The Increasing Complementarity between Cognitive and Social Skills

Catherine Weinberger
March 2010
University of California, Santa Barbara,
weinberg@econ.ucsb.edu

Working Paper, Comments Welcome

Abstract: Data linking early skill endowments to later outcomes in two cohorts of male high school seniors suggests increasing complementarity between cognitive and social skills. In fact, the well-documented growth in demand for cognitive skills during the 1980's and 1990's affected only those 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; earnings premia to occupations requiring high levels of both cognitive and social skill grew substantially through the 1980's and 1990's relative to occupations requiring only one or neither type of skill, and this emerging feature of the labor market has persisted into the new decade.

I gratefully acknowledge that this research was supported by a grant from the American Educational Research Association which receives funds for its "AERA Grants Program" from the National Science foundation and the U.S. Department of Education's National Center for Education Statistics and the Institute of Education Sciences under NSF Grant #REC-9980573. Opinions reflect those of the author and do not necessarily reflect those of the granting agencies.

I thank Peter Kuhn for complaining about driving his son to early morning water-polo practice, and for always asking "why?" Philip Babcock, Kelly Bedard, Olivier Deschenes, Melissa Kearney and Peter Kuhn made helpful comments on earlier drafts of this paper. David Autor generously provided well-documented data files linking DOT task measures to Census Occupation codes.

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, Moss and Tilly, 2001, Chapple, 2006), and by evidence of rising pay in occupations with interpersonal skill requirements (Borghans, ter Weel and Weinberg 2008, 2009, Bacolod and Blum 2009). 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.[2] 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 (or combinations of social and cognitive skills) have changed over time.

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.[3] Consistent with this model, they document a shift in the composition of jobs, with growing employment during the 1980's and 1990's 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). Previous studies had observed growth in the wage premium associated with math skills between 1979 and 1986 (Murnane, Willet and Levy, 1995, Grogger and Eide, 1995).

[1] See Bowles, Gintis and Osborne, 2001 for a review; some of the more recent contributions include Kuhn and Weinberger (2005), Mueller and Plug (2005), Borghans, ter Weel and Weinberg (2008), Cunha and Heckman (2008), Heckman, Stixrud, Urzua (2006), Stevenson (2006).

[2] Kuhn and Weinberger (2005) provide evidence suggesting a shift, but newly available data facilitate more precise comparisons between cohorts.

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

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.[4] 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 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 approach taken here is to examine adult earnings distributions, conditional on early endowments of both math-related and social skills, of two cohorts of young men who completed high school and entered the labor market twenty years apart.

In this analysis, individual-level information about the participation of successive cohorts of high school students in specific group activities is used to construct uniform measures of interpersonal attributes. The underlying assumption is that both the skills acquired through participation and the pre-existing attributes associated with selection into particular activities are relatively stable over time. Fortunately, the proportion of white male students selecting into sports (and several other activities) changed very little, bolstering confidence that the selection process did not change.[5]

Previous research has consistently documented earnings premia to high school sports participation, and to high school leadership activities (e.g. Anderson 2000, Barron,

[4] Bowles, Gintis and Osborne (2001) find no trend in regression coefficients on cognitive scores in a metaanalysis covering 4 decades, but most of the studies included did not examine math scores specifically.
[5] The earnings analysis is restricted to white males for all of the usual reasons, and also because patterns of selection to high school activities was less stable for other groups. (See Weinberger 2006).

Ewing and Waddell 2000, Eide and Ronan 2001, Persico, Postlewaite and Silverman 2004, Kuhn and Weinberger 2005, Stevenson 2006). 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.

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 1980's and 1990's; 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 (e.g. Card and DiNardo 2002). Using direct measures of usually unobserved skills, 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 measures precisely comparable to the 1979 measures previously available.

The measures used in this study were drawn from two cohorts of the NCES longitudinal high school studies. We compare samples of students who were high school seniors in 1972 or 1992, with earnings observed exactly seven years after high school in 1979 or 1999. The carefully constructed measures permit convincing comparisons. For example, this study finds that among 1992 high school seniors, those who had been high school leaders were earning 10 percent more than their classmates in 1999, while leaders of exactly the same activities among 1972 seniors earned only 5 percent more than their classmates in 1979.[6] This growth suggests an increase over time in the labor market valuation of characteristics correlated with participation in high school leadership roles. More generally, 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. This finding suggests increasing complementarity between cognitive and social skills among young workers. Supporting evidence drawn from the Census confirms that the labor market increasingly favors workers with strong endowments of both cognitive and social skills.

These findings reveal a previously unappreciated component of well-documented shifts over the 1980's and 1990's 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.

[6] The sample in this example includes white males only. The coefficient for 1992 seniors is statistically significant at the 1 percent level, with coefficient 0.104 and standard error 0.024. For 1972 seniors, the coefficient is 0.053 with standard error 0.015. (The standard errors are smaller than in the previous draft because weekly earnings, rather than annual earnings, is now the dependent variable).

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 $w_{MS} = B_{MS} = \max(B_M,B_S)$. 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.[7]

As described in the literature review above, previous research (Murnane, Willet and Levy, 1995, Grogger and Eide, 1995) suggests that the earnings premium associated with standardized math scores grew between 1980 and 1990. The goals of the analysis that

[7] Complementary goods provide more utility when they are consumed together. For example, a left shoe paired with the matching right shoe is far more useful than a pile of mismatched shoes. While it might seem that pairing M workers with S workers can yield the same skill mix as any conceivable set of multiskilled workers, communication costs are certainly lower when the entire skill set is embodied in a single individual.

follows are to examine whether this trend can be seen over a longer time interval (averaged over the M and MS populations), whether a similar trend can also be seen in the social skills premium (averaged over the S and MS populations), and to explore how the trend for the multiskilled group endowed with high levels of both cognitive and social skill compares with the trends among workers with either single type of skill (MS relative to M or 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. My job is to convince the reader that each of these two portions contains the same distribution of unobserved social skills in 1972 and 1992. If this indicator captures exactly the same set of social skills in both cohorts, then changes between cohorts in the associated earnings premium can be interpreted as a change in the social skill price, just as changes over time in the coefficient on carefully standardized math scores can be interpreted as a growing price of cognitive skill.

Data

The statistical analysis is based on data from two National Center for Education Statistics 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 comparable questions about extracurricular participation, leadership roles, and earnings 7 years after the senior year.[8] The sample is limited to white males, in order to avoid the confounding measurement issues related to

[8] All statistical analysis is weighted to reflect a representative sample of high school seniors. All samples are restricted to individuals who were surveyed as seniors in high school (and had the opportunity to participate in high school activities).

contemporaneous changes in both educational and labor market opportunities available to other demographic groups.

Both of the surveys include a standardized math test score. Evidence from NCES publications suggests that, among white 17-year-old men, performance on standardized math tests did not change between the 1972 and 1992 cohorts (NCES 1994). To create an easily comparable scale, math scores for each cohort are recoded to a percentile among all white men in the 12th grade, then divided by 100 so that the scores range from 0 to 1 (with .5 representing the median score).[9]

Although each survey asks a slightly different set of questions about extracurricular participation, both of the surveys contain a subset of questions that are comparable across cohorts. The analysis is limited to the five kinds of activities covered by these comparable questions: Sports, clubs (vocational, hobby or academic), performing arts, student government, and student publications.[10] Mean participation rates are described in Table 1.[11] Most of these changed very little over time. However, while the proportion of men involved in sports did not change, the fraction of sports participants indicating that they took a leadership role increased. Similarly, the proportion involved in student government changed between cohorts. Several kinds of activities display stable proportions over time, and these will play a special role in the analysis: Sports, clubs, performing arts, student publications, and leadership roles in either clubs, performing arts, or student publications.

[9] 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).

[10] Because the questions were asked in slightly different ways, some of these reflect aggregated categories. Performing arts includes music and theater, sports includes competitive and intramural, individual and team, varsity and junior varsity.

[11] See Weinberger (2006) for statistics by race and gender.

In addition to these participation measures, means of real weekly earnings and college graduation rates are displayed at the bottom of Table 1. Inflation-adjusted weekly earnings shows no change in the mean, but growing dispersion of the earnings distribution between cohorts.[12] Figure 1 compares the 1979 and 1999 real weekly earnings distributions, showing that for this population the between-cohort change is concentrated in the now fatter upper tail, above the 90th percentile of the earnings distribution.[13] A potentially related change is an increase in the proportion of high school seniors earning a college degree within 7 years, from 27 percent of the earlier cohort to 35 percent of the later cohort. The analysis will describe changes over time in the allocation of earnings, conditional on early endowments and college completion.

Of the two NCES cohorts, occupation was coded to Census categories only once (in 1986 for the earlier cohort). This means that, although a link between early endowments and later occupation can be established using the 1986 occupation data, 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.[14] To extend the analysis forward in time, similar samples were drawn from the Census Bureau's American Community Surveys (ACS), and the March Current Population Surveys (CPS).

---

[12] To fully capture earnings potential, the earnings measure is based on full-time workers.

[13] After dropping 3 observations with coded earnings less than $7 per week, the minimum is $57 in both cohorts, with maximum reaching $10,000 per week ($500,000 per year) in 1999 dollars.

[14] 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. DOT job-task codes are available for at least 99.8 percent of sampled workers in each Census year, and at least 98.3 in each CPS year.

The Census and CPS samples all include earnings and occupation data, nationally representative of 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).[15] 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." For the descriptive statistics computed below, I collapse the measures to high and low values with cut points at DOT-dcp>5 and DOT-math>5. Supervisors and news reporters have high values of DOT-dcp but not DOT-math, while technicians and computer programmers have high values of DOT-math but not DOT-dcp. Managers, physicians and scientists have high values of both types of skill. Results based on these occupation-level skill requirements provide supplemental evidence relative to those based on individual-worker-level skill endowments observed only in the high school cohort studies.

[15] To insure consistency over time, I took advantage of the occ1990 codes created by the ipums project (King, et. al. 2004, Ruggles, et. a. 2008). I merged the AML measures for men (using the 1991 version of DOT) into the 1980 and 1990 census, and then collapsed these measures by occ1990 to create a crosswalk. This crosswalk was used to merge the time-consistent set of measures, by occ1990, into all years of Census and CPS data.

Initial Observations on Means and Correlations

Before introducing the model, I make a few relevant observations. I begin by confirming that the trends toward higher employment in occupations requiring high levels of complex skills (DOT-math or DOT-dcp, as described by Autor, Levy & Murnane 2003) apply to the population of young men over the time period covered by the NCES data. The means shown in Table 2 confirm that the proportion of young men's employment requiring either high DOT-math or high DOT-dcp grew over the period of this study.[16] Therefore, if growth in both employment and the corresponding earnings premium indicates a shift in demand, the open question is whether there was growth in the earnings premium associated with each type of skill over the 1979-1999 interval.

A more nuanced analysis displayed in rows 3-5 of Table 2 reveals that virtually all of the employment growth was concentrated in those occupations requiring high levels of both types of skill. Employment in occupations requiring high levels of one skill, but not the other, remained about constant over time. This observation is consistent with the introduction of an innovation that increased demand for multiskilled workers.

On the supply side, it is instructive to examine the patterns of selection to education and career paths, and how these changed between the 1972 and 1992 cohorts of high school graduates. Evidence that students selected into many high school activities in a similar way in each of the two cohorts is presented in Table 3. The correlation between math scores and sports participation or leadership was small and constant between

---

[16] The rates of change estimated here are likely to be low relative to estimates in Autor, Levy and Murnane (2003) because they capture only changes due to shifts in young men's occupational distribution. At least three known sources of change over time are not included in these estimates: 1) within-occupation growth in job skill requirements, 2) the increased average number of hours worked per week by skilled workers, and 3) the entry of educated women to the labor force. These estimates are relevant to understanding the proportion of young men in each cohort likely to enter occupations in each of the indicated categories.

cohorts. Similarly, the correlation between high school math scores and later college graduation remained nearly constant, despite the 30 percent growth in college graduation rates noted in Table 1.

In contrast, the correlation between sports participation and college graduation grew substantially. This is evident in the last 2 rows of Table 3, and also in Table 4. Among the sports participants, the proportion earning college degrees grew 37 percent (from .330 to .453), while it grew only 20 percent (from .181 to .218) among the other white men.[17] However, the distribution of high school math scores among those who finished college did not change at all—the mean percentile score among college graduates was about 68 for both cohorts, for both the full sample and the subset of high school sports participants (Table 5). Today's white male college graduates are more likely to have played sports in high school, but have similar high school test scores when compared to college graduates of the previous generation. This is a remarkable shift considering there was no change in the proportion of men involved in high school sports, nor in the correlation between cognitive skill measures and sports involvement. Something not captured by math scores must underlie the increasing tendency for high school sports participants to invest in higher education.

Models

When modeling the choices made by adolescents, it often pays to consider that behavior might at times be completely myopic while at other times individuals (perhaps heeding adults who advise them) might behave as hypothesized by Roy (1951), considering their comparative advantage and selecting to apply themselves to a set of

[17] Similar growth did not occur among activities leaders who were not sports participants.

activities in which they are likely to do well in the long run. In this section I set out a framework to place the observed behaviors and resulting outcomes of the young men in this study into context.

In the previous section, I provided evidence that the proportion of white male students participating in high school sports and other activities, did not change over the time interval of interest (estimated to be between 55 and 57 percent in both of the samples examined), that initial endowments of math scores were comparable between cohorts, and that the small correlation between math scores and selection to sports or leadership roles remained constant as well. Therefore I will begin by assuming that, conditional on initial endowments, individuals of different cohorts selected into high school sports and other roles in the same way across cohorts.

However, there was a large change between cohorts in the proportion of students electing to pursue a college degree. In particular, there was a far larger shift in the propensity to attend college among higher scoring sports participants than among other white men. The fact that average math scores remained unchanged, both among college graduates and among sports participant college graduates, conveys some useful information. If the growth in enrollment were entirely driven by falling college costs, or rising earnings premia, then we would expect the new entrants to be less positively selected on cognitive scores (on average) as college becomes a good investment for previously marginal students. The stability of math scores among enrolled students suggests that either a relaxation of liquidity constraints or a shift in the taste for college enrollment (unrelated to the financial costs and benefits) probably played a role in increasing enrollment by previously excluded high-value-added students. This would be consistent with either of the models considered below.

In a completely myopic model of the adolescent, suppose that college recruiters began to aggressively encourage sports participants to attend their colleges (perhaps with the belief that this group would earn more in the future and make donations that more than offset current scholarships). In this case, the high school athletes might increase participation in college and (nearly accidentally) earn more as adults due to the acquisition of new cognitive skills during college. In this case, the change in the earnings premium to high school athletes would be fully explained by the increased rate of college-going. It would actually reflect the accumulation of more cognitive skills after high school, rather than growing demand for combinations of cognitive and other skills.

A contrasting model supposes that high school students in the later cohort note the high salaries of highly educated workers with a combination of cognitive and social skills. Those with strong initial endowments of both kinds of skill might expect to be good candidates for these jobs, but only if they finish college. In this case, the incentives for high school athletes to complete college are growing relative to the incentives available to classmates with similar levels of academic potential. Earnings premia would be increasing over time for those with strong initial endowments of both cognitive and social skills, augmented by cognitive skills gained in college. This group would enjoy a greater premium to college completion relative to classmates with similar high school cognitive scores, and also relative to similarly endowed individuals from the previous cohort. In this case, the increasing earnings premium reflects changes in demand for individuals with combinations of cognitive and other skills.

A hybrid of these two approaches might suppose that it is colleges, rather than adolescents, who notice the growing opportunities for individuals with a combination of social and cognitive skills. In this case, the students might still react myopically to college scholarship offers and yet enjoy the same labor market rewards as if they had been well-informed, while reflecting well on the reputation of their alma mater. The regression analysis presented below identifies a growing earnings premium to those with both cognitive and non-cognitive initial endowments, and then strives to distinguish between these competing models.

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

Recall that the primary goal of this paper is to search for between-cohort changes in the earnings premia to various kinds of skill. The models estimated in Table 6 are very straightforward regressions of the log of weekly earnings seven years after the senior year of high school, among white men employed full-time, on comparable measures of cognitive and non-cognitive skills, including high school leadership and activities participation.[18] Columns 1 and 5 of Table 6 report the earnings premium to high school leaders, with no other controls. This result was described in the introduction: Between cohorts the leadership premium to those who took any leadership role doubled from 0.053 (standard error 0.015) to 0.104 (0.024).

The regressions displayed in columns 2 and 6 estimate the leadership premium to three separate (but not mutually exclusive) components—athletic leadership, student government, and other leadership roles (in clubs, performing arts, or student

[18] Previous research found that the coefficients change little when more detailed controls for parent education, school characteristics or geography are included (Kuhn and Weinberger, 2005).

publications). Each of these three categories had a larger premium in the later cohort, with a modest increase in the premium to sports leadership, and substantial increases in the premia to student government or other leadership roles. However, the smaller change among sports leaders could partially reflect the larger proportion of (less-highly selected) seniors who filled sports leadership roles in the later cohort. Similarly, the increase in the student government premium could reflect increasing selectivity as the proportion of participants fell. In columns 3 and 7, the student government control is dropped, the control for sports leadership is replaced by a control for sports participation (with constant proportions across cohorts), and a control for participation in other activities is also included. Here, it becomes clear that the premium to both sports participation and other leadership roles experienced strong growth, while the premium to participation in other activities (clubs, performing arts, or student publications) was zero among those not in leadership roles.[19] Finally, in columns 4 and 8, a standardized math test score is included in the model. The coefficient on this measure more than doubled between cohorts, showing that the growing returns to mathematical cognitive skills documented by Murnane, Willet and Levy (1995) and Grogger and Eide (1995) can be observed over this much longer time frame.[20] However, inclusion of this control only slightly decreases the estimated leadership and sports premia. This is consistent with the findings of Kuhn and Weinberger (2005) that leadership and sports coefficients capture the value of skills that are nearly orthogonal to math scores.[21]

---

[19] This result is robust to adding controls for each activity separately.
[20] These studies compared the 1972 cohort to the 1980 cohort of high school seniors.
[21] Similarly, the math score coefficients are only slightly larger if the other controls are dropped from the regression. The math coefficient is 0.102 (0.025) in the earlier cohort, and 0.223 (0.044) in the later cohort in regressions with no additional controls.

Table 7 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 7 presents a baseline model, and shows that there is no overall time trend in earnings in the full, pooled sample. In column 2, a time trend interaction captures the overall trend in earnings premia among all individuals who either participated in high school sports or served in a high school leadership role, relative to those who did neither.[22] This time trend is statistically significant at the 5% level, as is the time trend in the premium associated with higher math scores. In order to better understand the nature of these time trends, a control for college degree attainment is added to the model in column 3. This addition has very little effect on the coefficients of interest. While the coefficient on math scores drops (part of the return to math scores works through the correlation between math scores and later college completion) the time trends in both returns to math scores and returns to sports or leadership hardly change at all.

In column 4, a control is added to capture the growing earnings premium to college graduates (trend*college graduate). This trend is strong, and causes the estimated trend in the math score premium to drop to zero. The trend among sports participants and leaders drops as well. In other words, much of the trend towards higher earnings premia among high school leaders and sports participants, and the entire trend towards higher pay for those with strong math scores, can be explained by the growing college premium. The interpretation of this result is not as simple as it would seem. It is possible that a growing demand for college educated workers, regardless of their pre-existing attributes, explains why these high achievers are enjoying higher relative earnings in the later

[22] Since the change in the student government premium estimated in Table 1 is small and imprecise, the Table 2 time trend is estimated for those who participated in sports or as leaders of clubs, publications or performing arts groups only.

cohort. But it is also possible that the trend in the college premium is simply capturing the growing value of pre-college characteristics that are correlated with college completion as well as with high school math scores, leadership or sports participation.

The 5th column of Table 7 pushes the analysis one step further. Here, the time trend in the college graduate earnings premium is estimated separately for sports or leadership participants and others. 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 grew larger (and perhaps less selective) over time.[23] This is strong evidence that there is growing demand for those with high levels of both cognitive and social skills.

To confirm the robustness of the estimated interactions, Table 8 replicates the analysis of Table 7, with several additional interaction terms. Of particular interest, the trend in the math score premium is estimated separately for the sports/leaders group and for others. This specification also allows the level of the earnings premium to be estimated separately for three subgroups within the sports/leaders group, with separate indicators for the subset of individuals who were both sports participants and leaders of other activities, those who were sports participants only and those who were leaders of other activities only. In order to be certain that any differential time trends in the math score premium are not actually picking up between-group differences in levels, an interaction between math scores and membership in the sports/leaders group is also

[23] This result is quite robust, with the coefficients on the trend variables changing very little if more interaction terms are included (for example, college graduate*high school characteristics and/or college graduate*math time trend), or if the trends are estimated for sports participants alone rather than sports participants plus leaders. Other robustness checks with little effect included clustering standard errors on sampled schools, including school fixed effects, and dropping outliers with weekly earnings > $2000.

included (although the coefficient of this interaction turns out to be close to zero in each specification).

The results of this change in specification confirm that the earnings premium (in levels) is shared by all three subsets of the sports/leaders group, and corroborates the growing complementarity of cognitive and social skills suggested by the Table 7 results. In both columns 2 and 3 of Table 8 (without, then with, a control for college completion), the time trend in the premium associated with math scores appears only within the sports participant/leader group. As in Table 7, the math score trend vanishes after accounting specifically for the time trend in the premium to college graduates (Table 8, column 4), particularly the time trend in the premium to college graduates with high levels of social skills (column 5). The results displayed in Tables 7 and 8 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.

Returning to the model proposed earlier, suppose that we do a thought experiment to account for the possibility of changing selection into college. We know that growth in the proportion of high school graduates completing college came disproportionately from the sports participant group. Suppose that this new group of students has particularly high value-added to college attendance, then part of the largest trend identified in Table 8 (for sports/leadership participants who attended college) might be due to disproportionate selection of this high-value-added group into college among the later cohort. However, a simulation to account for this possibility suggests that only a tiny portion of the large coefficient could be explained by changing selection. For example, suppose that the 27.2

percent (=(.453-.330)/.453) of 1999 college graduates who would not have appeared among college graduates in the 1979 cohort averaged twice the college value-added compared to the typical college graduate.[24] Even under this extreme assumption, the coefficient on the trend changes only slightly, from 0.102 to 0.095, with no change in the estimated standard error (0.019). This simulation strongly supports the conclusion that a demand shift, rather than changing composition, is primarily responsible for the large coefficient estimated in Table 8. This demand shift led to higher earnings premia, which may have provided sufficient incentives to explain the growing share of high school sports participants who chose to pursue a college education, or may have simply provided the incentives for a growing share of colleges to encourage this group to join the ranks of future donors by offering athletic scholarships.

Before concluding the analysis of interaction effects, I would like to emphasize that while the time trend is largest among those with strong endowments of both cognitive and social skills, there has been no decline in the earnings premium to individuals who graduated high school with above-average endowments of either one type of skill or the other. To illustrate this point, I present Figure 2, with mean real weekly earnings computed for four 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

[24] Students pulled into college attendance by quasi-experimental manipulations tend to have higher value-added than the typical college graduate, but rarely higher than twice the corresponding OLS estimate (Card 1995). To perform this simulation, the “college graduate” variable was set to 1.273 (rather than 1) among college graduates of the later cohort who were sports participants. This simulates the situation in which 27.2 percent of this group got twice as much benefit as the typical college graduate in the sample.

premium that grew substantially larger between cohorts. It is also worth noting that sports or leadership participants with below-average math scores did not experience the same decline in real earnings as their classmates with similarly low scores. While all of these observations can be inferred from the regressions presented in Table 8, the visual presentation of Figure 2 is particularly compelling.[25] There were large changes for the groups with the strongest and weakest skill endowments, but stability of inflation-adjusted earnings for intermediate groups.

It is possible that the downward shift of the group with lowest skill is related to structural features of the economy unrelated to skill (e.g declining minimum wages and union power) (Card and DiNardo 2002). However, the dramatic shift in the nature of skill premia depicted in Figure 2 provides compelling evidence that something pertaining to skills has fundamentally changed.

Linking 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 social experiences) and the DOT-math and DOT-dcp job task measures associated with each occupation.[26] I then use these job task measures to look for

[25] Table 9 lists the statistics used to generate Figure 2, followed by comparisons at even higher margins of cognitive skills. This table also includes statistics based on each workers's percentile rank in the earnings distribution, to control for the possibility that increasing earnings dispersion simply caused a mechanical shift in the relative earnings of the higher skill group (as described by Juhn, Murphy and Pierce 1993, Blau and Kahn 1997). This way of describing the data clarifies that the MS group had a higher mean percentile ranking in the later cohort, while none of the other groups increased along this dimension.

[26] 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 a link between adolescent sociability and entry into jobs requiring "people" skills (Borghans, ter Weel and Weinberg (2008, 2009)).

corresponding patterns of growing returns to skills, and growing complementarity of cognitive and social skills, using Census data.

Simple summary statistics help describe the magnitudes of correlations, but are not sufficient. For example, among 1972 graduates employed full time in 1986 (the only year in which Census occupation codes are available for either NCES cohort), the proportion employed in occupations requiring high levels of both DOT-math and DOT-dcp is .45 among high school sports or leadership participants with above average high school math scores, and only .17 among non-participants with lower scores. Of course, this difference could be entirely driven by differences in cognitive skill endowments. Therefore, a set of regressions with cognitive test score controls is needed to identify the independent effects of skills associated with participation in high school sports and leadership activities.

The regressions presented in Table 10 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 document that the tendency for the sports/leadership group to end up in occupations requiring more math is mediated by an increased propensity to earn a college degree.[27] After including the college control (column 2) the coefficient on high school sports or leadership drops to a fairly precise zero. In contrast, columns 3 and 4 verify that the sports/leadership group is likely to be employed in an occupation requiring higher levels of DOT-dcp, even after controlling for high school math scores and college completion. Columns 5 and 6 document that this group is also more likely to select into multiskilled occupations requiring high levels of both math and social skills, even

[27] 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.

conditional on high school math scores and college completion. Columns 7 and 8 present a slightly different specification to clarify that the difference in selection to multiskilled jobs between the lower half and upper half of the "social skills" distribution is about one half as large as the difference between the lower half and upper half of the math score distribution.

Even after establishing this link between the measures, it is surprising to see how closely the patterns observed in Census data, 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 (age 25-30 in the Census year) 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 1999 there is an additional premium to occupations requiring both.

Figures 4a and 4b present the corresponding data for older groups of workers. The between-group earnings differentials are consistently larger among older workers, but show the same pattern of increasing complementarity, with premia growing most rapidly among workers in occupations requiring both social and cognitive skill.

Finally, Figure 5 includes CPS and ACS data to extend the analysis forward in time. Since the samples from recent years are much smaller, all ages are pooled together.[28] This provides the best possible picture of what has occurred through the current decade (and

[28] To maintain comparability between the CPS and Census/ACS statistics, immigrants are included in the Figure 5 samples.

recession).[29] It seems that the earnings premium favoring workers in occupations requiring both social and cognitive skill has persisted, rather than burst along with the bubbles in the economy.

Discussion

To summarize, this analysis finds strong time trends in the earnings premia associated with early endowments, including both cognitive math skills and the social skills associated with sports or leadership experiences. The time trends show interactions suggesting growing complementarities between cognitive and social skills. This should not be confused to mean that skills are important only to the group possessing high levels of both types of skill. Throughout the period of this study, individuals with high school participation in sports or leadership activities and individuals with higher levels of cognitive scores earned more than their contemporaries, suggesting that both cognitive and social skills have been consistently important factors in wage determination over the past two decades. Similar patterns observed in real-time data also suggest stable high levels of demand for individuals with either type of skill, but growing demand for those who can fill jobs requiring both cognitive and leadership skill, between 1979 and 1999. The rapidly growing earnings premium among those with high levels of both types of skill, during a time when employment in these multiskilled occupations was growing, suggests a demand shift that particularly favored workers endowed with high levels of both social and cognitive skills.

[29] To reduce noise, earnings are not inflation-adjusted in Figure 5. Discontinuities reflect changes in earnings topcodes or occupation coding schemes.

Returning to the models discussed previously, these results do not support a view that the changing premia can be fully explained by the shift towards higher rates of college attendance by individuals who participated in high school activities. In fact, after controlling for interactions, the familiar time trends in both the college premium and the returns to math scores turn out to be absent or small within all other groups. The earnings premium grew *only* among those with early endowments of both types of skill. Card (1995) argues that the group of students pulled into college by the expansion of scholarship programs will tend to have higher returns to college education than the typical college student if low liquidity (rather than academic ability) had been the binding constraint. Thus, efficient expansion of athletic scholarship programs (which drew individuals with similar cognitive skills plus strong endowments of social skills) could be a viable explanation for a growing premium to young college-educated sports participants. However, a simulation described in the previous section suggests that only a small fraction of the trend can be explained in this manner.

Additional evidence inconsistent with changing educational selection as an explanation for the growing earnings premium among multiskilled workers is that a similarly timed shift can be seen among older workers in Census data. The evidence of rising earnings premia for multiskilled workers of all ages, coupled with constant or slightly growing employment, strongly suggests that demand has grown for individuals with high levels of both social and cognitive skills.

The findings of this research have implications for other questions too large to address adequately in a single paper. The most obvious is whether similar changes can be observed among women, and whether women's entry into jobs with high levels of both DOT-math and DOT-dcp played a role in the narrowing of the gender wage gap. Another important question raised by the patterns observed here is whether *within*-cohort growth in the returns to math scores—previously interpreted as a process of employer learning about ability (Farber and Gibbons 1996, Altonji and Pierret 2001)—might be related to the slower development of social skills that complement cognitive skills in high level job tasks. These issues will be addressed separately.

Conclusion

This research reveals an emerging feature of the labor market: The well-documented growth in demand for cognitive skills during the 1980's and 1990's was accompanied by a similar shift in demand for social skills, and primarily affected those with strong endowments of both cognitive and social skills. In 1979, earnings premia were similar for young men with endowments of either cognitive or social skill; by 1999 an extra premium accrued to those with strong endowments of both types of skill. While it is possible that declining wages among unskilled workers were driven by structural changes unrelated to skill, this change in the nature of skill premia almost certainly pertains to demand for worker skills.

In order to measure this phenomenon carefully, data from two cohorts of high school seniors 20 years apart were used to identify comparable pre-labor market measures of skill endowments (which changed very little between cohorts) and weekly earnings seven years after high school. Assuming stability of both the unobserved characteristics correlated with selection of individuals into high school activities, and the skill sets developed as a result of participation in those activities, the growth in the wage premium associated with a given set of high school roles provides evidence of growing economic returns to a “social” set of skills among young white male workers between 1979 and 1999. Coupled with growing employment in jobs requiring complex interactive tasks (as defined and documented by Autor, Levy & Murnane , 2003), between-cohort growth in the earnings advantage to high school sports participants, or leaders, supports the notion that the demand for social skills did indeed grow over time.

In this paper, evidence is presented showing that the returns to both cognitive skills (measured by math scores) and high school interactive experience, including sports and leadership activities, more than doubled between 1979 and 1999. These results are particularly easy to interpret when attention is restricted to a set of activities with fixed proportions of similarly selected participants between cohorts.

Pushing the analysis one step further reveals particularly strong growth in demand for individuals endowed with both types of skill. Between 1979 and 1999, both employment and earnings trends are strongest among multiskilled workers. This can be seen when comparing two cohorts of high school seniors, and also in Census data describing workers of all ages. These findings suggest increasing complementarity between cognitive and social skills.

Altonji, J., and C. Pierret. "Employer Learning and Statistical Discrimination" Quarterly Journal of Economics 116(1) (February 2001): 313-50.

Anderson, Deborah J. "'If You Let me Play': The Effects of Participation in High School Athletics on Students' Behavior and Economic Success". Unpublished paper, Cornell University and University of New Mexico, February 2000.

Autor, David, Frank Levy and Richard Murnane. "The Skill Content of Recent Technological Change: An Empirical Exploration." Quarterly Journal of Economics, November 2003.

Autor, David, Lawrence Katz and Melissa S. Kearney, "The Polarization of the U.S. Labor Market," American Economic Review Papers and Proceedings, 96(2), May 2006, 189 - 194.

Autor, David, Lawrence Katz and Melissa S. Kearney, "Trends in U.S. Wage Inequality: Revising the Revisionists," May 2008, Review of Economics and Statistics

Bacolod, Marigee and Bernardo Blum, 2009. "Two Sides of the Same Coin: U.S. "Residual" Inequality and the Gender Gap." Journal of Human Resources, forthcoming.

Barron, J. M., B. Ewing, and G. Waddell, "The Effects of High School Athletic Participation on Education and Labor Market Outcomes". Review of Economics and Statistics , August 2000, 82(3), pp. 1-13.

Blau, Francine D., and Lawrence M. Kahn. 1997. "Swimming Upstream: Trends in the Gender Wage Differential in 1980s." *Journal of Labor Economics*, Vol. 15, No. 1, (January, Part 1) pp. 1-42

Boning, Brent, Casey Ichniowski and Kathryn Shaw. 2007. "Opportunity Counts: Teams and Effectiveness of Production Incentives." *Journal of Labor Economics*, 25:1721-1758.

Borghans, Lex, Bas ter Weel, and Bruce Weinberg. 2009. "People People: Social Capital and the Labor Market Outcomes of Underrepresented Groups." Working Paper.

Borghans, Lex, Bas ter Weel, and Bruce Weinberg. 2008. "Interpersonal Styles and Labor Market Outcomes," Journal of Human Resources, 43(4):815-858.

Bowles, S., H. Gintis, and M. Osborne, "The Determinants of Earnings: Skills, Preferences and Schooling". Journal of Economic Literature 39(4) (December 2001): 1137-1176.

Card, David. 1995. "Earnings, Schooling and Ability Revisited," Research in Labor Economics, vol 14, pp 23-48, 1995.

Card, David, and John E. DiNardo, "Skill-Biased Technological Change and RisingWage Inequality: Some Problems and Puzzles," *Journal of Labor Economics* 20 (October 2002), 733–783.

Chapple, Karen. 2006. "Foot in the Door, Mouse in Hand: Low-Income Women, Short-Term Job Training Programs, and IT Careers" in *Women and Information Technology*, edited by J. Cohoon and W. Aspray, MIT Press.

Eide, Eric and Nick Ronan. 2001. "Is Participation in High School Athletics an Investment or Consumption Good? Evidence from High School and Beyond" Economics of Education Review, 20(5), pages 431-442

Farber, H. and R. Gibbons. "Learning and Wage Dynamics". Quarterly Journal of Economics 111(4) (November 1996): 1007-1048.

Farkas, George, Paula England, Keven Vicknair and Barbara Stanek Kilbourne, 1997. "Cognitive Skill, Skill Demands of Jobs, and Earnings among Young European American, African American, and Mexican American Workers," Social Forces, 75(3):913-940.

Goleman, D. Emotional Intelligence: Why it can matter more than IQ. New York: Bantam, 1997.

Goleman, D. Working with Emotional Intelligence. New York: Bantam, 1998.

Grogger, J. and E. Eide, "Changes in College Skills and the Rise in the College Wage Premium," Journal of Human Resources, 30(2), (1995):280-310.

Heckman, James J., Jora Stixrud, and Sergio Urzua. 2006. "The Effects of Cognitive and Noncognitive Abilities on Labor Market and Social Outcomes" Journal of Labor Economics, 24(3):411-482.

Miriam King, Steven Ruggles, Trent Alexander, Donna Leicach, and Matthew Sobek. Integrated Public Use Microdata Series, Current Population Survey: Version 2.0. [Machine-readable database]. Minneapolis, MN: Minnesota Population Center [producer and distributor], 2004.

Juhn, Chinhui, Kevin Murphy, and Brooks Pierce. 1993. "Wage Inequality and the Rise in Returns to Skill" *The Journal of Political Economy* 101(3), pp. 410-442.

Kuhn, Peter and Catherine Weinberger. 2005. "Leadership Skills and Wages." Journal of Labor Economics, 23(3):395-436.

Moss, P. and C. Tilly . 2001. Stories Employers Tell: Race, Skill, and Hiring in America. New York: Russell Sage Foundation.

Murnane, Richard J., John B Willet, and Frank Levy, 1995. “The Growing Importance of Cognitive Skills in Wage Determination,” Review of Economics and Statistics, 77(May): 251-66.

National Association of Colleges and Employers, “Ideal Candidate Has Top-Notch Interpersonal Skills, Say Employers”. January 18, 2000.

National Center for Education Statistics, 1994, “NAEP Trends in Academic Progress.” ED 378 237 (see e.g. pages 80, 83, A-69).

Persico, Nicola, Andrew Postlewaite and Dan Silverman "The Effect of Adolescent Experience on Labor Market Outcomes: The Case of Height," *The Journal of Political Economy* 112(5), October 2004, pp. 1019-53.

Roy, A.D. 1951, “Some Thoughts on the Distribution of Earnings,” Oxford Economic Papers, 3(2):135-146.

Steven Ruggles, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King, and Chad Ronnander. Integrated Public Use Microdata Series: Version 4.0 [Machine-readable database]. Minneapolis, MN: Minnesota Population Center [producer and distributor], 2008.

Segal, Carmit. 2006. “Motivation, Test Scores, and Economic Success.” Harvard Business School Working Paper.

Shaw, Kathryn, Patricia Beeson and Lara Shore-Sheppard. 2001. “Industrial change and Wage Inequality: Evidence from the Steel Industry” ILRR, 54 (March 2001):466-483.

Stevenson, Betsey. 2006. “Beyond the Classroom: Using Title IX to Examine the Return to Participating in High School Sports” Working Paper.

Weinberg, Bruce. 2000. “Computer Use and the Demand for Female Workers,” Industrial and Labor Relations Review, 53(3), 209-308.

Weinberger, Catherine. 2006. “Are There Racial Gaps in High School Leadership Opportunities?” UCSB Working Paper.

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

	1972 Seniors		1992 Seniors	
	Full 1972 base year sample	1979 Labor Force Sample	Full 1992 base year sample	1999 Labor Force Sample
Participation:				
Sports	0.57	0.57	0.56	0.55
Clubs (academic, vocational or hobby)	0.44	0.45	0.39	0.41
Performing Arts	0.26	0.25	0.22	0.21
Student Publications	0.14	0.14	0.15	0.14
Leadership Roles:				
Sports Team Captain	0.14	0.14	0.24	0.24
Student Government	0.18	0.17	0.13	0.14
Other Leadership Role	0.16	0.16	0.16	0.16
Any Leadership Role Above:	0.36	0.35	0.41	0.41
Sports Participant or Leader	0.66	0.65	0.67	0.65
Sports Participant or Leader in "Other"	0.63	0.63	0.64	0.63
Log Weekly Earnings 7 years after high school		6.44		6.43
(standard deviation)		(0.42)		(0.48)
Proportion with College Degree		0.27		0.35
Sample Size	6672	4421	3884	3024

This sample includes white men only. Columns 2 and 4 are 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. Leader in "Other" refers to individuals who filled leadership roles in clubs, student publications, or performing arts.

Table 2--Proportion of Young Men in Occupations Requiring High Levels of Skill

	Earlier Census 1980	Later Census 2000	Earlier CPS 1978-1982	Later CPS 1998-2002
High DOT-math Occupation	.307	.329	.322	.338
High DOT-dcp Occupation	.278	.301	.275	.301
Interactions:				
Both Math & dcp High (MS)	.204	.229	.219	.249
Only DOT-math High (M)	.103	.100	.103	.090
Only DOT-dcp High (S)	.074	.072	.056	.052
Sample Size	398746	339192	32022	22247

Sample: Men, Age 25-30, who worked at least 1500 hours last year
Census sample restricted to men born in the U.S.

High DOT-dcp occupations include those with social-skill task measure greater than 5,
High DOT-math occupations include those with cognitive task measure greater than 5.

Selected Correlations and Conditional Means within the Labor Force Sample

Table 3—Correlations between Important Variables

	1972 Seniors Cohort	1992 Seniors Cohort
Corr(Math Scores, Sports)	.15	.14
Corr(Math Scores, Sports or Leader)	.17	.16
Corr(Math Scores, College Grad)	.45	.45
Corr(College Grad, Sports)	.17	.25
Corr(College Grad, Sports or Leader)	.19	.23
Sample size	4421	3024

Table 4—Proportion Graduating College within 7 Years of High School

	1972 Seniors Cohort	1992 Seniors Cohort
Proportion of High School Sports Participants Graduating College within 7 Years of High School	0.330	0.453
Sample Size	2520	1772
Proportion of Sports Non-Participants Graduating College within 7 Years of High School	0.181	0.218
Sample Size	1901	1252

Table 5—Mean Math Score Percentile, Conditional on College Graduation

	1972 Seniors Cohort	1992 Seniors Cohort
Mean Math Percentile Scores among All College Graduates	68.5 (22.0)	67.8 (24.0)
Sample Size	1201	1170
Mean Math Percentile Scores among College Graduates who were High School Sports Participants	68.5 (21.8)	68.7 (22.9)
Sample Size	838	866

(Standard Deviation in Parentheses)

Table 6—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)
	Leadership alone	Participation	Participation & Leadership	Plus Math Scores	Leadership alone	Participation	Participation & Leadership	Plus Math Scores
Any Leadership Role	0.053 (0.015)**				0.104 (0.024)**			
Sports Leadership Role		0.058 (0.020)**				0.082 (0.026)**		
Student Government		0.042 (0.018)*				0.075 (0.035)*		
Other Leadership Role[30]		0.017 (0.020)	0.027 (0.021)	0.022 (0.021)		0.071 (0.031)*	0.100 (0.033)**	0.084 (0.034)*
Sports Participation			0.048 (0.014)**	0.040 (0.014)**			0.097 (0.024)**	0.082 (0.024)**
Participant in Other[31]			-0.001 (0.015)	0.000 (0.015)			-0.016 (0.026)	-0.019 (0.026)
Math Score[32]				0.089 (0.025)**				0.194 (0.045)**
Observations	4421	4421	4421	4421	3024	3024	3024	3024
R-squared	0.004	0.005	0.004	0.007	0.012	0.015	0.015	0.028

standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1% (NOTE: add 10%)
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

---

[30] Includes leadership roles in clubs, student publications, or performing arts.
[31] Clubs, student publications, or performing arts.
[32] Math percentile score divided by 100.

Table 7—Time Trends in Pooled Regressions (Combining both NCES Samples Used in the Table 6 Regressions)

	(1)	(2)	(3)	(4)	(5)
Levels:					
Leadership	0.049 (0.019)*	0.047 (0.019)*	0.044 (0.019)*	0.047 (0.019)*	0.046 (0.019)*
Sports Participation	0.060 (0.014)**	0.060 (0.014)**	0.052 (0.014)**	0.049 (0.014)**	0.047 (0.014)**
Math Score	0.144 (0.026)**	0.142 (0.025)**	0.101 (0.028)**	0.104 (0.028)**	0.102 (0.028)**
College Graduate			0.060 (0.017)**	0.054 (0.016)**	0.055 (0.016)**
Time Trends:					
Trend*(Sports or Leadership)		0.029 (0.015)*	0.028 (0.015)+	0.017 (0.015)	
Trend*(Math Score)		0.052 (0.026)*	0.051 (0.025)*	-0.006 (0.028)	-0.006 (0.028)
Trend*College Graduate				0.083 (0.016)**	
Trend*College Graduate*(not Sports & not Leader)					0.043 (0.035)
Trend*College Graduate*(Sports or Leadership)					0.102 (0.019)**
Trend*(Sports or Leadership) *(Not College Grad)					0.004 (0.017)
Time Trend*(omitted trend categories)	-0.007 (0.007)	-0.025 (0.012)*	-0.026 (0.012)*	-0.045 (0.012)**	-0.038 (0.013)**
Observations	7445	7445	7445	7445	7445
R-squared	0.02	0.02	0.02	0.03	0.03

Standard errors in parentheses + significant at 10%; * significant at 5%; ** significant at 1% The time trend variable is defined as (year-1989)/10.
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, so that all levels are evaluated in as of 1989, and the math score level is evaluated at the median math score in 1989. Leadership includes leadership roles in clubs, student publications, or performing arts.

Table 8—Time Trends in Pooled Regressions --Further Exploration of Interaction Effects

	(1)	(2)	(3)	(4)	(5)
Levels:					
Sports Participant and Leadership	0.098 (0.023)**	0.096 (0.023)**	0.083 (0.023)**	0.082 (0.023)**	0.080 (0.022)**
Sports Participation Only	0.065 (0.015)**	0.065 (0.015)**	0.056 (0.016)**	0.054 (0.016)**	0.052 (0.015)**
Leadership Only	0.070 (0.034)*	0.067 (0.034)*	0.064 (0.034)+	0.070 (0.034)*	0.070 (0.034)*
Math Score	0.147 (0.043)**	0.150 (0.042)**	0.119 (0.042)**	0.125 (0.042)**	0.123 (0.042)**
Math Score*(Sports Participation or Leadership)	-0.007 (0.054)	-0.014 (0.053)	-0.031 (0.053)	-0.036 (0.053)	-0.036 (0.053)
College Graduate			0.061 (0.017)**	0.055 (0.017)**	0.057 (0.016)**
Time Trends:					
Trend*(Sports or Leadership)		0.031 (0.015)*	0.029 (0.015)*	0.018 (0.015)	
Trend*(Math Score)*(Sports or Leadership)		0.073 (0.032)*	0.071 (0.032)*	0.005 (0.035)	-0.008 (0.035)
Trend*(Math Score)*(not Sports & not Leader)		0.017 (0.042)	0.019 (0.042)	-0.024 (0.042)	-0.003 (0.044)
Trend*College Graduate				0.083 (0.017)**	
Trend*College Graduate*(not Sports & not Leader)					0.043 (0.037)
Trend*College Graduate*(Sports or Leadership)					0.102 (0.019)**
Trend*(Sports or Leadership) *(Not College Grad)					0.003 (0.017)
Time Trend*(omitted trend categories)	-0.008 (0.007)	-0.028 (0.012)*	-0.029 (0.012)*	-0.047 (0.012)**	-0.038 (0.013)**
Observations	7445	7445	7445	7445	7445
R-squared	0.02	0.02	0.02	0.03	0.03

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

Table 8 notes, continued:
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 defined as in Table 7.

Table 9—Additional Descriptive Statistics to Illustrate Growing Complementarity of Cognitive and Social Skills

	Mean Weekly Earnings		Mean Percentile Rank		Sample Size & Weighted Share	
	1979	1999	1979	1999	1979	1999
Figure 2 Statistics:						
Low Math, Low Social Skill (Math percentile no greater than 50, Neither sports nor leadership)	$645.30 (9.48)	$629.31 (18.16)	45	42	n=1012 23.8%	n=593 22.2%
Low Math, High Social Skill (S) (Math percentile no greater than 50, either sports participant or leader)	$688.18 (8.91)	$702.46 (21.13)	49	48	n=1377 30.5%	n=863 28.9%
High Math, Low Social Skill (M) (Math percentile greater than 50, Neither sports nor leadership)	$692.87 (14.90)	$685.41 (19.42)	50	49	n=601 13.4%	n=430 14.7%
High Math, High Social Skill (MS) (Math percentile greater than 50, and sports participant or leader)	$708.69 (11.71)	$756.68 (13.22)	51	56	n=1431 32.3%	n=1138 34.2%
Even Stronger Skill Bundles:						
Higher Math, High Social Skill (Math percentile greater than 75, and sports participant or leader)	$743.94 (22.93)	$800.84 (20.15)	53	60	n=636	n=592
Higher Math, High Social Skill, and BA (Math percentile greater than 75, and (sports participant or leader) and college graduate)	$750.34 (23.74)	$860.14 (24.83)	56	65	n=410	n=441

Sample: Indicated subsets of the Tables 6-8 “Labor Force Sample”
“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 Table 7 & 8 regressions, “leadership” includes leadership roles in clubs, student publications, or performing arts.
Column1-2, row 1-4 means are depicted in Figure 2.

Table 10a—Early Endowments and Selection into Occupations 13 Years Later (Current Full-Time Workers)

	Job Skill Dependent Variable: **DOT-math**		Job Skill Dependent Variable: **DOT-dcp**		Job Skill Dependent Variable: **Both DOT-math and DOT-dcp above median**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sports or Leadership	**0.027 (0.008)****	**0.008 (0.008)**	**0.066 (0.017)****	**0.035 (0.017)***	**0.071 (0.020)****	**0.037 (0.020)+**	**0.081 (0.020)****	**0.039 (0.020)***
Math Score	**0.269 (0.014)****	**0.164 (0.015)****	**0.327 (0.028)****	**0.159 (0.032)****	**0.412 (0.034)****	**0.227 (0.038)****		
College Graduate		**0.136 (0.009)****		**0.218 (0.019)****		**0.239 (0.024)****		**0.257 (0.023)****
Math Score > Median							**0.199 (0.020)****	**0.105 (0.021)****
Observations	**2525**	**2525**	**2525**	**2525**	**2525**	**2525**	**2525**	**2525**
R-squared	**0.15**	**0.24**	**0.07**	**0.13**	**0.07**	**0.12**	**0.06**	**0.12**

Table 10b—Early Endowments and Selection into Occupations 13 Years Later (Current or Most Recent Occupation)

	Job Skill Dependent Variable: **DOT-math**		Job Skill Dependent Variable: **DOT-dcp**		Job Skill Dependent Variable: **Both DOT-math and DOT-dcp above median**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sports or Leadership	**0.030 (0.008)****	**0.014 (0.008)+**	**0.061 (0.016)****	**0.036 (0.016)***	**0.070 (0.019)****	**0.044 (0.018)***	**0.079 (0.019)****	**0.046 (0.018)***
Math Score	**0.258 (0.014)****	**0.154 (0.015)****	**0.313 (0.026)****	**0.148 (0.030)****	**0.378 (0.032)****	**0.209 (0.036)****		
College Graduate		**0.133 (0.008)****		**0.211 (0.018)****		**0.217 (0.022)****		**0.233 (0.021)****
Math Score > Median							**0.183 (0.018)****	**0.098 (0.020)****
Observations	**2918**	**2918**	**2918**	**2918**	**2918**	**2918**	**2918**	**2918**
R-squared	**0.14**	**0.22**	**0.06**	**0.12**	**0.06**	**0.10**	**0.05**	**0.10**

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

Table 10 Notes: “Sports or Leadership” is sports participation or Leadership in activities, as defined in Table 7
DOT-math and DOT-dcp job-task measures are divided by 10, so that the range is 0 to 1 (to match the scale of the control variables)
College Graduate is measured here as of the 1986 resurvey. Previously, it referred to educational attainment as of 1979.

Table 10a Sample: Subset of the 1979 “Labor Force” sample working full-time in 1986 with current occupation known.
Table 10b Sample: Subset of the 1979 “Labor Force” sample with current or most recent occupation observed in 1986

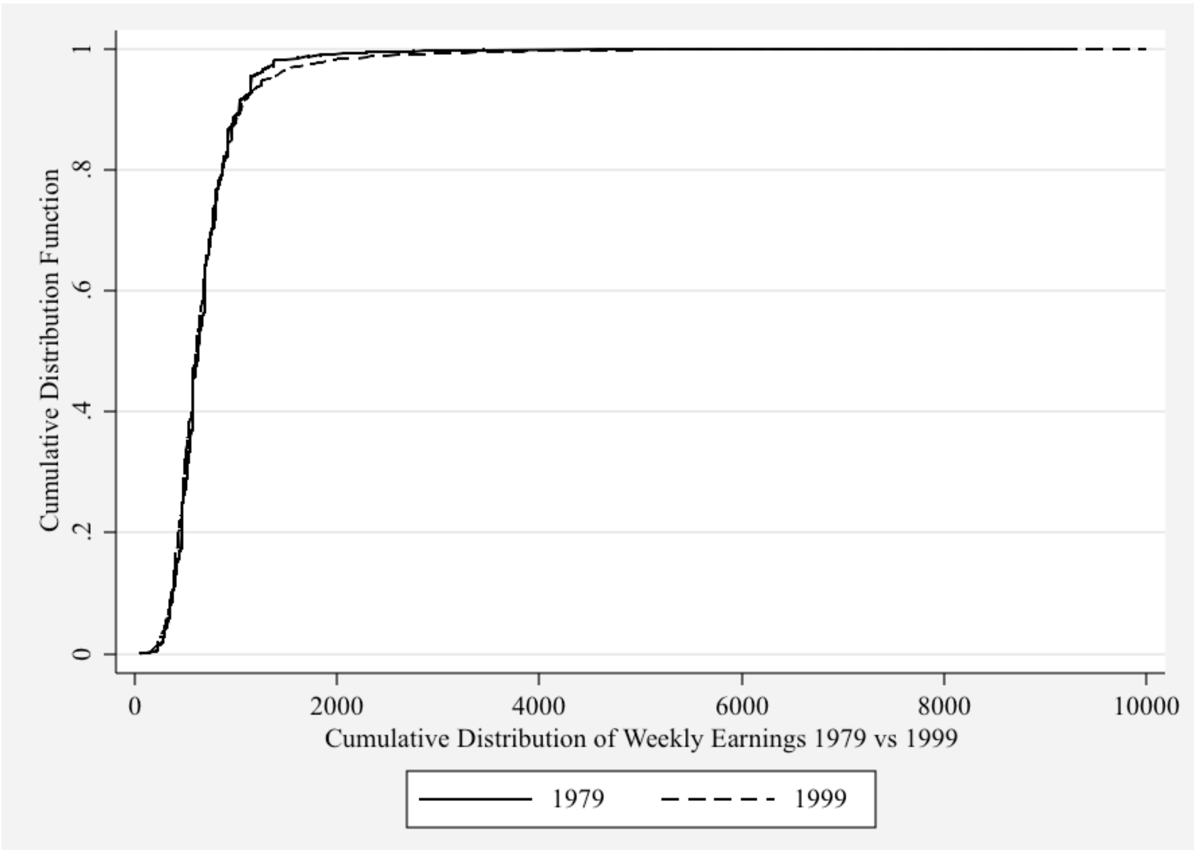


Figure 1-Cumulative Distribution of Real Weekly Earnings Seven Years after High School

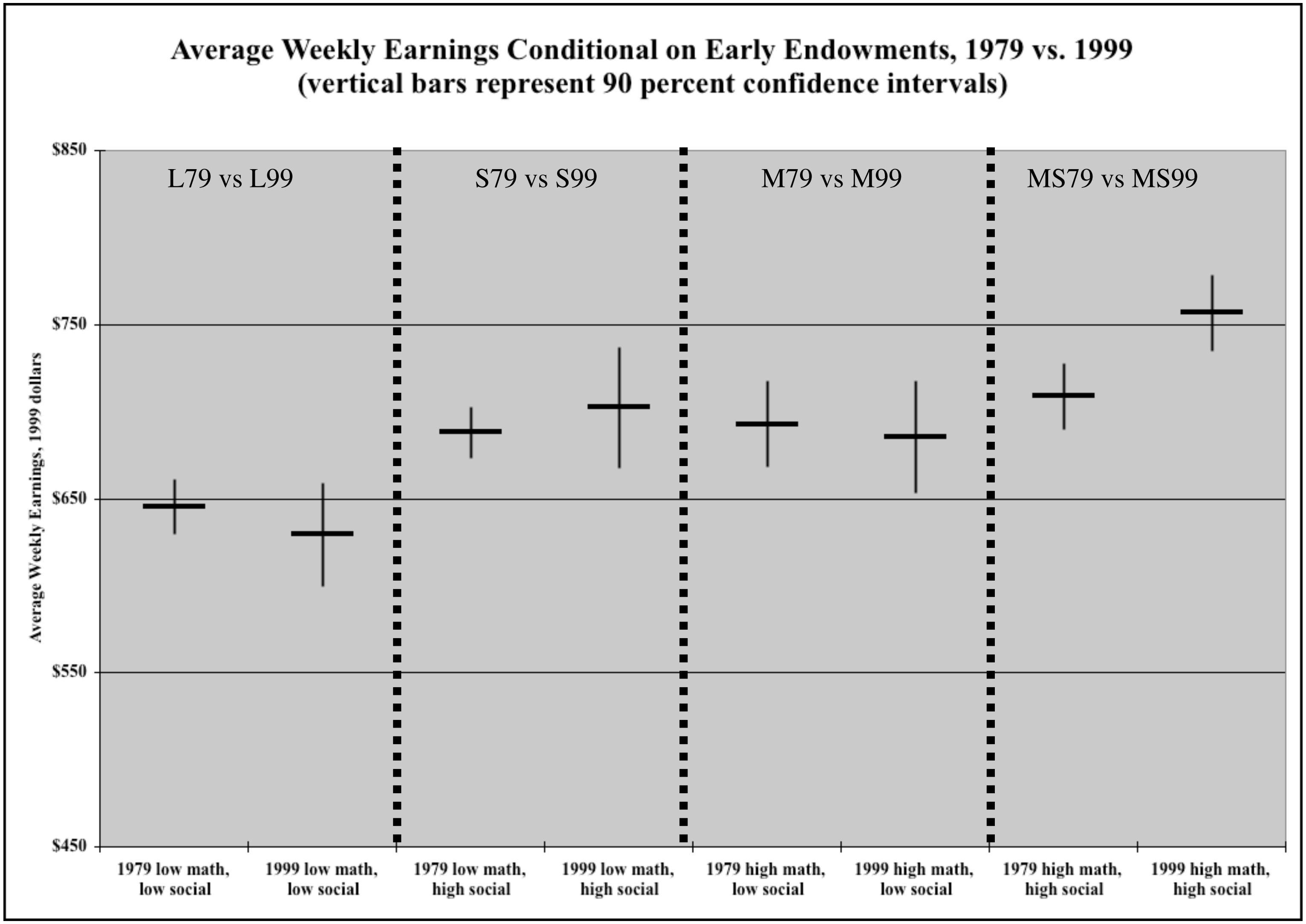


Figure 2--Mean Weekly Earnings Seven Years after High School, By Early Endowments and Cohort
(Sample same as Tables 6-8 “Labor Force Sample,” “high math”skill= senior year math score above median, “high social” skill=participated in sports or leadership roles during senior year of high school. See Table 9 for more detail.)

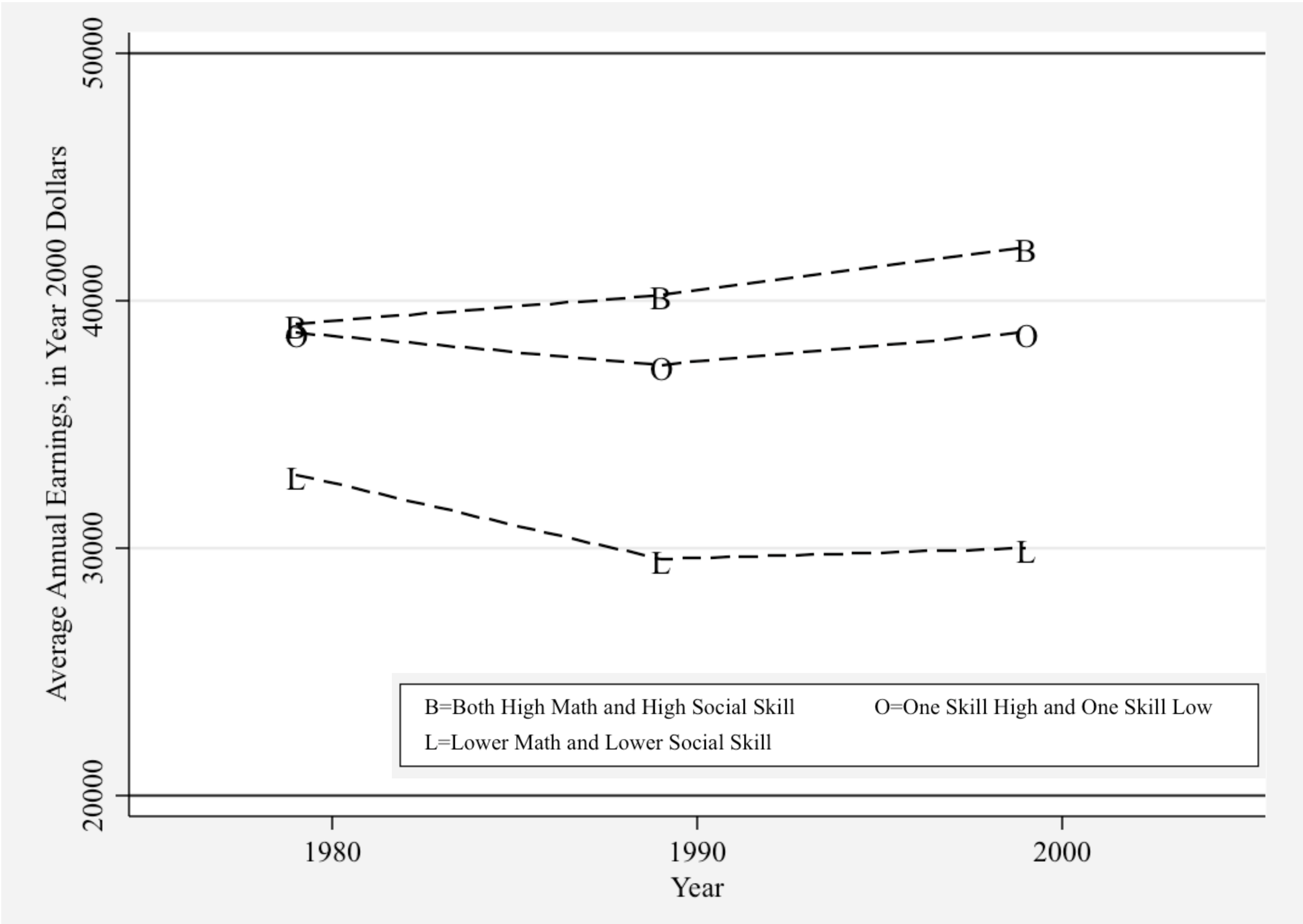
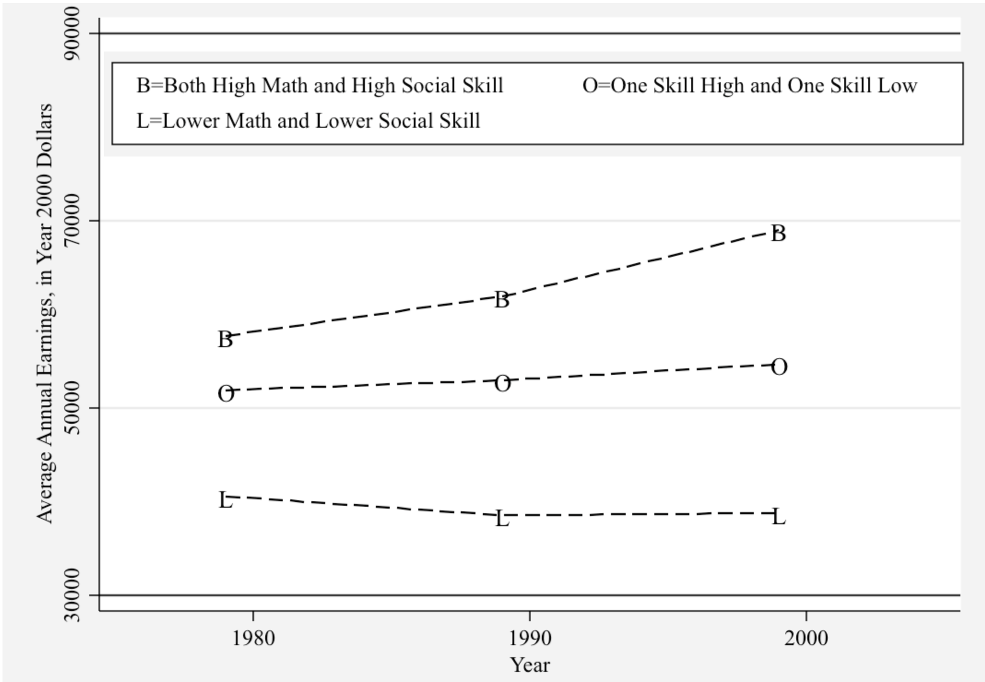
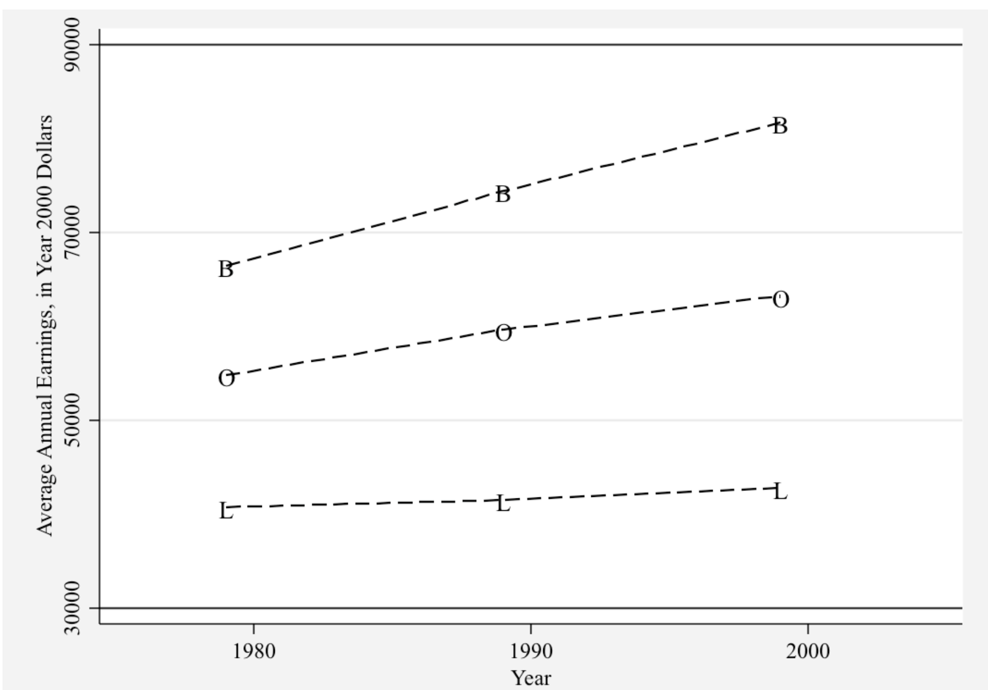


Figure 3—Average Annual Real Earnings of Young, US Born Men, By Occupational Skill Requirement
Sample of young men age 25-30 who worked at least 1500 hours in the preceding year was drawn from the 1980, 1990 & 2000 Census (annual earnings observed for years 1979, 1989, and 1999)



4a. Age 31-45



4b. Age 46-60

Figure 4—Average Annual Real Earnings of US Born Men, By Occupational Skill Requirement
Samples of men age 31-45 (top) or 46-60 (bottom) who worked at least 1500 hours in the preceding year were drawn from the 1980, 1990 & 2000 Census.

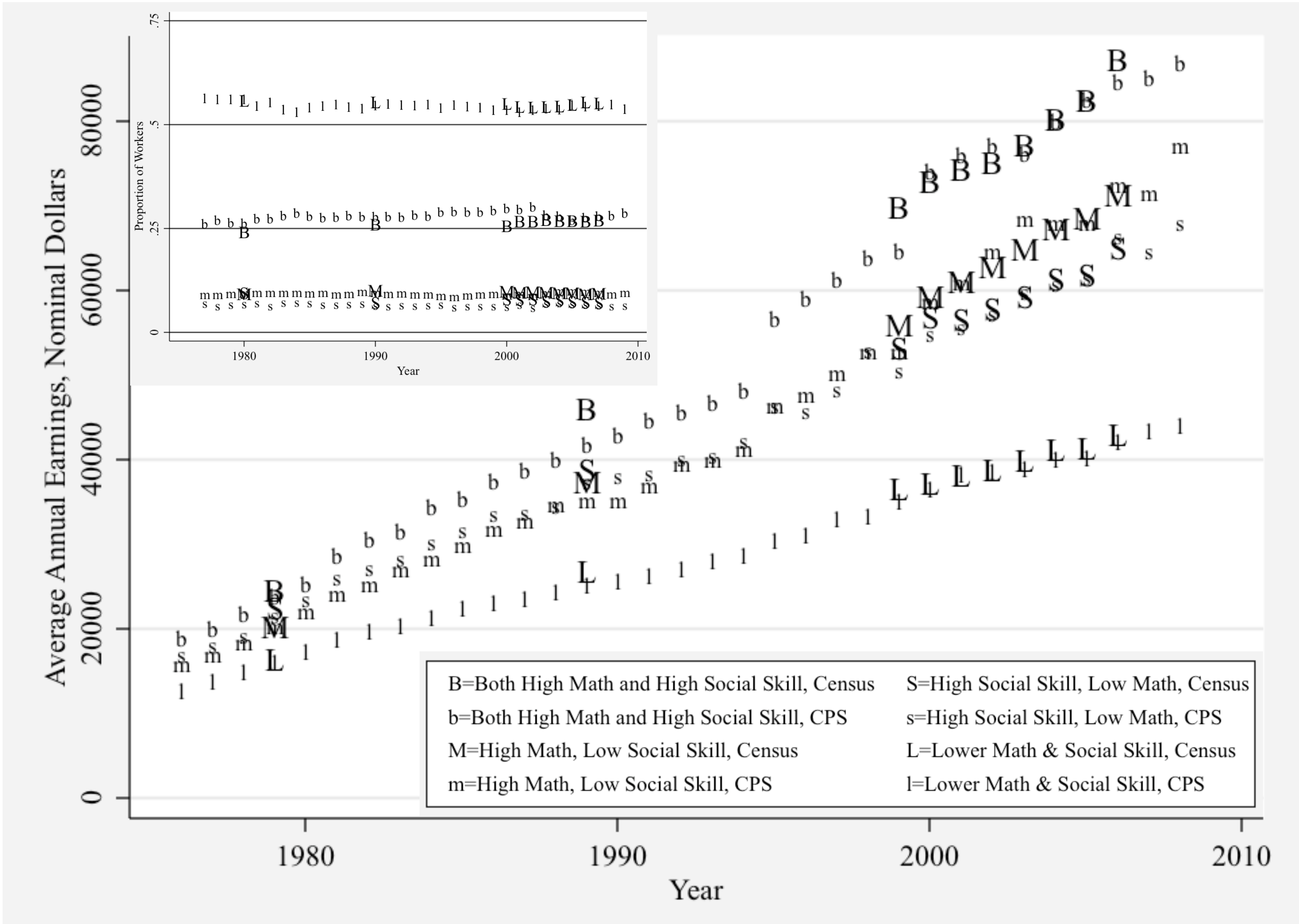


Figure 5—Average Annual Earnings of Men, by Occupational Skill Requirement
Inset: Share of Full-Time Workers in Each Skill Category
Sample: U.S. Men Age 25-60 in year of observation, annual earnings observed for the preceding year