The Changing Role of Family Income and Ability in Determining Educational Achievement*

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1 Introduction

A number of recent studies have documented important gaps in post-secondary enrollment by family income and cognitive ability or achievement (Manski and Wise 1983, Cameron and Heckman 1998, 2001, Ellwood and Kane 2000, Carneiro and Heckman 2002). This paper uses data from the 1979 and 1997 National Longitudinal Survey of Youth cohorts (NLSY79 and NLSY97) to analyze how the relationship between ability, family income, and educational attainment has changed over time. With the 1997 cohort, we also analyze the role played by family wealth in determining schooling outcomes. We document a dramatic increase in the effects of family income on college attendance rates across most ability quartiles (controlling for family background) but find little change in the effects of income on high school completion, which are small for both cohorts we analyze. While ability plays a very strong role in educational outcomes, changes in its role across the two NLSY cohorts are modest for both high school completion and college attendance. We then explore a number of potential explanations for a family income - college attendance relationship and the extent to which they can explain the observed changes across cohorts separated by two decades.

Most studies of the relationship between schooling, ability, and family income have focused on the potential role played by borrowing constraints. The strong correlation between cognitive ability and family income suggests that raw differences in educational attainment by family income may largely

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reflect the role played by ability differences. Thus, researchers have attempted to simultaneously control for ability and family income as well as other family background characteristics that might affect schooling decisions. Doing so substantially reduces the role of family income in most studies, but does not generally eliminate it. Elwood and Kane (2000) and Carneiro and Heckman (2002) have attributed lower college enrollment rates among low income families (after controlling for ability and other family background factors) to inefficiencies caused by borrowing constraints; although, their findings differ in the role played by family income. Elwood and Kane (2000) argue that differences by income are sizeable after controlling for math achievement test scores taken during the senior year of high school, while Carneiro and Heckman (2002) find relatively small gaps by family income after controlling for AFQT scores. Differences in educational attainment by measured ability are generally quite large (even after controlling for family income) and attributed to heterogeneous financial returns.

Differences in college-going may also differ by family income for reasons other than borrowing constraints that may suggest a different set of policies. For example, Kane (forthcoming) argues that many youth may be poorly informed about the costs and benefits of college. Dynarski and Scott-Clayton (2006) argue more specifically that federal financial aid policies are too complex for many students and parents to understand and need to be simplified. More generally, financial aid formulae themselves may generate different college-going decisions by family income and ability, since they create different implicit tuition costs by family resources. Wealthier and higher income parents are expected to contribute more to their children's schooling; therefore, they are typically offered less federal and institutional aid. Finally, schooling almost surely contains a consumption value for many parents and students, which is likely to be governed by the same rules determining the consumption of other goods – wealthier families will choose to 'purchase' more schooling for their children than poorer families.

A growing consensus argues that the rising returns to schooling can be linked to sharply increasing demand for skilled labor and a slow rise in the supply of skill to the labor market.[1] Kane (forthcoming) suggests that the recent rise in tuition costs, decline in Pell Grant offerings, and stability of student loan borrowing limits in the U.S. may be responsible for the sluggish response in aggregate college attendance rates despite the sharp rise in its economic returns. Financial aid formulae have also

[1]See, e.g. Katz and Murphy (1992) and Heckman, Lochner, and Taber (1998).

changed substantially in the last few decades. These dramatic economic and policy changes offer an opportunity to understand what underlies the substantial disparity in educational outcomes by ability and family income. By studying how and why ability - family income - schooling patterns have changed over time, we gain greater insight into the role played by borrowing constraints, financial returns to schooling, financial aid formulae, and the consumption value of schooling.

2 Related Literature on Borrowing Constraints and Schooling

Borrowing constraints are by far the most controversial and most favored explanation for enrollment gaps by family income. Ellwood and Kane (2000) emphasize credit constraints as an explanation for the large gaps in post-secondary enrollment by family income; although, they allow for other possibilities. Cameron and Heckman (1998, 2001) and Carniero and Heckman (2002) argue that most of the enrollment gaps by family income disappear after controlling for measures of cognitive ability, specifically the Armed Forces Qualifications Test (AFQT). Thus, they argue, long-run family factors that are highly correlated with family income (e.g. quality of the home environment, early investments in children) are far more important in explaining differential college enrollment rates by family income than are short-term borrowing constraints during university-going years.

Other researchers have taken different approaches to 'test' for the importance of borrowing constraints. Cameron and Taber (2004) use different instrumental variables estimators to test for individual heterogeneity in rates of return to school that would be consistent with differential borrowing interest rates. They find no evidence of discount rate heterogeneity and conclude that borrowing constraints are not important. Structural estimation of their model yields similar conclusions. Keane and Wolpin (2001) estimate a dynamic structural model of schooling behavior, allowing for individual heterogeneity, parental transfers, borrowing (with limits), and work while in school. While they estimate tight borrowing limits, their estimates suggest that these limits have little effect on final schooling outcomes. Instead, relaxing the borrowing constraints tends to increase consumption and reduce labor supply while in school.

It is noteworthy that all of the aforementioned studies arguing for a minimal role of borrowing constraints (Cameron and Heckman 1998, 2001, Keane and Wolpin 2001, Carneiro and Heckman 2002, Cameron and Taber, 2004) are based on the NLSY79 data. However, Kane (forthcoming) argues that

the role of family income may have become more important in recent years. Thus, it is natural to ask whether the same ability - family income - schooling patterns exist for more recent cohorts. If not, have credit constraints become more limiting? Our analysis uses similar methods to Carneiro and Heckman (2002) to analyze both the NLSY79 and NLSY97 data, so that we can place our findings in the context of this literature. We largely replicate Carneiro and Heckman's findings with the NLSY79 data (that family income has little effect on college enrollment after controlling for ability and family background), but find a substantially more important role for income in the NLSY79.

3 Data

Our analysis utilizes data from the NLSY 1979 and 1997 cohorts. The former reflects a random survey of American youth ages 14-21 at the beginning of 1979 and the latter samples youth ages 12-16 at the beginning of 1997. Thus, the 1997 cohort was born approximately twenty years after the 1979 cohort. We focus on high school completion and college attendance decisions, which took place in the early 1980s for the 1979 cohort and in the early 2000's for the 1997 cohort. We exclude youths that are part of the minority and poor white over-samples, using only the full random samples in our analysis.

These data contain rich measures of family background, including parental education, mother's age, family composition, race and ethnicity, and geographical indicators for urban or metropolitan residence. Most importantly, both data sources contain comparable measures of ability embodied in AFQT scores, a composite derived from tests of arithmetic reasoning, word knowledge, paragraph comprehension, and numerical operations.[2] Our analysis is conducted after categorizing individuals according to their AFQT score quartiles. Since AFQT percentile scores increase with age in the NLSY79, we determine an individual's quartile based on year of birth.[3] AFQT percentile scores in the NLSY97 have already been adjusted to account for age differences.

The NLSY79 contains measures of family income reported in early survey years, while the NLSY97 contains measures of both family income and net wealth in 1997.[4] For the 1979 cohort, we use average

[2] AFQT test scores are a widely used measure of cognitive achievement by social scientists using the NLSY and are strongly correlated with positive outcomes like education and post-school earnings. (See, e.g., Blackburn and Neumark 1993, Murnane, Willett, and Levy 1995, and Cawley, *et al.* 2000.)

[3] All respondents took the battery of tests that make up the AFQT scores in the summer and fall of 1980. See the *NLSY79 User's Guide* for details.

[4] Net wealth measures the net value of owned home, real estate, business and vehicles. Added to that is money kept in checking and savings bank accounts as well as Educational IRA accounts or other prepaid tuition savings accounts. Loans and credit card debt are subtracted. Assets like bills, bonds, life insurance policies, pension savings, shares in

family income when youth are ages 16-17, excluding those not living with their parents at these ages.[5] The NLSY97 analysis is based on family income and family net wealth in 1997, dropping individuals not living with their parents that year.[6] Given our NLSY97 sample age restrictions (discussed below), family income and wealth are reported when the youth are ages 14-17. We categorize individuals into income or wealth quartiles based on the random sample of persons ages 22-24 in 1997. In both NLSY samples, we denominate income in year 2000 dollars using the CPI for all urban consumers.

Our main results analyze whether individuals have completed high school or attended college at any time. To check the robustness of our findings, we also consider whether individuals complete at least one year of college. Educational attainment is measured as of ages 24-25 for our main NLSY79 analysis (attainment at age 24 is used unless that value is missing, in which case attainment at age 25 is used). For the NLSY97 data, we use outcomes reported in 2003, or 2002 if the value is missing in 2003 and the respondent meets our age sample criteria. We restrict the NLSY97 sample to individuals aged 20-24 for our main analysis, but we also consider a more limited age range of 22-24 in 2003 for some specifications. Since the oldest individuals in the NLSY97 recently turned 24 in the 2003 wave of data, we are forced to focus on a slightly younger age group. As a result, we examine college attendance but not completion. (We explore whether cohort differences are due to differences in ages across the two surveys below.)[7] Given the comparability of the two data sources, we perform separate but parallel analyses of educational attainment to determine how these choices depend on family background, cognitive ability, and family income (as well as family wealth for the 1997 cohort).

Our multivariate analysis controls for a host of family background variables. For both cohorts we control for maternal education by categorizing mothers as high school dropouts, as mothers who completed high school or more, and as mothers who completed at least one year of college.[8] We also account for family structure in the NLSY79 by controlling for the number of siblings the youth reported in 1979. For the NLSY97, we control for the number of household members under the age

publicly-held corporations and mutual funds are included.

[5] When income is only available at age 16 or 17 and not both, we use the available measure.

[6] We note that the NLSY79 family income variable is limited to those household members related to the respondent by blood or marriage, while the NLSY97 variable includes income for all members of the household.

[7] The use of family income measured at ages 16-17 limits our NLSY79 analysis to its younger sample respondents, while our focus on schooling outcomes at ages 20-24 in the NLSY97 limits that analysis to its older sample respondents.

[8] While our main specifications do not control for father's education (since many observations are missing), we check the robustness of our findings to the inclusion of indicators for whether father completed high school and whether he completed at least one year of college.

of 18 as of the 1997 survey date. Additional family structure information is provided by an indicator variable for whether both parents are present in the home at age 14 in the NLSY79 and in 1997 (i.e. ages 14-17) in the NLSY97. Family residence in an urban (metropolitan) area at age 14 (age 12) is accounted for with the 1979 (1997) cohort. We control for the mother's age at birth as well as gender and race (blacks, hispanics and whites for the NLSY79; blacks, hispanics, whites and others for the NLSY97 data). Finally, we allow for differences by year of birth in the NLSY79 and by age at which educational outcomes are measured in the NLSY97.

Descriptive statistics for all of these variables are provided in Table 1 for both cohorts and both age samples of the 1997 cohort.[9] Comparisons across cohorts reveal that schooling attainment is higher for the 1997 cohort. NLSY97 respondents have higher high school graduation rates and, despite their younger age, higher college attendance rates. We observe the same phenomenon with regard to maternal education, which is substantially higher for the later cohort. Another striking difference across cohorts is the much greater likelihood that both biological parents are present in the household during the child's adolescence in the NLSY79; however, mother's age at respondent's birth has changed very little. Minorities are slightly more prevalent in the NLSY97 data, consistent with national demographic trends. Average income levels are similar across cohorts; however, there appears to be greater dispersion in the NLSY97. At the high end of the income distribution, this partially reflects a much higher truncation value for family income in the later survey. For the 1997 cohort, average family wealth is quite close to average gross home value – most assets are in home equity. Table 2 reproduces the joint distribution of AFQT and income quartiles across cohorts. The distributions are remarkably similar, except for the larger fraction of individuals in the lowest ability/lowest AFQT quartiles in the NLSY79. Both distributions show a strong positive correlation; however, there are non-trivial percentages in high income/low AFQT and low income/high AFQT cells.

4 The Changing Role of Ability and Family Resources on Educational Achievement

Figures 1 and 2 show high school completion and college attendance rates by family income quartile and AFQT quartile in the NLSY79 and NLSY97 data. Not surprisingly, ability plays an important role

[9] These samples are restricted to individuals for whom we observe both AFQT scores and family income.

in determining educational attainment in both cohorts. Figures 1a and 1b reveal that nearly everyone in the highest ability quartile graduates from high school from both cohorts; however, graduation rates are substantially lower for those in the lowest ability quartile, especially those raised in low-income families. Ability appears to have become a slightly less important determinant of high school graduation for the recent cohort, while family income appears to have become more important for youth of low ability. Among the least able, high school graduation rates between the highest and lowest family income quartiles differ by about 15 percentage points for the earlier cohort, while that gap rises to about 25 percentage points for the more recent cohort.

Figures 2a and 2b show that college attendance rates are positively correlated with both ability and family income. For both cohorts, ability plays the more decisive role; however, differences by family income are substantial for the higher ability quartiles in the 1979 cohort and for all ability levels in the 1997 cohort. Based on these simple comparisons, it appears as though the role of ability has changed very little over the last two decades while family income has become more important in determining college-going (especially among the least able).

To further explore these relationships, we employ a similar methodology to that used in Carneiro and Heckman (2002), who use the NLSY79 to analyze the effects of family income and ability on college attendance and completion rates after controlling for other family background characteristics. We extend their basic methodology to analyze high school completion rates in addition to college attendance rates for all men and women (not just white men as in their paper). As we are mainly interested in how ability - family income - educational achievement relationships have changed over time, we employ nearly identical estimation specifications for both the NLSY79 and the NLSY97 cohorts.[10] Specifically, we regress educational outcomes on family income quartiles (or just family income in $10,000 deflated to year 2000 dollars) during the respondent's late teenage years, AFQT quartiles, and family background measures for both NLSY cohorts. We control for very similar family background measures to Carneiro and Heckman (2002), including parental education, whether the family is intact during adolescence, residence in an urban/metropolitan area during adolescence, and number of siblings (children under age 18 in the household for the NLSY97 analysis).[11] Because

[10] Elwood and Kane (2000) also employ a similar strategy in examining the High School and Beyond (HSB) survey of high school classes of 1980 and 1982 and the National Education Longitudinal Study (NELS) of the graduating high school class of 1992; although they do not have consistent test scores across the different surveys.

[11] We note that Carneiro and Heckman (2002) use AFQT terciles rather than quartiles, and they use family income

we examine the full random samples rather than just white males, we also control for race, hispanic ethnicity, and gender. Our NLSY79 results essentially replicate the findings of Carniero and Heckman (2002), so the differences in the sample universe and background measures do not appear to be important for our main conclusions.

Table 3 reports estimates of our main specifications for both the NLSY79 and NLSY97 data. The first two columns report results for high school completion and the second two reflect estimates for college attendance. The high school completion specifications are remarkably stable across the two cohorts. Youth raised in an intact family or with a mother who completed high school are substantially more likely to finish high school themselves. Mother's college attendance has no discernable impact on youth's high school completion decisions. Blacks and hispanics are more likely to complete high school, all else equal, than are whites; however, the black - white difference appears to have declined significantly for the NLSY97 cohort.

We are most interested in the role of ability, as measured by AFQT scores, and family income after controlling for family background. The estimates suggest that ability is an important determinant of high school completion for both cohorts as implied by Figures 1a and 1b. Among the lower half of the distribution, moving from the first to second ability quartile raises the probability of completing high school by nearly 20 percentage points for both cohorts after controlling for family background and income. In the top half of the distribution, moving from the third to top quartile has little effect on completion rates for both cohorts. While the role of ability changes little at the bottom and top ends of the distribution, the importance of ability appears to have weakened in the middle of the distribution: comparing the second and third ability quartiles, the high school completion gap falls from 12 to 2 percentage points across cohorts. Family income plays a relatively minor role in determining high school completion with little change across cohorts. The difference in completion rates between the lowest and highest ability quartiles is only 6 percentage points in both the NLSY79 and NLSY97. Overall, these results suggest remarkable stability in the role of both ability and family income in determining high school completion rates.

Turning to the college attendance specifications in Table 3, we observe more noticeable changes

measured at age 17 or in 1979, while we use average income measured over ages 16 and 17 for the NLSY79 data and family income in 1997 for the NLSY97 (corresponding to ages 14-17 for our sample). We do not control for father's education or residence in the south in our main specifications, while Carneiro and Heckman (2002) do; however, adding these additional covariates does not affect our main conclusions about the roles of ability and family income.

across the cohorts. Minority - non-hispanic white differences are sizeable but declining across the cohorts.[12] Among NLSY79 youth, mother's high school completion and college attendance have substantial effects on college-going behavior, both raising the probability of attending college by about 15 percentage points. The effects are roughly half that size for NLSY97 youth.

As with high school completion, ability plays a key role in college attendance decisions after controlling for family background and income. Moving from the lowest to second AFQT quartile raises attendance rates by 14 percentage points for the NLSY79 youth and by 25 percentage points for NLSY97 youth, suggesting that ability has become more important at the low end of the distribution. Moving from the second to third or third to top ability quartiles each raises attendance rates by about 20 percentage points for the older cohort and by about 15 percentage points for the more recent cohort. Thus, ability has become more important at the low end and slightly less important at the high end of the distribution.

While ability is important for both cohorts, family income appears to play an important role in determining college attendance only for NLSY97 youth. Consistent with Carneiro and Heckman (2002) we find little effect of family income differences in the NLSY79 data. A test for no income effects cannot be rejected at the 5 percent significance level (the test has a p-value of 0.06). Estimated effects of family income, controlling for family background and ability, are sizeable and statistically significant in the NLSY97 sample. These estimates suggest that youth coming from the highest family income quartile are 16 percentage points more likely to attend college than youth from the lowest income quartile. An F-test strongly rejects the hypothesis of no family income effects. Thus, while the role of ability has remained fairly stable across NLSY cohorts, family income appears to have become a significantly more important determinant of college-going decisions.

We look more closely at the joint role of ability and family income in Table 4, which reports the estimated effects of family income on high school completion and college attendance within each AFQT quartile (controlling for the same background characteristics as in Table 3). Consistent with the patterns shown in Figures 1a and 1b, we find that family income has modest effects on high school completion for the lowest able ability types and negligible effects for the higher ability quartiles.

[12] Black - white and hispanic - non-hispanic white differences are roughly 20 percentage points in the NLSY79, while the black - white difference falls to around 16 percentage points and the hispanic - non-hispanic difference drops further to about 5 percentage points for the more recent NLSY97 cohort.

Estimated effects of income are quite similar across cohorts. The only high school completion case in which we reject that there are zero income effects is for AFQT quartile 2 in the NLSY97.

Results for college attendance are again quite different, in line with the patterns reported in Figures 2a and 2b. Among NLSY79 youth, family income only appears to matter for those in the highest ability quartile. Among the most able, moving from the lowest to second family income quartile raises college attendance rates by 10 percentage points. Moving to the top income quartile raises attendance rates by an additional 5 percentage points. Our results for NLSY97 youth show sizeable and statistically significant effects of family income for all ability quartiles. Among the highest ability quartile, the effects of family income are quite similar to those observed for the NLSY79 cohort; however, for all other ability types, the effects tend to be at least twice as large. Among all but the top ability quartile, moving from the lowest to highest family income quartile implies a roughly 20 percentage point rise in college attendance rates. F-tests strongly reject the hypothesis of no family income effects for all ability groups.

The findings related to family income in Tables 3 and 4 are not driven by the widening of the family income distribution across NLSY cohorts (see Table 1). While the difference in average family income between the highest and lowest income quartiles has risen across the cohorts, this cannot explain the increased importance of income for college attendance as seen in Table 5. In this table, we simply control for family income in levels (denominated in year 2000 dollars) using the full sample (analogous to Table 3) and using each AFQT quartile sample (analogous to Table 4). Only the effects of income are reported. As Table 5 clearly shows, the effects of family income on high school completion have changed very little, while its effects on college attendance have risen substantially for all but the highest ability quartile. As in Table 4, family income effects are only significantly different from zero for the highest ability quartile in the NLSY79; income effects are significantly positive for all ability quartiles in the NLSY97. Among all but the top ability quartile, estimates suggest that youth from the recent cohort are 2-3 percentage points more likely to attend college for every $10,000 increase in family income. Among the most able in the NLSY97, an additional $10,000 is predicted to raise college attendance rates by about 0.8 percentage points.

Since we find such a large change in the role of family income on college attendance rates across the two NLSY cohorts, we explore the robustness of these results in Tables A1 and A2 in the appendix

using specifications similar to those in Table 3. Column (i) in both tables examines whether controlling for father's education (dummies for completed high school, attended college, or missing) in addition to the baseline controls changes the estimated effects of family income on college attendance. For both cohorts, controlling for father's education in addition to other background measures reduces the estimated effect of family income by a few percentage points but does not affect our main conclusions. Column (ii) conditions the sample on high school graduates only, which also has little effect on the family income estimates. Column (iii) conditions the sample on those youth whose mother attended college. It is worth noting that only about 20 percent of the NLSY79 mothers had completed some college while close to 50 percent of the NLSY97 mothers did. Thus, this NLSY79 sample is almost certainly more strongly selected on mother's scholastic ability. The estimated effects of family income rise considerably for the NLSY79 sample, however the significantly smaller sample size makes it difficult to precisely estimate the role of income. The estimated effects of family income are also larger in the NLSY97 when we limit the sample to children of mother's with at least some college education. These results suggest that the role of income may have increased less over time for the children of more educated mothers, but this is because income was always more important for these youth.

Column (iv) examines whether the age of our sample respondents plays an important role in our finding that income matters more in the NLSY97. Because the NLSY97 sample is still quite young, our main sample examines college attendance among those ages 20-24 (although few are age 24) in the final year we observe them, 2003. On the other hand, we measure educational attainment as of ages 24-25 in the NLSY79, better capturing their final educational status. Column (iv) of Table A1 instead examines college attendance as of ages 20-21 in the NLSY79 (a sample that is slightly *younger* on average than our main NLSY97 sample). In this specification, the estimated effects of family income are slightly larger than those for the NLSY79 in Table 3, but they are still substantially smaller than the corresponding estimates in the NLSY97. Alternatively, in column (iv) of Table A2, we adjust the sample in the NLSY97 to more closely match that of the NLSY79. Here, we limit the NLSY97 sample to those youth ages 22-24 in 2003, analyzing their college attendance at that time. We find slightly smaller effects of family income using this specification, but the effects are still twice as large as those for the NLSY79. Combining the estimates in column (iv) of Tables A1 and A2 with the main estimates in Table 3 suggests that low family income delays college attendance for some youth.

By their mid-twenties, individuals from low income families have made up a few percentage points of their early attendance "deficit" (measured at ages 20-21) when compared with those from high income families.

Column (v) of Tables A1 and A2 considers a slightly different definition of college attendance from what we have been using thus far. Our main specifications examine whether income and ability affect college attendance, regardless of whether an individual completes a full year of college or not. Here, we examine the likelihood that someone completes at least one year of college.[13] The estimated effects of family income are very similar to those in Table 3.

With the NLSY97, it is possible to more broadly examine the role of family resources, since the data contain measures of net family wealth and housing value in the 1997 survey. Table 6 explores whether net family wealth affects educational outcomes in the same way family income does for the later NLSY cohort. Columns 1-4 report estimates for high school completion, while columns 5-8 report estimates for college attendance. All specifications control for the same family background characteristics as in previous tables. Columns 1 and 5 are analogous to columns 2 and 4 of Table 3. These estimates suggest that net family wealth plays a similar role to that of family income, with slightly larger effects. Youth from families in the highest wealth quartile are about 10 percentage points more likely to complete high school and 20 percentage points more likely to attend college than are youth from the lowest wealth quartile. Columns 2 and 6 simultaneously control for family income and wealth quartiles. Interestingly, the estimated effects of wealth decline only slightly relative to those in columns 1 and 5, while the effects of family income typically drop by about one-third to one-half their values in Table 3. F-tests strongly reject the hypothesis that wealth has zero effect on high school completion and college attendance. F-tests also reject that income has no effect on college attendance. The combined effects of wealth and income on college attendance are substantial. Youth raised in low wealth and low income families (lowest quartiles in both) are nearly 30 percentage points less likely to attend college than youth with similar family backgrounds in the highest family income and wealth quartiles.

The remaining columns of Table 6 examine whether income effects vary by family wealth levels.[14]

[13] Practically, our main specifications consider whether the highest grade attended is greater than 12. This turns out to be nearly identical to other measures in both data sets that ask specifically about colleges attended. The alternative measure in Tables A1 and A2 considers whether the highest grade completed is greater than 12.

[14] The low wealth sample includes those in the bottom two quartiles, while the high wealth sample includes those in

For high school completion, the effects of family income are very similar regardless of the family wealth level, while ability appears to be substantially less important among youth from high wealth families. Estimates for college attendance in columns 7 and 8 show very similar effects of ability by family wealth, except at the top end. Thus, ability matters a lot for college-going regardless of family resources. Perhaps surprisingly, the estimates suggest that family income may be a stronger determinant of college attendance for youth from wealthier families, although the estimates are noisy. The fact that the effect of family income on college attendance does not disappear among youth from wealthy families raises questions about simple stories that rely on borrowing constraints as an explanation for the role played by family income.

5 What Explains the Increased Importance of Family Income?

Much has been made of the fact that family income does not appear to affect college attendance in the NLSY79. Most studies rejecting the idea that credit constraints play an important role at college-going ages are based on these data.[15] Therefore, our findings that family income has become substantially more important in the NLSY97 data (using very similar estimation specifications, measures of ability, and family income) may serve to re-open the debate about borrowing constraints and educational achievement. Rather than simply attributing all differences in attendance by family income to borrowing constraints (e.g. see Carneiro and Heckman, 2002), we consider what role borrowing constraints, along with other forces, play in explaining the rising (and now important) role of family income for college attendance. We also explore how changes in financial aid formulae have affected the implicit price of college by family income (and ability) over the past 25 years and whether this helps explain our empirical findings. The rising returns to education and ability in the labor market may also play a role in ability - family income - college attendance relationships, which we attempt to quantify. Finally, we consider whether other potential explanations for college attendance gaps by family income (e.g. the role of information or tastes for college) could have contributed to the rising role of family income.

the top two quartiles.

[15] Cameron and Heckman (1998, 2001), Keane and Wolpin (2001), Carneiro and Heckman (2002), and Cameron and Taber (2004) all use the NLSY79 and conclude that credit constraints have little effect on college-going decisions.

5.1 A Simple Model of College Attendance

We now develop a simple two-period model of college-going that helps shed light on the role played by factors that might affect the changing role of ability and family income. Consider the choice to attend college ($s = 1$) or not ($s = 0$). Let $W \geq 0$ reflect the initial resources of individuals (and their families) and $y_s(\theta)$ reflect earnings (when not enrolled in school) for someone with schooling level s and ability θ. We assume that $y_1(\theta) > y_0(\theta) > 0$ and $y_1'(\theta) > y_0'(\theta) > 0$ so that earnings are strictly increasing in schooling and ability, with ability having a greater effect on college earnings. Individuals value consumption, c_t, in each period $t = 1, 2$ according to the increasing and strictly concave function $u(c_t)$ and discount the future at rate β. They may also place an intrinsic value on attending college. This consumption value of school is ξ, which is distributed in the population according to the density function $G(\xi)$. Individuals may borrow any amount, d, up to an upper borrowing limit, $\bar{d}$, to smooth consumption over time. The gross interest rate is R. While enrolled in college, students must pay tuition $T(W)$, which is assumed to be increasing in initial resources (specifically, $0 \leq T(W) \leq W$ and $0 \leq T'(W) \leq 1$). This reflects the fact that financial aid policies are more generous to youth from lower income backgrounds. Those who do not enroll in college are assumed to work and earn $y_0(\theta)$ in both periods. Thus, college entails both direct and indirect costs.

Conditional on schooling level s, value functions are given by

$$V_s(W, \theta, \xi) = \max_d \{u(c_1) + \beta u(c_2) + s\xi\}$$

subject to

$$\begin{aligned} c_1 &= W + d + (1 - s)y_0(\theta) - sT(W) \\ c_2 &= y_s(\theta) - Rd \\ d &\leq \bar{d}. \end{aligned}$$

Individuals choose the schooling level that offers them the higher lifetime utility. Since the utility value of college, ξ, does not affect consumption and borrowing decisions conditional on schooling, it is helpful to define $v_s(W, \theta) = V_s(W, \theta, \xi) - s\xi$, which reflects the maximized lifetime utility from consumption alone for schooling choice s. Using this notation, individuals attend college if and only if $\xi \geq v_0(W, \theta) - v_1(W, \theta)$. College attendance rates for someone with resources W and ability θ are $1 - G(v_0(W, \theta) - v_1(W, \theta))$.

To simplify the analysis somewhat, we assume that $\beta R = 1$, so that agents will want to perfectly smooth consumption across periods. Given our specification (i.e. no income growth), this implies that non-college youth will always choose to save while young and will never be borrowing constrained. Their consumption in each period will be

$$c_1 = c_2 = \left[\frac{R}{1+R}\right] W + y_0(\theta) \equiv \bar{c}^0.$$

The value of the non-college alternative is, therefore,

$$v_0(W, \theta) = (1+\beta)u\left(\left[\frac{R}{1+R}\right] W + y_0(\theta)\right).$$

Clearly, this is increasing in wealth and non-college earnings levels, the latter increasing in θ. Tuition policy and borrowing limits have no effect on non-college utility.

Now, consider the value associated with college attendance. The unconstrained optimal amount of consumption is defined by

$$\bar{c}^1 = \frac{R(W - T(W)) + y_1(\theta)}{1+R}$$

yielding a value of

$$v_1^u(W, \theta) = (1+\beta)u\left(\frac{R(W - T(W)) + y_1(\theta)}{1+R}\right).$$

This is increasing in college earnings, ability, and initial resources. The unconstrained optimal borrowing amount is

$$d_1^u = \frac{y_1(\theta) - W + T(W)}{1+R},$$

which is increasing in college earnings and ability and decreasing in initial resources. This must be no greater than $\bar{d}$, or it is not a feasible allocation.

College attendees will be borrowing constrained if and only if $d_1^u > \bar{d}$. Substituting in for d_1^u, this implies that they will be constrained when

$$W - T(W) < y_1(\theta) - (1+R)\bar{d}$$

or, alternatively,

$$\theta > y_1^{-1}\left(W - T(W) + (1+R)\bar{d}\right) \equiv \theta^c(W, \bar{d}).$$

The cutoff ability level, θ^c, is increasing in both $\bar{d}$ and W. Youth with low resources and high ability are most likely to be constrained if they attend college. Constrained youth will borrow the maximum,

consuming

$$\begin{aligned} c_1^c &= W - T(W) + \bar{d} < \bar{c}^1 \\ c_2^c &= y_1(\theta) - R\bar{d} > \bar{c}^1, \end{aligned}$$

during and after school, respectively. Thus, their lifetime value is

$$v_1^c(W,\theta) = u\left(W - T(W) + \bar{d}\right) + \beta u\left(y_1(\theta) - R\bar{d}\right) < v_1^u(W,\theta).$$

As with unconstrained utility, this is increasing in initial resources and college earnings, while it is decreasing in tuition payments. Since $c_2^c > c_1^c$, lifetime utility will be increasing in the borrowing limit, $\bar{d}$, for constrained borrowers.

Altogether,

$$v_1(W,\theta) = \begin{cases} v_1^u(W,\theta) & \text{if } \theta \leq \theta^c(W,\bar{d}) \\ v_1^c(W,\theta) & \text{otherwise.} \end{cases}$$

Thus, the value of college will be independent of the borrowing limit for low ability individuals who are unconstrained, but it will be increasing in the limit for more able youth who cannot borrow as much as they would like while attending college.

Finally, it is useful to define the net lifetime financial gain from college, $G(\theta)$:

$$G(\theta) \equiv y_1(\theta) - RT(W) - (1+R)y_0(\theta).$$

We assume that this earnings gain is increasing in ability, so $G'(\theta) > 0$; otherwise, attendance rates will tend to be decreasing in ability (a pattern inconsistent with finding for both NLSY cohorts). This assumption further implies that there is a unique $\theta = \bar{\theta}(W)$ that satisfies $G(\theta) = 0$. For individuals with initial resources W and $\theta > \bar{\theta}(W)$, the net financial gain from college is strictly positive. Those with $\theta < \bar{\theta}(W)$ would lose financially from attending. It can easily be shown that $\bar{\theta}'(W) \geq 0$ (the derivative equals zero when $T'(W) = 0$ and is otherwise positive), so youth with high initial resources must be more able if they are to financially gain from college (since they pay higher tuition). Holding initial resources constant, more able youth gain more from college; holding ability constant, those with lower initial resources gain more.

What does this simple model predict for the ability - initial resources - schooling relationship? The effect of resources on attendance rates depends on how inframarginal agents are affected – those

indifferent about attending college. These are the agents who will alter their schooling decisions if anything changes. Indifference implies that $\xi = v_0(W,\theta) - v_1(W,\theta) \equiv \bar{\xi}(W,\theta)$. Anything that lowers $\bar{\xi}$ will raise attendance rates.

Differentiating the value functions for non-college as well as unconstrained and constrained college-goers with respect to family resources yields:

$$\begin{aligned}
\frac{\partial v_0}{\partial W} &= u'(\bar{c}^0) \\
\frac{\partial v_1^u}{\partial W} &= (1 - T'(W))u'(\bar{c}^1) \\
\frac{\partial v_1^c}{\partial W} &= (1 - T'(W))u'(c_1^c).
\end{aligned}$$

The effect of initial resources on non-college vs. college utility depends on consumption levels under the different choices and the effects of family resources on tuition (or financial aid). First, consider the case where no youth face binding borrowing constraints (i.e. $max\{\theta\} \leq \theta^c(W,\bar{d})$). In the absence of binding constraints, consumption levels depend only on lifetime earnings, so college consumption will be greater than non-college consumption when $G(\theta) > 0$ or, equivalently, $\theta > \bar{\theta}(W)$; otherwise, non-college consumption will be higher. For those with positive net financial gains, the inframarginal individual must dislike college (i.e. $\xi < 0$). Thus, the inframarginal person of high ability attends college only because it provides financial benefits and greater consumption opportunities. An increase in family resources makes him more willing to forego the financial gains to avoid the 'distaste' of college. Thus, an increase in wealth causes attendance rates to decline for these youth even if $T'(W) = 0$. When tuition is increasing in family resources, this creates an additional price disincentive associated with an increase in family resources. For unconstrained youth with $\theta > \bar{\theta}(W)$, the effect of wealth on attendance rates is unambiguously *negative*. Among less able youth (i.e. $\theta < \bar{\theta}(W)$), the inframarginal person must enjoy college (i.e. $\xi > 0$) and is willing to 'pay' for it through a negative net financial gain ($G(\theta) < 0$). Among these youth, an increase in family resources makes them more willing to pay for the intrinsic benefits of college, which tends to encourage attendance; however, the tuition 'tax' on family resources still serves to discourage attendance as resources increase. Thus, the net effects of resources on attendance are ambiguous for lower ability youth, but they will be more positive (or less negative) for the least able. The effects will tend to be positive when tuition prices are relatively unresponsive to resources.

In the absence of borrowing constraints, the model predicts that college attendance should be *decreasing* in family resources except possibly for those with negative financial returns from college (i.e. the least able). The presence of borrowing constraints changes the role of family resources for the more able who find the constraints binding. Since $c_1^c < \bar{c}^1$, it is clear that initial resources have a greater positive effect on the value of college if an individual is constrained than if he is not. Thus, for higher ability youth who are more likely to be constrained, initial resources are more likely to have a positive effect on attendance rates. This is consistent with the findings for the NLSY79; although, the NLSY97 reveals a strong positive family resource - college attendance relationship for all ability types. As we discuss below, this is consistent with more limiting borrowing constraints for the later cohort.

The rate at which tuition increases in family resources, W, affects the relationship between resources and attendance. When tuition is tightly linked to resources (i.e. $T'(W)$ is large), resources are more likely to be negatively related to attendance. However, where tuition is constant across resource levels, increases in family income and wealth are likely to have more positive effects on attendance. Thus, the shape of the $T(W)$ function, through federal and institutional financial aid policies, plays a key role in determining the effects of wealth on attendance rates. In practice, financial aid policies tend to generate an S-shaped $T(W)$ function. Financial aid is generous and not very responsive to changes in family income/wealth at the very low end of the distribution; as wealth and income increase, the implicit 'tax' through reduced aid increases over a range until aid becomes zero, at which point youth pay full tuition prices regardless of their family resource levels. This pattern suggests that the effects of family resources on tuition levels are small for low and high resource families but may be high for middle resource families. In this case, we might expect increases in family resources to have more negative (or less positive) effects on attendance rates among middle income/wealth families, since tuition prices respond most for them. Borrowing constraints should contribute to more positive effects of wealth at the low end of the income/wealth distribution, but should have little bearing on those from wealthier families. The combined effects of tuition price responses and borrowing constraints suggest a positive effect of family resources on the lowest income/wealth families and small or even negative effects of resources throughout the rest of the distribution. Empirically, both the NLSY79 and NLSY97 reveal fairly similar effects of income changes throughout the income distribution (see

Table 3). Table 6 further suggests that the effects of income on college attendance are strong even for youth from high wealth families in the NLSY97. The model offers little explanation for the strong positive income and wealth effects at the high end of the distribution.[16]

Now, consider the role of ability, θ, on the value of non-college and college:

$$\begin{aligned}
\frac{\partial v_0}{\partial \theta} &= (1+\beta)u'(\bar{c}^0)y_0'(\theta) \\
\frac{\partial v_1^u}{\partial \theta} &= (1+\beta)u'(\bar{c}^1)\left[\frac{y_1'(\theta)}{1+R}\right] = \beta u'(\bar{c}^1)y_1'(\theta) \\
\frac{\partial v_1^c}{\partial \theta} &= (1+\beta)u'(c_2^c)\left[\frac{y_1'(\theta)}{1+R}\right] = \beta u'(c_2^c)y_1'(\theta).
\end{aligned}$$

For lower ability youth ($\theta \leq \bar{\theta}(W)$), ability unambiguously increases attendance rates among those who are unconstrained, since $G'(\theta) > 0$ and $u'(\bar{c}^1) > u'(\bar{c}^0)$. For more able youth, ($\theta > \bar{\theta}(W)$ who receive a positive financial gain from college, the marginal utility of consumption is higher for the non-college choice, which may generate a negative ability - attendance pattern if $G'(\theta)$ is small enough. Ability has smaller (and, perhaps, negative) effects on attendance rates if individuals are borrowing constrained while attending college. Since $c_2^c > \bar{c}^1$, the marginal value of ability for college attendees is smaller when constraints are binding. That is, $\frac{\partial v_1^c(W,\theta)}{\partial \theta} < \frac{\partial v_1^u(W,\theta)}{\partial \theta}$ for any values of (W, θ) for which the constraints bind. It is noteworthy that the marginal value of ability for constrained college attendees is independent of initial resource levels, while the marginal value of ability for non-college youth is strictly decreasing in W. Thus, among youth that would be borrowing constrained if they attended college, ability should have its most positive effect on attendance rates among those with the lowest family resources.

To understand what might have changed ability - family income - college attendance patterns over time, it is useful to analyze how borrowing limits, financial aid policies, and the returns to skill impact attendance decisions. In particular, we are interested in determining what policy or economic changes might lead to a stronger positive effect of family income on attendance, without dramatically changing the effects of ability.

While borrowing limits have actually risen slightly in nominal terms since the early 1980s, their real value has declined substantially since that time.[17] When coupled with a near doubling in tuition,

[16] Perhaps, the dramatic stock market crash beginning in 2000 (after family wealth is measured but prior to many college attendance decisions are made for the NLSY97 sample) has left previously high wealth families in more precarious financial positions.

[17] In 1992, the Stafford loan limit for second year dependent students rose from $2,625 to $3,500, while loan limits

fees, room, and board charges (in real terms) at four-year public institutions between 1980 and 2000 (College Board 2005), there is reason for concern that the real value of borrowing opportunities has shrunk considerably over this period.

Consider the effects of reducing borrowing opportunities by lowering $\bar{d}$. Stricter borrowing limits will cause some college attendees to become constrained when they previously were not. This of course, lowers the value of college for them. Furthermore, lower borrowing limits will reduce the value of college among those who are already constrained ($\frac{\partial v_1^c}{\partial d} = u'(c_1^c) - u'(c_2^c) > 0$). Both of these forces serve to lower overall college attendance rates. The effects will, not surprisingly, be greater on those youth of high ability or from families with low resources, since they are more likely to be constrained already or to become constrained in response to the tighter limits. Considering only those who are constrained before borrowing limits are reduced, attendance should decline most among those of high ability and with low resources. This is because the marginal utility of consumption during school is declining in W while the marginal utility of consumption after school is declining in θ. As discussed earlier, family resources have a stronger positive effect on college attendance rates among youth who are constrained (if they attend) than among those who are unconstrained. To the extent that reduced borrowing limits cause more youth to become constrained, it should strengthen the relationship between family resources and attendance. Furthermore, it should extend the range of ability types that face constraints (to cover less and less able individuals), thereby generating a more positive resource - attendance relationship for lower ability types than previously existed. Finally, reduced borrowing limits will clearly lower student loan amounts among constrained college-goers.

Comparing the NLSY79 and NLSY97 cohorts, attendance rates increase rather than decrease, a pattern inconsistent with reduced borrowing opportunities. Clearly, changes in borrowing limits alone cannot explain all of the changes. However, the changes in the role of ability and family income are more consistent with the model's predictions when borrowing limits are reduced. For example, attendance rates appear to increase less at the high end of the ability distribution (the model predicts the strongest negative effects for these youth who are most likely to be constrained). More interestingly, the substantial increase in the effects of family income on college attendance rates is consistent with the possibility that borrowing constraints have become substantially more severe, to the point where

for third to fifth year dependent students rose from \$4,000 to \$5,500. The limit for first-year students has remained at \$2,625, since 1986 when it rose a mere \$125.

they may even constrain low ability youth in the later cohort (see Tables 3-5).

Changes in financial aid policies will also impact attendance rates. As noted above, real tuition levels have risen considerably since the early 1980s, which should increase student borrowing and discourage attendance for all types of students. To consider how changes in the level of tuition affect attendance patterns, suppose $T(W) = T$ is independent of resources. Increases in tuition levels will reduce θ^c, raising the fraction of the population that is borrowing constrained. The effects of tuition on attendance among unconstrained youth with $\theta < \theta^c$ will be larger for the least able and those with lower family resources, since they have the greatest marginal utility of wealth. The effects will also be larger for any particular individual if he/she is constrained, since they face a larger marginal utility of wealth while in college. Interestingly, the tuition effects will not vary by ability among constrained borrowers, since ability does not affect their college consumption levels. Constrained youth with lower family resources will be impacted more heavily by changes in tuition than will those with higher resources. Altogether, tuition effects on attendance are monotonically declining in family resources for all ability types. Thus, an increase in tuition will make the resource - attendance relationship more positive.

In general, $T(W)$ is an increasing function of resources. It is interesting to consider how changes in financial aid distribution (through changes in the shape of $T(W)$) have affected individuals with different economic backgrounds. Since implicit taxes on income through financial aid formulae tend to discourage attendance among youth from high income/wealth families, reductions in these tax rates will tend to create a more positive family income - college attendance relationship. One noticeable change was that home equity was dropped from the federal expected family contribution (EFC) formula by the Higher Education Amendments of 1992, reducing implicit taxes on housing wealth. However, Dick, Edlin, and Emch (2003) estimate similar implicit financial aid taxes in 1986-87 and 1995-96 using data from National Postsecondary Aid Surveys. (We are currently working on determining changes in financial aid formulae from the early 1980s to the early 2000s, which would apply to our cohorts.)

Finally, changes in the structure of earnings have been dramatic in the past few decades. Suppose $y_1(\theta) = \pi_1 f_1(\theta)$, where π_1 reflects the market price of skill and $f_1(\theta)$ reflects the skill produced by college. Then, we can model an increase in returns to market skills (including an increase in returns to

both ability and college attendance) with an increase in π_1.[18] Not surprisingly, an increase in returns to skill will increase college attendance rates, more so for the most able. Thus, the rising returns to skill should strengthen the relationship between ability and college-going. Because the marginal utility of consumption is decreasing in family resources for unconstrained youth, the effects of an increasing skill premium will be greater on more disadvantaged youth thereby weakening any positive relationship between resources and attendance. Among constrained borrowers, the effects of an increase in π_1 should be independent of initial resource levels, since post-school consumption is independent of W. Finally, increasing returns to skill should reduce θ^c causing more youth to be borrowing constrained.

None of these factors, by itself, can explain the changing patterns in attendance by ability and family income/wealth. However, it seems that some combination of rising tuition, declining borrowing limits, and rising returns to skill has the potential for generating the types of patterns we observe.

5.2 Some Additional Evidence

To be completed

6 Conclusions

Based on the current evidence arguing that short-term borrowing constraints during college years are unimportant, many economists have begun to argue that government policy should shift toward improving the university-preparedness of children from lower income families (e.g. enriched pre-school programs and early childhood programs).[19] It is argued that the benefits from expanded student loan programs are likely to be small, and university tuition subsidies are likely to provide a windfall for those who would already attend and would do little to eliminate enrollment gaps by family income. On the other hand, if recent rises in tuition (average tuition levels in the U.S. have roughly doubled since 1980) and reductions in Pell Grant amounts have forced individuals to borrow more from government student loan programs, it is quite possible that mandated limits on borrowing have begun to take their toll on those from low income families. Consistent with this hypothesis, our findings suggest that family income has become a substantially more important determinant of college attendance rates (though not high school completion rates) for recent students. The documented rise in returns to

[18] Decreases in the earnings associated with non-college would produce similar effects to those discussed here.
[19] See, e.g., Cunha *et al.* (forthcoming).

ability in the labor market has had relatively little impact on the role played by ability in determining educational outcomes.

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Figure 1a: High School Completion by AFQT and Family Income Quartiles (NLSY79)

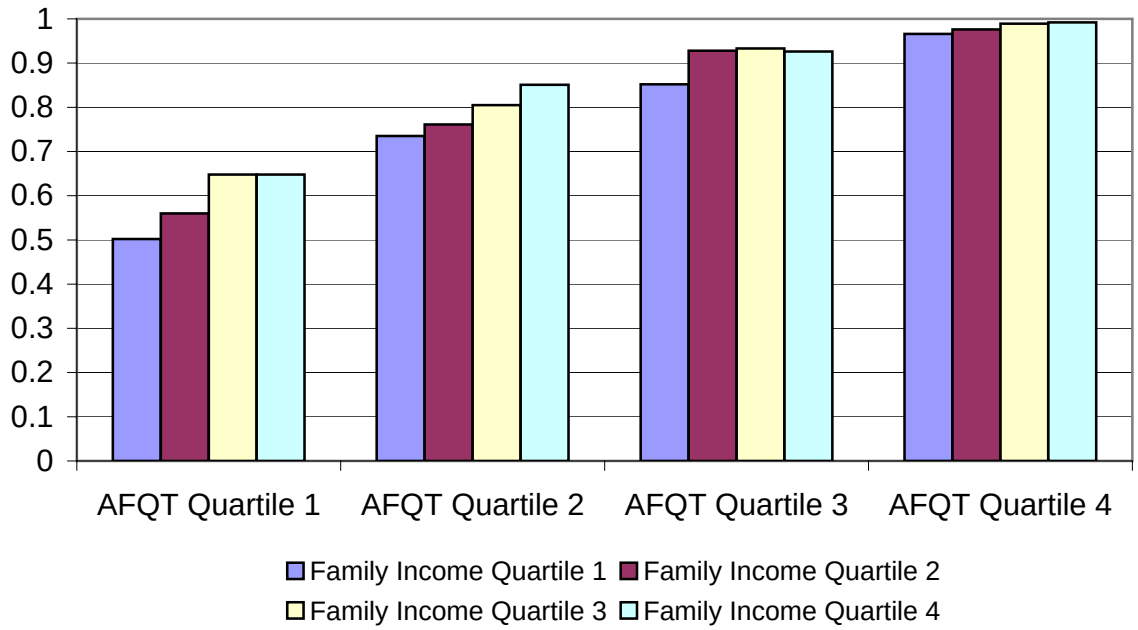

Figure 1b: High School Completion by AFQT and Family Income Quartiles (NLSY97)

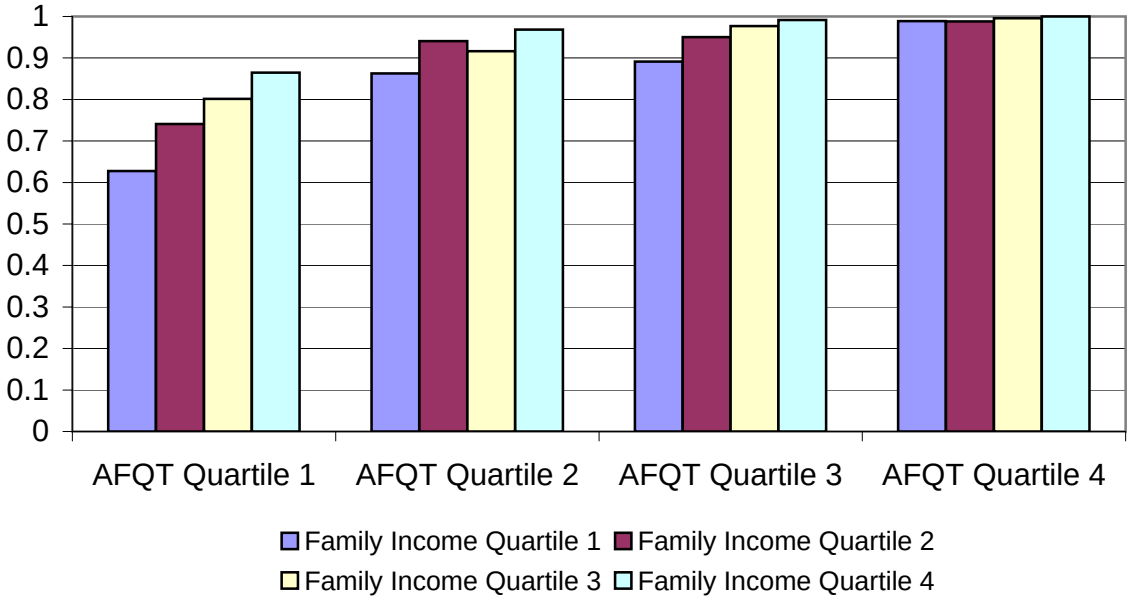

Figure 2a: College Attendance by AFQT and Family Income Quartiles (NLSY79)

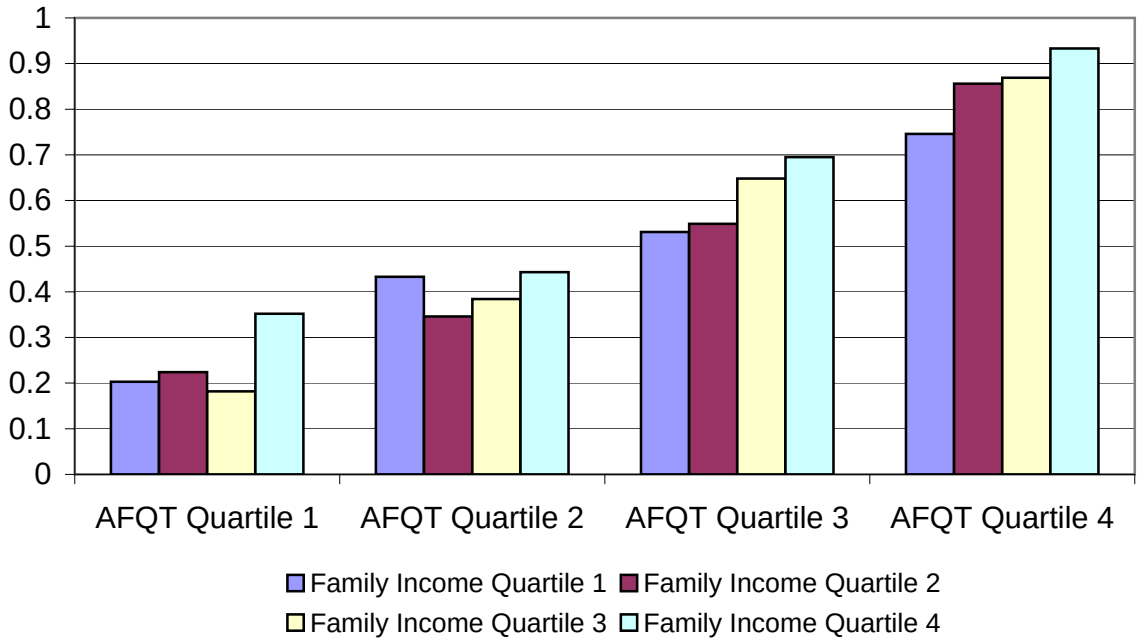

Figure 2b: College Attendance by AFQT and Family Income Quartiles (NLSY97)

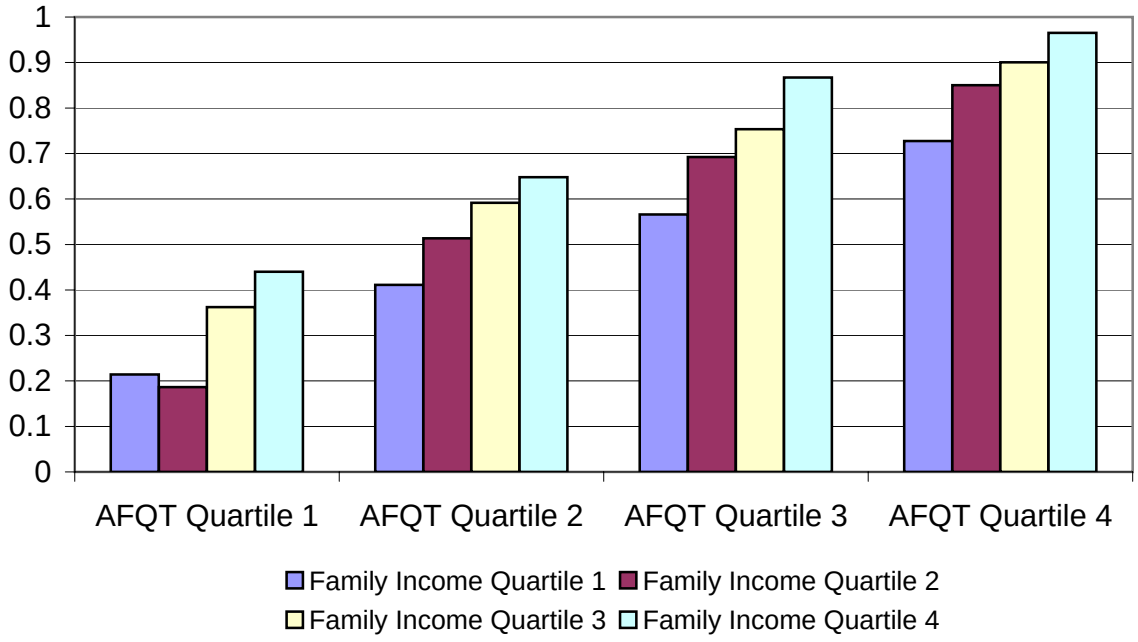

Table 1: Sample Descriptive Statistics

	NLSY79	NLSY97	
	Ages 24-25	**Ages 20-24**	**Ages 22-24**
Completed High School	0.811	0.904	0.921
	(0.391)	(0.295)	(0.270)
Attended College	0.532	0.622	0.635
	(0.499)	(0.485)	(0.482)
Completed at Least One Year of College	0.418	0.529	0.554
	(0.811)	(0.499)	(0.497)
Male	0.514	0.505	0.489
	(0.500)	(0.500)	(0.500)
Black	0.123	0.148	0.158
	(0.329)	(0.355)	(0.364)
Hispanic	0.076	0.112	0.108
	(0.264)	(0.316)	(0.310)
Mother's Age at Birth	26.647	25.534	25.226
	(6.218)	(5.083)	(5.094)
Intact Family during Adolescence	0.728	0.544	0.547
	(0.445)	(0.498)	(0.498)
Urban/Metropolitan Area during Adolescence	0.763	0.786	0.784
	(0.425)	(0.410)	(0.412)
Number of Siblings/Children under 18	3.200	2.290	2.190
	(2.178)	(1.140)	(1.126)
Mother HS Graduate	0.674	0.851	0.842
	(0.469)	(0.356)	(0.365)
Mother at Least Some College	0.197	0.476	0.451
	(0.398)	(0.500)	(0.498)
Family Income (in $10,000) during Late Adolescence	5.227	5.439	5.512
	(2.952)	(3.424)	(3.486)
Average Family Income (in $10,000) in Quartile 1	1.864	1.588	1.611
	(0.709)	(0.749)	(0.753)
Average Family Income (in $10,000) in Quartile 2	4.040	3.875	3.863
	(0.548)	(0.592)	(0.597)
Average Family Income (in $10,000) in Quartile 3	5.905	6.044	6.040
	(0.586)	(0.752)	(0.762)
Average Family Income (in $10,000) in Quartile 4	9.383	10.181	10.450
	(2.030)	(2.489)	(2.625)
Avg. Net Family Wealth (in $10,000) during Late Adolescence		11.635	11.868
		(14.492)	(14.730)
Avg. Net Family Wealth (in $10,000) in Quartile 1		0.162	0.178
		(0.786)	(0.802)
Avg. Net Family Wealth (in $10,000) in Quartile 2		3.196	3.116
		(1.284)	(1.295)
Avg. Net Family Wealth (in $10,000) in Quartile 3		10.536	10.534
		(3.196)	(3.209)
Avg. Net Family Wealth (in $10,000) in Quartile 4		32.721	32.817
		(14.865)	(14.894)
Parents Own Home during Late Adolescence		0.717	0.732
		(0.450)	(0.443)
Gross Home Value (in $10,000) for Parental Homeowners		11.797	11.489
		(9.981)	(10.152)
Age 20 in 2003		0.264	
		(0.441)	
Age 21 in 2003		0.262	
		(0.440)	
Age 22 in 2003		0.261	0.550
		(0.439)	(0.498)
Age 23 in 2003		0.202	0.426
		(0.402)	(0.495)
Age 24 in 2003		0.011	0.024
		(0.105)	(0.152)
Born in 1962	0.295		
	(0.456)		
Born in 1963	0.276		
	(0.447)		
Born in 1964	0.229		
	(0.420)		
Sample Size	2,528	3,131	1,485

Note: Table reports means with standard deviations in parentheses. Educational attainment measured at ages 24-25 in NLSY79 and either ages 20-24 or 22-24 in 2003 for NLSY97. See text for further details on these and other variables.

Table 2: Distribution over Family Income and AFQT Quartiles (NLSY79 and NLSY97)

	AFQT Quartile:			
	1	**2**	**3**	**4**
a. NLSY79				
Family Income Quartile 1	12.82%	6.25%	3.60%	2.37%
Family Income Quartile 2	6.37%	6.88%	6.29%	5.38%
Family Income Quartile 3	3.96%	6.57%	7.36%	7.20%
Family Income Quartile 4	2.22%	4.63%	8.03%	10.09%
b. NLSY97				
Family Income Quartile 1	9.81%	6.64%	4.22%	2.94%
Family Income Quartile 2	6.55%	6.26%	6.13%	5.53%
Family Income Quartile 3	4.09%	6.36%	7.22%	7.82%
Family Income Quartile 4	2.59%	5.62%	7.82%	10.41%

Notes: NLSY79 sample contains 2,528 individuals. NLSY97 sample contains 3,131 individuals (ages 20-24 in 2003).

Table 3: Estimated Effects of Family Income, AFQT, and Family Background on Educational Attainment

	High School Completion		College Attendance	
	NLSY79	**NLSY97**	**NLSY79**	**NLSY97**
Male	-0.0737	-0.0102	-0.0647	-0.0804
	(0.0143)	(0.0102)	(0.0176)	(0.0159)
Black	0.1603	0.0443	0.2160	-0.0079
	(0.0252)	(0.0282)	(0.0310)	(0.0442)
White		-0.0082		-0.1640
		(0.0253)		(0.0397)
Hispanic	0.0489	0.0459	0.1849	-0.1147
	(0.0292)	(0.0284)	(0.0359)	(0.0446)
Mother's Age at Birth	0.0036	0.0002	0.0051	0.0042
	(0.0012)	(0.0011)	(0.0015)	(0.0018)
Intact Family during Adolescence	0.0782	0.0638	0.0141	0.1055
	(0.0182)	(0.0118)	(0.0224)	(0.0184)
Urban/Metropolitan Area during Adolescence	-0.0322	-0.0226	0.0370	0.0200
	(0.0173)	(0.0127)	(0.0213)	(0.0199)
Number of Siblings/Children under 18	-0.0195	-0.0039	-0.0203	-0.0003
	(0.0038)	(0.0048)	(0.0047)	(0.0076)
Mother HS Graduate	0.1018	0.1333	0.1485	0.0877
	(0.0180)	(0.0167)	(0.0222)	(0.0261)
Mother at Least Some College	0.0139	0.0009	0.1704	0.0739
	(0.0197)	(0.0115)	(0.0242)	(0.0181)
AFQT quartile 2	0.1854	0.1705	0.1410	0.2481
	(0.0217)	(0.0155)	(0.0267)	(0.0243)
AFQT quartile 3	0.3014	0.1919	0.3406	0.3982
	(0.0229)	(0.0158)	(0.0282)	(0.0247)
AFQT quartile 4	0.3447	0.2134	0.5431	0.5219
	(0.0243)	(0.0164)	(0.0299)	(0.0256)
Family Income Quartile 2	0.0442	0.0512	0.0007	0.0411
	(0.0218)	(0.0156)	(0.0269)	(0.0245)
Family Income Quartile 3	0.0677	0.0419	0.0323	0.1056
	(0.0230)	(0.0165)	(0.0282)	(0.0259)
Family Income Quartile 4	0.0598	0.0612	0.0666	0.1608
	(0.0243)	(0.0173)	(0.0299)	(0.0271)
Test of no Income Effects (P-value)	0.0259	0.0019	0.0600	<0.0001
Sample Size	2,212	2,544	2,206	2,553

Notes: NLSY79 regressions control for cohort year of birth. NLSY97 regressions control for age at which education is measured. Standard errors are in parentheses. Test of no Income Effects is an F-test (3 d.o.f.) that all three coefficients on family income are zero. Education measured as of ages 24-25 in NLSY79 and ages 20-24 in the NLSY97.

Table 4: Estimated Effects of Family Income on Educational Attainment by AFQT Quartile (NLSY79 and NLSY97)

	High School Completion:				College Attendance:			
	AFQT Quartile 1	**AFQT Quartile 2**	**AFQT Quartile 3**	**AFQT Quartile 4**	**AFQT Quartile 1**	**AFQT Quartile 2**	**AFQT Quartile 3**	**AFQT Quartile 4**
a. NLSY79								
Family Income Quartile 2	0.0145	0.0149	0.0646	0.0145	0.0060	-0.0717	0.0291	0.1019
	(0.0519)	(0.0493)	(0.0381)	(0.0194)	(0.0441)	(0.0577)	(0.0672)	(0.0511)
Family Income Quartile 3	0.1217	0.0765	0.0334	0.0135	-0.0087	-0.0289	0.0834	0.1120
	(0.0637)	(0.0515)	(0.0381)	(0.0193)	(0.0536)	(0.0603)	(0.0672)	(0.0508)
Family Income Quartile 4	0.1022	0.0880	0.0226	0.0105	0.1181	-0.0418	0.0996	0.1541
	(0.0772)	(0.0563)	(0.0397)	(0.0192)	(0.0649)	(0.0656)	(0.0701)	(0.0504)
Test of no Income Effects (P-value)	0.1975	0.2446	0.3111	0.8880	0.2684	0.6543	0.3926	0.0237
Sample Size	514	546	577	575	509	545	577	575
b. NLSY97								
Family Income Quartile 2	0.0391	0.0831	0.0201	0.0073	-0.0999	0.1142	0.0611	0.0994
	(0.0468)	(0.0298)	(0.0246)	(0.0096)	(0.0462)	(0.0557)	(0.0540)	(0.0414)
Family Income Quartile 3	0.0577	0.0377	0.0360	0.0072	0.1024	0.1555	0.0842	0.1068
	(0.0566)	(0.0310)	(0.0256)	(0.0094)	(0.0558)	(0.0580)	(0.0561)	(0.0404)
Family Income Quartile 4	0.1358	0.0848	0.0532	0.0107	0.2178	0.1817	0.1813	0.1368
	(0.0655)	(0.0329)	(0.0260)	(0.0096)	(0.0642)	(0.0614)	(0.0570)	(0.0414)
Test of no Income Effects (P-value)	0.2290	0.0145	0.1971	0.7366	<.0001	0.0171	0.0065	0.0123
Sample Size	544	627	666	707	550	627	667	709

Notes: All regressions control for gender, race/ethnicity, mother's education (HS graduate, college attendance), intact family during adolescence, number of siblings/children under 18, mother's age at child's birth, urban/metropolitan area during adolescence, and year of birth/age at outcome observation. Education measured as of ages 24-25 in NLSY79 and ages 20-24 in the NLSY97. Test of no Income Effects is an F-test (3 d.o.f.) that all three coefficients on family income are zero. Standard errors are in parentheses.

Table 5: Estimated Effects of Family Income on Educational Attainment by AFQT Quartile (NLSY79 and NLSY97)
Linear-in-Income Specifications

	High School Completion:		College Attendance:	
Effect of Family Income (in $10,000) for:	**NLSY79**	**NLSY97**	**NLSY79**	**NLSY97**
Full Sample	0.0064	0.0054	0.0085	0.0189
	(0.0029)	(0.0018)	(0.0036)	(0.0028)
AFQT Quartile 1	0.0205	0.0177	0.0148	0.0276
	(0.0098)	(0.0076)	(0.0083)	(0.0076)
AFQT Quartile 2	0.0099	0.0065	-0.0008	0.0228
	(0.0070)	(0.0035)	(0.0082)	(0.0065)
AFQT Quartile 3	-0.0011	0.0055	0.0119	0.0241
	(0.0045)	(0.0026)	(0.0079)	(0.0055)
AFQT Quartile 4	0.0004	0.0006	0.0112	0.0080
	(0.0019)	(0.0009)	(0.0049)	(0.0037)

Notes: Each cell of the table reflects the effect of family income on the education measure at the top within the sample of individuals denoted at the left--each cell is from a separate regression. Sample sizes for each regression are very similar to those reported in Tables 3 and 4. All regressions control for gender, race/ethnicity, mother's education (HS graduate, college attendance), intact family during adolescence, number of siblings/children under 18, mother's age at child's birth, urban/metropolitan area during adolescence, and year of birth/age at outcome observation. Education measured as of ages 24-25 in NLSY79 and ages 20-24 in the NLSY97. Standard errors are in parentheses.

Table 6: Estimated Effects of Family Income and Family Wealth on High School Completion and College Attendance (Ages 20-24, NLSY97)

	High School Completion:				College Attendance:			
	All	**All**	**Low Wealth**	**High Wealth**	**All**	**All**	**Low Wealth**	**High Wealth**
AFQT Quartile 2	0.1640	0.1658	0.2060	0.0909	0.2454	0.2423	0.2422	0.2440
	(0.0163)	(0.0168)	(0.0288)	(0.0174)	(0.0242)	(0.0255)	(0.0367)	(0.0375)
AFQT Quartile 3	0.1895	0.1889	0.2274	0.1150	0.4090	0.4037	0.3882	0.4050
	(0.0166)	(0.0171)	(0.0309)	(0.0171)	(0.0246)	(0.0261)	(0.0393)	(0.0367)
AFQT Quartile 4	0.2084	0.2122	0.3118	0.1170	0.5161	0.5136	0.5969	0.4833
	(0.0176)	(0.0180)	(0.0360)	(0.0171)	(0.0261)	(0.0274)	(0.0458)	(0.0368)
Family Wealth Quartile 2	0.0657	0.0373			0.0629	0.0422		
	(0.0167)	(0.0181)			(0.0248)	(0.0276)		
Family Wealth Quartile 3	0.0955	0.0669			0.1268	0.0973		
	(0.0170)	(0.0191)			(0.0253)	(0.0291)		
Family Wealth Quartile 4	0.1005	0.0818			0.2070	0.1709		
	(0.0188)	(0.0214)			(0.0279)	(0.0327)		
Family Income Quartile 2		0.0358	0.0347	0.0386		0.0248	0.0464	0.0072
		(0.0178)	(0.0263)	(0.0233)		(0.0271)	(0.0335)	(0.0502)
Family Income Quartile 3		0.0196	0.0447	0.0029		0.0793	0.0858	0.0859
		(0.0195)	(0.0335)	(0.0226)		(0.0298)	(0.0426)	(0.0487)
Family Income Quartile 4		0.0281	0.0265	0.0243		0.1058	0.0491	0.1355
		(0.0211)	(0.0469)	(0.0224)		(0.0322)	(0.0598)	(0.0484)
Test of no Wealth Effects (P-value)	<.0001	0.0010			<.0001	<.0001		
Test of no Income Effects (P-value)		0.2307	0.4737	0.0429		0.0038	0.2159	0.0001
Test of no Income and no Wealth Effects (P-value)		<.0001				<.0001		
Sample Size	2,500	2,247	983	1,264	2,510	2,256	988	1,268

Notes: All regressions control for gender, race (black, hispanic, white), mother's education (HS graduate, college attendance), intact family during adolescence, number of children under 18, mother's age at child's birth, metropolitan area during adolescence, and age at outcome observation. Outcomes are measured in 2003 (or, in 2002 if missing in 2003) and family income is the family income in 1997. Low wealth sample includes those in the bottom two quartiles while high wealth includes those in the top two quartiles. Test of no Income Effects is an F-test (3 d.o.f.) that all three coefficients on family income are zero. Test of no Wealth Effects is an F-test (3 d.o.f.) that all three coefficients on family wealth are zero. Test of no Income and no Wealth Effects is an F-test (6 d.o.f.) that all three coefficients on family income and all three coefficients on wealth are zero. Standard errors are in parentheses.

Table A1: Robustness Checks for College Attendence Regressions (NLSY79)

	(i) Control for Father's Education	(ii) High School Graduate Sample	(iii) Mother Attended College Sample	(iv) Attendance Measured at Ages 20-21	(v) Dependent Variable: Completed at Least One Year of College
AFQT Quartile 2	0.1375	0.1212	0.0733	0.1156	0.1094
	(0.0274)	(0.0331)	(0.0738)	(0.0256)	(0.0259)
AFQT Quartile 3	0.3165	0.2836	0.2193	0.3093	0.3151
	(0.0290)	(0.0337)	(0.0714)	(0.0272)	(0.0274)
AFQT Quartile 4	0.5154	0.4518	0.3296	0.5477	0.5661
	(0.0309)	(0.0350)	(0.0699)	(0.0286)	(0.0290)
Family Income Quartile 2	-0.0080	-0.0160	0.1259	0.0150	0.0052
	(0.0274)	(0.0316)	(0.0602)	(0.0259)	(0.0261)
Family Income Quartile 3	0.0322	0.0198	0.0638	0.0224	-0.0064
	(0.0288)	(0.0326)	(0.0606)	(0.0272)	(0.0275)
Family Income Quartile 4	0.0444	0.0590	0.1298	0.0966	0.0606
	(0.0307)	(0.0341)	(0.0588)	(0.0288)	(0.0291)
Test of no Income Effects (P-value)	0.2033	0.0695	0.0532	0.0015	0.0332
Sample Size	2,107	1,816	444	2,312	2,212

Notes: All regressions control for gender, race/ethnicity, mother's education (HS graduate, college attendance), intact family during adolescence, number of siblings, mother's age at child's birth, urban area residence during adolescence, and year of birth. Education measured as of ages 24-25 except in column (iv). Test of no Income Effects is an F-test (3 d.o.f.) that all three coefficients on family income are zero. Standard errors are in parentheses.

Table A2: Robustness Checks for College Attendence Regressions (NLSY97)

	(i) Control for Father's Education	(ii) High School Graduate Sample	(iii) Mother Attended College Sample	(iv) Ages 22-24 Sample	(v) Dependent Variable: Completed at Least One Year of College
AFQT Quartile 2	0.2427	0.2132	0.2957	0.2468	0.1572
	(0.0243)	(0.0268)	(0.0372)	(0.0365)	(0.0254)
AFQT Quartile 3	0.3890	0.3519	0.4671	0.3846	0.3517
	(0.0248)	(0.0270)	(0.0363)	(0.0372)	(0.0258)
AFQT Quartile 4	0.5085	0.4607	0.5647	0.5301	0.5029
	(0.0258)	(0.0277)	(0.0352)	(0.0385)	(0.0268)
Family Income Quartile 2	0.0372	0.0262	0.0763	0.0289	0.0263
	(0.0246)	(0.0266)	(0.0369)	(0.0366)	(0.0256)
Family Income Quartile 3	0.0928	0.0988	0.1352	0.1226	0.0748
	(0.0262)	(0.0278)	(0.0366)	(0.0387)	(0.0271)
Family Income Quartile 4	0.1441	0.1425	0.1918	0.1283	0.1600
	(0.0275)	(0.0288)	(0.0371)	(0.0411)	(0.0283)
Test of no Income Effects (P-value)	<.0001	<.0001	<.0001	0.0017	<.0001
Sample Size	2,553	2,324	1,240	1,160	2,544

Notes: All regressions control for gender, race/ethnicity, mother's education (HS graduate, college attendance), intact family during adolescence, number of children under 18, mother's age at child's birth, metropolitan area residence during adolescence, and age at outcome observation. Education measured in 2003 for individuals ages 20-24, except in column (iv) when only those ages 22-24 are included. Test of no Income Effects is an F-test (3 d.o.f.) that all three coefficients on family income are zero. Standard errors are in parentheses.