The Increasing Complementarity between Cognitive and Social Skills

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Abstract: Data linking 1972 and 1992 adolescent skill endowments to adult outcomes reveals increasing complementarity between cognitive and social skills. In fact, previously noted growth in demand for cognitive skills affected only individuals with strong endowments of both social and cognitive skills. These findings are corroborated using Census and CPS data matched with DOT job task measures; employment in and earnings premia to occupations requiring high levels of both cognitive and social skill grew substantially compared with occupations that require only one or neither type of skill, and this emerging feature of the labor market has persisted into the new millennium.

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The importance to labor market outcomes of an individual worker's "social skills," including leadership, communication, and other interpersonal skills, has been firmly established.[1] A more elusive claim--that the relative importance of social skills is growing over time--is motivated by anecdotal evidence about what employers say they are looking for (e.g. Goleman, 1997, 1998, NACE 2000, Moss and Tilly, 2001, Chapple, 2006), and by evidence of rising pay and growing employment in occupations with complex interpersonal skill requirements (Autor, Levy and Murnane, 2003, Black and Spitz-Oener 2010, Borghans, ter Weel and Weinberg 2008, 2014, Bacolod and Blum 2010). Previous research has not carefully investigated whether there has been a between-cohort shift in the demand for workers with pre-labor market endowments of interpersonal skill. Kuhn and Weinberger (2005) provide evidence suggesting a shift, but newly available data facilitate more precise comparisons between cohorts. In this paper, virtually identical measures taken before labor market entry of two cohorts of high school seniors twenty years apart are used to estimate the extent to which the earnings premia associated with social skills, and combinations of both social and cognitive skills, have changed over time. The time-trends suggested by comparison of these two cohorts are then corroborated using decennial or annual observations drawn from Census and CPS surveys.

A model developed by Autor, Levy and Murnane (2003) posits that computerization has enhanced the productivity of those who engage in complex communications or problem-solving tasks.[2] Consistent with this model, they document a shift in the composition of jobs, with growing employment during the 1980s and 1990s in jobs that tend to require either complex interpersonal interactions (related to direction, control or planning) or analytic tasks (math skills) (Autor, Levy & Murnane, 2003). Borghans, ter Weel and Weinberg (2014) provide evidence that both employment levels in and the earnings premium to occupations requiring "people skills" grew during this period, with deceleration of the trend after the mid-1990s; they argue that initial computer technologies were complementary with interpersonal skills while more recent technologies are better able to substitute for human interactions.

[1] See Bowles, Gintis and Osborne (2001), Heckman and Kautz (2012), and Duncan and Dunifon (2012) for reviews.

[2] Other relevant papers investigating the impact of technological change on skills demanded in the labor market include Bartel, Ichniowski and Shaw (2007), Shaw, Beeson and Short-Sheppard (2001) and Weinberg (2000).

Previous studies had documented growth in the wage premium associated with pre-labor market endowments of math skills over the time interval 1979 to 1986 (Murnane, Willet and Levy, 1995, Grogger and Eide, 1995). Growing employment coupled with rising earnings premia provides evidence that the demand for math-related skills shifted outward over this period. However, Bowles, Gintis, and Osborne (2001) find no evidence that a trend toward higher returns to cognitive skills persisted over a longer time interval. The new data employed in this paper permit measurement of pre-labor market endowments of both social and math skills, and of the relationship between these early skill endowments and adult earnings over the longer time interval 1979 to 1999. In addition, the same measures used by Autor, Levy & Murnane (2003), are analyzed in a new framework to reveal the importance of trends in the demand for combinations of cognitive and social skills.

A related literature concerns the earnings premium associated with college graduation. It is well-known that the difference in earnings between college graduates and other workers is larger than it used to be, but it is unclear how much of this change is due to changes in the quantity or value of skills accrued in college. While there is evidence consistent with growing demand for workers with skill sets conferred in college (e.g. Card and Lemieux 2001, Grogger and Eide 1995), other possible (and not mutually exclusive) explanations include decreases in union influence leading to falling wages in the non-college sector (Card and DiNardo 2002), expansion of college opportunity to high value-added students via access to financial aid (Card 2001), and increasing labor market demand for unobserved skills that are correlated with college completion but predate college entry (Taber 2001).

The time period studied here has been marked by technological innovations that are believed to have changed workforce skill requirements. Bartel, Ichniowski & Shaw (2007) note simultaneity between the adoption of new IT-enhanced technologies, and training to enhance technical capabilities, complex communication skills, and teamwork. This observation suggests that the trend in demand for social skills related to complex interpersonal interactions and the contemporaneous trend in demand for math-related technical skills might both be the result of the same innovation process, and that these trends might be inextricably bound together. However, Handel (2014) argues that the majority of U.S. jobs require few skills, and that growing skill demands have not affected many workers.

There are therefore three open questions. The first is whether growing premia to math-related skills can be seen over a longer time horizon, the second is whether the wage premium associated with pre-labor-market endowments of social skills has also been growing, and the third question regards the interaction between these two trends. The answers to these questions are important to understanding the economic productivity of skill endowments or investments. The third question is the most important, as no previous research has explored whether the constellation of case studies documented by Bartel, Ichniowski & Shaw (2007) represents a trend so strong and widespread that it can be measured using national statistics on the distribution of earnings.

The first approach taken here is to examine adult earnings distributions, conditional on early endowments of both math-related and social skills, within each of two cohorts of young men who completed high school and entered the labor market twenty years apart. The second approach is to document trends in the relationship between earnings and occupation-specific skill sets, as measured more frequently in CPS and Census surveys.

Previous research has consistently documented earnings premia to early endowments associated with high school sports participation and other high school leadership activities (e.g. Barron, Ewing and Waddell 2000, Eide and Ronan 2001, Persico, Postlewaite and Silverman 2004, Kuhn and Weinberger 2005, Stevenson 2010). All of these studies find evidence that higher earnings reflect a combination of skills learned in the process of participation and the selection of capable, motivated individuals into high school roles. Bowles, Gintis and Osborne (2001) and Heckman, Stixrud and Urzua (2006) discuss the role of noncognitive skill as an input to the production of cognitive skill. But high school sports participants and other high school leaders earn higher wages as adults even after controlling for measures of cognitive skill including test scores and college graduation, (Kuhn and Weinberger 2005). Of particular relevance here, Kuhn and Weinberger (2005) documented the importance of social skill, as measured by psychological inventories of both sociability and leadership, as an explanatory factor in the wage premium to leaders.

The question of whether there is a time-trend in the premium enjoyed by high school leaders or sports participants has not previously been addressed in a systematic way. It is well documented that earnings dispersion increased throughout the 1980s and 1990s; a number of authors have interpreted this as a growing premium to unobserved skills (e.g.

Juhn, Murphy, Pierce 1993, Autor, Katz and Kearney 2006, 2008). However, this interpretation is controversial; for example, contemporaneous declines in union influence or other structural changes might have reduced earnings among less-skilled workers for reasons unrelated to the price of skill (e.g. Card and DiNardo 2002). Using direct, pre-labor market measures of usually unobserved characteristics, Kuhn and Weinberger (2005) found that the adult wage premium to high school leaders was larger in later cohorts, but the true magnitude of the change was confounded by differences between cohorts in both the leadership measures available and the time elapsed between high school and observation of adult wages. This paper is based on a more recent data set with 1999 labor market measures for 1992 seniors comparable to the 1979 measures previously available for 1972 seniors. This analysis shows that individuals who participated in high school sports, or who acted as high school leaders (in student clubs, publications, or performing arts groups) enjoyed a larger earnings premium seven years after high school if they were members of the later cohort.

A more nuanced analysis explores interactions and finds that, while math scores, sports, leadership roles, and college education are all associated with higher earnings over the entire 1979-1999 period, the time trend in the earnings premium was strongest among those individuals who participated in sports or leadership activities during high school *and* had higher levels of cognitive skills. Supporting evidence based on Census and CPS data matched with the Autor, Levy and Murnane (2003) job-task measures provides an independent observation also suggesting that the labor market increasingly favors workers with strong endowments of both cognitive and social skills. These findings, coupled with evidence of growing employment, suggest increasing complementarity between cognitive and social skills among young workers.

The trend described here is distinct from the increase in polarization identified by Autor and Dorn (2013); they observe that workers in occupations that had high average earnings in 1980 are increasingly favored relative to those in “middle skill” jobs with somewhat lower 1980 earnings. In fact, in both the longitudinal high school data, and also the Census and CPS data studied here, young workers with strong endowments of both cognitive and social skills earn a new premium today that did not exist in the 1980 economy.

These findings reveal a previously unappreciated component of well-documented shifts over the 1980s and 1990s toward greater earnings dispersion, higher returns to (cognitive) skill, and particularly pronounced changes in the fattening upper tail of the earnings distribution (e.g. Autor, Katz and Kearney, 2006, 2008). Evidence provided here suggests that a substantial portion of the change was driven by a small segment of the labor force, and that bundles of social skills and cognitive skills played an important role.

The Structure of Skill Premia

Suppose that some individuals are endowed with skills M or S, and that those using skill M on the job produce B_M more output than unskilled workers while those using skill S on the job produce B_S more output than unskilled workers. Then, under the assumptions that make labor economists' jobs easier (e.g. competitive markets, perfect and complete information), the wage premia to workers with only one skill or the other are likely to be $w_M=B_M$ and $w_S=B_S$. However, even in this simple situation it is hard to predict the productivity premium (B_{MS}) or wage premium (w_{MS}) among multiskilled workers endowed with both skills M and S. If workers can only use one skill at a time, then those endowed with both skills might choose to use the skill that brings the higher premium, earning $w_{MS} = B_{MS} = \max(B_M,B_S)$. This model is familiar to economists as a choice between fishing and hunting (Roy, 1951). If skills M and S can be used simultaneously, on the other hand, then a multiskilled worker will be more productive than a worker endowed with only one skill or the other, and might earn $w_{MS} = B_{MS} > \max(B_M,B_S)$. (Or, if only a few employers have invested in an expensive or proprietary new technology that enhances multiskilled workers' ability to use both skills at once, then perhaps the employer will reap the benefits: $B_{MS} > w_{MS} = \max(B_M,B_S)$). Borrowing from a concept used in utility theory, I will define "increasing complementarity" as a situation in which B_{MS} (or w_{MS}) increases over time more rapidly than B_M or B_S

The empirical approach depends on careful construction of an indicator of social skill that divides both cohorts of high school seniors into comparable higher- and lower-social skill portions. The thought experiment is contingent on the assumption that these categories capture exactly the same set of social skills in both cohorts. Under this assumption, between-cohort change in the associated earnings premium can be interpreted as a change in the social skill price, just as an increase in the premium to carefully standardized math scores can be interpreted as growth in the price of cognitive skill. To the extent possible within the space allotted here, evidence is presented in support of this assumption. However, the thought experiment will also open up questions that require further investigation.

Data and Descriptive Statistics

The statistical analysis is based on data from two National Center for Education Statistics (NCES) longitudinal studies of high school students: The National Longitudinal Study of the High School Class of 1972, and the National Education Longitudinal Study of 1988 (1992 seniors). Both surveys include senior year math scores, and comparable questions about extracurricular participation, leadership roles, and earnings 7 years after the senior year of high school.

Studies designed to reveal trends in U.S. math performance over time suggest that, among white 17-year-old men, performance on carefully standardized math tests did not change between the 1972 and 1992 cohorts, even as scores among black students were on a steep upward trend (NCES 1994). This stability of math performance over time among U.S. white male high school students (NCES 1994) underlies the decision to normalize math scores in each cohort to a percentile among all white men within each 12th grade base year sample. The percentile scores are then divided by 100 so that the scores range from 0 to 1 (with .5 representing the median score). In specifications where the math score is interacted with a time trend, .5 is subtracted from the score first, so that the coefficient on the math score level is estimated at the 50th percentile score (where the interaction is set to zero). For comparison, some specifications include a standardized normal version of the math score.

The primary reason for restriction of the NCES samples to white males is that similarity of endowments across cohorts does not hold for either black students or women. Math scores were stable across cohorts among white men, but not among black students (NCES 1994); meanwhile, women's participation in high school roles and activities changed dramatically during these years (Stevenson 2010, Weinberger 2014). Evidence that, among white men, patterns of selection to high school sports and other activities are also stable over time will be presented later (also see Appendix Table). The stability of both test scores and activity levels makes young white men the ideal group to implement a test requiring similar endowments across cohorts.

Although each survey asks a slightly different set of questions about extracurricular participation, the two surveys contain a subset of questions that are very similar across cohorts and maintain a stable share of white male students indicating involvement. The analysis is limited to the five kinds of activities covered by these questions: Sports (including both individual and team sports, varsity and junior varsity, competitive and intramural), clubs (vocational, hobby or academic), performing arts (including band, orchestra, chorus and theater), student publications (newspaper, yearbook, or literary magazine), and leadership roles in either clubs, performing arts, or student publications. Mean participation rates are described in Table 1, for three subsamples of each cohort: the full base-year sample, those followed for seven years, and those with full-time earnings data observed seven years after high school. In each of the six subsamples, 53-57 percent of the seniors participated in sports, 37-45 percent participated in clubs, 21-26 percent participated in performing arts, 14 percent participated in student publications, and 16-17 percent of students took a leadership role in clubs, performing arts or student publications. Tests for differences in means between different subsamples of a given cohort, and between the earlier and later cohorts for corresponding subsamples find very few differences that are both statistically significant and of substantial size.[3] The within-cohort similarity of observed characteristics across subsamples suggests that attrition from the longitudinal survey, and selection into the labor force, are nearly orthogonal to the variables of interest in this study. The between-cohort stability of participation rates, particularly in the "Sports or Other Leadership Role" category and its two components, is a necessary condition to support the assumed stability of selection to activities. Additional evidence supporting stability of selection is the observation that the correlation between math scores and selection to the "Sports or Other Leadership" category did not change between cohorts (0.15-0.16).

In addition to these participation measures, means of college graduation rates and the natural logarithm of real weekly earnings (among full-time workers) are displayed at the bottom of Table 1. The share of high school seniors who earned a college degree within seven years of high school grew from 0.27 to 0.33 between cohorts. The earnings measure shows no between-cohort change in the mean, but growing earnings dispersion. Some of the later analysis describes earnings outcomes using a measure of each workers's percentile rank

[3] Results of this analysis are available on request from the author.

in the earnings distribution, to control for the well-documented increase in earnings dispersion (as described by Juhn, Murphy and Pierce 1993, Blau and Kahn 1997).

Additional controls available for both cohorts include indicators of family structure and parent education, psychological measures, and behaviors related to college preparation. The family structure and college preparation variables are self-explanatory, but the psychological measures require some explanation. These are based on 4 questions from the Rosenberg Self-Esteem Scale and 3 questions from the Rotter Locus of Control Scale that were asked of seniors in both cohorts (Rosenberg 1965, Rotter 1966). The self-esteem measure reflects the degree to which a student feels good about himself, and the internal locus of control measure reflects the degree to which a student feels that hard work (rather than luck or circumstance) leads to success. Means of these variables are presented later in the paper (in the last two rows of Table 5, below each corresponding regression).

Occupation was coded to Census categories only for the earlier NCES cohort. This information is used to examine the relationship between high school endowments and occupational selection. Previous studies have demonstrated a link between AFQT scores and the cognitive demands of an individual's later occupation (Farkas, et. al. 1997), a link between high school leadership or sports activities and later entry into managerial occupations (Kuhn and Weinberger 2005), and links between multiple indicators of adolescent sociability and entry into jobs requiring "people" skills (Borghans, ter Weel and Weinberg 2008, 2014). The detailed data available for the earlier NCES cohort permits further investigation of the relationship between the measures of high school endowments used in this study and job task measures introduced by Autor, Levy and Murnane (2003).

However, due to the absence of comparable occupation data for the later cohort, occupational trends cannot be examined over the two NCES cohorts. For this reason, occupation and earnings data were drawn from the 1980, 1990 and 2000 Census, with samples representing male full-time workers in the non-military labor force. To extend the analysis forward in time, similar samples were drawn from the March Current Population Surveys (CPS) 1977 through 2012. Additional information on union coverage before 1990 was filled in using May CPS data. To maintain comparable selection over time, these Census and CPS samples were conditioned only on characteristics with consistent coding schemes: age, sex and (for the Census) place of birth in the U.S. Other characteristics, such as educational attainment and race, were coded differently in different years. Members of the armed forces were excluded due to changes in occupational coding detail. The Census and CPS samples all include earnings and occupation data, nationally representative of non-institutionalized civilian U.S. men.

In each of these samples, occupation was matched with two job task measures reflecting the average job requirements for what Autor, Levy & Murnane (2003) call "complex noncognitive" or "nonroutine interactive" tasks (e.g. responsibility for direction, control and planning) and "complex cognitive" or "nonroutine analytic" tasks (e.g. application of mathematics knowledge) among individuals in each given 3-digit occupation, as reported in the Dictionary of Occupational Titles (DOT). These measures take numerical values between 0 and 10, with 5 reflecting a median value within the 1960 task distribution (Autor, Levy & Murnane 2003). In this paper, I abbreviate the names of each measure, referring to them as "DOT-dcp" and "DOT-math."

These measures are job-specific indications of the typical skills required for competence in each occupation, originally devised to assist those advising the unemployed. Computer programmers and many technicians have high values of DOT-math but not DOT-dcp, while supervisors and news reporters have high values of DOT-dcp but not DOT-math. Managers, physicians and scientists tend to have high values of both types of skill. To divide the population into high and low skilled sectors, I arbitrarily chose the cut point DOT-dcp>5 and DOT-math>5. Autor, Murnane, Levy (2003) documented that, within the entire U.S. population, the share of employment in high skill occupations increased between 1977 and 2002. However, regressions displayed in Table 2 reveal that among the cohorts of men studied here all of the growth was in the category of jobs with *both* DOT-dcp>5 and DOT-math>5, while employment in occupations requiring high levels of one skill but not the other did not increase over time. This new observation motivates interest in the labor market for individuals with pre-labor market endowments of both cognitive and social skills.

Empirical Results on the Growing Returns to Cognitive and Social Skills, 1979-1999

The empirical analysis of the high school cohorts begins with cross-section earnings regressions for each of the two cohorts observed seven years after high school; these are displayed in Table 3. Pooled regressions to test for the statistical significance of time trends are deferred to Table 4. Columns 1 and 5 of Table 3 describe growth in the earnings premium to the entire group of sports participants and other high school leaders, with no other controls. Between cohorts the premium to this group doubled from 0.051 (standard error 0.014) to 0.126 (0.027).

The regressions displayed in columns 2-4 and 6-8 describe the leadership premium to three mutually exclusive categories of social engagement: Sports participants with no other leadership roles, those in other leadership roles but not sports, and those engaged in both sports and other leadership roles. The premium to each of these three categories is at least twice as large in the later cohort, whether or not a control for math scores is included. An indicator for participation in non-athletic activities, without rising to a leadership role by the senior year of high school, shows no correlation with earnings in either cohort.

Using either of two measures, the premium to math scores doubles between cohorts. The increasing earnings premium to math scores can also be seen after using rank in the earnings distribution as a control for growing dispersion, as depicted in Figure 1.

Table 4 explores the robustness and nature of the changes over time by pooling the two data sets and by including further controls and interactions. Column 1 of Table 4 presents a baseline model; the time-trend coefficient in the last row of this column shows that there is no overall time trend in earnings in the full, pooled sample. In column 2, time trend interactions capture trends in earnings premia within each of the four mutually exclusive categories. The trend is positive and statistically significant for the most endowed group with both above average math scores and high school interpersonal engagement (coefficient 0.063 with standard error 0.020). The trend is close to zero for the two intermediate groups (either above average math scores or interpersonal engagement), and negative for the least endowed omitted category (coefficient -0.039 with standard error 0.017). The statistically significant time trend within the "multiskilled" group, displayed in column 2, row 1, is the most important result of the paper. This estimate corresponds to the per-decade increase in the wage premium to multiskilled workers, w_{MS}.

In order to better understand the nature of the trend in the "multiskilled" premium, the next two columns of Table 4 explore the relationship between this trend and the contemporaneous trend in college completion rates. If it were the case that there was no change in either skill prices or college value-added, with the observed time trend driven entirely by growing college completion rates, then introduction of a single control for college degree attainment would eliminate the estimated time trend in the "multiskilled" premium. This control is added to the model in column 3. While the coefficient on math score levels drops (reflecting the high correlation between math scores and later college completion) the time trend in the "multiskilled" premium hardly changes at all. In column 4, the premium to college graduates (conditional on math scores) is allowed to depend on whether the graduate participated in high school sports or other leadership activities. This also has little effect on the trend in the "multiskilled" premium.

In column 5, additional interactions allow for the possibility that the earnings premium to college graduates of either type might have changed over time. This specification reveals that a growing premium to college graduates who were high school sports participants or other leaders is closely linked to the time trend in the "multiskilled" premium. There is no corresponding trend in the premium to other college graduates. This specification clarifies that most of the time trend towards higher earnings premia for college graduates is concentrated within the sports or leadership group, despite the fact that this group of college students grew larger (and perhaps less selective) over time. The column 5 results are consistent with a between-cohort shift in the labor market price of workers with high levels of both cognitive skills (as measured by either high school math scores or college graduation) and the usually unobserved characteristics associated with sports or leadership participation. However, given that selection to college is nonrandom and might have changed between cohorts, the coefficients in the column 5 specification do not identify causal effects of college graduation. In fact, even in a world where both college attendance and high school endowments could be randomly assigned, it might be impossible to disentangle either the magnitude of or the trend in the relative contributions of college attendance and high school endowments to the earnings premium (see e.g. Robins & Greenland 1992). While the relationships presented in columns 3-5 are intriguing, the reduced-form estimate presented in row 1 of column 2 is far easier to interpret, representing the per decade rate of change in the premium to multiskilled workers.

Returning focus to the column 2 specification of Table 4, it is important to investigate whether the trend in the multiskilled premium reflects a change in the pre-labor market characteristics of the multiskilled group, rather than growing demand for a fixed bundle of skills. Table 5 introduces a number of additional individual-level controls with means that changed between cohorts.[4] The first column of Table 5 presents a baseline specification with no new controls (but a slightly smaller sample size due to missing data for some controls), Columns 2-11 each introduce a different control for an observable characteristic of individual 12th graders reflecting family structure, psychological measures, and behaviors related to college preparation. Each added control is also allowed its own time-trend. Therefore, if the earlier results are driven by either changing endowments of traits related to one of the added controls, or by a growing labor market price of those traits, addition of the new pair of controls should reduce or eliminate the estimated trend in the multiskilled premium.

The results of this exercise show the robustness of the multiskilled trend to the inclusion of these controls; it remains statistically significant and large in every specification. The trend in the earnings premium to the multiskilled group remains between 0.063 and 0.068 in more than half of the specifications, and is only slightly reduced (from 0.066 to 0.059) by inclusion of controls for internal locus of control. Greater reductions to the 0.048-0.061 range (with standard errors no larger than 0.023) are seen after inclusion of controls related to the propensity to enroll in college (college-educated parent, at least 10 hours of homework per week, took a college entrance exam, and submitted multiple college applications). All but one of these college-related controls is more highly correlated with adult earnings in the later cohort. The final column of Table 5 includes all of the new controls, but without the corresponding new time trends, resulting in a relatively small reduction from 0.066 to 0.059. The consistent sensitivity to controls for indicators of college propensity, and particularly to the time trends interacted with these indicators, complement earlier observations to suggest once again that college might be an important pathway toward the growing premium to multiskilled individuals with early endowments of both high math scores and the characteristics associated with sports participation and other leadership experiences. The results displayed in Tables 3-5 strongly suggest that what had previously been interpreted as growing demand for cognitive skill was actually growing demand only for the subset of individuals who possess a combination of cognitive and social skills.

[4] The trends in means are mostly unsurprising (smaller families, better educated parents, rising self-esteem, and more time devoted to college preparation). However, note that the enormous increase in the share of high school students spending substantial time on homework might partially offset the decline in hours of study among college students that has been documented by Babcock and Marks (2011).

Before concluding the analysis of interaction effects, I emphasize that while the time trend in the earnings premium is largest among those with strong endowments of both cognitive and social skills (MS), there has been no decline in real weekly earnings among individuals who graduated high school with above-average endowments of either one type of skill (S) or the other (M). To illustrate this point, I present Figure 2, with mean real weekly earnings computed for three subsets of each cohort, according to high school skill endowments. This visual presentation clarifies that individuals with either high school sports or leadership experience *or* senior year math scores above the median (S or M, but not both) had similar average pay in both cohorts. However, the multiskilled group (MS) with both high school sports experience and high school math scores above the median enjoyed a premium that grew substantially between cohorts, while the low skill group fell behind.

Table 6 describes between-cohort comparisons of both earnings levels and rank, including some of the statistics used to generate Figure 2, followed by comparisons at even higher margins of cognitive skills. The large increase in real weekly earnings, and rank, can be seen in these even more highly selected groups of individuals with strong endowments of both cognitive and social skill. The disaggregated statistics also include a new finding that those with below-average test scores but high levels of social engagement did not experience the same decline in real earnings as their classmates with similarly low scores. There were large changes in opposite directions for the groups with the strongest and weakest skill endowments, but stability of inflation-adjusted earnings for intermediate groups.

It is likely that the declining relative and real earnings of the group with lowest skill is related to structural features of the economy unrelated to skill, as argued by Card and DiNardo (2002). For example, examination of CPS data on union representation set into the framework of this paper reveals that those in lower-skill occupations have been disproportionately affected by union decline. Among young men age 25-30 employed full-time in occupations that require high levels of either DOT-math or DOT-dcp skills, 21 percent of full-time workers were represented by a union in 1978-1980, compared to only 9 percent in 2010-2012. Among those in occupations with low requirements for both DOT-math and DOT-dcp skills, the decline was far greater: 40 percent were represented by a union in 1978-1980, compared to only 11 percent in 2010-2012. Nonetheless, the dramatic shift in the nature of skill premia *within* the higher-skill sector (depicted in Figure 2)—including the emergence of a new premium to individuals who possess bundles of both cognitive and social skill, relative to those who possess only one skill or the other—provides compelling evidence that something pertaining to skills has fundamentally changed.

Linking High School Skill Endowments to Occupational Outcomes

Recall that detailed occupation data are only available for the earlier cohort. I use these data to confirm the link between early endowments (as measured by senior year math scores and sports or leadership experiences) and the DOT-math and DOT-dcp job task measures associated with each occupation. The regressions presented in Table 7 confirm that individuals with stronger skill endowments as high school seniors tend to select into jobs requiring higher levels of skill. Columns 1 and 2 of Table 7 suggest that, among full-time workers, the tendency for the sports/leadership group to end up in occupations requiring more math could be mediated by an increased propensity to earn a college degree. After including the college control (column 2) the coefficient on high school sports or leadership drops to the size of the standard error. Hence, it is possible (though not necessarily the case) that selection to this set of cognitively challenging occupations is entirely due to cognitive skills as measured by math test scores and college graduation. In contrast, columns 3 and 4 verify that the sports/leadership group is likely to be employed in an occupation requiring higher levels of responsibility for direction, control and planning (DOT-dcp), even after controlling for high school math scores, psychological measures, and college completion. This is compelling evidence that participation in high school sports or leadership activities—a behavioral indicator of social skills—can be linked to the complex interpersonal skills studied by Autor, Levy and Murnane (2003). Column 5 introduces a last bit of information about an individual's cognitive ability: a measure of whether the individual is in a more cognitively demanding job than would be predicted on the basis of other observed characteristics (the residual DOT-math skill level, after subtracting out the DOT-math skill level that would be predicted by the column 2 regression). This regression confirms that individuals with higher than predicted occupational achievement in one domain (DOT-math) also tend to have higher occupational achievement in the other (DOT-dcp). But the Sports or Leadership coefficient remains robust to inclusion of this additional information about an individual's cognitive ability, strengthening the case that individuals from the sports/leadership group select into high DOT-dcp occupations for reasons unrelated to cognitive skill endowments or requirements.

Empirical Results Based on Census and CPS Data

Even after establishing this link between the measures, it is surprising to see how closely the patterns observed in Figure 3 (with groups defined by occupation) correspond to the patterns observed in Figure 2 (with groups defined by high school activities). Figure 3 shows a growing earnings premium to young men employed in multiskilled occupations requiring high levels of both social and cognitive skill, fairly constant real earnings among those employed in occupations requiring high levels of either social or cognitive skill (but not both), and falling real earnings among those in lower skill occupations. As in Figure 2, the skill premium depends only on the requirement for either social *or* cognitive skill in 1979, but by 1989 there is an additional premium to occupations requiring both.

Statistics presented in the first panel of Table 8 confirm that a similar pattern is seen when relative labor market outcomes are measured by percentile rank in the earnings distribution, rather than relative earnings. Among young workers employed in occupations requiring strong endowments of both type of skill, relative earnings rose quickly during the 1980s. In both CPS and Census data, the earnings rank among young workers in this set of occupations grew 5 percentile points over a decade, and the higher relative earnings level persisted across longer time intervals. Figure 4, based on CPS data, illustrates the persistence of this shift despite the recent economic downturn. The estimates based on earnings rank are particularly important because they clarify that the emerging wage premium to the group with both types of skill is not simply an artifact of growing earnings dispersion or polarization. Groups of young workers with similar or identical average earnings in 1979 have a new differential that emerged during the 1980s, and has persisted for two decades.

The remaining panels of Table 8 suggest that growth in the relative earnings of multiskilled workers is more muted but still significant among slightly older workers in the 30-44 age group, and is nonexistent within the 45-59 age group. This might reflect the tendency of wages to be more sensitive to current labor market conditions among younger, entering workers. However, regression analysis with occupation fixed effects finds strong within-occupation growth in annual earnings among workers of all three age groups within occupations requiring high levels of both cognitive (DOT-math) and social (DOT-dcp) skill (Table 9). This analysis clarifies that the previously noted earnings growth among workers in the "multiskilled" group is not due to disproportionate growth in employment among higher-paid occupations within the group, but is rather the result of within-occupation increases in relative earnings.

Conclusion

This research reveals an emerging feature of the labor market: The well-documented growth in demand for cognitive skills during the 1980s and 1990s was accompanied by a similar shift in demand for social skills, and primarily affected those with strong endowments of both cognitive and social skills. Both employment trends and earnings trends are strongest among young multiskilled workers. This can be seen when comparing two cohorts of high school seniors, and also in Census or CPS data describing workers of all ages. These findings suggest increasing complementarity between cognitive and social skills.

In laymen's terms, employers in 1979 were apparently equally happy either to hire a pair of workers each specialized in one type of skill or to hire two workers endowed with both types of skill. Today, employer demand has shifted toward preference for two workers who are each prepared to engage in work requiring a combination of technical expertise and complex communication skills.

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Table 1- Sample Means for Two Cohorts of U.S. High School Seniors

	1972 Seniors			1992 Seniors		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full 1972 Base Year Sample	Subset Persist to 1979	Subset in 1979 Labor Force Sample	Full 1992 Base Year Sample	Subset Persist to 1999	Subset in 1999 Labor Force Sample
Participation:						
Sports	0.57	0.57	0.57	0.55	0.53	0.54
Clubs (academic, vocational or hobby)	0.44	0.45	0.45	0.37	0.39	0.41
Performing Arts	0.26	0.26	0.25	0.22	0.22	0.21
Student Publications	0.14	0.14	0.14	0.14	0.14	0.14
Non-Athletic Leadership Roles:						
Clubs (academic, vocational or hobby)	0.09	0.10	0.10	0.08	0.09	0.09
Performing Arts	0.05	0.05	0.05	0.07	0.07	0.06
Student Publications	0.03	0.03	0.03	0.04	0.04	0.03
Any Leadership Role Above (Non-Athletic):	0.16	0.16	0.16	0.16	0.17	0.16
Sports Participant or Other Leadership Role	0.63	0.63	0.63	0.62	0.62	0.61
Log Weekly Earnings 7 years after high school			6.44			6.42
(Standard Deviation)			(0.42)			(0.48)
Proportion with College Degree			0.27			0.33
Sample Size	6672	5639	4421	5513	3380	2673

This sample includes white men only. Columns 1 and 4 include all 1972 or 1992 observations. Columns 2 and 5 are restricted to those observed again in 1979 or 1999. Columns 3 and 6 are further restricted to individuals observed working full-time seven years after high school with high school math score and weekly earnings non-missing. This is referred to later as the "Labor Force Sample." Earnings are inflation adjusted to 1999 dollars. "Other Leader" refers to individuals who filled leadership roles in clubs, student publications, or performing arts.

Table 2- Trends in High-Skill Male Employment (CPS Data 1977-2002)

	Young Men, Ages 25-30			Men, Ages 25-60		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Share Employed in Occupations with BOTH HIGH MATH AND HIGH SOCIAL	Share Employed in Occupations with HIGH MATH ONLY	Share Employed in Occupations with HIGH SOCIAL ONLY	Share Employed in Occupations with BOTH HIGH MATH AND HIGH SOCIAL	Share Employed in Occupations with HIGH MATH ONLY	Share Employed in Occupations with HIGH SOCIAL ONLY
Time Trend	0.012**	-0.009**	-0.002+	0.012**	-0.002*	-0.003**
	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.216**	0.105**	0.055**	0.273**	0.098**	0.073**
	(0.004)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
Number of Years with Share Observed	26	26	26	26	26	26
R-squared	0.402	0.562	0.133	0.803	0.218	0.353
Number of Individual Observations	141,803	141,803	141,803	719,889	719,889	719,889

Standard errors in parentheses + significant at 10%; * significant at 5%; ** significant at 1%
Sample: Men age 25-60 in the CPS March Surveys 1977-2002. Columns 1-3 restricted to young men age 25-30.
Dependent Variable: Employment shares computed per year among employed men: HIGH MATH ONLY (DOT-dcp≤5 and DOT-math>5), HIGH SOCIAL ONLY (DOT-dcp>5 and DOT-math≤5), BOTH (DOT-dcp>5 and DOT-math>5).
Time Trend= (year-1980)/10

Table 3—High School Roles and Adult Earnings Seven Years Later

	1972 Graduates in 1979				1992 Graduates in 1999			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sports or Other Leadership	0.051 (0.014)**				0.126 (0.027)**			
Sports and Other Leadership		0.062 (0.027)*	0.052 (0.027)+	0.053* (0.027)		0.172** (0.045)	0.135** (0.046)	0.137** (0.046)
Sports Only		0.040 (0.019)*	0.032 (0.019)+	0.032+ (0.019)		0.108** (0.035)	0.088* (0.035)	0.089* (0.036)
Other Leadership Role Only		0.024 (0.036)	0.017 (0.036)	0.017 (0.036)		0.140* (0.060)	0.122+ (0.063)	0.125* (0.064)
Other Participant but Not Leader		-0.018 (0.023)	-0.017 (0.023)	-0.017 (0.023)		-0.012 (0.044)	-0.014 (0.044)	-0.014 (0.044)
Math Score			0.089 (0.025)**				0.205** (0.049)	
Math Z Score				0.025** (0.007)				0.057** (0.015)
Observations	4421	4421	4421	4421	2673	2673	2673	2673
R-squared	0.004	0.004	0.008	0.008	0.016	0.018	0.032	0.030

Standard errors in parentheses + significant at 10%; * significant at 5%; ** significant at 1%
Sample: Full-time white male workers who were high school seniors in either 1972 or 1992
Dependent Variable: Log weekly earnings 7 years after high school; Data Source: NCES
"Other Leadership" and "Other Participant" refers to leadership or participation in clubs (vocational, hobby or academic), performing arts (including band, orchestra, chorus and theater), student publications (newspaper, yearbook, or literary magazine).
Math score is percentile score divided by 100.
Math z score is normalized to have standard normal distribution.

Notes to accompany Table 4, next page:
Sample: Full-time white male workers, high school seniors in either 1972 or 1992.
Dependent Variable: Log weekly earnings 7 years after high school; Data Source: NCES
Note: Interactions are computed with the math score normalized to zero at the median score and time normalized to zero in 1989.
"Leadership" refers to leadership roles in clubs (vocational, hobby or academic), performing arts (including band, orchestra, chorus and theater), or student publications (newspaper, yearbook, or literary magazine). "Higher Math Score" refers to scores above the median.

Table 4—Time Trends in Pooled Regressions

	(1)	(2)	(3)	(4)	(5)
Time Trends:					
Trend*(Higher Math Score)*(Sports or Leadership) **(= "MULTISKILLED" TREND=MST)**		0.063** (0.020)	0.061** (0.020)	0.059** (0.020)	0.005 (0.023)
Trend*(Lower Math Score)*(Sports or Leadership)		0.019 (0.021)	0.018 (0.021)	0.017 (0.022)	0.003 (0.022)
Trend*(Higher Math Score)*(not Sports & not Leader)		0.014 (0.025)	0.015 (0.025)	0.015 (0.025)	0.008 (0.026)
Trend*College Graduate*(Sports or Leadership)					0.101** (0.018)
Trend*College Graduate*(not Sports & not Leader)					0.028 (0.038)
Time Trend in omitted trend category	-0.010 (0.007)	-0.039* (0.017)	-0.039* (0.017)	-0.039* (0.017)	-0.041* (0.017)
Levels:					
Sports Participation and Leadership	0.102** (0.037)	0.099** (0.023)	0.088** (0.024)	0.077** (0.025)	0.072** (0.025)
Sports Participation Only	0.068* (0.032)	0.067** (0.016)	0.060** (0.017)	0.050** (0.018)	0.047** (0.018)
Leadership Only	0.081+ (0.048)	0.077* (0.037)	0.074* (0.037)	0.065+ (0.038)	0.070+ (0.038)
Math Score	0.149** (0.045)	0.148** (0.028)	0.109** (0.030)	0.109** (0.030)	0.105** (0.030)
Math Score*(Sports Participation or Leadership)	-0.000 (0.056)				
College Graduate			0.056** (0.018)		
College Graduate*(Sports or Leadership)				0.068** (0.019)	0.067** (0.019)
College Graduate*(not Sports & not Leader)				0.026 (0.039)	0.024 (0.037)
Observations	7094	7094	7094	7094	7094
R-squared	0.019	0.022	0.024	0.025	0.031

Standard errors in parentheses + significant at 10%; * significant at 5%; ** significant at 1%   The time trend variable is defined as (year-1989)/10.

Table 5— Time Trends in Pooled Regressions with Additional Pre-Labor Market Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Time Trends:												
Trend*(Higher Math Score)	0.066**	0.066**	0.065**	0.056**	0.068**	0.059**	0.063**	0.065**	0.061**	0.053*	0.048*	0.059**
***(Sports or Leadership)=MST**	(0.020)	(0.020)	(0.020)	(0.022)	(0.020)	(0.021)	(0.021)	(0.020)	(0.020)	(0.023)	(0.022)	(0.020)
Trend*(Lower Math Score)	0.019	0.019	0.019	0.016	0.021	0.019	0.020	0.018	0.018	0.015	0.012	0.018
***(Sports or Leadership)**	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Trend*(Higher Math Score)	0.006	0.006	0.005	-0.001	0.007	0.002	0.005	0.005	0.005	-0.002	-0.004	0.005
***(not Sports & not Leader)**	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Time Trend in	-0.041*	-0.043*	-0.036*	-0.047**	-0.052	-0.073**	-0.087*	-0.039+	-0.045**	-0.045**	-0.045**	-0.040*
omitted trend category	(0.017)	(0.018)	(0.017)	(0.017)	(0.034)	(0.024)	(0.035)	(0.022)	(0.017)	(0.017)	(0.017)	(0.017)
Levels:												
Sports Participation	0.105**	0.104**	0.104**	0.103**	0.103**	0.102**	0.102**	0.106**	0.099**	0.106**	0.097**	0.059**
and Leadership	(0.023)	(0.023)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.024)	(0.024)	(0.020)
Sports Participation Only	0.072**	0.072**	0.071**	0.071**	0.070**	0.070**	0.069**	0.073**	0.070**	0.073**	0.066**	0.018
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.022)
Leadership Only	0.083*	0.083*	0.083*	0.083*	0.082*	0.082*	0.082*	0.084*	0.081*	0.084*	0.079*	0.005
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.038)	(0.038)	(0.037)	(0.037)	(0.038)	(0.037)	(0.024)
Math Score	0.145**	0.145**	0.143**	0.141**	0.142**	0.130**	0.131**	0.149**	0.142**	0.154**	0.128**	-0.040*
	(0.028)	(0.027)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.030)	(0.029)	(0.017)
Additional Controls:												
Added Variable Description:	Baseline (compare to Table 4, Col. 2)	Small Family (only 1 or 2 Kids)	No Dad at Home Grade 12	College Graduate Parent	Self-Esteem	Locus of Control Internal	Self-Esteem + Locus of Control	Feels Teachers Care	Home-work 10 or more hours per week	Took SAT or ACT exam	Applied to more than one College	All Controls (From Cols 2-6 and 8-11)
Added Variable Estimate		-0.004	-0.016	0.005	0.015+	0.021*	0.016**	-0.023	0.006	-0.009	0.029+	
		(0.015)	(0.018)	(0.016)	(0.009)	(0.008)	(0.005)	(0.019)	(0.022)	(0.017)	(0.017)	
Added Variable * Time Trend		0.009	-0.008	0.034*	0.002	0.014+	0.007	0.005	0.052*	0.023	0.042*	
		(0.015)	(0.018)	(0.016)	(0.009)	(0.008)	(0.005)	(0.019)	(0.022)	(0.016)	(0.017)	
Observations	6985	6985	6985	6985	6985	6985	6985	6985	6985	6985	6985	6985
R-squared	0.023	0.023	0.023	0.024	0.024	0.025	0.025	0.024	0.025	0.024	0.026	0.028
Mean of Added Variable, 1972 Seniors (n=4394)		0.23	0.12	0.24	3.2/4	2.3/3	5.5/7	0.50	0.03	0.48	0.20	
Mean of Added Variable, 1992 Seniors (n=2591)		0.42	0.34	0.42	3.8/4	2.4/3	6.2/7	0.82	0.21	0.57	0.37	

Standard errors in parentheses * significant at 5%; ** significant at 1% Dependent Variable: Log weekly earnings 7 years after high school; Sample and variables (other than added variables) are as defined in Table 4, with slightly smaller sample size due to missing data for psychological measures.

Table 6—Descriptive Statistics to Illustrate Increasing Complementarity of Cognitive and Social Skills

	Mean Weekly Earnings		Mean Percentile Rank		Sample Size & Weighted Share	
	1979	1999	1979	1999	1979	1999
Detailed Statistics:						
Low Math, Low Social Skill (Math percentile no greater than 50, Neither sports nor leadership)	$645.30 (9.48)	$624.48 (19.66)	45.1 (0.9)	42.3 (1.2)	n=1012 23.8%	n= 521 22.6%
Low Math, High Social Skill (S) (Math percentile no greater than 50, either sports participant or leader)	$688.18 (8.91)	$698.38 (22.17)	49.3 (0.8)	47.5 (1.1)	n=1377 30.5%	n=692 26.4%
High Math, Low Social Skill (M) (Math percentile greater than 50, Neither sports nor leadership)	$692.87 (14.90)	$676.89 (18.65)	49.1 (1.2)	49.0 (1.4)	n=601 13.4%	n=418 16.3%
High Math, High Social Skill (MS) (Math percentile greater than 50, and sports participant or leader)	$708.69 (11.71)	$770.44 (17.02)	51.4 (0.8)	56.4 (0.9)	n=1431 32.3%	n=1042 34.9%
Even Stronger Skill Bundles:						
Higher Math, High Social Skill (Math percentile greater than 75, and sports participant or leader)	$743.94 (22.93)	$810.77 (21.17)	53.4 (1.1)	60.2 (1.2)	n=636	n=575
Higher Math, High Social Skill, and BA (Math percentile greater than 75, and (sports participant or leader) and college graduate)	$750.34 (23.74)	$852.48 (25.14)	56.2 (1.3)	64.8 (1.3)	n=410	n=429

Sample: Indicated subsets of the "Labor Force Sample" used in Tables 3 and 4.
"High math skill" = senior year math score above median,
"High social skill"=participated in sports or leadership roles during senior year of high school.
"Mean percentile rank"=within-group mean of percentile in the full-sample earnings distribution
As in the regressions displayed in Tables 3-5, "leadership" includes leadership roles in clubs, student publications, or performing arts.
Column 1-2, row 1 and 4 means are depicted in Figure 2. Standard errors in parentheses.

Table 7—Early Endowments and Selection into Occupations Seven Years After High School (1979)

	Job Skill Dependent Variable: **DOT-math**		Job Skill Dependent Variable: **DOT-dcp**		
	(1)	(2)	(3)	(4)	(5)
Sports or Leadership	0.020** (0.007)	0.006 (0.006)	0.067** (0.013)	0.047** (0.013)	0.047** (0.011)
12th Grade Math Z Score (standardized)	0.063** (0.003)	0.037** (0.003)	0.077** (0.006)	0.039** (0.007)	0.039** (0.006)
12th Grade Psychological (standardized)	0.018** (0.003)	0.015** (0.003)	0.030** (0.006)	0.025** (0.006)	0.025** (0.005)
College Graduate		0.145** (0.008)		0.210** (0.016)	0.210** (0.014)
Occupation DOT-math (Column 2 Residual)					1.002** (0.028)
Observations	4,122	4,122	4,122	4,122	4,122
R-squared	0.128	0.208	0.070	0.118	0.343

+ significant at 10%; * significant at 5%; ** significant at 1%

Sample: Subset of the 1979 "Labor Force" sample with all relevant measures available (93 percent of the original sample).
Dependent Variables: DOT-math and DOT-dcp job-task measures are divided by 10, so that the range is 0 to 1.
Table 7 Notes: "Sports or Leadership" indicates participation in sports or other Leadership in activities during the senior year of high school. "12th Grade Math Z Score" is normalized to have mean zero and standard deviation 1. "12th Grade Psychological" measure is the sum of the Locus of Control and Self Esteem measures described in Table 5, normalized to have mean zero and standard deviation 1. "Occupation DOT-math" is the residual of the column 2 regression, equal to the difference between the DOT-math score of an individual's occupation minus the DOT-math score predicted by entering the individual's characteristics into the column 2 regression equation.

Table 8—Average Rank in the Earnings Distribution among Full-Time Male Workers, By Occupational Skill Requirement for Cognitive (DOT-math) and Social (DOT-dcp) Skills

	Mean Rank 1979	Mean Rank 1989	Mean Rank 1999	Change 1979-1989 (Per Decade) Census	Change 1979-1999 (Per Decade) Census	Change 1976-1989 (Per Decade) CPS	Change 1976-1999 (Per Decade) CPS	Change 1976-2011 (Per Decade) CPS
Age 24-29								
Both High	56.06 (0.10)	61.75 (0.10)	62.27 (0.10)	5.69** (0.14)	3.06** (0.07)	5.31** (0.53)	2.96** (0.25)	2.09** (0.13)
One High	56.34 (0.11)	57.74 (0.11)	56.02 (0.12)	1.40** (0.15)	-0.11 (0.08)	3.65** (0.60)	1.40** (0.29)	0.76** (0.16)
Not High	45.95 (0.06)	43.44 (0.06)	42.90 (0.06)	-2.51** (0.08)	-1.55** (0.04)	-2.71** (0.31)	-1.60** (0.15)	-1.26** (0.08)
Age 30-44								
Both High	61.38 (0.07)	63.03 (0.06)	64.95 (0.05)	1.65** (0.09)	1.79** (0.04)	0.66* (0.33)	1.85** (0.14)	1.34** (0.07)
One High	56.82 (0.07)	56.92 (0.06)	55.59 (0.06)	0.09 (0.10)	-0.65** (0.05)	0.88* (0.39)	0.13 (0.17)	0.09 (0.09)
Not High	42.04 (0.04)	40.88 (0.04)	40.54 (0.04)	-1.15** (0.06)	-0.72** (0.03)	-1.38** (0.22)	-1.08** (0.10)	-0.99** (0.05)
Age 45-59								
Both High	65.52 (0.08)	65.11 (0.07)	64.67 (0.06)	-0.41** (0.11)	-0.43** (0.49)	-0.90* (0.40)	-0.95** (0.17)	0.02 (0.08)
One High	57.85 (0.08)	56.86 (0.08)	55.41 (0.07)	-1.00** (0.12)	-1.23** (0.05)	-0.35 (0.47)	-0.34 (0.21)	-0.15 (0.10)
Not High	40.87 (0.05)	39.36 (0.05)	39.32 (0.04)	-1.51** (0.07)	-0.75** (0.03)	-2.12** (0.26)	-1.17** (0.12)	-0.86** (0.06)

Standard errors in parentheses.
"Both High" is defined as DOT-math>5 and DOT-dcp>5
"One High" is defined as DOT-math>5 or DOT-dcp>5, but not both
"Not High" is defined as neither DOT-math nor DOT-dcp greater than 5
Estimated rate of change per decade is based on the slope of a linear regression.
Samples: Men age 25-60 who worked at least 1500 hours in the preceding year.
Census samples were drawn from the 1980, 1990 & 2000 Census (annual earnings at age 24-59 observed for 1979, 1989, and 1999) and are restricted to US born men. CPS Samples were drawn from the March CPS 1977-2012 (annual earnings at age 24-59 observed for 1976-2011).
All Census cells contain more than 50,000 individual observations.
All CPS regressions contain more than 10,000 individual observations.

Table 9— Within-Occupation Time Trends in Annual Earnings, by Job Task Category and Age Group

	Age 25-30		Age 31-45		Age 46-60	
	(1)	(2)	(3)	(4)	(5)	(6)
(Both DOT-Math & DOT-dcp High) * Trend	0.011**	0.008+	0.029**	0.040**	0.070**	0.041**
	(0.003)	(0.005)	(0.002)	(0.003)	(0.002)	(0.004)
Only DOT-math High * Trend	-0.013**	-0.024**	-0.005*	-0.009*	0.037**	0.008
	(0.004)	(0.007)	(0.003)	(0.004)	(0.004)	(0.006)
Only DOT-dcp High * Trend	-0.059**	-0.037**	-0.028**	-0.033**	0.017**	-0.003
	(0.005)	(0.009)	(0.003)	(0.005)	(0.003)	(0.006)
(Both DOT-Math & DOT-dcp Low)* Trend	-0.095**	-0.084**	-0.065**	-0.063**	-0.022**	-0.042**
	(0.002)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)
# Occupation*College Graduate Fixed Effects	749	716	757	743	752	724
Observations	759108	133988	1657664	320484	1055278	198604
R-squared	0.165	0.240	0.239	0.312	0.277	0.301
Sample	Census 1980-1990	CPS 1977-2002	Census 1980-1990	CPS 1977-2002	Census 1980-1990	CPS 1977-2002

+ significant at 10%; * significant at 5%; ** significant at 1%, standard errors in parentheses
Dependent Variable: Log of real annual earnings in the preceding year, inflation adjusted to 1999 dollars.
Sample: Men, Age 25-60 who worked at least 1500 hours last year in the civilian labor force, drawn from either the Census (1980 or 1990, born in the U.S.) or CPS (1977-2002, includes immigrants). These samples include only the years before a substantial revision of occupation codes.
Trend=(year-1980)/10.
"Both DOT-math and DOT-dcp High" is defined as DOT-math>5 and DOT-dcp>5

Appendix Table—Pooled Selection Regressions Finding No Time-Trends in Patterns of Selection on Observables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	**Sports**	**Sports**	**Other Leadership**	**Other Leadership**	**Sports or Leadership**	**Sports or Leadership**	**College Graduate**	**College Graduate**
Levels:								
College Grad Parent	0.130** (0.022)	0.086** (0.022)	0.025 (0.016)	0.005 (0.015)	0.128** (0.022)	0.079** (0.021)	0.316** (0.019)	0.196** (0.018)
Small Family (1-2 kids)	-0.037 (0.025)	-0.053* (0.023)	0.006 (0.016)	-0.001 (0.017)	-0.029 (0.026)	-0.046 (0.024)	0.101** (0.020)	0.062** (0.018)
Small Family*College Graduate Parent	0.010 (0.039)	0.025 (0.038)	0.040 (0.028)	0.047 (0.028)	0.012 (0.038)	0.029 (0.037)	-0.014 (0.037)	0.023 (0.032)
No Father in Home		-0.058** (0.021)		-0.010 (0.014)		-0.059** (0.022)		-0.068** (0.015)
Math Percentile Score		0.227** (0.030)		0.101** (0.023)		0.253** (0.030)		0.633** (0.023)
Time Trends:								
Trend*Parent College Grad	0.020 (0.022)	0.016 (0.022)	0.001 (0.016)	-0.006 (0.015)	0.013 (0.022)	0.008 (0.021)	0.016 (0.019)	0.000 (0.018)
Trend*Small Family	0.020 (0.025)	0.011 (0.023)	-0.001 (0.016)	-0.005 (0.017)	0.010 (0.026)	-0.000 (0.024)	0.004 (0.020)	-0.017 (0.018)
Trend*Small Family *Parent College Graduate	-0.019 (0.039)	-0.010 (0.038)	-0.021 (0.028)	-0.016 (0.028)	-0.019 (0.038)	-0.008 (0.037)	-0.007 (0.037)	0.018 (0.032)
Trend* No Father		0.002 (0.021)		0.003 (0.014)		-0.001 (0.022)		-0.015 (0.015)
Trend*(Math Score)		-0.010 (0.030)		0.029 (0.023)		-0.007 (0.030)		0.009 (0.023)
Time Trend * (omitted trend categories)	-0.036* (0.015)	-0.025+ (0.014)	-0.001 (0.009)	0.003 (0.009)	-0.023 (0.015)	-0.011 (0.014)	-0.009 (0.008)	0.014 (0.010)
Constant	0.518** (0.015)	0.552** (0.014)	0.144** (0.009)	0.155** (0.009)	0.584** (0.015)	0.621** (0.014)	0.164** (0.008)	0.237** (0.010)
Observations	7094	7094	7094	7094	7094	7094	7094	7094
R-squared	0.017	0.036	0.003	0.010	0.016	0.040	0.118	0.268

Note: Interactions and constant term are computed with the math score normalized to zero at the median score and time normalized to zero in 1989.

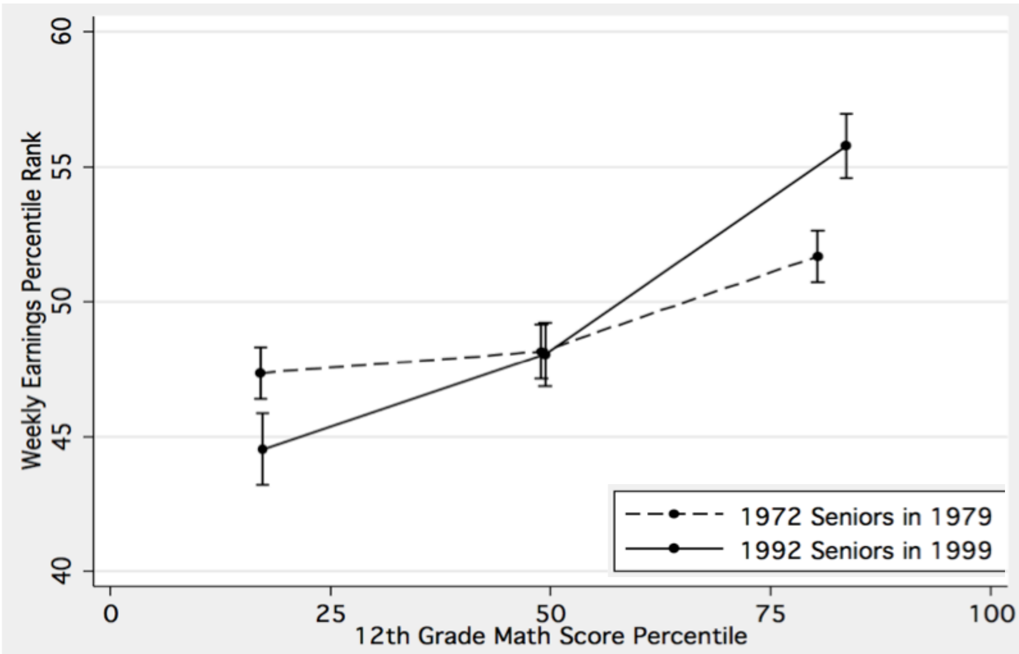

Figure 1—The Relationship between High School Math Scores and Adult Earnings, 1979 and 1999
Mean Percentile Rank in the Earnings Distribution among those in the lower, middle, and upper third of the 12^{th} Grade Math Score distribution.
Sample: Full-time white male workers who were high school seniors in either 1972 or 1992, with earnings observed in 1979 or 1999.

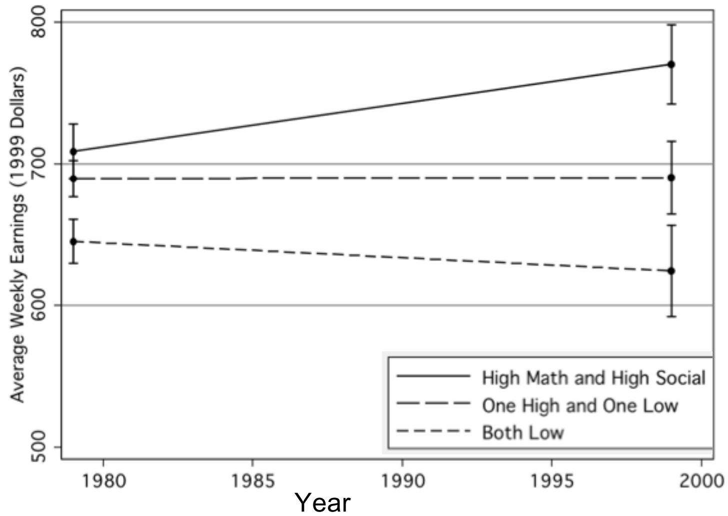

Figure 2--Mean Weekly Earnings Seven Years after High School, 1979 and 1999, By Early Endowments (NCES Data)
"High Math"= Senior year math score above median,
"High Social"=Participated in sports or leadership roles during senior year of high school.
Bars around point estimates indicate 90 percent confidence intervals.
Sample: Full-time white male workers who were high school seniors in either 1972 or 1992, with earnings observed in 1979 or 1999. See Table 6 for more detail.

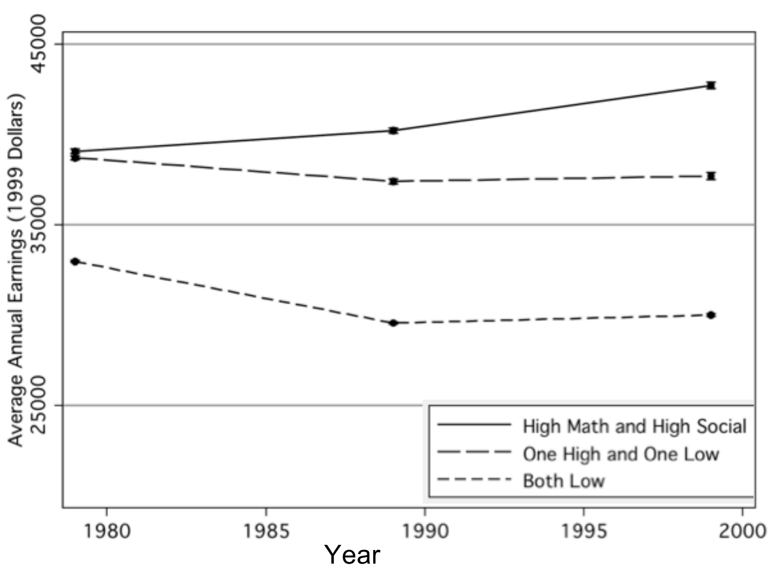

Figure 3—Mean Annual Earnings among Young Men Age 24-29 in 1979, 1989, and 1999, By Occupational Skill Requirement (Census Data)
"High Math"= DOT-math>5, "High Social"= DOT-dcp>5
Bars around point estimates indicate (very tight) 90 percent confidence intervals.
Sample: Young, US born men who worked at least 1500 hours in the preceding year, drawn from the 1980, 1990 & 2000 Census (annual earnings observed for 1979, 1989, and 1999 at age 24-29).

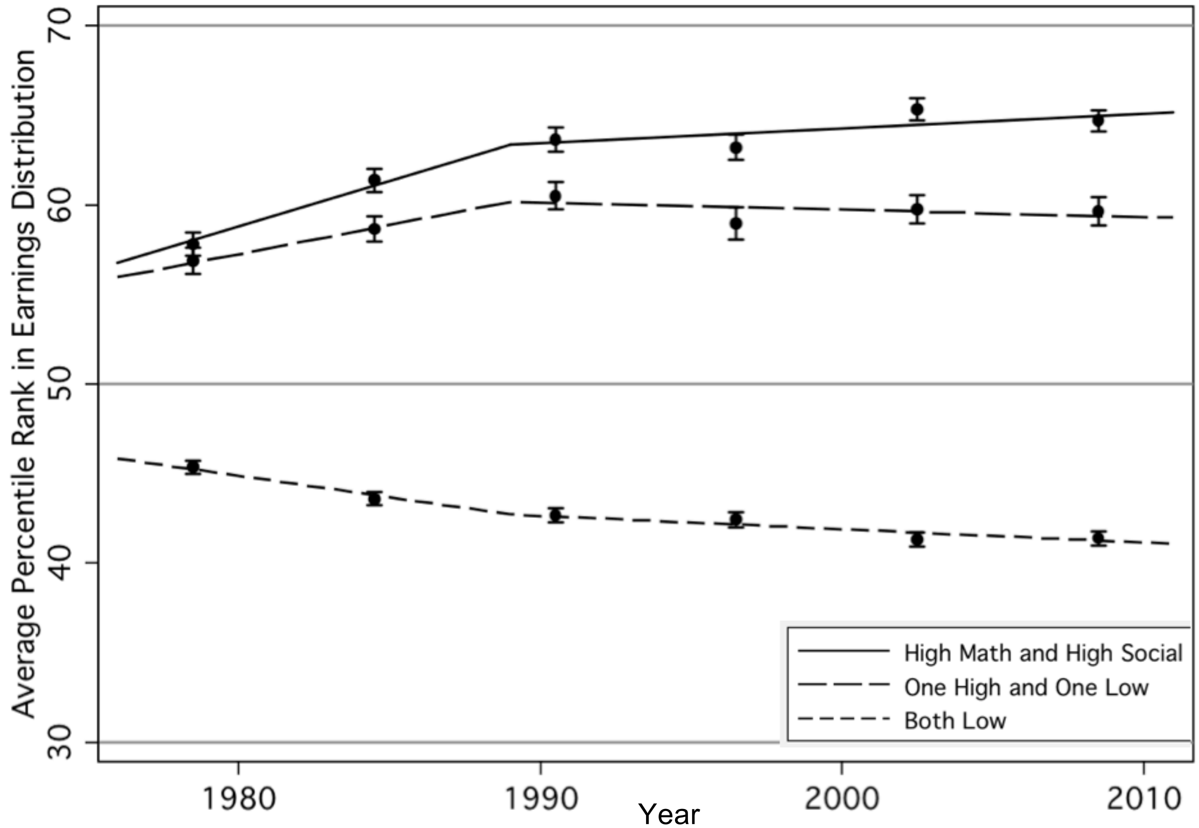

Figure 4--Mean Percentile Rank in the Annual Earnings Distribution among Young Men Age 24-29 in 1976-2011, By Occupational Skill Requirement (CPS Data)

High Math"= DOT-math>5, "High Social"= DOT-dcp>5
Point estimates are means within each 6-year interval, bars around point estimates indicate 90 percent confidence intervals.
Fitted piecewise linear functions are based on regressions using all individual observations, with kink at 1989.
Sample: Young men who worked at least 1500 hours in the preceding year, drawn from the
1977-2012 March CPS (annual earnings observed for 1976-2011 at age 24-29).