and clinical

laboratory technicians, surgical technologists, and licensed practical and licensed vocational nurses—almost identical to those where critical job vacancies currently exist. Note that many of these jobs involve tasks that require personal interaction or abstract thinking and are unlikely to be outsourced and/or automated in the future, unlike other middle-skill jobs such as telemarketers, clerks, and computer operators.

How will the education/skill levels of future labor force participants stack up against those demanded by firms over the next decade? To assess any potential imbalances, we compare the future ***distribution*** and ***number*** of jobs projected by education category to the future number and share of labor market participants by education level. We focus on both aspects because even if the share of jobs and workers is distributed similarly, we may still find an imbalance within particular segments of the labor market if the total number of workers is insufficient. Our projections indicate that by 2022, any potential mismatch in the distribution of labor supply versus demand would likely occur in the middle of the distribution. In this category, the ***share*** of middle-skill labor is likely to exceed supply by 3.4 percentage points (see Figure 12). This makes sense given that the BLS projects that the greatest jobs growth will be among middle-skill jobs in healthcare, personal care, and construction occupations. In addition, as the Baby Boom generation continues to retire over the coming decade, the ***number*** of middle-skill workers is likely to fall short of demand. Our projections show that by 2022 the number of middle-skill jobs will exceed the number of middle-skill workers by 1.3 million.

In sum, based on our crude calculations, the share of middle-skill jobs is likely to exceed the share of middle-skill workers by 2002, suggesting an imbalance in the distribution of demand and supply. In addition, the retirement of the Baby Boom generation will be such that the supply of middle-skilled workers will likely not grow fast enough to keep pace with demand over the

next decade. Market adjustments such as increased educational attainment, higher labor force participation among older workers, and greater use of technology may ameliorate this shortage. In addition, employers appear to have increased requirements for middle-skill workers during the Great Recession, such that a greater share of these jobs may now require a Bachelor's degree. Yet there are likely to be some labor market adjustments over the next decade in response to these gaps on the part of both workers and employers. Workers may adjust by obtaining more education or training or applying current skills in their existing jobs to growing occupations. Employers may adjust by adopting new technology or restructuring jobs. We will discuss these potential adjustment further in the following section.

VI. Conclusions and Recommendations: What, if anything, should policymakers consider doing?

Currently we do not find strong evidence of a broad-based mismatch across the economy that would require massive increases in formal educational attainment. Prior to the Great Recession, there appeared to be a potential mismatch in the middle of the labor market that has since abated. In 2006, the share of middle-skill jobs (employment plus vacancies) in the labor force exceeded the share of middle-skill workers by 3.8 percentage points. By 2012, that imbalance had reversed itself such that relative supply of middle-skill workers supply exceeded demand by 2.1 percentage points. Yet it should be noted that in 2012 the labor market was still recovering from the Great Recession and that we have seen significant tightening since then.

That said, there is strong evidence of mismatch in some specific occupational and industry sectors. Most notably, these include occupation groups with "critical" vacancies such as management, business and financial operations, computer and mathematical science, architecture and engineering, and healthcare practitioners and technical occupations. Contrary to

conventional wisdom, these professional occupations—categories often labeled as "high-skill"—contain a significant percentage of middle-skill jobs. For example, within the healthcare practitioner and technical occupation group, critical vacancies exist in detailed occupations such as medical and clinical laboratory technicians, surgical technologists, licensed practical and licensed vocational nurses, and medical records and health information technicians—jobs that employ a high share of workers with only some college or an associate's degree. Moreover most of these middle-skill occupations exhibit high and rising wages as well as projected growth through 2022.

In addition, in the future it appears that the retirement of the Baby Boom generation will disproportionately shrink the supply of middle-skill workers such that it is unlikely to keep pace with demand. Our projections indicate that by 2022, any potential mismatch in the distribution of labor supply versus demand would likely occur in the middle of the distribution. In this category, the ***share*** of middle-skill labor is likely to exceed supply by 3.4 percentage points and the ***number*** of middle-skill workers is likely to fall short of demand on the order of 1.3 million. Yet, these projections are limited to the extent that they cannot account for endogenous employment growth and vacancy creation. In fact, our projections might well understate the extent of mismatch if employers adjust to it by *not* creating jobs in hard-to-fill occupations.

As a result, there are several reasons why some sort of policy intervention seems warranted in the short-, mid-, and long-term. In the short-term, the level and variance of quality in the middle-skill education category should be addressed aside from any concerns regarding overall mismatch in the labor market. The completion rate at the nation's community colleges is extremely low such that most individuals in the "some college" category have no postsecondary credential. In addition, lack of guidance and information leads many individuals, mostly

disadvantaged, to end up with credentials that are not in high demand. In addition, the lack of national recognized standards across programs leads to high variation in employment and earnings for individuals with certificates versus vocational degrees versus Associate degrees.

In the mid-term, there are many margins along which employers can adjust, but these margins have different welfare implications that policymakers may want to take into account. Employers may choose to increase productivity through greater automation or offshoring of production, rather than raising wages, raising concerns about the types of jobs that will be created and the possibility of lost opportunities for the nation's workers. For example, we have seen that labor demand (and the mix of jobs created) is likely endogenous to what employers see in terms of quality of labor supply. If employers believe that non-BAs do not have the right soft-skills, they will create fewer jobs requiring middle skills, and will instead rely on a combination of low-skill and high-skill jobs instead. This is consistent with a multiple equilibrium model where employers can create either low-wage or higher-wage jobs to maximize profit. If the skills they want are in limited supply, then they will more likely choose the low-wage equilibrium, which will result in greater income inequality rather than mismatch.

In the long-term, the retirement of the Baby Boom generation will disproportionately shrink the supply of middle-skill workers such that it is unlikely to keep pace with demand. Market forces may alleviate much of this imbalance over time, yet the period of adjustment may be slow and the mechanisms inefficient. For example, rather than wages rising to induce workers to obtain additional training, we may initially see growing nonparticipation in the labor force of the less-educated.

However, it seems unlikely that a one-size-fits-all approach will be efficient or effective given that labor markets for middle-skill workers are inherently local. Labor demand is quite

specific to a given locality as a lower share of these workers tend to migrate compared to college graduates. As a result, workforce development activities that are guided by national trends are destined to miss their targets. Better matching and planning between current and future job openings and current and future job seekers on a local level seems wise. Government, employers, and educational institutions all have a shared responsibility to play a role in coordinating for future outcomes.

Government should improve the flow of information. A top priority should be to improve the dissemination and feedback regarding what skills are in demand. Addressing sector specific information problems will require greater transparency and uniformity of information across employers, industry leaders, educators/trainers, and the government. Employers should write better job descriptions that are competency-based. Industry leaders should work with educators/trainers to develop and vet curriculum. Educators/trainers should be receptive and responsive to industry input. Government should facilitate reporting of employer demands and foster/support linkages between industry and educators/trainers.

Although there are several examples of particular sectors or geographic areas where information exchanges are working efficiently and effectively, these initiatives are not the norm and they vary widely. There are few employer or industry-led standards for classifying skill requirements and no such standards as to how often curriculum should be reviewed and revised. Finally, there is no single accepted clearinghouse for job posting information. Only 11 percent of job seekers use the workforce development system to search for a job and about half that report that schools and universities are a good source of information on job opportunities.

Workers are more likely to use online job boards (30 percent) or refer to their personal network (15 percent) to search for work.[28]

Here again is an opportunity for government to provide community colleges and workforce development boards with the tools and training to be more strategic about where to invest their dollars as well as how to advise students and program participants. Federal and state governments can use existing surveys for the reporting of employment data to do capture better job posting data. The federal Job Openings and Labor Market Turnover Survey is woefully underfunded, allowing for analysis of labor market dynamics at only the four broad Census regions of the U.S. and only for industries—not occupations. In response, twelve states have implemented their own job vacancy surveys, but few have the funding to conduct the survey more than once per year and some cannot even consistently find funding from one year to another. As a result, state workforce development agencies have turned to using real-time labor market information that is aggregated from the internet by companies such as Burning Glass Technologies and the Commerce Board (Help Wanted OnLine). Yet we know little about how these real-time data sources differ from traditional surveys of employers that ask about hiring needs and track outcomes such as employment and separations.

Employers should cultivate talent pipelines. Another priority should be to cultivate talent pipelines to meet specific needs around middle-skills jobs. Again, this type of activity cannot be accomplished by a single labor market entity. Employers need to identify potential career pathways and commit to building internal labor markets. Industry leaders need to establish recognized credentials in middle-skill competencies that can be used by employers.

[28] Accenture Research, Accenture Job Seekers Survey 2013.

Educators/trainers need to build curriculum that teach core competencies and award the credentials that employers will recognized (e.g. degrees, certificates or digital badges). And government needs to support these activities through a blend of in-depth internship and apprenticeship programs, internal training programs, and community partnerships.

For example, Alcoa, has formed successful partnerships with community colleges in South Carolina, Tennessee, and Virginia, which have trained nearly a thousand machinists, welders, and industrial maintenance workers. Similarly, Siemans arranged with Central Piedmont College in Charlotte, NC to develop a "mechatronics" curriculum within the associate's degree program.[29] Other large corporations have signed up to participate in the Skills for America's Future Program, a federal initiative designed to foster partnerships between companies and community colleges. But partnerships like these tend to be ad hoc, and are largely underutilized by small and medium sized businesses.[30]

In addition, degrees and certificates in vocational fields are not based on common standards, making skills less portable across states and occupations. Community colleges set their own curricula and standards such that diplomas and certificates in the same major may require different coursework. To make things more standardized, the National Association of Manufacturers (NAM) endorsed a national Manufacturing Skills Certification System in Production, Machining & Metalworking, Welding, Technology & Engineering, Automation, Die Casting, Fabrication, Fluid Power, Distribution & Logistics, Aviation & Aerospace, Bioscience and Energy. As of 2012, seventeen states had national philanthropic funding for deploying the

[29] Whoriskey, Peter. 2012. "U.S. manufacturing sees shortage of skilled factory workers." *Washington Post*, February 19.
[30] Haass, Richard and Klaus Kleinfeld. 2012. "Column: Lack of skilled employees hurting Manufacturing." *USA Today*, July 3.

Manufacturing Skills Certification System, and 18 states had grass-roots efforts and strategic partnerships advocating deployment.[31]

Supply-side institutions should work with employers to foster and support on-the-job training and experiential learning. Without question, on-the-job training or experiential learning needs to be a bigger part of the picture. Spending time in the workplace allows students to gain the exact technical skills and knowledge that employers demand, acquire the soft skills that are difficult to replicate in a classroom setting, and possibly earn wages to while continuing their training. The Accenture survey found that one in four HR leaders called out soft skills, such as work ethics, communications, teamwork, and leadership, as a barrier to finding talent for the most difficult to fill jobs in their organization. Yet the old adage still applies: "to get a job you need experience, yet to get experience you need a job."

Yet despite success in other countries, there is a decided lack of internships for middle-skills jobs, and apprenticeship programs remain scarce. Again, here is a clear role for government to act as a catalyst for workforce development by fostering and supporting long-term relationships between employers and educators/trainers. The biggest barrier is funding. Community colleges and vocational high schools know how to collaborate with employers but lack the resources to do so. Yet, a little financial nudge in the right direction can go a long way. For example, South Carolina's Apprenticeship Carolina program provides support for any company providing a single job.

All labor market entities should give up preconceived notions of traditional roles. Over time, organizations and institutions become entrenched in a particular mindset or role that can

[31] Hemphill, Thomas and Mark Perry. 2012. "U.S. Manufacturing and the Skills Crisis." *Wall Street Journal*, February 27.

make them slow to respond to changing market dynamics. For example, employers have increasingly come to rely on various tools for hiring such as external recruiters, online screens, and pre-employment tests—most of which have been focused on high-skill, white collar workers. Yet firms need to consider a more active role in hiring middle-skill workers that is more interactive and dynamic to find and develop the right talent. Similarly, many community colleges have traditionally seen their role as providing low-cost access to post-secondary education that can be used as a stepping-stone to a four year education. Yet playing a more active role in workforce development does not diminish, but rather enhances, that role—giving students multiple pathways to success that includes both employment and higher education. Finally, government at all levels needs to play a greater role in providing the infrastructure and regulating the rules for market participants. The recent passage of the Workforce Innovation and Opportunity Act (WIOA) represents an important opportunity for the nation's workforce development system to better serve employers and participants alike.

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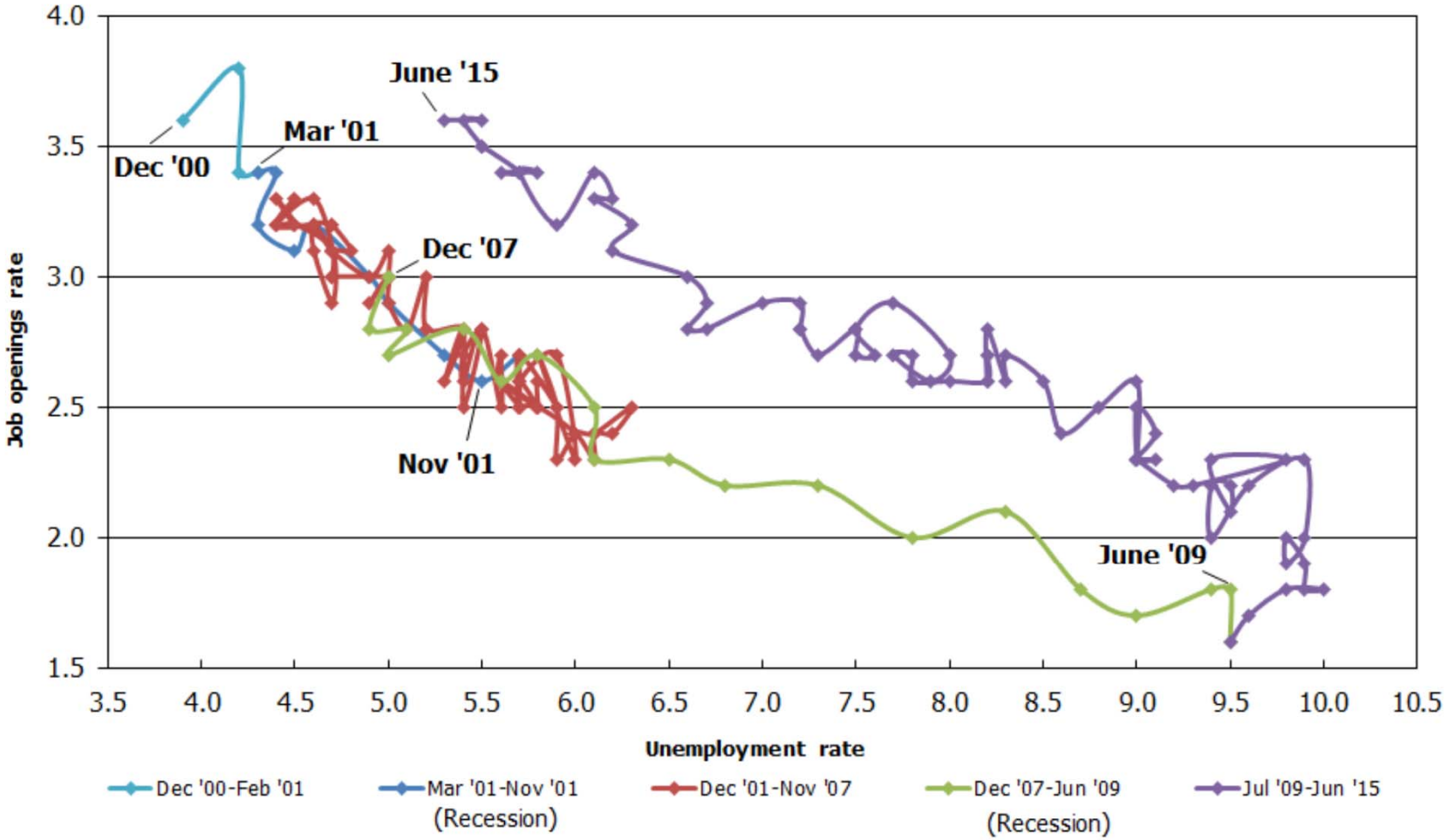
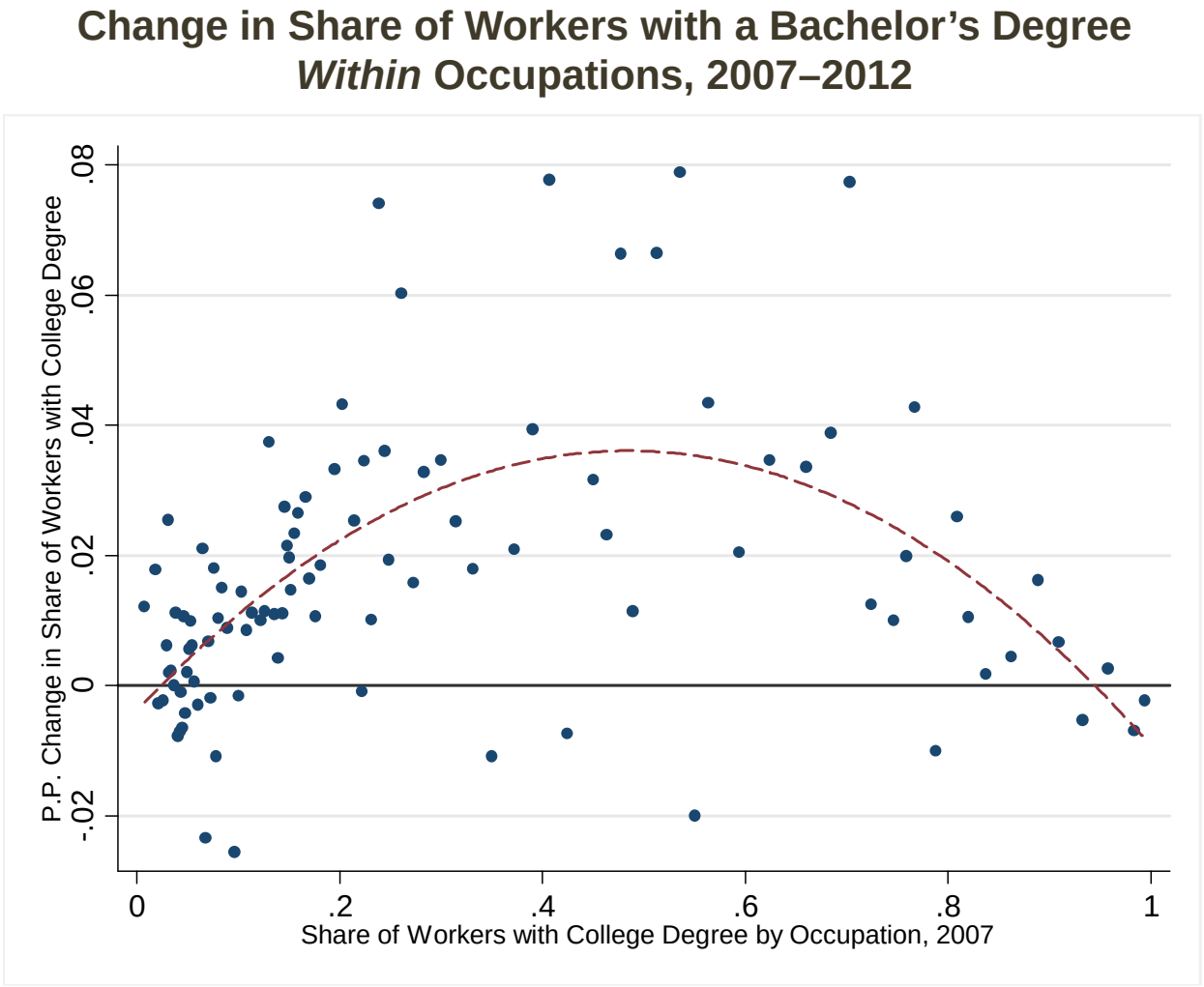
Figure 1. The Beveridge Curve: Job Openings versus Unemployment Rate (seasonally adjusted)



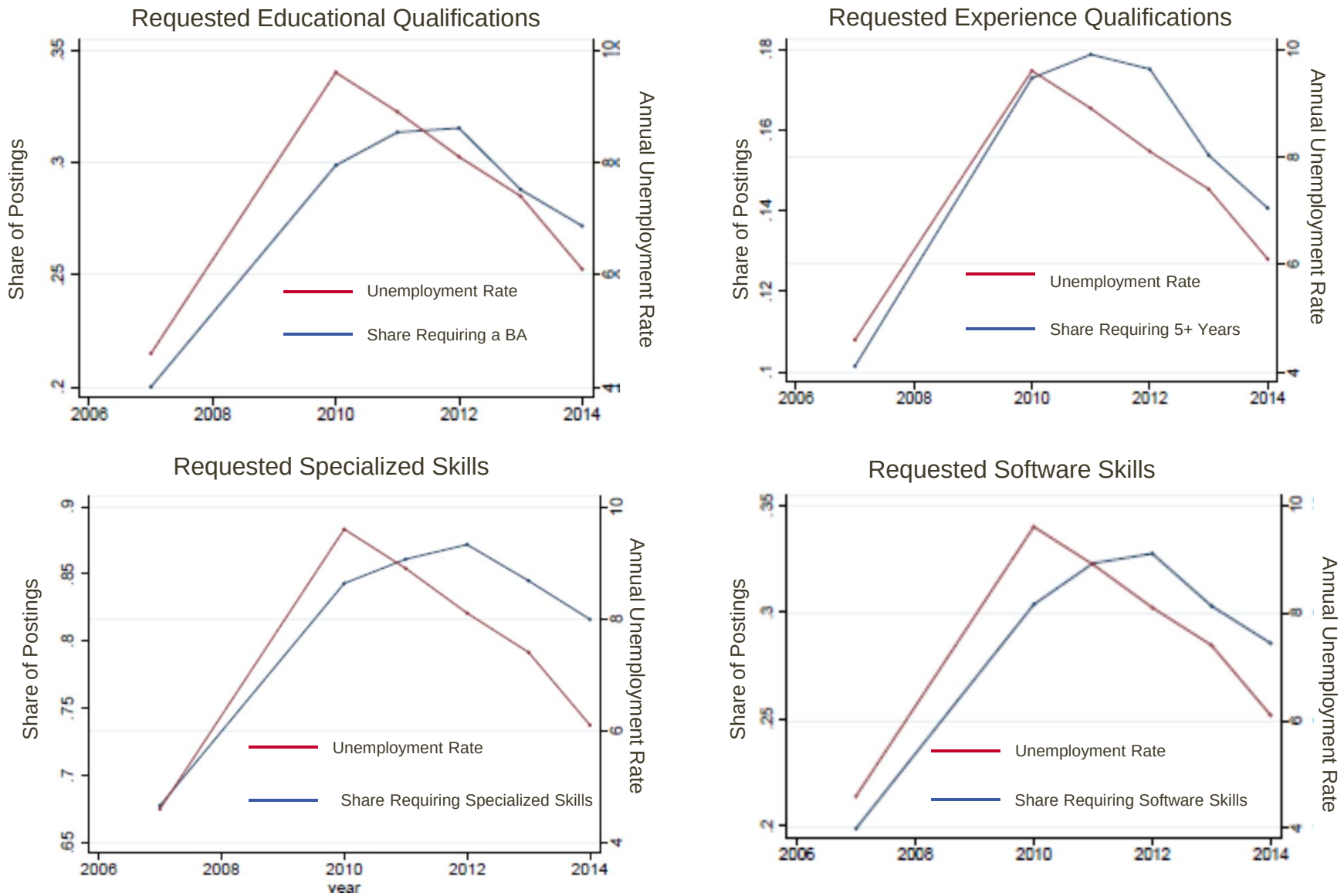
Source: Bureau of Labor Statistics, Current Population Survey and Job Openings and Labor Turnover Survey, May 12, 2015.

Figure 2. Between 2007 to 2012 the share of workers with a Bachelor's degree in traditionally middle- skill occupations increased rapidly.



Source: ACS 1yr PUMS, IPUMS-USA, 2007 and 2012.
Note: Sample restricted to employed persons aged 25–65.

Figure 3. There is a positive relationship between the unemployment rate and the share of jobs requiring more education, more years of years experience, and greater skill.



Source: Modestino, Shoag, and Ballance. 2015. Authors' analysis using job vacancy data from Burning Glass Technologies between 2007 and 2014.

Figure 4. Employers often require a very specific set of skills that is not captured by aggregate data on labor supply and demand used by economists.

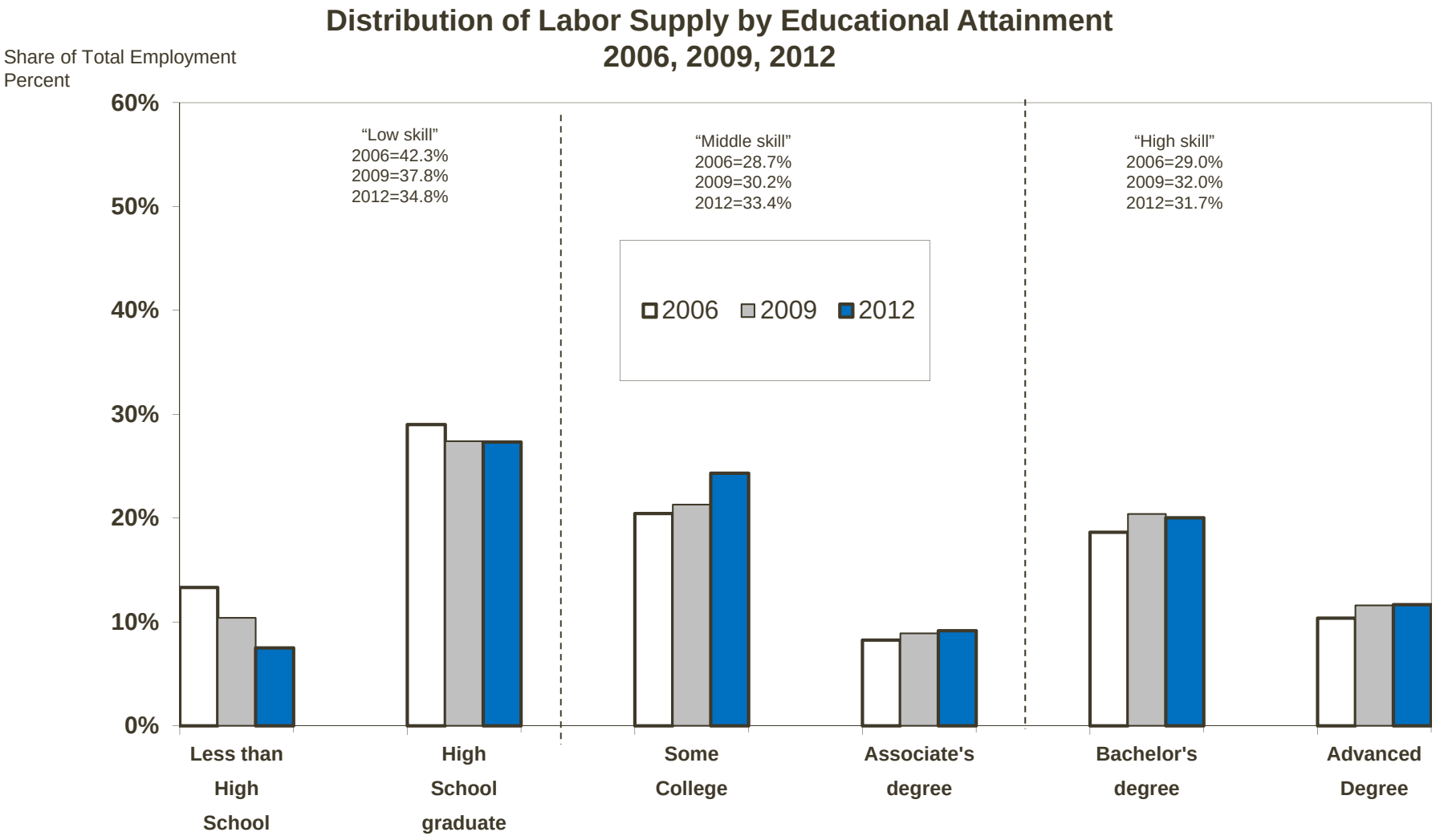
Medical Records Coder

Medical Records Coding is responsible for managing and coordinating the medical records staff involved in coding and abstracting diagnosis, treatments and other information from patient records. The manager is the primary coding and documentation consultant, and an ongoing resource to the leadership, physicians, non physician providers, and the Compliance department.

Job Requirements

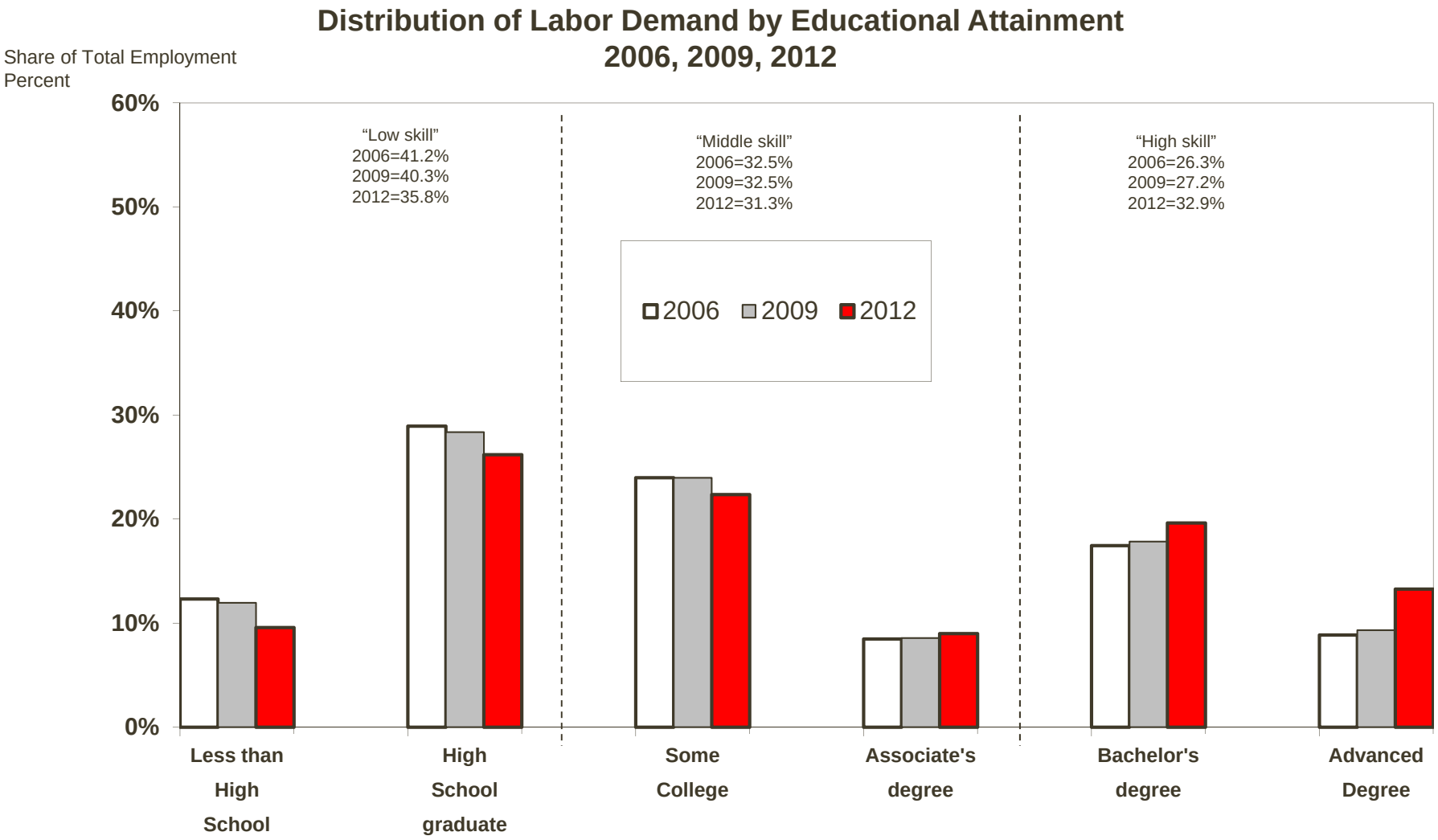
- Must be certified as an AHIMA Certified Coding Specialist (CCS).
- Bachelors' degree in Medical Record Technology, Health Services Administration, Nursing or Finance/Business.
- Five years coding experience.
- Thorough knowledge of coding practices and official guidelines, HCPCS, ICD and CPT codes.
- Experience using electronic medical record/health record systems such as Cerner, EPIC or other comparable systems desired.
- Demonstrated auditing skills for coding quality and compliance.
- Strong interpersonal and analytical skills.

Figure 5. The share of middle-skill workers has increased steadily since 2006, while the share of low-skill workers has decreased.



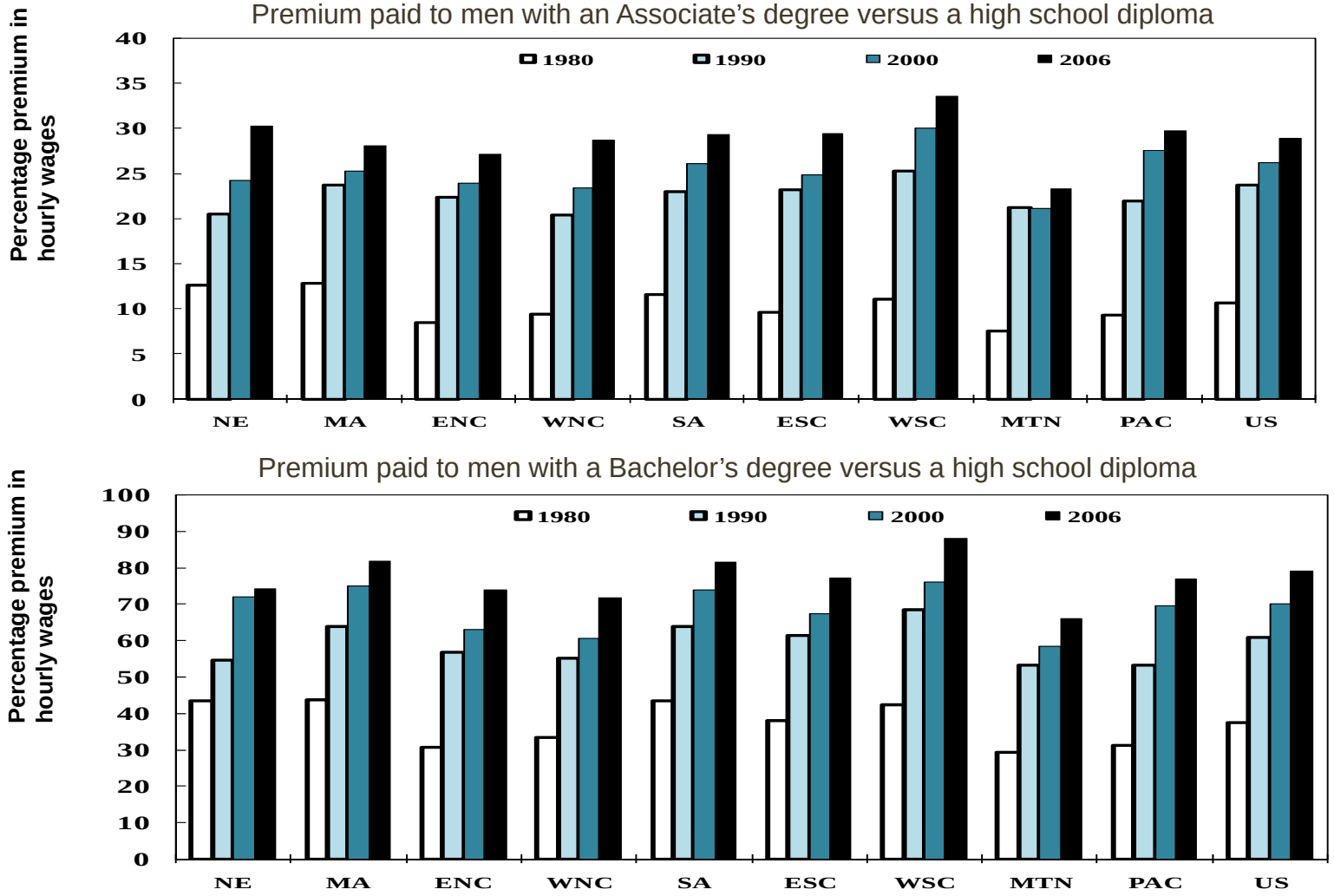
Note: Author's calculations based on the educational attainment of the resident population using the 3-Year combined American Community Survey, various years.

Figure 6. Labor demand appears to have decreased for low-skill jobs, increased for high-skill jobs, and held steady in the middle.



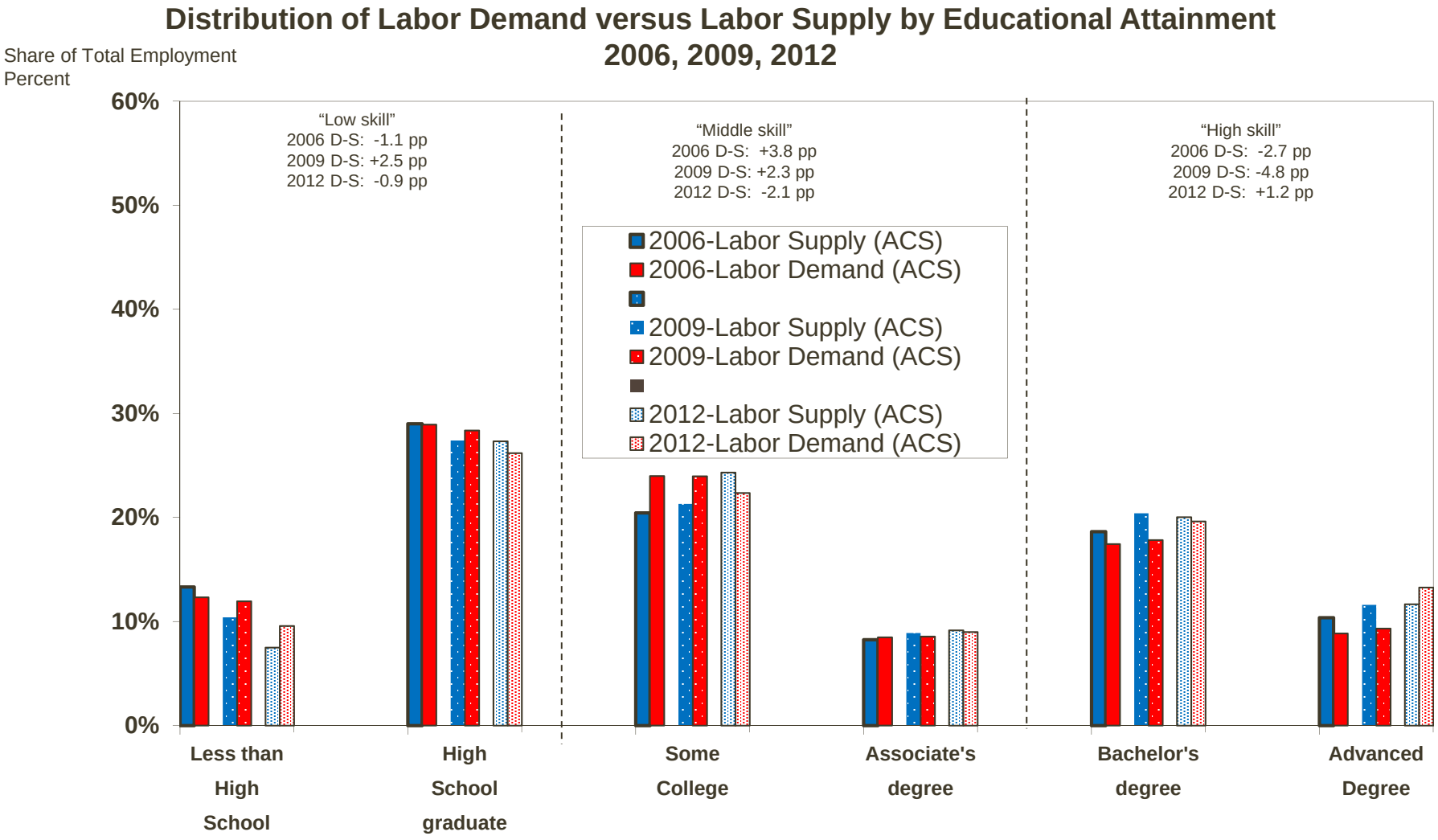
Note: Author's calculations based on total demand equal to employment by detailed occupations for 2012 reported by the Bureau of Labor Statistics plus vacancies reported by Burning Glass Technologies. Total demand is categorized by skill level using educational attainment as calculated from the 3-year 2012 American Community Survey. See the data appendix for more details on the methodology.

Figure 7. The premium employers are willing to pay middle- and high-skill workers relative to those with only a high school degree has been increasing, although less slowly over time.



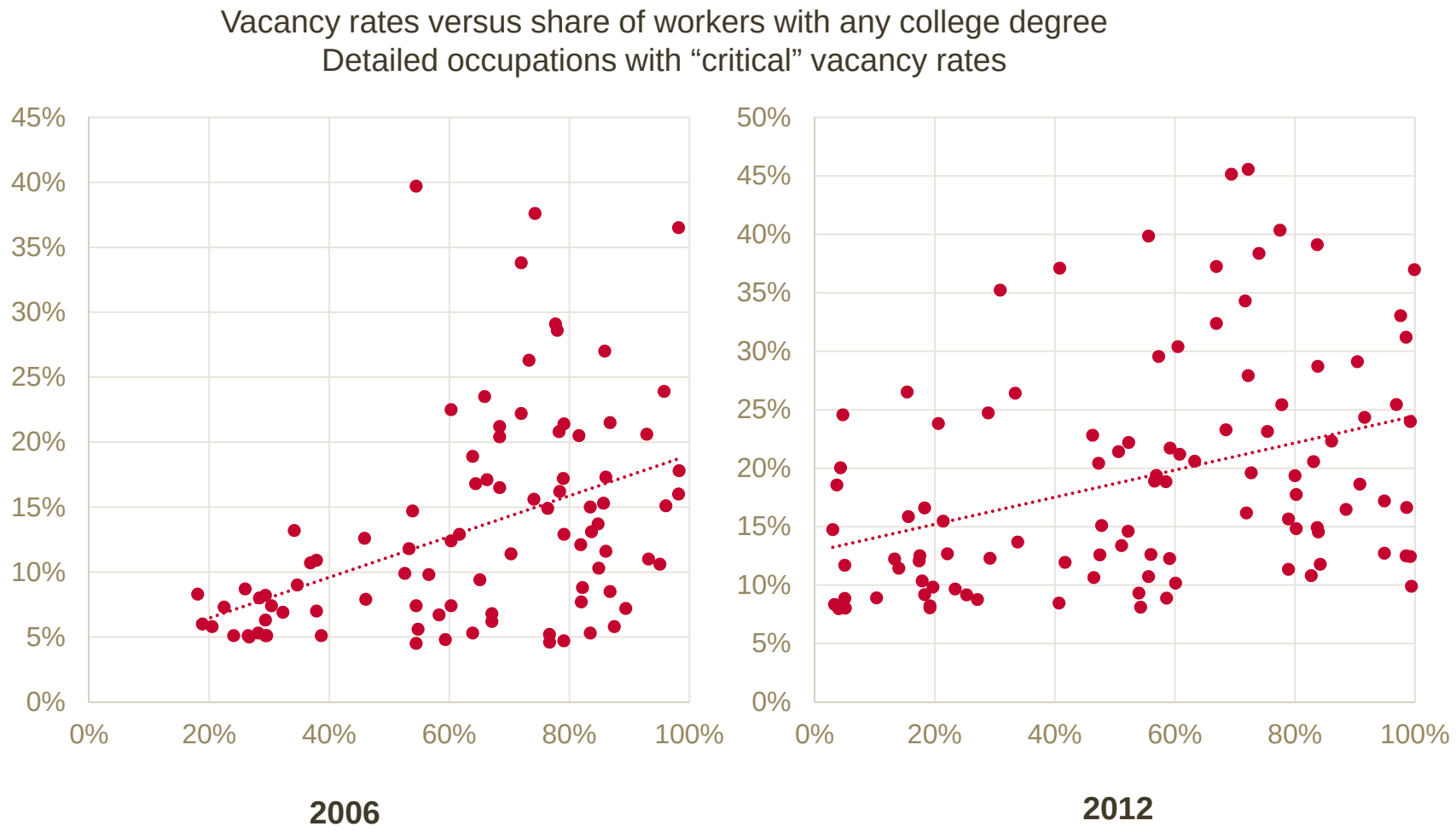
Source: Author's calculations based on the 1980, 1990, and 2000 decennial Census and the combined 2006 American Community Survey for full-time, full-year workers age 25 to 64 years, controlling for a quartic in experience, race, and ethnicity.

Figure 8. Prior to the Great Recession, there appeared to be a potential mismatch in the middle of the labor market that has since abated.



Note: Author's calculations of labor supply are based on the educational attainment of the resident population using the 3-Year combined American Community Survey, various years. Author's calculations of labor demand are based on total demand equal to employment by detailed occupations for 2012 reported by the Bureau of Labor Statistics plus vacancies reported by HWOL (2006 and 2009) and Burning Glass Technologies (2012). Total demand is categorized by skill level using educational attainment as calculated from the 3-year combined American Community Survey, various years.

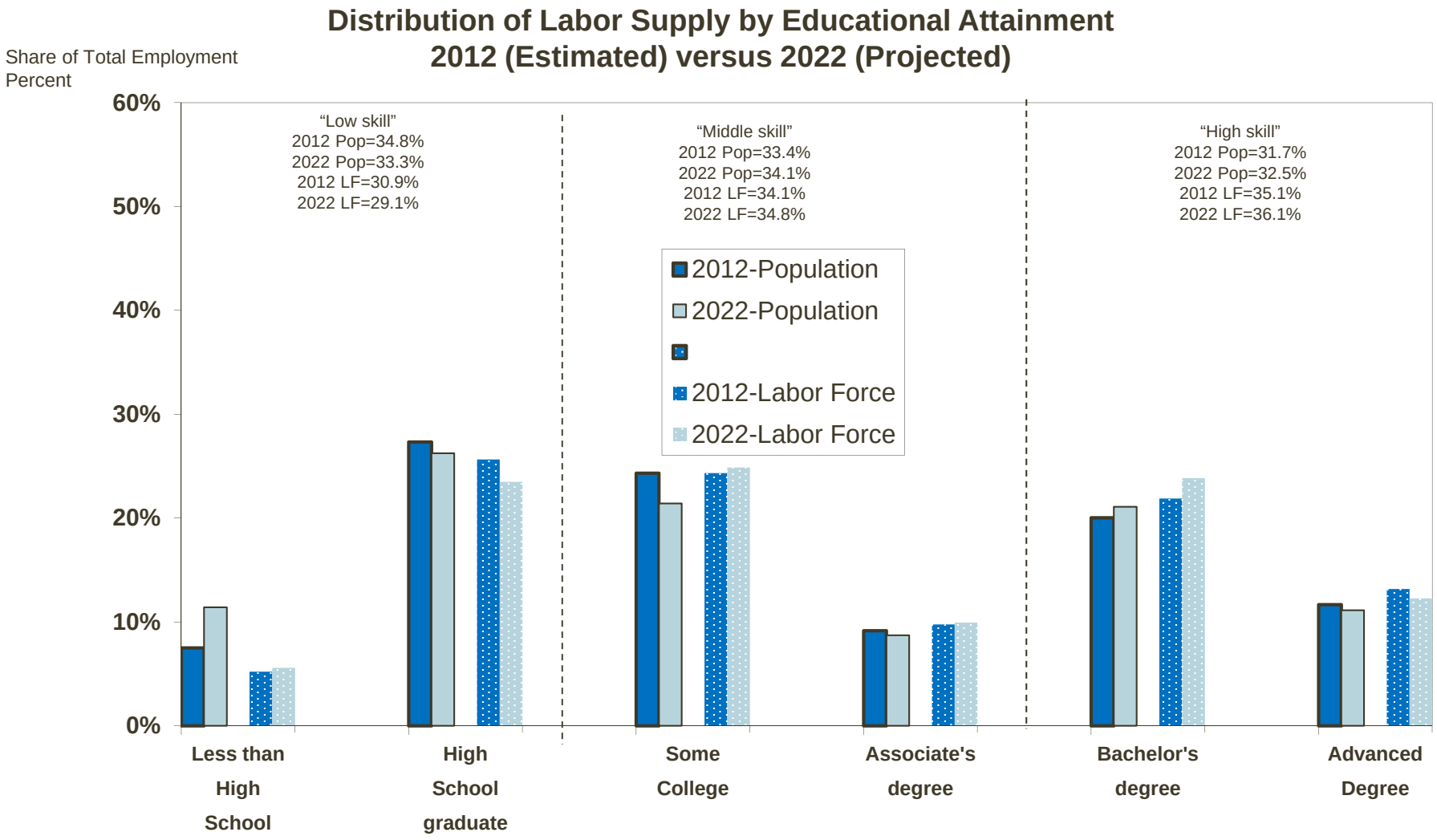
Figure 9. Detailed occupations that employ a greater share of middle- and high-skill workers had higher vacancy rates in both 2006 and 2012.



Source: Vacancy rates are the author's calculations based on vacancies reported by the Help Wanted Online Survey from the Conference Board and employment reported by the Bureau of Labor Statistics. The share of workers with any college degree are the author's calculations using the 2005-2007 combined American Community Survey.

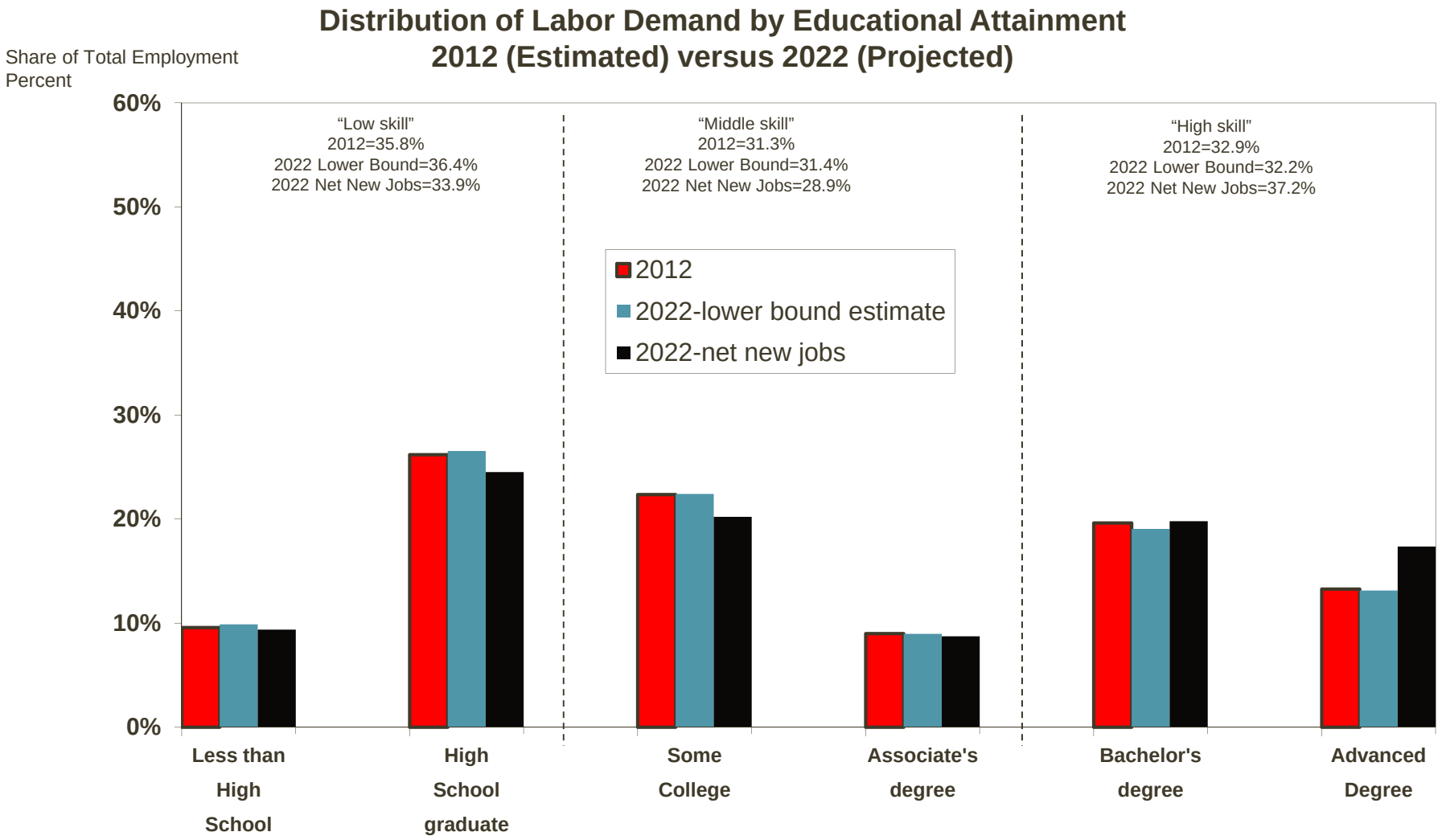
Note: College shares are calculated as the percentage of workers age 25 to 64 years who are college educated in each detailed occupation. Scatter plot includes occupations with vacancy rates greater than or equal to 5%, number of vacancies greater than or equal to 400, and total employment greater than or equal to 1,500 as of 2006. See Table A4 for a complete listing of vacancies and college-educate shares by occupation for New England.

Figure 10. Projected labor supply suggests that the share of middle-skill workers will hold steady while that of high-skill workers will rise slightly.



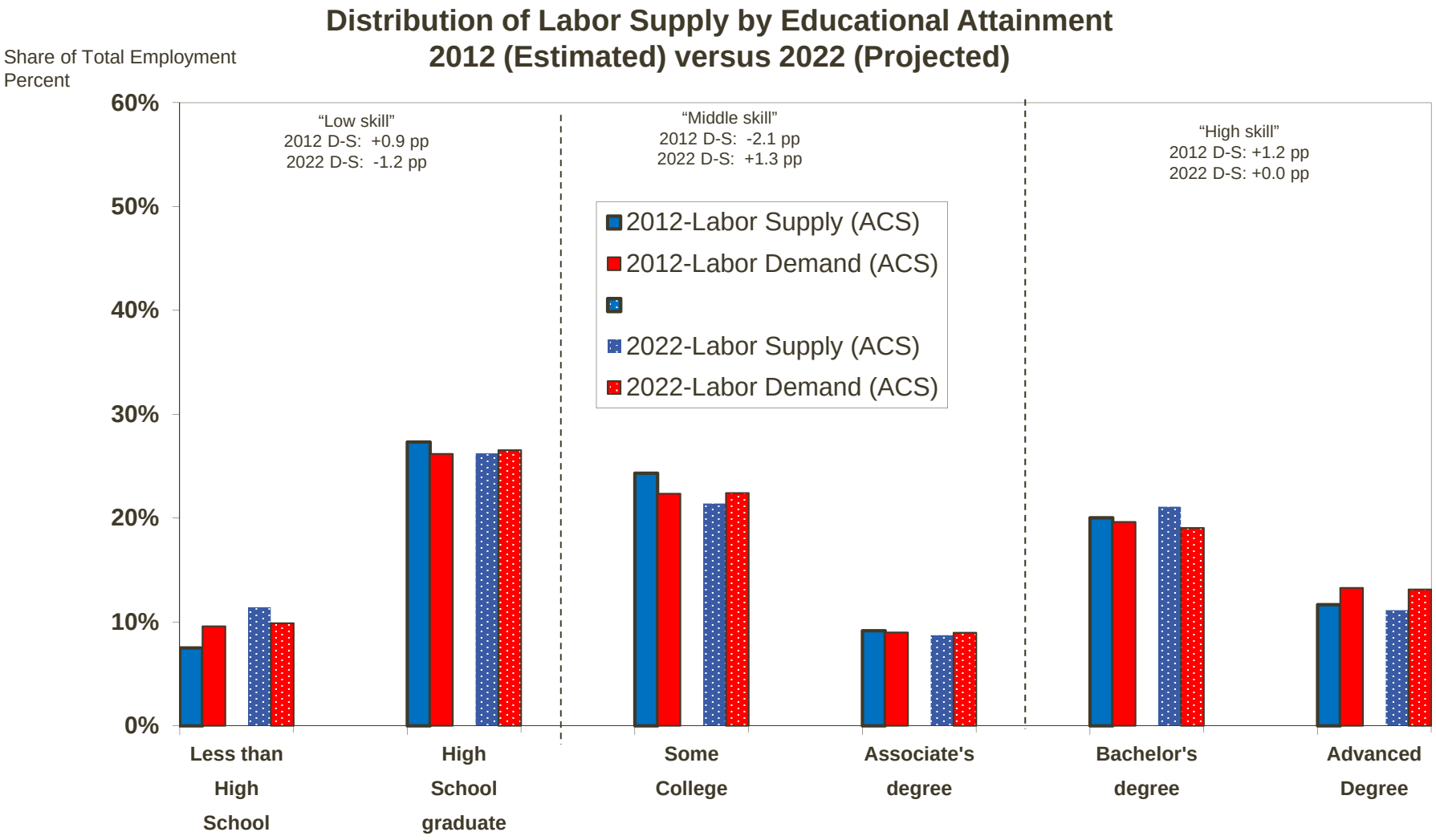
Source: Author's projections of labor supply using a cohort component model . See data appendix for details.

Figure 11. Projected labor demand suggests that a greater share of net new jobs due to growth and replacement will be high-skill.



Note: Author's calculations based on total demand equal to employment by detailed occupations for 2012 reported by the Bureau of Labor Statistics plus vacancies reported by Burning Glass Technologies. Total demand is categorized by skill level using educational attainment as (1) specified by O*NET, (2) calculated from the 3-year 2012 American Community Survey, and (3) calculated from 2012 vacancies collected by Burning Glass Technologies. See the data appendix for more details on the methodology.

Figure 12. Projected labor demand and supply suggest that any potential mismatch would likely occur in the middle of the distribution.



Note: Author's calculations based on the educational attainment of the resident population using the 3-Year combined American Community Survey, various years.

Table 1. Major occupation groups with persistently high vacancy rates employ a higher share of both middle- and high--skill workers.
United States

	Education Distribution of Workers			Vacancies							Projected Employment Growth
	2012			2006		2009		2012			
Major Category	Low-Skill	Middle-Skill	High-Skill	Vacancy rate	Vacancy Share	Vacancy rate	Vacancy Share	Vacancy rate	Vacancy Share		Percent Change 2012 to 2022
Management occupations	19.3%	28.4%	61.0%	9.0%	14%	4.4%	11%	8.5%	14%		7.2%
Business and financial operations occupations	10.9%	26.1%	55.4%	5.0%	8%	2.3%	5%	7.9%	10%		12.5%
Computer and mathematical science occupations	6.2%	27.7%	67.9%	17.3%	14%	8.4%	11%	18.6%	17%		18.0%
Architecture and engineering occupations	8.9%	27.4%	65.6%	7.7%	5%	4.6%	4%	10.4%	5%		7.3%
Life, physical, and social science occupations	6.2%	13.5%	79.0%	6.3%	2%	4.4%	2%	8.5%	2%		10.1%
Community and social services occupations	10.0%	21.3%	71.1%	2.5%	1%	2.0%	1%	4.0%	2%		17.2%
Legal occupations	5.2%	15.6%	68.2%	2.7%	1%	1.9%	1%	5.4%	1%		10.7%
Education, training, and library occupations	8.2%	16.3%	77.4%	0.7%	2%	0.7%	2%	1.9%	3%		11.1%
Arts, design, entertainment, sports, and media occupations	12.2%	27.1%	60.7%	4.7%	2%	4.7%	3%	5.3%	2%		7.0%
Healthcare practitioners and technical occupations	7.7%	38.3%	69.7%	6.6%	12%	5.2%	15%	6.9%	10%		21.5%
Healthcare support occupations	41.4%	47.7%	22.2%	2.0%	2%	2.3%	4%	2.2%	2%		28.1%
Protective service occupations	29.7%	47.0%	20.6%	0.9%	1%	0.7%	1%	2.0%	1%		7.9%
Food preparation and serving related occupations	61.6%	28.9%	11.3%	0.8%	2%	0.6%	3%	0.7%	1%		9.3%
Building and grounds cleaning and maintenance occupations	72.5%	21.5%	12.1%	0.8%	1%	0.7%	1%	0.6%	1%		12.5%
Personal care and service occupations	44.3%	37.0%	25.8%	1.4%	1%	1.4%	2%	1.2%	1%		20.9%
Sales and related occupations	35.8%	34.9%	28.8%	2.7%	10%	2.3%	12%	4.1%	11%		7.3%
Office and administrative support occupations	35.8%	44.5%	20.8%	2.1%	13%	1.2%	10%	2.9%	11%		6.8%
Farming, fishing, and forestry occupations	79.8%	13.9%	6.6%	1.0%	0%	1.1%	0%	0.3%	0%		-3.4%
Construction and extraction occupations	67.0%	26.7%	3.9%	1.1%	2%	0.7%	2%	0.5%	1%		21.4%
Installation, maintenance, and repair occupations	53.8%	38.8%	9.9%	2.0%	3%	1.5%	3%	2.8%	3%		9.6%
Production occupations	65.2%	28.0%	6.6%	1.1%	3%	0.7%	3%	1.7%	2%		0.8%
Transportation and material moving occupations	65.2%	27.4%	6.9%	1.4%	3%	0.8%	3%	1.3%	2%		8.6%
Total	35.8%	31.3%	32.9%	2.9%		1.9%		4.0%			10.8%

Source: Author's calculations

Notes:

Vacancy rates are the author's calculations of vacancies as a share of total employment.

Number of vacancies for 2006 and 2009 are from The Conference Board Help Wanted OnLine (HWOL); 2012 are from Burning Glass Technologies.

Total employment is equal to employment plus vacancies. Employment is from the U.S. Bureau of Labor Statistics.

The education distribution is the share of workers within each occupation that are low-skill (less than high school plus high school graduates), middle-skill (some college plus associate's degree), and high-skill (bachelor's degree or higher) as calculated from the 3-year Combined 2012 American Community Survey.

Table 2. Detailed occupation groups with high vacancy rates show strong wage and employment growth for middle-skill jobs.
United States

		Education Distribution of Workers (2012)			Vacancies (2012)		Annual Wage Growth		Projected Employment Growth
Detailed Occupations		Low-Skill	Middle-Skill	High-Skill	Vacancy rate	Vacancy Share	Median Wages 2012	Wage Growth 2012 to 2014	Percent Change 2012 to 2022
Management occupations									
11-2021	Marketing managers	9.2%	24.0%	66.8%	38.4%	0.9%	$119,480	6.4%	12.7%
11-2022	Sales managers	9.2%	24.0%	66.8%	32.4%	1.4%	$105,260	5.1%	8.3%
11-2031	Public relations and fundraising managers	3.5%	13.8%	82.7%	37.2%	0.3%	$95,450	6.3%	12.9%
11-3011	**Administrative services managers**	**19.0%**	**40.4%**	**40.6%**	**10.8%**	**0.3%**	**$81,080**	**3.3%**	**12.2%**
11-3021	Computer and information systems managers	4.1%	23.2%	72.7%	8.5%	0.2%	$120,950	5.5%	15.3%
11-3031	Financial managers	11.5%	27.6%	60.9%	19.6%	1.0%	$109,740	5.1%	8.9%
11-3051	Industrial production managers	24.2%	31.4%	44.4%	21.2%	0.4%	$89,190	3.7%	-2.4%
11-3071	**Transportation, storage, and distribution managers**	**33.9%**	**37.3%**	**28.8%**	**19.4%**	**0.2%**	**$81,830**	**4.4%**	**4.8%**
11-3121	Human resources managers	15.1%	28.2%	56.7%	30.4%	0.4%	$99,720	3.1%	13.2%
11-9033	Education administrators, postsecondary	5.8%	14.0%	80.2%	17.7%	0.3%	$86,490	2.2%	14.5%
11-9041	Architectural and engineering managers	3.2%	13.0%	83.8%	14.8%	0.3%	$124,870	4.6%	6.8%
11-9051	**Food service managers**	**38.2%**	**37.1%**	**24.7%**	**14.5%**	**0.4%**	**$47,960**	**1.3%**	**1.6%**
11-9111	Medical and health services managers	10.5%	29.0%	60.5%	37.1%	1.5%	$88,580	4.8%	23.2%
11-9141	**Property, real estate, and community association managers**	**24.6%**	**36.7%**	**38.7%**	**9.3%**	**0.2%**	**$52,610**	**3.2%**	**11.8%**
11-9199	Managers, all other	17.8%	28.2%	54.0%	18.8%	1.7%	$100,890	4.1%	5.9%
Business and financial operations occupations									
13-1023	**Purchasing agents, except wholesale, retail, and farm products**	**21.1%**	**37.8%**	**41.1%**	**13.7%**	**0.4%**	**$58,760**	**3.8%**	**2.9%**
13-1041	Compliance officers	12.1%	29.4%	58.5%	10.7%	0.2%	$62,020	4.7%	4.6%
13-1051	**Cost estimators**	**26.2%**	**40.3%**	**33.5%**	**8.9%**	**0.2%**	**$58,860**	**2.0%**	**26.2%**
13-1071	Human resources specialists	12.3%	30.4%	57.3%	26.4%	1.2%	$55,800	2.9%	7.9%
13-1081	**Logisticians**	**15.4%**	**42.8%**	**41.8%**	**29.6%**	**0.4%**	**$72,780**	**1.5%**	**22.0%**
13-1111	Management analysts	5.5%	17.8%	76.7%	11.9%	0.8%	$78,600	2.9%	18.6%
13-1141	**Compensation, benefits, and job analysis specialists**	**13.4%**	**38.8%**	**47.8%**	**19.4%**	**0.2%**	**$59,090**	**2.6%**	**5.8%**
13-1151	**Training and development specialists**	**14.1%**	**33.6%**	**52.3%**	**15.1%**	**0.3%**	**$55,930**	**2.5%**	**15.5%**
13-1161	Market research analysts and marketing specialists	5.2%	18.0%	76.8%	14.6%	0.6%	$60,300	1.6%	31.6%
13-2011	Accountants and auditors	4.2%	17.4%	78.4%	12.6%	1.5%	$63,550	3.8%	13.1%
13-2051	Financial analysts	3.5%	10.4%	86.1%	20.6%	0.5%	$76,950	2.2%	15.6%
13-2052	Personal financial advisors	3.7%	15.5%	80.8%	22.3%	0.5%	$67,520	20.1%	27.0%
13-2072	Loan officers	15.5%	33.4%	51.1%	13.4%	0.4%	$59,820	4.7%	7.7%
Computer and mathematical science occupations									
15-1121	Computer systems analysts	5.2%	23.1%	71.7%	24.3%	1.3%	$79,680	3.8%	24.5%
15-1122	Information security analysts	7.0%	36.4%	56.6%	34.3%	0.3%	$86,170	3.2%	36.5%
15-1131	Computer programmers	5.2%	22.6%	72.2%	18.9%	0.6%	$74,280	4.4%	8.3%
15-1132	Software developers, applications	2.7%	13.6%	83.7%	45.6%	4.1%	$90,060	6.1%	22.8%
15-1133	Software developers, systems software	2.7%	13.6%	83.7%	14.9%	0.6%	$99,000	3.9%	20.4%
15-1134	Web developers	5.0%	25.7%	69.3%	39.1%	0.7%	$62,500	1.6%	20.2%
15-1141	Database administrators	6.5%	25.0%	68.5%	45.1%	0.8%	$77,080	4.2%	15.1%
15-1142	**Network and computer systems administrators**	**7.4%**	**42.0%**	**50.6%**	**23.3%**	**0.9%**	**$72,560**	**4.5%**	**11.7%**
15-1143	**Computer network architects**	**5.2%**	**35.5%**	**59.3%**	**21.4%**	**0.3%**	**$91,000**	**8.2%**	**14.6%**
15-1151	**Computer user support specialists**	**11.5%**	**45.3%**	**43.2%**	**21.7%**	**1.2%**	**$46,420**	**2.6%**	**20.2%**
15-1199	Computer occupations, all other	10.2%	38.5%	51.3%	68.4%	3.5%	$81,140	2.8%	3.8%
Architecture and engineering occupations									
17-2041	Chemical engineers	3.0%	8.5%	88.5%	40.4%	0.2%	$94,350	2.7%	4.5%
17-2051	Civil engineers	2.9%	11.8%	85.3%	16.5%	0.4%	$79,340	3.4%	19.7%
17-2071	Electrical engineers	3.4%	17.6%	79.0%	27.9%	0.5%	$87,920	4.0%	4.8%
17-2112	Industrial engineers	5.3%	22.7%	72.0%	16.2%	0.3%	$78,860	3.3%	4.5%
17-2141	Mechanical engineers	4.8%	20.8%	74.4%	23.1%	0.6%	$80,580	3.1%	4.5%
17-2199	Engineers, all other	3.4%	14.6%	82.0%	20.6%	0.3%	$92,030	2.4%	3.8%
17-3023	**Electrical and electronics engineering technicians**	**26.8%**	**55.7%**	**17.5%**	**12.1%**	**0.2%**	**$57,850**	**3.4%**	0.0%
Healthcare practitioners and technical occupations									
29-1051	Pharmacists	0.3%	1.6%	98.1%	9.9%	0.3%	$116,670	3.7%	14.5%
29-1069	Physicians and surgeons, all other	0.3%	0.5%	99.2%	12.4%	0.4%	NA	NA	18.7%
29-1071	Physician assistants	4.2%	21.5%	74.3%	24.0%	0.2%	$90,930	5.4%	38.4%
29-1122	Occupational therapists	0.4%	9.2%	90.4%	37.0%	0.5%	$75,400	4.5%	29.1%
29-1123	Physical therapists	1.3%	7.6%	91.1%	29.1%	0.7%	$79,860	3.2%	36.0%
29-1127	Speech-language pathologists	0.4%	0.5%	99.1%	24.7%	0.4%	$69,870	2.4%	19.4%
29-1141	Registered nurses	1.2%	43.3%	55.5%	12.5%	3.1%	$65,470	1.8%	19.4%
29-1171	Nurse practitioners	0.6%	2.6%	96.8%	25.4%	0.3%	$89,960	6.0%	33.7%
29-1199	Health diagnosing and treating practitioners, all other	3.5%	9.3%	87.2%	33.0%	0.2%	$72,710	0.9%	7.8%
29-2012	**Medical and clinical laboratory technicians**	**11.9%**	**35.7%**	**52.4%**	**22.2%**	**0.4%**	**$37,240**	**3.0%**	**29.7%**
29-2055	**Surgical technologists**	**27.3%**	**54.4%**	**18.3%**	**16.6%**	**0.2%**	**$41,790**	**3.7%**	**29.7%**
29-2061	**Licensed practical and licensed vocational nurses**	**19.7%**	**75.6%**	**4.7%**	**9.2%**	**0.6%**	**$41,540**	**2.3%**	**24.8%**
29-2071	**Medical records and health information technicians**	**29.5%**	**51.5%**	**19.0%**	**24.6%**	**0.5%**	**$34,160**	**5.1%**	**22.1%**
29-2099	**Health technologists and technicians, all other**	**22.0%**	**47.0%**	**31.0%**	**35.2%**	**0.4%**	**$40,700**	**1.8%**	**26.8%**
Total (all occupations)		35.8%	31.3%	32.9%	4.0%		$34,750	2.3%	10.8%

Source: Author's calculations

Notes:
Vacancy rates are the author's calculations of vacancies as a share of total employment.
Number of vacancies are from Burning Glass Technologies.
Total employment is equal to employment plus vacancies. Employment is from the U.S. Bureau of Labor Statistics.
The education distribution is the share of workers within each occupation that are low-skill (less than high school plus high school graduates), middle-skill (some college plus associate's degree), and high-skill (bachelor's degree or higher) as calculated from the 3-year Combined 2012 American Community Survey.
Occupations in red are those that employ a relatively high share of middle-skill workers.

Table 3. Major occupation groups that employ a high share of middle- and high-skill workers have low unemployment relative to the number of vacancies.
United States

	Education Distribution of Workers			Unemployment			Post-Secondary Degrees Completed		
	2012			2014			2014		
Major Category	Low-Skill	Middle-Skill	High-Skill	Ratio: Unemployed/Vacancies	Unemployment Rate	Unemployment Share	Sub-Baccalaureate	Baccalaureate	Post-Baccalaureate
Management occupations	19.3%	28.4%	61.0%	0.67	2.6%	4.6%	18.8%	45.3%	45.8%
Business and financial operations occupations	10.9%	26.1%	55.4%	0.78	3.6%	2.7%	3.7%	0.8%	1.5%
Computer and mathematical science occupations	6.2%	27.7%	67.9%	0.27	2.7%	0.0%	5.5%	1.1%	1.1%
Architecture and engineering occupations	8.9%	27.4%	65.6%	0.43	3.1%	1.2%	8.1%	1.0%	0.3%
Life, physical, and social science occupations	6.2%	13.5%	79.0%	0.72	3.8%	0.9%	1.5%	3.9%	3.8%
Community and social services occupations	10.0%	21.3%	71.1%	0.69	3.1%	0.6%	1.0%	1.3%	6.3%
Legal occupations	5.2%	15.6%	68.2%	1.11	2.4%	0.8%	0.1%	0.0%	0.8%
Education, training, and library occupations	8.2%	16.3%	77.4%	3.95	3.4%	0.5%	26.3%	43.7%	37.7%
Arts, design, entertainment, sports, and media occupations	12.2%	27.1%	60.7%	0.86	6.2%	3.2%	1.7%	0.6%	0.2%
Healthcare practitioners and technical occupations	7.7%	38.3%	69.7%	0.29	2.1%	2.0%	4.5%	1.8%	2.4%
Healthcare support occupations	41.4%	47.7%	22.2%	1.30	5.4%	1.9%	4.5%	0.0%	0.0%
Protective service occupations	29.7%	47.0%	20.6%	2.27	4.4%	1.5%	0.5%	0.1%	0.1%
Food preparation and serving related occupations	61.6%	28.9%	11.3%	3.66	8.5%	0.0%	1.7%	0.0%	0.0%
Building and grounds cleaning and maintenance occupations	72.5%	21.5%	12.1%	4.15	8.7%	2.0%	0.2%	0.0%	0.0%
Personal care and service occupations	44.3%	37.0%	25.8%	5.03	6.9%	1.5%	7.2%	0.0%	0.0%
Sales and related occupations	35.8%	34.9%	28.8%	1.53	6.1%	7.9%	0.3%	0.1%	0.1%
Office and administrative support occupations	35.8%	44.5%	20.8%	1.54	5.8%	5.7%	4.9%	0.1%	0.0%
Farming, fishing, and forestry occupations	79.8%	13.9%	6.6%	8.09	11.6%	4.1%	0.1%	0.0%	0.0%
Construction and extraction occupations	67.0%	26.7%	3.9%	4.00	9.6%	8.5%	2.8%	0.0%	0.0%
Installation, maintenance, and repair occupations	53.8%	38.8%	9.9%	0.93	4.4%	0.0%	3.4%	0.0%	0.0%
Production occupations	65.2%	28.0%	6.6%	3.45	7.0%	10.6%	2.9%	0.1%	0.0%
Transportation and material moving occupations	65.2%	27.4%	6.9%	2.01	7.7%	11.4%	0.3%	0.1%	0.0%
Total (all occupations)	35.8%	31.3%	32.9%	1.96	6.2%	100.0%	100.0%	100.0%	100%

Sources:
Ratio of unemployed to the number of vacancies is the author's calculation.
Number of unemployed, the unemployment rate, and the share of unemployment are as reported by the Bureau of Labor Statistics from the Current Population Survey.
Number of vacancies are from The Conference Board Help Wanted OnLine (HWOL).
Postsecondary degrees completed are from the Integrated Postsecondary Education Data System (IPEDS).