Between- and Within-Occupation Inequality: The Case of High-Status Professions

By
YU XIE,
ALEXANDRA KILLEWALD,
and
CHRISTOPHER NEAR

In this article, we present analyses of the roles of education and occupation in shaping trends in income inequality among college-educated workers in the United States, drawing data from two sources: (1) the 1960–2000 U.S. Censuses and (2) the 2006–2008 three-year American Community Survey. We also examine in detail historical trends in between-occupation and within-occupation income inequality for a small set of high-status professionals, with focused attention on the economic well-being of scientists. Our research yields four findings. First, education premiums have increased. Second, between-occupation and within-occupation inequality increased at about the same rates for college graduates, so that the portion of inequality attributable to occupational differences remained constant. Third, scientists have lost ground relative to other similarly educated professionals. Fourth, trends in within-occupation inequality vary by occupation and education, making any sweeping summary of the roles of education and occupation in the overall increase in income inequality difficult.

Keywords: occupation inequality; within-occupation inequality; earnings inequality; high-status professions; trends in earnings inequality

It is well known that the earnings returns to higher education have increased dramatically since the end of World War II (Autor,

Yu Xie is Bert G. Kerstetter '66 University Professor of Sociology and researcher at the Princeton Institute of International and Regional Studies, Princeton University. He is also a Visiting Chair Professor of the Center for Social Research, Peking University. His main areas of interest are social stratification, demography, statistical methods, Chinese studies, and sociology of science. His recently published works include: Marriage and Cohabitation *(University of Chicago Press 2007) with Arland Thornton and William Axinn,* Statistical Methods for Categorical Data Analysis *with Daniel Powers (Emerald 2008, second edition), and* Is American Science in Decline? *(Harvard University Press, 2012) with Alexandra Killewald. Throughout his career, especially during his years as a graduate student at the University of Wisconsin–Madison between 1983 and 1989, he has been mentored, supported, and inspired by Robert and Tess Hauser.*

Correspondence: yuxie@umich.edu

DOI: 10.1177/0002716215596958

Katz, and Kearney 2008; Bound and Johnson 1992; Fischer and Hout 2006; Goldin and Katz 2008; Lemieux 2008) and that this trend has contributed to rising income inequality since 1980 (Levy and Murnane 1992; Morris and Western 1999). Although the cause of this rising inequality has been hotly debated, particularly the role of skill-biased technological change (Acemoglu 2002; Autor, Katz, and Kearney 2008; Autor, Levy, and Murnane 2003; Bound and Johnson 1992; Card and DiNardo 2002; Katz and Murphy 1992), there is no disputing the importance of widening income differences by educational attainment. High levels of income inequality raise concerns about the ability of those at the bottom of the distribution to support themselves and about the opportunity for all members of society to share in national prosperity.

Yet variation by education is not the only source of rising income inequality. Much previous research documents the rise of within-group income inequality by age, race, gender, education, industry, and experience in the last decades of the twentieth century (Bernhardt et al. 2001; Juhn, Murphy, and Pierce 1993; Levy 1995; Levy and Murnane 1992; Morris and Western 1999). Rising within-group inequality implies that wage dispersion has increased even among narrowly-defined subgroups, such as white, male, college-educated workers employed as engineers.

In this article, we consider the role of occupation in rising income inequality among college-degreed workers. An occupation can be considered the aggregation of different jobs that are similar in terms of the duties, tasks, and skills required (Grusky 2005; Hauser and Warren 1997) and has long been considered an indicator of social stratification by sociologists (Blau and Duncan 1967; Featherman and Hauser 1978; Treiman 1977), defining what Weeden and Grusky (2005) call a "micro-class." Previous research relating occupation to trends in income inequality has found that, in the overall American occupational structure, between-occupation inequality has risen faster than within-occupation inequality (Autor, Katz, and Kearney 2006; Massey and Hirst 1998; Mouw and Kalleberg 2010; Weeden et al. 2007; see also Kim and Sakamoto 2008). However, this line of research does not control for education differences across occupations, so the observed rise in between-occupation inequality may be due mainly to the rise of inequality across educational groups. Although Mouw and Kalleberg (2010) find evidence of increases in both between- and within-occupation inequality between 1983 and 2008 after accounting for education

---

Alexandra Killewald is Associate Professor of Sociology at Harvard University. Her research takes a demographic approach to the study of social stratification, with a focus on the work-family intersection. Her recent research has been published in outlets such as American Sociological Review *and* Demography, *and she is co-author, with Yu Xie, of* Is American Science in Decline? *(Harvard University Press, 2012).*

Christopher Near is a doctoral candidate in Sociology at the University of Michigan. His current research focuses on processes of social stratification through child development, including how family background affects child skills and outcomes through parenting and child care. His other interests include processes of gender, cultural production and reception, and new media use, especially as they relate to children. His previous work has been published in Sex Roles.

NOTE: We thank Cindy Glovinsky for assistance. Part of the article is drawn from chapter 4, "American Scientists: Who Are They?" in *Is American Science in Decline?* by Yu Xie and Alexandra Killewald (Harvard University Press 2012).

and other individual-level factors, they attribute most of the increase in overall inequality to an increase in between-occupation differences. They further identify just three occupational groups—computer systems analysts, secretaries, and managers not otherwise classified—that are responsible for 18 percent of the overall increase in inequality, primarily due to declines in the proportion of workers who are secretaries (a middle-wage occupation) and increases in the proportion who are computer systems analysts and managers not otherwise classified (high-wage occupations). We build on this earlier research by examining variability of within-occupation inequality and its trends over time, with a focus on high-status professions.

We choose to focus on college-educated workers for several reasons. First, substantial attention has already been paid to the polarization of occupational attributes into "good jobs" and "bad jobs." This leads to what is termed an hourglass economy, as the occupational structure is heavy at the top and bottom, with fewer jobs in the middle (Autor, Katz, and Kearney 2008; Levy and Murnane 1992; Massey and Hirst 1998; Wright and Dwyer 2003). By examining trends in wage inequality among the college educated, we are able to examine in greater detail the portion of the inequality increase that is due not to changes in the returns to education per se, or between "good jobs" and "bad jobs," but to changes in differences across different types of "good jobs." We show that, even within this group that has benefited overall from increasing returns to college education, there are still relative "winners" and relative "losers."

Furthermore, although inequality in the middle and bottom ranges of the earnings distribution stabilized after the mid-1980s, earnings inequality in the top half of the earnings distribution has steadily increased (Autor, Katz, and Kearney 2008; Lemieux 2008). It is thus among highly educated workers that secular increases in inequality have been the most pronounced. Mouw and Kalleberg's (2010) list of the twenty occupational groups making the largest contributions to changing inequality includes several high-status professionals, including managers, physicians, computer systems analysts, computer operators, and registered nurses. We ask whether income inequality has increased within this group of highly educated workers and, if so, whether this is due primarily to increasing inequality across different occupations, or to rising variation within occupations.

Finally, occupations are concrete social positions filled by individuals whose work may impact the lives of other people. This is particularly true when work in certain occupations, such as science and teaching, has positive "spillover" effects on the larger society (Mankiw 2003). In the second half of this chapter, then, we present detailed results for a small set of high-status professionals. Scientific innovation has long been recognized as an engine of economic growth, and the recruitment of talented and qualified individuals into scientific occupations is widely viewed in policy circles as a necessary condition for a healthy U.S. economy (Ben-David 1971; National Academy of Science, National Academy of Engineering, and Institute of Medicine 2007; Romer 1990; Solow 1957). In recent decades, some American scientists, policy-makers, and journalists have expressed concern that America is in danger of failing in this respect (Atkinson 1990; Ezell and Atkinson 2008; Grogan 1990; National Academy of Science, National Academy of Engineering, and Institute of Medicine 2007), while others have contested these

claims (Butz et al. 2003; Galama and Hosek 2008; Lowell and Salzman 2007; see Neal, Smith, and McCormick [2008, 277–93] for a review of the debate).

We engage this debate in detail elsewhere (Xie and Killewald 2012). Here, we focus on changes between 1960 and the present in both the average earnings and the earnings variability of scientists, i.e., workers in scientific occupations, relative to those in other professions that require a similar amount of training, such as teaching, medicine, and law. Temporal changes in scientists' earnings relative to those of other professions tell us two important things about the relative attractiveness of science as an occupation. On one hand, scientists' low earnings relative to those of other high-status professionals suggest that science may not be financially attractive to youth considering different career options. On the other hand, a decline in scientists' relative earnings may indicate an oversupply of scientists in the labor market (see Xie and Killewald [2012] for a fuller discussion).

Previous research shows that the earnings of scientists increased more slowly in the last two decades of the twentieth century than did those of other professionals in occupations requiring similar levels of training, such as medicine and law (Lemieux 2008). However, it is possible that medical doctors and lawyers have achieved large earnings gains because they are disproportionately holders of graduate degrees, a group that has experienced more consistent earnings increases than those with only bachelor's degrees (Autor, Katz, and Kearney 2008; Mincer 1997). Comparison of trends in within-occupation inequality across different high-status occupations may be similarly confounded by compositional differences in education. In our own study, we examine trends separately for those with only a bachelor's degree and those with more advanced degrees.

Data and Methods

Our study draws on analyses of data from two sources: (1) the 1-percent Integrated Public Use Microdata Series (IPUMS) of the decennial U.S. Censuses in 1960, 1970, 1980, 1990, and 2000 (Ruggles et al. 2010); and (2) the 2006–2008 three-year American Community Survey Public Use Microdata Sample, a subsample from the American Community Survey (ACS). We refer to the 2006–2008 ACS data as "2007" data for brevity. The ACS is an annual survey of 5 percent samples of PUMAs (nonoverlapping state partitions, each with a population of about 100,000 residents). In all analyses, we restrict the samples to employed members of the civilian labor force, aged 35 to 45, who are working full time year-round and earn at least $5,000 in 2000 dollars (calculated using data from the Consumer Price Index). We focus on prime-age workers in a relatively narrow age range in order to avoid the possibility of occupation effects being confounded with age effects due to changes in the age structure by occupation. Workers meeting our criteria were then categorized into one of forty-one broad occupational categories. We created the classification scheme of occupational groups with two conflicting objectives: (1) to reduce the number of occupational categories and (2) to group more detailed occupations in a category only when socioeconomic status and work content are sufficiently similar across these occupations. Appendix A presents the list of the occupational groups.[1]

For our analysis of trends in education premiums, we exclude workers with less than a high school degree and categorize the remaining sample into four groups according to educational degree attained: (1) a high school diploma and no postsecondary education, (2) some college education but no bachelor's degree, (3) a bachelor's degree only, or (4) an advanced (graduate) degree. In the 1960, 1970, and 1980 data sets, it was necessary to construct the respondent's highest degree obtained from data on the number of years of education the respondent had completed, whereas in the 1990, 2000, and 2007 data sets, respondents were specifically asked to report their highest degree obtained. There is no simple method of keeping the coding scheme consistent. Coding respondents with 17 years of education as having a bachelor's degree would underestimate the number of respondents with an advanced degree, whereas coding respondents with 17 years of education as having an advanced degree would overestimate the number of respondents with an advanced degree.[2] We experimented with both coding schemes and found that they produced almost identical results. We report results based on coding respondents with 16 finished years of education as having a bachelor's degree and respondents with 17 or more years of finished education as having an advanced degree.

While the 1980 and later data differentiate between master's and doctoral degrees as highest degree obtained, the 1960 and 1970 data do not. In many of the results given below, we consider "advanced" degree-holders as an aggregate group for consistency across years, combining all individuals with graduate and professional degrees beyond the bachelor's level. For some results, we report average earnings separately for master's and doctoral degree (professional degree or PhD) holders, with the results estimated for 1960 and 1970 using an imputation method described in Appendix B. However, estimation of within-group variance separately among master's degree holders and among doctoral degree holders for 1960 and 1970 is not possible.

To mitigate the potential bias caused by allocated values for missing earnings data in these data sets, we followed Mouw and Kalleberg's (2010) recommendation and repeated the analyses with and without the allocated earnings data. Differences in results were relatively minor. We present the results from analyses that exclude allocated values, due to concerns that including these observations may artificially inflate within-occupation variation in earnings (Mouw and Kalleberg 2010).

We conducted four analyses for this chapter. Each was performed separately for men and women and at four levels of educational attainment: bachelor's degree, master's degree, doctoral degree, and advanced degree (combined master's and doctoral levels). In the first analysis, we document trends in the returns to postsecondary education. We use an ordinary least squares (OLS) regression of the log of earnings on different levels of education, controlling for age and a linear spline function of hours of work per week (with knots at 40 and 50). From the regression results, we are able to derive earnings premiums for higher levels of education over a high school diploma in each year.

We then turn to an examination of earnings inequality among individuals with at least a college degree and discuss the role of occupations in these trends within an education level. Specifically, we decompose total earnings inequality,

measured by the variance of log-earnings, into components that are within and between occupational categories, separately by educational groups. In this analysis, we are able to determine whether increases in income inequality for college-degreed workers were driven primarily by increasing income differences between occupations or increasing heterogeneity within them.

After describing general trends in inequality between and within educational and occupational groups, we present a case study of certain high-status professions, using the experiences of basic scientists as our benchmark. We compare basic scientists to engineers, computer scientists, teachers, social scientists, medical doctors, and lawyers between 1960 and 2007. If income inequality has increased due to a rising trend in between-occupation differences in average income, some occupations must have gained ground relative to others. By examining trends for a selected group of high-status professionals at a given education level, we gain insight about changes in the relative economic status of these alternative high-status professions. At degree levels for which we did not have to impute earnings (bachelor's and advanced degrees in all data sets and master's and doctoral degrees in the 1980, 1990, 2000, and 2007 datasets), our third analysis calculates earnings ratios for selected professions relative to scientists by estimating OLS regressions for each degree level in each data set, separated by sex, of the log of earnings on a set of profession dummy variables (with scientists as the reference category), controlling for age and a linear spline function of hours of work per week (with knots at 40 and 50). Thus, in each case, the earnings ratio of scientists to other professionals is the exponentiated coefficient for that profession in the regression. Prior to 1980, we do not have information that allows us to distinguish between individuals who hold master's degrees and those who hold doctoral degrees. For these years, we used a somewhat more complicated method to compute earnings premiums at different education levels. This method is discussed in detail in Appendix B.

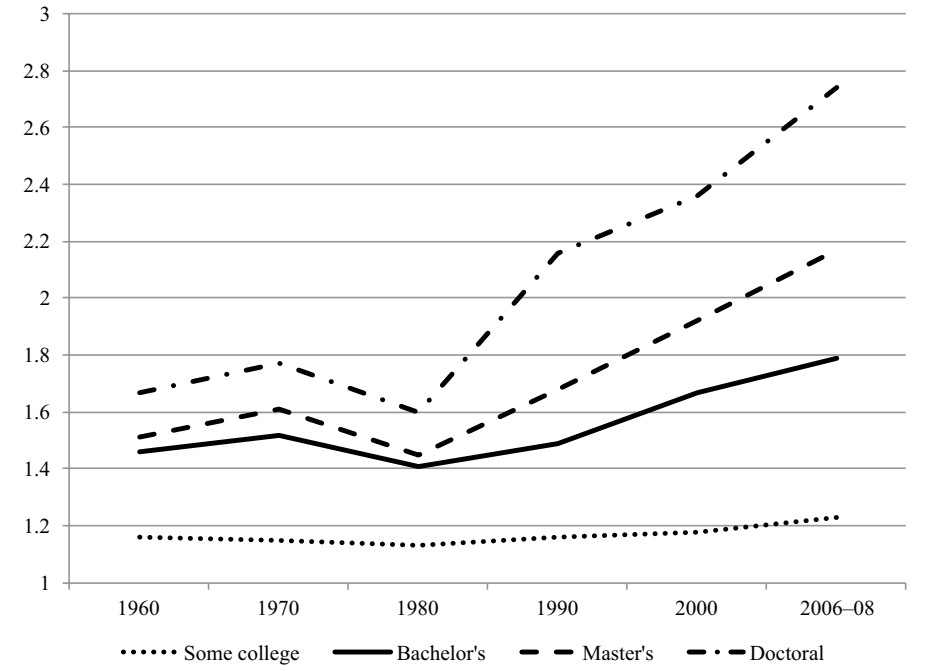
Lastly, we consider that occupations may vary not only in their average earnings but also in the variation of earnings within each occupation. In addition to average earnings, the chance to be highly successful and the risk of doing poorly influence an occupation's relative attractiveness to youth (Xie and Shauman 1997). Since most individuals tend to be risk-averse (Holt and Laury 2002), a high variance within an occupation is generally unattractive to youth making a career choice. Our final analysis compares, for the same set of professions as in the third analysis, the variation in earnings using a ratio of the 90th to 10th percentiles of earnings by profession, year, and educational level.

Results

Earnings premiums for education

In this analysis, we compare the mean earnings of full-time, full-year workers ages 35 to 45 across five different levels of highest educational attainment: (1) high school diploma, (2) some college, (3) bachelor's degree, (4) master's degree,

FIGURE 1A
Male Earnings Ratio to High School Diploma, by Degree Level



and (5) doctoral degree. We conduct our analysis separately for men and women and control for age and hours of work per week through regression analysis with the log of earnings as the dependent variable. We present the results as ratios in earnings of workers with a higher level of education to those of workers with only a high school diploma in each decade.

Figure 1a shows our results for men. Not surprisingly, in all years, more education is associated with higher earnings. Compared to workers with only a high school diploma, workers with an associate's degree or some college earned 13 to 23 percent more, those with a bachelor's degree earned 41 to 79 percent more, those with a master's degree earned 45 to 117 percent more, and those with a doctoral degree earned 60 to 174 percent more. Over time, we see generally consistent trends across all levels of education: education premiums increased slightly from 1960 to 1970, decreased to slightly below 1960 levels between 1970 and 1980, and then monotonically increased at a moderate rate from 1980 to 2007. Consistent with past research, the increase in education premiums was greater at higher levels than at lower levels of education. Whereas the premiums for some college or a bachelor's degree over a high school diploma increased by less than 75 percent from 1960 to 2007, the premium for a master's degree increased by 129 percent and the premium for a doctoral degree increased by 160 percent over the same period.

FIGURE 1B
Female Earnings Ratio to High School Diploma, by Degree Level

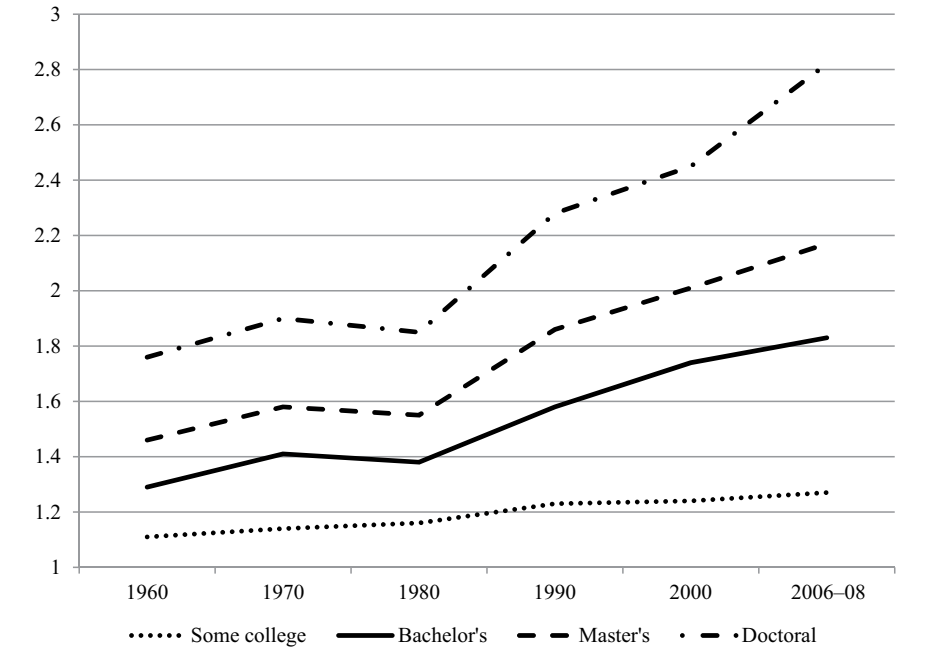


Figure 1b shows similar results for women. Patterns for women were the same as those for men, and earnings premiums were often of similar magnitudes for men and women, particularly by 2007. The greatest difference between the two is that education premiums for some college and a bachelor's degree increased much more for women (by 145 percent and 186 percent, respectively) than for men between 1960 and 2007.

Earnings variation within and between occupations

Our second analysis decomposes the total variation in earnings into one component due to between-occupation variation and another due to within-occupation variation, by gender and education. We then examine trends in these components of variation over time. Although we conduct analyses for all groups considered, we focus on trends for two groups of workers: those with a bachelor's degree and those with a more advanced degree. As we mentioned earlier, we combine workers with a master's degree and those with a doctoral degree into a single group because we cannot estimate separate within-occupation variances for these groups prior to 1980. Lumping workers with either a master's or a doctoral degree together allows us to compare trends in variance components across all time periods.

FIGURE 2A
Total Variance in Log Earnings, by Degree Level and Sex

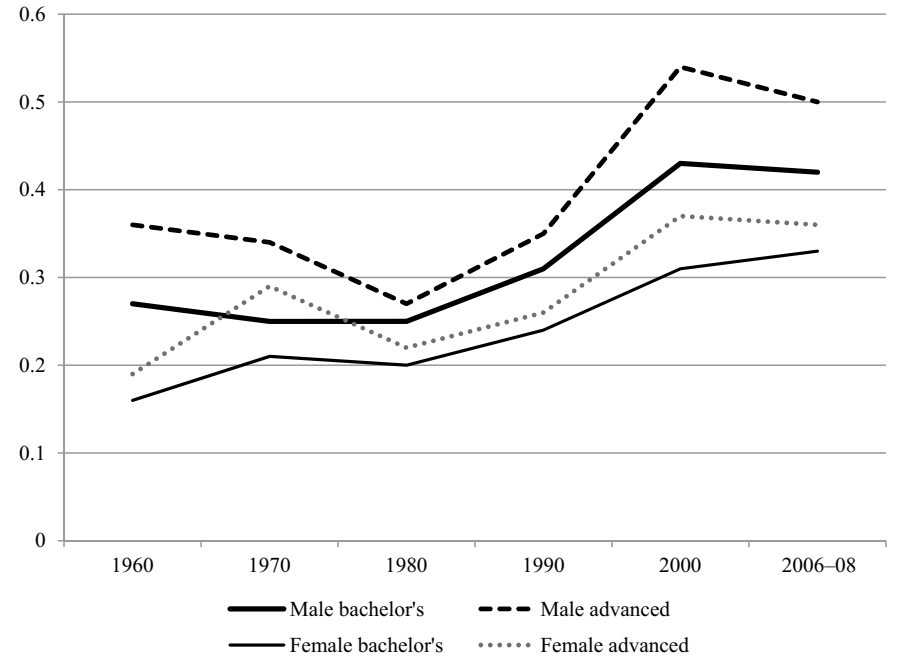
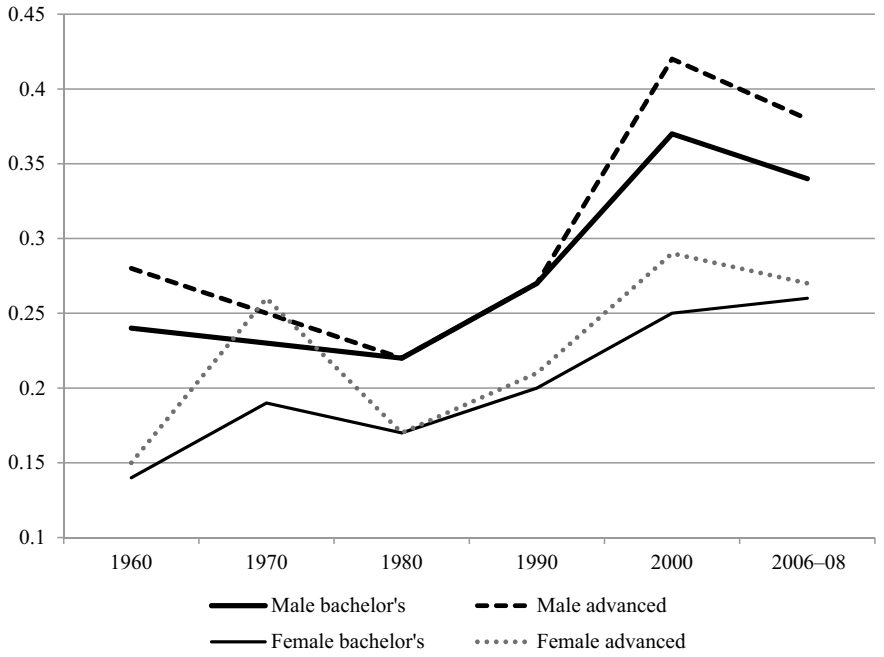


Figure 2a displays the total variance in log earnings for workers by gender, education level, and year. Among men with a bachelor's degree, the variance in log-earnings was stable at about 0.25 between 1960 and 1980, then increased to 0.43 in 2000 and remained at almost the same level (0.42) in 2007. Variance in log earnings for men with advanced degrees was higher but followed a somewhat similar pattern, decreasing from 0.36 in 1960 to 0.27 in 1980, then increasing to 0.54 in 2000 and again decreasing to 0.50 in 2007. For women with a bachelor's degree, variance in log earnings almost monotonically increased, from 0.16 in 1960 to 0.33 in 2007. Finally, for women with an advanced degree, variance in log earnings increased from 0.19 in 1960 to 0.29 in 1970, decreased to 0.22 in 1980, and then increased to about 0.37 in 2000 and later. These results confirm earlier studies, which also found a general increase in earnings inequality from 1980 to the early 2000s (Mouw and Kalleberg 2010; Weeden et al. 2007).

Figure 2b displays the estimated variance of the error term (mean squared error [MSE]) from OLS regressions of log earnings on occupational categories by gender, educational group, and year. In effect, these estimated variance terms represent within-occupation variance after accounting for mean differences in earnings across the forty-one occupational categories. The resulting pattern for within-occupation variance resembles that for total variance. For men with a bachelor's degree, the within-occupation variance decreased slightly from 0.24 to

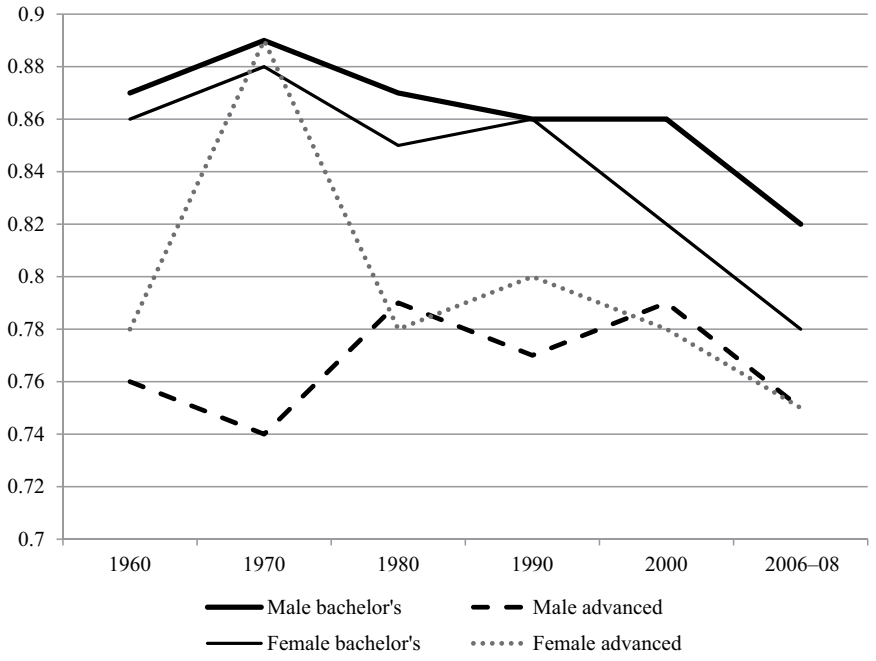
FIGURE 2B
Within-Occupation Variance in Log Earnings, by Degree Level and Sex



0.22 between 1960 and 1980, increased to 0.37 in 2000, and then decreased slightly to 0.34 in 2007. For men with an advanced degree, the within-occupation variance decreased from 0.28 in 1960 to 0.22 in 1980, then increased to 0.42 in 2000 and decreased to 0.38 in 2007. For women, the within-occupation variance monotonically increased (except for 1980) for those with a bachelor's degree, from 0.14 in 1960 to about 0.26 in 2000 and 2007. For women with an advanced degree, it increased from 0.15 in 1960 to 0.26 in 1970, decreased to 0.17 in 1980, increased to a maximum of 0.29 in 2000, and finally decreased to 0.27 in 2007. In more detailed analyses for the period between 1980 and 2007, the period of the greatest increase in overall income inequality, we found that within-occupation inequality (as measured by MSE) increased for both sexes and within all educational groups, but the trend was much more pronounced for doctoral degree holders.

An overarching conclusion from this analysis is that earnings inequality has generally increased since 1960 for full-time workers with at least a college degree, both overall and within occupational categories. To compare the two trends, we calculate the ratio of within-occupation inequality to overall inequality and interpret the ratio as the proportion of inequality that is within occupation. Figure 2c presents the ratio by gender, year, and educational level. This comparison reveals that the proportion of inequality that is within each occupational category has been stable or decreasing for those with only a bachelor's or master's

FIGURE 2C
Estimated Proportion of Variance within Occupation, by Degree Level and Sex



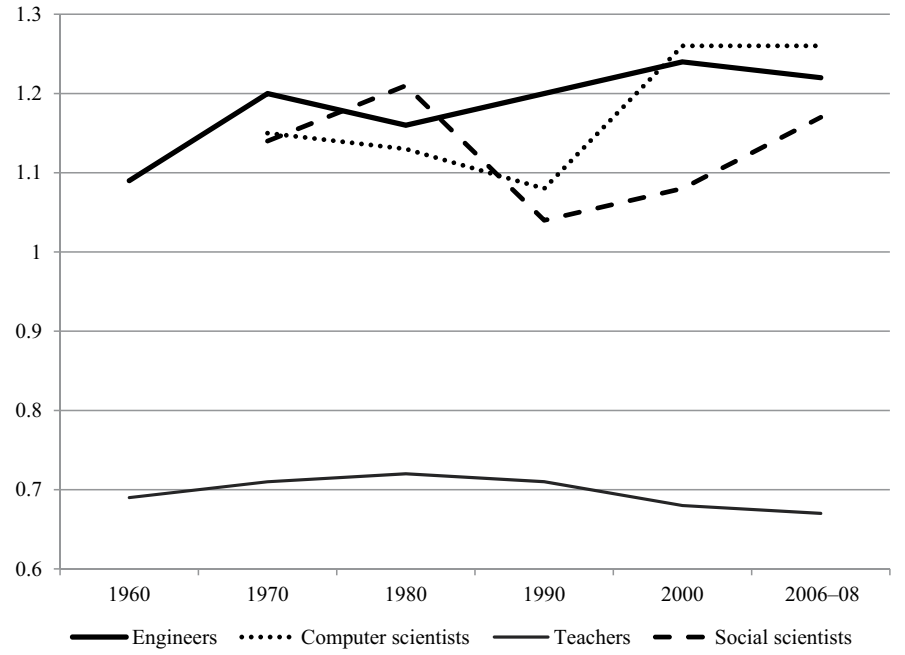
degree, or when workers with master's degrees or doctoral degrees are lumped together. The fraction of within-occupation variance increased slightly for workers with doctoral degrees, by less than 10 percent between 1980 and 2007.

Scientists' earnings relative to those of other professionals

Using the same Census and ACS data described earlier, we use "basic" scientists—those in physical science, life science, and mathematical science—as our reference and compare their earnings to those of workers in other professions. We conduct regression analyses separately for men and women and control for the individual's age and weekly hours worked. Due to data limitations, our statistical methods yield only approximate results that are confounded by both measurement and sampling errors. In particular, we should be skeptical of numbers that are based on a small number of cases, so we suppressed results based on fewer than fifty cases.

In Figures 3a through 3c, we present the core results of this analysis for men. We focus on men because there were too few women in most of these professions to obtain reliable estimates before 1990. At both the bachelor's and the master's degree levels, we track trends over time in the relative earnings of engineers, computer scientists, teachers, and social scientists. Computer scientists and engineers are part of the overall scientific workforce, but a more detailed analysis allows us to consider

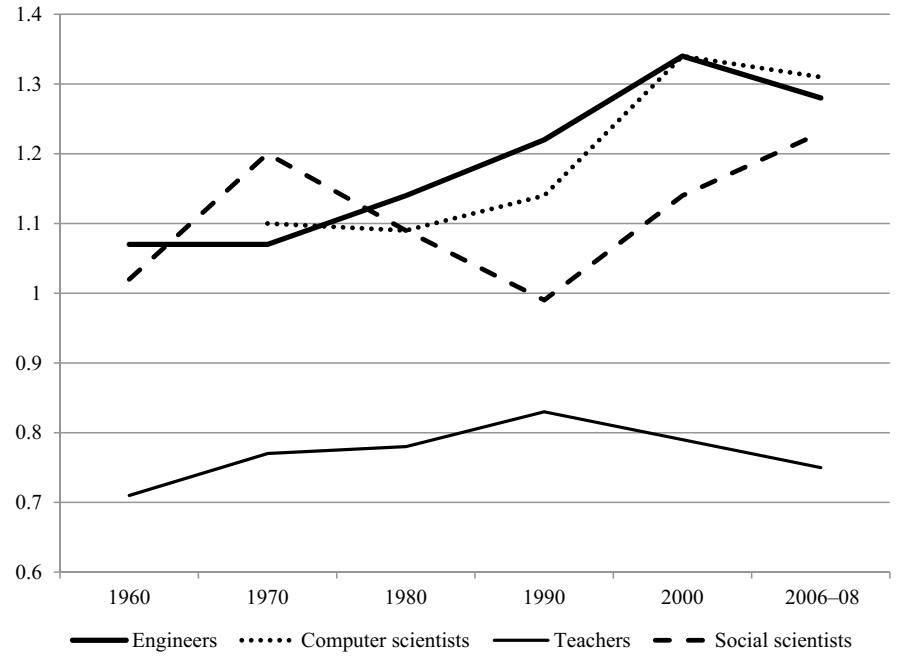
FIGURE 3A
Estimated Earnings Ratios of Professionals to Basic Scientists, Male Bachelor's Level



both changes in the financial incentives for science as opposed to nonscience careers and changes in the rewards to subfields within science, for example, comparing applied science versus basic science. At the doctoral degree level, we present analogous comparisons for engineers, computer scientists, social scientists, medical doctors, and lawyers.

A point in Figures 3a through 3c represents the ratio in earnings of a profession (i.e., teachers) to scientists at a given level of education, age and work hours being equal. We find that basic scientists generally earned less than engineers, computer scientists, and social scientists, but more than teachers. Engineers with bachelor's degrees earned 9 to 24 percent more than basic scientists with the same education throughout the period. The highest premium for engineers was reached in 2000 (24 percent), but engineers in 2007 also had a higher premium (22 percent) than did engineers in 1960 (9 percent). For those with a master's degree, the premium for engineers was about 7 percent between 1960 and 1970, but increased to a peak of 34 percent in 2000 before decreasing to 28 percent in 2007. The premium also rose for computer scientists with a bachelor's degree, from about 15 percent in 1970 and 1980 to 26 percent in 2000 and 2007. Computer scientists with a master's degree earned 10 percent more than comparable scientists earned in 1970 and 1980, and considerably more in later years (14 percent in 1990 and 31–34 percent in 2000 and 2007). We find similar comparative trends for engineers and computer scientists at the doctoral level. In

FIGURE 3B
Estimated Earnings Ratios of Professionals to Basic Scientists, Male Master's Level



summary, at all education levels, the average earnings of applied scientists in 2007 are significantly higher (by about one-fifth to one-fourth) than those of basic scientists, and the premium for applied science has generally increased since 1960.

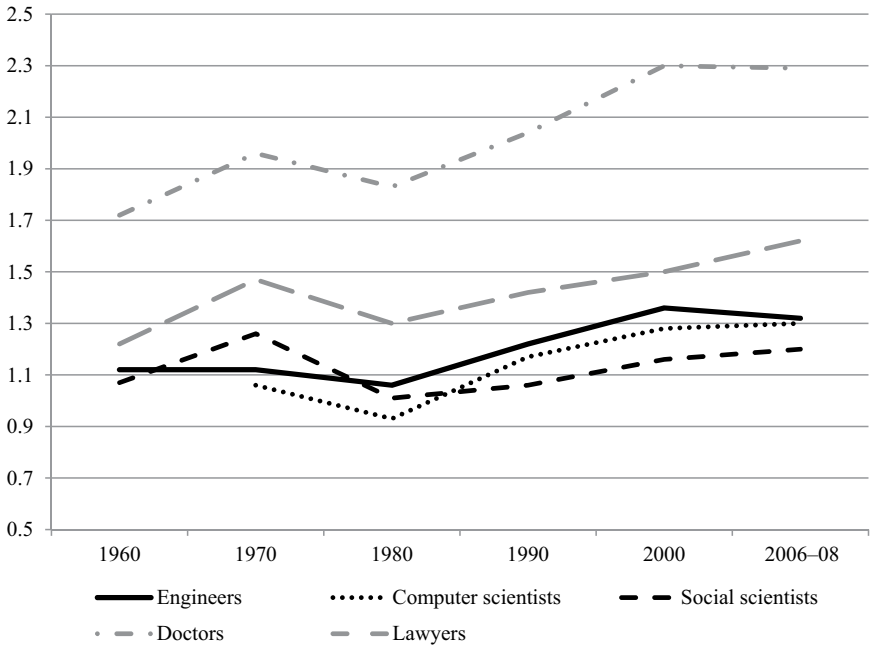
How does this compare with the earnings of nonscientists? Social scientists generally out-earned scientists of the same education level, but there are no clear trends in the amount of the premium. In 2007, social scientists with at least a bachelor's degree earned 17 percent (at the bachelor's level) to 23 percent (at the master's level) more than similarly educated scientists. For teachers, earnings were about 70 percent as high as scientists at both the bachelor's level and the master's level, with no obvious trends.

At the doctoral level, we find, unsurprisingly, that medical doctors and lawyers earned more than scientists throughout the period. Medical doctors earned 72 percent more than scientists in 1960, and about 130 percent more in 2000 and 2007. The premium for lawyers also rose substantially, from 22 percent in 1960 to 62 percent in 2007. Thus, scientists with doctoral degrees lost significant ground to both medical doctors and lawyers.

Earnings inequalities within professions

Our final analysis examines the level of earnings inequality by profession, expressed as a ratio of the 90th percentile of the earnings distribution to the 10th

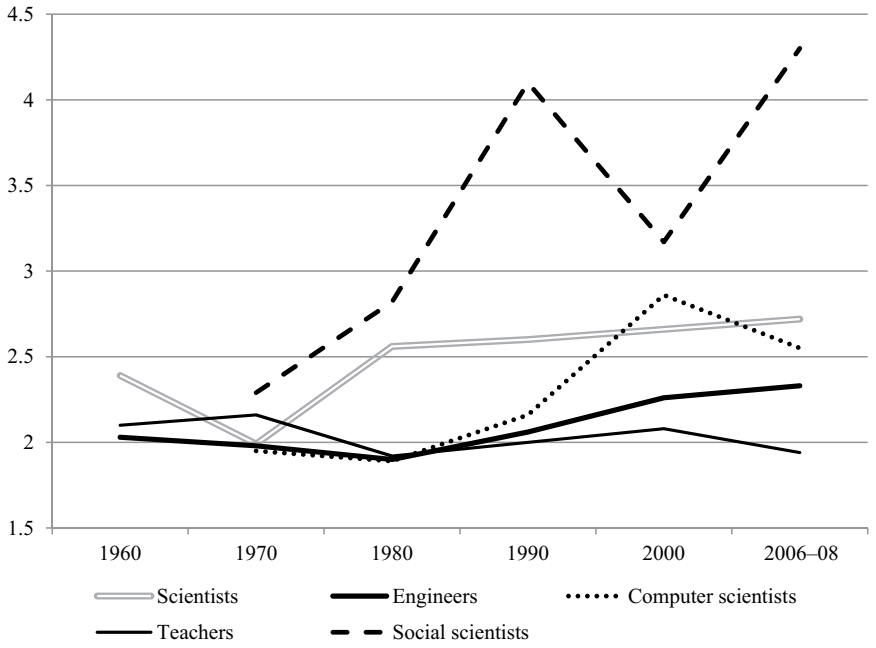
FIGURE 3C
Estimated Earnings Ratios of Professionals to Basic Scientists, Male Doctoral Level



percentile of the earnings distribution for full-time workers within each profession. For simplicity, we refer to it as the 90/10 ratio. Again, we conduct separate analyses by gender, year, and education level. We retain the same list of professions as in the previous analysis for this analysis: basic scientists, engineers, computer scientists (in 1970 and later), social scientists, teachers, medical doctors, and lawyers. Since our analysis is within each occupation at each level of education, we interpret the 90/10 ratio as a measure of profession-specific earnings inequality.

We present results from this analysis in Figures 4a and 4b for male workers with a bachelor's degree and those with an advanced degree, which combines the master's degree and doctoral degree levels. Again, there were too few women in most professions before 1990 for us to study trends for women. The results show generally increasing trends in profession-specific earnings inequalities between 1960 and 2007, although trends were not monotonic across all years for all professions, especially in the 1960 to 1970 period and the 2000 to 2007 period. Inequality as measured by the 90/10 ratio was most stable among teachers (8 percent change or less between 1960 and 2007 at the bachelor's and advanced levels), followed by engineers (4 percent increase at the advanced level and 15 percent increase at the bachelor's level between 1960 and 2007) and scientists with bachelor's degrees (14 percent increase from 1960 to 2007). Inequality increases were somewhat higher for computer scientists, advanced-level

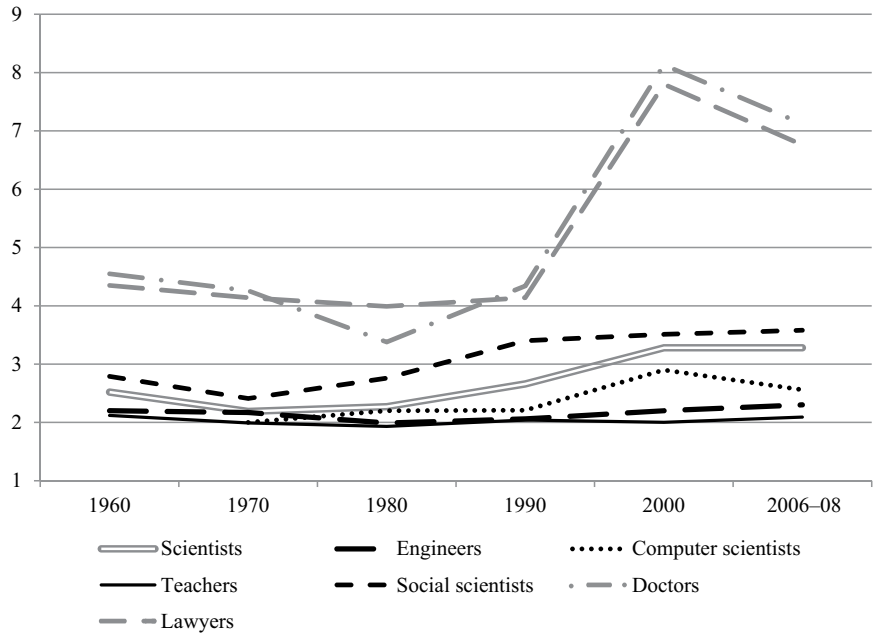
FIGURE 4A
90/10 Earnings Ratio within Profession, Male Bachelor's Level



scientists, and advanced-level social scientists (about 25 percent from the earliest available year to 2007), and were much higher for medical doctors, lawyers, and social scientists with bachelor's degrees (between 50 and 90 percent). Taken together, the data show that professions that began with a greater degree of internal variation in 1960 have also experienced the greatest percentage increase in level of inequality.

While we cannot tell from our data what produced these trends, we speculate on some possible causes. First, the professionals who experienced smaller changes in levels of earnings inequality, such as engineers, teachers, and (to a lesser extent, especially at the advanced level) scientists, might be characterized as more technical and less specialized by subfield than other professionals. That is, practitioners within each of these professions tend to work in more similar settings and do more similar work than practitioners in some other professions. In contrast, the professionals who experienced the greatest inequality increases—medical doctors, lawyers, and social scientists—may have become more specialized and dissimilar in terms of where they work and what work they do. For instance, with the proliferation of medical specializations in the last 50 years, medical doctors may earn vastly different incomes depending on whether they are general practitioners or neurosurgeons; they also work in a variety of settings, from private practice to public hospitals, and receive differing amounts of public funds. Similarly, lawyers can now take on a wide variety of specializations, from

FIGURE 4B
90/10 Earnings Ratio within Profession, Male Advanced Level



corporate law to divorce, and work for a variety of agencies, from county governments to not-for-profit organizations to corporations. Meanwhile, further specialization of scientists may have occurred, but earnings inequality among basic scientists remains small relative to that among medical doctors and lawyers, perhaps due to the homogenizing forces of institutions where science is typically conducted.

Conclusion

A rise in economic inequality has become a hallmark of contemporary American society in the past few decades. What accounts for this rise in inequality in America? What is the role of education and the occupational structure in this rise?

In this article, we have tried to answer these questions with analyses of data from 1960–2000 decennial U.S. Censuses and 2006–2008 American Community Surveys. We paid close attention to what has happened to high-status occupations in the past five decades. A few findings have emerged from our study.

First, as has previously been documented, education premiums have increased. In an economy that is commonly characterized as a knowledge economy, or technologically driven economy, earnings returns to higher education, particularly at

higher tiers, have steadily and sharply increased. In short, education pays, now more than ever.

Second, within educational groups at the bachelor's level and above, between-occupation and within-occupation inequality increased at about the same rates, so that the portion attributable to occupational differences remained constant. We characterize this trend as the *constancy* of the mediating role of occupation in the broader context of an overall increase in economic inequality. Therefore, it is accurate to say that occupation is increasingly important in determining economic outcomes, as between-occupation inequality has increased, even among individuals of the same sex and educational attainment. However, it is also accurate to say that residual inequality has increased, as there is a growing divergence among individuals within the same occupation, again controlling for sex, age, work hours, and education. The pattern may thus be characterized as an expansion in the income distribution that has exerted a similar "stretch" into both differences between occupations and those within occupations.

Third, examining a select group of high-status professions at bachelor's, master's, and doctoral levels of education, we gain new insights into trends in earnings differences across occupations. Relative to the earnings of those in other professions demanding similar education, the earnings of basic scientists generally declined since 1960. In short, science does not pay as well as it used to. In an economy commonly understood as being driven by technology, why are other highly educated professionals better rewarded than scientists, the very workers who produce technology? Among scientific workers, including scientists, computer scientists, and engineers, why have wages increased more for those in the applied as opposed to basic sciences? We explore possible explanations for these puzzles in our other work (Xie and Killewald 2012).

Finally, trends in within-occupation inequality also vary across different high-status occupations and at different educational levels. It seems that inequality grew the fastest when work was relatively unstructured (as in medicine and law) and the slowest when work was relatively structured (as in engineering and teaching). This final finding suggests the limitation of drawing inferences about the decomposition of trends in inequality to an "average" between-occupation portion and an average within-occupation portion, because such averages mask substantial differences across occupations. That is, the within-occupation earnings variability also varies by occupation.

In other words, our findings show that occupations *differ* from one another not only in terms of vertical socioeconomic standing (Duncan 1961; Hauser and Warren 1997) and class-like social enclosure and institutionalization (Grusky 2005; Weeden and Grusky 2005) but also in terms of within-occupation heterogeneity: the social meaning of an occupation varies by occupation. Some occupations (such as engineering, nursing, and teaching) are relatively homogeneous, as they are composed of jobs that require similar levels of training and demand similar tasks on the job. Other occupations, such as sales work and management, are highly heterogeneous. It is sometimes only for accounting purposes that we collapse certain highly heterogeneous jobs into an occupation. For our study of high-status occupations, we suspect that some professional occupations, such as

medicine and law, have become more heterogeneous over time in the United States, resulting in a sharp increase in within-occupation earnings inequality in these occupations. More research is needed to help us understand how differential within-occupation heterogeneity and its differential growths have contributed to overall changes in earnings inequality in the labor market.

Appendix A

Occupational Categories (with 2000 Census occupational titles)

Life scientists: Agriculture and food scientists; Biological scientists; Conservation scientists and foresters; Medical scientists; Professors and post-secondary instructors, life sciences (imputed in 2000 and 2007)

Physical scientists: Astronomers and physicists; Atmospheric and space scientists; Chemists and materials scientists; Environmental scientists and geoscientists; Physical scientists, all other; Professors and post-secondary instructors, physical sciences (imputed in 2000 and 2007)

Social scientists: Economists; Market and survey researchers; Psychologists; Sociologists; Urban and regional planners; Miscellaneous social scientists and related workers

Mathematicians: Actuaries; Mathematicians; Statisticians; Miscellaneous mathematical science occupations; Professors and postsecondary instructors, mathematical (imputed in 2000 and 2007)

Engineers: Aerospace engineers; Agricultural engineers; Biomedical engineers; Chemical engineers; Civil engineers; Computer hardware engineers; Electrical and electronics engineers; Environmental engineers; Industry engineers, including health and safety; Materials engineers; Mechanical engineers; Mining and geological engineers, including mining safety engineers; Nuclear engineers; Petroleum engineers; Engineers, all other; Sales engineers; Professors and post-secondary instructors, engineering (imputed in 2000 and 2007)

Architects: Architects, except naval

Physicians, dentists, and related practitioners: Chiropractors; Dentists; Optometrists; Physicians and surgeons; Podiatrists; Audiologists; Veterinarians; Health diagnosing and treating practitioners, all other

Nurses, dietitians, therapists: Dieticians and nutritionists; Pharmacists; Physician assistants; Registered nurses; Occupational therapists; Physical therapists; Radiation therapists; Recreational therapists; Respiratory therapists; Speech-language therapists; Therapists, all other; Massage therapists

Elementary and preschool teachers: Preschool and kindergarten teachers; Elementary and middle school teachers

Secondary, vocational, and adult education teachers: Secondary school teachers; Special education teachers; Other teachers and instructors; Other education, training, and library workers

Postsecondary teachers: Postsecondary teachers (unless otherwise noted)

Health technicians: Clinical laboratory technologists and technicians; Dental hygienists; Diagnostic related technologists and technicians; Emergency medical technicians and paramedics; Health diagnosing and treating practitioner support technicians; Medical records and health information technicians; Opticians, dispensing; Miscellaneous health technologists and technicians; Other healthcare practitioners and technical occupations; Medical, dental, and ophthalmic laboratory technicians

All other technicians: Appraisers and assessors of real estate; Surveyors, cartographers, and photogrammetrists; Marine engineers and naval architects; Drafters; Engineering technicians, except drafters; Surveying and mapping technicians; Agricultural and food science technicians; Biological technicians; Chemical technicians; Geological and petroleum technicians; Nuclear technicians; Other life, physical, and social science technicians; Paralegals and legal assistants; Miscellaneous legal support workers; Library technicians; Miscellaneous media and communication workers; Broadcast and sound engineering technicians and radio operators; Television, video, and motion picture camera operators and editors; Media and communication equipment workers, all other; Animal trainers; Aircraft pilots and flight engineers; Air traffic controllers and airfield operations specialists; Locomotive engineers and operators; Railroad brake, signal, and switch operators; Railroad conductors and yardmasters; Subway, streetcar, and other rail transportation workers; Ship and boat captains and operators; Ship engineers; Bridge and lock tenders; Transportation inspectors

Computer specialists: Computer scientists and systems analysts; Computer programmers; Computer software engineers; Computer support specialists; Database administrators; Network and computer systems administrators; Network systems and data communications analysts; Operations research analysts; Computer control programmers and operators; Professors and post-secondary instructors, computer science (imputed in 2000 and 2007)

Writers, artists and media workers: Artists and related workers; Designers; Actors; Producers and directors; Athletes, coaches, umpires, and related workers; Dancers and choreographers; Musicians, singers, and related workers; Entertainers and performers, sports and related workers, all other; Announcers; News analysts, reporters and correspondents; Public relations specialists; Editors; Technical writers; Writers and authors; Photographers

Lawyers and judges: Lawyers; Judges, magistrates, and other judicial workers

Librarians, archivists, and curators: Archivists, curators, and museum technicians; Librarians

Social and recreation workers: Counselors; Social workers; Miscellaneous community and social service specialists; Recreation and fitness workers; Residential advisors

Religious workers: Clergy; Directors, religious activities and education; Religious workers, all other

Accountants and financial analysts: Financial managers; Cost estimators; Accountants and auditors; Budget analysts; Credit analysts; Financial analysts; Personal financial advisors; Insurance underwriters; Financial examiners; Loan

counselors and officers; Tax examiners, collectors, and revenue agents; Tax preparers; Financial specialists, all other

Administrators and public officers: Legislators; Administrative services managers; Education administrators; Natural sciences managers; Postmasters and mail superintendents; Social and community service managers; Compliance officers, except agriculture, construction, health and safety, and transportation

Managers and proprietors: Chief executives; General and operations managers; Advertising and promotions managers; Marketing and sales managers; Public relations managers; Computer and information systems managers; Human resources managers; Industrial production managers; Purchasing managers; Transportation, storage, and distribution managers; Farm, ranch, and other agricultural managers; Construction managers; Engineering managers; Food service managers; Funeral directors; Gaming managers; Lodging managers; Medical and health services managers; Property, real estate, and community association managers; Managers, all other; Purchasing agents and buyers, farm products; Wholesale and retail buyers, except farm products; Purchasing agents, except wholesale, retail and farm products; Human resources, training, and labor relations specialists; Management analysts; Other business operations specialists

Sales workers, retail: First-line supervisors/managers of retail sales workers; Cashiers; Counter and rental clerks; Parts salespersons; Retail salespersons; Door-to-door sales workers, news and street vendors, and related workers

Sales workers: Agents and business managers of artists, performers, and athletes; First-line supervisors/managers of non-retail sales workers; Advertising sales agents; Insurance sales agents; Securities, commodities, and financial service sales agents; Travel agents; Sales representatives, services, all other; Sales representatives, wholesale and manufacturing; Models, demonstrators, and product promoters; Real estate brokers and sales agents; Telemarketers; Sales and related workers, all other; Reservation and transportation ticket agents and travel clerks

Clerical workers: Claims adjusters, appraisers, examiners, and investigators; Logisticians; Meeting and convention planners; Teacher assistants; First-line supervisors/managers of gaming workers; Gaming service workers; First-line supervisors/managers of office and administrative support workers; Switchboard operators, including answering service; Telephone operators; Communications equipment operators, all other; Bill and account collectors; Billing and posting clerks and machine operators; Gaming cage workers; Payroll and timekeeping clerks; Procurement clerks; Tellers; Brokerage clerks; Correspondence clerks; Court, municipal, and license clerks; Credit authorizers, checkers, and clerks; Customer service representatives; Eligibility interviewers, government programs; File clerks; Hotel, motel, and resort desk clerks; Interviewers, except eligibility and loan; Library assistants, clerical; Loan interviewers and clerks; New accounts clerks; Order clerks; Human resources assistants, except payroll and timekeeping; Receptionists and information clerks; Information and record clerks, all other; Cargo and freight agents; Couriers and messengers; Dispatchers; Meter readers, utilities; Postal service clerks; Postal service mail carriers; Postal service mail sorters, processors, and processing machine operators; Production, planning, and expediting clerks; Shipping, receiving, and traffic clerks; Stock

clerks and order fillers; Weighers, measurers, checkers, and samplers, recordkeeping; Computer operators; Data entry keyers; Word processors and typists; Desktop publishers; Insurance claims and policy processing clerks; Mail clerks and mail machine operators, except postal service; Office clerks, general; Office machine operators, except computer; Proofreaders and copy markers; Statistical assistants; Office and administrative support workers, all other

Bookkeepers: Bookkeeping, accounting, and auditing clerks

Secretaries: Secretaries and administrative assistants

Mechanical workers: Elevator installers and repairers; First-line supervisors/managers of mechanics, installers, and repairers; Computer, automated teller, and office machine repairers; Radio and telecommunications equipment installers and repairers; Avionics technicians; Electric motor, power tool, and related repairers; Electrical and electronics installers and repairers, transportation equipment; Electrical and electronics repairers, industrial and utility; Electronic equipment installers and repairers, motor vehicles; Electronic home entertainment equipment installers and repairers; Security and fire alarm systems installers; Aircraft mechanics and service technicians; Automotive body and related repairers; Automotive glass installers and repairers; Automotive service technicians and mechanics; Bus and truck mechanics and diesel engine specialists; Heavy vehicle and mobile equipment service technicians and mechanics; Small engine mechanics; Miscellaneous vehicle and mobile equipment mechanics, installers, and repairers; Control and valve installers and repairers; Heating, air conditioning, and refrigeration mechanics and installers; Home appliance repairers; Industrial and refractory machinery mechanics; Maintenance and repair workers, general; Maintenance workers, machinery; Telecommunications line installers and repairers; Coin, vending, and amusement machine services and repairers; Locksmiths and safe repairers; Riggers; Signal and track switch repairers; Engine and other machine assemblers

Carpenters: Carpenters; Cabinetmakers and bench carpenters; Model makers and patternmakers, wood; Woodworking machine setters, operators, and tenders, except sawing; Woodworkers, all other

Electricians: Electricians; Electrical power-line installers and repairers; Precision instrument and equipment repairers

Construction workers: First-line supervisors/managers of construction trades and extraction workers; Brickmasons, blockmasons, and stonemasons; Carpet, floor, and tile installers and finishers; Cement masons, concrete finishers, and terrazzo workers; Paving, surfacing, and tamping equipment operators; Pile-driver operators; Drywall installers, ceiling tile installers, and tapers; Glaziers; Insulation workers; Painters, construction and maintenance; Paperhangers; Pipelayers, plumbers, pipefitters, and steamfitters; Plasterers and stucco masons; Reinforcing iron and rebar workers; Roofers; Sheet metal workers; Structural iron and steel workers; Construction and building inspectors; Fence erectors; Hazardous materials removal workers; Septic tank services and sewer pipe cleaners; Miscellaneous construction and related workers; Manufactured building and mobile home installers

Craftsmen: Boilermakers; Millwrights; First-line supervisors/managers of production and operating workers; Aircraft structure, surfaces, rigging, and systems assemblers; Electrical, electronics, and electromechanical assemblers; Structural metal fabricators and fitters; Bakers; Food batchmakers; Model makers and patternmakers, metal and plastic; Molders and molding machine setters, operators, and tenders, metal and plastic; Tool and die makers; Welding, soldering, and brazing workers; Lay-out workers, metal and plastic; Tool grinders, filers, and sharpeners; Metalworkers and plastic workers, all other; Bookbinders and bindery workers; Fabric and apparel patternmakers; Upholsterers; Furniture finishers; Jewelers and precious stone and metal workers; Photographic process workers and processing machine operators; Semiconductor processors; Etchers and engravers; Molders, shapers, and casters, except metal and plastic; Tire builders

Textile machine operators: Laundry and dry-cleaning workers; Pressers, textile, garment, and related materials; Sewing machine operators; Shoe and leather workers and repairers; Shoe machine operators and tenders; Tailors, dressmakers, and sewers; Textile bleaching and dyeing machine operators and tenders; Textile cutting machine setters, operators, and tenders; Textile knitting and weaving machine setters, operators, and tenders; Textile winding, twisting, and drawing out machine setters, operators, and tenders; Textile, apparel, and furnishings workers, all other

Metalworking and transportation operators: Highway maintenance workers; Rail-track laying and maintenance equipment operators; Commercial drivers; Extruding and drawing machine setters, operators, and tenders, metal and plastic; Forging machine setters, operators, and tenders, metal and plastic; Rolling machine setters, operators, and tenders, metal and plastic; Cutting, punching, and press machine setters, operators, and tenders, metal and plastic; Drilling and boring machine tool setters, operators, and tenders, metal and plastic; Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic; Lathe and turning machine tool setters, operators, and tenders, metal and plastic; Milling and planing machine setters, operators, and tenders, metal and plastic; Machinists; Metal furnace and kiln operators and tenders; Multiple machine tool setters, operators, and tenders, metal and plastic; Heat treating equipment setters, operators, and tenders, metal and plastic; Plating and coating machine setters, operators, and tenders, metal and plastic; Extruding, forming, pressing, and compacting machine setters, operators, and tenders; Cleaning, washing, and metal pickling equipment operators and tenders; Supervisors, transportation and material moving workers; Ambulance drivers and attendants, except emergency medical technicians; Bus drivers; Driver/sales workers and truck drivers; Taxi drivers and chauffeurs; Motor vehicle operators, all other; Sailors and marine oilers; Other transportation workers; Industrial truck and tractor operators; Shuttle car operators; Tank car, truck, and ship loaders; Material moving workers, all other

Operators, except textile, metalworking and transportation: Motion picture projectionists; Operating engineers and other construction equipment operators; Derrick, rotary drill, and service unit operators, oil, gas, and mining; Earth drillers, except oil and gas; Explosives workers, ordnance handling experts, and blasters; Mining machine operators; Roof bolters, mining; Other extraction workers;

Miscellaneous assemblers and fabricators; Butchers and other meat, poultry, and fish processing workers; Food and tobacco roasting, baking, and drying machine operators and tenders; Food cooking machine operators and tenders; Job printers; Prepress technicians and workers; Printing machine operators; Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers; Sawing machine setters, operators, and tenders, wood; Power plant operators, distributors, and dispatchers; Stationary engineers and boiler operators; Water and liquid waste treatment plant and system operators; Miscellaneous plant and system operators; Chemical processing machine setters, operators, and tenders; Crushing, grinding, polishing, mixing, and blending workers; Cutting workers; Furnace, kiln, oven, drier, and kettle operators and tenders; Inspectors, testers, sorters, samplers, and weighers; Packaging and filling machine operators and tenders; Painting workers; Cementing and gluing machine operators and tenders; Cooling and freezing equipment operators and tenders; Paper goods machine setters, operators, and tenders; Production workers, all others; Conveyor operators and tenders; Crane and tower operators; Dredge, excavating, and loading machine operators; Hoist and winch operators

Laborers, except farm: Grounds maintenance workers; Nonfarm animal caretakers; Construction laborers; Helpers, construction trades; Roustabouts, oil and grease; Helpers- extraction workers; Helpers- installation, maintenance, and repair workers; Other installation, maintenance, and repair workers; Helpers-production workers; Service station attendants; Cleaners of vehicle and equipment; Laborers and freight, stock, and material movers, hand; Machine feeders and offbearers; Packers and packagers, hand; Pumping station operators; Refuse and recyclable material collectors

Farmers and farm laborers, including forestry and fishing: Farmers and ranchers; Fish and game wardens; First-line supervisors/managers of farming, fishing, and forestry workers; Agricultural inspectors; Animal breeders; Graders and sorters, agricultural products; Miscellaneous agricultural workers; Fishers and related fishing workers; Hunters and trappers; Forest and conservation workers; Logging workers

Cleaning service and food service workers: Chefs and head cooks; First-line supervisors/managers of food preparation and serving workers; Cooks; Food preparation workers; Bartenders; Combined food preparation and serving workers, including fast food; Counter attendants, cafeteria, food concession, and coffee shop; Waiters and waitresses; Food servers, nonrestaurant; Dining room and cafeteria attendants and bartender helpers; Dishwashers; Hosts and hostesses, restaurant, lounge, and coffee shop; Food preparation and serving related workers, all other; First-line supervisors/managers of housekeeping and janitorial workers; First-line supervisors/managers of landscaping, lawn service, and groundskeeping workers; Janitors and building cleaners; Maids and housekeeping cleaners; Pest control workers

Health service workers: Licensed practical and licensed vocational nurses; Nursing, psychiatric, and home health aides; Occupational therapist assistants and aides; Physical therapist assistants and aides; Dental assistants; Medical assistant and other healthcare support occupations

Personal service workers and barbers: First-line supervisors/managers of personal service workers; Ushers, lobby attendants, and ticket takers; Miscellaneous entertainment attendants and related workers; Funeral service workers; Barbers; Hairdressers, hairstylists, and cosmetologists; Miscellaneous personal appearance workers; Baggage porters, bellhops, and concierges; Tour and travel guides; Transportation attendants; Child care workers; Personal and home care aides; Personal care and service workers, all other; Parking lot attendants

Protective service workers: First-line supervisors/managers of correctional officers; First-line supervisors/managers of police and detectives; First-line supervisors/managers of fire fighting and prevention workers; Supervisors, protective service workers, all other; Fire fighters; Fire inspectors; Bailiffs, correctional officers, and jailers; Detectives and criminal investigators; Parking enforcement workers; Police and sheriff's patrol officers; Transit and railroad police; Animal control workers; Private detectives and investigators; Security guards and gaming surveillance officers; Crossing guards; Lifeguards and other protective service workers

Appendix B

Imputation Method for Advanced Degrees

For Figure 1, we used proportions of master's and doctoral degree holders (P_m and P_p) and the earnings premium of a doctoral degree over a master's degree (*premium* (p)) from 1980 to decompose the estimated premium in log of earnings of an advanced degree over a high school diploma in a given year (γ_Y) into separate premiums for a master's (λ_{mY}) and doctoral (λ_{pY}) degree over a high school diploma, controlling for age and work hours per week. The following two equations describe the relationships (separately by sex):

$$\gamma_Y = P_m * \boldsymbol{\lambda_{mY}} + P_p * \boldsymbol{\lambda_{pY}}$$
$$premium(p) = \boldsymbol{\lambda_{pY}} - \boldsymbol{\lambda_{mY}}$$

These equations allow us to solve for the two unknowns, highlighted in bold font. In Figure 3, we used 1980 proportions of master's and doctoral degree holders (P_{mK} and P_{pK}) for each profession (K) among advanced degree holders and assuming a constant 1980 earnings premium of a doctoral degree over a master's degree for each profession [*premium* (p_K)] in order to impute the earnings ratios of other professions to scientists at the master's and doctoral levels in 1960 and 1970 (controlling for age and work hours per week). Due to the constancy assumptions, we can estimate these quantities from the 1980 data. To these pieces of information, we further add the estimated difference in log earnings between scientists and members in each profession among those with advanced degrees (γ_{YK}) (controlling for age and work hours per week) in the year (Y) for which we are imputing. The following two equations describe the decompositional relationships (separately by sex):

$$\gamma_{YK} = P_{mK} * \boldsymbol{\lambda_{mYK}} + P_{pK} * \boldsymbol{\lambda_{pYK}}$$
$$\boldsymbol{\lambda_{pYK}} = premium\left(p_K\right) + \boldsymbol{\lambda_{mYK}}.$$

Given the two equations, we can solve for two unknowns, highlighted by bold fonts in the two equations. Note that $\gamma_{YK} = 0$ for basic scientists as a special case.

Notes

1. In collapsing detailed occupations into these forty-one categories in different years, we made every effort to maintain comparability over time. See www.yuxie.com for a complete occupation coding scheme, and see Xie and Killewald (2012) for details on coding academics in the 2000 Census and the 2006–2008 ACS. We slightly revised the codes used in Xie and Killewald (2012) so that the results reported here are not exactly as those in Xie and Killewald (2012).

2. Respondents with a bachelor's degree are much more common than respondents with an advanced degree, but respondents with 17 years of education represent a much larger proportion of respondents with an advanced degree than they do respondents with a bachelor's degree.

References

Acemoglu, Daron. 2002. Why do new technologies complement skills? Directed technical change and wage inequality. *Quarterly Journal of Economics* 113:1055–89.

Atkinson, Richard D. 1990. Supply and demand for scientists and engineers: A national crisis in the making. *Science* 248:425–32.

Autor, David H., Lawrence F. Katz, and Melissa S. Kearney. 2006. The polarization of the U.S. labor market. *American Economic Review* 96:189–94.

Autor, David H., Lawrence F. Katz, and Melissa S. Kearney. 2008. Trends in U.S. wage inequality: Revising the revisionists. *Review of Economics and Statistics* 90:300–323.

Autor, David H., Frank Levy, and Richard J. Murnane. 2003. The skill content of recent technological change: An empirical investigation. *Quarterly Journal of Economics* 118:1279–1333.

Ben-David, Joseph. 1971. *The scientist's role in society: A comparative study*. Chicago, IL: University of Chicago Press.

Bernhardt, Annette, Martina Morris, Mark S. Handcock, and Marc A. Scott. 2001. *Divergent paths: Economic mobility in the new American labor market*. New York, NY: Russell Sage Foundation.

Blau, Peter, and Otis Dudley Duncan. 1967. *The American occupational structure*. New York, NY: Free Press.

Bound, John, and George Johnson. 1992. Changes in the structure of wages in the 1980's: An evaluation of alternative explanations. *American Economic Review* 82:371–92.

Butz, William P., Gabrielle A. Bloom, Mihal E. Gross, Terrence K. Kelly, Aaron Kofner, and Helga E. Rippen. 2003. Is there a shortage of scientists and engineers? How would we know? RAND Science and Technology Issue Paper, RAND, Santa Monica, CA.

Card, David, and John E. DiNardo. 2002. Skill-biased technological change and rising wage inequality: Some problems and puzzles. *Journal of Labor Economics* 20:733–83.

Duncan, Otis Dudley. 1961. A socioeconomic index for all occupations. In *Occupations and social status*, ed. Alert J. Reiss Jr., 109–38. New York, NY: Free Press.

Ezell, Stephen J., and Robert D. Atkinson. 2008. *RAND's rose-colored glasses: How RAND's report on U.S. competitiveness in science and technology gets it wrong*. The Information Technology and Innovation Foundation. Available from http://www.itif.org (accessed 23 July 2010).

Featherman, David L., and Robert M. Hauser. 1978. *Opportunity and change*. New York, NY: Academic Press.

Fischer, Claude S., and Michael Hout. 2006. *Century of difference: How America changed in the last one hundred years*. New York, NY: Russell Sage Foundation.

Galama, Titus, and James Hosek, eds. 2008. *U.S. competitiveness in science and technology*. Santa Monica, CA: RAND.

Goldin, Claudia, and Lawrence F. Katz. 2008. *The race between education and technology*. Cambridge, MA: The Belknap Press of Harvard University Press.

Grogan, William R. 1990. Engineering's silent crisis. *Science* 247:381.

Grusky, David B. 2005. Foundations of a neo-Durkheimian class analysis. In *Approaches to a class analysis*, ed. Erik O. Wright, 51–81. New York, NY: Cambridge University Press.

Hauser, Robert M., and John Robert Warren. 1997. Socioeconomic indexes for occupations: A review, update, and critique. *Sociological Methodology* 27:177–298.

Holt, Charles A., and Susan K. Laury. 2002. Risk aversion and incentive effects. *American Economic Review* 92 (5): 1644–55.

Juhn, Chinhui, Kevin M. Murphy, and Brooks Pierce. 1993. Wage inequality and the rise in returns to skill. *Journal of Political Economy* 101:410–42.

Katz, Lawrence F., and Kevin M. Murphy. 1992. Changes in relative wages, 1963-1987: Supply and demand factors. *Quarterly Journal of Economics* 107:35–78.

Kim, ChangHwan, and Arthur Sakamoto. 2008. The rise of intra-occupational wage inequality in the United States, 1983 to 2002. *American Sociological Review* 73:129–57.

Lemieux, Thomas. 2008. The changing nature of wage inequality. *Journal of Population Economics* 21:21–48.

Levy, Frank. 1995. Incomes and income inequality. In *State of the Union: America in the 1990s*, vol. 1, ed. Reynolds Farley, 1–57. New York, NY: Russell Sage Foundation.

Levy, Frank, and Richard J. Murnane. 1992. U.S. earnings levels and earnings inequality: A review of recent trends and proposed explanations. *Journal of Economic Literature* 30:1333–81.

Lowell, B. Lindsay, and Hal Salzman. 2007. Into the eye of the storm: Assessing the evidence on science and engineering education, quality, and workforce demand. Unpublished manuscript, The Urban Institute, Washington, DC.

Mankiw, N. Gregory. 2003. *Principles of microeconomics*. 3rd ed. Boston, MA: South-Western College.

Massey, Douglas S., and Deborah S. Hirst. 1998. From escalator to hourglass: Changes in the U.S. occupational wage structure, 1948-1989. *Social Science Research* 27:51–71.

Mincer, Jacob. 1997. Changes in wage inequality, 1970-1990. In *Research in labor economics*, vol. 16, ed. S. W. Polacheck, 1–18. Greenwich, CT: JAI Press.

Morris, Martina, and Bruce Western. 1999. Inequality in earnings at the close of the twentieth century. *Annual Review of Sociology* 25:623–57.

Mouw, Ted, and Arne L. Kalleberg. 2010. Occupations and the structure of wage inequality in the United States, 1980s to 2000s. *American Sociological Review* 75:402–31.

National Academy of Science, National Academy of Engineering, and Institute of Medicine. 2007. *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: National Academies Press.

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick. 2008. *Beyond Sputnik: U.S. science policy in the twenty-first century*. Ann Arbor, MI: University of Michigan Press.

Romer, Paul M. 1990. Endogenous technological change. *Journal of Political Economy* 98:S5–S71.

Ruggles, Steven, J. Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek. 2010. Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]. Minneapolis, MN: University of Minnesota.

Solow, Robert M. 1957. Technical change and the aggregate production function. *Review of Economics and Statistics* 39:312–20.

Treiman, Donald. 1977. *Occupational prestige in comparative perspective*. New York, NY: Academic Press.

Weeden, Kim A., and David B. Grusky. 2005. The case for a new class map. *American Journal of Sociology* 111:141–212.

Weeden, Kim A., Young-Mi Kim, Matthew Di Carlo, and David B. Grusky. 2007. Social class and earnings inequality. *American Behavioral Scientist* 50:702–36.

Wright, Erik Olin, and Rachel E. Dwyer. 2003. The patterns of job expansions in the U.S.A.: A comparison of the 1960s and 1990s. *Socio-Economic Review* 1:289–325.

Xie, Yu, and Alexandra Killewald. 2012. *Is American science in decline?* Cambridge, MA: Harvard University Press.

Xie, Yu, and Kimberlee A. Shauman. 1997. Modeling the sex-typing of occupational choice: Influences of occupational structure. *Sociological Methods and Research* 26:233–61.