HHS Public Access
Author manuscript
Am Sociol Rev. Author manuscript; available in PMC 2019 July 09.

Published in final edited form as:
Am Sociol Rev. 2018 ; 83(4): 771–801. doi:10.1177/0003122418785371.

Relative Education and the Advantage of a College Degree

Jonathan Horowitz
University of North Carolina-Chapel Hill

Abstract

What is the worth of a college degree when higher education expands? The relative education hypothesis posits that when college degrees are rare, individuals with more education have less competition to enter highly-skilled occupations. When college degrees are more common, there may not be enough highly-skilled jobs to go around; some college-educated workers lose out to others and are pushed into less-skilled jobs. Using new measurements of occupation-level verbal, quantitative, and analytic skills, this study tests the changing effect of education on skill utilization across 70 years of birth cohorts from 1971 to 2010, net of all other age, period, and cohort trends. Higher-education expansion erodes the value of a college degree, and college-educated workers are at greater risk for underemployment in less cognitively demanding occupations. This raises questions about the sources of rising income inequality, skill utilization across the working life course, occupational sex segregation, and how returns to education have changed across different life domains.

Keywords

education; inequality; stratification; college; work; occupations; labor force; relative education effects

---

Over the past 80 years, the United States experienced a dramatic increase in college enrollment and completion. In 1950, only 7.7 percent of people in the United States age 25 to 29 had a bachelor's degree or more, but this number tripled to 22.5 percent in 1980, and further increased to 31.7 percent by 2010 (Snyder, de Brey, and Dillow 2018). With increased state support for universities during the twentieth century (Fischer and Hout 2006), the increasing cultural value that individuals and employers attach to college education (Baker 2011), the diffusion of educational expectations across class lines (Goyette 2008), and visible economic returns to education stimulating university attendance (Goldin and Katz 2008), college is increasingly an institutionalized part of the life course (Rosenbaum 2001). Furthermore, the advantages of college appear to be strengthening: the monetary returns to education increased dramatically in the last part of the twentieth century (Autor 2014; Fischer and Hout 2006; Goldin and Katz 2008). With a strong empirical case that "education makes life better"—both directly and by leading to better jobs (Hout

---

Corresponding Author: Jonathan Horowitz, 123 W. Franklin Street, Chapel Hill, NC 27516, jonathanhorowitzresearch@unc.edu.
[15]Just as before, I assume that the individual is 27 years old, lives in 1999 within a central city in the Mid-Atlantic census division, and is white and married.

2012:394; Kalleberg 2011)—researchers typically treat increases in college education as a positive outcome.

The positive news about education has largely displaced older concerns that the expansion of college education might not run parallel with an increased demand for skilled labor, leading to an erosion of the competitive advantage conferred by a college degree (Berg 1970; Bills 2016; Brown 1995; Collins 1979; Freeman 1976; Hirsch 1976; Smith 1986). Indeed, several decades ago, scholars were concerned about the possibility of *relative education effects*. When college degrees are rare, individuals with more education have less competition to enter highly-skilled occupations. When college degrees are more common, there may not be enough skilled jobs to go around—some college-educated workers may lose out to others and be pushed into low-skilled jobs instead. Many scholars dismiss the relative education hypothesis in light of research on wage differentials, but this may be premature. The relative education argument applies to skill utilization in the labor market (Hirsch 1976), and only indirectly to the wage premium. Wages are a separate outcome subject to institutional as well as market forces, such as returns to a specific occupation or industry, union power, and favorable regulatory environments for high-income workers (Cappelli 2015; Jacobs and Dirlam 2016; Jacobs and Myers 2014; Kalleberg 2011; Lin and Tomaskovic-Devey 2013; Tomaskovic-Devey and Lin 2011).

This study combines 40 years of the Current Population Survey data and new measures of cognitive skill utilization to re-examine the relative education hypothesis (Flood et al. 2015). I begin with a brief overview of differing perspectives on recent trends in returns to a college education, explain why wage premiums are not a good proxy for skill utilization, and develop new measures of cognitive skill utilization at work based on an analysis of O*NET data (see also Liu and Grusky 2013). I then test the relative education hypothesis with these direct measures of skill utilization—net of all age, period, and cohort trends that could confound the hypothesis. I address the extent to which rising educational attainment across birth cohorts pushes college-educated individuals into less-skilled jobs. The findings provide new directions for the study of labor market mismatch, occupational sex segregation, and labor market careers across the life course. The study also calls into question the prevailing explanations for rising income inequality, how the returns to education have changed across different life domains, and whether sending more students to college is a viable strategy to reduce inequality.

THE RELATIVE EDUCATION HYPOTHESIS: A BRIEF SYNOPSIS

The heart of this study is a test of relative education effects. Relative education theory can be summarized by the following points: (1) All else being equal, for individuals to obtain a scarce resource such as a good job, they need to have more education than other potential applicants. (2) As more individuals attend college in order to obtain better jobs and higher social status, these educational credentials no longer help employers narrow down their job searches. With a crowd of individuals competing for the same position, employers raise the educational requirements to screen for better-qualified applicants, and sometimes there are not enough jobs to absorb all of the well-educated workers in the population. As a result, (3) the advantage a college degree confers depends on the education level of one’s peers. A person who earns a college degree in the context of a less-educated labor force may be seen as highly desirable, whereas in a highly-educated labor pool, that same person is seen as minimally qualified rather than elite.

Ultimately, the value of a college degree is not absolute but is relative to the amount of education held by one's peers. The value of a degree depreciates as it becomes more common in the labor market, unless skilled jobs increase at a similar or greater rate. With the dramatic increase in educational attainment over successive birth cohorts, if all else is equal we would expect the value of a college degree to drop. Put another way, we may be witnessing degree inflation in the United States, where each individual college degree is less effective at helping a worker obtain skilled employment. If this is correct, individuals born in later cohorts who have college degrees are less likely to find jobs that utilize the verbal, quantitative, and analytic skills they develop in school.

Education as a Positional Good

Educational attainment signals to employers that a job-seeker is desirable (Spence 1973). Screening workers for a minimum level of educational attainment is a low-cost strategy for removing undesirable candidates: it complies with anti-discrimination regulations, and exceptionally well-educated workers may be flagged for further review. But although education represents acquisition of skills, it is also a positional good, which means at least some of its value is relative—whether you have more or less of it than your competition. Hirsch (1976) provides the most vivid explanation of how positional goods work with the metaphor of the job queue (see also Reskin and Roos 2009; Thurow 1976). Imagine you are in a line for a job in your town, where all job candidates are ordered from most qualified to least qualified; if you gain more education, you will probably move forward in the line and are more likely to land the job. However, if you move to a new metropolitan area that has better-educated job candidates than your previous town, you will find yourself further back in line than before. Without any change in your own absolute educational attainment, your degree's power in the labor market has lost value, because a greater proportion of applicants are ahead of you in the labor queue. In economies like the United States, relative position in the queue is usually more relevant to landing a job than the absolute value provided by educational training (Di Stasio 2017; Goldthorpe 2014).

Relative education theorists disagree about what signals college completion sends to potential employers. Scholars working within a broad human capital tradition emphasize that education signals productive capacity in the workplace. Workers learn skills from a variety of sources, but academic college skills are particularly prized by employers and society as a whole (Baker 2011). Furthermore, in the absence of concrete knowledge about an applicant's future productivity, education completion may signal the capacity to learn new tasks (Spence 1973).

In contrast, the credentialist strain of relative education theory suggests that the relationship between education, skills, and hiring is spurious: workplace skills are often learned through on-the-job training. Credentialist theorists suggest that employers prefer college-educated workers for two related cultural reasons. First, employers are looking for workers with high levels of cultural capital, and educational attainment signals mastery of dominant U.S.

cultural norms (Collins 1979). Thus, when firms look for employees, they believe that college-educated workers have a greater work ethic and more poised self-presentation; in other words, they seek workers whose cultural training and background matches their own (Berg 1970; Brown 2001). Second, by setting an artificial educational bar for new hires, workplaces announce their own prestige and status by excluding those with lower social standing (Collins 1979).

In both strands of relative education theory, workers who earn a degree are able to better signal their desirable qualities to potential employers. The signal helps applicants distinguish themselves from others and moves them further toward the front of the labor market queue. Therefore, young adults with sufficient resources and ability often stay in school until they reach a desirable position in the labor market queue to advance their careers (Goldthorpe 2014; Thurow 1976; Van de Werfhorst and Andersen 2005).

Dynamics and Consequences of Degree Inflation

The proportion of individuals attending college rapidly increased over birth cohorts, as young adults and their families have increasingly realized that education is an effective path toward economic advancement, financial aid and the university system has expanded, and high schools have adopted policies encouraging all students to attend college (Goldin and Katz 2008; Goyette 2008; Rosenbaum 2001). Thus, to maintain a desired position in the labor market, prospective workers in later cohorts must distinguish themselves with more education, creating a feedback loop where each individual needs to obtain more education to protect against others leapfrogging them in the labor market queue (Collins 1979, 2002; Freeman 1976; Hirsch 1976; Thurow 1976; Van de Werfhorst and Andersen 2005).

The expansion of higher education has a number of effects on the labor market. From the human capital perspective, college education increases an individual’s skills,[1] but mass education increases the number of skilled individuals, making it harder for each degree-holder to stand out[2] (Smith 1986). From the credentialist perspective, if everyone has the same cultural qualifications, employers will insist on higher-prestige or more advanced degrees to maintain the same selectivity (Collins 1979, 2002). Furthermore, just as the economy cannot absorb particularly large birth cohorts (Easterlin 1987; Pampel and Peters

[1]Human capital theorists in this tradition tend to emphasize “hard” skills such as verbal, mathematic, and analytic skills over “soft” skills such as interpersonal demeanor.

[2]The human capital approach might pay too much attention to the advantages conferred by college and not enough on a degree’s relationship with latent traits, or on heterogeneity within colleges themselves. In a draft of this article, one reviewer suggested that latent personality traits or cognitive abilities are activated and certified by college education. In other words, there is an interaction between “good latent traits” (GLTs) and college education, and increasing the number of college-bound undergraduates may mean a larger number of college-educated job-seekers with worse cognitive skills or personality traits. It is important to note that this is only true if GLTs are fixed as a proportion of the population and are not modifiable by the college environment, and if GLTs are unrelated to college completion.

Similarly, another reviewer suggested that perhaps the explosion of lower-tier college options led to college graduates with fewer skills. There is likely greater heterogeneity among college-educated workers today, but this is unlikely to explain a divergence between skill utilization and income.

Under either scenario, college-educated job-seekers would increasingly find worse jobs and have lower incomes because the population of college-educated job-seekers has become less desirable. GLTs and college preparation likely have similar effects on obtaining high-skilled work and income; this is because high-skilled work is a major determinant of income (Cappelli 2015) and because traits and college preparation should both be rewarded in workplace contexts. If GLTs or college preparation had an effect on income but not occupation, this would result in rising within-occupation inequality, which has not increased steadily over time (Mouw and Kalleberg 2010). However, future research should investigate increasing heterogeneity among college graduates, and whether it could interact with relative education levels.

1995; Slack and Jensen 2008), it may not be able to absorb larger numbers of college-educated individuals in the contemporary labor market. From all perspectives, adding a large number of educated individuals to the queue without a comparable increase in the number of jobs means more people are unable to turn their college degree into skilled work. These individuals are said to be “overeducated” or “underemployed by skill underutilization” (Burris 1983:454; Clogg 1979:9). Thus, academic degrees are subject to inflation in the labor market. Just as an oversupply of money makes each dollar less valuable, an excess of degrees makes each one less important (Collins 2002). Or, as Hirsch (1976:5) says, “If everyone stands on tiptoe, no one sees better.”

Research on skill underutilization suggests this is a special type of labor market mismatch, in which workers have a poor fit with their jobs (Handel 2003). Just as an individual may struggle to find a job close to home, or a job that provides an appropriate number of work hours, obtaining a position that does not fully utilize one’s collegiate skills is a poor outcome (Kalleberg 2008). At the individual level, low-skilled work often results in worse extrinsic and intrinsic rewards for the employee (Kalleberg 2011). Educational mismatch at work also has a scarring effect on employees, so that skill underutilization early in a career hurts subsequent attempts to earn later jobs (Pedulla 2016). Finally, a nation’s economy cannot take advantage of its workers’ skills, keeping the nation below full working capacity and rendering educational training unnecessary (Clogg 1979; Hirsch 1976).

Some recent evidence suggests that the relative education theory is correct, and that college degrees have lost power in the labor market. Overeducation has increased dramatically since 1972, with individuals steadily taking jobs for which they are overqualified (Vaisey 2006). Bol (2015) finds that increases in education have eroded the absolute earning power of college degrees in industrialized nations, Boylan (1993) finds that college-educated workers displace those with a high school diploma from lower-skilled jobs, and Bernstein (2007) argues that sex work has become an avenue for well-educated women to supplement incomes. Finally, newspaper columnists and trade groups show numerous cases where companies increasingly hire workers with college degrees, even for jobs that should not require one (Burning Glass 2014; Rampell 2013). However, the most extensive evidence for the relative education hypothesis in the United States is approximately 40 years old (Berg 1970; Collins 1979; Freeman 1976; but see Brown 1995), with recent research arguing against relative education effects in the United States (Goldin and Katz 2008; Hout 2012).

MONETARY RETURNS TO EDUCATION

Relative education theory is a simple, theoretically robust account of the effects of educational expansion on obtaining skilled work. However, there is a major set of contrary findings: relative education theory suggests that the value of a college degree is on the decline, but evidence shows that the dollar return to college degree has *increased* over the past few decades in the United States (Goldin and Katz 2008). With few exceptions, sociologists largely agree that this evidence refutes relative education theory as it applies to the United States[3] (e.g., Baker 2011; Handel 2003; Hout 2012; Pfeffer and Hertel 2015; Rauscher 2015; for a dissenting view, see Collins 2002).

The primary theory and evidence against the relative education hypothesis in the United States is "skill-biased technological change" (SBTC): growth in educational attainment in the United States led to major technological advances and business productivity starting in the late twentieth century (Goldin and Katz 2008; Liu and Grusky 2013; see also Rauscher 2015), and the sharp increase in the demand for college-educated workers allegedly outstripped the supply of college graduates, leading to a skills shortage in the U.S. labor market (Goldin and Katz 2008; but see Cappelli 2015). The evidence for the hypothesized skills shortage is demonstrated by the increased monetary return to education, which indicates there are not enough skilled workers to fill all the job positions.

Recent research suggests revisions to the SBTC thesis but does not contradict it. Liu and Grusky (2013) demonstrate that the increasing dollar return to education is driven mostly by the increasing return to occupation-level analytic skill; net of skill, education provides only a slightly greater advantage in 2010 than it did in 1985. This finding echoes Mouw and Kalleberg (2010), who find that wage inequality is disproportionately driven by changes to a few occupations, such as managers and computer systems analysts, and that the effect of education has not changed since 1992. Many occupations that supposedly have a shortage of skilled workers—such as STEM fields—have seen no income gains at all (Teitelbaum 2014).

However, there is a flaw in skill-biased technological change theory: it is only valid if changes in wages are primarily due to changes in supply and demand for skills. This is a major problem because increasing income polarization by occupation is due to a large host of factors beyond increased demand for skilled workers (Boylan 1993; Cappelli 2015; Kalleberg 2011). Starting in the 1980s, neoliberal policies favored higher-paid occupations, unions became less powerful and less able to set wages, and the white-collar financial industry began to capture an increasing share of income in the United States (Jacobs and Dirlam 2016; Jacobs and Myers 2014; Kristal and Cohen 2016; Lin 2015; Lin and Tomaskovic-Devey 2013; Tomaskovic-Devey and Lin 2011; Volscho and Kelly 2012). If the United States has shifted toward a winner-take-all economy—where income is highly polarized between good and bad paying jobs (Hacker and Pierson 2010)—being on top of the occupational pyramid is far more lucrative than in the past, and educated workers would stand to benefit.[4]

If relative education theory is correct, then individuals with college degrees are increasingly being shuffled into lower-skill jobs (Hirsch 1976). However, the dramatic increase in monetary returns to certain occupations means that individuals who do obtain high-skill jobs are compensated more than ever before (Liu and Grusky 2013; Mouw and Kalleberg 2010). And because individuals with greater educational credentials often land jobs closer to the top of the occupational hierarchy, the dollar returns to education may rise even as a smaller

[3]Many of these assertions have not been subtle. Baker (2011:10) writes: "[T]he notion of credentialism should be laid to rest so that broader hypotheses about widespread educational credentialing in postindustrial society can be considered." In a similar vein, Hout (2012:391) argues: "As evidence of a true causal effect of education on pay accumulates, the discussions of credentialing, training robbery, and overeducation become irrelevant."

[4]Furthermore, the growth of neoliberal policy in the United States explains why the relative education hypothesis holds in the developed world overall, but not in the United States (Bol 2015).

proportion of college-educated individuals benefit (Boylan 1993; Smith 1986). This logic does not assume that wages are a proxy for demand, as Goldin and Katz (2008) imply: the relationship between the demand for skilled workers and salaries is not only imperfect and limited, but it also varies over time. Although we do not yet know for certain, it is therefore possible that the wage premium is increasing *despite* a glut of college-educated workers.

Furthermore, it is important to note that in the present U.S. economy, a failure to land at the top of the occupational hierarchy poses major problems for workers. Many middle-class occupations have shrunk in the United States due to technological advances, offshoring, and economic restructuring (Kalleberg 2011). In the years following World War II, college-educated workers who failed to translate their degrees into high-skilled work may have been able to find middle-class jobs anyway. However, with stagnant and declining middle-class occupational growth and rapid expansion of the low-skilled service sector, college-educated workers may slide far down the occupational hierarchy in the present economic circumstances.

Studies of the educational wage premium are important, but they cannot disprove the relative education hypothesis, because wages and salaries are governed by institutional forces beyond labor queuing (Hirsch 1976; see also Smith 1986). If analysts wish to evaluate the relative education hypothesis, they should investigate whether college-educated individuals are increasingly likely to take lower-skilled jobs. In particular, we would expect changes in verbal, quantitative, and analytic skill utilization at work, because college directly improves these academic skills that are prized in the job market (Baker 2011).

Formulating Hypotheses

Both SBTC and relative education theory argue that the supply of educated workers and the growth of high-skilled jobs change at different rates. Under the SBTC hypothesis, a shortage of skilled workers would occur as more technological change and economic growth—which is often driven by increasing rates of education—generates a boom in high-skilled jobs (Acemoglu and Autor 2012; Goldin and Katz 2008; Rauscher 2015). With more high-skilled jobs available, college degree-holders will increasingly find it easier to find jobs that require more verbal, quantitative, and analytic skills. This means *as the proportion of college-educated individuals rises, individual degree-holders will end up in jobs that require more cognitive skills*, and the relationship between education and skill utilization will strengthen.

Alternatively, if relative education theory is correct, higher-education expansion will lead to more new college graduates than new highly-skilled jobs, and other factors that lead to the growth of high-skilled jobs will not make up the difference. Because the rate of college graduates increases faster than the rate of skilled jobs, there is more competition for each skilled job. With increased competition, it is harder to obtain highly-skilled work, and the relationship between education and finding skilled work should weaken. Therefore, *as the proportion of college-educated individuals increases across birth cohorts, individuals with college degrees will end up in jobs that require fewer cognitive skills, such as verbal, quantitative, and analytic reasoning capabilities.*

The result of this process is twofold. First, we would expect individuals with college degrees to work in less cognitively demanding jobs when more of their peers have graduated from college. Second, we would expect that as college-educated individuals work less cognitively demanding jobs, the gap in skill utilization between college-educated and non-college-educated workers will narrow. As a result, the advantage of a college degree should decline in both absolute and relative terms: college graduates should find less skilled work compared to previous eras, and college graduates will have less of an advantage in obtaining skilled work.

ACCOUNTING FOR DIFFERENT TEMPORAL AND SEX-BASED TRENDS

Scholars studying changes in the relationship between education and work should be especially sensitive to two analytic issues. First, researchers should remove potential sources of spuriousness across age, period, and cohort (Clogg 1979; Glenn 2003). Second, men and women should be analyzed separately to account for changing male–female gaps in education and occupational participation since 1960 (e.g., Buchmann and DiPrete 2006; England and Li 2006; Reskin and Roos 2009; Tomaskovic-Devey et al. 2006).

Advantages of an Age-Period-Cohort Design

Because individuals who enter the labor force primarily compete against people a few years earlier and later than them, cohort-level education should increase competition and make it harder to obtain skilled work (Easterlin 1987; Freeman 1976; Pampel and Peters 1995; Tenn 2005). Employment outcomes at the start of one's career also affect later work trajectories, so especially tight labor markets and widespread underemployment may scar entire cohorts of workers (Elder 1999; Pedulla 2016). However, other trends across birth cohorts could bias the results and should be accounted for, such as the effects of cohort size on employment opportunities (Easterlin 1987; Slack and Jensen 2008). Because age, period, and cohort are perfectly correlated with each other,[5] *any* time-varying trend that affects changes in skill utilization and is also correlated with educational attainment could lead to spurious results (Clogg 1979; Glenn 2003). Normally, age-period-cohort (APC) models are used to disentangle these effects; these models can be repurposed to partial out spurious age, period, and cohort effects that otherwise may confound the relationship between education and skill utilization.

What are some of the age, period, and cohort changes that could occur at the same time as changes in educational attainment and skill utilization? First, a number of institutional changes to workplaces and the labor market occurred between 1970 and 2010 that affected population-level skill utilization. These include companies' increasing tendency to lay off unwanted workers during robust economies, employer reluctance to retrain workers, and offshoring of jobs to other countries (Cappelli 2015; Kalleberg 2011). These changes, along with macro-level economic booms and busts, have a potential relationship with the growth and loss of certain occupations and therefore affect the total amount of skill utilization (Clogg 1979; McKee-Ryan and Harvey 2011). Institutional and demographic changes also

[5]Period minus age always equals cohort, meaning they form a perfect linear relationship and will always be correlated with each other.

may exert a cohort effect on skill utilization. Workers entering labor markets in the mid-twentieth century benefitted from internal labor markets whereas later cohorts did not, while the especially large baby boom cohorts experienced increased labor market competition for jobs (Easterlin 1987; Slack and Jensen 2008), and curricular changes in K-12 school systems led to different skill sets in later cohorts (Cappelli 2001; Schoenfeld 2007; Slack and Jensen 2008; Thornton 2008). Finally, there should be substantial relationships between age, cohort-level education, and skill utilization. Later cohorts of workers are the most likely to get a college degree, but they are also the youngest and least likely to have advanced far in their careers (Clogg 1979). This gives them less time to accumulate human capital at work, or to advance into mid-career jobs with higher skill requirements. Age-period-cohort models are ideal in this case because they can simultaneously partial out the variance associated with birth cohort size, macro-economic booms and busts, and any other time-varying trend that could bias the results.

In addition, age-period-cohort models can accommodate the changing effects of race, marital status, and region on skill utilization that would otherwise bias the present findings. For example, we would expect that passage of anti-discrimination laws and their implementation in the twentieth century generated cohort differences in the return to education by race (del Río and Alonso-Villar 2015; Dobbin 2009). However, if employer preferences have not become more egalitarian over time (see Quillian et al. 2017), then we should expect to find more African American and Latino workers in under-skilled jobs. Employment outcomes also differ substantively by region and the type of metro area, partially because certain regions have more vibrant economies but also because cost-of-living differences lead to differences in wages (Bishop, Formby, and Thistle 1992; McLaughlin and Perman 1991). Furthermore, it is important to remove variation associated with regional economies that change over time, such as the flight of manufacturing jobs (and their associated skills) to developing countries or other parts of the United States. The age-period-cohort design accommodates these compositional shifts.

Accounting for Sex-Specific Trends

Additionally, any observed change in the relationship between education and labor market outcomes could be due to women's increased prominence in higher-education institutions and the labor force. Sex stratification in relation to higher education and the workplace happens at several distinct points in the life course, including differential access to higher education, different educational and social experiences on campus, and differentiated economic returns to college (Jacobs 1996). Moreover, the sex differentials in occupational attainment and the broad economic benefits of a college education have changed markedly over the past 50 years (Buchmann and DiPrete 2006; England and Li 2006; Tomaskovic-Devey et al. 2006). Put another way, women's educational and labor market experiences are different from men's, and the relationship between women's and men's educational and labor market experiences has evolved over the past 50 years in different ways (Cotter, Hermsen, and Vanneman 2001; Reskin 1993; Reskin, McBrier, and Kmec 1999; Reskin and Roos 2009). Separate models by sex are therefore necessary to capture men's and women's positions in labor market queues and how they change over time.

One major change in sex stratification over the prior 50 years is the dramatic increase in women attending and graduating from college. Historically, U.S. college campuses were dominated by men, but women currently have a slight edge in college completion rates (Buchmann and DiPrete 2006). However, women are still less likely to apply to and attend elite academic institutions (Bielby et al. 2014; Jacobs 1996; Turley, Santos, and Ceja 2007). Furthermore, mass expansion of college education led more women from disadvantaged families to apply to college, but men from those families are less likely to attend college (Buchmann and DiPrete 2006). Thus, women from later birth cohorts are more likely to go to college, but they may also increasingly suffer from disadvantages in family background or institutional prestige.

When women did attend college, they typically majored in female-typed disciplines such as nursing and education. These majors provide less analytic and quantitative skill development but more verbal skill development (for examples, see England and Li 2006). Although differences have not been erased, women today are more likely than before to major in male-typed fields such as business, life sciences, and mathematics (Jacobs 1996; but see England and Li 2006), and they have made progress entering male-dominated, high-skilled workplaces (Baunach 2002; Queneau 2006; Tomaskovic-Devey et al. 2006).

Due to these factors, men’s and women’s trajectories should differ for three main reasons. First, college-educated women should have greater access to high-status jobs today than in the 1970s, which opens up more opportunities to use college degrees in skilled occupations. Second, the increased number of women entering high-skilled work means highly-educated men increasingly have more job market competition from educated men *and* women. Thus, women should have more opportunities today than in the past to partially counteract rising competition, whereas men face a steeper increase in labor market competition as women enter male-typed jobs. This should lead to a greater decline in skill utilization among college-educated men than among women. Third, the demand for female-typed occupations has grown dramatically at the same time that growth in male-typed occupations has plateaued (Cotter et al. 2001; Kalleberg 2011). As a result, women should have less difficulty than men obtaining work as college education rates rise. This trend may be exacerbated by the increasing feminization of previously male-typed working-class occupations, which limits the fallback options for college-educated men who cannot find skilled work (Reskin and Roos 2009).

METHODS

The present study asks whether individuals from better-educated cohorts are pushed into less-skilled work by increasing cohort competition. In contrast to research that uses wages as a proxy for skill utilization, I develop occupational skill ratings using O*NET data alongside a measure of substantive significance to interpret the effect of education on skill utilization as the higher-education system expands. Using the skill ratings and the Annual Social and Economic Supplement from 1971 to 2010, I examine how individuals’ education levels affect skill utilization when education rises in their birth cohort and region net of age, period, cohort, and other demographic trends.

DATA

The Annual Social and Economic Supplement (ASEC)—conducted as part of the Current Population Survey (CPS) every March—is an ideal dataset for this analysis (Flood et al. 2015). The ASEC includes a large number of demographic and occupational variables, repeats them across a long period of time in a comparable way, and is large enough to produce stable results in an APC analysis.[6] The variables in this analysis are all consistently available from 1971 to the present, and thus I use all ASEC data between 1971 and 2010. I exclude part-time workers who prefer part-time work to a full-time job.[7] Individuals who choose part-time work may not necessarily be getting less of a return on their education, in contrast to those who have part-time work because they cannot obtain full-time employment. I also limit the analysis to individuals older than 25, because four-year degree completion usually occurs by then, and I exclude individuals older than 62 because they may move into retirement jobs that are substantially different from their earlier careers.

The detailed occupational codes in ASEC are especially important to this analysis because they allow one to link each employed individual to their likely job tasks. Until 2003, the U.S. Department of Labor used trained, independent raters to assess the skill levels of all occupation categories listed by the U.S. Census. This was published in either the Dictionary of Occupational Titles or the Department of Labor's O*NET database (Boese et al. 2001). With multiple measurements for verbal, quantitative, and analytic skills, the Department of Labor's skill utilization ratings are the most comprehensive database of occupational skills in the United States. They are therefore the best option for large-scale, quantitative analyses of occupational skill in economics and sociology (see Autor and Dorn 2013; Liu and Grusky 2013).

I construct the dependent variable with confirmatory factor analysis to predict verbal, quantitative, and analytic skill factor scores for each occupation (see also Liu and Grusky 2013; Yu and Kuo 2017). The indicators come from the 2003 O*NET database. I follow Boese and colleagues' (2001) recommendation and use a one-year database instead of multiple years; prior analyses show very little change in skill ratings over time (Liu and Grusky 2013). With little change in skills, the findings in this study represent changes in the amount of people entering an occupation, not changes to the jobs themselves.

I estimate factor scores for verbal skills from observed skill ratings for oral comprehension, written comprehension, and written expression; quantitative skills from indicators for mathematics knowledge and mathematical reasoning skill; and analytic skills from measurements of on-the-job learning and complex problem-solving skill. These skill ratings

[6]APC models remove time trends associated with aging, cohort change, and historical changes, all of which could be correlated with rising levels of educational attainment. But because age, period, and cohort together form a perfect linear combination, additional constraints are necessary to identify the model. When coupled with a large number of dummy variables for period and cohort—which, depending on the constraints applied, can number between 18 and 100 before any interactions or other variables are included—APC models become very unstable in smaller samples.

[7]In the Current Population Survey, all participants who worked part-time were asked why they worked part-time. If an individual who wants full-time work cannot get it, then they are getting a lower return on their degree and thus are comparable to full-time workers. However, many respondents stated that they actually preferred a part-time job, which would mean that obtaining a part-time job would actually be a labor market reward in itself. Because this represents a qualitatively different set of job-seeking behavior, I exclude these participants from the analysis.

comprise the dependent variables for the analysis. I then use consistent occupational codes developed by Autor and Dorn (2013) and Dorn (2009) to harmonize job ratings across multiple years. As Liu and Grusky (2013) note, skill is multidimensional; individuals may have high levels of mathematical knowledge but not analytic reasoning, and the same is true of jobs. Therefore, separate measures for each skill level is the best approach. More information on the construction of these variables is located in the Appendix. The skill ratings used in this study are posted at a public research archive and are also in Part C of the online supplement.[8]

To test the relative education and skill-biased technological change hypotheses, I report three sets of independent variables: variables for cohort-level educational attainment, individual-level educational attainment, and an interaction between the two to show how the returns to education change as educational attainment increases across cohorts. I calculate cohort-specific relative education within region and time period (see also Goldin and Katz 2008; Horowitz 2015; Tenn 2005). To reflect different levels of education across the country, I calculate the proportion of individuals with a four-year degree by subdividing the sample into the nine different census regions, subdividing each region by five-year periods, and then calculating the number of individuals with a four-year degree for five-year birth cohorts. This approach captures competition more accurately than would an overall measure of period-based educational attainment, because people are generally in competition with others who are a few years older or younger in a specific labor market (Easterlin 1987; Freeman 1976; Horowitz 2015; Pampel and Peters 1995). All control variables are included in all models.

Figure 1 shows the proportion of individuals who have earned a college degree for each census division over cohorts. There is substantial heterogeneity in educational attainment across different census divisions, although all regions show a secular increase in educational attainment. For example, only 7.3 percent of respondents in the 1915 to 1919 cohort within the East-South Central Division[9] have a four-year college degree; this more than triples to 28.7 percent by the 1980 to 1984 cohort. Change is even more dramatic in the Northeast Division, where the number of respondents with a four-year degree increases more than fourfold, from 10.1 percent in the 1915 to 1919 cohort to 46.8 percent in the 1980 to 1984 cohort. In general, the largest increases came along the Atlantic coast (Northeast, Mid-Atlantic), and the smallest increases came in the western portion of the United States (Pacific, Mountain West).

I use the measure of relative education, dummy variables for educational attainment, and an interaction between the two to identify how the returns to education change as educational attainment rises. I use three dummy variables for educational attainment—completed some college, completed a four-year degree, or earned more education than a four-year degree, with individuals who have completed no college as the reference category. Using dummy variables is the best solution for estimating nonlinear returns to education, because in the United States, degree completion has more substantial effects on job market outcomes than

[8]The skill scores may be accessed in Part C of the online supplement or downloaded at https://dx.doi.org/10.17605/OSF.IO/FNQV7.
[9]This census division consists of Alabama, Kentucky, Mississippi, and Tennessee.

years of education (Bills 2016). I then interact the proportion of individuals with a college degree with the series of dummy variables for education level. Table 1 lists the key independent variables, dependent variables, and additional covariates.

ANALYSIS

I estimate six separate regression models that test the effects of education on verbal, quantitative, and analytic skill utilization, separately for men and for women. The key independent variables are the cohort-, period- and census division–specific proportion of individuals with a four-year degree, and the interaction between educational attainment and the proportion of four-year degree-holders. I also include a large number of additional covariates to partial out potentially spurious explanations. The most important covariates are variables for age, period, and cohort. I operationalize age, period, and cohort using different time scales: I estimate age effects using linear, quadratic, and cubed functional forms; period effects using one-year intervals; and cohort effects using five-year cohort groupings (Yang and Land 2008). Yang and Land (2008:301) refer to this as a “fixed-effects” model, because age and period are treated as dummy variables instead of random effects. However, the term “fixed-effects model” leads to some confusion, because it also describes an econometric regression model that only measures within-unit changes over time (Halaby 2004:514). Thus, some researchers may prefer the term “dummy variable model,” because period and cohort are represented as dummy variables instead of random effects.

It is important to note that there is considerable disagreement over the best way to estimate APC models. To break the linear relationship between age, period, and cohort, a constraint needs to be added to the APC model, which sometimes leads to inconsistent age, period, or cohort estimates (Luo and Hodges 2016; Luo et al. 2016; Yang, Fu, and Land 2004). Although the age, period, and cohort trends in this study are not the primary focus of the analysis, inaccurate estimation of temporal trends could bias the key independent variables. Thus, it is important to demonstrate that the present findings are robust to alternative models for age, period, and cohort. Part A of the online supplement presents five different APC models with different philosophical underpinnings, discusses their strengths and weaknesses, and uses each to evaluate the relative education hypothesis (Harding and Jencks 2003; Luo 2015; Riebler, Held, and Rue 2012; Yang and Land 2008). Different age-period-cohort modeling strategies provide the same support for the hypotheses. The age-period-cohort trends are not the main focus of this article, but readers may find the overall trends useful. For this purpose, I present graphs of age, period, and cohort trends in skill utilization in Part B of the online supplement.

I also include several other dummy variables and interactions to account for other potential demographic changes across cohorts: race (white, black, Hispanic, other); metro area (central city, outside central city, not in a metro area, not identifiable); census division; and marital status (married, never married, separated/widowed/divorced). I also include race–cohort and marital status–cohort interactions. This accounts for changing social conditions that could lead to more or fewer dual-earner couples, as well as accounting for changing anti-discrimination laws and enforcement. Finally, while it is important to capture changes in relative education change across cohorts, features of regional economies may be correlated with absolute education level or historical trends. I therefore include interactions between census division and education level, as well as between census division and time period. Thus, the full regression model is represented by the following equation (Model 1):

$$y = \beta_0 + \beta_1\left(X_{collprop}\right) + \beta_2\left(X_{somecollege}\right) + \beta_3\left(X_{fouryeardegree}\right) + \beta_4\left(X_{morethanfouryears}\right) +$$

$$\beta_5\left(X_{somecollegeXcollprop}\right) + \beta_6\left(X_{fouryeardegreeXcollprop}\right) + \beta_7\left(X_{more4yrsXcollprop}\right) + \beta_8\left(X_{age}\right)$$

$$+ \beta_9\left(X_{age^2}\right) +$$

$$\beta_{10}\left(X_{age^3}\right) + \sum\delta_j\left(D_{year}\right) + \sum\delta_k\left(D_{cohort}\right) + \sum\delta_m\left(D_{marital\ status}\right) + \sum\delta_r\left(D_{race}\right) + \sum\delta_a\left(D_{metroarea}\right) +$$

$$\sum\delta_d\left(D_{censusdivision}\right) + \sum\delta_{km}\left(D_{cohortXmaritalstatus}\right) + \sum\delta_{kr}\left(D_{cohortXrace}\right) + \sum\delta_{de}$$

$$\left(D_{censusdivisionXeducation}\right) +$$

$$\sum\delta_{dj}\left(D_{censusdivisionXyear}\right) + \varepsilon_i$$

Where X represents specific independent variables, β represents a single coefficient, D represents a vector of dummy variables, and δ represents a set of coefficients for each dummy variable. The findings are robust to models with fewer additional covariates, and models with fewer independent variables are available upon request. I conducted all analyses in Stata 13. To further validate the model, I also estimated changes in wages as education levels rise, and I identified similar findings as previous research: in recent birth cohorts, the dollar return to education has increased compared to less-educated individuals' wages.

One of the benefits of this dataset is its size. With over one million men and over 750,000 women, the standard errors are unusually small. This means the estimates in this model are likely to be stable and close to the true population parameters. It also means that nearly every key independent variable is statistically significant at $p < .001$. It is rarely appropriate to interpret statistical significance as an effect size, but this is especially problematic in such a large dataset (Kline 2004). A better solution is to develop standards for "substantive" or "practical" significance to interpret effect sizes (Bernard, Chakhaia, and Leopold 2017).

To develop these standards, I identified the qualitative differences between descriptions of job responsibilities in O*NET and compared them to the quantitative differences in skill utilization in my model.[10] The results of my qualitative analysis suggest it is very difficult to identify gaps between occupations less than .2 points away from each other; thus, differences in skill rating less than .2 points are deemed not substantively meaningful. However, I was able to consistently identify qualitative differences between occupations that were .2 to .4 points apart in skill rating, and jobs that were .4 to 1.0 points apart in skill

[10]I developed these standards using the following coding scheme. First, I sorted the full list of 316 occupations by verbal skill utilization. I then selected an occupation and downloaded the qualitative description of job responsibilities from O*NET. I then read the job descriptions for jobs that had slightly higher and lower verbal skill utilization scores and recorded whether I noticed no difference, some difference, a large difference, or a very large difference in verbal skill utilization. I continued reading job descriptions and recording the qualitative size of the skill difference between jobs until I consistently identified "very large" differences. I repeated this process several times for several different occupations, and then for quantitative and analytic skill utilization.

rating had large qualitative differences. Occupations more than one point apart in quantitative skill rating had dramatically different qualitative task responsibilities. Table 2 presents a selection of occupational titles, skill scores, and qualitative descriptors of job skills.

FINDINGS

Table 3 presents three key sets of covariates from the fixed-effects/dummy-variable models. The first is the proportion of the cohort with a four-year degree. The second are the dummy variables for educational attainment, and each one represents the effect of a certain amount of college compared to not having any college at all. The third are the interactions between a college degree and the college proportion in a given birth cohort—these represent the relative education effect of education on skill utilization. When this coefficient is negative and the others positive, it means the advantages of going to college decline as educational attainment rises. When the coefficient is negative *and* larger than the effect size for college proportion, individuals with college degrees are increasingly ending up in lower-skilled jobs as the proportion of college-educated persons rises. For example, male participants with college experience are more likely to use verbal skills at work than respondents without college experience, shown by the positive and statistically significant dummy variables for some college, four-year degree, and more than a four-year degree. The positive and statistically significant effect of college proportion shows that as the number of college-educated individuals increases over birth cohorts, so does the verbal skill utilization of workers with no college degree. Finally, the interaction terms between education level and college proportion are all negative; thus, although individuals with college experience use verbal skills more than those without a college background do, this advantage declines as the proportion of college-educated individuals increases.

The findings across all six fixed-effects/dummy-variable models are listed in Table 3, and they are broadly similar across men and women, as well as across all three skill domains. Individuals with college degrees utilize more skills on the job than do those without any college, but the interaction between education level and college proportion is negative in nearly all cases, indicating that individuals with college degrees lose their advantages over those without a college degree when there are relatively more of them.[11] Additionally, in most cases the interaction between education level and college proportion is negative *and* larger than the skill level increases for all workers; generally speaking, individuals with college degrees are taking less-skilled jobs as cohort-level education rises.[12] In other words, greater education generally leads to more skill usage, but this effect weakens when more people earn college degrees. This finding is consistent with the relative education hypothesis and inconsistent with skill-biased technological change.

[11]The only exception is that men with more than a four-year degree do not use any more or less quantitative skills as college proportion increases; it is the only non-significant coefficient in Table 3.

[12]One exception is women with a four-year degree, who are using approximately the same amount of quantitative skills as in the past. This is because the education by college proportion interaction (−.384) is approximately the same size as the coefficient for college proportion (.398).

There are two ways to interpret the effect of education on skill utilization. An “absolute” interpretation and a “contextual” or “gap” interpretation. To make each interpretation clearer, I show how the relationship between education and skill utilization depends on the proportion of college degree-holders for a hypothetical job occupant, holding all other variables constant. I assume that the hypothetical individual is 27 years old; this is because the effects of an overcrowded labor market should be most apparent as individuals are transitioning into the labor force. I also assume the individual lives in 1999 within a central city in the Mid-Atlantic census division and is white and married. Changing these characteristics alters the overall predicted skill levels by shifting the intercept up or down, but it does not change the interaction between individual educational attainment and relative education levels, which is the primary concern. The only independent variable that changes is the proportion of college-educated individuals, which is defined from 8 to 40 percent, because this is the approximate range in the present data.[13] Individuals who belong to cohorts with a low percentage of college-educated individuals—about 8 percent—were largely born prior to 1930. Individuals who belong to cohorts with high rates of college completion—around 40 percent—were almost entirely born in 1975 or later.

The “absolute” interpretation judges whether individuals with college degrees end up in less-skilled jobs as cohort competition increases. Figure 2 shows the absolute decline in skill utilization that occurs as the proportion of college-educated individuals increases, while Table 4 shows the difference in skill utilization in cohorts that are 8 percent versus 40 percent college-educated; the table also lists guidelines for interpreting changes in skill levels. Generally speaking, most of the declines in skill utilization are noticeable but not especially large—in the range of .2 to .4 point declines. For example, our hypothetical man with a college degree loses .32 points for verbal skill utilization, and this drop in verbal skill utilization is roughly the difference between a news reporter and a librarian; between a librarian and a clergy member; or between a physical therapist and a bank teller. The decline in verbal skill utilization for the hypothetical woman with a college degree is slightly smaller (−.22 points). This is roughly the difference in verbal skill utilization from a middle school teacher to a physical therapist; from a secretary[14] to a social worker; or from a social worker to a customer service representative.

Overall, in the present simulation, men with four-year degrees have noticeable but moderate declines in verbal and quantitative skill utilization, and women with four-year degrees have similar declines in verbal and analytic skill utilization. The largest decline is for men’s analytic skill utilization, which declines .45 points as the proportion of the college-educated population increases from 8 to 40 percent. Skill differences between .2 and .4 points are noticeable, but a skill difference between .4 and 1.0 is substantively larger. For example, the .45 decline in analytic skill utilization is about the same as the decline from an actuary to a middle school teacher; from a budget analyst to a news reporter; or from a physical therapist to a clergy member. In this scenario, there is no decline in quantitative skill utilization for women with college degrees; women with four-year degrees are just as likely

[13]The full range is from 2.2 to 48.7 percent, but very few cohort-period-region combinations are below 8 percent or above 40 percent.

[14]Secretarial positions require substantial verbal skills, despite the stigma attached to them as pink-collar jobs.

to utilize quantitative skills in well-educated cohorts as in cohorts with less educational attainment.

It is important to note that the results in Figure 2 are due to both uneven growth across different types of occupations and the skills of the college-educated population. Specifically, the decline in analytic skill utilization is larger than for verbal and quantitative skills, which suggests either too many analytically skilled workers or too few analytically-oriented jobs. Because Liu and Grusky (2013) report more growth in analytic skill usage than in verbal or quantitative usage, this is likely due to an oversupply of analytic skill.

The second way of determining how much the effect of education on skill utilization has declined is a "contextual" or "gap" interpretation. This approach involves predicting the skill utilization gap between college-educated and non-college-educated workers in low-education cohorts, and then comparing it to the same gap in high-education cohorts. The contextual interpretation demonstrates how the advantage of a college degree changes as the proportion of college-educated individuals rises over birth cohorts. Diminishing advantages in skill utilization can reflect either a rise in skill utilization among low-education workers, a decline in skill utilization among high-education workers, or both.

In Figure 3, I graph the skill-utilization advantage under the assumption that 8 percent and 40 percent of a participant's birth cohort is college-educated; Table 4 shows the gap differences. The first finding is that although hypothetical male and female college-educated workers are using fewer verbal skills at work as the proportion of college-educated individuals rises, there has also been a small increase in verbal skill utilization for individuals without college degrees. The result is that while the absolute declines in skill utilization for four-year degree-holders are only moderate, the decline in the *advantage* over non-college-educated workers is substantively larger. The approximate .5 point decline in verbal skill utilization for both men and women is equivalent to the difference between librarians and physical therapists, or from a middle school teacher to a bank teller. Similarly, although the increase in quantitative skill usage for our hypothetical non-college-educated man is below .2, the gap between the college-educated and non-college-educated man declines by −.38, which is a noticeable and moderate decline. This is approximately the difference between an accountant and an insurance underwriter, or the difference between insurance underwriters and middle school teachers.[16]

Finally, holding constant other factors, there is a relatively large decline in the amount of analytic tasks that college-educated workers perform as the share of college-educated individuals grows, which is combined with an increase in analytic skill usage by the non-college-educated. The result is that the gap between four-year degree-holders' and non-college-educated persons' analytic skill usage shrinks by approximately .6 for men and women. A .6 change in analytic skill usage is substantively large. At the lower end of the scale, it is the difference between the analytic skill usage of a customer service representative and a grounds maintenance worker. Among occupations with more analytic

[16]On the other hand, the difference in quantitative skill usage between college-educated and non-college-educated women is not substantively meaningful.

skill requirements, it is larger than the difference between occupational therapists and customer service representatives; larger than the gap between middle school teachers and secretaries; and larger than the gap between budget analysts and news reporters. In other words, as college education rises, workers with no college degree are entering occupations with more analytic skill requirements concurrently with college-educated individuals entering less analytically-oriented occupations. The result is that the advantage a college-educated individual has in analytic skill utilization declines as cohorts become better-educated.

That said, it is important to note that despite the decline in the advantage of a college degree, individuals who earn a college degree still take more skilled jobs than do those with no college experience. For example, if 40 percent of the cohort-specific population has a college degree, men with college degrees have a 1.3-point advantage in analytic skill utilization compared to men without any college experience. This is substantively very large; it is approximately the difference between an insurance underwriter and a tool and die maker; or the difference between a librarian and an automotive mechanic. However, although the present findings indicate that a college degree still provides a large advantage in the labor market today, further increases in the rate of college completion may continue to erode the relative advantage of a college degree.

One key question is whether men and women have similar levels of skill utilization, and whether this changed at the same time as education rose in the population. The tables and figures presented here suggest that the relationship between education and skill utilization at work varies across skill domain and sex and is consistent with sex-specific differences in college major choice and occupational sex segregation. Figure 2 shows that men with college degrees have greater overall quantitative and analytic skill usage holding all other variables constant, and women have higher verbal skill-utilization at work. This is due to men’s over-representation in STEM majors, as well as long-standing skill differences between traditional male- and female-typed occupations.

Men do utilize more quantitative and analytic skills at work than women, but Figure 2 shows that college-educated men’s skill utilization declines faster than women’s skill utilization, net of other demographic and temporal differences. This is likely because (1) more college-educated women entered male-typed occupations and (2) there was a large increase in the demand for female-typed labor at the same time as higher education expanded. Being able to join more skilled labor queues increases women’s skill utilization, so college-educated women’s increased competition is partially offset by increased opportunities. Furthermore, declining occupational sex segregation creates more competition for men, shuffling even more college-educated men into less-skilled jobs and leading to a steeper decline in skill utilization. However, it is important to note that although educational expansion is likely correlated with sex desegregation in collegiate major and occupation, it is quite possible that they have separate and independent effects on sex-specific labor queues.

DISCUSSION

In the present study, I use ASEC data and skill ratings derived from O*NET to test the relative education hypothesis, investigating whether college degree-holders increasingly find themselves in lower-skilled jobs as more of their peers attend college. The findings support the hypothesis that as educational attainment rises in the population, individuals with college degrees are increasingly shuffled into lower-skilled jobs. The hypothesis holds across verbal, quantitative, and analytic skill utilization; in both male and female samples; and is net of all confounders from age, period, and cohort trends, as well as other demographic and geographic changes to the labor force.

Previous research failed to find this effect because it tested for gaps in wages instead of directly measuring skill utilization. Prior researchers have argued that because wages and demand for skills are correlated, increasing dollar returns to education means workers are utilizing their skills at work. But the relationship between wages and skills is not constant over time, and the dollar return to education reflects both the demand for skills and institutional factors (Cappelli 2015; Hirsch 1976; Kalleberg 2011). The result is that even though more college-educated individuals are being squeezed into less-skilled work, the large gains made by workers at the top of the occupational pyramid can counterbalance and sometimes outweigh the losses of those who cannot find work appropriate for their skills. At the same time, college-educated individuals who cannot find skilled work have fewer palatable options. There are fewer middle-class and middle-skilled jobs today compared with low-skilled service jobs (Kalleberg 2011), meaning that college-educated workers who cannot find skilled jobs are likely to find menial service jobs instead.

Future researchers could extend these findings in several ways. For example, positional crowding likely has the largest effects on less prestigious bachelor's degrees. Alumni of schools like Harvard and Stanford continue to differentiate themselves on the job market (Rivera 2011), and expansion of less prestigious universities may produce workers who are less attractive to employers. Additionally, not all academic disciplines have grown proportionally with the expansion of the university, and it is possible that the proliferation of certain majors (e.g., psychology or political science) is more important than the total number of college degrees; it is theoretically possible to have an oversupply of physicists but an undersupply of chemists. Future research should also investigate the geographic variation in underemployment by skills, because there is evidence that overeducation is often most severe in areas with universities (Davia, McGuinness, and O'Connell 2017). There is likely substantial heterogeneity within the college-educated workforce, and this heterogeneity could affect both occupation-level skill utilization and income. Furthermore, mismatch by university prestige, academic major, geography, and the interactions between them may lead to much greater underemployment in specific areas or within certain occupations, and may partially explain wage increases in a few occupations.

In addition to the study of labor market mismatch, this study points to four new research directions. First, the findings suggest that institutional factors, rather than skill-biased technological changes, are the driving factors behind wage and salary changes. There is no doubt that there have been increasing monetary returns to education over the past few years,

[17] with increasing income polarization between "good" and "bad" jobs (Kalleberg 2011; Mouw and Kalleberg 2010). However, the proposed mechanism for this increase is that high-skilled jobs have expanded faster than the rate of college graduates, which meant young adults entering the labor force increasingly found more skilled work (Goldin and Katz 2008). My findings here demonstrate that individuals with college degrees are *not* moving into more skilled work as overall education increases; in fact, they are entering lower-skilled work. This means the wage premium to education is increasing *despite* increased competition, and not becauseit declined. This runs counter to theories of skill-biased technological change, and it re-opens the question of why college-educated workers suddenly began earning more money.

If college-educated workers are not in greater demand today for their cognitive skills, what caused the monetary returns to education to dramatically increase? The answer is beyond the scope of this study. However, the most likely factors are three institutional effects on income polarization, which are especially pronounced in the United States and which could counteract relative education effects on income seen in other countries (Bol 2015; Cappelli 2015; Kalleberg 2011). First, labor unions play a critical role in setting wage standards across industries and the country, and the weakness of unions has led to increased inequality as the economy has expanded (Brady, Baker, and Finnigan 2013; Jacobs and Myers 2014; Kristal and Cohen 2016; Volscho and Kelly 2012; Western and Rosenfeld 2011). Second, the deregulation of the financial industry has led to dramatic income increases in the white-collar financial sector, creating large inequalities in wealth and income (Lin 2015: Lin and Tomaskovic-Devey 2013; Tomaskovic-Devey and Lin 2011; Volscho and Kelly 2012). Third, there is evidence that neoliberal policies widened income inequality, with a greater share of income going to a smaller segment of the population (Jacobs and Dirlam 2016; Volscho and Kelly 2012). None of these explanations are perfect; some research suggests that the effects of labor unions on income inequality are independent of the returns to education (e.g., Kristal and Cohen 2016; Western and Rosenfeld 2011), and the mechanism connecting conservative politics to income shares is not well-specified. However, these changes likely increase between-occupation wage inequality, and they could easily explain the apparent increases in the return to analytic skill and to white-collar management (Liu and Grusky 2013; Mouw and Kalleberg 2010). Future research should directly test for institutional mechanisms that connect occupations and wage inequality, net of decreasing skill utilization in the labor market.

Second, researchers should refine the present analyses to distinguish between skill utilization at the beginning and end of the work career, which is beyond the scope of the present study. We might expect that individuals entering a highly competitive labor market would also struggle to improve their prospects later in life (Elder 1999). It is possible that using few work skills early in one's career might lead to cumulative disadvantage. Early work skills help develop future job prospects, so individuals who enter low-skill jobs early in their careers may not develop the human capital to move into higher-skill jobs later in life. Alternatively, cohort competition might be most pronounced when individuals enter the

[17]Using the analysis described in the Analysis section, I also estimated whether education's effect on income has declined or increased, and I found similar patterns to those reported in other publications (e.g., Fischer and Hout 2006; Goldin and Katz 2008).

labor market and do not yet have work histories. Further research on this topic could help us understand whether overcrowded labor markets “scar” entire cohorts of workers for the remainder of their careers (Pedulla 2016), or whether the effects gradually dissipate as workers obtain more experience and their labor market competition changes.

Third, the present study shows that the returns to education over time differ somewhat by sex. College-educated women show no substantive decline in quantitative skill utilization at work, and they are penalized less by relative education effects in other skill domains. Based on previous research, sex differences in the education–skill relationship are likely at least partially due to declining sex segregation by academic major and occupation (Jacobs 1996; Reskin and Roos 2009). Women’s increased ability to move into high-status professions would create more competition for men at the same time that it improves women’s task responsibilities. However, I do not test this proposed explanation in this study. Future research should explicitly test for the relationship between higher-education expansion, sex desegregation, and the shape of sex- and education-specific labor queues; these processes may be causally linked, or could operate independently of each other.

Fourth, the present study shows the need to further research the returns to a college degree and occupation across different life domains. As Hermanowicz (2010) demonstrates, individuals spend an extraordinary amount of time at work, and thus our jobs affect us in a variety of different ways. Jobs help structure our social lives, affect our health, impact our happiness, and place limits on our free time (Horowitz 2016). In theory, as individuals obtain more education, they should obtain better jobs and therefore have better social outcomes. If individuals with college degrees are being squeezed into less desirable jobs, then the social returns to education should also decline. For example, there is increasing evidence that the civic returns to education have dropped as more individuals earn college degrees (Campbell 2009; Horowitz 2015; Nie, Junn, and Stehlik-Barry 1996). However, because education leads to less complex jobs but results in more money, the social returns to education could vary substantially by outcome. Future research is needed to disentangle the effects of education, income, and task responsibilities on outcomes such as marriage and divorce, social networks and social capital, and health. At a more general level, sociologists should include positional measures of education in their research. Few sociologists believe that education is an absolute good across contexts, yet research that looks at time-varying effects of education is rare (Shavit and Park 2016).

Finally, the current study highlights the question: Is sending more students to college a viable strategy to reduce inequality? Economists suggest that sending more individuals to college leads to concrete technological advances and economic growth (Acemoglu and Autor 2012; Goldin and Katz 2008). From this perspective, sending more high school students to college is justified. However, this study confirms that even as the average dollar return to college increases, college-educated workers are less likely to enter the highly-skilled jobs that take advantage of this increased monetary return. Although the number of high-skilled jobs is not fixed, it is also not infinite and is likely outstripped by the supply of well-educated adults entering the labor force.

Of course, it is still rational to encourage individual students to complete college. Hout (2012) convincingly points out that sending an *individual* to college improves that person's life outcomes, and the present study shows college degrees are still worth a substantial amount in the job market. But absent a much larger increase in high-skilled work, sending *everyone* to college guarantees that more college-educated workers end up in less-skilled work, and there is no guarantee that a college degree will retain its value if enrollment continues to rise. Put another way, sending more people to college to improve their life circumstances leads to diminishing returns for occupational advancement, and it is not an ideal intervention to reduce population-level inequality. Or, as Hirsch (1976:5) argues: "If everyone stands on tiptoe, no one sees better."

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

I would like to express thanks to Barbara Entwisle, Arne Kalleberg, Kenneth T. Andrews, Colin Campbell, Ted Mouw, and Jessica Pearlman for their advice and feedback. I also would like to thank the editors and four anonymous reviewers who provided a number of helpful suggestions and critiques. Furthermore, I thank Liying Luo and Claire Y. Yang for ongoing discussions about best practices in cohort analysis. Finally, I would like to thank David Autor and David Dorn for harmonizing occupational coding schemes across years, and for sharing this data on their websites. The occupation skill scores used in this study may be found in Part C of the online supplement or at the following link: https://dx.doi.org/10.17605/OSF.IO/FNQV7.

Funding

This research received support from the Population Research Training grant (T32 HD007168) and the Population Research Infrastructure Program (P2C HD050924) awarded to the Carolina Population Center at The University of North Carolina at Chapel Hill by the National Institute of Child Health and Human Development.

References

AcemogluDaron, AutorDavid. What Does Human Capital Do? A Review of Goldin and Katz's *The Race between Education and Technology*. Journal of Economic Literature. 2012; 50(2):426–63.

AutorDavid H. Skills, Education, and the Rise of Earnings Inequality among the 'Other 99 Percent'. Science. 2014; 344(6186):843–51. DOI: 10.1126/science.1251868 [PubMed: 24855259]

AutorDavid H, , DornDavid. The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market. American Economic Review. 2013; 103(5):1553–97.

BakerDavid P. Forward and Backward, Horizontal and Vertical: Transformation of Occupational Credentialing in the Schooled Society. Research in Social Stratification and Mobility. 2011; 29(1): 5–29. DOI: 10.1016/j.rssm.2011.01.001

BaunachDawn Michelle. Trends in Occupational Sex Segregation and Inequality, 1950 to 1990. Social Science Research. 2002; 31(1):77–98. DOI: 10.1006/ssre.2001.0719

BergIvar E. Education and Jobs: The Great Training RobberyNew York: Praeger Publishers; 1970

BernardFabrizio, ChakhaiaLela, LeopoldLiliya. 'Sing Me a Song with Social Significance': The (Mis)Use of Statistical Significance Testing in European Sociological Research. European Sociological Review. 2017; 33(1):1–15. DOI: 10.1093/esr/jcw047

BernsteinElizabeth. Sex Work for the Middle Classes. Sexualities. 2007; 10(4):473–88.

BielbyRob, PosseltJulie Renee, JaquetteOzan, BastedoMichael N. Why Are Women Underrepresented in Elite Colleges and Universities? A Non-Linear Decomposition Analysis. Research in Higher Education. 2014; 55(8):735–60. DOI: 10.1007/s11162-014-9334-y

BillsDavid B. Congested Credentials: The Material and Positional Economies of Schooling. Research in Social Stratification and Mobility. 2016; 43:65–70. DOI: 10.1016/j.rssm.2016.03.002

BishopJohn A, , FormbyJohn P, , ThistlePaul D. Explaining Interstate Variation in Income Inequality. The Review of Economics and Statistics. 1992; 74(3):553–57. DOI: 10.2307/2109501

BoeseRon, LewisPhil, FrugoliPam, LitwinKaren. Summary of O*Net 4.0 Content Model and DatabaseNational Center for O*NET Development; 2001

BolThijs. Has Education Become More Positional? Educational Expansion and Labour Market Outcomes, 1985–2007. Acta Sociologica. 2015; 58(2):105–120. DOI: 10.1177/0001699315570918

BoylanRoss D. The Effect of the Number of Diplomas on Their Value. Sociology of Education. 1993; 66(3):206–221. DOI: 10.2307/2112737

BradyDavid, BakerRegina S, , FinniganRyan. When Unionization Disappears: State-Level Unionization and Working Poverty in the United States. American Sociological Review. 2013; 78(5):872–96.

BrownDavid K. Degrees of Control: A Sociology of Educational Expansion and Occupational CredentialismNew York: Teachers College Press; 1995

BrownDavid K. The Social Sources of Educational Credentialism: Status Cultures, Labor Markets, and Organizations. Sociology of Education. 2001; 74:19–34. DOI: 10.2307/2673251

BuchmannClaudia, DiPreteThomas A. The Growing Female Advantage in College Completion: The Role of Family Background and Academic Achievement. American Sociological Review. 2006; 71(4):515–41.

Burning GlassMoving the Goalposts: How Demand for a Bachelor's Degree Is Reshaping the WorkforceBoston, MA: Buring Glass; 2014(https://www.burning-glass.com/wp-content/uploads/Moving_the_Goalposts.pdf)

BurrisVal. The Social and Political Consequences of Overeducation. American Sociological Review. 1983; 48(4):454–67. DOI: 10.2307/2117714

CampbellDavid E. Civic Engagement and Education: An Empirical Test of the Sorting Model. American Journal of Political Science. 2009; 53(4):771–86. DOI: 10.1111/j.1540-5907.2009.00400.x

CappelliPeter H. Assessing the Decline of Internal Labor Markets. In: BergI, , KallebergAL, editorsSourcebook of Labor MarketsBoston, MA: Springer; 2001207245

CappelliPeter H. Skill Gaps, Skill Shortages, and Skill Mismatches: Evidence and Arguments for the United States. ILR Review. 2015; 68(2):251–90. DOI: 10.1177/0019793914564961

CloggClifford C. Measuring UnderemploymentNew York: Academic; 1979

CollinsRandall. The Credential Society: An Historical Sociology of Education and StratificationNew York: Academic Press; 1979

CollinsRandall. Credential Inflation and the Future of Universities. In: BrintS, editorThe Future of the City of Intellect: The Changing American UniversityStanford, CA: Stanford University Press; 20022346

CotterDavid A, , HermsenJoan M, , VannemanReeve. Women's Work and Working Women: The Demand for Female Labor. Gender and Society. 2001; 15(3):429–52.

DaviaMaria A, , McGuinnessSeamus, O'ConnellPhilip J. Determinants of Regional Differences in Rates of Overeducation in Europe. Social Science Research. 2017; 63(Supplement C):67–80. DOI: 10.1016/j.ssresearch.2016.09.009 [PubMed: 28202157]

del RíoCoral, Alonso-VillarOlga. The Evolution of Occupational Segregation in the United States, 1940–2010: Gains and Losses of Gender–Race/Ethnicity Groups. Demography. 2015; 52(3):967–88. DOI: 10.1007/s13524-015-0390-5 [PubMed: 25951798]

Di StasioValentina. Who Is Ahead in the Labor Queue? Institutions' and Employers' Perspective on Overeducation, Undereducation, and Horizontal Mismatches. Sociology of Education. 2017; 90(2):109–26. DOI: 10.1177/0038040717694877

DobbinFrank. Inventing Equal OpportunityPrinceton, NJ: Princeton University Press; 2009

DornDavid. PhD dissertationGraduate School of Business Administration, Economics, Law and Social Sciences, University of St. Gallen; Switzerland: 2009Essays on Inequality, Spatial Interaction, and the Demand for Skills.

EasterlinRichard A. Birth and Fortune: The Impact of Numbers on Personal WelfareChicago: University of Chicago Press; 1987

ElderGlen H. Children of the Great Depression: Social Change in Life ExperienceBoulder, CO: Westview Press; 1999

EnglandPaula, LiSu. Desegregation Stalled: The Changing Gender Composition of College Majors, 1971–2002. Gender & Society. 2006; 20(5):657–77. DOI: 10.1177/0891243206290753

FischerClaude S, , HoutMichael. Century of Difference: How America Changed in the Last One Hundred YearsNew York: Russell Sage Foundation Publications; 2006

FloodSarah, KingMiriam, RugglesSteven, Robert WarrenJ. Integrated Public Use Microdata Series, Current Population Survey: Version 4.0Minneapolis: University of Minnesota; 2015

FreemanRichard B. The Overeducated AmericanNew York: Academic Press; 1976

GlennNorval D. Distinguishing Age, Period, and Cohort Effects. In: MortimerJT, , ShanahanMJ, editorsHandbook of the Life CourseNew York: Springer Science; 200346576

GoldinClaudia D, , KatzLawrence F. The Race between Education and TechnologyCambridge, MA: Belknap Press; 2008

GoldthorpeJohn H. The Role of Education in Intergenerational Social Mobility: Problems from Empirical Research in Sociology and Some Theoretical Pointers from Economics. Rationality and Society. 2014; 26(3):265–89. DOI: 10.1177/1043463113519068

GoyetteKimberly A. College for Some to College for All: Social Background, Occupational Expectations, and Educational Expectations over Time. Social Science Research. 2008; 37(2):461–84. DOI: 10.1016/j.ssresearch.2008.02.002 [PubMed: 19069055]

HackerJacob S, , PiersonPaul. Winner-Take-All Politics: Public Policy, Political Organization, and the Precipitous Rise of Top Incomes in the United States. Politics & Society. 2010; 38(2):152–204. DOI: 10.1177/0032329210365042

HalabyCharles N. Panel Models in Sociological Research: Theory into Practice. Annual Review of Sociology. 2004; 30:507–544. DOI: 10.1146/annurev.soc.30.012703.110629

HandelMichael J. Skills Mismatch in the Labor Market. Annual Review of Sociology. 2003; 29:135–65.

HardingDavid J, , JencksChristopher. Changing Attitudes toward Premarital Sex: Cohort, Period, and Aging Effects. The Public Opinion Quarterly. 2003; 67(2):211–26.

HermanowiczJoseph C. Lives in Science: How Institutions Affect Academic CareersChicago: University of Chicago Press; 2010

HirschFred. Social Limits to GrowthCambridge, MA: Harvard University Press; 1976

HorowitzJonathan. Doing Less with More: Cohorts, Education, and Civic Participation in America. Social Forces. 2015; 94(2):747–74. DOI: 10.1093/sf/sov065

HorowitzJonathan. Dimensions of Job Quality, Mechanisms, and Subjective Well-Being in the United States. Sociological Forum. 2016; 31(2):419–40. DOI: 10.1111/socf.12251

HoutMichael. Social and Economic Returns to College Education in the United States. Annual Review of Sociology. 2012; 38(1):379–400. DOI: 10.1146/annurev.soc.012809.102503

JacobsDavid, DirlamJonathan C. Politics and Economic Stratification: Power Resources and Income Inequality in the United States. American Journal of Sociology. 2016; 122(2):469–500. DOI: 10.1086/687744

JacobsDavid, MyersLindsey. Union Strength, Neoliberalism, and Inequality: Contingent Political Analyses of U.S. Income Differences since 1950. American Sociological Review. 2014; 79(4):752–74.

JacobsJerry A. Gender Inequality and Higher Education. Annual Review of Sociology. 1996; 22:153–85.

KallebergArne L. The Mismatched Worker: When People Don't Fit Their Jobs. Academy of Management Perspectives. 2008; 22(1):24–40.

KallebergArne L. Good Jobs, Bad Jobs: The Rise of Polarized and Precarious Employment Systems in the United States, 1970s–2000sNew York: Russell Sage Foundation; 2011

KlineRex. Beyond Significance Testing: Reforming Data Analysis Methods in Behavioral ResearchWashington, DC: American Psychological Association; 2004

KristalTali, CohenYinon. The Causes of Rising Wage Inequality: The Race between Institutions and Technology. Socio-Economic Review. 2016; 15(1):187–212.

LinKen-Hou. The Financial Premium in the US Labor Market: A Distributional Analysis. Social Forces. 2015; 94(1):1–30. DOI: 10.1093/sf/sou132

LinKen-Hou, Tomaskovic-DeveyDonald. Financialization and U.S. Income Inequality, 1970–2008. American Journal of Sociology. 2013; 118(5):1284–1329. DOI: 10.1086/669499

LiuYujia, GruskyDavid B. The Payoff to Skill in the Third Industrial Revolution. American Journal of Sociology. 2013; 118(5):1330–74. DOI: 10.1086/669498

LuoLiying. PhD dissertationDepartment of Sociology, University of Minnesota; Minneapolis, MN: 2015Age-Period-Cohort Analysis: Critiques and Innovations.

LuoLiying, HodgesJames S. Block Constraints in Age–Period–Cohort Models with Unequal-Width Intervals. Sociological Methods & Research. 2016; 45(4):700–726. DOI: 10.1177/0049124115585359

LuoLiying, HodgesJames, WinshipChristopher, PowersDaniel. The Sensitivity of the Intrinsic Estimator to Coding Schemes: Comment on Yang, Schulhofer-Wohl, Fu, and Land. American Journal of Sociology. 2016; 122(3):930–61. DOI: 10.1086/689830

McKee-RyanFrances M, , HarveyJaron. ‘I Have a Job, But … ’: A Review of Underemployment. Journal of Management. 2011; 37(4):962–96. DOI: 10.1177/0149206311398134

McLaughlinDiane K, , PermanLauri. Returns vs. Endowments in the Earnings Attainment Process for Metropolitan and Nonmetropolitan Men and Women. Rural Sociology. 1991; 56(3):339–65. DOI: 10.1111/j.1549-0831.1991.tb00438.x

MouwTed, KallebergArne L. Occupations and the Structure of Wage Inequality in the United States, 1980s to 2000s. American Sociological Review. 2010; 75(3):402–431.

NieNorman H, , JunnJane, Stehlik-BarryKenneth. Education and Democratic Citizenship in AmericaChicago: University of Chicago Press; 1996

PampelFred C, , Elizabeth PetersH. The Easterlin Effect. Annual Review of Sociology. 1995; 21(1): 163–94. DOI: 10.1146/annurev.so.21.080195.001115

PedullaDavid S. Penalized or Protected? Gender and the Consequences of Nonstandard and Mismatched Employment Histories. American Sociological Review. 2016; 81(2):262–89. DOI: 10.1177/0003122416630982 [PubMed: 27182069]

PfefferFabian T, , HertelFlorian R. How Has Educational Expansion Shaped Social Mobility Trends in the United States? Social Forces. 2015; 94(1):143–80.

QueneauHervé. Is the Long-Term Reduction in Occupational Sex Segregation Still Continuing in the United States? The Social Science Journal. 2006; 43(4):681–88. DOI: 10.1016/j.soscij. 2006.08.019

QuillianLincoln, PagerDevah, HexelOle, MidtbøenArnfinn H. Meta-Analysis of Field Experiments Shows No Change in Racial Discrimination in Hiring over Time. Proceedings of the National Academy of Sciences. 2017; 114(41):10870–75.

RampellCatherine. It Takes a B.A. To Find a Job as a File Clerk. New York Times. 2013 Feb 19.

RauscherEmily. Educational Expansion and Occupational Change: US Compulsory Schooling Laws and the Occupational Structure 1850–1930. Social Forces. 2015; 93(4):1397–1422.

ReskinBarbara. Sex Segregation in the Workplace. Annual Review of Sociology. 1993; 19(1):241–70. DOI: 10.1146/annurev.so.19.080193.001325

ReskinBarbara F, , McBrierDebra B, , KmecJulie A. The Determinants and Consequences of Workplace Sex and Race Composition. Annual Review of Sociology. 1999; 25:335–61.

ReskinBarbara F, , RoosPatricia A. Job Queues, Gender Queues: Explaining Women’s Inroads into Male OccupationsPhiladelphia, PA: Temple University Press; 2009

RieblerAndrea, HeldLeonhard, RueHåvard. Estimation and Extrapolation of Time Trends in Registry Data: Borrowing Strength from Related Populations. Annals of Applied Statistics. 2012; 6(1):304–333.

RiveraLauren A. Ivies, Extracurriculars, and Exclusion: Elite Employers' Use of Educational Credentials. Research in Social Stratification and Mobility. 2011; 29(1):71–90. DOI: 10.1016/j.rssm.2010.12.001

RosenbaumJames E. Beyond College for All: Career Paths for the Forgotten HalfNew York: Russell Sage Foundation; 2001

SchoenfeldAlan H. Problem Solving in the United States, 1970–2008: Research and Theory, Practice and Politics. ZDM. 2007; 39(5):537–51. DOI: 10.1007/s11858-007-0038-z

ShavitYossi, ParkHyunjoon. Introduction to the Special Issue: Education as a Positional Good. Research in Social Stratification and Mobility. 2016; 43:1–3. DOI: 10.1016/j.rssm.2016.03.003

SlackTim, JensenLeif. Birth and Fortune Revisited: A Cohort Analysis of Underemployment, 1974–2004. Population Research and Policy Review. 2008; 27(6):729–49. DOI: 10.1007/s11113-008-9091-8

SmithHerbert L. Overeducation and Underemployment: An Agnostic Review. Sociology of Education. 1986; 59(2):85–99. DOI: 10.2307/2112434

SnyderThomas D, , de BreyCristobal, DillowSally A. Digest of Education Statistics 2016National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education; Washington, DC: 2018

SpenceMichael. Job Market Signaling. Quarterly Journal of Economics. 1973; 87(3):355–74. DOI: 10.2307/1882010

TeitelbaumMichael S. Falling Behind? Boom, Bust, and the Global Race for Scientific TalentPrinceton, NJ: Princeton University Press; 2014

TennSteven. An Alternative Measure of Relative Education to Explain Voter Turnout. Journal of Politics. 2005; 67(1):271–82.

ThorntonStephen J. Continuity and Change in Social Studies Curriculum. In: LevstikLS, , TysonCA, editorsHandbook of Research in Social Studies EducationNew York: Routledge; 20081532

ThurowLester C. Generating InequalityLondon, UK: Macmillan London; 1976

Tomaskovic-DeveyDonald, LinKen-Hou. Income Dynamics, Economic Rents, and the Financialization of the U.S. Economy. American Sociological Review. 2011; 76(4):538–59. DOI: 10.1177/0003122411414827

Tomaskovic-DeveyDonald, ZimmerCatherine, StainbackKevin, RobinsonCorre, TaylorTiffany, McTagueTricia. Documenting Desegregation: Segregation in American Workplaces by Race, Ethnicity, and Sex, 1966–2003. American Sociological Review. 2006; 71(4):565–88. DOI: 10.1177/000312240607100403

TurleyRuth N, , LópezMartín Santos, CejaCecilia. Social Origin and College Opportunity Expectations across Cohorts. Social Science Research. 2007; 36(3):1200–18. DOI: 10.1016/j.ssresearch.2006.09.004

VaiseyStephen. Education and Its Discontents: Overqualification in America, 1972–2002. Social Forces. 2006; 85(2):835–64.

Van de WerfhorstHerman G, , AndersenRobert. Social Background, Credential Inflation and Educational Strategies. Acta Sociologica. 2005; 48(4):321–40. DOI: 10.1177/0001699305059945

VolschoThomas W, , KellyNathan J. The Rise of the Super-Rich: Power Resources, Taxes, Financial Markets, and the Dynamics of the Top 1 Percent, 1949 to 2008. American Sociological Review. 2012; 77(5):679–99. DOI: 10.1177/0003122412458508

WesternBruce, RosenfeldJake. Unions, Norms, and the Rise in U.S. Wage Inequality. American Sociological Review. 2011; 76(4):513–37.

YangYang, FuWenjiang J, , LandKenneth C. A Methodological Comparison of Age-Period-Cohort Models: The Intrinsic Estimator and Conventional Generalized Linear Models. Sociological Methodology. 2004; 34(1):75–110. DOI: 10.1111/j.0081-1750.2004.00148.x

YangYang, LandKenneth C. Age–Period–Cohort Analysis of Repeated Cross-Section Surveys: Fixed or Random Effects? Sociological Methods & Research. 2008; 36(3):297–326. DOI: 10.1177/0049124106292360

YuWei-hsin, KuoJanet Chen-Lan. The Motherhood Wage Penalty by Work Conditions: How Do Occupational Characteristics Hinder or Empower Mothers? American Sociological Review. 2017; 82(4):744–69. DOI: 10.1177/0003122417712729

APPENDIX

In this appendix, I provide more detail on the construction of the dependent variables: ratings for verbal, quantitative, and analytic skills. Overall, the dependent variables are comparable to previous measures constructed by Autor and Dorn (2013) and Liu and Grusky (2013). These skill ratings may be accessed in the online supplement or downloaded at the SocArXiv website.[18]

Autor and Dorn (2013) used skill ratings from the Dictionary of Occupational Titles to identify the degree of abstract reasoning and routine work for each occupation, and they merged this into an occupational categorization scheme based on the 1990 census occupation categories. They operationalize abstract task activities as an average of the quantitative reasoning requirements of the job and the amount of planning and coordinating activities the job involves. Routine tasks are measured by an average of the ability to execute precise actions and manual finger dexterity requirements. However, the validity of this measurement is unknown, and averaging indicators together is a less desirable method than predicting factor scores.

Liu and Grusky (2013) analyze data from O*NET, a more recent web-based version of the Dictionary of Occupational Titles. They create scales for several different skill types, including verbal, quantitative, and analytic abilities. They identify an eight-factor skill model, comprising 45 separate indicator variables. Using confirmatory factor analysis, Liu and Grusky develop separate scales for verbal, quantitative, and analytic skill, which together comprise a fairly strong operationalization of task complexity. As a result, Liu and Grusky's (2013) approach is more theoretically and empirically robust than Autor and Dorn's (2013); it uses a broader range of cognitive skills and estimates a scale using factor analysis instead of simple averaging. However, replication of Liu and Grusky's (2013) cognitive scales reveals that the fit statistics for these three constructs are poor. Thus, Autor and Dorn's (2013) measurements are too narrow, and Liu and Grusky's (2013) scale is too broad.

The measurement of skill I use here is comparable to those constructed by Autor and Dorn (2013) and Liu and Grusky (2013), but I make several improvements. Like Liu and Grusky (2013), I use data from the O*NET, but I include fewer indicators. The path diagram for this measurement model is presented in Figure A1, with the factor loadings presented in Table A1. The factor structure for verbal and quantitative skills is relatively simple. I estimate the latent variable for verbal skill utilization with independent ratings of oral comprehension, written comprehension, and written expression, and I estimate quantitative skill using mathematics knowledge and mathematics reasoning skill. The factor structure for analytic skills is more complex, because it is represented by a latent variable for on-the-job learning and an observed measurement of complex problem-solving skill. All of these categories,

[18]The data may be found at the following link: https://dx.doi.org/10.17605/OSF.IO/FNQV7.

with the exception of mathematics knowledge, are skill ratings; because knowledge is technically the result of a learning process rather than a skill, I allow the errors for mathematical knowledge to correlate with the errors for learning and complex problem-solving.

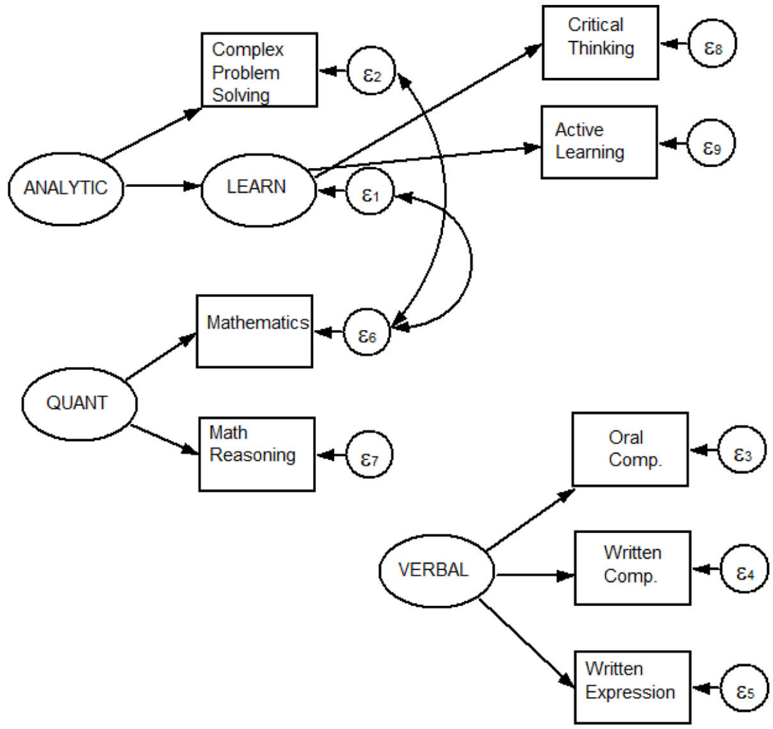

Figure A1.

Measurement Model Used for Factor Scores, Using Indicators from O*NET

Table A1

Measurement Model Factor Loadings, for Factor Score Prediction

Factor	Indicator	Coefficient	Standard Error
Verbal	Oral Comprehension	1	(0)
	Written Comprehension	1.102***	(.0238)
	Written Expression	1.365***	(.0288)
Quantitative Reasoning	Mathematical Reasoning	1	(0)
	Mathematics	.896***	(.0276)
Analytic Reasoning	Complex Problem-Solving	1	(0)
	Ongoing Learning (Latent)	1.123***	(.0158)
Ongoing Learning	Critical Thinking	1	(0)
	Active Learning	1.043***	(.0140)

Note: Standard errors are in parentheses.

Statistical significance tests are two-tailed.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

The fit statistics for this model are either excellent (CFI: .994; TLI: .989) or good (RMSEA: .069), indicating that this factor structure converges on consistent constructs. Using the measurement model, I predict factor scores for each occupation for three different latent variables: verbal, quantitative, and analytic skill utilization (as in Liu and Grusky 2013). I then use Autor and Dorn's (2013) occupational coding scheme to harmonize the occupational skill ratings over time. However, just as Liu and Grusky (2013) welcome further attempts to develop their scale, I welcome further attempts to develop the one presented here. In particular, it would be beneficial to incorporate more of Liu and Grusky's (2013) indicators into this model.

For all analyses, I use the 2003 update of the O*NET database (Boese et al. 2001). The 2003 O*NET update is the last time the Department of Labor used independent task raters; all contemporary O*NET ratings are the result of surveys sent to workers currently at their jobs. For this purpose, surveys are inferior to using independent task raters; workers can only compare their skill utilization at their present job to jobs they have already had. It also means several rare occupations are only rated by a handful of respondents.

Unlike Liu and Grusky, I use only one O*NET database year. The authors of O*NET strongly recommend using only a single year of occupation rating at a time, perhaps because of changes to rating protocols from year to year. Furthermore, although Liu and Grusky (2013) present a compelling rationale for looking at skill changes over time, they find almost no change in non-computer skills. They describe the change in skills as "glacial" (Liu and Grusky 2013:1346) and conclude that only intra-occupational change for computing skills is noticeable—which, according to Liu and Grusky (2013:1346), is also not a major driver of increasing wage inequality: "[I]f a major upgrading in skill is to be found, it will either be confined to computing alone or be driven by changes in the mix of occupations rather than within-occupation changes in skill content."

If Liu and Grusky (2013) are incorrect—and cognitive skill content of occupations has changed over time—then could the present findings be biased? It is possible, but only if two other conditions are true. First, cognitive skill upgrading would have to disproportionately affect occupations with a high proportion of better-educated workers. This is inconsistent with the tenets of SBTC, which posit that skill upgrading occurred across all occupations; furthermore, there is not much evidence to support the notion that highly-skilled occupations require more cognitive skill than in the past. Second, cognitive skill upgrading would have to occur within occupational categories, and not via the growth and decline of occupational groups. It is possible that Liu and Grusky (2013) are incorrect that cognitive skill has remained stable over time. It is also possible that skill upgrading primarily affects already highly-skilled occupations, or that cognitive skill upgrading happens within occupations instead of through changes to the occupational structure. However, the likelihood that all three of these conditions are true is much less likely, lending support to the analyses in the present study.

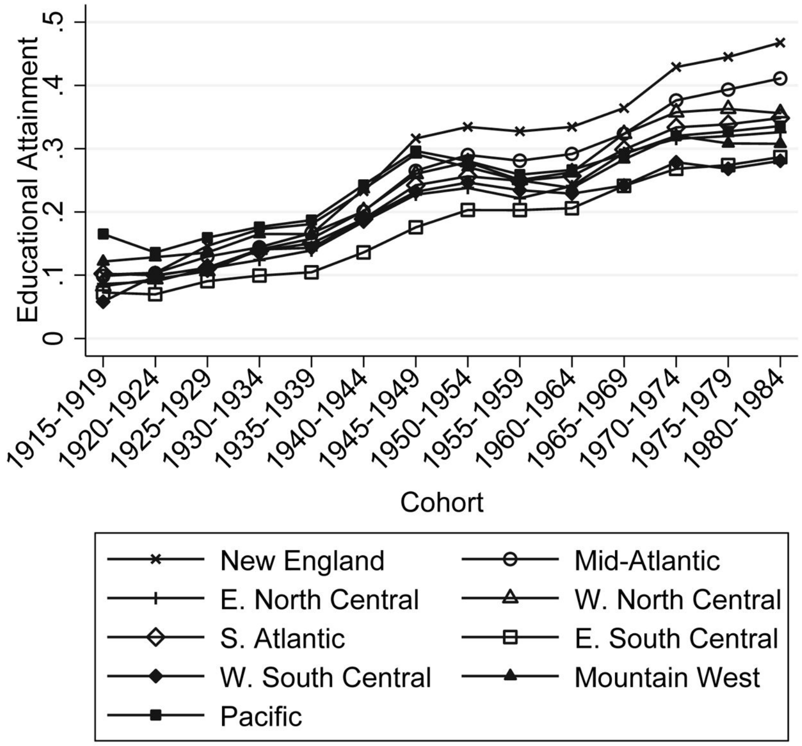

Figure 1.

Proportion of College-Educated Individuals per Birth Cohort and Census Division

Source: Annual Social and Economic Supplement of the Current Population Survey: 1971 to 2010 (Flood et al. 2015).

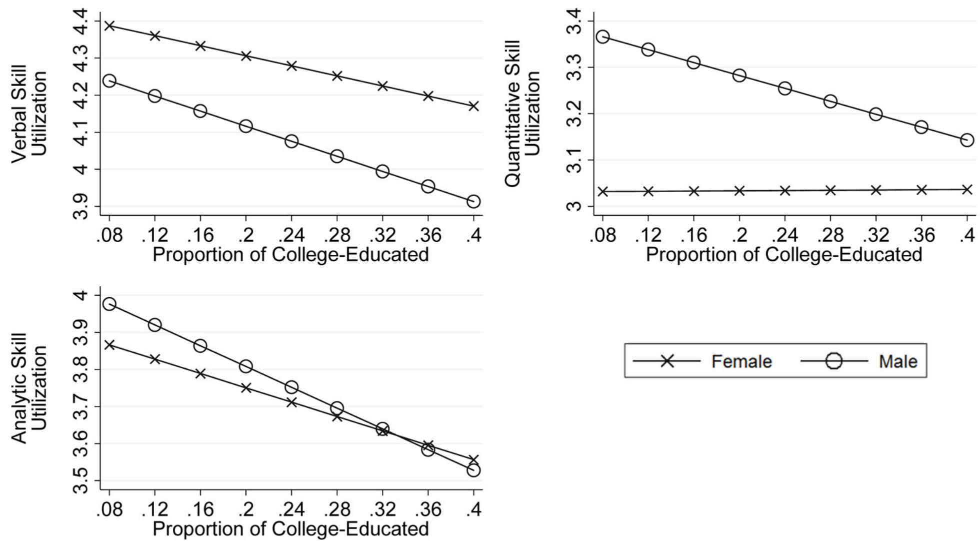

Figure 2.

Predicted Changes in Absolute Skill Utilization of College-Educated Individuals as the Proportion of College-Educated Persons Rises over Birth Cohorts

Source: Table 3.

Note: Predictions are for 27-year-old individuals who live in 1999, within a central city in the Mid-Atlantic census division, and who are white and married.

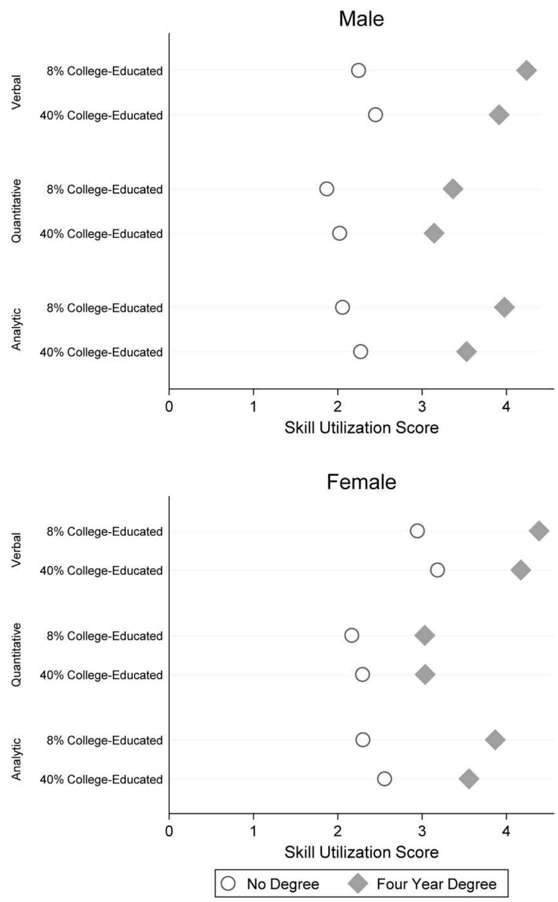

Figure 3.

Predicted Gaps in Skill Level between Four-Year Degree-Holders and Persons without a College Degree: Differences between Cohorts with 8 versus 40 percent College-Educated

Source: Annual Social and Economic Supplement of the Current Population Survey: 1971 to 2010 (Flood et al. 2015).

Note: Findings are net of age (linear, squared, cubed), cohort (five-year dummy variables), year, marital status (married, never married, separated/widowed/divorced), race (white, black, Hispanic, other), metro area (central city, outside central city, not in metro area, not identifiable), census division, and interactions by race–cohort, marital status–cohort, census division–education, and census division–year. Predictions are for 27-year-old individuals who live in 1999, within a central city in the Mid-Atlantic census division, and are white and married.

Table 1

Descriptive Statistics

Variable	Male		Female		Both Sexes	
	Mean	SD	Mean	SD	Minimum	Maximum
Dependent Variables						
Verbal Skill Utilization	2.36	1.16	2.28	1.29	0	6.2
Quant. Skill Utilization	3.19	1.31	2.81	1.50	.2	6.2
Analytic Skill Utilization	2.75	1.28	2.61	1.38	.33	6.33
Independent Variables						
Age	4.91	1.00	4.70	1.04	25	62
Four-Year Degree Proportion	.26	.07	.25	.07	.02	.49
Metro Area: Not Identified	.16	.36	.16	.36	0	1
Metro Area: Not in Central City	.23	.42	.24	.43	0	1
Metro Area: Central City	.25	.43	.23	.42	0	1
Metro Area: Outside Central City	.36	.48	.37	.48	0	1
Geographic Region: Northeast	.09	.28	.09	.28	0	1
Geographic Region: Mid-Atlantic	.13	.34	.13	.34	0	1
Geographic Region: E. North Central	.14	.35	.15	.36	0	1
Geographic Region: W. North Central	.10	.30	.10	.29	0	1
Geographic Region: S. Atlantic	.18	.38	.16	.37	0	1
Geographic Region: E. South Central	.05	.23	.05	.22	0	1
Geographic Region: W. South Central	.09	.29	.09	.28	0	1
Geographic Region: Mountain West	.09	.29	.10	.30	0	1
Geographic Region: Pacific	.12	.32	.13	.33	0	1
White	.76	.43	.78	.41	0	1
Black	.13	.34	.09	.28	0	1
Hispanic	.12	.32	.13	.34	0	1
Married	.62	.49	.75	.43	0	1
Never Married	.16	.36	.15	.35	0	1
Widowed/Divorced/Separated	.23	.42	.11	.31	0	1
No College	.63	.48	.65	.48	0	1

Variable	Male		Female		Both Sexes	
	Mean	SD	Mean	SD	Minimum	Maximum
Some College	.11	.31	.10	.29	0	1
Four-Year Degree	.18	.38	.16	.37	0	1
More than Four-Year Degree	.08	.27	.09	.28	0	1

Source: Annual Social and Economic Supplement of the Current Population Survey: 1971 to 2010 (Flood et al. 2015).

Note: Four-year degree proportion is by cohort, time period, and census division.

Author Manuscript
Author Manuscript
Author Manuscript

Table 2

Sample of Common Occupations and Their Skill Ratings Using Confirmatory Factor Analysis

Occupation	Verbal Skill Score	Quantitative Skill Score	Analytic Skill Score	Sample Activities
Baggage Porters and Bellhops	2	1.4	1.16	Handle luggage or other possessions for patrons. Greet customers, patrons, or visitors.
Cashiers	3	3.16	1.5	Process sales or other transactions. Answer customer questions about goods or services.
Tellers	3.66	3.16	1.5	Verify accuracy of financial or transactional data. Execute financial transactions. Enter information into databases.
Agricultural/Food Science Technicians	2.8	2.6	1.83	Record research or operational data. Analyze chemical compounds. Test quality of materials or finished products.
Grounds Maintenance Workers	1	.6	2	Operate grounds maintenance equipment.
Nursing and Home Health Aides	1.4	.6	2	Encourage patients during therapeutic activities. Maintain medical records.
Carpenters	1.4	1.8	2	Review blueprints or specifications. Mark reference points on construction materials.
Customer Service Representatives	3.4	2.4	2.6	Discuss goods or services information with customers or patrons. Respond to customer problems or complaints.
Occupational Therapists	3.4	2.4	3.16	Analyze patient data to determine patient needs or treatment goals. Record patient medical histories.
Insurance Sales Agents	3.6	2	3.33	Gather information to determine customer needs. Explain financial information to customers. Sell products or services.
Insurance Underwriters	3.6	3.4	3.5	Explain regulations or procedures. Assess financial status of clients. Assess risks to business operations.
Secretaries	3.8	2	3.66	Answer telephones and email to direct inquiries or provide information. Enter information into databases. Prepare documentation for reports.
Librarians	4.5	2.83	3.66	Help patrons use library or archival resources. Search information sources to find specific data. Classify materials according to standard systems.
Clergy	4.2	.6	3.83	Lead classes or community events. Counsel clients or patients regarding personal issues. Develop educational programs.
Social Workers	3.6	2.4	3.83	Counsel clients or patients on substance abuse, health, or interpersonal issues. Advocate for individual or community needs.
News Analysts and Reporters	4.8	.6	4	Analyze information obtained from news sources. Edit written materials. Report news to the public.
Elementary/Middle School Teachers	4.2	3	4.16	Modify teaching methods or materials to accommodate student needs. Establish rules governing student behavior. Evaluate student work.
Physical Therapists	4	1	4.33	Develop medical treatment plans. Record patient medical histories. Analyze patient data to determine patient needs or treatment goals.
Budget Analysts	4	4.6	4.5	Analyze budgetary or accounting data. Advise others on financial matters. Verify accuracy of financial information.

Occupation	Verbal Skill Score	Quantitative Skill Score	Analytic Skill Score	Sample Activities
Accountants and Auditors	4.8	3.8	4.83	Examine financial records or processes. Analyze business or financial data. Calculate tax information.
Actuaries	4.2	4.4	4.83	Manage financial activities. Develop organizational goals or objectives. Analyze data to identify trends or relationships among variables.

Source: O*NET 4.0 Database (Boese et al. 2001).

Note: The skill scores are occupation-level variables representing how much each detailed occupational category utilizes cognitive skill. The scores range from 0 to 6.20 (for verbal skill utilization), .20 to 6.20 (for quantitative skill utilization), and .33 to 6.33 (for analytic skill utilization). Each score is measured using a predicted factor score from a measurement model. The observed indicators are independent skill ratings from O*NET. For more details on the measurement model, see the Appendix.

Table 3

Fixed-Effects/Dummy-Variable APC Models, Showing Differential Effects of Education on Skill Utilization as Proportion of College-Educated Persons Rises

	Model 1. Verbal Skill Utilization		Model 2. Quantitative Skill Utilization		Model 3. Analytic Skill Utilization	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Proportion of Cohort with Four-Year Degree	.630 (.0621)	.746 (.0669)	.475 (.0587)	.398 (.0642)	.672 (.0566)	.803 (.0647)
Educational Attainment (ref.: No College)						
Some College	1.553 (.0266)	1.396 (.0279)	1.198 (.0251)	.847 (.0267)	1.245 (.0242)	1.109 (.0270)
Four-Year Degree	2.179 (.0215)	1.651 (.0238)	1.633 (.0203)	.894 (.0228)	2.132 (.0196)	1.791 (.0230)
More than Four-Year Degree	2.543 (.0270)	1.944 (.0343)	1.193 (.0255)	1.125 (.0329)	2.545 (.0246)	2.093 (.0331)
Relative Educational Effects by Attainment						
Some College × College Proportion	−2.183 (.0686)	−1.894 (.0718)	−1.602 (.0648)	−1.181 (.0689)	−1.658 (.0625)	−1.163 (.0694)
Four-Year Deg. × College Proportion	−1.648 (.0555)	−1.424 (.0611)	−1.173 (.0525)	−.384 (.0586)	−2.075 (.0506)	−1.772 (.0590)
More than Four-Year Deg. × College Proportion	−1.256 (.0707)	−1.281 (.0879)	−.0884 (.0668)	−.875 (.0842)	−1.242 (.0644)	−1.132 (.0849)
Constant	1.483 (.108)	3.030 (.116)	1.451 (.102)	2.187 (.111)	1.289 (.0985)	1.776 (.112)
Observations	1,003,679	759,162	1,003,679	759,162	1,003,679	759,162
R-Squared	.339	.255	.211	.131	.351	.272

Source: Annual Social and Economic Supplement of the Current Population Survey: 1971 to 2010 (Flood et al. 2015).

Note: Coefficients for age (linear, squared, cubed), cohort (five-year dummy variables), year, marital status (married, never married, separated/widowed/divorced), race (white, black, Hispanic, other), metro area (central city, outside central city, not in metro area, not identifiable), census division, and interactions by race–cohort, marital status–cohort, census division–education, and census division–year included in model but not listed here; full results are available by request. All coefficients statistically significant at $p < .001$ except “more than four-year deg. × college proportion” (male quant) which is not significant.

Table 4

Differences in Skill Utilization by Education Level: 8 percent versus 40 percent College-Educated in Cohorts

	Verbal Skill Utilization		Quantitative Skill Utilization		Analytic Skill Utilization	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Decline in Skill Utilization of Four-Year Degree from 8% to 40%	−.32	−.22	−.22	.00	−.45	−.31
Decline in the Advantage of Four-Year Degree vs. No College Degree Going from 8% to 40%	−.53	−.46	−.38	−.12	−.66	−.57
Interpretation of Skill Differences:	0 to .2: not a substantively meaningful difference .2 to .4: noticeable/moderate substantive difference .4 to 1.0: large substantive difference Above 1: very large substantive difference					

Source: Annual Social and Economic Supplement of the Current Population Survey: 1971 to 2010 (Flood et al. 2015).

Note: Findings are net of age (linear, squared, cubed), cohort (five-year dummy variables), year, marital status (married, never married, separated/widowed/divorced), race (white, black, Hispanic, other), metro area (central city, outside central city, not in metro area, not identifiable), census division, and interactions by race–cohort, marital status–cohort, census division–education, and census division–year.