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INCOME, ABILITY, AND THE DEMAND FOR HIGHER EDUCATION

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This paper develops and estimates a model of college attendance that focuses on the influences of public policy and of the economic environment. The policy instruments examined are tuition, admissions requirements, college location, breadth of curriculum, draft deferments, and class integration of neighborhoods. The aspects of the economic environment examined are the opportunity cost of the students' study time and the size of the anticipated earnings payoff to college graduation. The model is separately estimated for twenty groups of male high school juniors stratified by ability quartiles and for five family income categories. We report here only reduced-form estimates of total impacts. Defining the paths by which each of these variables influences decisions about college and the process of preparing for college is part of a larger project of which this is a part, but it is not attempted here. Also left for another paper are the impacts of public policy and the economic environment on the proportion of college entrants who complete one, two, or four years.

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The first five sections of the paper develop a theory of college attendance and then apply it to the choice and definition of variables and the selection of functional form for the estimating equation. Section 1 examines the college entrance decision when unlimited borrowing is possible at a given interest rate. Section 2 handles the more realistic situation of imperfect capital markets. Section 3 applies this theory to the selection of the college whose characteristics will be used in the estimation (that is, the college that is most attractive to those unsure about whether they can or should go to college). Section 4 examines how planning for college influences model specification and the selection of variables. Section 5 derives the functional form for estimation and describes how the estimated parameters will be used to test the hypothesis discussed in sections 1 and 2. Section 6 describes the data and section 7 presents the results. Section 8 analyzes the effectiveness of public subsidies of undergraduate education by calculating the subsidy cost of an extra student from each of the twenty ability-by-income strata and discusses the policy implications of the results.

1. Perfect Capital Markets

It is assumed that an individual will enter college if the utility of any of the feasible college alternatives is greater than the utility of the noncollege alternative. Let $G_j = 1$ be an indicator that the "j"th individual attends college.

$$G_j = 1 \text{ if for some "i", } U_{ij} > U_{oj} \qquad i = 1 \ldots n$$

where i indexes the set of relevant colleges 1 through n and U_{oj} = the utility of the best noncollege alternative.

The human capital model of schooling emphasizes the investment character of this decision. The private costs of going to school are tuition, fees, and current foregone earnings opportunities. The benefits are primarily the higher earnings that can be obtained in the future. An interesting special case of the human capital approach occurs when

a. capital markets are perfect, that is, unlimited borrowing and lending are possible at interest rate r, and

b. there is no risk or debt aversion.

Under these circumstances, investment decisions are separable from consumption decisions. The future consumption benefits of college may be valued and discounted in the same manner that earnings effects are. The decision rule $U_i > U_o$ may be rewritten in a more specific manner. For a four-year college program, $U_i > U_o$ becomes

$$1)\quad B_{ij} = \left[\sum_{t=0}^{50} \frac{\Delta Y_{ijt} + C_{ijt}}{(1+r)^t} - \sum_{t=0}^{3} \frac{T_{ijt} + R_{ijt} + Q_{ijt} - S_{ijt}}{(1+r)^t} \right] > 0$$

$$2)\quad B_{ij} = \sum_{t=4}^{50} \frac{\Delta Y_{ijt} + C_{ijt}}{(1+r)^t} + \sum_{t=0}^{3} \frac{\Delta Y_{ijt} + C_{ijt} - T_{ijt} - R_{ijt} + Q_{ijt} + S_{ijt}}{(1+r)^t}$$

ΔY_{ijt} = the expected additional earnings received or lost relative to the best noncollege alternative as a consequence of attending and completing the "i"th college.

C_{ijt} = the anticipated dollar value of the increment to non-pecuniary benefits and the "i"th college relative to the best noncollege alternative. Among other things this includes the student's taste for attending classes, living on a college campus, and the status of being a college man. The parental component of C_{ijt} is their maximum willingness to pay for the satisfaction they derive from having college-educated children. It is C^p_{ijt}.

T_{ijt} = tuition and fees at the "i"th college.

R_{ijt} = the price of the travel, room, and board costs of attending college including the opportunity cost of travel time.

Q_{ijt} = sacrificed leisure time valued at the wage rate (positive if college increases leisure).

S_{ijt} = scholarships, grants, and loan subsidies.

Assuming that part-time jobs of varying time commitment are available and that the full-time and part-time wage rates are equal, then

$$3)\quad \Delta Y_{ijt} + \Delta Q_{ijt} = -w_{jt} \cdot X^{s}_{ijt} \quad .$$

where w_{jt} is the wage rate of the "j"th potential student and

X^{s}_{ijt} is the time required at the "i"th college by the "j"th student to study for and to attend classes.

The model implies that higher tuition, room and board charges, and travel distances and higher high school graduate wage rates should discourage college attendance. Greater parental willingness to pay and scholarship availability should encourage college attendance. Furthermore, cost and benefit elements that are scaled in dollars, measured with equal "reliability," and uncorrelated with omitted variables should have the same coefficient in the behavioral model.[1] The impact of a dollar of tuition on the decision to attend should be equal to the impact of a dollar of foregone earnings or a dollar of travel costs. This hypothesis will be called the perfect capital market hypothesis.

2. Imperfect Capital Markets

The hypothesis of a perfect capital market, however, seems unrealistic. In 1961 only a few states had their own guaranteed loan programs and the National Defense Student Loan program was new, made only small awards, and generally required a financial need analysis for eligibility.

Fisherian consumption-investment theory implies that when markets are perfect the decision to undertake a profitable investment (such as college) increases one's permanent income, and thus should result in higher consumption in every period. In fact, however, most students accept a reduction in current consumption (imputing no current consumption value to the schooling itself) when they attend college. This means that either capital markets are imperfect or the current consumption benefits of college are so large that they outweigh the reductions in spending on other items.

The institutional and informational constraints on lending institutions mean that beyond some minimal amount loans are either unavailable or carry precipitously higher marginal rates of interest. One solution to the cash flow problem this creates would be to finance the investment concurrently by attending part-time or intermittently. This, however, has the disadvantage of shortening the payoff period and sacrificing the greater efficiency of continuous full-time study. Our model, therefore, assumes continuous full-time study.

When large discrete investments are being compared and capital markets are imperfect, there is no observable market interest rate that expresses the individual's tradeoff between present and future consumption. In (2), we must therefore substitute r_{jt}^{*}, the individual's own rate of time preference, for r. Making the additional substitutions implied by (3), the "j"th individual will attend college only if $B_{ij} > 0$ for some i, where

$$4)\quad B_{ij} = \sum_{t=4}^{50} \frac{\Delta Y_{ijt} + \Delta C_{ijt}}{(1+r_{jt})^t} + \sum_{t=0}^{3} \frac{\Delta C_{ijt} - w_{jt} \cdot X_{ijt}^s - T_{ijt} - R_{ijt} + S_{ijt}}{(1+r_{jt})^t}.$$

The second change that capital market imperfections produce in the model is to require that each college option pass a second test: namely, that it can be financed. If a "preference" in the sense of (4) for the "i"th college over the best noncollege option is to result in attendance, a second inequality--a cash flow constraint--must also be satisfied. The resources available must be at least as great as the incremental out-of-pocket costs of four years of college, T + R, and some minimum standard of living (M_{jt}). In other words F_{ij}, resources minus costs, must be positive.

$$5)\quad F_{ij} = \sum_{t=-3}^{3} s_{jt} \cdot w_{jt} \cdot X_{jt}^w + \sum_{t=0}^{3} (L_{jt}^* + S_{ijt} + \Delta C_{ijt}^p - T_{ijt} - R_{ijt} - M_{jt}) \geq 0$$

where

s_{jt} = proportion of youth's earnings that are set aside for college expenses. During the investment period itself t = 0, 1, 2, 3, $s_{jt} = 1$

X_{jt}^w = the time available to a full-time student for market work. Since full-time attendance and study take 1300 hours per year, the upper limit for X_{jt}^w is approximately 1000 hours.

L^{*}_{jt} = upper limit on yearly loan.

ΔC^{P}_{ijt} = the maximum willingness of parents to contribute toward their child's expenses at the "i"th college.

M_{jt} = the minimum standard of living that a student can or is willing to accept while attending college.

Student earnings are summed over a seven-year period, -3 to +3, because significant student savings are assumed to begin three years prior to the prospective date of college entrance.

3. Minimum Cost: The Price of College Attendance

Our theory now states that college attendance occurs only when two conditions are simultaneously met. Student "j" will attend if, relative to the best noncollege alternative, there is at least one college that is both preferred ($B_{ij} > 0$) and that can be financed ($F_{ij} \geq 0$). One college is all that is necessary. It is not, therefore, the average tuition, selectivity, and proximity of the colleges in some jurisdiction that should enter our model, but rather the characteristics of the most attractive (meaning the one that comes closest to meeting both tests). Determining which college is most attractive, however, is no easy matter. While for each individual it is possible to rank colleges unambiguously on any one criterion, both preferences and colleges are multifaceted and it is not clear what relative weight should be given each facet.

One approach would be to estimate a college choice model within a sample of those attending college and use it to predict the preferred college of those not attending college.[2] This requires, however, the unrealistic assumption that students near the margin between attending and not attending college place the same relative value on different aspects of a college environment as do those who attend college.

The theory sketched earlier provides an alternative approach, for it can be used to select among colleges as well as to decide whether to attend one at all. The college that is least likely to be rejected by the cash flow constraint is the cheapest one: the college with minimum $T_{ij} + R_{ij} - S_{ij}$.[3] For students on the margin between college entrance and the army or a full-time job, the cheapest college is also likely to rank high on the utility maximizing criterion, B_{ij}. While lower expected pecuniary and nonpecuniary benefits can in specific instances outweigh advantages of low cost, this population is assumed to consider qualitative differences among colleges to be small relative to whether they will be admitted and whether they can afford (finance) it. When a student is admissible at the low-cost public colleges of a state, a rise in tuition at higher-cost private colleges is not likely to dissuade him altogether from attending college, even if he has planned to go to a private college.

As long as a few minimum requirements are met, colleges are considered close substitutes. Besides admissibility, only an unspecialized curriculum and a compatible racial and religious atmosphere are required. A computer program was written that chose each student's cheapest way of attending each major type of college--public four-year, private four-year, and junior colleges. Teachers' colleges, art schools, Bible schools, seminaries, business colleges, and engineering colleges were excluded from consideration. Almost all southern colleges were segregated in 1961. Whites were assumed to consider all predominantly black colleges irrelevant and white colleges were similarly assumed to be irrelevant to black southerners.[4] Catholics were assumed to exclude Protestant denominational colleges from consideration, and vice versa.[5] One final restriction on the set of relevant colleges was that the admissions policy be liberal enough to admit at least the top 20 percent of the local high school graduating class.

The primary determinants of the cost of each individual's minimum-cost means of college attendance were his state's in-state tuition level, whether he lived in a political jurisdiction (county, town, or city) with access to a low-tuition junior college,[6] and the distance from his home to the nearest public institution. Finding the minimum-cost college involves comparing modes of attendance--commuting versus living on campus--as well as colleges. The marginal cost of commuting is the sum of the out-of-pocket transportation costs (3 1/3¢ per one-way mile or $9.60 per mile per year) plus time costs, which fluctuate with the local wage level around a mean of $7.20 per mile per year (based upon a national average value of time of 75¢ per hour and a mean speed of thirty miles per hour). Valued this way, commuting was always cheaper when a public college was within twenty miles. In states with high room and board charges the cutoff point often went as high as thirty-five miles. The premiums for out-of-state tuition and the rise of travel cost with greater distance mean that the minimum-cost college is typically a public college in one's own state and more often than not a local one. The tuition at this college (which will be entered as a separate variable) is generally the same throughout the state.

4. <u>The Implications of the Planned Nature of College</u>

In most families college plans are made many years in advance of high school graduation. In 1960 only 20 percent of ninth-grade boys answered that they "did not know" when asked whether they were going to college and what type of college they expected to attend. Plans are made because attending college requires preparation. Educating one's children is a large once-in-a-lifetime expense, so saving in anticipation of this expense is very common.

College must also be prepared for academically. Admission is contingent upon having studied academic subjects in high school and having achieved some minimum standard of performance. Second, the more prepared a student is the better his grades will be. Grades in college measure performance relative to a standard. They do not measure value added. Consequently, the institution's willingness to let the student remain and the impressiveness of the transcript that results depend upon how hard he worked in high school. Third, except for the most brilliant students, studying in high school and studying in college are complementary. College professors expect students to arrive in their courses with certain basic skills already under their belt. A sink-or-swim philosophy prevails and students without these skills sink.

The fact that college must be prepared for has important substantive policy implications. For a public policy to have its maximum impact, students and their parents must know about it when the children are young. The full impact of government policies will lag a few years behind their implementation. Since public policies like the tuition level influence the early plans of parents and children, they can be expected to influence concrete actions like whether an academic curriculum is chosen, how much time is devoted to studying, and parental encouragement of college as a goal. These in turn affect grades in high school and performance on achievement tests.

The necessity of preparation for college also affects the empirical specification of our model of college attendance. The families' financial capacity should be measured by permanent income, not current income, and college availability variables should reflect the environment prior to as well as at the time of high school graduation.

Second, measures of student academic ability should be purged of the effects of student effort in high school. We would prefer to control for ability by a very early IQ measure. However, since the only test scores available are for the eleventh grade, the ability control used in this study is an academic aptitude composite purged as much as possible of subtests that reflect a college preparatory curriculum.[7]

The endogeneity of one's high school credentials has further implications. The set of feasible colleges becomes endogenous. The set of prices for college that a student will face when he graduates depends upon his performance in high school. Better credentials mean a student can get into more schools and is more likely to be awarded scholarships. While the choice of college may cause expenditures to rise, better credentials lower the price (the cost of the cheapest method of attending) of college. Since, however, his performance in high school if influenced by expected college availability, making the set of relevant colleges a function of the student's credentials makes tuition simultaneously a cause of and a consequence of college plans. We choose to finesse this problem. The set of feasible colleges is not a function of the student's ability, and no attempt is made to measure scholarship availability. Instead, college admission standards (percent of the region's high school graduates able to meet its admission criteria) are entered as a separate variable in the analysis.

We will, therefore, be estimating a reduced-form model that encompasses both the student's behavior--choice of curriculum, effort in high school, applications to and choice of colleges--and the college's admission decision.

5. Empirical Specification

The theory proposed is deterministic:

$$G_j = 1 \text{ if } B_j > 0 \text{ and } F_j \geq 0$$

$$G_j = 0 \text{ if } B_j \leq 0 \text{ or } F_j < 0$$

where B_j and F_j are the B_{ij} and F_{ij} of the "most preferred" college. The "most preferred" college is the college with maximum B_{ij} subject to the constraint that $F_{ij} \geq 0$. When all colleges have $F_{ij} < 0$, it is the school with maximum F_{ij}. However, many of its elements ΔY_{ijt}, C_{jt}, C^p_{jt}, S_{it}, L^*_{jt}, M_{jt}, are either endogenous or unmeasurable. Imperfectly correlated indicators like IQ, family income, and parents' education must substitute for some of the dollar values that appear in (4) and (5). Consequently empirical implementation must be probabilistic.

Let us rewrite B_j and F_j in terms of the variables that will be used in estimation.

$$6)\quad B_j = B^m_j + u_j = \underline{\alpha}_1 Z - d_4[w^m \cdot \bar{X}^s + T_j + R_j] + d^*\phi\Delta Y^m + u_j$$

$$7)\quad F_j = F^m_j + v_j = \underline{\alpha}_2 Z\ d_4[T_j + R_j] + \sum_{t=-2}^{4} \dot{s}_{jt} w^m \bar{X}^w + v_j$$

where

B^m_j and F^m_j = our best estimates of B_j and F_j using the measurable variables and proxies.

Z = a vector of proxies for the cost and benefit elements not measured in dollars (that is, for C^p_{jt}, C_{jt}, ΔY_{jt}, and so forth). Z includes ability, family income, education, and high school and community characteristics.

$\underline{\alpha}_1$ and $\underline{\alpha}_2$ = a vector of coefficients for these proxies in predicting the unmeasured elements of B_j and F_j.

d_4 = ratio of discounted four-year sum to beginning-year value when the yearly amount is the same in each year.

$$\sum_{t=0}^{3} (1+r_j)^{-t} = d_4$$

$\bar{X}^s$ = the average time a full-time student spends attending classes and studying.

$\bar{X}^W$ = the maximum time available for market work in a year in which one is a full-time student.

d^* = ratio of the present value of benefits in the payoff period to their yearly value. If the yearly value were constant,

$$d^* = \Sigma_{t=4}^{50} (1+r_j)^{-t} .$$

ϕ = the regression coefficient of the local earnings differential, ΔY^m, predicting the unobservable expected earnings differential, ΔY_j. ϕ should be less than one because the expected differential is an average of local and national differences.

u_j and v_j are errors in measurement that are not uncorrelated with each other ($Cov(u,v) > 0$) but that are assumed uncorrelated with Z_j, T_j, R_j, and W_j.

We expect u_j and v_j to have a unimodel distribution not unlike the normal distribution. Another way of stating this is that the density functions for $B_j|B_j^m$ and for $F_j|F_j^m$ are unimodal. The conditional probability that the "j"th individual will attend college given B_j^m and F_j^m is the probability that B_j and F_j are jointly greater than zero. We approximate this by a logistic function that is linear in B_j^m and F_j^m.

$$8)\quad P_j = P(G_j = 1|B_j^m, F_j^m) = \int_0^\infty\int_0^\infty f(B_j, F_j|B_j^m, F_j^m)\, \partial\beta_j\, \partial F_j \simeq \frac{e^{\theta+\beta B_j^m+\gamma F_j^m+\varepsilon}}{1+e^{\theta+\beta B_j^m+\gamma F_j^m+\varepsilon}}$$

$$9)\quad \log \frac{P_j}{1-P_j} = \theta + \beta B_j^m + \gamma F_j^m + \varepsilon$$

$$10)\quad \log \frac{P_j}{1-P_j} = \theta + (\beta\alpha_1+\gamma\alpha_2)Z - d_4(\beta+\gamma)(T_j+R_j) - w^m(\beta d_4\bar{\bar{X}}^s-\gamma\sum_{t=-3}^{3}(1+r)^{-t}s_{jt}\bar{\bar{X}}^w)$$

$$+ \beta d^*\Delta Y^m + \varepsilon$$

$$11)\quad \log \frac{P_j}{1-P_j} = \theta + \theta_1 Z + \theta_2(T_j+R_j) + \theta_3\bar{\bar{X}}^s w^m + \theta_4\Delta Y^m + \varepsilon\ .$$

The assumption in (8) that the log of the odds is an additive linear function of B_j and F_j produces this very economical specification. Two interesting hypotheses may be conveniently tested in the context of this specification. If there is a perfect capital market, $\gamma=0$, both θ_2 and θ_3 should be negative, and $\theta_3 \leq \theta_2$. If the cash flow constraint were to totally predominate, $\beta=0$ and θ_3 should be positive. Furthermore, θ_3 should equal $\theta_2 \frac{\bar{\bar{X}}^w}{\bar{\bar{X}}^s d_4} \sum_{t=-3}^{3} s_t(1+r)^{-t}$. The expression behind θ_2 is the discounted ratio, hours available to work for pay for college over the hours required by college attendance. The fact that seven years of work are available to help pay for college while only four years of study are required suggests that this ratio is greater than one. However, wage rates are substantially lower during high school, only part of the money earned at that time will be saved, and the time required by school during a year of full-time attendance (1300 hours) is greater than the time available for market work in that year. Consequently we believe that $\sum_{t=-3}^{3} s_t\bar{\bar{X}}^w(1+\bar{r})^{-t} \simeq d_4\bar{\bar{X}}^s$. This gives the dominating cash flow constraint hypothesis a further implication, $\theta_3 \geq |\theta_2|$. Not only is the effect of the local wage rate positive but the coefficient on w^m (1300 hours) should be equal in absolute size to the coefficient on tuition.

In the likely event that neither of these extreme cases characterizes the college attendance decision, we may use the sign of θ_3 and the relative sizes of θ_2 and θ_3 to provide information on how imperfect capital markets are. θ_2 is d_4 times the sum of $\beta+\gamma$, the sum of the preference and cash flow parameters. Since $d_4\bar{X}^s \simeq \Sigma_{t=-3}^{3} \; s_j\bar{X}^{w}(1+r)^{-t}$, θ_3 provides a good approximation of their difference, $d_4(\beta-\gamma)$.

These results may also be derived by a verbal argument. Imperfect capital markets make the student and his family's ability to self-finance the educational investment an important determinant of college attendance. The student's own ability to contribute toward the expenses of college depends upon the wage rates he can obtain for summer and part-time work and the free time left him by the class attendance and study requirements of high school and college. The student's opportunity cost--the wage rate of jobs that can be obtained in his community by recent high school graduates--is both a cost of and a financing mechanism of college. Higher local wage levels thus simultaneously discourage and encourage college attendance. We, therefore, expect an extra dollar of foregone earnings to have a smaller negative influence on attendance than an extra dollar of tuition, and higher local wage rates might even have a positive impact on attendance. The size of the difference between θ_2 and θ_3 gives us a measure of the relative importance of the cash flow constraint.

According to (11), an incremental dollar of travel, room, and board costs should have the same impact as a dollar of tuition. However, the difficulty of accurately measuring travel costs and the additional costs of living on campus suggest that the travel, room, and board coefficient will be biased downward. Furthermore, while public tuition levels are constant throughout a state, distance refers to a particular college. If this college is not the preferred one there will be errors in measurement of R. Finally, it is possible that because of its high visibility tuition has a uniquely powerful psychological impact. A hundred dollars of tuition is therefore likely to be a more powerful disincentive than a hundred dollars of travel, room, and board costs. Tuition in 1959 is therefore entered in competition with minimum total cost in 1961, and it is expected to be significantly negative.

The coefficient of θ_4 also tells an interesting story. It allows us to place an upper bound on the discount rate by which high school students and their parents jointly value the higher incomes that start four years in the future. Since βd_4 can be determined by comparing θ_2 and θ_3, we may solve for $\frac{d^*}{d_4}\phi = \frac{\theta_4}{\beta}$. Since $0 \leq \phi \leq 1$, and higher discount rates lower the ratio d^*/d_4, we may calculate an upper bound for r_j from $d^*/d_4 = \theta_4/\beta$.

6. Data

The data base for this study is 27,046 males who were high school juniors in 1960 and for whom information was obtained in one of the two Project Talent follow-up efforts. Over 95 percent of our population are in the Project Talent 5 percent stratified random sample of the nation's high schools, so the juniors originally contacted in 1960 are broadly representative. The proportion of these juniors who responded to one of the questionnaires sent in 1962 and 1966 was only 53 percent, however.

For a 5 percent sample of the male questionnaire nonrespondents, efforts were made by Project Talent regional coordinators, principals of the TALENT high schools, and Retail Credit to obtain the required information on jobs and schooling experience, and a 90 percent response rate was obtained.

A comparison of the two samples reveals that responding to a mailed questionnaire is positively related to one's perceptions of one's own success. Controlling for family background, the college attendance rate of the mail nonrespondent sample was two-thirds that of the respondents. Probability of responding to the mailed questionnaires is not solely a function of college attendance, however. Consequently, an unweighted logit model will yield biased estimates of many of the crucial parameters. The solution to this statistical problem is to treat nonrespondent samples as a one-in-twenty random sample of those who did not respond to the mailed questionnaires and to use a maximum likelihood logit program that accommodates weighting. The computer program used was a modified version of "Maximum Likelihood Estimators for the Logistic Model with Dichotomous Dependent Variables" written by Paul Schultz and Kenneth Maurer.

7. Results

We present separate results for each of twenty income-by-ability groups. Academic ability is the TALENT IQ composite purged of subtests with college preparatory course content. The income index measures permanent, not current, income. It is based on questions on the age of the family car, the home's value and number of rooms, and the number of household durables and appliances. An estimate of current family income was only one of the ten questions. Background characteristics were controlled both by the stratification and by entering in each model an index of frequency and recency of school changes, the TALENT socioeconomic status scale, academic ability test score, and the number of siblings.

Tables 2 through 9 present the logit coefficients for each of the policy variables that appear in the estimating model. If every income-by-ability group had the same β, γ, and r_j and variance of measurement error $V(\epsilon_i)$, we would expect these coefficients to be the same. R^2, entropies, and entropy reductions were calculated. The R^2 for models run on particular strata ranges between .38 and .067. Entropy reductions range between .211 and .034. The entropy of the distribution before stratification was .6687. The average conditional entropy of our models is .4737.

Table 1 presents a simple means of translating logit coefficients into more familiar elasticities and impacts on probability. The elasticity is given by $\theta_i \bar{X}_i (1-\hat{P})$. The left-hand side of Table 1 tabulates 1-P, the probability of not entering college. Note that for a given logit coefficient elasticities are larger when the group is less likely to attend. The change in probability per unit of change of X_i, $\frac{\partial P}{\partial x}$ is given by $\theta_i \hat{P}_j (1-\hat{P}_j)$. The $\hat{P}_j(1-\hat{P}_j)$ multiplier for each ability-by-income group is tabulated on the right-hand side. Note that this multiplier is largest for groups with approximately one-half attending.

Tables 2, 3, and 4 present estimates of the impact of different types of out-of-pocket costs on college entrance. Except for a few groups in the lowest ability quartile and the high-income, high-ability group, higher costs consistently and significantly lower the probability of college entrance. An extra $100 of travel, room, and board costs lowers college attendance by almost a whole percentage point, .89 percent. Tuition is even more powerful; significantly more so in 13 strata. Adding the coefficients on Tables 2 and 3, we see that a $100 higher tuition lowers the college entrance proportion by .029. The lower middle ability quartile, the most responsive of all, has its probability of college entrance lowered by .056.

The total effect of tuition is positive in only four of the twenty strata and never significantly so. The pattern is revealing, however, for the model breaks down exactly where it might be expected to. Many students in the lowest ability quartile project themselves to be irreconcilably ineligible for admission to the minimum-cost college. For them the cost at this college is irrelevant. The three strata with positive tuition effects are highly responsive to admissions policy (an elasticity of .85 with respect the percentage admissable). The other group unaffected by tuition is the high-ability, high-income stratum. These students can both afford and be admitted to better colleges than the local inexpensive college that enters the model. Their high social status and ability have most likely given them a taste for a more distinctive type of college.

Even costs at four-year colleges that are not the cheapest affect college entrance. If the Carnegie Commission's recommendation of higher tuition in the junior and senior year had been in effect in 1961, each $100 would have lowered entrance into freshman year by at least six tenths of a percentage point over all and by 1.2 percentage points in the highest ability quartile.

Except for students from poverty backgrounds, admissions requirements also have substantial effects on attendance (Table 5). If a state were to go from accepting half to accepting all of its high school graduates, the proportion of juniors attending would rise by .038. As one would expect, the less able are quite sensitive to admissions policy; the proportion entering from the bottom ability quartile would rise by .067. The breadth of curriculum at the cheapest college also has an important impact on college entrance. When the cheapest college is a two-year extension campus without vocational programs, the proportion entering college is reduced by .057.

In the early sixties the selective service system was contending that "many young men would not have pursued higher education had there not been a Selective Service program of student deferment." The effectiveness of "channelling" as this policy objective was called, is supported by our results (Table 9). Significant positive coefficients are obtained in nine of twenty strata. A one standard deviation change in our draft pressure measure lowers overall college entrance by .015. Extrapolated to zero draft pressure, these cross-sectional results imply that the nation's adoption of a volunteer army lowered college entrance by 7.6 percentage points. No doubt the estimate is too large. Extrapolating outside the range of variation of the independent variable is risky. However, the size of the effect was quite robust in linear probability models when multitudes of other control variables were added.

Another unexpectedly powerful variable was the social status of the neighborhood (Table 6). Nine significant positive and three significant negative coefficients were obtained. A standard deviation improvement in neighborhood status raises the overall proportion entering college by .023. This is a large effect; per $1000 of real income it is nearly as large as the effect of the income of one's own family. Comparing the college nonattendance rates in the columns of Table 1, we obtain, per $1000 of real income, .025 change in probability as the approximate total effect of family income holding ability constant. Competing with many additional variables, the point estimate for neighborhood effects is .016 per $1000. Part of the neighborhood effect is caused by the fact that parents with higher aspirations for their children choose higher-status neighborhoods. Linear probability models run on juniors living outside of SMSAs in towns with only one high school have smaller neighborhood effects.

The impact of the local college--high school earnings differential did not consistently follow a priori expectations (Table 7). Five coefficients were significantly negative and eight coefficients were significantly positive. The groups with negative coefficients are the bottom ability quartile and the strata that combine high ability and high income. Because they are often excluded by admissions policies, costs and returns seem to have only a small effect on the bottom ability quartile. For them the most important determinants are admissions policy, neighborhood status, and draft pressure. The absence of a positive effect for those who combine high ability and high income may reflect their greater tendency to judge returns on the basis of national, as opposed to local, evidence.

If the differential were to fall by a third ($1000), the overall drop in college entrance would only be .021. These very small impacts suggest that future returns are heavily discounted. Table 10 presents the discount rates extracted by solving the estimated equations for the underlying theoretical parameters β, γ, and r_j. The upper bound discount rate (for $\phi = 1$) can be interpreted as the implicit risk adjusted discount rate for valuing local earnings differentials when the cash flow constraint is not binding. The implicit discount rate for valuing economy-wide changes in future returns is lower. If only one quarter of the geographic variation in earnings differentials are translated into shifts of the projections of individual students and their parents, we obtain the discount rates presented in the lower right of Table 10. Even these discount rates are high. Unless judgments about expected earnings differentials even more heavily discount local experience (that is, ϕ is even closer to 0), we cannot expect a large supply reduction to occur in response to the recent declines in the payoff to college.

Theory makes no prediction about the sign of the coefficent on the opportunity cost of attending college, the wage rate for recent high school graduates (Table 8). The theory sketched in sections 2 and 5 suggests that the sign of the forgone wage variable reveals whether the net benefits test or the cash flow constraint is more important. Coefficients are more negative for the higher-income groups, indicating that a cash flow constraint is less binding on them. Relative to the tuition coefficients (sum of Tables 2 and 3), forgone earnings coefficients are small, however. If the effect of tuition is taken to be the best estimate of $d_4(\beta+\gamma)$, interpreting θ_3 as $d_4(\beta-\gamma)$ implies that in 1961 cash flow problems were a serious impediment to college attendance (Table 10).

The availability of unsubsidized loans shifts out the cash flow constraint and therefore γ can be interpreted as a prediction of their impact. Using the impact of tuition (rather than other costs) as the estimate of $d_4(\beta+\gamma)$ provides an upper-bound estimate of $\gamma/\beta+\gamma$. This ratio averages .47, implying that 47¢ of grant aid has at least as great an incentive effect as the availability of $1.00 of loans. Thus loan aid (and possibly job aid as well) will be cost effective if their net costs are less than 47¢ on the dollar. On the other hand, loans failed a direct test in the linear probability models. Borrowing insured by state guarantee agencies divided by the number of the state's citizens attending college had a negative coefficient more frequently than a positive one. This study, therefore, cannot provide definitive evidence on the cost effectiveness of loan and job aid.

8. Conclusions

Our model of college entrance seems to work quite well. As measured by entropy, the uncertainty of a particular individual's choice is reduced by almost a third. If other background characteristics had been added, uncertainty would have been reduced even more. Policy variables generally have the sign predicted a priori and are statistically significant in about half the strata.

Tuition's impact is large. If in 1961 full-cost tuition ($1100) had prevailed in all colleges without compensating increases in grant aid, these equations predict that the college entrance rate would have been about 17 percent rather than 40 percent.

State governments are monopoly suppliers of low-cost educational opportunity to the citizens of their state. The budgetary cost to the state of increasing the number of college attenders by maintaining low tuition, the marginal subsidy cost, is equal to the per-student subsidy of instructional cost plus the difference between the price paid and the marginal revenue. The lower the tuition elasticity, the higher the marginal subsidy cost. Therefore, students from different backgrounds have quite different marginal subsidy costs (Table 10). The bottom and top ability quartiles have the highest and the lower middle quartile has the lowest. For middle-income students the marginal subsidy cost declines with ability from $12,000 to $1725 to $1122. Social policy has typically been to subsidize the smartest the most. Unless the education of an upper-quartile student produces substantially greater externalities than the education of lower-middle-quartile students, this pattern of marginal subsidy costs suggests that the pattern of price discrimination should be reversed. Smarter students should be charged higher prices.

Within ability quartiles higher-income students typically have somewhat higher marginal subsidy costs. The effect is weak, however, so lower prices for low-income students must be justified on equality of opportunity, not efficiency, grounds.

Table 1

Multipliers for Interpreting Logit Coefficients

	Probability of <u>Not</u> Entering College by Income and Ability: Multiplier for Determining Elasticity*					Multiplier for Determining the Effect on Probability of a Unit Change of an Independent Variable**			
	Ability Percentile					Ability Quartile			
Income	100-73	72-49	48-27	26-0	All Abilities	Top	Upper Mid	Lower Mid	Bottom
High	.158	.394	.595	.626	.376	.113	.199	.212	.147
High mid	.248	.563	.643	.708	.502	.145	.202	.179	.151
Middle	.258	.577	.782	.806	.587	.175	.218	.147	.120
Low mid	.336	.681	.832	.865	.701	.176	.193	.126	.109
Poverty	.439	.751	.882	.907	.809	.202	.162	.093	.073
All incomes	.251	.582	.761	.809	.601				

*The elasticity of college attendance with respect to any right-hand-side variable is obtained by multiplying its mean by its logit coefficient by this probability of nonattendance.

**The impact in the sample of a unit change in an independent variable on the proportion attending college can be obtained by multiplying this by its logit coefficient. $\Sigma \hat{P}_j(1-\hat{P}_j)wt_j/\Sigma wt_j$ is the weighted average of $\hat{P}_j(1-\hat{P}_j)$ of each sample observation where $\hat{P}_j$ is the model's predicted probability of attendance for the "j"th individual.

Table 2

Impact of $100 Increase in Tuition and a Simultaneous Reduction in Other Costs at the Minimum-Cost College on the Log Odds of College Entrance (t ratio)

	Ability Quartile								All Abilities	
Income	Top		Upper Mid		Lower Mid		Bottom		Coefficient	Probability
High	.014	(.26)	-.273	(5.87)	-.010	(.19)	-.181	(2.73)	-.095	-.0179
High mid	-.224	(4.56)	-.042	(.90)	-.803	(10.7)	.111	(1.55)	-.218	-.0374
Middle	.078	(2.73)	-.116	(3.50)	-.411	(8.87)	.045	(1.15)	-.082	-.0135
Low mid	-.098	(2.49)	-.109	(2.89)	-.134	(2.59)	.042	(.88)	-.067	-.0113
Poverty	-.227	(2.79)	-.162	(2.08)	-.382	(3.25)	-.454	(4.23)	-.342	-.0339
Total										
Coefficient	-.043		-.134		-.317		-.063		-.136	
Probability	-.0069		-.0265		-.0467		-.0040		-.0197	

NOTE: This coefficient tests whether a dollar of extra tuition has a stronger disincentive impact than a dollar of other out-of-pocket costs.

Table 3

Impact of an Extra $100 of Travel, Room, and Board Cost on the Log Odds of College Entrance (t ratio)

	Ability Quartile				All Abilities	
Income	Top	Upper Middle	Lower Middle	Bottom	Coefficient	Probability
High	.006 (.17)	-.025 (.80)	-.186 (4.95)	.192 (4.67)	-.008	-.0040
High mid	-.105 (3.04)	-.103 (3.55)	.240 (6.13)	-.269 (4.37)	-.069	-.0105
Middle	-.126 (5.85)	-.095 (4.24)	-.007 (.26)	.027 (.98)	-.054	-.0106
Low mid	-.106 (3.90)	-.031 (1.21)	-.196 (5.64)	-.009 (.29)	-.081	-.0118
Poverty	.140 (2.57)	.066 (1.23)	-.147 (2.29)	-.197 (3.41)	-.087	-.0036
Total						
Coefficient	-.072	-.053	-.074	-.036	-.059	
Probability	-.0119	-.0114	-.0096	-.0029	-.0089	

Table 4

Impact of the Cheapest Four-Year College Being $100 More Costly Than the Cheapest College of Any Kind on the Log Odds of Entrance (t ratio)

	Ability Quartile								All Abilities	
Income	Top		Upper Mid		Lower Mid		Bottom		Coefficient	Probability
High	-.011	(.36)	-.025	(.93)	-.021	(.69)	.267	(4.28)	.031	.0041
High mid	-.122	(4.19)	-.075	(2.61)	.116	(3.25)	-.037	(.55)	-.047	-.0074
Middle	-.050	(2.46)	-.048	(2.26)	.028	(1.11)	-.045	(1.30)	-.031	-.0056
Low mid	-.190	(8.48)	-.027	(1.18)	-.113	(3.88)	-.044	(.99)	-.088	-.0134
Poverty	.092	(2.05)	.022	(.46)	-.163	(2.70)	-.138	(1.95)	-.091	-.0049
Total										
Coefficient	-.073		-.037		-.033		-.023		-.042	
Probability	-.0119		-.0078		-.0027		-.0009		-.0060	

NOTE: A negative coefficient indicates that higher costs at four-year colleges even when junior colleges are cheaper and stay at the same price will lower college entrance rates.

Table 5

Impact of the Proportion of High School Graduates Admissible at the Minimum-Cost College on the Log Odds of Attendance (t ratio)

Income	Ability Quartile: Top	Upper Middle		Lower Middle		Bottom		All Abilities: Coefficient	All Abilities: Probability
High	0	.11	(.41)	.50	(1.79)	2.87	(7.86)	.62	.099
High mid	0	1.61	(6.71)	.85	(2.50)	.69	(1.82)	.77	.145
Middle	0	-.17	(1.04)	.59	(2.66)	1.25	(5.72)	.41	.052
Low mid	0	.54	(3.03)	1.19	(5.40)	.90	(3.29)	.70	.092
Poverty	0	-.35	(1.0)	-.18	(.35)	-.36	(.95)	-.27	-.026
Total									
Coefficient	0	.37		.68		.99		.51	
Probability	0	.074		.03		.1345		.0758	

NOTE: Selectivity was constrained to have a zero coefficient for those in the top ability quartile because they were admissible at the most selective of the minimum-cost colleges.

Table 6

Impact of the Social Status of Neighborhood on the Log Odds of College Attendance

Income	Ability Quartile: Top		Upper Mid		Lower Mid		Bottom		All Abilities: Coefficient	Probability
High	.001	(.36)	-.003	(1.03)	.013	(2.56)	.032	(5.17)	.008	.0012
High mid	.014	(2.61)	.027	(5.22)	.030	(4.65)	.014	(1.79)	.021	.0037
Middle	-.005	(2.50)	.027	(6.39)	.001	(.12)	.036	(9.84)	.014	.0023
Low mid	-.008	(2.2)	-.018	(3.42)	-.009	(1.38)	.024	(4.24)	-.001	-.0006
Poverty	.040	(4.9)	.030	(4.42)	.008	(.86)	-.017	(1.93)	.006	.0017
Total										
Coefficient	.002		.011		.005		.020		.010	
Probability	.0003		.0022		.0010		.0028		.0016	

NOTE: Social status of neighborhood is the real median family income in hundreds of dollars in Lower Middle through Upper Middle income classes and median years of education of adults over age 25 measured in tenths of years of schooling in the poverty and high-income strata. The standard deviation of both these variables is 14.6. The neighborhood is defined as the census tracts immediately surrounding the high school in big cities, the town or village in suburbs and small cities, and the rural part of the county in communities with populations smaller than 2500.

Table 7

Impact of $100 Higher Local Labor Market Earnings Differential Between College and High School Graduate Occupations on the Log Odds of College Entrance (t ratio)

Income	Ability Quartile: Top		Upper Mid		Lower Mid		Bottom		All Abilities: Coefficient	All Abilities: Probability
High	-.039	(2.83)	-.035	(2.82)	.073	(5.49)	-.039	(2.09)	-.016	-.0013
High mid	-.039	(3.13)	.001	(.06)	.070	(3.91)	-.070	(3.16)	-.012	-.0014
Middle	.003	(.28)	.036	(3.97)	.058	(5.43)	-.018	(1.51)	.017	.0032
Low mid	.010	(.97)	.052	(4.91)	.055	(4.44)	-.016	(1.34)	.023	.0039
Poverty	.050	(2.06)	.092	(5.10)	.031	(1.35)	.002	(.11)	.034	.0051
Total										
Coefficient	-.0113		.025		.058		-.022		.0125	
Probability	-.0011		.0048		.0090		-.0030		.0021	

NOTE: The local labor market is either the SMSA of residence (1970 definition) or the non-SMSA portion of the state. The earnings differential is between median operative earnings and the average of accountants, male secondary school teachers, and electrical and mechanical engineers. Mean and standard deviations are 29.5 and 5.7 respectively.

Table 8

Impact of $100 of Extra Real Forgone Earnings or Earnings Capacity on the Log Odds of College Entrance

Income	Ability Quartile: Top		Upper Mid		Lower Mid		Bottom		All Abilities: Coefficient	Probability
High	-.100	(3.83)	-.120	(5.01)	-.011	(.38)	-.086	(2.45)	-.085	-.0128
High mid	-.079	(3.08)	-.039	(1.50)	-.009	(.25)	-.053	(1.18)	-.049	-.0079
Middle	.005	(.29)	-.106	(5.73)	.037	(1.57)	-.084	(3.77)	-.037	-.0068
Low mid	.108	(4.59)	-.007	(.31)	.076	(2.84)	-.152	(5.64)	-.006	.0011
Poverty	-.045	(1.07)	.039	(1.0)	-.005	(.11)	-.078	(1.78)	-.039	-.0023
All incomes										
Coefficient	-.019		-.059		.029		-.100		-.037	
Probability	-.0014		-.0124		.0037		-.0116		-.0054	

NOTE: Real forgone earnings is defined as one-third of median yearly earnings of operatives in the SMSA or county (outside SMSAs) adjusted for cost of living differentials. Using 1300 hours as the estimate of study time and taking account of the lower wage rates received for part-time and summer jobs, the ratio of before-tax forgone earnings to yearly earnings of operatives is .41. A marginal tax rate of 20 percent makes .33 the ratio of a youth's after-tax earnings to the gross earnings of operatives.

Table 9

Impact of Draft Pressure on College Attendance by Income and Ability: Log Odds Coefficient and (asymtotic t ratio)

	Ability Quartiles				All Abilities	
Income	Top	Upper Mid	Lower Mid	Bottom	Coefficient	Probability
High	.381 (4.74)	.279 (3.68)	-.067 (-.71)	.470 (4.71)	.282	.0392
High mid	.169 (2.06)	.061 (.79)	-.461 (4.79)	.467 (3.35)	.072	.0090
Middle	.144 (2.42)	.032 (.58)	.184 (2.82)	.529 (7.47)	.226	.0325
Low mid	-.039 (.58)	.008 (.12)	.049 (.62)	.337 (4.58)	.109	.0117
Poverty	-.154 (1.21)	-.373 (3.80)	.047 (.35)	-.228 (1.76)	-.177	-.0219
Total						
Coefficient	.156	.039	.003	.326	.131	
Probability	.0203	.0093	-.0028	.0445	.0188	

NOTE: Draft Pressure is 100 times the ratio of induction and preinduction physicals passed to the stock of nonfathers under 26 who are or would be classified 1-A, 1-A-0, IS or II-S. Note that as defined the actual number of deferred college students from a state does not affect the measure. Its mean and standard deviation are 4.05 and .817. It is higher where mental test failure rates are high, where occupational and hardship deferment policies are liberal, and where voluntary enlistment is uncommon. A positive coefficient is predicted by the "channeling" hypothesis.

Table 10

Derived Theoretical Parameters

	$\hat{d_4\beta}$ (Net Benefits Test Parameter)[1]				$\hat{d_4\gamma}$ (Cash Flow Constraint Parameter)[2]			
	Top	Upper Mid	Lower Mid	Bottom	Top	Upper Mid	Lower Mid	Bottom
High	*	−.209	−.103	*	*	−.089	−.093	*
High mid	−.204	−.092	−.286	−.105	−.125	−.053	−.277	−.053
Mid	−.022	−.159	−.191	*	−.027	−.053	−.277	*
Low mid	−.048	−.073	−.127	*	−.156	−.066	−.173	*
Poverty	−.035	−.028	−.267	−.364	−.021	−.068	−.262	−.297
All Incomes	−.057	−.123	−.181	−.076	−.063	−.064	−.202	−.358
	Upper-Bound Discount Rate[3]				Discount Rate when $\phi = .25$[4]			
High	*	∞	.22	*	*	∞	.07	*
High mid	∞	1+	.40	∞	∞	.90	.16	∞
Mid	.60	.44	.36	*	.28	.18	.14	*
Low mid	.45	.22	.30	*	.19	.07	.11	*
Poverty	.21	.06	.60	1+	.07	.00	28	1+

[1] Change in the log odds of college entrance from a hundred-dollar improvement in the Net Benefits Test (B_j) while there is no change in the Cash Flow Constraint. It is based on the tuition coefficient and calculated as $(\theta_2 + \theta_3) \div 2$. * indicates where the model breaks down because $\hat{\theta}_2 > 0$.

[2] The corresponding parameter for the cash flow constraint and, therefore, an estimate of the effect of loan or job aid. $d_4\hat{\gamma} = (\theta_2 - \theta_3) \div 2$.

[3] The interest rate that equates d^*/d_4 and θ_4/β, assumed as when $\theta_4 < 0$.

[4] The interest rate that equates $.25d^*/d_4$ and θ_4/β.

FOOTNOTES

[1]One way this can happen is for the true variable X^T to be related to the measure X^M by $X^T = a + X^M + u$, where a is a constant and u a random error independent of X_1^M. When the error-generating process is of this type we will call it Bergsonian. If in a multivariate model u is uncorrelated with other variables in the model, the coefficient on X^M is an unbiased estimate of the true coefficient. Too high a level of aggregation for an independent variable is one way in which measurement errors of this kind are caused. While coefficients are unbiased, the variance explained and the statistical significance of the variable decline.

[2]In a recent paper, Kohn, Manski and Mundel have used this approach. For those attending college in their sample they estimated a conditional logit model of college choice separately in two states--Illinois and North Carolina--and for three social status groups. The independent variables employed were tuition, room and board charges, distance, average ability of students, college revenue per student, type of college, and the student's ability relative to the average for the college. Except for the college actually attended, the ten colleges that were compared were randomly chosen from among a set of feasible colleges that could be as large as 100. The coefficients of the choice model may be interpreted as generating a utility index for each school for each person.

The variation across individuals in the maximum value of this utility index was solely a function of the parts of the choice model that interact student and college characteristics: physical proximity, the congruence of one's own ability with the average for all students at the school, and admissibility. Because the college going model was estimated separately for each state, none of the variation in the maximum of the utility index was due to tuition.

[3]Here we are assuming that when choosing among colleges parents generally expect their children to share the extra costs of more expensive options: $\frac{\partial C^p}{\partial (T+R-S)} < 1$.

[4]Predominantly white southern colleges were considered biracial, actually in a black's choice set, if the number of black students was either greater than fifteen or at least a percentage of the student body equal to one tenth of the black percentage of that state's population. By this criterion in 1961 no white colleges were biracial in Alabama, Georgia, Mississippi, and South Carolina. There were one each in Arkansas and Florida, seven or eight in Louisiana and North Carolina, ten out of thirty-eight in Tennessee, and thirty-nine out of ninety in Texas.

[5]In 1961 Catholic and Protestant denominational colleges typically required some form of religious education. At Catholic colleges Catholics were required to take eight to eighteen hours of theology. Non-Catholics were generally allowed to substitute "religion" courses. Protestant denominational colleges typically had compulsory chapel. In 1967 only 2.9 percent of the freshmen at Catholic four-year colleges were Protestant and only 6.7 percent of freshmen at Protestant colleges were Catholic.

[6] In 1961 many publicly supported institutions charged lower fees to students who applied from within the district that provided financial support. In 1961 schools of this type were the municipal universities of Kansas, Kentucky, Ohio, Nebraska, and New York and public junior colleges in Arizona, Colorado, Florida, Idaho, Illinois, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Oregon, Texas, and Wyoming. In some states the in-out district price differential was smaller--$40 or so in Iowa--but in others, Illinois and Maryland for instance, it was between $200 and $300.