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 very similar 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. Cognitive ability plays an important role in determining educational outcomes for both NLSY cohorts. The effects of ability on high school completion decline for the later cohort, while the effects of ability on college attendance are fairly stable over time.

We explore a number of potential explanations for the family income - college attendance relationship and the extent to which they can explain the observed changes across cohorts separated by two decades. Most previous studies of the relationship between schooling, ability, and family income have focused on the potential role played by borrowing constraints in determining college attendance.

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These studies have generally recognized the strong correlation between cognitive ability and family income, so some 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 largely 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 (in the High School and Beyond Survey, HSB, and National Education Longitudinal Study of 1992, NELS) 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 (in the NLSY79) after controlling for Armed Forces Qualifying Test (AFQT) scores.[1] Differences in educational attainment by measured cognitive achievement are generally quite large (even after controlling for family income) and attributed to differential financial returns by ability.

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 (2007) suggests 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, many believe that schooling contains a consumption value for 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

[1] 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.)

demand for skilled labor and a slow rise in the supply of skill to the labor market.[2] Kane (2007) suggests that the recent rise in tuition costs, decline in Pell Grant offerings, and gradual erosion of real student loan borrowing limits in the U.S. may be responsible for the modest response in aggregate college attendance rates despite the sharp rise in its economic returns. These dramatic economic and policy changes offer an opportunity to understand what generates 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

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

reduce labor supply while in school.

It is noteworthy that all of the aforementioned studies arguing that borrowing constraints have little impact on college-going (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 (2007) 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 or is there some other explanation? 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 attendance – measured at older ages – after controlling for ability and family background), but find a substantially more important role for income in affecting college attendance in the NLSY97. Interestingly, we find moderate effects of family income on high school completion rates in both surveys, but the effects are fairly stable over time.

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. 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 family income when youth are ages 16-17, excluding those not living with their parents at these ages.[5] This limits our sample to the younger cohorts of the NLSY79 born in 1961-1964. The NLSY97 analysis is based on family income and family net wealth in 1997, dropping individuals not living with their parents that year.[6] Since we analyze schooling outcomes at ages 21 (and older), family income and wealth are reported when the youth are ages 14-17 in our NLSY97 sample. For comparability with our NLSY79 analysis, we categorize youth in the NLSY97 into income or wealth quartiles based on the random sample of persons ages 16 or 17 in 1997. In both NLSY samples, we denominate income in year 2000 dollars using the CPI for all urban consumers.

Our main analysis focuses on high school completion and college attendance as of age 21.[7] Since the oldest individuals in the NLSY97 recently turned 24 in the 2004 wave of data, we are forced to focus on a slightly younger age group.[8] 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.)[9] 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 net family wealth for the 1997 cohort).

We also examine the effects of cognitive ability and family income on a few other measures of schooling attainment and enrollment as well as measures of work during the academic year. First, we

[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 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] Respondents are assumed to have completed high school if they completed 12 or more years of school. As discussed further below, some of these youth received a GED rather than high school diploma. Individuals are considered to have attended college if they attended 13 or more years of school. Schooling attainment at age 22 is used if it is missing or unavailable at age 21 (fewer than 10% of all respondents in both surveys).

[8] A very small number were 25 at the time of the 2004 wave of the NLSY97.

[9] 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.

examine college attendance measured at different ages to determine whether the roles of ability and family income fade or grow with age. Fade-out effects are consistent with college delay for certain subgroups. Second, we study ability - family income - schooling patterns for completion of at least one, two or more, and four or more years of college. We examine the latter two outcomes at both ages 21 and 23. Third, we examine the effects of ability and family income on current enrollment in any college at age 20 (results are similar for ages 19 and 21) as well as enrollment in a four-year college at age 20. Finally, we examine how ability and family income affect work decisions (fraction of weeks worked and average hours worked per week) during the academic year among students enrolled in college at age 20. The academic year is defined as the last 16 weeks of a calendar year and the first 16 weeks of the following year.[10]

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, those who completed high school or more, and those who completed at least one year of college.[11] 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 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 both samples.

Descriptive statistics for these variables are provided in Table 1 for both cohorts.[12] Comparisons across cohorts reveal that schooling attainment is higher for the 1997 cohort. We observe the same phenomenon for 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

[10]Individuals missing work data on more than 4 of these 32 weeks are dropped from the analysis.

[11]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.

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

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 is greater dispersion in the NLSY97. At the high end of the income distribution, this partially reflects a higher truncation value for family income in the 1997 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 in determining educational attainment in both cohorts. Figures 1a and 1b reveal that nearly everyone in the highest ability quartile completes high school from both cohorts; however, completion rates are substantially lower for those in the lowest ability quartile, especially those raised in low-income families. Ability appears to have become a 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 completion 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, the role of ability appears to have 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.[13] Specifically, we regress educational outcomes on family income quartiles (or 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).[14] Because we examine the full random samples rather than just white males, we also control for race, hispanic ethnicity, and gender. The main difference between our analyses is the age of our samples. Carneiro and Heckman (2002) analyze schooling outcomes at late ages (late 20s), while our main results measure educational attainment as of age 21 due to the youth of the NLSY97 sample. As we discuss further below, using attendance measured at age 21 rather than at older ages implies a slightly larger role of family income than is estimated by Carneiro and Heckman (2002). The effect of family income on college attendance appears to fade out with age in the NLSY79. Our NLSY79 results measuring college attendance as of age 24 essentially replicate the findings of Carneiro and Heckman (2002) in that there is little effect of family income.

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 significantly

[13]Elwood and Kane (2000) also employ a similar strategy in examining the HSB Survey of high school classes of 1980 and 1982 and the NELS study of the graduating high school class of 1992; although they do not have consistent test scores (i.e. ability measures) across the two surveys.

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

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 15-20 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 11 to 3 percentage points across cohorts. Family income plays a modest role in determining high school completion with little change across cohorts. The difference in completion rates between the lowest and highest ability quartiles is 7-8 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.[15]

Turning to the college attendance specifications in Table 3, we observe more noticeable changes across the cohorts. Minority - non-hispanic white differences are sizeable but declining.[16] 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 much smaller but still significant 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 13 percentage points for the NLSY79 youth and by 24 percentage points for

[15]Family income has become slightly more important for high school completion when individuals with a GED are considered not to have finished high school. In this case, the highest-lowest income quartile differences rise slightly for the NLSY79 (to 0.9) and increase more for the NLSY97 (to 0.12).

[16]Black - non-hispanic white and hispanic - non-hispanic white differences are roughly 20 percentage points in the NLSY79, while the black - non-hispanic white difference falls to around 15 percentage points and the hispanic - non-hispanic white difference drops further to less than 5 percentage points for the more recent NLSY97 cohort.

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. The difference in attendance between the most and least able has changed very little over time.

While ability is equally important for both cohorts, family income plays a substantially more important role in determining college attendance for the NLSY97 youth as seen from columns 3 and 4 of Table 3. Our estimates suggest modest effects of family income on attendance for the NLSY79 sample (a 9 percentage point difference between the highest and lowest income quartiles), slightly larger than reported in Carneiro and Heckman (2002). As can be seen from Appendix Tables A1 and A2, our larger NLSY79 estimates are due to the fact that we measure attendance as of age 21 rather than at older ages as in Carneiro and Heckman (2002). When we measure attendance as of age 24, attendance differences between the highest and lowest income quartiles shrink to 6.7 percentage points, consistent with their results. While we reject the hypothesis that income has no effect on attendance at ages 20-23, we cannot reject zero income effects on attendance when measured at age 24 (p-value is 0.06). Altogether, these results suggest that NLSY79 youth from lower family income quartiles were more likely to delay college a few years (by about 3 percentage points) than their higher income counterparts, but final attendance rates are largely invariant to family income. The NLSY97 results imply substantial effects of family income on college attendance measured at all ages from 20-23, with little evidence of any decline in attendance gaps with age. (However, the sample size declines substantially when we look at older ages, making it difficult to precisely estimate the effects of family income on college delay for the 1997 cohort.) Our main specification in Table 3, measuring attendance as of age 21, suggests that college attendance rates are 16 percentage points higher for NLSY97 youth from the highest income quartile relative to the lowest – nearly twice the NLSY79 difference. Regardless of the age at which we measure college attendance, differences by family income have risen substantially across cohorts.

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 moderate effects on high school completion for the lowest able ability types and negligible effects for the higher ability quartiles. Nearly everyone from the highest ability quartile completes high school regardless of family income. Estimated effects of income are quite similar across cohorts. The only high school completion case in which we reject (at the 5% level) that there are zero income effects is for AFQT quartile 2 in the NLSY97.

Results for college attendance are quite different, in line with the patterns shown in Figures 2a and 2b. Among NLSY79 youth, family income only appears to matter for those in the top two ability quartiles. Among the more able, moving from the lowest to second family income quartile raises college attendance rates by nearly 10 percentage points. Moving from the second to the top income quartile raises attendance rates by an additional 7-9 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 actually declined when compared with the NLSY79 cohort. Family income effects remained stable across cohorts for quartile 3. For the lowest two ability quartiles, the effects of income are more than twice as large for the NLSY97 cohort. Among all but the top ability quartile, moving from the lowest to highest family income quartile raises college attendance rates by 15-30 percentage points. F-tests strongly reject the hypothesis of no family income effects for all ability groups in the NLSY97.

The findings related to family income in Tables 3 and 4 are not driven by the slight widening of the family income distribution across NLSY cohorts. 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 most able. 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 only 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 A3 and A4 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) of Tables A3 and A4 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.[17] 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

[17]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.

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 24 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.[18] 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 entire role played by family income.

Most of the gains from college come from completion and not simple attendance (see Heckman, Lochner, and Todd 2007). While our NLSY97 cohort is still fairly young, it is possible to examine whether income and ability have similar effects on completion of at least two or at least four years of

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

college. Table 7 reports estimates from specifications similar to Table 3, using completion of two or more years of college and four or more years of college as the dependent variables instead of college attendance. We explore the effects of ability and income on the first measure at both ages 21 and 23 and the latter at age 23 only. For reference, 29% (32.4%) of the NLSY79 sample had completed at least two years of college by age 21 (age 23), while 41% (45%) of the NLSY97 had completed at least two years by that age. Only 19% of the NLSY79 respondents and 27% of the NLSY97 respondents had completed four or more years of college by age 23; however, many still remain in school at that age. As is clear from the table, the main conclusions from our analysis of attendance carry over here. Ability has strong effects on completion of at least two or four year of college (smaller effects on the latter). Family income plays little role in determining completion of two or four years of college for NLSY79 youth (differences between the highest and lowest income quartiles range from 3-6 percentage points), but it is important for the NLSY97 youth. Estimated effects on completion of two years in the NLSY97 are comparable to the estimated effects on attendance (a 15 percentage point difference between the highest and lowest income quartiles), while the effect on completion of four years is slightly smaller at 10 percentage points.

Next, we explore similar specifications for current enrollment in college at age 20. This offers an alternative measure of college attendance and also allows us to see whether ability and income affect enrollment in four-year vs. two-year colleges. 23% were enrolled in a four-year institution. Among NLSY97 youth, 44% were enrolled in college and 33% in four-year colleges. Approximately 33% of NLSY79 youth were enrolled in college at age 20. Table 8 reports results for both the NLSY79 and NLSY97 using current enrollment status at the time of the interview when youth were age 20.[19] As we see from the table, the estimated effects of ability and family income on current enrollment in any college at age 20 are similar to the estimated effects on attendance (at any time) as of age 21 reported in Table 3. Estimated effects of income on enrollment in a four-year college are slightly smaller for the NLSY79 and slightly larger for the NLSY97. The highest - lowest income differential grew by about 7.5 percentage points for enrollment in a four-year college and by about 6 percentage points for enrollment in any college. Conditioning on enrollment in any college at age 20, we find that more

[19] We explored an alternative measure of enrollment in the NLSY97 that examined whether a youth was enrolled during any part of the academic year when a youth was age 20 (age as of December 31 that year). The results were very similar to those reported here.

able youth attend a four-year institution in both cohorts. There is little difference by family income in the NSLY79; however, enrolled students from higher income families are more likely to be enrolled in a four-year college. Figures 3a and 3b graphically display enrollment rates in four-year institutions conditional on enrollment in any college by ability and family income quartiles.

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.[20] 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.

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.

[20] 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.

While enrolled in college, students must pay tuition $T(W)$, which is assumed to be increasing in initial resources (specifically, $T(W) \geq 0$ 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. 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 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 $F(\xi)$. Individuals may borrow d (savings reflects $d < 0$) to smooth consumption over time earning a gross interest rate of R. We begin our analysis assuming there are no constraints on borrowing, then discuss how the addition of borrowing constraints affects the model's implications for the ability - family income/wealth - college attendance relationship.

No Borrowing Constraints

When there are no constraints on borrowing, the value function for schooling level s is

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

subject to

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

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 $1 - F(v_0(W, \theta) - v_1(W, \theta))$.

To simplify the analysis, 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

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

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

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

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

Now, consider the value associated with college attendance. The optimal amount of consumption each period is

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

yielding a value of college, $v_1(W,\theta)$, equal to

$$v_1^u(W,\theta) = (1+\beta)u\left(\frac{R(W - T(W)) + y_1(\theta)}{1+R}\right). \tag{2}$$

This is increasing in college earnings, ability, and initial resources. The 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.[21]

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

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

We assume that this earnings gain is increasing in ability, so $\frac{\partial G}{\partial \theta} = y_1'(\theta) - (1+R)y_0'(\theta) > 0$; otherwise, attendance rates will tend to be decreasing in ability (a pattern inconsistent with both NLSY cohorts). This assumption further implies that there is a unique $\theta = \bar{\theta}(W)$ for all W that satisfies $G(\theta, W) = 0$. 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

[21] We use the 'u' superscript to denote unconstrained optimal values and choices, since they will also play a role in the model with borrowing constraints.

tuition). Holding initial resources constant, more able youth gain more from college; holding ability constant, those with lower initial resources gain more.

The effect of resources and ability on attendance rates depends on how marginal 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. Changes in attendance rates for any (W,θ) type will depend on how $\bar{\xi}$ is affected as well as the density of college tastes at $\bar{\xi}$. With this in mind, we now analyze what this simple model predicts for the ability - initial resources - schooling relationship and how that relationship changes in response to economic or policy changes?

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

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

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). In the absence of binding constraints, consumption levels depend only on lifetime earnings. College consumption will be greater than non-college consumption when $G(\theta, W) > 0$ or, equivalently, $\theta > \bar{\theta}(W)$; otherwise, non-college consumption will be higher. Among those with positive net financial gains, the marginal person must dislike college (i.e. $\xi < 0$). He would be willing to pay money to avoid college and would only attend because it provides financial benefits and greater lifetime consumption opportunities. An increase in family resources would make him more willing to forego the financial gains to avoid the 'distaste' of college. This implies a *negative* relationship between family resources and attendance even if $T'(W) = 0$. When tuition is increasing in family resources (i.e. $T'(W) > 0$), there is an additional price disincentive associated with higher family resources. In the absence of borrowing constraints, both wealth and price effects imply an unambiguously *negative* family resource - college attendance relationship for everyone with a positive financial gain from college.

Among less able youth with a negative financial gain to college, the marginal person must enjoy college (i.e. $\xi > 0$) in order to be willing to 'pay' for it. An increase in family resources makes

these youth more willing to pay for the intrinsic benefits of college, which tends to encourage their attendance; however, the tuition 'tax' on family resources still serves to discourage attendance as resources increase. 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 for the least able when tuition prices are relatively unresponsive to resources.

When tuition and financial aid are tightly linked to resources (i.e. $T'(W)$ is large), resources are more likely to be negatively related to attendance. 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 the most negative (or least positive) effects on attendance rates among middle income/wealth families, since tuition prices respond most for them.

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

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

For lower ability youth ($\theta \leq \bar{\theta}(W)$), ability unambiguously increases attendance rates, since $\frac{\partial G}{\partial \theta} > 0$ 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 $\frac{\partial G}{\partial \theta}$ is small enough. Empirically, ability always appears to be positively related to attendance, suggesting that the substitution effects of ability on the financial returns to college dominates any wealth effects acting through the marginal utility of consumption.

To understand what might have changed ability - family income - college attendance patterns over time, it is useful to analyze how the returns to skill and tuition/financial aid policies 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.

Changes in the structure of earnings have been dramatic in the past few decades, with both the returns to ability and education rising significantly since the early 1980s. Suppose $y_1(\theta) = \pi_1 h_1(\theta)$, where π_1 reflects the market price of skill and $h_1(\theta)$ reflects the skill associated with college attendance. 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.[22] Not surprisingly, an increase in returns to skill will increase college attendance rates. In general, the impacts on the ability - attendance relationship are ambiguous; however, increasing returns to skill will tend to reduce the marginal value of θ for lower W college students while raising the value for higher W students. Thus, it should tend to reduce the role of ability among the wealthy and increase it among the poor.[23] Because the marginal utility of consumption is decreasing in family resources, the effects of an increasing skill premium will be greater on more disadvantaged youth thereby weakening any positive relationship (or strengthening a negative relationship) between resources and attendance. This theoretical prediction is strongly at odds with the empirical evidence, which suggests that the effects of family income have become significantly more positive over time.

Between 1980 and 2000, the sum of tuition, fees, room, and board roughly doubled at four-year public institutions (College Board 2005). This should increase student borrowing and discourage attendance for all types of students. To consider how changes in the level of tuition affect income - ability - attendance patterns, suppose $T(W) = T$ is independent of resources. The negative effects of tuition on attendance will be greater for the least able and those with lower family resources, since they have the greatest marginal utility of wealth. Because tuition effects on attendance are monotonically declining in family resources for all ability types, an increase in tuition should make the resource - attendance relationship more positive.

In general, $T(W)$ is an increasing function of resources. 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. Interestingly, the financial aid formula employed by the federal government and most

[22] Decreases in the earnings associated with non-college would produce similar effects to those discussed here.

[23] See the Appendix for the mathematical derivation of all comparative static results discussed in the text.

colleges and universities has changed little since the early 1980s.[24] Consistent with the stability in official aid formulae, Dick, Edlin, and Emch (2003) estimate similar implicit 'financial aid taxes' in 1986-87 and 1995-96 using data from National Postsecondary Aid Surveys.

If college raises lifetime earnings for most youth, it is difficult to reconcile the data with the theoretical predictions of this standard schooling choice model.[25] Most significantly, the theory predicts a negative relationship between family resources and college attendance for all youth who earn a positive financial return. By contrast, the NLSY79 reveal a positive family income - attendance relationship for the most able, who should have the highest financial return, and little effect of income for other ability types. The NLSY97 reveals a strong positive relationship for all ability types. Increases in the financial return to college should strengthen the negative relationship between family resources and attendance, but the data suggest that the opposite has occurred. So, even if the financial gains from college are negative for many youth, the rising returns to college should have weakened any positive family income - attendance relationship. The model does, however, predict that a rise in tuition will create a more positive (less negative) effect of resources on attendance. Thus, the rising tuition levels over the last few decades may have played some role in the rising importance of family income. This will also be true when we introduce borrowing constraints, as we do next.

Adding Borrowing Constraints

Now allow for the possibility that some youth may be borrowing constrained. Suppose that individuals can borrow no more than a specified borrowing limit, $\bar{d}$. Because youth want to save if they do not attend college (due to consumption smoothing and the lack of earnings growth), non-college decisions are unaffected by the introduction of a borrowing limit.[26] Thus, the value of non-college is defined above by equation (1).

[24] 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.

[25] Heckman, Lochner, and Todd (2007) estimate high internal rates of return to college in recent decades, suggesting that the financial returns are positive for reasonable interest rates. They further summarize findings from a number of recent studies (e.g. Cunha, Heckman, and Navarro 2005, and Cunha and Heckman 2006) that account for heterogeneity in returns and psychic costs. These findings typically suggest high financial returns to college along with high 'psychic costs' for marginal students.

[26] If individuals prefer declining consumption profiles or experience wage growth, it is possible that some non-college youth may find borrowing limits binding. In this case, constraints on college attendees would be even more severe.

College attendees will be borrowing constrained if and only if $d_1^u > \bar{d}$, or when

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

The cutoff ability level, θ^c, is increasing in both $\bar{d}$ and W. This implies that youth with low resources and high ability will be constrained if they attend college. Constrained students 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.

Youth with ability below θ^c will be unconstrained if they choose to attend college, so their value function is defined by equation (2) above. Altogether,

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

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.

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 and wealthiest). The presence of borrowing constraints implies a more positive effect of family resources among the more able poor who find the constraints binding. Since

$$\frac{\partial v_1^c}{\partial W} = (1 - T'(W))u'(c_1^c)$$

and $c_1^c < \bar{c}^1$, initial resources have a more 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.

As noted above, the S-shape of the $T(W)$ function implies bigger negative price effects for youth from middle income families. 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 population where financial gains from college are positive. Empirically, both the NLSY79 and NLSY97 reveal 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. Borrowing constraints offer little explanation for the strong positive income and wealth effects at the high end of the income/wealth distribution. However, it is possible that high tuition prices for recent cohorts imply a negative financial return to college for the most wealthy paying full tuition levels. As noted above, this can generate a positive income - attendance relationship.[27] The fact that tuition rose substantially more among private four-year colleges (where wealthier students tend to go) than public two- and four-year colleges (College Board 2005) makes this an interesting possibility. In this case, the positive effects of income on attendance observed in the NLSY97 would reflect a combination of borrowing constraints acting on the lower income/higher ability youth and a positive consumption value of schooling for marginal youth from wealthier families.

The marginal value of ability for constrained college attendees is

$$\frac{\partial v_1^c(W,\theta)}{\partial \theta} = \beta u'(c_2^c) y_1'(\theta) = (1+\beta) u'(c_2^c) \left[\frac{y_1'(\theta)}{1+R} \right],$$

which is less than $\frac{\partial v_1^u(W,\theta)}{\partial \theta}$ for any values of (W,θ) for which the constraints bind. Thus, ability has smaller (and, perhaps, negative) effects on attendance rates if individuals are borrowing constrained while attending college. 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.

[27] It is also possible that the 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.

An increasing college skill premium, π_1, raises attendance rates among constrained and unconstrained youth, but it will tend to reduce θ^c thereby raising the population of youth that are constrained. Among youth who remain unconstrained, the effects on attendance will be greater on those that are more economically disadvantaged. Thus, among lower ability or higher resource youth, a rising skill premium should weaken any positive relationship between resources and attendance. The effects of an increase in π_1 should be independent of initial resource levels for more able and less wealthy youth that are constrained, since their post-school consumption is independent of W. The family resource - attendance relationship for constrained borrowers is, therefore, unaffected by a rise in the college wage return. Overall, the model predicts that the rising college wage premium should have increased attendance rates and weakened any positive family income - attendance relationship. The former prediction is consistent with the data, while the latter is not.

Increases in tuition levels will reduce θ^c, raising the share of the population that is borrowing constrained. As noted above, the effects of tuition on attendance among unconstrained youth 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 be even larger for any particular individual that is constrained, since he faces a higher marginal utility of wealth while in college. Interestingly, tuition effects will not vary by ability among constrained borrowers, since ability does not affect their college consumption levels, which determines the effects of tuition on constrained students. 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 (constrained and unconstrained). Thus, an increase in tuition will make the resource - attendance relationship more positive, with the largest effects on those that are or become constrained. As discussed above, the predicted responses to rising tuition levels are broadly consistent with the changes in the role of income across the NLSY79 and NLSY97, except that higher tuition alone should reduce attendance rather than raise it.

While borrowing limits have actually risen slightly in nominal terms since the early 1980s, their real value has declined substantially since that time.[28] The near doubling in tuition, fees, room, and board

[28]Prior to 1986, dependent students were able to borrow up to $2,500 per year in Stafford loans. Beginning in the 1986-87 year, Stafford loan limits for first- and second-year dependent students were raised to $2,625 while limits for third- to fifth-year students were raised to $3,500. In 1992, the loan limit for second-year dependent students rose further to $3,500, while loan limits for third- to fifth-year students rose to $5,500.

charges (in real terms) at four-year public institutions between 1980 and 2000 (College Board 2005) is further cause for concern that the real value of borrowing opportunities has shrunk considerably.

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. 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 than among those who are unconstrained. To the extent that lowering borrowing limits causes more youth to become constrained, it should strengthen the relationship between family resources and attendance. In particular, 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 should lower student borrowing amounts among constrained college-goers.

Comparing the NLSY79 and NLSY97 cohorts, attendance rates increase rather than decrease, a pattern inconsistent with reduced borrowing opportunities. However, the changes in the role of ability and family income are more consistent with the model's predicted responses to reduced borrowing opportunities. 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 they may even constrain low ability youth in the later cohort (see Tables 4 and 5).

None of these factors, by itself, can explain the changing patterns in attendance by ability and

family income/wealth, but some combination of rising tuition, declining borrowing limits, and rising returns to skill may have the potential for generating the patterns we observe.

5.2 Some Additional Evidence (Incomplete)

Discuss Tables 9 and 10, Figures 4 and 5–evidence on work during the academic year. Main conclusion: family income does not have very large effects on total weeks worked or hours worked per week during the academic year (last 16 weeks of a year and first 16 weeks of the next year) among students enrolled in college at age 20. Largest effects are for hours per week among the most able in the NLSY97–for them, an extra $10,000 in family income reduces hours per week by about 0.6.

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).[29] 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 (although not high school completion rates) for recent students. We also document a large positive role of family income for youth in the top half of the family wealth distribution, which is difficult to attribute to borrowing constraints. For these youth, a strong positive consumption value of college (at the margin) is necessary to explain the positive income - attendance pattern. Given the policy importance of distinguishing between borrowing constraints and other factors, additional evidence on this question is certainly warranted. The documented rise in returns to ability in the labor market has had relatively little impact on the role played by ability in determining educational outcomes.

[29] See, e.g., Cunha *et al.* (2007).

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Appendix: Comparative Statics Results for the Model

This appendix shows how changes in college skill prices, tuition levels, and borrowing limits affect the value functions (non-college, unconstrained college, and constrained college) and the marginal value of wealth and ability for the different schooling outcomes.

First, consider changes in π_1, where $y_1(\theta) = \pi_1 h_1(\theta)$. This will clearly have no effect on the value of non-college. An increase in π_1 raises the value of college for both constrained and unconstrained youth; although, the effect is smaller on the value of college for constrained youth:

$$\begin{aligned} \frac{\partial v_1^u}{\partial \pi_1} &= \beta u'(\bar{c}^1) h_1(\theta) > 0 \\ \frac{\partial v_1^c}{\partial \pi_1} &= \beta u'(c_2^c) h_1(\theta) > 0. \end{aligned}$$

Because $c_2^c > \bar{c}^1$ for any (W, θ) type that is constrained, $\frac{\partial v_1^c}{\partial \pi_1} < \frac{\partial v_1^u}{\partial \pi_1}$. An increase in π_1 has no effect on the marginal value of W for constrained students, but it lowers the marginal value of W for unconstrained college students:

$$\frac{\partial^2 v_1^u}{\partial \pi_1 \partial W} = (1 - T'(W)) u''(\bar{c}^1) h_1(\theta)/(1+R) \leq 0.$$

The effects of π_1 on the marginal value of ability for both constrained and unconstrained college attendees are ambiguous:

$$\begin{aligned} \frac{\partial^2 v_1^u}{\partial \pi_1 \partial \theta} &= \beta h_1'(\theta) \left[u''(\bar{c}_1) y_1(\theta)/(1+R) + u'(\bar{c}_1) \right] \\ \frac{\partial^2 v_1^c}{\partial \pi_1 \partial \theta} &= \beta h_1'(\theta) \left[u''(c_2^c) y_1(\theta) + u'(c_2^c) \right] \end{aligned}$$

Notice that $\frac{\partial^2 v_1^u}{\partial \pi_1 \partial \theta} > 0$ if and only if the intertemporal elasticity of substitution for consumption is greater than the share of total discounted lifetime wealth that comes from post-college earning:

$$IES = -\frac{u'(\bar{c}^1)}{u''(\bar{c}^1)\bar{c}^1} > \frac{R^{-1} y_1(\theta)}{W - T(W) + R^{-1} y_1(\theta)}.$$

Among constrained borrowers, $\frac{\partial^2 v_1^c}{\partial \pi_1 \partial \theta} > 0$ if and only if

$$IES = -\frac{u'(c_2^c)}{u''(c_2^c) c_2^c} > \frac{y_1(\theta)}{y_1(\theta) - R\bar{d}} > 1.$$

Since most estimates put the intertemporal elasticity below one (see Browning, Hansen, and Heckman 1999), it is likely that an increase in π_1 will reduce the marginal value of ability for all constrained

and many unconstrained college attendees. However, the marginal value of ability is likely to be increasing in π_1 for unconstrained borrowers with relatively high levels of family resources even when the intertemporal elasticity of substitution is less than one.

Now, consider the effect of changes in T when $T(W) = T$ is constant and independent of family resources. This will clearly have no effect on the value of non-college. Not surprisingly, increases in tuition will reduce the value of college with stronger negative effects on those that are constrained:

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

An increase in tuition raises the marginal value of wealth for constrained and unconstrained college-goers:

$$\begin{aligned} \frac{\partial^2 v_1^u}{\partial T \partial W} &= -u''(\bar{c}^1)R/(1+R) > 0 \\ \frac{\partial^2 v_1^c}{\partial T \partial W} &= -u''(c_1^c) > 0. \end{aligned}$$

An increase in the level of tuition has no effect on the marginal value of ability for constrained college-goers, but it raises the marginal value for those that are unconstrained:

$$\frac{\partial^2 v_1^u}{\partial T \partial \theta} = -u''(\bar{c}^1)y_1'(\theta)/(1+R) > 0.$$

Finally, consider changes in borrowing limits. Changes in $\bar{d}$ do not affect the value of non-college and unconstrained college attendees (unless a reduced limit causes them to become constrained). An increase in borrowing limits raises the value of college attendance, lowers the marginal value of family resources, and raises the marginal value of attendance for constrained youth:

$$\begin{aligned} \frac{\partial v_1^c}{\partial \bar{d}} &= u'(c_1^c) - u'(c_2^c) > 0 \\ \frac{\partial^2 v_1^c}{\partial \bar{d} \partial W} &= (1 - T'(W))u''(c_1^c) \leq 0 \\ \frac{\partial^2 v_1^c}{\partial \bar{d} \partial \theta} &= -u''(c_2^c)y_1'(\theta) > 0. \end{aligned}$$

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

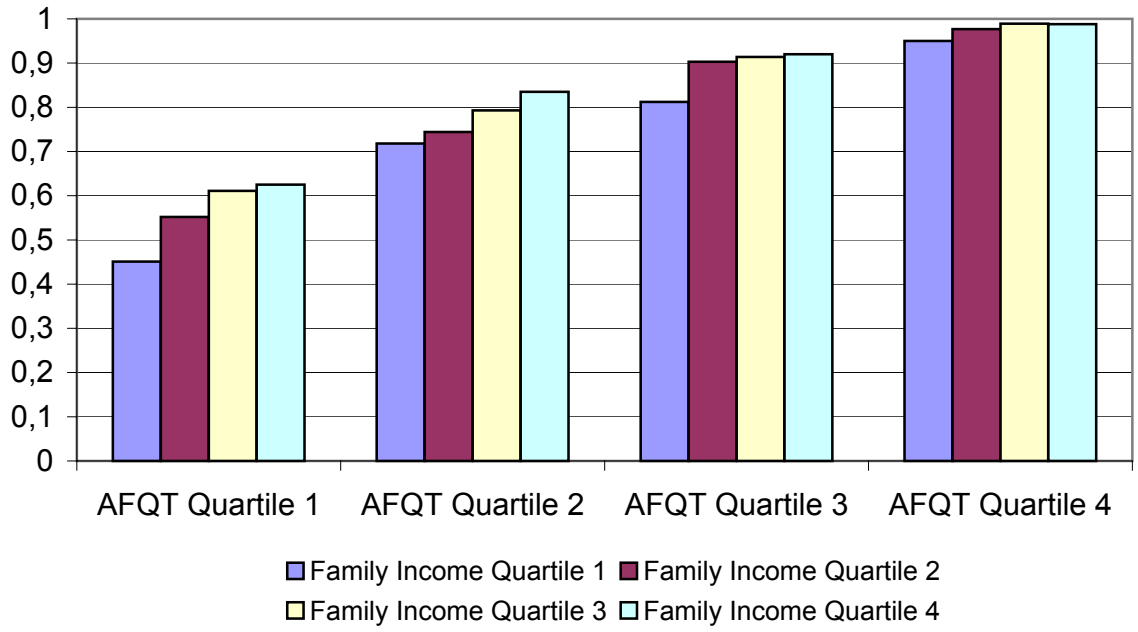

Figure 1b: High School Completion by AFQT and Family Income Quartiles (NLSY97)

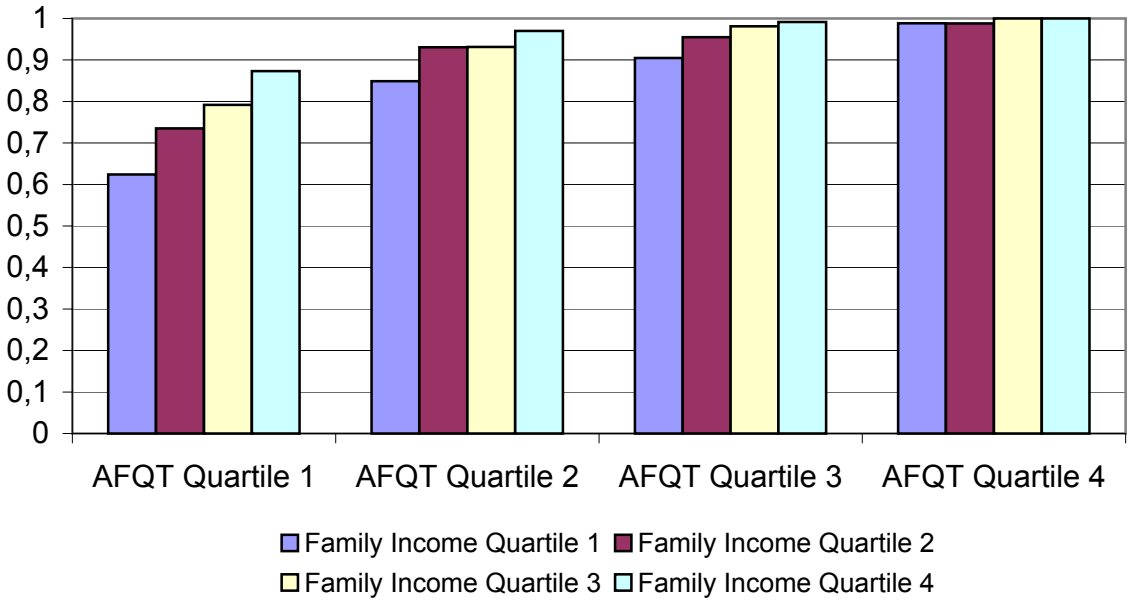

Figure 2a: College Attendance by AFQT and Family Income Quartiles (NLSY79)

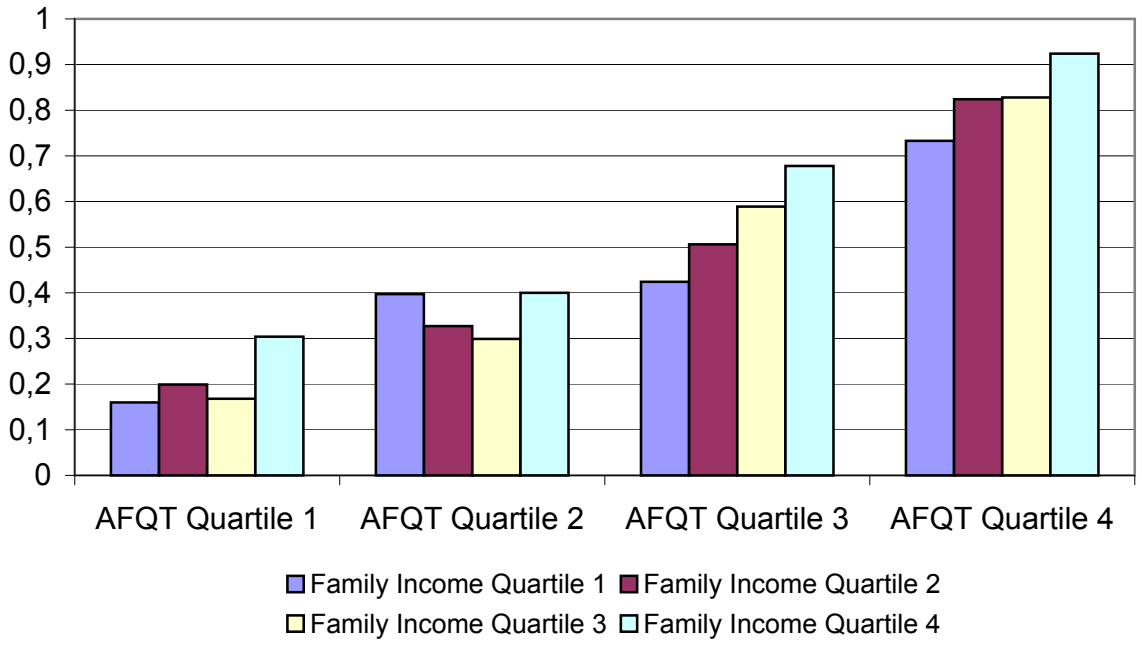

Figure 2b: College Attendance by AFQT and Family Income Quartiles (NLSY97)

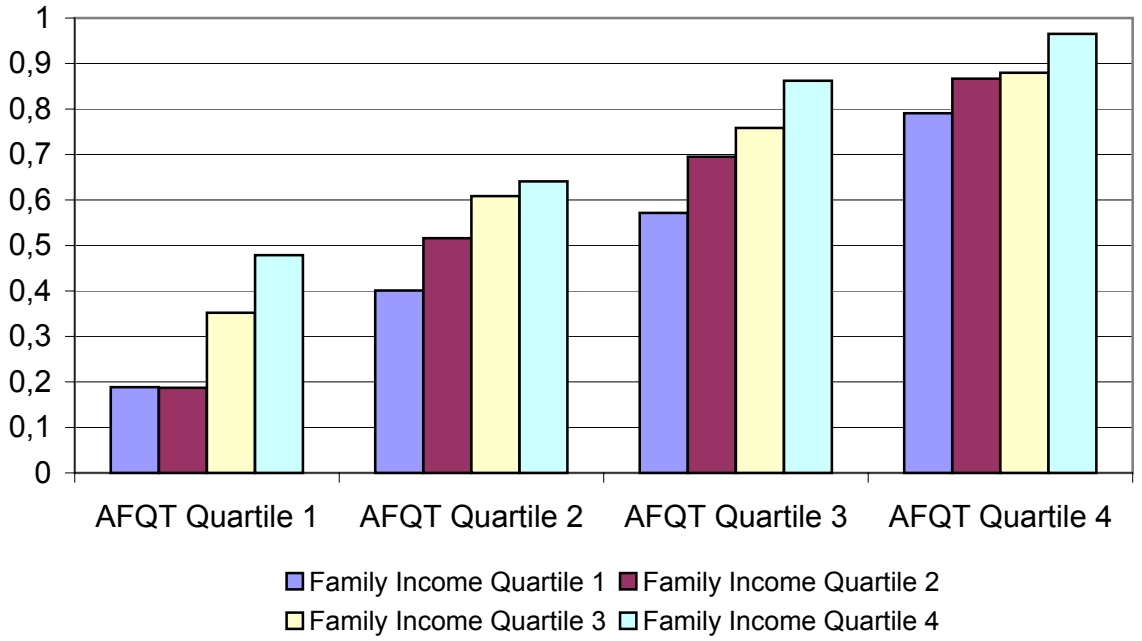

Figure 3a: Enrolled in 4-year College at Age 20, Conditional on Enrollment in any College (NLSY79)

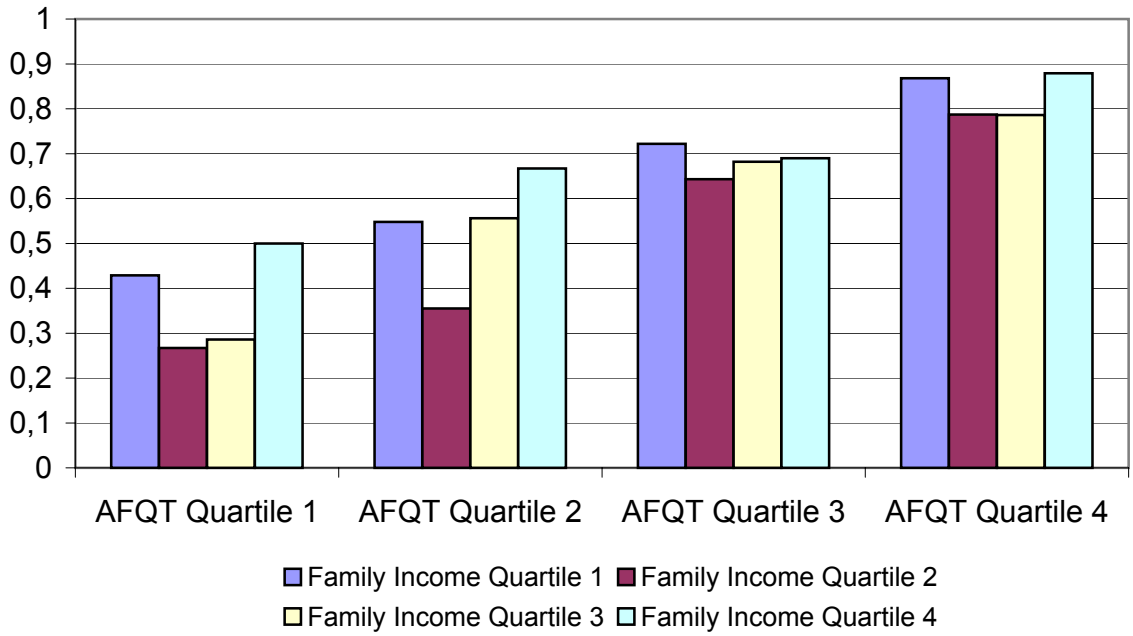

Figure 3b: Enrolled in 4-year College at Age 20, Conditional on Enrollment in any College (NLSY97)

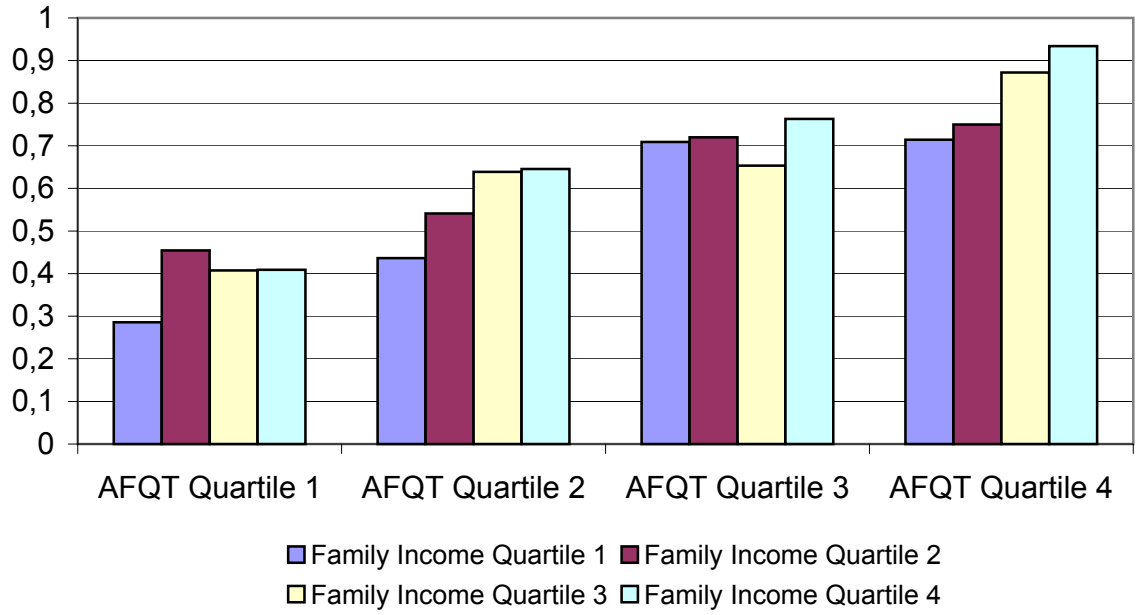

Figure 4a: Share of Weeks Worked during School Year by AFQT and Family Income Quartiles (NLSY79)

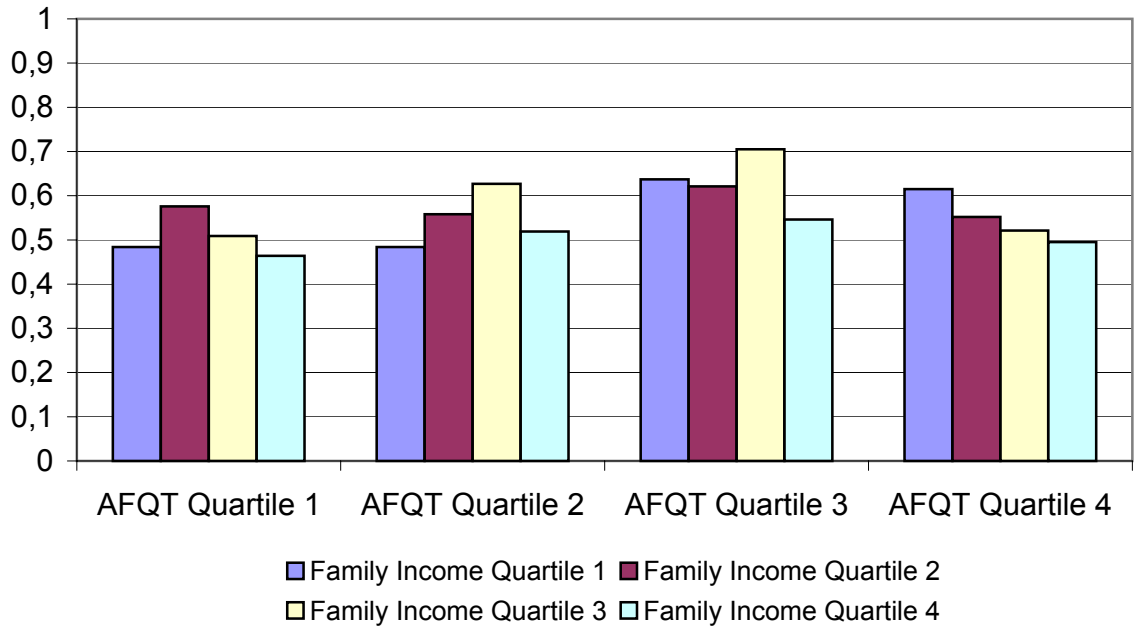

Figure 4b: Share of Weeks Worked during School Year by AFQT and Family Income Quartiles (NLSY97)

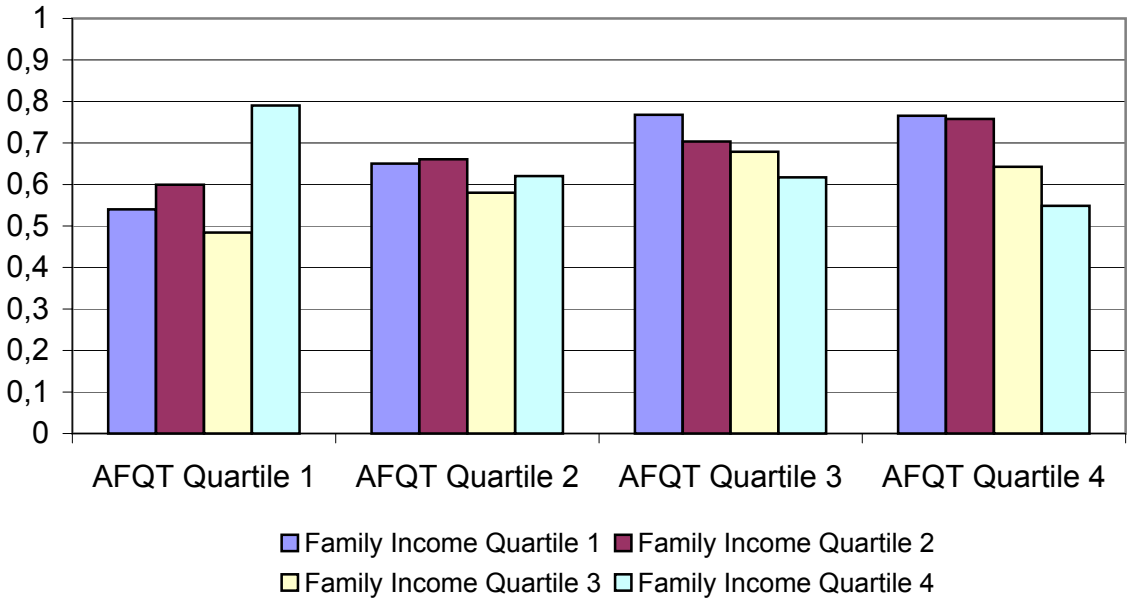

Figure 5a: Average Hours Worked per Week during School Year by AFQT and Family Income Quartiles (NLSY79)

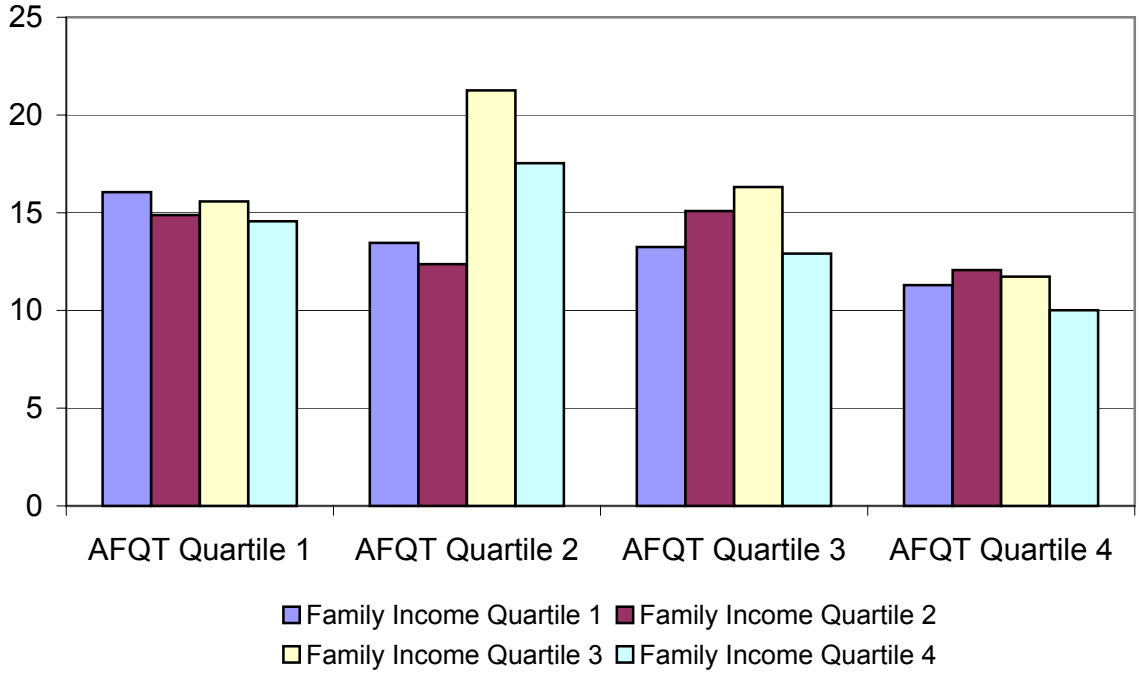

Figure 5b: Average Hours Worked per Week during School Year by AFQT and Family Income Quartiles (NLSY97)

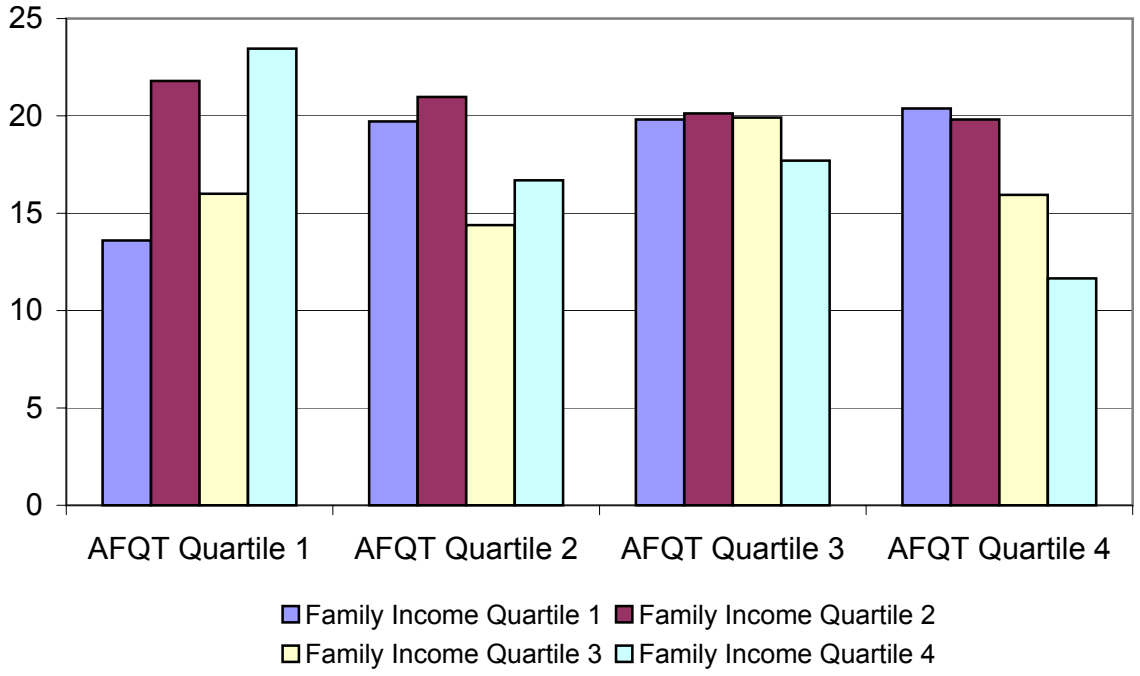

Table 1: Sample Descriptive Statistics

	NLSY79	NLSY97
Completed High School (age 21)	0,792	0,905
	(0,406)	(0,294)
Attended College (age 21)	0,493	0,622
	(0,500)	(0,485)
Completed at Least One Year of College (age 21)	0,381	0,529
	(0,486)	(0,499)
Male	0,514	0,501
	(0,500)	(0,500)
Black	0,123	0,147
	(0,329)	(0,354)
Hispanic	0,076	0,113
	(0,264)	(0,317)
Mother's Age at Birth	26,647	25,512
	(6,218)	(5,076)
Intact Family during Adolescence	0,728	0,552
	(0,445)	(0,497)
Urban/Metropolitan Area during Adolescence	0,763	0,785
	(0,425)	(0,411)
Number of Siblings/Children under 18	3,200	2,277
	(2,178)	(1,133)
Mother HS Graduate	0,674	0,849
	(0,469)	(0,358)
Mother at Least Some College	0,197	0,476
	(0,398)	(0,499)
Family Income (in $10,000) during Late Adolescence	5,227	5,462
	(2,952)	(3,435)
Average Family Income (in $10,000) in Quartile 1	1,864	1,592
	(0,709)	(0,760)
Average Family Income (in $10,000) in Quartile 2	4,040	3,875
	(0,548)	(0,592)
Average Family Income (in $10,000) in Quartile 3	5,905	6,036
	(0,586)	(0,749)
Average Family Income (in $10,000) in Quartile 4	9,383	10,200
	(2,030)	(2,475)
Avg. Net Family Wealth (in $10,000) during Late Adolescence		11,635
		(14,415)
Avg. Net Family Wealth (in $10,000) in Quartile 1		0,161
		(0,786)
Avg. Net Family Wealth (in $10,000) in Quartile 2		3,221
		(1,290)
Avg. Net Family Wealth (in $10,000) in Quartile 3		10,533
		(3,176)
Avg. Net Family Wealth (in $10,000) in Quartile 4		32,547
		(14,742)
Parents Own Home during Late Adolescence		0,720
		(0,449)
Gross Home Value (in $10,000) for Parental Homeowners		11,861
		(10,052)
Sample Size	2.528	3.182

Note: Table reports means with standard deviations in parentheses. NLSY79 sample includes individuals with non-missing AFQT and family income measured at ages 16 or 17 (i.e. cohorts born in 1961-64). NLSY97 sample includes individuals with non-missing AFQT and family income measured in 1997 if they had reached age 21 by 2004.

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	9,96%	6,44%	4,21%	2,83%
Family Income Quartile 2	6,35%	6,35%	6,10%	5,63%
Family Income Quartile 3	4,09%	6,32%	7,13%	7,89%
Family Income Quartile 4	2,45%	5,91%	7,79%	10,56%

Notes: NLSY79 sample contains 2,528 individuals. NLSY97 sample contains 3,182 individuals (at least 21 years old in 2004). See Table 1 for data sample description.

Table 3: Estimated Effects of Family Income, AFQT, and Family Background on Educational Attainment at Age 21

	High School Completion		College Attendance	
	NLSY79	**NLSY97**	**NLSY79**	**NLSY97**
Male	-0,0794	-0,0046	-0,0658	-0,0846
	(0,0145)	(0,0101)	(0,0172)	(0,0160)
Black	0,1632	0,0396	0,2236	-0,0084
	(0,0256)	(0,0277)	(0,0302)	(0,0440)
White		-0,0097		-0,1587
		(0,0249)		(0,0396)
Hispanic	0,0558	0,0395	0,1712	-0,1253
	(0,0295)	(0,0280)	(0,0349)	(0,0444)
Mother's Age at Birth	0,0045	0,0001	0,0058	0,0024
	(0,0012)	(0,0011)	(0,0015)	(0,0018)
Intact Family during Adolescence	0,0807	0,0525	0,0080	0,1103
	(0,0185)	(0,0117)	(0,0218)	(0,0184)
Urban/Metropolitan Area during Adolescence	-0,0506	-0,0225	0,0330	0,0212
	(0,0175)	(0,0126)	(0,0207)	(0,0199)
Number of Siblings/Children under 18	-0,0208	-0,0010	-0,0211	-0,0066
	(0,0038)	(0,0048)	(0,0045)	(0,0077)
Mother HS Graduate	0,0885	0,1162	0,1483	0,1053
	(0,0182)	(0,0166)	(0,0216)	(0,0261)
Mother at Least Some College	0,0127	0,0028	0,1789	0,0661
	(0,0199)	(0,0114)	(0,0235)	(0,0181)
AFQT quartile 2	0,1983	0,1578	0,1315	0,2434
	(0,0219)	(0,0154)	(0,0259)	(0,0244)
AFQT quartile 3	0,3095	0,1888	0,3243	0,4009
	(0,0232)	(0,0158)	(0,0275)	(0,0249)
AFQT quartile 4	0,3701	0,2076	0,5489	0,5227
	(0,0245)	(0,0163)	(0,0290)	(0,0258)
Family Income Quartile 2	0,0674	0,0520	0,0232	0,0393
	(0,0222)	(0,0156)	(0,0262)	(0,0246)
Family Income Quartile 3	0,0883	0,0568	0,0292	0,1005
	(0,0233)	(0,0165)	(0,0275)	(0,0261)
Family Income Quartile 4	0,0848	0,0711	0,0934	0,1600
	(0,0247)	(0,0172)	(0,0291)	(0,0272)
Test of no Income Effects (P-value)	0,0009	0,0003	0,0058	<0.0001
Sample Size	2.292	2.518	2.288	2.529

Notes: All regressions control for year of birth. 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 age 21 (age 22 if missing at age 21).

Table 4: Estimated Effects of Family Income on Educational Attainment at Age 21 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	0,0525	0,0201	0,0745	0,0334	0,0273	-0,0526	0,0956	0,0862
	(0,0516)	(0,0498)	(0,0411)	(0,0210)	(0,0408)	(0,0547)	(0,0668)	(0,0544)
Family Income Quartile 3	0,1415	0,0990	0,0364	0,0307	0,0258	-0,0730	0,1222	0,0887
	(0,0624)	(0,0521)	(0,0409)	(0,0210)	(0,0490)	(0,0572)	(0,0664)	(0,0544)
Family Income Quartile 4	0,1338	0,1081	0,0360	0,0250	0,1172	-0,0486	0,1818	0,1541
	(0,0764)	(0,0572)	(0,0425)	(0,0208)	(0,0600)	(0,0627)	(0,0691)	(0,0539)
Test of no Income Effects (P-value)	0,0974	0,1123	0,2981	0,4245	0,2810	0,6340	0,0664	0,0232
Sample Size	540	562	593	597	536	562	593	597
b. NLSY97								
Family Income Quartile 2	0,0467	0,0831	0,0122	0,0065	-0,0585	0,0908	0,0448	0,0627
	(0,0476)	(0,0302)	(0,0232)	(0,0079)	(0,0462)	(0,0557)	(0,0542)	(0,0424)
Family Income Quartile 3	0,0828	0,0652	0,0260	0,0099	0,1294	0,1590	0,0865	0,0311
	(0,0573)	(0,0313)	(0,0242)	(0,0077)	(0,0558)	(0,0579)	(0,0565)	(0,0414)
Family Income Quartile 4	0,1640	0,1002	0,0408	0,0077	0,2847	0,1653	0,1910	0,0735
	(0,0666)	(0,0328)	(0,0245)	(0,0079)	(0,0650)	(0,0606)	(0,0573)	(0,0425)
Test of no Income Effects (P-value)	0,0991	0,0112	0,3407	0,6476	<.0001	0,0234	0,0020	0,1967
Sample Size	533	629	653	703	541	630	654	704

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. Education measured as of age 21 (age 22 if missing at age 21). 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 at Age 21 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	0,0087	0,0061	0,0123	0,0194
	(0,0030)	(0,0018)	(0,0035)	(0,0028)
AFQT Quartile 1	0,0273	0,0198	0,0194	0,0323
	(0,0097)	(0,0076)	(0,0076)	(0,0074)
AFQT Quartile 2	0,0130	0,0082	-0,0025	0,0216
	(0,0071)	(0,0035)	(0,0078)	(0,0064)
AFQT Quartile 3	0,0007	0,0045	0,0194	0,0256
	(0,0048)	(0,0024)	(0,0078)	(0,0055)
AFQT Quartile 4	-0,0007	0,0003	0,0116	0,0067
	(0,0020)	(0,0007)	(0,0052)	(0,0038)

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. Regressions for full sample also control for AFQT quartiles. Education measured as of age 21 (age 22 if missing at age 21). Standard errors are in parentheses.

Table 6: Estimated Effects of Family Income and Family Wealth on High School Completion and College Attendance (Age 21, NLSY97)

	High School Completion:				College Attendance:			
	All	**All**	**Low Wealth**	**High Wealth**	**All**	**All**	**Low Wealth**	**High Wealth**
AFQT Quartile 2	0,1579	0,1535	0,1872	0,0862	0,2316	0,2243	0,2477	0,2019
	(0,0162)	(0,0167)	(0,0291)	(0,0168)	(0,0242)	(0,0257)	(0,0370)	(0,0377)
AFQT Quartile 3	0,1915	0,1865	0,2301	0,1137	0,4044	0,3991	0,3811	0,3960
	(0,0166)	(0,0172)	(0,0312)	(0,0166)	(0,0248)	(0,0264)	(0,0397)	(0,0372)
AFQT Quartile 4	0,2051	0,2059	0,3059	0,1142	0,5038	0,5040	0,5971	0,4630
	(0,0174)	(0,0179)	(0,0362)	(0,0166)	(0,0261)	(0,0275)	(0,0461)	(0,0372)
Family Wealth Quartile 2	0,0584	0,0315			0,0662	0,0539		
	(0,0166)	(0,0180)			(0,0249)	(0,0276)		
Family Wealth Quartile 3	0,0953	0,0664			0,1384	0,1145		
	(0,0169)	(0,0189)			(0,0253)	(0,0292)		
Family Wealth Quartile 4	0,1014	0,0778			0,2386	0,2097		
	(0,0186)	(0,0212)			(0,0279)	(0,0326)		
Family Income Quartile 2		0,0370	0,0310	0,0396		0,0179	0,0357	0,0174
		(0,0177)	(0,0268)	(0,0223)		(0,0272)	(0,0340)	(0,0502)
Family Income Quartile 3		0,0347	0,0476	0,0256		0,0607	0,0612	0,0826
		(0,0195)	(0,0337)	(0,0217)		(0,0299)	(0,0429)	(0,0487)
Family Income Quartile 4		0,0401	0,0226	0,0440		0,0820	0,0415	0,1283
		(0,0210)	(0,0473)	(0,0215)		(0,0323)	(0,0602)	(0,0483)
Test of no Wealth Effects (P-value)	<.0001	0,0011			<.0001	<.0001		
Test of no Income Effects (P-value)		0,1649	0,4962	0,1000		0,0426	0,5078	0,0011
Test of no Income and no Wealth Effects (P-value)		<.0001				<.0001		
Sample Size	2.483	2.228	969	1.259	2.496	2.238	977	1.261

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 year of birth. Education measured as of age 21 (age 22 if missing at age 21). Family income and wealth are measured 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.

Table7: Estimated Effects of Family Income and AFQT on Completion of 2+ or 4+ Years of College

	NLSY79			NLSY97		
	Age 21, 2+ Years of College	**Age 23, 2+ Years of College**	**Age 23, 4+ Years of College**	**Age 21, 2+ Years of College**	**Age 23, 2+ Years of College**	**Age 23, 4+ Years of College**
AFQT quartile 2	0,0510	0,0712	0,0077	0,1105	0,0182	0,0821
	(0,0235)	(0,0243)	(0,0212)	(0,0251)	(0,0042)	(0,0357)
AFQT quartile 3	0,2291	0,2597	0,1094	0,3067	0,3574	0,2335
	(0,0249)	(0,0257)	(0,0224)	(0,0256)	(0,0390)	(0,0367)
AFQT quartile 4	0,5170	0,5528	0,4000	0,5142	0,5676	0,4500
	(0,0262)	(0,0272)	(0,0237)	(0,0265)	(0,0402)	(0,0379)
Family Income Quartile 2	-0,0341	-0,0207	-0,0263	0,0279	0,0524	-0,0164
	(0,0237)	(0,0244)	(0,0213)	(0,0253)	(0,0381)	(0,0359)
Family Income Quartile 3	-0,0325	-0,0165	-0,0567	0,0585	0,1187	0,0247
	(0,0249)	(0,0258)	(0,0225)	(0,0268)	(0,0399)	(0,0376)
Family Income Quartile 4	0,0346	0,0614	0,0537	0,1537	0,1504	0,0960
	(0,0264)	(0,0272)	(0,0238)	(0,0279)	(0,0425)	(0,0400)
Test of no Income Effects (P-value)	0,0050	0,0014	<.0001	<.0001	0,0023	0,0120
Sample Size	2.292	2.225	2.225	2.518	1.140	1.140

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. 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.

Table 8: Estimated Effects of Family Income and AFQT on College Enrollment at Age 20

	NLSY79			NLSY97		
	Enrolled in Any College	Enrolled in 4-Year College	Enrolled in 4-Year College Conditional on Enrollment in Any College	Enrolled in Any College	Enrolled in 4-Year College	Enrolled in 4-Year College Conditional on Enrollment in Any College
AFQT quartile 2	0,0701	0,0387	0,2045	0,1248	0,0870	0,1864
	(0,0252)	(0,0227)	(0,0782)	(0,0234)	(0,0219)	(0,0497)
AFQT quartile 3	0,1916	0,1445	0,3490	0,2780	0,2361	0,3180
	(0,0267)	(0,0240)	(0,0765)	(0,0238)	(0,0223)	(0,0478)
AFQT quartile 4	0,4788	0,4348	0,5018	0,4616	0,4650	0,4518
	(0,0281)	(0,0253)	(0,0761)	(0,0247)	(0,0231)	(0,0476)
Family Income Quartile 2	-0,0085	-0,0376	-0,1086	-0,0028	0,0054	0,0302
	(0,0254)	(0,0229)	(0,0566)	(0,0232)	(0,0217)	(0,0399)
Family Income Quartile 3	-0,0172	-0,0318	-0,0830	0,0493	0,0487	0,0605
	(0,0267)	(0,0241)	(0,0589)	(0,0245)	(0,0230)	(0,0390)
Family Income Quartile 4	0,0840	0,0683	-0,0428	0,1248	0,1428	0,1192
	(0,0283)	(0,0255)	(0,0580)	(0,0258)	(0,0242)	(0,0393)
Test of no Income Effects (P-value)	<.0001	<.0001	0,1754	<.0001	<.0001	0,0050
Sample Size	2.304	2.293	753	3.194	3.194	1.453

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. 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.

Table 9: Estimated Effects of Family Income and AFQT on Work During School Year at Age 20

	Share of Weeks Worked		Average Hours Worked per Week	
	NLSY79	**NLSY97**	**NLSY79**	**NLSY97**
AFQT quartile 2	0,0110	0,0116	-0,4330	-0,6942
	(0,0763)	(0,0573)	(2,3394)	(2,0255)
AFQT quartile 3	0,1139	0,0604	-1,3293	1,1453
	(0,0733)	(0,0552)	(2,2478)	(1,9524)
AFQT quartile 4	0,0329	0,0255	-4,2684	-2,5332
	(0,0713)	(0,0548)	(2,1856)	(1,9369)
Family Income Quartile 2	-0,0074	-0,0234	0,7292	0,9818
	(0,0559)	(0,0480)	(1,7141)	(1,6988)
Family Income Quartile 3	0,0091	-0,0406	2,4292	-0,2325
	(0,0577)	(0,0465)	(1,7693)	(1,6442)
Family Income Quartile 4	-0,0639	-0,0875	0,2649	-1,9920
	(0,0566)	(0,0467)	(1,7357)	(1,6539)
Test of no Income Effects (P-value)	0,2760	0,1675	0,2895	0,1330
Sample Size	758	1.084	758	1.081

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. 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. Sample includes those enrolled in college at age 20.

Table 10: Estimated Effects of Family Income on Work during School Year at Age 20 by AFQT Quartile (NLSY79 and NLSY97)
Linear-in-Income Specifications

	Share of Weeks Worked		Average Hours Worked per Week	
Effect of Family Income (in $10,000) for:	**NLSY79**	**NLSY97**	**NLSY79**	**NLSY97**
Full Sample	-0,0112	-0,0100	-0,0858	-0,3734
	(0,0058)	(0,0040)	(0,1787)	(0,1410)
AFQT Quartile 1	-0,0230	0,0145	-0,2380	0,7041
	(0,0311)	(0,0173)	(1,1120)	(0,6545)
AFQT Quartile 2	0,0095	-0,0155	0,5011	-0,6522
	(0,0171)	(0,0095)	(0,6253)	(0,3495)
AFQT Quartile 3	-0,0191	-0,0113	-0,1568	-0,1899
	(0,0120)	(0,0072)	(0,3707)	(0,2784)
AFQT Quartile 4	-0,0114	-0,0133	-0,1462	-0,5953
	(0,0076)	(0,0061)	(0,2122)	(0,2025)

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. 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. Regressions for full sample also control for AFQT quartiles. Sample includes those enrolled in school at age 20. Standard errors are in parentheses.

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

	(i) Attendance Measured at Age 20	(ii) Attendance Measured at Age 21	(iii) Attendance Measured at Age 22	(iv) Attendance Measured at Age 23	(v) Attendance Measured at Age 24
AFQT Quartile 2	0,1156	0,1315	0,1333	0,1292	0,1410
	(0,0256)	(0,0259)	(0,0262)	(0,0265)	(0,0267)
AFQT Quartile 3	0,3093	0,3243	0,3286	0,3338	0,3406
	(0,0272)	(0,0275)	(0,0278)	(0,0281)	(0,0282)
AFQT Quartile 4	0,5477	0,5489	0,5464	0,5356	0,5431
	(0,0286)	(0,0290)	(0,0294)	(0,0297)	(0,0299)
Family Income Quartile 2	0,0150	0,0232	0,0215	0,0090	0,0007
	(0,0259)	(0,0262)	(0,0265)	(0,0267)	(0,0269)
Family Income Quartile 3	0,0224	0,0292	0,0368	0,0316	0,0323
	(0,0272)	(0,0275)	(0,0277)	(0,0282)	(0,0282)
Family Income Quartile 4	0,0966	0,0934	0,0845	0,0738	0,0666
	(0,0288)	(0,0291)	(0,0294)	(0,0297)	(0,0299)
Test of no Income Effects (P-value	0,0015	0,0058	0,0244	0,0461	0,0600
Sample Size	2.312	2.288	2.261	2.217	2.206

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 age in column heading (measured in following year if missing for that age). 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 at Different Ages (NLSY97)

	(i) Attendance Measured at Age 20	(ii) Attendance Measured at Age 21	(iii) Attendance Measured at Age 22	(iv) Attendance Measured at Age 23
AFQT Quartile 2	0,2021	0,2434	0,2668	0,2573
	(0,0220)	(0,0244)	(0,0291)	(0,0365)
AFQT Quartile 3	0,3678	0,4009	0,4026	0,4145
	(0,0224)	(0,0249)	(0,0295)	(0,0377)
AFQT Quartile 4	0,4795	0,5227	0,5454	0,5471
	(0,0232)	(0,0258)	(0,0307)	(0,0389)
Family Income Quartile 2	0,0355	0,0393	-0,0076	0,0460
	(0,0219)	(0,0246)	(0,0290)	(0,0367)
Family Income Quartile 3	0,0778	0,1005	0,0655	0,1434
	(0,0232)	(0,0261)	(0,0308)	(0,0385)
Family Income Quartile 4	0,1562	0,1600	0,1083	0,1401
	(0,0243)	(0,0272)	(0,0323)	(0,0410)
Test of no Income Effects (P-value	<.0001	<0.0001	0,0003	0,0005
Sample Size	3.244	2.529	1.809	1.145

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 year of birth. Education measured as of age in column heading (measured in following year if missing for that age). 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 A3: Robustness Checks for College Attendence (at Age 21) Regressions (NLSY79)

	(i) Control for Father's Education	(ii) High School Graduate Sample	(iii) Mother Attended College Sample	(iv) Dependent Variable: Completed at Least One Year of College
AFQT Quartile 2	0,1343	0,1195	0,1389	0,1017
	(0,2654)	(0,0333)	(0,0755)	(0,0249)
AFQT Quartile 3	0,3023	0,2767	0,3122	0,2842
	(0,0282)	(0,0339)	(0,0726)	(0,0264)
AFQT Quartile 4	0,5230	0,4649	0,4281	0,5519
	(0,2990)	(0,0350)	(0,0711)	(0,0279)
Family Income Quartile 2	0,0149	-0,0050	0,1476	0,0035
	(0,0266)	(0,0318)	(0,0624)	(0,0252)
Family Income Quartile 3	0,0270	0,0043	0,0720	-0,0139
	(0,0280)	(0,0328)	(0,0621)	(0,0265)
Family Income Quartile 4	0,0774	0,0744	0,1500	0,0761
	(0,0299)	(0,0343)	(0,0602)	(0,0281)
Test of no Income Effects (P-value)	0,0397	0,0173	0,0205	0,0009
Sample Size	2.186	1.842	459	2.291

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 age 21 (age 22 if missing at age 21). 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 A4: Robustness Checks for College Attendence (at Age 21) Regressions (NLSY97)

	(i) Control for Father's Education	(ii) High School Graduate Sample	(iii) Mother Attended College Sample	(iv) Dependent Variable: Completed at Least One Year of College
AFQT Quartile 2	0,2369	0,2106	0,2532	0,1477
	(0,0244)	(0,0270)	(0,0378)	(0,0255)
AFQT Quartile 3	0,3909	0,3538	0,4283	0,3550
	(0,0250)	(0,0272)	(0,0372)	(0,0260)
AFQT Quartile 4	0,5073	0,4592	0,5323	0,5275
	(0,0260)	(0,0279)	(0,0361)	(0,0269)
Family Income Quartile 2	0,0356	0,0249	0,0558	0,0025
	(0,0246)	(0,0268)	(0,0376)	(0,0257)
Family Income Quartile 3	0,0862	0,0837	0,1122	0,0532
	(0,0263)	(0,0279)	(0,0374)	(0,0272)
Family Income Quartile 4	0,1408	0,1328	0,1708	0,1232
	(0,0275)	(0,0288)	(0,0378)	(0,0283)
Test of no Income Effects (P-value)	<.0001	<.0001	<.0001	<.0001
Sample Size	2.529	2.309	1.237	2.518

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 year of birth. Education measured as of age 21 (age 22 if missing at age 21). 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.