Financial Aid, Borrowing Constraints and College Attendance: Evidence from Structural Estimates

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The idea that borrowing constraints may preclude low-income youth from attending college is widespread. Here I will review some recent work on the importance of borrowing constraints, and the impact of financial aid programs (i.e., guaranteed student loans and tuition subsidies) designed to counteract them. This work suggests that borrowing constraints have little effect on college attendance decisions. There is evidence that tuition subsidies play a modest role in reducing inequality in schooling and earnings. But most inequality appears to be driven by unequal human capital accumulation prior to college-going age.

Empirical work on college attendance decisions has consistently produced two findings: 1) parents' income helps predict college attendance, even conditional on other observed characteristics of youth, and 2) the effect of tuition on probability of college attendance is greater for children from low-income families. There is some (mixed) evidence that: 3) the rate of return to education is higher for low-income youth. These findings are commonly viewed as strong evidence for borrowing constraints.

Recent work by Stephen Cameron and James Heckman (1998) challenges these findings. Furthermore, recent work by Michael Keane and Kenneth Wolpin (2001) shows they are compatible with a model in which liquidity constraints have a negligible impact on college attendance rates. To understand this work, it is useful to consider a very simple discrete-choice model of college attendance decisions. The model has the following features:

1) Agents are infinitely lived. Time is discrete.

2) In period 1 agents decide whether to attend college. The tuition cost is t.

3) The wage rate in period 1 is w_1. In the subsequent periods, the wage rate is $w_2+\beta$ if the agent attended college in period 1, and w_2 if not.

4) The discount factor is ρ and the interest rate is r.

5) Agents can borrow or save in period 1. Call the net amount borrowed b. In periods 2 onward agents make fixed annuity payments rb on the loan.

6) Agents are endowed with L units of time each period. College requires s units of time.

7) Denote time devoted to work by h.

8) Students can work while in college.

9) Agents receive a transfer payment y_1 from their parents in period 1.

10) Agents receive utility from school attendance, denoted ϕ.

11) In period 1 agents receive utility from consumption c and leisure l. The utility function, denoted $u(c,l)$, is concave in both arguments, and $L \geq l \geq 0$.

12) From period 2 onward, agents inelastically supply 1 unit of labor, so utility is $u(c,1)$.

The value function conditional on school attendance is:

$$V_s = Max_{\{h,\, b\}}\ u(y_1 + w_1 h + b - t, L\text{-}s\text{-}h) + \phi + \rho^{-1} u(w_2 + \beta - rb, 1)$$

And the value function for an agent who does not attend is:

$$V_0 = Max_{\{h,\, b\}}\ u(y_1 + w_1 h + b, L\text{-}h) + \rho^{-1} u(w_2 - rb, 1)$$

The decision rule for college attendance can be written (approximately) as:

Attend school iff: $\beta/r + \phi/\lambda_1 > t + sw_1$.

where $\lambda_1 = u_1(c_1,l_1)$ is the marginal utility of consumption (MUC) in period 1.[1] Treating ϕ and β as unobserved latent variables that are heterogeneous in the population generates a random utility model.

If there is no utility from school attendance ($\phi=0$), the parental transfer y_1 does not enter the decision rule. Hence, parental income should not effect college attendance decisions in the absence of borrowing constraints.

But if people get utility from college ($\phi>0$), parental transfers enter through the MUC. An increase in parental transfers lowers λ_1, thereby increasing ϕ/λ_1. Thus, assuming wealthier parents make larger transfers, the decision rule implies, *ceteris paribus*, that children of wealthier parents are more likely to attend college.

Furthermore, larger parental transfers reduce the effect of tuition on attendance decisions. In the limit, as parents become very wealthy, and transfers become so large as to drive the MUC to near zero, tuition will have no effect on attendance decisions, which become entirely based on utility from school. Finally, a larger parental transfer, and correspondingly larger ϕ/λ_1, implies a lower reservation β for attendance. This implies a lower average return to college among people with wealthier parents.

Now let's introduce borrowing constraints. Assume students can only borrow up to a fraction θ of tuition, and the constraint is binding, so all students borrow θt. Assume that non-students cannot borrow in period 1. The (approximate) decision rule becomes:

Attend school iff: $\beta/r\ [r\lambda_2/\rho\lambda_1] + \phi/\lambda_1 > \theta t\ [r\lambda_2/\rho\lambda_1] + (1-\theta)t + sw_1$.

With a binding constraint, $\lambda_1>r\lambda_2/\rho$. Therefore, as θ declines, the effective tuition cost increases. A larger parental transfer mitigates this effect by reducing λ_1. Thus parental transfers affect attendance decisions.

Finally, suppose youth may receive an additional parental transfer y_s that is contingent on college attendance. This lowers the cost of college from t to $t-y_s$, just as a tuition subsidy would.

To summarize, three mechanisms may generate a positive relation between parental wealth (or income/education) and children's college attendance, assuming that wealthier parents make larger transfers:

1) If school generates utility, higher parental wealth increases demand for school through an income effect.
2) With borrowing constraints, larger parental transfers lower the effective cost of college by reducing the MUC while in school.
3) If wealthier parents make larger contingent transfers, their children face a lower direct cost of college attendance.

Two additional mechanisms arise from correlation between parent and child characteristics:

4) Parental wealth may be positively related to skill endowments of children, which may in turn increase their gain from college, β.
5) Parental wealth may be positively related to children's taste for school, ϕ.

Much of the literature has focused on a pure wealth maximization model where only mechanisms 2-4 are operative. Then, even if neither borrowing constraints nor the contingent transfer mechanism is important, a "spurious" correlation with parental wealth may arise if one estimates a decision rule for college that fails to adequately control for youths' skill endowment.

This is precisely the problem addressed by Cameron and Heckman (1998), henceforth CH. They estimate decision rules for college attendance that include time invariant family background measures (such as parents' education), a measure of family income at age 16, and a measure of children's skill "endowment" when they reach college-going age.[2] Using the Armed Forces Qualifying Test (AFQT) score as the endowment measure,[3] CH find that family income is not statistically significant. This implies that parental income (at a point in time) does not affect college attendance decisions either through the borrowing constraint or the contingent transfer mechanism.

Keane and Wolpin (2001), henceforth KW, attempt to disentangle the relative importance of all five mechanisms linking parental wealth and college attendance. They structurally estimate a model of school, work and savings decisions of young men, using the NLSY. The model explicitly incorporates borrowing constraints; agents in the model have an (estimated) asset lower bound. They can finance college in four ways: 1) borrowing, up to the maximum determined by the asset lower bound, 2) spending down savings, 3) transfers from parents, and 4) work while in school. Agents begin making decisions about school, work and savings at age 16. Each model "year" contains three periods: two school semesters and the summer.

In the KW model parental transfers are allowed to differ by education level of parents. This can be interpreted as a proxy for parental wealth, and indeed, Larry Leslie (1984) finds that more educated parents provide much larger transfers to help finance college.[4] The KW estimates are consistent with this observation. They imply children whose parents did not complete high school receive only $3000 per semester in transfers, while children with college educated parents receive $8400 (1987 dollars).

On this point, note that the NLSY does not contain direct measures of transfers, so KW identify parental transfers from asset behavior. Loosely speaking, their model infers that more educated parents make larger transfers to children in college because asset decumulation during college tends to be greater for children with less educated parents.[5]

The KW estimates imply borrowing constraints are rather tight. The minimum permitted <u>net</u> asset position for college-aged individuals is roughly minus one thousand (1987) dollars.

What drives this result is that, in the NLSY, net asset positions of youth rarely go below this level, even for college graduates with several thousand dollars in student loan debt.

KW use simulations of their model to analyze the impact of borrowing constraints and financial aid on college attendance and subsequent earnings. But before we can have any confidence in these predictions, model validation is necessary. KW show that the model fits in-sample data on educational choices, asset distributions, wages and career choices rather well. They also present several external validation exercises. For example, the KW estimates of how parental transfers differ by parent's education are similar to parents' reports in the NLS young women's data.

The KW model predicts that a $100 annual tuition increase ('82-'83 dollars) would lower the college enrollment rate of 18-24 year olds by –1.2 percentage points. This figure seems credible, since it is in the ballpark of prior estimates based on time-series and cross-sectional variation in tuition costs (see, e.g., the survey by Larry Leslie and Paul Brinkman (1987)). The KW model also predicts that tuition effects on enrollment are greater for low-income youth, a pattern consistently found in prior work. Specifically, a $100 tuition increase reduces college enrollment rates of 18-19 year old high school graduates by –2.2, -1.9, -1.5 and –0.8 percent for children whose parents' highest education level is less than high school, high school, some college, or college degree, respectively.

Despite the tightness of the borrowing constraint, KW obtain a striking result: They simulate that a substantial relaxation of the constraint – making it possible to finance almost the entire cost of college via borrowing – has almost no effect on college attendance decisions of youth from low-income families. The primary effect is on their labor supply while in college. In fact, earnings of full-time students whose parents did not complete high school drop 24 percent.

Consistent with the KW predictions, prior studies have typically found that tuition subsidies have large effects on college attendance rates, while student loans have little effect. Furthermore, the predicted labor supply effect of financial aid is qualitatively consistent with historical evidence. As discussed in Leslie (1984), during the 1973-1980 period, loan and grant programs were expanded considerably, and the real value of own earnings and savings used to finance college dropped 38 percent.

Thus, the KW model implies that borrowing constraints are almost completely reflected in the labor supply margin, and not in college attendance decisions. But since the model is rather complex, one might reasonably wonder if this result is at all robust, or merely an artifact of some special assumptions.

To address this concern, I tried to construct an extremely simple model that generates a similar pattern. Take the expository model presented earlier, and assume $u(c,l)=ln(c)+\gamma ln(L-s-h)$. Let L=4 and s=3/4. Choose γ=3, which implies agents without non-labor income set h=1. Thinking of one period as 4 years, set w_1=100,000, w_2=105,000, β=40,000, r=.25 and ρ=.25. Finally set t=30,000, y_1=20,000, ϕ=0.[6]

Table 1 shows how the value of attending college changes as successively tighter borrowing constraints are introduced into this model. This value is defined as the first period monetary payment that sets $V_s – V_0$=0. In the absence of borrowing constraints this is $55,789. But if borrowing cannot exceed tuition (θ=1) it falls to $31552. Thus, simply preventing borrowing to finance consumption while in college wipes out 43% of the value of a college degree. Successively imposing tighter borrowing constraints further lowers the value of college, down to $14947 when θ=0.

But the value of college drops much more rapidly if hours are not free to adjust. If hours cannot rise above h=.50, the value goes negative when θ=0. If maximum hours is h=.25, the value goes negative when θ=3/4. And if work while in school is precluded, college attendance is not optimal even when θ=1!

Thus, the effect of borrowing constraints is substantially mitigated if agents are free to adjust labor supply. Clearly, a key reason the KW model implies little impact of borrowing constraints is that it allows for work while in school. But, as this example shows, while this may substantially mitigate effects of borrowing constraints, they are not eliminated. The second key factor is endowment heterogeneity.

In the KW model there are four "types" of agents who have different skill endowments (at age 16). Most types are well above or below the margin of indifference for college attendance. Only one type is close enough to the margin for borrowing constraints to impact their attendance decisions, but they are less than 15% of the population. Thus, borrowing constraints only potentially alter the behavior of a small group.

While the KW model implies little effect of borrowing constraints on college attendance, it implies large effects of parental transfers. Recall that a contingent transfer is exactly like a tuition reduction. KW estimate that the contingent transfer to youth with college educated parents is over \$5000 per semester, while that for youth whose parents did not finish high school is about \$2000. Thus, the effective cost of college is more than \$3000 greater for the later group.

KW simulate that a \$3000 per semester tuition subsidy, offered only to youth whose parents did not finish high school, would raise their mean highest grade completed from 11.7 to 12.6 years (the population mean is 13.5). It would also raise their college attendance rate to slightly above the population mean, and their mean wage rate at ages 27-30 by 67 cents per hour (an 8% increase), bridging nearly half the gap with the population mean. This suggests, *prema facie*, that tuition subsidies to reduce the effective cost of college for low-income youth may be an effective policy to reduce earnings inequality.[7,8]

Nevertheless, it is important to keep in mind the big picture. KW also simulate that a complete equalization of parental transfers would lead to only minor equalization of educational attainment and wages. This is because heterogeneity in age 16 “endowments” accounts for the bulk of inequality. KW conclude that college financial aid can only play a modest role in reducing inequality. Government policies can only have major effects if they (successfully) target the factors that generate unequal outcomes much earlier in the life cycle.

References

Cameron, Stephen V. and Heckman, James J. "Life Cycle Schooling and Dynamic Selection Bias: Models and Evidence for Five Cohorts of American Males." *Journal of Political Economy*, April 1998, 106(2), pp. 262-333.

Keane, Michael P. and Wolpin, Kenneth I. "The Effect of Parental Transfers and Borrowing Constraints on Educational Attainment," *International Economic Review*, November 2001, 42(4), pp. 1051-1103.

Keane, Michael P. and Wolpin, Kenneth I. "Eliminating Race Differences in School Attainment and Labor Market Success," *Journal of Labor Economics*, October 2000, 18(4), pp. 614-652.

Leslie, Larry L. "Changing Patterns in Student Financing of Higher Education," *Journal of Higher Education*, May-June 1984, 55(3), pp. 313-346.

Leslie, Larry L. and Brinkman, Paul T. "Student Price Response in Higher Education: The Student Demand Studies," *Journal of Higher Education*, March-April 1987, 58(2), pp. 181-204.

Table 1: Effects of Borrowing Constraints and Hours Constraints

	Hours Unconstrained		**Maximum Hours Constraint**			
θ	h	$V_s - V_o$	h=.6625	h=.50	h=.25	h=0
∞	0	55789	55789	55789	55789	55789
1	.6625	31552	31552	28662	9000	-12510
¾	.7188	27809	27472	22151	-1654	-18296
½	.7750	23795	22343	14072	-7116	-24192
¼	.8313	19508	15979	4047	-12708	-30193
0	.8875	14947	8127	-3392	-18423	-36288

Note: For the no-school option, h=.85 in period 1, and c=105,000 in all periods.

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[1] This assumes the constraint on leisure is nonbonding, and is based on a first order Taylor series expansion of V_s around V_0, at the point of indifference. Given interior solutions for hours (both h_s and h_0), this means the point where consumption is equal whether or not the agent attends school.

[2] CH present a simple structural model that rationalizes their decision rule.

[3] Keane and Wolpin (2001) discuss potential problems with using AFQT to control for endowments.

[4] Leslie reports that the relation of parental assistance with parental education is actually somewhat stronger than that with parental income.

[5] Also, children with less educated parents work more while in college. Another identifying assumption is that children who are not dependents receive no parental transfers. Then, differences in asset accumulation between dependent and non-dependent children identify the average level of transfers.

[6] Since β/r=160,000 and $sw_1 + t$ =101,250, an unconstrained agent would attend college. Parameters were chosen so a person who does not attend would set b=0, which simplifies the analysis of liquidity constraints.

[7] KW don't present a cost-benefit analysis, but some quick calculations suggest roughly a breakeven situation. The present value at age 18 of the wage increase, assuming 1600 hours per year starting at age 22, is roughly $(.95)^4 \cdot 1072/.05 \approx \$17{,}500$. The cost of the subsidy, assuming the mean years of college for this group is 0.9+0.25=1.15, is about $6500 per eligible person.

The forgone earnings from 1.15 years of college attendance is roughly $11,000, since the hourly wage rate at ages 18-20 is about $6.

[8] This large wage effect contrasts with results in Keane and Wolpin (2000). They simulate school completion bonuses for blacks, large enough to eliminate black/white differences in schooling. This only raises earnings of blacks at age 30 by 4.5%, leaving them 27.5% below whites. And present value of lifetime earnings increases only $3627, compared to a cost per eligible of $8464. That this earlier model didn't incorporate borrowing constraints may partly explain the difference, but more important is that it did allow for white vs. blue-collar work. The estimated education coefficient in the blue-collar log-wage equation was only .024. And blacks are more concentrated in blue-collar than whites, even with the bonus scheme. This limits the subsidy's impact on blacks' wages.