Research in Higher Education, Vol. 46, No. 1, February 2005 (© 2005)
DOI: 10.1007/s 11162-004-6291-x

MODEL MIS-SPECIFICATION IN ASSESSING THE IMPACT OF FINANCIAL AID ON ACADEMIC OUTCOMES

Sigal Alon*,**

The focus of the paper is the development of a novel conceptual framework that aims to remedy a critical mis-specification in prior research on the impact of financial aid on academic outcomes: the blending of the effect of aid eligibility with the influence of aid amounts on academic outcomes. To assess the impact of aid amounts received on college graduation while considering aid receipt status as an endogenous variable, I use the procedure of Instrumental Variable Probit. Empirical illustration of this model confirms that the interrelationships between aid eligibility and graduation mask the positive impact of financial aid on graduation.

KEY WORDS: financial aid; college graduation; endogenous variable; instrumental variable probit.

INTRODUCTION

Recently, several authors have investigated the impact of financial aid on college persistence and graduation. Their results, however, are inconclusive, and range from a positive to a negative effect as well as no effect altogether (Cofer and Somers, 2000; DesJardins, Ahlburg, and McCall, 2002; Hu and St. John, 2001; Paulsen and St. John, 2002; St. John and Starkey, 1995). Plausibly, one reason for these incongruous findings is the difficulty in controlling for the relationship between aid eligibility and college outcomes. Specifically, the effect of aid received on graduation may be due to a random selection into aid eligibility. This produce spurious correlations between aid receipt and unmeasured characteristics that are related to graduation. Thus, comparing college success of financial-aid recipients to nonrecipients is not straightforward because

*Tel Aviv University, Tel Aviv, Israel.
**Address correspondence to: Sigal Alon, Department of Sociology and Anthropology, Tel Aviv University, Ramat Aviv, Tel Aviv 69978, Israel. E-mail: salon1@post.tau.ac.il

financial-aid recipients may differ from nonrecipients in several unobserved aspects that are independently related to persistence and graduation, such as academic preparation and family background. As with the likelihood of graduating from college, being qualified for aid depends also on family and personal attributes; hence, the challenge in analyzing the impact of financial assistance on college performance is to separate eligibility for aid from the direct effect of the money received on persistence and graduation. Rather than assume that financial aid eligibility is exogenous to subsequent academic success, aid eligibility and the likelihood of graduation should be modeled simultaneously.

This paper contributes to prior research on the impact of financial aid on academic outcomes by implementing stronger statistical controls for the interrelation between aid eligibility and graduation that otherwise may mask the true impact of financial aid on college outcomes. To assess the impact of aid amounts received on college graduation while considering aid receipt status as an endogenous variable, I use the procedure of Instrumental Variable Probit (Maddala, 1983; Newey, 1987). The model I develop in this paper allow me tease out the net effect of several types of financial aid (grants, loans, work study, and campus employment) on students' graduation rate; and to assess the impact not only of financial-aid status but also of the dollar amounts received.

I empirically demonstrate my conceptual framework with the College & Beyond (C & B) database (Bowen and Bok, 1998). The C & B database contains detailed institutional records on students' graduation status as well as family background. Information drawn from students' transcripts is both more reliable and accurate than self-reports of outcomes available from survey data. Most germane to our focus, C & B data also detail the sources and amounts of financial aid that students received. Results confirm that the interrelationships between aid eligibility and graduation mask the positive impact of financial aid on graduation. Financial aid eligibility (except for merit-based aid) exerts a negative effect on persistence while an increase in the dollar amounts is positively related to college success. The results establish that grant dollars are the most effective component of financial assistance in enhancing college success.

THE PROBLEM

Financial aid should affect college outcomes, like graduation, because it reduces the cost of persistence. Aid should be related to college performance by reducing the need of students to direct time away from academic activities and in so doing, ultimately lower their chances of

dropping out for lack of funds. There are several studies that assess the impact of financial aid on college persistence and graduation. Using data from Indiana's public institutions, St John, Hu, and Weber (2001) find that receipt of grants improves college success, but loans neither lower nor raise college persistence for the cohort matriculated in 1990–91. St. John and Starkey's (1995) analysis, based on a national sample, shows no influence of grant aid on persistence, but aid packages involving loan and work-study dollars lowered persistence. However, restricting the analysis to low-income students, the authors show that grant dollars significantly lower persistence, but neither loans nor work exert significant impact on persistence. Conversely, using the same data, Cofer and Somers (2000) report that grant and loan amounts were all positively and significantly related to persistence for both private and public-school students. Paulsen and St. John (2002) find a negative impact for grant and loan dollars on college persistence of low-income students, but not on middle- or upper-income students. For a sample of students attending the University of Minnesota, Twin Cities campus, DesJardins et al. (2002) find that except for work-study, other components of financial aid do not directly influence graduation chances. However, some components of financial aid are related to stop-out (the temporary halting of education but not dropping out altogether) prevention. They argue that work-study may promote graduation over time.

The lack of consistent evidence that positively links grant aid to college success is the most puzzling result of existing studies in this area. How can we explain the negative influence that grant dollars conferred on low-income students bears on their college persistence? Some researchers interpret this finding by suggesting that a negative effect of aid implies that the dollar amount received is insufficient, while a neutral effect presumes both adequacy of awards and equalization of the odds of graduation (Hu and St. John, 2001; St. John and Starkey, 1995). However, such interpretation, not only being short of explaining the puzzling finding, also assumes that grant recipients are identical to nonrecipients in all other characteristics. For example, a neutral effect means that, *among otherwise comparable students*, grant-recipients are as likely as nonrecipients to persist and graduate. However, this frequently used interpretation of the effect of financial aid is invalid if aid-eligible students differ from noneligible students in many unmeasured attributes that independently affect college success. Therefore, the use of such interpretation not only is conditioned on a careful account for measured background characteristics, but, more importantly, on a simultaneous assessment of aid receipt and graduation in order to control for the unmeasured attributes affecting both eligibility and academic performance.

Clearly, empirical evidence on the impact of financial aid on college success is mixed, partly because studies differ in their methods and samples. Notwithstanding, I argue that the main problem producing inconsistent findings regarding the impact of financial aid on college outcomes is model mis-specification. In the following section I develop a formal model that proposes a way to remedy this problem by assessing the impact of aid amounts received on college graduation while considering aid receipt status as an endogenous variable.

THE MODEL

In fact, we must examine three different, yet highly correlated, constructs: First, academic success; second, eligibility for financial aid; and finally, the dollar amount received by recipients.

The following two equations formally summarize the model. Let Y_i be a measure of college graduation of the ith individual (coded as "1" if the individual graduates); F is a variable indicating the dollar amount of financial aid received and α is its coefficient; $\underline{X}$ is a vector of various observed attributes that influence college graduation; $\underline{B}$ is a vector of their coefficients; and ε is an error term that captures both random errors and unobserved factors affecting graduation. This equation is the one that has been estimated by scholars studying this topic.

The second equation is the financial aid receipt equation. Let T_i^* be a latent continuous variable of financial aid eligibility of the ith individual, ranging from -1 to 1 and T_i is a two value observed variable of the same individual. $T_i = 1$ if $T_i^* > 0$ (received financial aid) and $T_i = 0$ if $T_i^* \leq 0$ (not received financial aid). $\underline{Z}$ is a vector of values on various exogenous (to graduation) observed variables that affect financial aid eligibility; $\underline{C}$ is a vector of their coefficients and v is an error term that captures unobserved factors that affect financial aid receipt.

$$\Pr(Y_i = 1 | F = f_i; \underline{X} = x_i) = \alpha F_i + \underline{B}' \underline{X}_i + \varepsilon_i \tag{1}$$

$$\Pr(T_i = 1 | \underline{Z}_i = z_i) = \underline{C}' \underline{Z}_i + v_i \tag{2}$$

Of great consequence is the fact equations 1 and 2 are related. F and T^* are related as $F_i > 0$ if $T_i^* > 0$ (received financial aid) and $F_i = 0$ if $T_i^* \leq 0$ (not received financial aid). Moreover, T^* and ε are correlated since the same family and personal characteristics influence Y_i and T_i^*. This relationship highlights the problem with the specification of equation 1: under these circumstances assessing (and interpreting) the impact of F on Y is not straightforward because the correlation between T^* and ε will also

produce biased estimates for α. Because the determinants of aid *eligibility* T_i^* and graduating from college Y_i overlap to a large extent, I argue that it is necessary to jointly estimate these outcomes (eligibility and graduation) in order to obtain unbiased estimates for the dollar amount parameters, α.

Instrumental variable technique is adequate for addressing this problem: this model attempts to create a new (predicted) T_i^*, $\hat{T}_i$, that is uncorrelated with the resulting error term ε. $\underline{Z}$ is assumed to be uncorrelated with ε, so it serves as the potential instrument for producing $\hat{T}$. Thus, the inclusion of the instrumented $\hat{T}$ into the graduation equation, as done in equation 3, is purging any correlation between F and the new error term v and produces an unbiased estimates for the dollar amount parameters, β. Moreover, this strategy properly distinguishes between the influence of aid eligibility from that of the dollar amount: δ is the coefficient of the instrumented value $\hat{T}$ and represents the effect of aid eligibility on Y, whereas β captures the net effect of dollar amount on Y.

$$\Pr(Y_i = 1 | \hat{T} = \hat{t}_i; F = f_i; \underline{X} = x_i) = \delta \hat{T}_i + \beta F_i + \underline{G}' \underline{X}_i + v_i \tag{3}$$

Using an adequate specification that separates aid eligibility from aid amounts is the thrust of my conceptual framework. However, another issue that needs to be taken into account when assessing the impact of financial aid on academic outcomes is that different types of aid (i.e., grants, loans, and work-study), may have unequal effects on college persistence and graduation (DesJardins, Ahlburg, and McCall, 1999; 2002). Loan dollars should differ from grant dollars because of their future financial burden and differences in risk evasiveness of students accepting them (Cofer and Somers, 2000; Somers, Woodhouse, and Cofer, 2000). Effects of loans on college persistence can be offsetting: future financial obligation may motivate graduation to cash in on the market advantages of a college diploma but it can also discourage persistence in the face of dwindling performance and an increasing debt load (Cofer and Somers, 2000). It is also important to incorporate a measure of students' campus employment—aside from participating in a work-study program that is need-based—as it constitutes a substantial part of students' financial resources (DesJardins et al., 1999; 2002). For example, if the positive effect of aid on graduation results from lowering the need to work, then campus employment need not enhance college success, whereas work-study aid that places a cap on hours employed should demonstrate a smaller negative effect, no effect or even a positive effect. To differentiate the influence of aid types on the likelihood of graduation the model is replicated for each type of aid as both δ and β are assumed to vary by aid type.

In summary, the focus of the paper is the development of a novel conceptual framework that aims to remedy a critical mis-specification in prior research: the blending of the effect of aid eligibility with the influence of aid amounts on academic outcomes. Consequently, the model suggests a simultaneous modeling of aid eligibility and the likelihood of graduation. To illustrate my arguments and demonstrate the implementation of the suggested model, I use the C & B database and its financial aid information. The following analysis disaggregates aid into distinct aid types, and for each type assesses both impact of financial aid status (instrumented) and the dollar amount obtained on 6-year college graduation.

AN ILLUSTRATION

Data

This study uses the restricted-access C & B database—compiled by the Andrew W. Mellon Foundation between 1995 and 1997—for illustration purposes. The core of the C & B database is an institutional data file, which consists of individual records of more than 90,000 undergraduate students who enrolled at one of 34 academically selective colleges and universities in the fall of 1951, 1976, and 1989 (see Bowen and Bok, 1998, Appendix A). In this study I focus exclusively on the 1989 entering cohort at the C & B schools that provided graduation and financial-aid information. The institutional file draws on students' applications and transcripts, including students' race, sex, SAT scores, college grade-point average, need-based financial aid status, and date of graduation.[1] These individual student records are linked to several other sources, of which I use those provided by the Higher Education Research Institute (HERI) at the University of California, Los Angeles, because of the detailed financial-aid information it makes available. Therefore, the analysis is limited only to 22 C & B institutions that were part of the HERI study.[2] I limit the analysis to U.S. citizens/permanent residents for whom graduation status data were available. The final sample consists of 15,196 students.

Variables

Table 1 provides definitions and descriptive statistics of all variables. The main dependent variable—6-year graduation—was constructed using variables from the institutional file: ''graduation status'' and ''status date.'' Eighty-seven percent of the students in the C & B sample graduated

TABLE 1. Descriptive Statistics of the Sample, 1989 C & B Students

Variable	Definition	Mean / %	Std. Dev.	Min	Max	Source[a]
Grad6	6-year graduation rate	0.87		0	1	Inst. Transcript; Survey
Grants receipt	Received Grants 1 = Yes, 0 = No	0.47		0	1	HERI
Grant amount	Amounts in $	3220.68	2162.04	250	18000	HERI
Grant amount $1000	In $k categories (top coded)	3.60	1.95	1	8	HERI
Loan receipt	Received Loans 1 = Yes, 0 = No	0.33		0	1	HERI
Loan amount	Amounts in $	2516.92	1440.79	250	12000	HERI
Loan amount $1000	in $k categories (top coded)	2.92	1.26	1	6	HERI
Work-study Receipt	Received Work-study 1 = Yes, 0 = No	0.15		0	1	HERI
Work-study amount	Amounts in $	1097.54	518.09	250	2500	HERI
Work-study amount $1000	in $k categories (top coded)	1.64	0.55	1	3	HERI
Worked	Campus employment 1 = Yes, 0 = No	0.32		0	1	HERI
Work amount	Amounts in $	909.57	672.31	250	7250	HERI
Work amount $1000	in $k categories (top coded)	1.46	0.61	1	4	HERI
Independent resources	Received Other Aid 1 = Yes, 0 = No	0.95		0	1	HERI
Independent resources amounts	in $	4110.55	1653.64	250	14000	HERI

TABLE 1. (*Continued*)

Variable	Definition	Mean / %	Std. Dev.	Min	Max	Source[a]
Independent resources $1000	in $k categories (top coded)	4.47	1.53	1	8	HERI
White	White, not of Hispanic origin	0.83		0	1	Composite
Black	Black, not of Hispanic origin	0.07		0	1	Composite
Hispanic	Hispanic, regardless of race	0.03		0	1	Composite
Asian	Asian or Pacific Islander	0.07		0	1	Composite
Parental income $1000	Family income in 15 categories	58.44	35.19	0	175	Composite
Parental education: both BA	Both parents with BA	0.52		0	1	Composite
SAT/100	SAT score/100	11.95	1.96	0	16	Composite
HS Class Rank: top ten	in top 10% of HS class rank	0.55		0	1	Inst. Transcript
Institutional selectivity	Mean inst. SAT scores represented in 50 points increments (1050–1400)	3.76	1.59	1	7	Inst. Transcript
Athlete	Whether the student was an athlete					Inst. Transcript
Mentor	A count of people with whom the student had meaningful contact while in college	0.25	0.71	0	8	Survey
Female	Female = 1, Male = 0	0.55		0	1	Inst. Transcript
No of observations		15196				

[a]A composite variable indicates that several data sources were used to construct this variable.

within 6-years of matriculation. Obviously, this is a very high graduation rate in comparison to national figures. Financial-aid information from the HERI file is derived from a questionnaire administered to college freshmen as part of the Cooperative Institutional Research Program.[3] Important for my purposes, the HERI questionnaire asked students for the sources and amounts of financial aid that they received for college. Nineteen possible aid sources were listed, which I grouped into five main categories. *Grants* included Pell Grant, Supplemental Educational Opportunity Grant, state scholarship or grant, other college grant or scholarship, other private grant, and other government aid (e.g., ROTC, BIA, and GI); *loans* included Federal Guaranteed Student Loan, National Direct Student Loan, other college loan, and other loan; and *work-study* included college work-study grant. The *work* category included part-time job on campus, other part-time job while in college, or full-time job while in college. In doing so, I follow DesJardins et al. (1999; 2002) recommendation to include a measure of students' campus employment aside from participating in a work-study program. This distinction is important for the current analysis as work-study is need-based and is administered through financial aid, whereas on-campus employment is not (DesJardins et al., 2002).

The three aid categories—grants, loans, and work-study—as well as the work category are considered external aid resources. All other resources are grouped as a residual of independent resources—including aid from parents or spouse, savings from summer work, other savings, and other aid—and are not included in the multivariate analysis. I distinguish between whether aid was received and the amounts received. Amounts ranged from nothing to over $18,000 for each financial aid type. To facilitate interpretation of the impact of aid types, I grouped aid amounts in $1000 increments. The descriptive results, depicted in Table 1, show that about one out of two students received grants while, on average, they collected about $3220. One in three students took loans to finance higher education, averaging $2517. Only 15 percent of students participated in work-study programs, collecting around $1110, on average. Most likely this amount reflects a cap on the number of hours that students are allowed to work.

Results

The multivariate analysis is designed to isolate the net effect of amounts of financial aid received (by type) on 6-year graduation status (1 = yes, 0 = no) of C & B students. I estimated two probit models that predict the probability of college completion for the C & B 1989 entering cohort.[4] The first model is a simple probit model of graduation

probability (Eq. 1 in the formal model) that assesses the impact of dollar amounts of aid received, ignoring the possible endogeneity between aid receipt and graduation. The analysis is repeated for each financial aid source (grants, loans, work-study, and work). All models control for race and ethnicity, parental education, academic ability (SAT), past academic performance (high-school class rank), athlete status, number of "mentors" in college,[5] institutional selectivity,[6] and sex.[7] To facilitate the interpretation of the probit regression coefficients, I report the delta-ρ statistic, which is the change in the probability in graduation within 6 years of matriculation associated with one unit change in each independent variable (Petersen,1985; Cabrera, 1994; Peng, So, Stage, and St. John, 2002).[8]

The first probit model, depicted in Table 2, corroborates prior evidence regarding the negative influence of grant dollars on graduation probability. However, these effects of amounts of aid received on graduation may be due to a nonrandom selection into aid eligibility that induces spurious correlations between aid receipt and unmeasured characteristics that are related to graduation. To assess the impact of aid amounts received on college graduation while considering aid receipt status as an endogenous variable, I use the procedure of Instrumental Variable Probit based on Amemiya Generalized Least Squares (AGLS) estimators for probit and tobit with endogenous regressors (Maddala, 1983; Newey, 1987). The endogenous regressor, i.e., aid receipt, is treated as a linear function of empirically derived instruments and the other exogenous variables and is purged of any correlation with the error term in the graduation equation (Pindyck and Rubinfeld, 1998).

Accordingly, the second model replicates the first model while instrumenting aid receipt status and estimating the effect of dollar aid on graduation probabilities (using the specification of equation 3 in the formal model). Results obtained while instrumenting for grants receipt, support my assumption that the positive effect of grant dollars on graduation is masked by the negative influence of grant eligibility. For a student who is average on all characteristics (including the dollar amount of grant aid), an additional $1000 in grant aid increases the probability of graduation by 0.06 (the β coefficient in Eq. 3). However, grant eligibility (δ) decreases the probability of graduation by 0.41. Thus, as expected, students who need financial support to attend college are more likely to drop out of college in the first place, but grant money is potentially capable of partially offsetting this initial disadvantage in the starting line.

Parallel analyses for loans and work-study aid produce very similar results. Dollar amounts of all financial aid components exert a negative influence on graduation in a simple probit model; but when the aid

TABLE 2. Probit and Instrumental Variable Probit Models of 6-year Graduation Among 1989 C & B Students[a] (Delta-*P* statistic is reported and asymptotic standard errors of the underlying coefficients are in parentheses)[b]

	Grants		Loans		Work study		Work	
Variable	(1) Probit	(2) IV Probit	(3) Probit	(4) IV Probit	(5) Probit	(6) IV Probit	(7) Probit	(8) IV Probit
IV (grant/loan/work-study/ work receipt)		−0.407** (0.495)		−0.180** (0.184)		−0.468** (0.698)		−0.302* (0.720)
Grant/loan/work-study/ work $1000 (centered)	−0.005** (0.006)	0.063** (0.086)	−0.008** (0.009)	0.039** (0.049)	−0.019** (0.020)	0.225** (0.373)	−0.022** (0.017)	0.138 (0.388)
Observations	15196	15196	15196	15196	15196	15196	15196	15196

*significant at 5%; **significant at 1%.

[a]All models control for race/ethnicity, parental BA, academic ability (SAT), past academic performance (HS class rank), athlete status, number of "mentors" in college, Institutional selectivity, and sex. Models also include flags for missing data.

[b]The interpretation of the delta- statistic for a centered continuous variable (centered discrete change) is the change in the predicted probability of 6-year graduation associated with a unit change in the independent variable that is centered around its mean, holding all other variables at their mean.

eligibility is accounted for, the amount of aid received from all components (except for campus employment) is positively related to college success. However, there are few differences between the long-term impact of money channeled through grants and scholarships, and other financial-aid components. Loan eligibility exerts a smaller penalty on graduation probability than grant eligibility, but the gains from every additional 1000 loan dollars, in terms of college success, are smaller as well.

Conversely, the magnitude of the effect for work-study dollars is larger than that depicted for grants. Plausibly, this reflects the limited amounts that can be collected from such programs due to the cap on the number of hours that students work. In other words, work-study compensation has a positive influence on graduation, but conceivably only because there is a ceiling on the number of hours a student can work while in college. This interpretation is substantiated by the lack of statistically significant positive effect for money obtained from other campus employment (not through the work-study program) on graduation likelihood. These results clearly demonstrate the necessity to separate financial aid eligibility from amounts received. They also are very straightforward about the superiority of grant dollars on money obtained from all other aid components.

DISCUSSION AND DIRECTIONS FOR FUTURE RESEARCH

The novel conceptual framework implemented herein aims to separate the influence of eligibility for aid on academic outcomes from the influence of the actual dollar amount received. The results show that it is critical to separate financial aid receipt from college outcomes, because the same factors that produce aid eligibility are also independently related to college success. Implementing stronger statistical controls for the interrelationship between aid eligibility and graduation establishes that this relationship does mask the positive impact of financial-aid dollars on graduation. This insight helps us re-visit the puzzling evidence found in the literature about a negative effect of dollar aid on persistence without resorting to complex interpretations as was done in past research. Evidently, this negative effect is resulting from a model mis-specification of not separating aid eligibility from future college success.

Moreover, this insight can also explain why the evidence in the literature regarding the effect of aid on persistence is mixed. When aid eligibility is unaccounted for, its influence is delegated through the effect of the financial aid amounts variables (α in Eq. 1). Since aid eligibility depends on background characteristics, the effect of financial aid—when aid eligibility not accounted for—depends on the specification of the

background characteristics' vector (the $\underline{X}$ vector in equation 1) included in each analysis. A good illustration is the difference between Cofer and Somers (2000) and St. John and Starkey (1995) analyzing same data but arriving at different findings regarding the effect of dollar aid. I hope further research will build on the current research's conceptual framework and use the correct specification for modeling the impact of financial aid on academic outcomes. Future research should extend such investigation to other college outcomes, such as within-year persistence decisions, while using other data sets to strengthen the external validity of my findings.

Another key issue should be incorporated in future research when implementing this model, especially when estimating the impact of grant aid on college outcomes. Since grants and scholarships may be awarded to meeting need and/or rewarding talent, it is essential to distinguish between two types of aid eligibility: need- versus merit-based aid. It is important to separate the effects of these two scholarship types because while receipt of need-based aid would likely indicate greater probability of inadequate academic preparation and low socioeconomic status, receipt of merit–based aid may reflect just the opposite. If this is the case, then a separate estimation of equation 3 for need- or merit-based aid, should produce a need-based aid eligibility, δ_n, that is negatively correlated with graduation likelihood while the merit-based eligibility, δ_m, should be positively correlated with the graduation outcome. Results obtained using the C & B data (not presented here) demonstrate this contrast between the need- and merit-based aid eligibilities: while need-based aid eligibility is negatively associated with 6-year graduation likelihood, the opposite is true for merit-based aid eligibility. Moreover, in light of the growth in merit aid (Heller, 2001; McPherson and Schapiro, 1998), it is important to examine whether dollars received to acknowledge academic performance produce similar results as dollars given to meet students' need. Since mixing them in the same model may confound the findings, future analyses should differentiates the influence of receiving need-based from merit-based aid on the likelihood of graduation.

ACKNOWLEDGMENTS

This research was supported by a grant from the Andrew W. Mellon Foundation to the Office of Population Research, Princeton University. I am grateful for comments made by Marta Tienda, Yitchak Haberfeld, and two anonymous reviewers on an earlier version of this paper.

ENDNOTES

1. For most institutions, the C & B data files included the entire entering cohorts. However for some institutions the data are derived from samples (Bowen and Bok, 1998). In these cases, sample weights are equal to the inverse of the probability of being sampled. All descriptive statistics presented use appropriate sample weights so that the results accurately represent the entire entering cohort at each institution. These weights allow projections to all C & B institutions (but not to the entire postsecondary universe). Weights are not used in the multivariate analysis because such a procedure would violate the assumption of independence of observations (Winship and Radbill, 1994).
2. To assess the potential bias associated with limiting the analysis to the HERI data, I compare descriptive statistics for selected variables. The results from this sensitivity analysis, available upon request, assure that no bias is caused by limiting the analysis to the HERI data.
3. The financial aid data were collected at the beginning of the first freshman year and were not supplemented later. More recent information of financial aid could, of course, strengthen the analysis.
4. The C & B sample design (small number of institutions and large number of students) requires that all multivariate analyses be adjusted to account for the complex survey design of the data set, namely the clustering of observations in primary survey units. This correction is designed to affect the estimated standard errors and the variance-covariance matrix of the estimators, but not the estimated coefficients. It specifies that the observations are independent across clusters (institutions), but not necessarily within clusters. Unfortunately, the current version of IV probit in STATA does not allow using this option. To assess the effect of potential reduction in variance resulting from not correcting for clustering, I estimated a simple probit model (Model 1 in Table 2) twice: with and without clustering correction (available upon request). As expected, the point estimates are not affected, but the standard errors obtained from modeling without correction are smaller than they should be. This could lead to a type-I error in which estimates are found to be significantly different from zero when actually they are not because of the downward-biased standard errors. However, the sensitivity analysis reveals that all variables (except for three: Hispanic, athlete status, and female) that were significantly different from zero in the model without implementing the clustering correction were also statistically significant in the clustered model. Thus, the multivariate analysis, although not responsive to the survey design, is not severely biased.
5. The evidence on interaction with faculty members unequivocally suggests that more contacts with professors and others on campus is conducive to increasing graduation rates (National Center for Education Statistics, 1996; Von Destinon, 1988; Davis, 1991; Nettles et al., 1986; Nettles, 1991; Pascarella, Terenzini, and Hibel, 1978; Pascarella and Terenzini, 1980). If students receiving aid also receive other support in their institution, the observed positive effect of financial aid on persistence and graduation may capture the effects of other institutional support mechanisms, such as academic tutoring and interaction with faculty members. To tease out the impact of financial aid from other support mechanisms, I examine the effect of both on college success.
6. Evidence suggests that attending a more selective school positively impinges on graduation rates of comparable students (Alon and Tienda, 2003; Bowen and Bok, 1998; Kane, 1998).
7. Flags for missing values are included in all models, but are not reported in the results presented here. Using this strategy, a modified zero-order method, I fill all missing data with zeros and add a dummy variable that takes the value of ''one'' for missing

observations and "zero" for complete ones. These flags provide a useful method for testing whether the pattern of missing observations is random with respect to Y. The modified zero-order strategy is the simplest solution when the proportion of missing data is small (Anderson, Basilevsky, and Hum 1983). However, as with most remedies for missing data, this strategy does not completely eliminate its biasing effect.

8. Since the magnitude of the delta-ρ depends on the reference category, I centered all continuous variables on their mean to facilitate a more meaningful interpretation (Kaufman, 1996; Long, 1997). Similarly, the interpretation of the delta-ρ statistic for a centered continuous variable (centered discrete change) is *the change in the predicted probability of 6-year graduation associated with a unit change in the independent variable that is centered around its mean, holding all other variables at their mean* (Long, 1997).

REFERENCES

Alon, S., and Tienda, M. (2003). Hispanics and the "Mismatch" Hypothesis: Differentials in college graduation rates by institutional selectivity. *Paper presented at the "Color Lines" conference, organized by the Civil Rights Project*. Harvard University, in Boston Massachusetts.

Anderson Andy, B., Alexander, Basilevsky, and Derek, P. J. Hum (1983). "Missing Data":A review of the literature. In: Peter H. Rossi, James D. Wright, and Andy B. Anderson (eds.), *Anderson Handbook of Survey Research*, Academic Press, New York, pp. 415–94.

Bowen, W. G., and Bok, D. (1998). *The Shape of the River:Long-term Consequences of Considering Race in College and University Admissions*, Princeton University Press, Princeton, NJ.

Cabrera, A. F. (1994). Logistic regression analysis in higher education: An applied perspective. In: Smart, J. C. (ed.), *Higher Education: Handbook of Theory and Research*, Agathon, New York.

Cofer, J., and Somers, P. (2000). A comparison of the influence of debtload on the persistence of students at public and private colleges. *Journal of Student Financial Aid*, 30(2): 39–58.

Davis, R. B. (1991). Social support networks and undergraduate students' academic-success-related outcomes: A comparison of black students on black and white campuses. In: Walter, R. A., Epps E. G., and Haniff N. Z. (eds.), *College in Black and White: African American Students in Predominantly White and in Historically Black Public Universities*, State University of New York Press, New York, pp. 143–157.

DesJardins, S. L., Ahlburg, D. A., and McCall, B. P. (1999). An event history model of student departure. *Economics of Education Review*, 18: 375–390.

DesJardins, S. L., Ahlburg, D. A., and McCall, B. P. (2002). A temporal investigation of factors related to timely degree completion. *Journal of Higher Education*, 73(5): 555–581.

Heller, D. E. (2001). State merit scholarship programs:An introduction. In: Heller, D. E., and Marin, P. (ed.), *Who Should We Help? The Negative Social Consequences of Merit Aid Scholarships. Working Paper*. The Civil Rights Project, Harvard University, http://www.civilrightsproject.harvard.edu/research/meritaid/call_merit02.php (Retrieved 11/11/2003).

Hu, S., and St. John, E. (2001). Student persistence in a public higher education system:Understanding racial and ethnic differences. *Journal of Higher Education*, 72(3): 256–286.

Kane, T. J. (1998). Misconceptions in the debate over affirmative action in college admissions. In: Gary Orfield, and Edward Miller, (ed.), *Chilling Admissions: The Affirmative Crisis and the Search for Alternatives*, Harvard Education Publishing Group, Cambridge. 17–32

Kaufman, R. L. (1996). Comparing effects in dichotomous logistic regression: A variety of standardized coefficients. *Social Science Quarterly*, (77): 90–109.

Long, J. S. (1997). *Regression Models for Categorical and Limited Dependent Variables*, Sage Publications, Inc., Thousand Oaks, CA.

Maddala, G. S. (1983). *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge, MA, Cambridge University Press.

McPherson, M. S., and Schapiro, M. O. (1998). *The Student Aid Game: Meeting Need and Rewarding Talent in American Higher Education*, Princeton University Press, Princeton, NJ.

National Center for Education Statistics (1996). The condition of education. *Table* 10–1. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid = 97372 (Retrieved 11/11/2003)

Nettles, M. T. (1991). Racial similarities and differences in the predictors of college student achievement. In: Walter R. A., Epps E. G., and Haniff N. Z. (eds.), *College in Black and White: African American Students in Predominantly White and in Historically Black Public Universities*, State University of New York Press, New York, pp. 75–91.

Nettles, M. T., Thoeny, A. R., and Gosman, E. J. (1986). Comparative and predictive analyses of black and white students' college achievement and experiences. *Journal of Higher Education*, 57(3): 289–318.

Newey, W. (1987). Simultaneous estimation of limited dependent variable models with endogenous explanatory variables. *Journal of Econometrics*, 36: 231–250.

Pascarella, E.T., and Terenzini, P. T. (1980). Predicting freshman persistence and voluntary dropout decisions from a theoretical model. *Journal of Higher Education*, 51(1): 60–75.

Pascarella, E.T., Terenzini, P. T., and Hibel, J. (1978). Student-faculty interactional settings and their relationship to predicted academic performance. *Journal of Higher Education*, 49(5): 450–463.

Paulsen, M. B., and St. John, E. P. (2002). Social class and college costs: Examining the financial nexus between college choice and persistence. *Journal of Higher Education*, 73(2): 189–236.

Peng, C. Y. J., So, T. S. H., Stage, F. K., and St. John, E. P. (2002). The use and interpretation of logistic regression in higher education journals:1988–1999. *Research in Higher Education*, 43(3): 259–293.

Petersen, T. (1985). A comment on presenting results from logit and probit models. *American Sociological Review*, 50(1): 130–131.

Pindyck, R. S., and Rubinfeld, D. L. (1998). *Econometric Models and Economic Forecasts (4th Ed)*, Prentice Hall, Upper Saddle River, NJ.

Somers, P., Woodhouse, S., and Cofer, J. (2000). *Persistence of first-generation college students*. Paper presented at the Association for the Study of Higher Education Meeting in Sacramento, California.

St. John, E. P., Hu, S. P., and Weber, J. (2001). State policy and the affordability of public higher education: The influence of state grants on persistence in Indiana. *Research in Higher Education*, 42(4): 401–428.

St. John, E. P., and Starkey, J. B. (1995). An alternative to net price: Assessing the influence of prices and subsidies on within-year persistence. *Journal of Higher Education*, 66(2): 156–186.

Von Destinon, M. (1988). *Chicano Student Persistence:The Effects of Integration and Involvement*, University of Arizona Press, Tucson.

Winship, C., and Radbill, L. (1994). Sampling Weights and Regression Analysis. *Sociological Methods and Research*, 23(2): 230–257.

Received August 6, 2003.