DISCUSSION PAPERS IN ECONOMICS

Working Paper No. 01-07

IQ, Academic Performance, Environment and Earnings

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May 2001

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22 May 2001

Joseph Altonji, William Dickens, Christopher Jencks, Terra McKinnish, Daniel Sullivan, anonymous referees and seminar participants at the 1997 Allied Social Sciences Association meeting, Clemson University, the Federal Reserve Bank of Chicago, Georgetown University, Georgia Institute of Technology, Georgia State University, the Institute for Research on Poverty at the University of Wisconsin, Northwestern University, Oregon State University, the University of Colorado at Denver, the University of Georgia, the University of Illinois at Chicago, the University of Texas at Dallas and the Urban Institute have been generous with comments.

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Abstract

This paper explores the effects of peers, friends, family, IQ and academic performance, observed in the last year of high school, on earnings at ages 35 and 53. All significantly affect earnings at both ages. The effects of IQ are much smaller than asserted in, for example, The Bell Curve, and badly overstated in the absence of controls for family, wider context or academic performance. Aspirations appear to be very important. Socialization and role models may be as well, but not ability spillovers. Feasible increases in academic performance and education can compensate for the effects of many cognitive and contextual deficits.

J.E.L. Classifications J31, D13

Economic success depends both on an individual's internal resources and the context in which the individual develops them. Internal resources consist of innate human capital, the capacity to augment any such 'endowment' through additional investments and the work effort derived from this capital. 'Context' comprises the family, school and community resources that may contribute to the productivity of these efforts.

There is a vast literature examining the relationship between wages or earnings and personal characteristics that can serve as proxies for the accumulation of human capital, such as age, education, labor market experience, gender and race. However, there are perhaps no more than a dozen papers that examine the relationship between earnings and pre-labor market measures of intellectual capacity.

Similarly, relatively little is known about the relationship between contextual effects and subsequent wages or earnings. Two recent reviews together identify only eight papers that address this issue (Haveman and Wolfe (1995), Jencks and Mayer (1990)). Collectively, they demonstrate that income as a young adult is related to characteristics measured during childhood and adolescence. However, they offer little conclusive evidence regarding temporal, social or spatial proximity: the span within the life-cycle during which these effects are important, the degree of personal intimacy necessary to generate them, or the geographic area within which they are concentrated.

Analyses that do not incorporate measures of both individual capacity and context must be interpreted with care because the two are almost surely correlated: more intelligent children are likely to be offered richer environments, at least educationally. Richer environments presumably stimulate the development or realization of intelligence. To the extent that capacity is inherited, more intelligent parents are more likely to be able to afford the inputs that create richer environments, and to have more intelligent children.

However, analyses that include measures of both individual capacity and context require unusually detailed data. In consequence, the intersection of the literatures discussing the effects of cognitive ability and contextual effects on earnings consists, arguably, of only Kiker and Condon (1981). This paper constitutes another member of this intersection. It presents new evidence regarding the contributions of both individual intellectual capacity and adolescent context to earnings. It simultaneously estimates the contributions of IQ, characteristics of family, high school friends, high school peers and their families, and high schools to earnings at ages 35 and 53.

These estimates are noteworthy, first, because an extensive array of covariates minimizes the biases attributable to any omissions. Second, this is one of only a very few papers to examine the magnitudes of these contributions at ages beyond the mid-thirties. Third, the estimates of contextual contributions here are distinctive because they derive from a uniquely exhaustive description of an entire hierarchy of contexts, from family through friends and peers to high schools. Fourth, the estimates here are the first to meaningfully evaluate the contribution of high school academic performance, measured by high school rank, to adult earnings. Lastly, they are the first to control for academic performance in estimating the effects of IQ.

I. IQ and earnings

Previous evidence regarding the relationship between intellectual capacity and earnings is not entirely consistent. Several papers suggest that it is unimportant; Kiker and Condon (1981) and Cohn and Kiker (1986) estimate that the cognitive ability measure in the Panel Study of Income Dynamics (PSID) has negligible effects on log earnings.[1] Murnane, Willett

[1] With cognitive ability scores rescaled to standard deviations of 15, both papers estimate that even statistically significant effects of intelligence on earnings are unimpor-

and Levy (1995, 259) estimate that a difference of approximately one standard deviation in mathematics achievement scores has "a very modest impact" on wages for 24 year-old males in 1978, though a larger effect in 1986. Bound, Griliches and Hall (1986, 94) conclude that, in the National Longitudinal Study of Youth (NLSY), "(t)he role of the [unobserved] 'ability' factor in the wage equation is marginal, both in the sense that its coefficients are not significantly different from zero and in the sense that it contributes little to the explanation of the variance of wages."[2]

However, Crouse (1979) estimates returns of approximately 15 percent to income for each standard deviation of measured intelligence, using several sixth grade tests for 692 individuals enrolled in the Kalamzoo, Michigan school district between the years of 1928 and 1952. Bishop (1989, 181) adopts .190 as his central "estimate of the response of the logarithm of the wage to a one population standard deviation change in adult GIA [general intellectual achievement]" among males in the PSID. Neal and Johnson (1996) estimate a log wage response of .172 to a standard deviation change in Armed Forces Qualification Test (AFQT) scores among males in the NLSY. Cameron and Heckman (1993, tables 2 and 10) imply returns of 7-10% to this change among NLSY respondents.

These estimates suggest that the difference in earnings associated with a one standard deviation difference in measured cognitive ability is equal to that associated with a difference of at least one, and perhaps as many as three years of schooling.[3] Gottfredson, et

tant.

[2] Blackburn and Neumark (1993) estimate small and often negative wage effects for what they call the "academic test" in the NLSY in the presence of other NLSY test scores.

[3] "(O)n average, an extra year of schooling still increases earnings by at least a substantial 6-8 percent" (Heckman (1995, 1111-2)). However, Ashenfelter and Krueger (1994, 1171) assert that "the returns to schooling in our data are never less than 9 percent per year completed" and appear to be 12-16 percent.

al. (1997, 14) conclude that "(w)hatever IQ tests measure, it is of great practical and social importance." Heckman (1995, 1107) concurs. The preeminence of IQ is arguably the principal, and certainly a controversial, theme in Herrnstein and Murray (1994).

This paper estimates the effects of IQ, measured at age 17, on earnings at ages 35 and 53.[4] Only two other known studies include observations towards or at the end of the peak earnings years.[5] In contrast to the work here, Crouse (1979) and Bishop (1989) pool observations from many cohorts. Only Crouse (1979) examines the persistence of the relationship between adolescent cognitive ability and labor market earnings.

II. The theory and measurement of contextual effects

Child development almost universally takes place within the context of families. Accordingly, the success of that development may depend on parental wealth and effort (Becker and Tomes (1986)). It may also depend on the number and types of siblings who compete for shares in familial resources.

However, broader contextual effects may also alter individual behavior, through several social mechanisms. Jencks and Mayer (1990, 113-5) list models of epidemics, collective socialization and institutional influences as implying positive relationships between

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[4] IQ measurements as of late high school are appropriate here because the issue is whether subsequent interventions can compensate for cognitive deficits in the determination of earnings during the peak years. In addition, these measurements can incorporate only limited experience effects. In contrast, Bishop (1989, 180) requires "that GIA [general intellectual achievement] be measured long after the completion of schooling and as close as possible to the date of the wage rate observations" because "the more recent test is by far the more powerful predictor of earnings". Achievement test scores that are contemporaneous with earnings measures must derive some of their predictive power from their relationship with work experience (Bishop (1989, 179) and Neal and Johnson (1996, 873)).

[5] Observations are 24 years old in Murnane, Willett and Levy (1995), between 26 and 29 in Neal and Johnson (1996), between 19 and 32 in Kiker and Condon (1981), between 26 and 38 in Bound, Griliches and Hall (1986) and apparently between the early thirties and early forties in Cohn and Kiker (1986).

contextual activity and individual behavior. Respectively, these models predict that individuals are more likely to adopt and pursue an objective if this choice is popular among their peers, encouraged by neighborhood adults or external authorities.

Positive effects are also possible through explicitly economic relationships. Peer 'ability' may be an important input in the educational production function (de Bartolome (1990)). Adults may influence adolescent choices by providing, for example, information regarding the returns to investments in human capital (Durlauf (1994, 840), Montgomery (1991)). Exposure to employed adults may affect the quantity and quality of labor market contacts available to individuals entering the labor force (O'Regan and Quigley (1993)).

At the same time, the social and economic consequences of contextual effects can be negative (Jencks and Mayer (1990, 116-7)). Individuals may assess their prospects as based on the differences between their own ability or status and the average abilities or status levels of their peers. Those who are less able or exalted may react to the perception of 'relative deprivation' by reducing their subsequent investments in human capital.

Other mechanisms may amplify these reactions. With limited resources or opportunities, increases in the number of colleagues with greater ability or resources will also discourage effort on the part of individuals with smaller endowments.[6] If the variance in resources or performance is sufficient, individuals experiencing relative deprivation may form a critical mass, leading to a 'deviant subculture' which provides further encouragement to limit effort and human capital investments.

More general negative community-based effects may also arise. de Bartolome (1990) demonstrates that household optimization in response to contextual externalities may lead to inefficient community composition. Benabou (1993) presents a model in which these

[6] This result is familiar in the tournament literature (Lazear and Rosen (1981), McLaughlin (1988)).

inefficiencies can lead to "the collapse of the productive sector" (pg. 619). Durlauf (1994) describes how contextual effects might be responsible for the formation of persistently disadvantaged communities.

Discrimination among the various hypothesized contextual mechanisms requires measures describing a multitude of different contextual levels. In practice, available data are limited to the point that few if any of the previous studies have examined the relative effects associated with different levels.

Moreover, the most intimate measured context outside of the family is usually the 'neighborhood'. This concept has a variety of implementations: as examples, the high school (Evans, Oates and Schwab (1992)), the census tract (Brooks-Gunn, et al. (1993)) and the zip code (Datcher (1982), Corcoran et al. (1992)). Tracts and zip codes are poor approximations to neighborhoods because the intensities of the interactions between sampled individuals and others sharing this same geographic area are unknown. Schools are better approximations, because those attending the same school must have some association. More intimate definitions appear only in Case and Katz (1991), where individuals apparently responded to questions regarding their neighborhoods based on self-defined boundaries, referring to areas "roughly one or two square blocks in size" (pg. 14).

In addition, the contextual effects studied most thoroughly are those on social behaviors that are contemporaneous or near-contemporaneous, such as cognitive performance, high school graduation, educational attainment, child-bearing, sexual and criminal activities as teen-agers or young adults (Jencks and Mayer (1990)). Effects on earnings or wages have received much less attention. Furthermore, the extent to which these effects persist through adulthood is unknown.

III. Data and method

The Wisconsin Longitudinal Study of Social and Psychological Factors in Aspiration and Attainment (WLS) contains information regarding 10,317 individuals. Together, these individuals constitute approximately one-third of all seniors in Wisconsin high schools in 1957.[7] The WLS includes self-responses from sample members, siblings, and parents, and administrative data, collected in a series of surveys beginning in 1957, and continuing in 1964, 1975 and 1993.[8]

By definition, this data set is restrictive. In particular, Wisconsin high schools in 1957 contained very few black or Hispanic students.[9] Wisconsin was also a relatively wealthy state. It presumably contained few of the severely disadvantaged neighborhoods that are the focus of, for example, Freeman (1986), Case and Katz (1991) and Wilson (1996).[10]

However, these limitations are advantageous, analytically. The possible contextual effects associated with race, segregation and extreme poverty are especially vexed and

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[7] All WLS respondents graduated from high school (Hauser and Sweeney (1997, 542)). School enrollment rates were .880 among 14 through 17 year olds in the East North Central region in 1958 (Goldin (1994)) and .883 among 16 and 17 year olds in Wisconsin in 1960 (U.S. Bureau of the Census (1963b)). The ratio of high school graduates to 17 year olds in the East North Central region in 1958 was .610 (Goldin (1994)).

[8] Robert M. Hauser, William H. Sewell and J. Kenneth Little are the principal investigators for the WLS. The Inter-University Consortium for Social and Political Research distributes it as data set number 6163. Sewell and Hauser (1980) provide a general description. Work based on the WLS has "heavily influenced subsequent work both quantitative sociology and economics" (Haveman and Wolfe (1995, 1840)).

[9] In 1960 only 1.93% of Wisconsin high school students were non-white (U.S. Bureau of the Census (1963b)). Non-whites comprised 2.35% of the Wisconsin population. "Negros" comprised 1.89%. The WLS does not record race, only ancestry. Fewer then ten members of the sample of table 3 below identify their paternal ancestry as "African".

[10] According to the U.S. Bureau of the Census (1963a, 1963b), the 1959 median incomes in current dollars for families and unrelated individuals in Wisconsin and in the U.S. were $5,173 and $4,791, respectively. In Wisconsin, 11.5% of all families and unrelated individuals had 1959 incomes below $1,000, and 20.5% below $2,000. The corresponding proportions for the U.S. were 12.8% and 23.3%.

intricate (Corcoran and Adams (1997), Jencks and Mayer (1990), Wilson (1996)). More typical contextual effects may be easier to discern in their absence.

In addition, the WLS provides extensive data regarding many of these other effects. Table 1 presents averages of the contextual variables used here, for the sample of 2,959 male respondents analyzed in section IV.[11] The public use version of this data set identifies the population category of the town in which each respondent attended high school, but no other population characteristics. Here, these towns are characterized by dummy variables identifying those with less than 10,000 and more than 49,999 in population.[12] The WLS also provides three variables that identify high school auspice and size of graduating class. Sample averages for these variables, which represent the two 'outermost' contextual levels, appear in the first two panels of table 1.

The WLS contains a wealth of unique information regarding four additional, increasingly intimate contextual levels.[13] The public-use version of the WLS does not reveal the actual identity of individual high schools. However, it identifies high school classmates, and samples approximately one-third of them. These classmates, male and female, constitute the 'peers' of this analysis. Their average characteristics and those of their families

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[11] This paper examines men because, arguably, they would almost all have aspired to labor market success. In contrast, family formation would have been a competing and perhaps predominant objective for women of this generation. The analysis for them must therefore treat family structure and labor force participation, as well as income, as outcomes.

[12] Wisconsin cities with 1960 populations in excess of 49,999 were Green Bay, Kenosha, Madison, Milwaukee, Racine, Wauwatosa and West Allis. All but the last two exceeded this threshold in 1950 as well (U.S. Bureau of the Census (1963b)).

[13] Rowe (1997, 145-6) advocates analyses addressing multiple contextual levels: "Analyses of environments should also adopt nested analytical strategies. ... By analyzing hierarchically, one may reveal environmental effects at a particular level of the social system."

Table 1

Summary statistics, contextual variables

Variable	Average	Standard deviation
Community characteristics:		
High school in town <10,000 population	.287	.452
High school in town >49,999 population	.272	.445
School characteristics:		
Private school	.0159	.125
Catholic school	.0997	.300
Size of high school graduating class	174.	133.
Peer household characteristics:		
Average household income ($10,000s)	3.01	1.16
% fathers graduated high school	.315	.120
% fathers graduated college	.0856	.0951
Peer characteristics:		
Average IQ	101.	5.12
% planning college	.752	.125
% planning white collar occupation	.731	.132
% planning military service	.0461	.0505
% planning to farm	.0348	.0605
Friends' characteristic:		
Friends planning college	.385	.487

Notes: All income variables are in 1992 dollars. The sample consists of 2,959 men.

represent two additional levels of contextual effects.[14]

The third panel of table 1 presents three variables that measure average peer family characteristics. If the two measures of educational attainment among peer fathers are important, they would be consistent with hypotheses based on collective socialization, or 'role models' (Crane (1991), for example). The average peer household income should be a proxy for community wealth and perhaps for the level of material resources available to the school.

The fourth panel of table 1 presents measures of context at one less remove from the individual. These five variables measure characteristics of peers themselves: the percentages reporting that they planned to attend college, pursue a white collar occupation, enter the military or engage in farming[15], and the average IQ.[16]

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[14] Olson and Ackerman (1999) augment the WLS with detailed information describing individual school districts. Case and Katz (1991) disregard the information available in their sample regarding the parents of other children in the same neighborhood because "parent peers may not provide a representative sample of non-familial adult behavior in a youth's neighborhood" (pg. 13). However, 'relatedness' rather than 'representativeness' is the important analytical issue. In Case and Katz (1991), nothing is known about the extent of contact between observed individuals and parents of other 'neighborhood' children. Here, it is plausible that the parents of peers exercise some influence, directly or otherwise, over sample individuals. Therefore, these data provide a useful opportunity to test for both the presence and proximity of adult-based contextual effects.

[15] The "% planning college" is the proportion of respondents from each high school answering "yes" to "Ever plan to attend college?". The three occupational variables represent the proportions choosing among mutually exclusive responses to "Respondent's intended occupational class".

[16] Wisconsin administrative records provide IQ scores from the Henmon-Nelson Test of Mental Ability, administered to eleventh graders. Robert Hauser "estimates the reliability of this test to be between 0.92 and 0.95" (Crouse (1979, 93)), excellent by conventional standards. Herrnstein and Murray (1994, 584) report a correlation of .71 between scores on this test and on the AFQT for 152 NLSY respondents. Christopher Jencks asserts (private communication) that, for unknown reasons, the Henmon-Nelson test "yields lower correlations with both its causal antecedents ... and respondents' later attainments than most other reliable cognitive tests". This may imply a downward bias in the IQ effects estimated here. At the same time, this test is clearly superior to the index of cognitive ability in the PSID, which is not derived from a true IQ test.

These variables provide opportunities to distinguish between hypotheses regarding the sources of contextual effects. As examples, the estimated effects of average peer IQ test the assumption that peer intelligence is an input into the educational production function. Those of peer-reported ambitions test the importance of the epidemic or 'contagion' effects.

'Friends' represent a level of context that is both more intimate and, presumably, more influential than peers. Measures of their characteristics provide the opportunity to assess this presumption. The last panel of table 1 reports the percentage of friends planning to attend college, as reported by each respondent.[17]

Measures of the characteristics of high school classmates are rare, and of friends appear to be unique in the literature examining contextual effects. The WLS also includes a full complement of the variables ordinarily employed in this literature to measure family characteristics, representing the most intimate contextual level.

Table 2 presents average values for these variables. Among them are arrays of dummy variables for mother's and father's education and occupation, and parental attitudes towards college education. These variables also include a dummy variable for the absence

[17] This variable is one response to "Respondent's perception of friends' probable post-high school behavior". Preliminary estimates including additional responses to this question demonstrated that, statistically, the single variable measuring college plans captured the relationship between the attributes of friends and respondent incomes most effectively. The tabulated proportion of friends planning college is smaller than the proportion of peers with the same plans for two reasons. First, the relevant horizon for friends' aspirations is shorter than that for self-reported peer aspirations, as described in footnote 15. Second, the table 1 average for peer college intentions is essentially an average of the proportion of students within a high school planning college attendance at any time in the future, weighted by the number of students in the high school. It is dominated by larger high schools, with higher rates of planned college attendance.

Table 2

Summary statistics, household and individual variables

Variable	Average	Standard deviation
Parental attitude:		
Parents encouraged college attendance	.608	.488
Parents discouraged or did not permit college attendance	.0297	.170
Family resources:		
Household income ($10,000s)	3.09	3.07
Father's education:		
Father's education missing	.0703	.256
Father graduated high school but not college	.325	.468
Father graduated college	.0923	.289
Mother's education:		
Mother's education missing	.0754	.264
Mother graduated high school but not college	.395	.489
Mother graduated college	.0940	.292
Parental occupations:		
Father has white collar job	.299	.458
Mother has white collar job	.165	.371
Household structure:		
One or both natural parents absent	.0757	.265
Number of siblings	3.11	2.50
Individual characteristics:		
1974 labor market earnings ($10,000s)	4.47	2.35
1974 log earnings	10.60	.507
IQ	102.	14.9
Respondent planning college	.424	.494

Notes: Incomes are in 1992 dollars. The omitted category for father's and mother's education consists of those who reported their education as terminating prior to high school graduation. The "white collar" occupational category includes those reporting their occupation as "clerical worker", "proprietor", "manager" or "professional/technical". The sample consists of 2,959 men.

of at least one natural parent.[18] Sibling counts represent the possibility of intra-sibling competition for scarce family resources.[19]

The household income variable in the WLS is unique. It consists of the average of parental incomes reported to the Wisconsin Department of Revenue during the four years beginning in 1957, taken directly from administrative files. It is therefore based on a rigorously consistent definition for all observations. Consequently, it is a more accurate proxy for permanent income than are measures employed by previous analyses of contextual effects.[20]

The last panel of table 2 presents average values for three essential characteristics of the respondents themselves. The first is self-reported labor market earnings in 1974, at approximately age 35. The log of these earnings is the dependent variable in the analyses

[18] In total, the analysis below accounts for eight household and parental characteristics. The number of associated variables is greater because several require arrays of dummy variables to represent the relevant categories. The complete WLS descriptions of parental education consist of seven dummy variables. Those for parental occupations consist of nine dummy variables. Four dummy variables describe the variations in parental presence. The authors can provide upon request an appendix of extended tables which reproduces the analyses in this paper with these complete descriptions. These tables reveal no substantive differences with those in the text.

[19] The appendix discussed in footnote 18 also employs sibling counts distinguished by sex and birth order. Butcher and Case (1994) claim that sibling effects on educational attainment depend on sex composition for women but not for men. However, Kaestner (1997) asserts that educational attainment for either is independent of sibling sex composition. Kessler (1991) demonstrates that wage levels and growth are independent of childhood family size and birth order for both. Here, disaggregation permits replication of these results, tests of aggregation itself and of hypotheses regarding the source of any role model effects (Haveman and Wolfe (1995, 1834), for example). Stratified sibling counts are individually and collectively insignificant in all analyses. Most analyses of contextual effects aggregate sibling counts into a single sum (Haveman and Wolfe (1995)), as here. The analysis here disregards detailed 1975 WLS data describing a single randomlyselected sib. These data are contemporaneous with the first earnings observations rather than with the high school experience, and not available for the entire sample.

[20] The income variable is based on tax reports for 1954-6 or 1961-4 if none were filed during 1957-60. The sample excludes those families for which no income information was available.

below. Footnote 16 describes the second, respondent IQ. The third measures the respondent's own intention to attend college.

The contextual variables here arise in part out of family choices of residence and high school. They might therefore reflect unmeasured family-specific traits and attitudes that also affect later economic success. Although measured many years prior to adult income, there remains the possibility that they could be endogenous with it. They would then be inappropriate as OLS regressors for the log of earnings (Evans, Oates and Schwab (1992)).

Contextual variables that would not plausibly affect future individual incomes are possible instruments for potentially endogenous contextual explanatory variables. Instrumenting equations for the contextual variables of table 1 demonstrate that instruments of this type have substantial explanatory power. Nevertheless, Hausman tests applied to 2SLS estimates of the log earnings equations below uniformly fail to reject the hypothesis that the contextual explanatory variables are truly exogenous.[21] Therefore, the following sections rely on OLS estimations.

The WLS contains variables that are measured subsequent to high school. However, this paper attempts to distinguish, in the last year of high school, those likely to enjoy relatively high incomes throughout adulthood from those who might require additional encouragement or investment to attain acceptable welfare levels. Therefore, all explanato-

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[21] The authors can provide these and all other ancillary estimates upon request. The instruments consist of the average occupational status and prestige scores for peer fathers and mothers and the proportions of high school classmates identifying themselves as Catholic, Protestant and Jewish, who took the National Merit and College Entrance Board examinations, who discussed future plans with teachers or parents, whose occupational plans were influenced by marriage plans, and whose planned occupation did not require a college education. Many of these achieve t-statistics in excess of two in each of the instrumenting equations. The Hausman test for model 3 of table 3 achieves a p-value of .205. Those for the 1974 and 1992 equations of table 6 achieve p-values of .361 and .189, respectively. All substantive results here reappear in the 2SLS estimates, with the exception that peer effects are not significant in the latter.

ry variables here are measured in or before the last year of high school, with the partial exception of the household income variables.[22]

At age 35 the individuals examined here were, for the most part, slightly more mature labor force members than those in the papers surveyed in Haveman and Wolfe (1995) and Jencks and Mayer (1990). A subsample of 2,264 individuals also reported earnings in 1992, at approximately age 53. Sections IV and V analyze the relationships between family and contextual variables and earnings in these two years, respectively. Together, these analyses offer a unique opportunity to examine the persistence of individual resources and contextual effects over the life-cycle.

IV. Earnings at age 35

Neal and Johnson (1996, table 1, column 3) regress the log of earnings on IQ, age and race. The latter two are constant in this sample. Therefore, the equivalent specification here contains only IQ.

Model 1 of table 3 presents the estimate of this regression for the log of earnings at age 35. The coefficient on IQ implies that a difference of 15 IQ points, approximately equal to one standard deviation, is associated with an earnings difference of more than eleven percent. This is smaller than the estimate of Neal and Johnson (1996) for cohorts of

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[22] Neal and Johnson (1996, 871-2) provide an especially clear justification for this analytical strategy: "The model underlying our empirical results views the amount of human capital youths have attained by their late teens as a predetermined initial condition that constrains the future path of human capital and, hence, future wages. After the late teens, further investments in human capital, work experience, and occupation are endogenous choices that affect wages but are constrained by the initial level of human capital. ... reduced-form wage equations are appropriate because we are primarily interested in the total effect of race [or, here, of personal and contextual characteristics] on wages after age 18, not the partial effect conditioning on endogenous covariates."

roughly similar age, perhaps because of differences in period. However, it is still a substantial effect, and more supportive than not of recent claims that earnings depend heavily on innate ability.

Model 2 of table 3 adds conventional measures of family context to the specification. This model demonstrates, as suggested in the introduction, that the estimated coefficient of IQ is inflated by the omission of contextual variables. Those included here reduce it by nearly one-third.

Model 3 of table 3 augments model 2 with variables for respondent and parental college aspirations, and the contextual variables as described in the previous section. In consequence, the estimated IQ coefficient declines further. The reduction in its magnitude between models 2 and 3 is identical to that between models 1 and 2. The estimated IQ coefficient in model 3 is barely half of its value in model 1. This suggests that the estimated IQ coefficients in Bishop (1989) and Neal and Johnson (1996), omitting aspirational and contextual controls, are similarly inflated.

The estimate in model 3 implies that an IQ difference of one standard deviation is associated with an income difference of only six percent.[23] This is no greater than typical estimates of the return to an additional year of schooling. It is less than half of the estimates preferred by Ashenfelter and Krueger (1994).

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[23] Quadratic specifications for IQ fail to reveal non-linear effects. The regressions here omit completed education because it is a consequence of high school experience and context, and more likely to be mutually endogenous with income at 35. Illustratively, model 3 of table 3, augmented by a completed education variable, estimates a significant but small return to schooling of approximately 3.0%. The IQ coefficient, while still significant at better than 1%, declines by more than half, to .00280. This is consistent with, though the converse of, Heckman (1995, 1111) "controlling for ability lowers -- but by no means eliminates -- the return to schooling.". However, this result contradicts Herrnstein and Murray (1994, 97), "the correlation between intelligence and income is not much diminished by partialing out the contributions of education, work experience, marital status, and other demographic variables."

Table 3

The determinants of 1974 labor market earnings

Explanatory variables	Model 1	Model 2	Model 3
Respondent characteristics:			
Respondent IQ	.00752	.00577	.00390
	(12.4)	(9.11)	(5.72)
Respondent planning college	-	-	.0795
			(3.44)
Household characteristics:			
Household income ($10,000s)	-	.0399	.0265
		(6.15)	(3.92)
Household income ($10,000s squared)	-	-.000767	-.000475
		(4.52)	(2.74)
Father has white collar job	-	.0647	.0412
		(2.86)	(1.81)
Mother has white collar job	-	.0388	.0277
		(1.55)	(1.11)
One or both natural parents absent	-	.0251	.0230
		(.725)	(.667)
Number of siblings	-	-.00324	.00151
		(.864)	(.399)
Father's education:			
Father's education missing	-	-.0134	-.0163
		(.311)	(.383)
Father graduated high school but not college	-	.00373	-.0102
		(.167)	(.462)
Father graduated college	-	.0367	.00443
		(.932)	(.112)
p-value	-	.785	.940
Mother's education:			
Mother's education missing	-	.0575	.0582
		(1.38)	(1.40)
Mother graduated high school but not college	-	.0184	.00769
		(.852)	(.357)
Mother graduated college	-	.0346	.0234
		(.945)	(.636)
p-value		.471	.537

Table 3, continued

The determinants of 1974 labor market earnings

Explanatory variables	Model 1	Model 2	Model 3
Parental attitude towards college:			
Parents encouraged college attendance	-	-	.0465 (2.03)
Parents discouraged or did not permit college attendance	-	-	.0214 (.398)
p-value	-	-	.128
Community characteristics:			
High school in town <10,000 population	-	-	.0151 (.580)
High school in town >49,999 population	-	-	-.0234 (.916)
p-value	-	-	.538
School characteristics:			
Private	-	-	-.163 (1.98)
Catholic	-	-	.0596 (1.83)
Size of class (100s)	-	-	.0182 (1.79)
p-value	-	-	.0086
Peer household characteristics:			
Average income ($10,000s)	-	-	.0303 (2.18)
% of fathers who graduated from high school	-	-	-.124 (1.33)
% of fathers who graduated from college	-	-	.0116 (.0776)
p-value			.0483

Table 3, continued

The determinants of 1974 labor market earnings

Explanatory variables	**Model 1**	**Model 2**	**Model 3**
Peer characteristics:			
Average IQ	-	-	.00149
			(.626)
% planning to pursue college	-	-	-.0313
			(.337)
% planning to pursue white collar job	-	-	-.0469
			(.498)
% planning to pursue military service	-	-	.144
			(.745)
% planning to pursue farming	-	-	-.386
			(2.26)
p-value	-	-	.164
Friends' characteristic:			
Planning college	-	-	.0555
			(2.51)
Constant	9.83	9.87	9.84
	(157.)	(147.)	(44.5)
R^2	.0491	.0830	.107
Adjusted R^2	.0488	.0790	.0982

Notes: The dependent variable is the natural logarithm of 1974 annual wages and salaries, measured in 1992 dollars. Tables 1 and 2, and the accompanying discussions, define all other variables. The sample consists of 2,959 men.

Other variables in model 3 are arguably as important as IQ. Respondent plans in high school to attend college are associated with earnings increases of approximately eight percent, with better than one percent significance. This increase is nearly one-third greater than that associated with a one standard deviation difference in measured intelligence.

Parental encouragement towards college attendance is also associated with a positive and significant effect on sons' earnings. This increase is more than half as large as that associated with respondent aspirations, and nearly 80% of that associated with a one standard deviation difference in IQ.

The coefficients of other parental and household characteristics indicate smaller relationships. Respondents whose families had higher incomes had significantly but not substantially higher earnings themselves. The difference between $30,000 and $60,000 of parental income, roughly equal to the sample mean income and the income level one standard deviation above the mean, is associated with a difference in sons' earnings of approximately 6.7%.

In other words, a dramatic difference in parental income is associated with a difference in sons' income that is again comparable to that arising out of an additional year of education.[24] Moreover, the effect associated with parental encouragement to attend college is more than two-thirds as large as that associated with a standard deviation increase in parental income. This supports the assertion that the former can be as important as a relatively large increase in the latter.

Variables measuring levels of educational attainment for both father and mother are

[24] Haveman and Wolfe (1995, 1864) and Mayer (1997, 56-57) summarize previous research as estimating that parental incomes have a much larger effect on those of their sons. However, Mayer (1997, 114) presents evidence that the true effects are smaller than previously believed, as demonstrated here.

collectively insignificant. Furthermore, none are individually significant.[25] These results are consistent with Ashenfelter and Krueger (1994, 1166), who conclude that parental education has no reliable effect on children's wage rates.

Jencks and Mayer (1990, 120) assert that, in addition to parental income and educational attainment, proper controls for family socio-economic status must account for parental occupations and household structure. Table 3 demonstrates that log earnings at age 35 are greater, with 10% significance, if the father's occupation is white collar. However, parental presence and sibling counts are both insignificant.[26]

Contextual levels beyond the family also demonstrate significant but selective associations. At the furthest remove, the size of the town of high school attendance in 1957 has no relationship to income in 1974.[27] However, there is weak evidence that incomes are greater for respondents from larger high schools. Incomes are highest for graduates of Catholic high schools and substantially lower for graduates of other private high schools.[28]

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[25] Haveman and Wolfe (1995, 1864) conclude that "estimates of the effect of parental educational choices on children's labor market attainments are difficult to interpret". They tentatively suggest (pg. 1873) that the problems of data reliability, multicollinearity and endogeneity that characterize analyses of contextual effects may justify adopting lower standards of statistical significance. The presentation here continues to focus on conventional levels of 10% or better, but addresses this problem through additional emphasis on the joint significance of variable arrays.

[26] The absence of sibling count effects contrasts with previous research, where larger sibships are associated with less favorable social outcomes (Haveman and Wolfe (1995, table 3b), for example) and lower incomes for white males (Datcher (1982)). Although Jencks and Mayer (1990, 120 and 176) assert the contrary, omitting these family variables does not alter the peer and friend effects estimated here.

[27] Spuriously significant effects appear at this level of context if more proximate contextual levels are not represented. Model 2 of table 3, augmented by only the two variables measuring size of place, estimates a coefficient of -.0432 for places of less than 10,000 in population, with a t-statistic of 1.95.

[28] The magnitude of the Catholic high school effect here is slightly larger than that estimated by Neal (1997, table 9, column a) in the NLSY. The large negative effect of secular private high schools suggests that, in this sample, many may have been remedial.

Characteristics of the community served by the high school are also important. The average parental income of high school peer households has a significant positive coefficient. Furthermore, its magnitude is as large as that of own-household income, although of course this variable has a much smaller range.

The effect of average peer household incomes is consistent with the general proposition that "(g)rowing up in a neighborhood with 'good' characteristics ... has a positive effect on a child's choices regarding ... earnings" (Haveman and Wolfe (1995, 1871).[29] The strength of this effect suggests that these incomes may represent both the level of community inputs into the educational process (de Bartolome (1990)), and socialization through exposure to successful members of the labor force.

The characteristics of high school peers, themselves, seem to be less related to respondents' future earnings. These earnings are significantly and substantially less for respondents from high schools where larger proportions of peers plan to engage in farming.[30] However, they are unrelated to average peer IQ. This suggests that the positive ability spillovers that are central to models such as de Bartolome (1990) may not exist.[31]

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[29] Jencks and Mayer (1990, 173) assert that "(a) high school's mean SES does not have much effect on its graduates' economic prospects" especially for whites in the northern United States, with controls for other exogenous influences (1990, 130 and 141). To the extent that measured socioeconomic status does not incorporate income, this is not inconsistent with the significance of peer family income here. Furthermore, it is supported by the absence of significant effects from peer paternal educational attainment. Quadratic terms in average peer household income are insignificant and unimportant when entered into model 3 of table 3.

[30] Analogously, Bishop (1989) estimates a reduction of 15% to 16% in weekly earnings associated with the PSID variable BORNFARM, which he does not formally define.

[31] This discussion assumes that table 3 estimates of individual and peer IQ effects are unbiased. Gottfredson, et al. (1997, 13) essentially assert that IQ measures intelligence without error. If measurement error arises, however, it would alter somewhat the interpretations of the results here. Appendix A presents a simple characterization of possible error. It suggests that table 3 would understate the effects of individual intelligence and overstate those of peer intelligence. If so, its results would be more consistent with previous

Lastly, the college aspirations of friends are positively and significantly related to respondent's later earnings. The magnitude of this effect is slightly larger than that of parental encouragement to attend college. These two effects, and that of respondent college plans, demonstrate that the overall association between aspirations and future income is quantitatively large. The three together are associated with earnings increases in excess of 18%.[32]

In sum, model 3 of table 3 demonstrates that sons' earnings at age 35 are related to own aspirations and intelligence and some, but by no means all, family characteristics. Earnings are clearly associated with family material resources and parental aspirations. Socialization, through exposure to some parental occupations, may also play a role. However, parental credentials, either educational or, in most cases, occupational, appear to have little influence.

This model also demonstrates that earnings at age 35 are associated with characteristics of the school itself, its students, parents in the school community and the students who affiliate as friends.[33] The magnitudes of many of these associations are readily

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estimates of small but consistently negative peer achievement spillovers in general (Jencks and Mayer (1990, 128)) and in the WLS (Hauser, Sewell and Alwin (1976)). As explained in section III, own and peer household incomes are presumably free of measurement error by construction.

[32] The correlation coefficients for any pair of own, parents' and friends' aspirations regarding college all lie between .408 and .520, significant at better than 1% but indicating substantial orthogonal components. The omission of any one increases the coefficients on the remaining two in model 3 of table 3. However, these increases are almost always less than .02 log points. The sum of the two remaining coefficients is always less, by at least .035 log points, than the sum of the three coefficients in model 3. Therefore, all three are necessary to completely capture the effects of aspirations. Their coefficients are unaffected by the omission of the variable measuring peer aspirations. Parenthetically, a variable measuring respondents' perceptions of their teachers' aspirations for them is also insignificant in all specifications.

[33] As the introduction suggests, the omission of IQ strengthens many of these effects. Jencks and Mayer (1990, 121-4) propose that interactions between individual, family and

apparent because they are estimated by single coefficients. However, peer influences are represented by multiple variables. Table 4 summarizes the net peer and peer household associations in confidence intervals for predicted log earnings based on 'improvements' of one standard deviation in the array of values for each of these contextual levels.

The first line of table 4 presents the confidence interval for predicted log earnings based on the average values of all explanatory variables. The second line replaces the average values of each of the five peer variables with values that differ from these averages by one standard deviation in the direction that would increase predicted log earnings, as given by the sign on the corresponding coefficient.[34] It demonstrates that a one-standard deviation 'improvement' in the quality of peers is associated with an increase of approximately five percent in predicted log earnings, and with increases of approximately two and eight percent in the lower and upper bounds of the associated confidence interval.

One standard deviation 'improvements' in the characteristics of peer households also increase predicted log earnings by about five percent. The upper and lower confidence interval bounds increase by three- and seven-hundredths of a log point. As a rough summary, a one standard deviation increase in the 'quality' of either contextual levels is associated with a slightly smaller increase in earnings than is one additional year of schooling.

One standard deviation improvements in context are associated with earnings increases that are also only slightly less than the effect associated with an increase of one standard

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neighborhood characteristics may be important. None prove so here. When added to the specification of table 3, interactions between own and peer IQs, between own and peer household incomes and between IQ and income variables all yield consistently insignificant coefficients.

[34] All confidence intervals assume that values for explanatory variables are not stochastic.

Table 4

Predicted 1974 log earnings and 95% confidence intervals

Explanatory variable values	Predicted 1974 log earnings	95% confidence interval for predicted log earnings: Lower bound	Upper bound
Averages for all variables	10.60	10.58	10.62
One standard deviation improvement in peer characteristics	10.65	10.60	10.70
One standard deviation improvement in peer household characteristics	10.65	10.61	10.69

deviation in IQ. This is a dramatic contrast to the general theme of Herrnstein and Murray (1994, Part II). They assert that variations in IQ are much more important than are 'equivalent' variations in socioeconomic status in the determination of social and economic experiences.[35]

With the exception of place of residence, all high school contextual levels represented in model 3 of table 3 have at least one significant association with future earnings for the sample as a whole. Stratified regressions available from the authors demonstrate, however, that the magnitudes and significances of these associations can differ for subsamples with different personal or contextual 'endowments'.

For example, stratifications of the sample at the IQ value of 101, the approximate median, yield subsamples of 1,460 men with equal or lower scores and 1,499 with higher. Regressions on these subsamples demonstrate that the association between IQ and earnings exhibits diminishing returns. The coefficient for IQ among the former is .00451, but only .00325 among the latter. Wealth in the adolescent household also, in general, has a stronger association with future earnings for those with lower IQ scores. The linear coefficients for parental income are .0348 and .0203 in the two subsamples.[36]

At the same time, these regressions suggest that the relationship between contextual and especially aspirational influences and earnings is stronger for individuals with higher

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[35] Interpretations of the comparisons in Herrnstein and Murray (1994) are problematic, as discussed in Goldberger and Manski (1995) and Heckman (1995).

[36] An F-test rejects the null hypothesis that the specification of model 3, table 3 is superior to the stratification discussed here at better than 5% significance. Virtually identical comparisons arise if the sample is partitioned into the 1,375 men with IQ scores of 100 or less, and the 1,584 men with IQ scores in excess of 100. All coefficients cited in this and the following four paragraphs are significant at 5% or better unless otherwise stated. The quadratic term for household income is insignicant in the regression for the subsample with IQ scores in excess of 101, negative and significant in the regression for the subsample with scores of 101 or less.

levels of measured intelligence. In the subsample of men with IQ scores of 101 or less, only Catholic schooling and peers planning to enter farming have significant coefficients, of .106 and -.561, respectively. Among those with IQ scores in excess of 101, the coefficients for peer household incomes and private schooling are .0367 and -.248.

Most dramatically, however, the coefficients for own and friends' aspirations to attend college on earnings are quantitatively negligible, as well as insignificant, for men with IQ scores of 101 or less. The coefficient for parental encouragement to attend college for these men is equivalent to that of model 3 in table 3, but with a t-statistic of only 1.60. In contrast, all three coefficients are individually significant and larger than those of that model for men with IQ scores above 101. Their combined magnitude for this subsample is .285 log points, more than 50% greater than in the sample as a whole.

Similarly, the coefficients for individual, contextual and aspirational variables differ between individuals with large and small high school friendship circles. The former consist of those able to identify three or more high school friends retrospectively in 1975. Only IQ, parents' and own college aspirations, and Catholic high school attendance obtain significant coefficients in the regression for their earnings at age 35.

In contrast, the earnings of those able to recall fewer friends are associated with many contextual variables.[37] They are positively related to high school class size, parental and peer household incomes, and to friends' college plans, though unrelated to their own or parental attitudes. They are negatively related to the proportions of peer fathers with only high school degrees and the proportions of peers planning to enter farming.

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[37] An F-test rejects the null hypothesis that the specification of model 3, table 3 is superior to the stratification by number of friends at better than 5% significance. Slightly fewer than half of the sample identified friends who also appear in the WLS. Experimental regressions with this subsample yield inconsistent evidence regarding the additional predictive value of friend-reported variables.

In sum, the earnings of those with more close high school relationships are not related to those relationships or almost any other element of high school context. The earnings of those with fewer relationships are associated with many of those elements. This apparent paradox suggests, if anything, that the number of friends may have been driven more by "supply" than by "demand"; peers may have been more attracted to those with high levels of self-reliance than to those whose characters were more responsive to their surroundings.[38]

V. Earnings at age 53

Of the 2,959 men analyzed in section IV, 2,264 remain in the sample in 1992, at age 53. The first model of table 5 reproduces model 1 of table 3 for this subsample. It demonstrates that the estimated coefficients on IQ at age 35, ignoring contextual and aspirational variables, are essentially identical in this subsample and in the sample of section IV.

The second model of table 5 demonstrates that, with the same specification, the coefficient of IQ on income at age 53 is nearly twice as large. It implies that a one standard deviation difference in IQ score would be associated with a difference in income of more than 21%. This exceeds the effect in Neal and Johnson (1996) for the same period, perhaps because of differences in cohort age.

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[38] The WLS reports residence state in 1975. Model 3 of table 3, stratified by whether or not the respondent resided in Wisconsin in 1975, is superior to model 3 itself at better than 1% significance. It suggests that migrants experience higher returns to individual characteristics but no friend or peer effects. These latter effects appear only among those remaining in Wisconsin. This contrast may indicate that migration occurs disproportionately among individuals who are not responsive to the influences of peers and friends. It may also indicate that these influences arise only through continued exposure. These suggestions are only tentative because out-of-state residence is probably endogenous with income in 1974.

Table 5

Regression of labor market earnings in 1974 and 1992 on IQ

Explanatory variables	1974: Coefficient	1974: t-statistic	1992: Coefficient	1992: t-statistic
Respondent IQ	.00744	(11.0)	.0139	(14.3)
Constant	9.85	(140.)	9.22	(91.0)
R^2	.0508		.0827	
Adjusted R^2	.0503		.0823	

The IQ effect of Neal and Johnson (1996) lies between those estimated in the two models of table 5. This suggests that the WLS and the NLSY yield broadly similar results under equivalent specifications. Table 6 explores the question of whether the expanded specification of model 3 in table 3, including contextual and aspirational variables, reduces the apparent effects of IQ on income at age 53 as well as at 35.

The first column of table 6 presents this specification for 1974 earnings in the subsample of observations with reported 1992 earnings. The determinants of 1974 earnings in this subsample are largely similar to those in the entire sample of section III, with one partial exception. The collective significance levels of peer and peer household effects are similar, but individual effects are no longer significant.[39]

The second column of table 6 employs the same specification to explain the log of earnings in 1992.[40] The explanatory variables, though measuring characteristics as of 1957, have similar explanatory power with respect to earnings in both years. The coefficients of respondent IQ and respondent's plans to attend college have similar

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[39] This result and that of footnote 21 suggest that the true extents and magnitudes of peer effects remain uncertain.

[40] The average and standard deviation for 1992 earnings are $54,658 and $54,735. The WLS documentation describes the data item for 1992 earnings as "wages, salary, commissions, and tips". It describes the item for 1974 earnings as "wages and salaries". "Commissions and tips" do not appear in the description for any 1974 data item.

Table 6

The determinants of labor market earnings in 1974 and 1992

Explanatory variables	1974: Coef-ficient	1974: t-statistic	1992: Coef-ficient	1992: t-statistic
Respondent characteristics:				
Respondent IQ	.00363	(4.81)	.00898	(8.20)
Respondent planning college	.0867	(3.46)	.116	(3.19)
Household characteristics:				
Household income	.0287	(3.91)	.0308	(2.89)
Household income^2	-.000537	(2.97)	-.000597	(2.28)
Father has white collar job	.0355	(1.42)	.0162	(.48)
Mother has white collar job	.0348	(1.29)	-.0322	(.823)
One or both natural parents absent	.0519	(1.35)	.156	(2.80)
Number of siblings	.00440	(1.06)	.00911	(1.52)
Father's education:				
Missing	.0137	(.291)	.00133	(.0194)
Graduated high school	-.00561	(.231)	.0360	(1.02)
Graduated college	-.00497	(.117)	.0511	(.827)
p-value		.981		.726
Mother's education:				
Missing	.0236	(.507)	.0317	(.470)
Graduated high school	-.00492	(.209)	.0570	(1.66)
Graduated college	-.00186	(.0463)	.128	(2.19)
p-value		.946		.138
Parental attitude toward college:				
Encouraged	.0665	(2.63)	.0600	(1.64)
Discouraged or did not permit	.0389	(.632)	-.108	(1.21)
p-value		.0306		.0884
Community characteristics:				
High school in town <10,000 population	-.00871	(.304)	-.0545	(1.31)
High school in town >49,999 population	-.0309	(1.09)	-.0297	(.724)
p-value		.534		.343

Table 6, continued

Explanatory variables	1974: Coef-ficient	1974: t-statistic	1992: Coef-ficient	1992: t-statistic
School characteristics:				
Private	-.215	(2.36)	-.279	(2.11)
Catholic	.0622	(1.73)	.0696	(1.33)
Size of class (100s)	.0105	(.928)	.00539	(.330)
p-value		.0126		.0668
Peer household characteristics:				
Average household income ($10,000s)	.0220	(1.47)	-.000667	(.0306)
% fathers graduated high school	-.113	(1.12)	-.0933	(.632)
% fathers graduated college	.115	(.707)	.372	(1.58)
p-value		.0968		.233
Peer characteristics:				
Average IQ	.00387	(1.49)	.000425	(.112)
% planning college	-.0325	(.324)	-.0914	(.628)
% planning white collar	-.0708	(.695)	-.0264	(.178)
% planning military service	.143	(.675)	.557	(1.81)
% planning to farm	-.278	(1.48)	-.296	(1.09)
p-value		.454		.204
Friends' characteristic:				
Planning college	.0606	(2.53)	.0859	(2.47)
Constant	9.66	(40.0)	9.47	(27.0)
R^2	.117		.136	
Adjusted R^2	.105		.124	

Notes: The dependent variables are the natural logarithms of 1974 and 1992 annual wages and salaries, measured in 1992 dollars. The sample consists of 2,264 men.

significance.[41]

Parental characteristics are also associated with earnings at both ages. The coefficients for household income are of similar magnitude and significance in both years. The coefficients for parental attitudes toward college are similar in magnitude in the two years, though just short of significance at the 10% level in 1992. However, increasing levels of maternal education are associated with earnings effects that increase in both magnitude and significance in that year.[42]

Contextual effects at other levels are also significant at both ages. The coefficients for friends' plans to attend college are significant at approximately equivalent levels at ages 35 and 53. They are 41.7% larger in magnitude at the latter age.

As suggested above, the influences of peers and peer households are less clear in this subsample than in table 3. Peer household characteristics are collectively significant at better than 10% in 1974, but collectively insignificant in 1992. However, peers planning to enter military service are associated with a large increase in 1992 earnings, significant at better than 10%, while all individual effects at both contextual levels are insignificant in 1974.

Similarly, the comparison between the effects of school characteristics at ages 35 and 53 is ambiguous. The earnings discount associated with attendance at a non-Catholic private

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[41] Section VII considers interpretations of the differences between coefficients at ages 35 and 53. The 1992 log earnings regression in table 5, augmented by completed years of schooling, yields a schooling coefficient of .0770, significant at 1%, comparable to standard estimates and more than double the coefficient for age 35 (see footnote 23). This equation reduces the IQ coefficient to .00608, significant at 1%. Parenthetically, the further addition of 1974 log earnings to this specification reduces the coefficients on education and IQ to .0632 and .00457 respectively, both significant at 1%. The coefficient on 1974 log earnings is .560, significant at 1%.

[42] Estimated log earnings in 1992 are significantly higher for the 166 men raised in households with at least one natural parent absent. Six of these individuals, with extremely high 1992 earnings, are apparently responsible for this counter-intuitive effect.

Table 7

Predicted 1974 and 1992 log earnings and 95% confidence intervals

Explanatory variable values	Predicted log earnings	95% confidence interval for predicted log earnings: Lower bound	Upper bound
1974:			
Averages for all variables	10.61	10.59	10.63
One standard deviation improvement in peer characteristics	10.67	10.61	10.73
One standard deviation improvement in peer household characteristics	10.66	10.62	10.71
1992:			
Averages for all variables	10.65	10.62	10.68
One standard deviation improvement in peer characteristics	10.71	10.63	10.79
One standard deviation improvement in peer household characteristics	10.70	10.61	10.78

high school increases between the two ages, with essentially constant significance. The earnings premium associated with Catholic school attendance is of similar magnitude at the two ages, but significant only at the first.[43]

These results suggest that labor market performance is associated with high school contextual levels through most of the working life.[44] Table 7 suggests that the magnitudes of the net associations between peer and peer households and log earnings are approximately equivalent at ages 35 and 53. As in table 4, one standard deviation improvements in peer and peer household variables are associated with increases in log earnings at both ages that are approximately equal to lower estimates of the returns to a year of schooling.

VI. High school fixed effects and high school class rank

The analyses of sections IV and V include an exhaustive array of explicit contextual measures in order to identify all sources of contextual associations with adult earnings as precisely as possible. The results demonstrate that these effects occur at a variety of levels.

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[43] This subsample, stratified by IQ or numbers of high school friends, yields results that are roughly similar to those at the end of section IV for both years. However, they are generally weaker, especially, as with table 6, in regards to peer effects. F-tests indicate that the stratifications by IQ are not superior to the models of table 6 for either year. The stratification by number of friends is superior to those models only for 1992. The stratification by whether or not the respondent resided in Wisconsin in 1974 yields estimates that are superior, at better than 1% significance, to either of the models of table 6. The stratified estimates for 1974 are essentially identical to those for the full sample, discussed in footnote 38. Those for 1992 yield weaker contrasts, with one significant peer effect for those who had left the State.

[44] Haveman and Wolfe (1995, 1874) suggest that "individuals appear to follow quite different trajectories as they move toward their ultimate attainments in life." This may be consistent with the experiences of WLS respondents: The correlations between earnings and log earnings at ages 35 and 53 are only .531 and .470, respectively. These correlations would presumably be larger if the effects of individual high school characteristics at these ages differed less.

However, they are not overwhelming in magnitude. Furthermore, the regressions in these sections exhibit R^2 values that do not greatly exceed those typically obtained in log earnings regressions on data containing few or no contextual variables.

These considerations suggest either that a large fraction of adult incomes are orthogonal to high school contextual effects, or that these analyses still omit important contextual characteristics. Dummy variables for each high school allow for a partial test of this latter possibility. These controls will absorb any contextual effects that are constant across classmates. Their inclusion should therefore give some indication of the maximum explanatory power that can be attributed to these effects, regardless of source.

This strategy has some disadvantages; any significant high school effects will not have obvious behavioral interpretations. Furthermore, these effects preempt some of the behavioral interpretations suggested above because they are perfectly collinear with, and therefore replace, the variables describing school, peer and peer household characteristics.

At the same time, this strategy has a collateral advantage. The WLS reports rank in high school graduating class by percentiles. Comparisons of this variable across high schools are meaningless. However, in regressions that include high school fixed effects, it captures differences in academic performance within the same high school class.[45]

The use of this variable is consistent with the posture adopted by this paper. It would be available at age 17 for the purpose of predicting economic success subsequent to high school graduation. Furthermore, it is clearly predetermined with regard to earnings at ages 35 and 53, and therefore an appropriate explanatory variable in the regressions here.

Nevertheless, the class rank variable presents an interpretive challenge. It is determined subsequent to, and therefore partially by, many of the other explanatory variables in

[45] Hauser and Sweeney (1997) also present a regression of 1992 income with IQ and class rank among the explanatory variables. However, they omit high school fixed effects.

this analysis. This raises the possibility that it is only an intervening variable between its precursors and later incomes.

However, more than half of the variation in class rank comes from sources other than family background, friends, peers, peer families, school characteristics and measured ability.[46] This suggests that class rank embodies some important individual characteristics that are not represented by other variables employed here. Only these characteristics, represented by that part of class rank that is orthogonal to all of the other explanatory variables, can have any explanatory power.[47] In other words, the class rank variable captures any differences that would arise in adult labor market earnings between two men with different class ranks but from the same high school class, with identical family, friend and peer characteristics, and, most importantly, the same measured IQ.[48]

The full sample contains individuals from 391 high schools. Individuals from 382 high schools appear in the sub-sample reporting 1992 incomes. Table 8 presents three regressions, each including dummy variables for every high school that appears in the associated sample. They offer only mixed evidence regarding the explanatory power of high school fixed effects.

All three regressions attain R^2 values that are approximately double those associated with earlier specifications. However, the adjusted R^2 values increase by much less. The high school fixed effects are collectively significant only in the determination of the log of

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[46] In the sample of table 3, the regressions of class rank on IQ alone and on all of the explanatory variables in model 3 yield R^2 values of .347 and .450, respectively. Section VII discusses the factors that might be responsible for the influence of class rank.

[47] Greene (1997, 245-7) presents a representative proof of this result.

[48] The public-use versions of the NLSY and PSID do not allow this treatment of class rank because neither identifies high school. Both are based on national samples from multiple years. Whether either contains enough classmates to support estimates of high school performance effects analogous to those here is unknown.

Table 8

1974 and 1992 earnings with high school fixed effects

Explanatory variables	1974: 1974 sample	1974: 1992 sample	1992: 1992 sample
Respondent characteristics:			
Respondent IQ	.00277	.00265	.00696
	(3.24)	(2.67)	(4.88)
Respondent rank in high school	.00102	.00101	.00244
	(2.22)	(1.90)	(3.20)
Respondent planning college	.0697	.0712	.0504
	(2.74)	(2.47)	(1.22)
Household characteristics:			
Household income	.0121	.0132	.0143
	(3.49)	(3.37)	(2.55)
Household income^2	-.000105	-.000115	-.000136
	(2.43)	(2.45)	(2.02)
Father has white collar job	.0463	.0265	.0267
	(1.91)	(.952)	(.667)
Mother has white collar job	.0234	.0304	-.0228
	(.887)	(1.03)	(.537)
One or both natural parents absent	.0144	.0478	.128
	(.386)	(1.10)	(2.05)
Number of siblings	.00132	.00637	.0112
	(.320)	(1.36)	(1.66)
Father's education:			
Missing	-.0205	.00862	-.0592
	(.448)	(.164)	(.784)
Graduated high school	-.00504	.00192	.0172
	(.211)	(.0704)	(.440)
Graduated college	-.00193	-.00146	.00474
	(.0467)	(.0313)	(.0710)
p-value	.975	.998	.795
Mother's education:			
Missing	.0418	.000642	.0720
	(.936)	(.0123)	(.962)
Graduated high school	.0103	.00410	.0804
	(.445)	(.156)	(2.13)
Graduated college	.0210	-.00938	.153
	(.534)	(.207)	(2.36)
p-value	.790	.990	.063

Table 8, continued

1974 and 1992 earnings with high school fixed effects

Explanatory variables	1974: 1974 sample	1974: 1992 sample	1992: 1992 sample
Parental attitude toward college:			
Encouraged	.0362	.0706	.0455
	(1.47)	(2.47)	(1.11)
Discouraged or did not permit	.0181	.0596	-.169
	(.313)	(.871)	(1.72)
p-value	.340	.0420	.0888
Friends' characteristic:			
Planning college	.0581	.0545	.104
	(2.38)	(1.98)	(2.63)
High school fixed effects:			
p-value	.0306	.923	.649
R^2	.233	.244	.276
Adjusted R^2	.110	.123	.159

Notes: The dependent variables are the natural logarithms of 1974 and 1992 annual wages and salaries, measured in 1992 dollars.

1974 earnings for the complete sample.

These results do not support the suspicion that earlier specifications omit essential elements of high school contexts that are shared across classmates. Instead, they reinforce the importance of more intimate contextual effects. The patterns of significance for variables describing household and friends' characteristics are identical to those of tables 3 and 6, with two exceptions: The negative coefficient associated with parental discouragement in 1992 and the positive coefficient associated with sibling counts in 1992 are both insignificant in table 6, and marginally significant in table 8.[49]

The evidence regarding the effects of high school rank is much more dramatic. In all three regressions this variable is significant, and at better than 5% in two. An increase of ten percentile points in class rank is associated with an increase of about 1% in 1974 earnings, and approximately 2.5% in 1992 earnings. According to the estimates for both 1974 and 1992, a difference of two to three percentile points in rank is associated with the same difference in earnings as is a difference of one IQ point.

Moreover, this analysis reveals that the interaction between IQ and academic performance has important implications for the apparent effect of IQ on earnings. Omitting high school class rank, the full sample regression for 1974 log earnings yields a coefficient of .00374 for IQ, with a t-statistic of 5.10. The analogous estimates for 1974 and 1992 log earnings in the subsample reporting 1992 earnings are .00362 and 4.26, and .00932 and 7.62. These estimates are approximately equal to those in tables 3 and 6.

Furthermore, they are at least 35% greater than the IQ coefficients in table 8. The omission of controls for academic performance imparts a substantial upward bias to

[49] The regressions of table 8, stratified by IQ, number of high school friends, or 1974 migrant status yield inconsistent contrasts regarding the effects of the remaining variables.

estimated effects of IQ. No previous analysis of the relationship between earnings and IQ has adequately controlled for academic performance directly or through proxies. Therefore, all previous estimates of this relationship must be similarly exaggerated.[50]

The 1974 regressions of table 8 imply that a one standard deviation increase in adolescent IQ is associated with an increase of approximately four percent in log earnings at age 35. Again, an equivalent increase could be achieved with as little as a few months, and with no more than three-quarters of a year of additional education. The same difference in IQ is associated with a difference of .104 in log earnings at age 53, equivalent to the effect of an additional .6 to 1.8 years of education.

For Herrnstein and Murray (1994, 96), the difficulty of altering measured IQ implies that low-wage workers would benefit "only modestly" from additional education. This conclusion must rest on the implicit assumption that additional education affects earnings largely through its effect on measured IQ. Four years of education may indeed be necessary to close a gap of one standard deviation in IQ scores (Neal and Johnson (1996)). However, the earnings differences that are associated with that gap at ages 35 and 53 can be erased with less than one and less than two years of additional education, respectively. Even less schooling may be sufficient, if distinguished by better academic performance.[51]

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[50] The complete array of explanatory variables in table 8 reduces the estimated coefficients of IQ on 1974 earnings to no more than 37% of their magnitudes as given in model 1 of table 3 and the 1974 model of table 5. The estimated coefficient of IQ on 1992 earnings in table 8 is half that of the 1992 model of table 5.

[51] Heckman (1995, 1103) criticizes Herrnstein and Murray (1994): "Their implicit assumption of an immutable *g* [basic cognitive faculty] that is all-powerful in determining social outcomes leads them to disregard a lot of evidence that a variety of relevant labor market and social skills can be improved, even though efforts to boost IQ substantially are notoriously unsuccessful." This criticism is entirely consistent with the evidence here. Gottfredson (1997, 9-10), concurs: "The search for a means to raise low intelligence should continue, but more attention might be turned to helping people make better use of the abilities they have. ... When the goal is to equalize outcomes, variation in intelligence is undoubtedly a bigger constraint when intelligence is more functionally important. For

VII. Interpretations

The results of sections IV, V and VI raise two important interpretational issues. First, to what extent do reductions in the coefficients on IQ indicate that intelligence plays a smaller role in the determination of earnings than previously indicated? Second, to what extent do differences in coefficients at ages 35 and 53 reveal underlying economic trends?

IQ tests are specifically designed to measure 'intelligence';

> "Intelligence is a very general mental capacity that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. ... Intelligence, so defined, can be measured, and intelligence tests measure it well. ... They do not measure creativity, character, personality or other important differences among individuals, nor are they intended to." (Gottfredson, et al. (1997, 13)).

The regressions here demonstrate unambiguously that the magnitude of the relationship between IQ and subsequent income is dramatically reduced by the addition of other explanatory variables. However, intelligence might also influence some of these additional variables, such as class rank or college plans. If so, its net effect on adult earnings would combine the coefficients on IQ and these additional variables.

The following example, originally suggested by Daniel Sullivan, illustrates this point. Abstracting from all explanatory variables with the exception of IQ and class rank, assume that IQ is equal to intelligence, $IQ_i=I_i$, that class rank depends on both intelligence and effort: $CR_i=\alpha I_i+E_i$, $\alpha>0$, and that $\ln(Y_i)$, the natural log of earnings, embodies a random error ϵ_i. The true estimating equation is therefore

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example, it can be expected to be a big constraint on changing variation in educational performance because educational success is strongly influenced by intelligence level. In contrast, the link between intelligence and income is much weaker".

$$\begin{aligned}\ln Y_i &= \beta_1 IQ_i + \beta_2 CR_i + \epsilon_i \\ &= \beta_1 I_i + \beta_2(\alpha I_i + E_i) + \epsilon_i \\ &= (\beta_1 + \alpha\beta_2) I_i + \beta_2 E_i + \epsilon_i \ .\end{aligned}$$

In the presence of class rank, the expected value of the coefficient on IQ understates the true effect of intelligence, $\beta_1+\alpha\beta_2$. This is likely to be the case in models 2 and 3 of table 3 and in the regressions of tables 6 and 8.[52]

However, the omission of class rank would entail opposite biases. In this model its coefficient is identified only because it depends on a second factor, in this case effort. This should hold generally; the variables added to models 2 and 3 of table 3 almost surely include components that are orthogonal to intelligence and to each other because these models are estimable.[53] Moreover, where the coefficients on these variables are statistically significant these components must be relatively large.[54]

In other words, the statistical significance of variables such as class rank and college

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[52] If IQ measures ability with error, as in the Appendix, the analysis of bias may be more complicated.

[53] If more than one explanatory variable embodies latent factors, there is almost surely more than one latent factor. As an example, define k as the number of explanatory variables, n the number of observations and j the number of latent factors. X is the nxk matrix of explanatory variables, L the nxj matrix of latent factors, which may include columns of X. If the explanatory variables are all linear functions of the elements of L, then A represents the jxk matrix that transforms L into X: X=LA. The kx1 vector of estimated regression coefficients is then

$$\hat{\beta} = \left(X'X\right)^{-1}X'Y = \left(L'A'AL\right)^{-1}X'Y \ .$$

The matrix (A'L'LA) is of dimension kxk. In order to be invertible, it must also be of rank k. A necessary condition is that $j \geq k$; the number of latent factors must equal or exceed the number of explicit explanatory variables. This lower bound may be reduced if variables can be nonlinear or error-ridden transformations of the factors. However, existing analyses of intelligence do not specify its relationships with the other explanatory variables employed here to this degree of precision.

[54] Their magnitudes affect the standard errors and t-statistics for these coefficients negatively and positively, respectively (Greene (1997, 249)).

plans implies that factors other than intelligence probably contribute to their relationship with adult earnings. The example above illustrates the consequences. In regressions which omit CR_i, the expected value of the coefficient estimated for IQ_i is $\beta_1+\alpha\beta_2+\gamma\beta_2$, where $\beta_1+\alpha\beta_2$ is the true return to intelligence and γ is the coefficient for IQ_i in an auxiliary regression for E_i.

This coefficient is almost surely positive; equilibrium effort levels should be greater for more intelligent individuals because their return to effort net of costs is higher.[55] In consequence, the expected value of the IQ coefficient in the absence of class rank exceeds the true return to intelligence in this example. This is also likely to be general; it should hold throughout the previous literature, as well as in model 1 of table 3 and the regressions in table 5.

In sum, the true intelligence effect on earnings at age 35 in the sample examined here almost surely lies between the coefficients on IQ in model 1 of table 3 and the 1974 models in table 8. That for earnings at age 53 almost surely lies between the coefficients on IQ in the 1992 models in table 5 and table 8.

In the example above, the true effect of intelligence cannot be estimated without restrictions on α or direct measurements of E_i. In the regressions here, estimation would require explicit models of the relationships between the explanatory variables and their underlying factors, or measurements of the factors themselves. The first is beyond the scope of the present analysis. The second is beyond the scope of the data analyzed here.

However, some potential factors can be tentatively identified. They may include that of the example here, effort, as well as those factors identified by Gottfredson, et al. (1997) as

[55] The tournament literature (Lazear and Rosen (1981), McLaughlin (1988)) makes the analogous argument relating effort to 'ability'. The same argument arises in the literature on incentives (MacLeod and Malcomson (1988)).

ignored by IQ tests: creativity, character, and personality. Other candidates might include aspirations, social and administrative skills.[56] In addition, some qualitative conclusions are possible regarding the mapping between these factors and the explanatory variables employed here.

Measured intelligence is essentially non-malleable by the time of late adolescence. Gottfredson (1997, 2) asserts that it "is basically stable over the life span". According to Rowe (1997, 140), it appears to be only transitorily sensitive to changes in family environments. Neisser (1998, 16-17) concludes that "genetic factors contribute substantially to individual differences in intelligence". Neal and Johnson (1996, 891) estimate that approximately four years of additional secondary schooling would be necessary to change IQ scores (as measured by the AFQT) by as much as a standard deviation.

The IQ variable therefore captures those elements of human capital that are determined relatively early in life.[57] These may include other non-malleable factors in addition to intelligence, such as psychological "traits" (Goldsmith, Veum and Darity (1997)) and "dispositions" (Duncan and Dunifon (undated)). It is these factors whose contributions to

[56] Theoretical models often define 'ability' as uni-dimensional (de Bartolome (1990), MacLeod and Malcomson (1988) and Prendergast (1999) as examples). While convenient for analytical purposes, this restriction is not empirically supportable (Heckman (1995, section IIA) , as well as the distinctions between intelligence and other factors drawn by Gottfredson, et al. (1997)).

[57] Crouse (1979, 86) offer a similar interpretation: "Tests [of academic ability] given as early as sixth grade appear to predict educational attainment, occupational status, and earnings as well as tests given later. This suggests that it is not cognitive skill per se that affects later success. Rather, the stable motivations and aptitudes that lead to the development of cognitive skills also affect later success. A test's predictive power appears to derive in large part form its relationship to these stable underlying factors." Smith, Brooks-Gunn and Klebanov (1997) suggest that cognitive ability is malleable on the basis of positive associations between early childhood ability and parental income. However, their analysis omits parental cognitive ability. The secular increase in average IQ scores suggests that they respond to environmental changes. However, the papers in Neisser (1998) seem to imply that this increase represents differences in IQ scores across cohorts rather than changes in individual scores.

adult earnings have been overstated in previous literature, and are bounded by the estimates in tables 3, 5 and 8 here.

The orthogonal components of explanatory variables such as class rank and college plans must represent those elements that can be altered at later points. In other words, the coefficients for these variables estimate the effects of the variable components of human capital on adult earnings.[58] It is these effects that have been ignored in the previous literature. The results here suggest that, even if intelligence is relatively fixed, the income advantage conferred by greater ability can be mitigated by investments in more variable components of human capital.

The second interpretational issue addresses the evolution of earnings determinants over time. As given in table 7, the average values for ln earnings in 1974 and 1992 differ by very little. With fixed values for the explanatory variables, this would imply, all else equal, similar coefficient values in the two years.[59] Among variables that are significant in both years, this implication holds only for household income in both tables 6 and 8.

Random noise presumably explains variations in the magnitudes of coefficients that are consistently insignificant. However, apart from household income, the coefficients for all variables that are significant in the regression for 1992 ln earnings are substantially larger in magnitude than the corresponding coefficients for 1974. At least some of these changes in magnitudes must be attributable to changes in underlying economic forces.

These forces could include 'time' -- the evolution of the economic environment -- aging of

[58] In the example above, where class rank depends on intelligence as well as effort, but IQ depends only on intelligence, the coefficient on class rank is an unbiased estimator of the return to effort.

[59] The standard deviation of ln earnings increases from .488 to .717 between 1974 and 1992. However, there appears to be no simple relationship between mean-preserving changes in the variance of a dependent variable and coefficient estimates.

the cohort in question, or both. However, the increase in returns to 'skill' from 1978 to 1986 identified by Murnane, Willett and Levy (1995) incorporates the effects of time and cohort differences. The similarity between these increases and those in the effects of IQ in table 8 is at least suggestive that the common time effects may be dominant.

The literature on earnings inequality interprets these time effects as representing increased return to cognitive ability, driven by skill-biased technical change (Bound and Johnson (1992), Herrnstein and Murray (1994), Juhn, Murphy and Pierce (1993) and Katz and Murphy (1992)). However, holding constant IQ, tables 6 and 8 demonstrate increased returns to many elements of 'ability' or 'capacity' that are not related to intelligence.

At the very least, this implies that the "skills" favored by technical change should be defined more thoughtfully. It also suggests that some of the changes in coefficient magnitudes may derive from increases in labor productivity that are not skill-biased. If so, these labor market trends deserve greater attention. They may include, for example, improvements in human resource management practices (Ichniowski, Shaw and Prennushi (1997)).[60]

VIII. Conclusion

The results here distinguish between several sociological explanations of contextual effects.

[60] Joseph Altonji suggests that these increases could also arise if employer estimates of the productive value of worker characteristics become more precise over time. If employers discount payments for these characteristics to compensate for uncertainty regarding their value, these discounts should diminish with age. The introduction of high school fixed effects into the equation for 1992 earnings reduces the coefficient on own college aspirations by half, to insignificance. The coefficients for parents' aspirations also become algebraically smaller. The apparent increase in the returns to friends' college aspirations may be attributable, in part, to these changes and the correlations between the aspirational variables, which range between .41 and .52 for the sample with 1992 earnings. In the absence of the variable for friends' college aspirations, the coefficient on own aspirations is nearly 50% larger and significant at better than 10%.

The strong influences of friends' college plans and parental aspirations regarding respondent college attendance could represent the effects of contagion or collective socialization. However, 'role models' in the form of adult occupational or educational experiences, or of older siblings, have little influence.

The results here also distinguish between several of the economic theories describing the role of contextual effects in the production of human capital. The significance of peer household average incomes in table 3 suggests that community wealth affects individual economic success.

However, these results provide little support for models of inter-community inequalities. Intelligence spillovers are unimportant. Economic success does not depend on the community's 'stock' of adult human capital during adolescence. Moreover, the link between externalities as experienced by individuals and the evolution of community welfare may be altered by migration, as mentioned in footnote 38.

In sum, adult economic performance is related to several different adolescent contextual levels. The true effects of context almost surely arise from complicated and subtle social interactions that are only crudely approximated by the contextual measures available here. From this perspective, this analysis may still understate them.

At the same time, previous analyses have overstated the role of intelligence in economic success. Controls for family and high school context dramatically reduce the estimated income effects of IQ. High school class rank reduces them further, suggesting that adult economic success also depends on effort and the development and exercise of skills apart from those captured by IQ tests in high school.

Perhaps the most striking result here, is, however, the limited scope of all effects included in this analysis. At least 85% of the variation in earnings at age 35, and 75% of that at age 53, is orthogonal to everything measured as of age 18. Even with a generous allowance for measurement error and transitory income components in the variance that remains, there is plenty of opportunity for individuals to rise above or fall below the level to which their endowments and environment might direct them.

Appendix: Measurement error in intelligence

Assumptions:

1. IQ_i measures intelligence I_i with a random error ϵ_i that is uncorrelated with IQ_i, all other explanatory variables and ϵ_j: $I_i=IQ_i+\epsilon_i$, $COV(IQ_i,\epsilon_i)=0$, $COV(\epsilon_i,\epsilon_j)=0$.
2. Average peer IQ, IQ_P, measures average peer intelligence I_P approximately without error because $E(\epsilon_i)=0$: $COV(IQ_P,\epsilon_i)\approx 0$ and $IQ_P \approx IA_P$.
3. Individual and peer intelligence tends to be similar, $IQ_i+\epsilon_i=I_i\approx I_P\approx IQ_P$. Therefore, $IQ_i+\epsilon i\approx IQ_P$ and $IQ_i-IQ_P\approx -\epsilon_i$, on average. This implies $COV(IQ_i-IQ_P,\epsilon_i)<0$.

Suppressing the constant and all other explanatory variables for notational convenience, the estimating equation is

$$\begin{aligned}\ln Y_i &= \beta_1 I_i + \beta_2 I_P + \nu_i \\ &\approx \beta_1 (IQ_i + \epsilon_i) + \beta_2 IQ_P + \nu_i \\ &= \beta_1 (IQ_i - IQ_P) + (\beta_1 + \beta_2) IQ_P + \nu_i + \beta_1 \epsilon_i \ .\end{aligned}$$

The estimate of the coefficient of I_i, β_1, is biased downwards because IQ_i-IQ_P is negatively correlated with $\beta_1\epsilon_i$ in the residual. The coefficient of I_P, β_2, is the difference between the estimated coefficients of IQ_i-IQ_P and IQ_P. The latter is unbiased because IQ_P is uncorrelated with all residual terms. The negative bias in the former therefore implies a positive bias in the difference.

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