Student Time Allocation and Scholastic Ability

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Abstract

This paper examines the relationship between academic ability and student allocation of time to school work, market work and "leisure" activities. Based on a sample of undergraduates at two U.S. universities, we find that students with greater scholastic aptitude allocate greater amounts of time to studies and to market work, while consuming lower amounts of leisure. These results indicate the existence of a dominant substitution effect in time allocation with respect to the time price of grades.

I. Introduction

The likely impact of educational reforms depend on the nature of student response to changes in the academic environment. In order to correctly predict these responses, a delineation of the alternative uses of students and time and the associated costs and benefits of various activities is necessary. Numerous studies have analyzed the impact of alternative instructional methods (Frieden and Staaf, 1973; Kelly, 1972; Prince, 1981; Wetzel, 1977) and the accuracy of the grading system (Kelley, 1975) on student achievement, or learning, in their courses. This study does not focus on achievement per se, but rather employs a utility maximizing model of student behavior (McKenzie and Staaf, 1974; W. Becker, 1982) to look at the effect of differential academic ability (controlling for differential market productivity) on student time allocation decisions (G. Becker, 1965).

In a similar fashion to the analysis of labor supply in a family context (Mincer, 1962), the student may be viewed as having a tripartite choice in the allocation of his time while in school; (1) (i) allocation to studies, (ii) allocation to market work, and (iii) a residual category that may be thought of as leisure time. (2) From basic price theory we know that the optimal allocation of time will occur where the marginal utility from an activity relative to the price of engaging in that activity is equalized across all relevant activities. Students with greater academic capacity, namely a greater ability to transform their time into knowledge, essentially face a lower time price of grades (and a higher opportunity cost of leisure and market work) than do less academically capable students. As with the standard labor supply problem, this lower price will produce both substitution and income effects, the former encouraging time at school work, the later skewing time towards market work and/or leisure activities. The net result is theoretically indeterminate and, hence, is ultimately an empirical question. As such, this study attempts to shed light on the nature of student time allocation responses to relative prices based on a sample of undergraduates enrolled at two U. S. universities.

The paper is organized as follows - Section II develops an expository model of student time allocation, the implications of which are tested on our sample of undergraduates in Section III. Section IV reports our conclusions and possible policy implications.

II. Student Time Allocation

As stated above, the purpose of this paper is to conduct an empirical investigation of student time allocation decisions. As such we have not attempted to formally model student behavior, but rather present a largely expository statement of the nature of the problem, albeit in a static setting. (3) Hence, the nature of the problem facing the student may be simplified for graphical representation by collapsing the time allocation problem into one between school work and leisure. Let student utility be written as a function of grades, G, (4) and leisure, L;

$$U = U(G,L) \quad (1)$$

where U(G,L) is assumed to be continuous and twice differentiable with positive first partials and negative second partials for both arguments. Accumulated knowledge, X, is produced by a production function (assumed to be linear for simplicity; see Hanushek, 1979; W. Becker, 1983), where β_0 denotes an initial endowment of knowledge, β_1 student academic ability, S time allocated to school. (5)

$$X = \beta_0 + \beta_1 S \tag{2}$$

Grades are assumed for simplicity to be proportional to knowledge, with g denoting the factor or proportionality;

$$G = gX \tag{3}$$

Substituting (2), and a time budget constraint T = L + S, into (3) yields;

$$G = g[\beta_0 + \beta_1(T - L)] \tag{3'}$$

Maximizing (1) subject to (3'), and then solving for the change in time allocated to studies consequent on a change in academic ability, yields;

$$\partial S/\partial\beta_1 = (-\lambda D_{11} + SD_{31})\, g/D \tag{4}$$

where D_{ij} is the i,j determinant of the corresponding Hessian. We may rewrite (4) as;

$$\partial S/\partial\beta_1 = [(\partial S/\partial\beta_1)_U + S\partial S/\partial\beta_0] \tag{4'}$$

which is the familiar Slutsky equation in the context of time costs, where $(\partial S/\partial\beta_1)$ is the uncompensated ability effect, $(\partial S/\partial\beta_1)_U$ is the compensated ability (substitution) effect, and $(S\partial S/\partial\beta_0)$ is the income, or initial (precourse) endowment of knowledge effect. Since the substitution effect is positive, and the endowment effect is negative (assuming that leisure is a normal good), the total effect is, as usual, indeterminate.

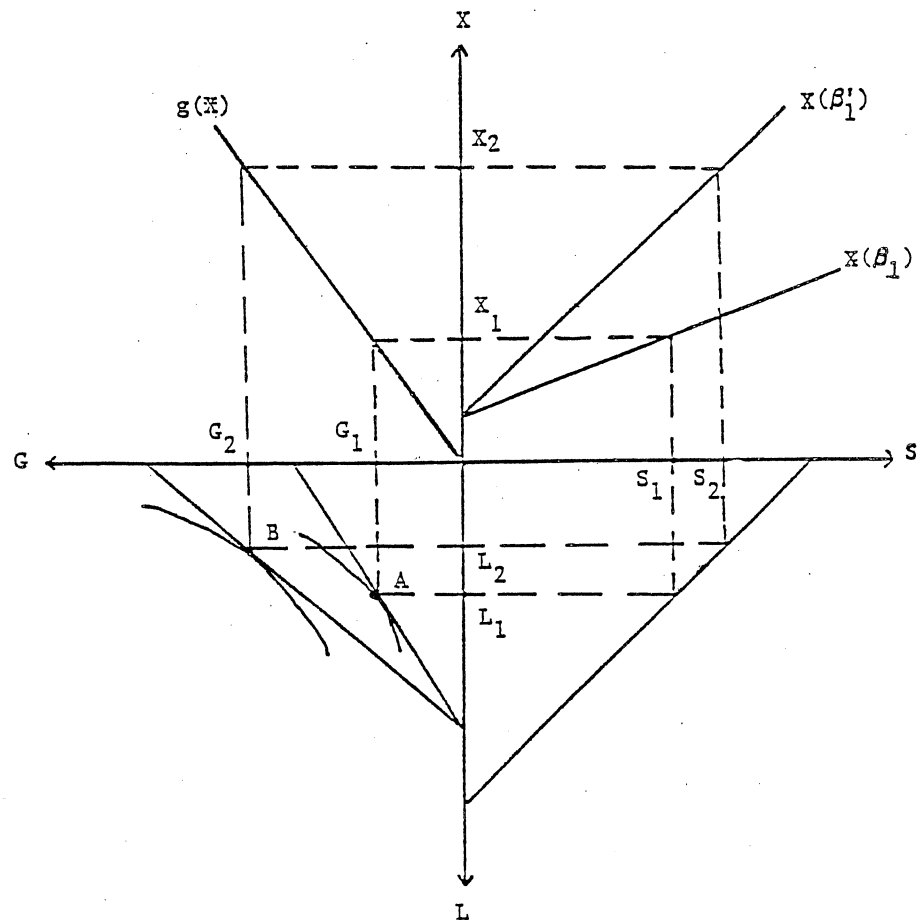
The above relationships are graphically represented in Figure 1 below. Equation (3) is depicted in the northwest quadrant, equation (2) in the northeast quadrant, equations (1) and (3') in the southwest quadrant, with the time budget constraint in the southeast quadrant. Assume that the student is initially maximizing utility at point A, where the rate at which he can substitute leisure for grades equals his willingness to do so, yielding time allocation (L_1,S_1) and resulting (X_1,G_1). Say that there is now an exogenous increase in ability (alternatively, say that we look at a more capable student) from β_1 to β_1', so that the production function rotates upwards. As β_1 increases, we also find that the constraint in (3') rotates outward, (6) indicating that at any level of leisure a higher G is attainable, and that L may now be transformed into G at a greater rate.

Clearly, any number of possible time allocation patterns can result from this change depending on the relative magnitudes of the substitution and income effects. As β_1 rises, the time price of grades falls and the price of leisure rises, so that if the resulting substitution effect on leisure dominates the income effect (shown in Figure 1), the new tangency point will be above the initial point A, say B, thereby yielding an increase in time allocated towards school (from S_1 to S_2) and a reduction in leisure time (from L_1 to L_2). Alternatively, if the opposite is true (not shown in Figure 1), then we will observe a higher level of leisure (7) and a lower amount of time allocated to school, but not necessarily a corresponding fall in either grades or achievement (assuming that grades are normal goods). (8)

As noted above, the sign of the net effect of varying scholastic ability is theoretically indeterminate; yet, insight into the relative strengths of the substitution and income effects may be inferred from looking at actual time allocation patterns for a cross-section of students. Table 1 lists the definitions of the variables used, with their means and standard deviations, while Table 2 and 3 report the estimates from a series of time use equations, for University of Miami (U.M.) and University of Tennessee (U.T.) students, respectively. (9)

Looking at Table 1, we see that both groups of students exhibited highly similar time allocation patterns, with U.M. students spending somewhat less time in the market and allocating this time predominantly to leisure activities. Average weekly study time differed by only approximately 1.5 hours between the samples. (10) In order to investigate the relationship between academic ability and these time allocations, Table 2 reports multivariate estimates of time allocation patterns. Each time allocation regression includes actual or predicted (11) average hourly earnings as an explanatory variable in order to take into account the effects of productivity in the market (the opportunity cost, or price, of not allocating time to the market) on time allocation. In addition, we include a measure of academic ability as an explanatory variable in order to capture the effects of academic productivity - namely the time price of grades. Although admittedly imperfect, we use test score results (SAT scores for U.M. and ACT scores for U.T.) to proxy academic ability. Other possible proxies, such as high school rank or current university cumulative GPA would capture both productivity in learning (e.g. the amount of time necessary to acquire a given unit of knowledge) and prior time allocation decisions, and,

Figure 1
The Time Allocation Effects of an Increase in Scholastic Ability



hence, are less desirable as a relative price measure. (12) We, additionally, control for parental income (and the percentage of college costs borne by the student) in order to take into account income effects and/or the effects of socio-economic background or preferences, habits (Becker and Murphy, 1988), and/or expectations placed on the student. (13)

The first column of Tables 2 and 3 report OLS estimates of the determinants of student allocation of time to studies. (14) The second column reports probit estimates of the probability of a student holding a job, while the third column reports selectivity corrected estimates (using the selection equation results in column 2; Heckman, 1979) of the student's labor supply (to the market) decision. Finally, column 4 reports OLS estimates of time allocated to "leisure" (non-academic and non-income earning activities).

In both samples, we see that students with greater scholastic ability allocate significantly more time to studies and significantly less time to leisure activities, even after controlling for potential market returns, (15) parental income, and student monetary investments (16) in their college degree. For example, a hundred point increase in SAT scores (U.M.) would yield an average increase in study hours of 1.6 per week and an average decrease in time allocated to leisure activities of approximately 2 hours per week.

Concerning scholastic ability effects on time allocated to the market, we see that as ability increases, U.M. students are significantly less likely to hold a paying job, yet (controlling for selection into the market) are not significantly different from other students with regard to how many hours they work. (17) For U.T. students, the opposite result seems to hold; more capable students are more likely to hold paying jobs, although their weekly hours are also

Table 1: Variable Definitions and Descriptive Statistics[a]

Variable	Definition	Mean (Standard Deviation)			
		U.M.		U.T.	
MWAGE	Imputed[b] hourly earnings during the school term	5.62	(2.04)	3.97	(1.09)
WAGE	Actual hourly earnings for students with jobs	5.59	(2.90)	4.10	(1.35)
HWORK[c]	Average hours worked per week during the school term	16.75	(8.51)	20.43	(9.85)
TSAT	Combined Scholastic Aptitude Test scores	1116.00	(144.5)	-	-
ACT	American College Test scores	-	-	20.87	(4.0)
STUD	Average weekly hours spent studying during the semester (includes 1 hour per credit)	29.47	(10.70)	28.74	(8.03)
LEIS[d]	Average weekly leisure hours during the semester	74.03	(15.18)	70.40	(14.08)
AGE	Respondent's age	19.39	(1.25)	20.25	(1.60)
PCOST	Percentage of total college costs paid by the family	20.97	(31.49)	36.97	(39.38)
PINC2	=1 if parents' income is between $15,000 and $24,999	0.08	(0.27)	0.19	(0.39)
PINC3	=1 if parents' income is between $25,000 and $50,000	0.24	(0.43)	0.45	(0.50)
PINC4	=1 if parents' income exceeds $50,000	0.64	(0.48)	0.31	(0.46)
CREDIT	Number of credit hours currently being taken	14.55	(2.13)	15.48	(2.46)
SEX	=1 if male	0.61	(0.49)	0.51	(0.50)
BLACK	=1 if black	0.05	(0.21)	0.08	(0.27)
WHITE	=1 if white	0.73	(0.44)	0.91	(0.29)
MAR	=1 if married	0.01	(0.11)	0.08	(0.27)
JOB	=1 if the respondent has a job for pay	0.44	(0.50)	0.57	(0.50)
FT	=1 if the respondent has a full-time job	0.03	(0.17)	0.07	(0.25)
LAMBDA	Selectivity correction term	0.80	(0.26)	0.60	(0.26)

a. The Miami sample (UM) had 339 complete observations, while the Tennessee sample (UT) had 252 complete observations.
b. See footnote 12 for a discussion of the imputation process.
c. HWORK values are averaged over those respondents reporting positive hours of work for pay (sample sizes of 155 and 146 for UM and UT, respectively).
d. LEIS is calculated as 112-HSTUD2-HWORK (where 112 = 7 daysX16hours per day).

Table 2: Student Time Allocation Patterns (U.M.)*

Regressors	HSTUD	JOB	HWORK	LEIS
Constant	9.700	-2.832[b]	33.406	110.87[a]
	(11.08)	(1.38)	(64.48)	(14.76)
TSATx10	0.161[a]	-0.009[c]	0.079	-0.202[a]
	(0.04)	(0.005)	(0.14)	(0.05)
MWAGE	0.513[a]			-0.697[c]
	(0.32)			(0.44)
WAGE			0.458[c]	
			(0.25)	
PCOSTx10	0.557[a]	0.051[b]	0.269	-0.962[a]
	(0.18)	(0.02)	(0.78)	0.25)
MAR	-7.868[d]	0.765	15.909[a]	2.988
	(5.39)	(0.70)	(6.22)	(7.15)
AGE	-0.212	0.122[b]	-0.267	-0.460
	(0.51)	(0.06)	(1.90)	(0.68)
PINC	12.640	0.078	-2.257	-4.000
	(3.51)	(0.43)	(3.77)	(4.65)
PINC	22.735	0.050	-4.858[d]	-3.387
	(3.06)	(0.38)	(3.37)	(4.06)
PINC	30.766	-0.304	-1.888	0.926
	(2.91)	(0.36)	(5.38)	(3.87)
FT	0.906			-25.571[a]
	(3.41)			(4.52)
SEX	-0.735	-0.073	0.743	1.349
	(1.21)	(0.15)	(1.76)	(1.60)
WHITE	1.094	-0.660[a]	4.011	1.506
	(1.48)	(0.18)	(10.09)	(1.96)
BLACK	4.773	-0.690[b]	5.327	-2.219
	(2.91)	(0.35)	(11.01)	(3.84)
LAMBDA			-7.747	
			(24.66)	
R^2	0.1140		0.1696	0.2261
Log-likelihood		-214.53		

*Standard errors are listed in parentheses. Columns (1) and (4) are estimated by OLS, column (2) reports probit estimates, while column (3) reports selectivity corrected results (OLS). Superscripts a-e denote significance at the 1%, 5%, 10%, 15% and 20% levels, respectively. Columns (1), (2) and (4) use the full sample of 339, while column (3) is just for the sample of students with jobs. (n-152).

Table 3: Student Time Allocation Patterns (U.T.)*

Regressors	HSTUD	JOB	HWORK	LEIS
Constant	14.035[c] (8.33)	-3.434[d] (1.41)	74.382 (150.20)	111.131[a] (12.47)
ACT	0.280[b] (0.13)	0.050[b] (0.02)	-1.174 (1.66)	-0.614[a] (0.20)
MWAGE	-0.394 (0.58)			0.164 (0.87)
WAGE	0.782 (1.50)			
PCOSTx10	0.237[b] (0.136)	0.002 (0.002)	0.014 (0.08)	-0.051[a] (0.02)
MAR	0.808 (2.03)	0.100 (0.35)	3.191 (6.86)	-2.467 (3.04)
AGE	0.744[c] (0.40)	0.146[b] (0.063)	-1.159 (4.39)	-1.570[a] (0.61)
PINC1	-1.177 (2.50)	-0.412 (0.44)	7.996 (14.52)	4.269 (3.74)
PINC2	-1.173 (2.35)	-0.182 (0.42)	3.852 (8.59)	2.490 (3.52)
PINC3	-0.466 (2.45)	-1.022[b] (0.42)	19.469 (34.85)	7.323[b] (3.67)
FT	-4.593[b] (2.32)			-22.021[a] (3.46)
SEX	-1.674[d] (1.07)	-0.230[e] (0.17)	6.968 (8.65)	2.555[d] (1.60)
WHITE	-3.884[b] (1.81)	0.187 (0.29)	1.047 (8.66)	1.374 (2.70)
LAMBDA			-35.640 (58.02)	
R^2	0.0875		0.3239	0.3369
Log-likelihood		-154.6		

*Standard errors are listed in parentheses. Columns (1) and (4) are estimated by OLS, column (2) reports probit estimates, while column (3) reports selectivity corrected results (OLS). Superscripts a-e denote significance at the 1%, 5%, 10%, 15% and 20% levels, respectively. Columns (1), (2) and (4) use the full sample of 252, while column (3) is just for the sample of students with jobs (n=146).

insignificantly different from less academically able working students. Nevertheless, the significant labor supply results in the third column are of a rather small order of magnitude, indicating relative insensitivity to academic ability of time allocation decisions to the market. It may be the case, therefore, that students view market work and school work as weak substitutes, and instead respond to a lower time price of grades by varying their leisure time. (18)

IV. Conclusions

In order to achieve social goals, it is critical that policy makers possess knowledge concerning the behavior of the subjects of their policy, and their likely responses to variations in policy. In this study, we have attempted to intuitively describe the factors influencing student time allocation decisions, and to quantify the nature of this behavior, in order to better facilitate the design of educational policy. Our test results are generally supportive of a view of student time allocation behavior as responding to relative prices. This stands in contrast to the recent study by Gleason and Walstad (1988), which although addressing a somewhat different issue than that dealt with here, (19) does not find support for systematic student time allocation patterns.

To summarize our key results, first we find that students are responsive to the time price of grades, and that the substitution effects generated by higher academic ability outweigh income effects. Hence, higher ability students, on average, substitute away from relatively more expensive leisure (in terms of foregone learning, or grades) and towards the relatively cheaper (in terms of required time per unit of knowledge, or grades) time in studies. This result implies that, holding constant the market's evaluation of the worth of the particular institution's degree, professors may increase student effort in their courses by reducing the time price of grades. This may, of course, be accomplished by structuring a course so that the student clearly knows what is required in order to achieve certain grades, and thereby has a higher yield per unit of time allocated to the course, or by simply making it easier to get high grades. Of course, if the latter policy was followed, otherwise A students would now devote less time to the course; hence, the professor who desires to achieve greater student effort in his course, per se, would be unlikely to choose this policy.

Our results also indicate that students are relatively unresponsive to market wages, so that variations in relevant wages (say an increase in the minimum wage) is unlikely to have a deleterious effect on students' devotion to their studies. (20) Finally, we found that students who pay a larger percentage of their college costs by themselves actually devote more time to their studies, less time in leisure activities and, as expected, are more likely to hold a job (in one of our samples). Hence, policies that, say, provide loans to students yet have an accompanying work clause, may further the student's education rather than detract from it.

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Notes

1. A more general model would endogenize the schooling decision. In this paper, though, we take school enrollment as given so that the time allocation decisions investigated may be thought of as conditional on an initial college attendance decision.

2. Time spent in campus organizations might be considered part of the students' academic investment; nevertheless, we treat this as distinct from study time and include it in our leisure category.

3. See Gronau (1979) for a formal model of three sector time allocation (market, home production, and leisure) for married women. A complete model of the student's problem would have to explicitly take into account the relative yields of market experience while in school and grades in an explicitly dynamic (i.e. investment) setting (see Ehrenberg and Schumann, 1986).

4. If grades per se yield minimal utility in themselves, but rather act as intermediary products in the production of post-school earnings which directly enter the utility function, then a more appropriate specification of (1) would be $U = U(W(G),L)$, where W denotes post-school earnings. For simplicity of exposition, Figure 1 below essentially assumes direct proportionality between G and W, so that the g-axis may be changed to W(G) without any loss of our objectives.

5. Faculty teaching efficiency and non-human educational capital goods available at the university will clearly also influence student efficiency in learning. Nevertheless, we do not empirically take these factors

into account since the latter will not vary a great deal across students at a given university, while the former is too imprecise a concept to be able to reasonably quantify.

6. This follows from ----- (G/ L) = -g < 0.

7. Of course, in the more general time allocation context, leisure and/or market work could vary. For diagrammatic purposes, we abstract from the latter; yet, our empirical work explicitly allows for time allocation to market work.

8. Figure 1 could also be used to analyze the effects of making a course more difficult. In this case, the grading function would be rotated upwards, so that any G requires a higher level of X. This would result, ceteris paribus, in an increase in the time price of grades and, hence, a reduction in student time allocation to school if we have a dominant substitution effect. (The quantitative magnitude, though, may be small. There is no a priori reason to believe that the relative strengths of the substitution and income effects of a change in the time price of grades are invariant to the source of the change.) It is interesting to note in this regard that the commonly held belief that increasing course requirements will necessarily raise students's time allocated to studies critically rests on an assumed dominant income effect.

9. We run the two samples separately primarily because students at Miami disproportionately took the SAT tests, while those at Tennessee took the ACT tests, and because the two groups face differential options for non-scholastic endeavors (both market and leisure).

10. Testing for differences in sample means we find that mean HSTUD does not significantly differ between the two schools; yet, HWORK and LEIS both exhibit significant differences in mean values.

11. Wage imputation was necessary in order to estimate the shadow price for market work for those not holding jobs for pay. This was done using Heckman's two stage procedure (1979), where the resulting MWAGE variable uses imputed wages for those who do not report wages, and actual wages for those that do.

12. The fact that SAT scores have been shown to only weakly predict success in a university does not pose a problem here since success in college will be a function both of the student's ability and time allocated to school work while enrolled.

13. Our ethnicity and gender dummies are also introduced in order to control for these factors.

14. The dependent variable, HSTUD, is constructed by taking the number of hours, on average, that the student devoted to studies per week during the semester, plus 1 hour per credit for classroom time. Tobit regressions were also estimated on study time that did not include classroom hours (available on request), both with and without controls for number of credits taken (the former would essentially give us an estimate of study time per credit), and yielded similar results to those shown here. We feel, though, that the reported measure is most consistent with our model, although a fully dynamic model would have to address the question of the optimal speed with which to complete a given degree, and, hence, explicitly model the number of credits taken as a decision variable.

15. Our results were essentially invariant to nonlinear specifications of actual and potential market returns.

16. In both samples, parental income does not seem to exert any effect on student time allocation decisions, although it is quite interesting to note that in both samples, the higher the percentage of college costs borne by the student, the greater amount of time the student allocates to his/her grades.

17. It may be the case that minimum hours restrictions are producing this result; yet, even though both samples do not have widely different average weekly hours (16.75 and 20.43), they both have rather large standard errors.

18. It is instructive to note, in this regard, that wages have no effect on hours worked for U.T. students, while for U.M. students there is a significantly positive effect, albeit rather small. In order to supply an additional hour per week to the market, students require, on average, in excess of $2.00 higher (hourly) wages.

19. Gleason and Walstad focus on testing the model developed by W. Becker (1983) which looks at student achievement (and their allocation for study time) from the perspective of demand theory, while our model focuses on time allocation decisions between school, leisure and market work. Nevertheless, both studies provide evidence on the applicability of optimizing models of time allocation (G. Becker, 1965) to student decision making.

20. This result, of course, strictly only holds for students already enrolled in school; yet, since increases in the minimum wage tend to reduce expected wages through increased youth unemployment, a rise in the

minimum would most likely increase enrollments (Mattila, 1978).

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