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Estimating the influence of financial aid on student retention: A discrete-choice propensity score-matching model

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Abstract

The greatest limitation in establishing causality in observational studies on the effect of financial aid is the presence of endogeneity or selection bias associated with aid status. To control for this statistical confoundedness that besets the research corpus to date, this study estimates the effect of financial aid on freshmen retention at a moderately selective, public university using propensity score-matching in multi-stage regression analyses. The correlational pattern that emerged from twenty-four logit models suggests higher-income students accrue a retention benefit from financial aid, unlike low-income students, net of first-year academic experience and type and amount of aid received. Conversely, retention of low-income freshmen is more likely due to academic performance compared to those from high-income background. Findings on the effect of aid are consistent with the economics of moral hazard and unobservable behavior.

INTRODUCTION

Studies on the role of financial aid in college access and student success abound. A reading of those that ascribe lack of higher education opportunity among low-income students to inadequate financial assistance (Reindl, 2007; Burdman; 2005; Heller, 2002; Fitzgerald, 2004; The Pell Institute, 2004; College Board, 2004) may readily convince one that large numbers of prepared students are prevented from realizing their educational aspirations solely due to cost. The Advisory Committee on Student Financial Assistance (ACSFA) to the US Congress reported that in 2002 alone over 400,000, or close to 50%, of academically qualified low-income students failed to enroll at a four-year college in the United States due to financial barriers, the cumulative estimate being 4.4 million by the end of this decade (ACSFA, 2002). Lack of access, Gerald and Haycock (2006) argue, is particularly acute at the country's flagship universities, where at least 60,000 (perhaps several hundred thousand) academically well qualified low-income students could financially not afford to enroll according to 2003 admission test records. Gerald and Haycock (2006) conclude that flagship universities fail to matriculate enough low-income students.

However, the finding that well-prepared students from economically disadvantaged background cannot afford to enter a higher education institution hinges on the definition of "academically prepared" and on what constitutes "sufficient" enrollment of low-income students. ACSFA defines "college prepared" as "minimally qualified" on the basis of a student's highest score in terms of high school grades (GPA), class rank, college admission test (ACT/SAT score), or the national college-readiness index (ACSFA, 2002; Berkner & Chavez, 1997). Accordingly, a GPA of 2.7 or an ACT score of 19 is considered "minimally qualified" (Greene and Winters, 2005). For example, the University of Nevada, Reno, a moderately selective flagship institution, requires a minimum 2.75 GPA for admission; the California State University system, encompassing the state's less selective universities, requires students with a verbal ACT test score of less than 25 (on a scale of 36) to take remedial courses. Hence, the ACSFA study overestimates the number of college-prepared high school graduates. Applying three, more meaningful criteria to define "college ready," Greene and Winters (2005) estimate that the 4-year college-going rate among US high school graduates surpasses their readiness rate on the basis of 2001 through 2003 national enrollment numbers (NCES, 2005). In short, more high school graduates enter 4-year institutions than are estimated to be prepared. Similarly, closer examination of Gerald and Haycock's data source (Hill and Winston, 2006) reveals that the 50 flagship universities (one per each US state) captured 38% of the nearly 110,000 low income students that took the ACT/SAT nationwide in 2003 and were well prepared according to Gerald and Haycock (i.e., scored at least a 24 on the ACT or 1110 on the SAT). Since the flagships make up less than 2% of the total number of over 2,800 US colleges and universities that confer a Bachelor's or higher degree, their 38% share of well-prepared low income students suggests are rather impressive capture of the materially disadvantaged. Judging an institution's success in catering to low-income solely on the percentage of enrolled students that received a Pell grant (the largest aid program for low-income students) is equally flawed due to institutional variations in program offerings, the proportion of Pell-eligible students enrolled at any given time (e.g., foreign and non-degree-seeking students are ineligible), and demographic differences in the primary geographic recruitment area (Tebbs and Turner, 2005).

A recent analysis of nationally representative enrollment data of college students in the United States fails to identify entry barriers for prepared low-income students and instead stresses the lack of *enrollment persistence* following initial college matriculation among such students. Lack of continued college participation of low-income students is attributed primarily to inadequate academic preparation and student self-reported reasons other than financial aid (Adelman, 2007). However, the influence of aid on student enrollment persistence is mediated by a complex web of interrelated factors: including the timing, type, and amount of aid and how they correlate with persistence in the presence of other student attributes (Pascarella and Terenzini, 2005). In spite of voluminous research on student success, enrollment retention models yield little insight to evaluate the impact of financial aid. The problem stems from a preoccupation with, first, descriptive studies that fail to control for the multiple influences that govern student behavior; second, studies that employ inferential statistics without subject randomization or controls for treatment selection bias; and third, studies that omit to underpin quantitative findings with qualitative explanations to guide institutional interventions for enhancing student success (St. John, 2006).

ANALYTICAL APPROACH

To address these gaps in research on student financial aid, this study estimates the influence of aid on freshmen retention via a propensity score matching model that accounts for demographic, pre-college, and first-year university experience variables. Newly enrolled full-time freshmen are grouped by the type of first-year aid received, namely those with grant and/or merit-based scholarships versus those who relied on loans as part of their aid package. These two groups—the aid-treated—are compared to students without any first-year aid—the untreated—on the basis of similar or identical (i.e., matched) propensity for receiving aid. The estimated propensity score helps control for self-selection bias associated with students who received aid versus those that did not.

Following the seminal work by Rosenbaum and Rubin (1983), the effect of aid is estimated for propensity score-matched aided versus unaided students derived from factors associated with aid to students. Accordingly, as explained in Lee (2006),

$$p(X) = prob(D = 1 \mid X) \qquad (1)$$

and

$$D \perp Y(0), Y(1) \mid p(X) \quad \text{and} \quad D \perp X \mid p(X) \qquad (2)$$

where (1) assumes a set of covariates is reduced to a scalar function to yield a propensity score $p(X)$ in treatment assignment D, leading to a condition of ignorable treatment selection, while (2) expresses the balancing property of propensity scores, where observations for both treatment and control group within subclasses (strata) have similar or identical values of $p(X)$.

Scores are estimated via a non-ordered multinomial logistic regression model with aid status as the dependent variable and socio-demographic attributes, pre-collegiate academic preparation, college major, first-year credit load, campus residency, and timing of the university-entry test as independent variables (Table 1).[1] Correlation with the need for financial aid governs the selection of these variables. For example, income background and academic preparation likely influence the need for support and eligibility for different types of aid. Similarly, how early freshmen take the admission test prior to enrollment indicates their intent to enter college and may likely influence the range of available aid as students get admitted.

Though propensity score-matching may not *fully* account for endogeneity bias in aid status (Lunceford and Davidian, 2004; Rubin, 2004; Rosenbaum and Rubin, 1984; Titus, 2006)—particularly in the presence of omitted variables strongly related to the outcome and uncorrelated with the propensity score—matching based on a minimum of five strata is estimated to remove 90 percent of bias associated with observed covariates (Cochran, 1968). Table 2 shows little imbalance in the propensity for aid and the distribution of observed characteristics associated with aid. Following balance verification techniques by Lee (2006) and Agodini and Dynarski (2004), of the 120 Bonferroni-adjusted t-tests, including tests for each of 20 covariates across 6 strata, only 4.2% (5 out of 120) showed a significant difference between gift-aided and unaided students; slightly larger (9%) is the imbalance in covariates between students with loans and those with no aid. Five percent of all tested covariates may differ by chance alone. Matching students with only gift aid to those with no aid required an extra split in one stratum to ensure sufficient covariate balance without adding interaction or quadratic terms to the scoring model, as recommended by Dehejja and Wahba (2002). To maximize the likelihood of matches, observations were divided into strata of equal score range. The percentage of matched cases ranged from 91 to 97 for models comparing gift-aided to unaided students, and 83 to 93 for models comparing students with loans in their aid package to unaided students. Thus, propensity score pairing resulted in few case deletions due to the large common support area, as illustrated with box plots in Figures 1 and 2. Using observations within the common support area that match aided with unaided students on the basis of their propensity to receive aid, the study is designed to offer a more accurate estimate of the

[1] Though a multinomial logit model assumes the independence of irrelevant alternatives, unlike a multinomial probit model, the latter is not well suited for estimating the probability of an underlying nominal, qualitative outcome variable that is unevenly distributed, as is the case in this study (due to the assumption of a cumulative normal distribution). Also, the probit model failed to converge at a global optimum. The logit vs. probit issue is examined in Dow and Endersby (2004) and Pampel (2000).

true effect of aid on student persistence compared to conventional multivariate models (e.g., Herzog, 2005; Dowd, 2004; Somers, 1995; Stampen and Cabrera, 1988; Voorhees, 1985).

Results are based on approximately 5,000 first-year students at a public university in the United States and measure the correlation between the likelihood of receiving aid (i.e., the propensity score stratum) and second-year retention both before and after taking into account first-year math experience and cumulative grade point average (GPA). Stepwise inclusion of these two variables is critical in estimating the influence of aid on student retention, since academic performance and success in math have been identified as key determinants in enrollment persistence (Adelman, 2004, 1999; Pascarella and Terenzini, 2005; Herzog, 2005). Variable entry at the second step also includes controls for the amount and type of money received and the amount of remaining need after accounting for all aid received, which in turn dictated that the cohorts analyzed be limited to spring-retained freshmen that entered the previous fall, since aid is typically allocated on an annual basis. Moreover, students whose income background could not be ascertained from the three data sources used—namely the institutional student information system, ACT's Student Profile Section (SPS), and the College Student Survey administered by the Cooperative Institutional Research Program (CIRP)—were excluded, as well as foreign students and varsity athletes—yielding 71% of all freshmen in the cohorts. To identify the presence of selection bias, results from matched students are juxtaposed with those from unmatched students. Because merit-based financial aid is awarded to academically stronger students, the analysis included collinearity tests for all variables to ensure regression models were not overspecified.[2] The less intuitive odds ratio is interpreted in terms of percentage change—using a linear transformation of the log odds ($p*[1-p]*\beta$) per Morgan and Teachman (1988)—in the probability of second-year re-enrollment in the discussion of model results. All statistical output was generated with SPSS 14.0 for Windows.

[2] Of twenty-four tested regression models, two models exhibited intolerable collinearity in the variance decomposition matrix (> 0.80; condition index > 15) associated with first-year GPA; removal of that variable did not affect the statistical significance threshold or direction of the other predictors.

FINDINGS

Tables 3 through 7 list the estimated influence of financial aid on freshmen retention by estimated family contribution (EFC), which categorizes students by their ability to pay the cost of attending the institution. Tables decompose the treatment effect of aid to detect selection bias associated with the aid recipient. The 'unmatched' column shows the effect of aid without matching students on propensity for aid support; conversely, the 'matched average effect' column controls for aid selection bias, while 'matched average treated' and 'matched average untreated' provide answers to what would have been the probability for retention had the aided student not received any aid, or had an unaided student received the aid, respectively. The latter two scenarios offer a counterfactual approach in gauging the *potential* effect of aid, net of the pre-treatment variables used in estimating a student's propensity for aid and the two post-treatment variables (i.e., first-year GPA and math experience) that are known to strongly influence freshmen retention.

Table 3 suggests that, without considering the cost a student (or parent) has to bear for college attendance (i.e., the EFC), traditional regression without propensity score matching underestimates the influence of aid on freshmen retention. Specifically, using matched students, those with an average propensity for receiving grants and/or scholarships are almost 6% (two strata higher: 2 x 2.94) more likely to persist compared to freshmen with a low chance for aid. Those most likely to receive such aid (i.e., with a high propensity for getting aid), are on average nearly 15% (5 strata higher: 5 x 2.94) more likely to persist into the second year than freshmen least likely to get aid. The positive effect of aid is cancelled out, however, after taking into account academic performance. Without considering the EFC, a one letter-grade rise in GPA correlates with a 12% increase in persistence probability, while doing well in advanced math raises that probability by an additional 5%. Posing the counterfactual argument, had an aided freshman not received grant and/or scholarship support (the 'matched average treated' column), the chance for persistence would have dropped on average by an estimated 3% (3.06), or slightly more than the average freshman (2.94); conversely, had an unaided freshman received such support (the 'matched average untreated' column), the persistence benefit would have been less than students on average (2.76 vs. 2.94). But in either case, a student's GPA and math performance would have rendered the change in aid status statistically inconsequential on the potential for persistence.

To gauge the influence of financial aid on retention of students from different income background, the study furnishes separate estimates by EFC level.[3] An EFC of less than $4,000 includes students from low-income backgrounds that are eligible for federal need-based grants, such as Pell Grants and Supplemental Education Opportunity Grants. On average, they received between $2,000 and $3,000 in such aid for the first year (Table 8). Middle income students with identified financial need are typically those with an EFC between $4,000 and $10,000 ($9,700 in adjusted 2005-$). They derive need-based assistance from state and institutionally funded sources, receiving on average between $800 and $900 (Table 8). In contrast, students with an EFC of over $10,000 ($9,700 in adjusted 2005-$) have little or no identified financial need and, therefore, rely principally on merit-based aid and unsubsidized loans (Table 8). Notably, low-EFC students face considerably higher remaining need after factoring in all aid received in comparison to their high-EFC peers, likely due to some constraints in taking on greater loan aid. Hence, the following results control for amount and type of aid as well as net remaining need. For 982 freshmen, the EFC could not be determined, since they did not fill out a federal aid application form (FAFSA).

As Table 3 shows, there is no correlation between the chance of receiving gift aid and retention of low-income freshmen (EFC of less than $4,000) net of GPA and math experience, and the propensity for receiving aid remains insignificant regardless of low-income students' level of academic success (i.e., insignificant GPA-propensity score level interaction).[4] Similarly, the amount and type of aid does not correlate with retention of such students after factoring in their academic experience (Table 4). However, a one letter-grade increase in GPA is associated with a 15% rise in retention of low-income freshmen receiving aid, but doing well in math does not enhance their retention when controlling for aid selection bias.

For freshmen expected to carry a greater share of the college attendance cost, namely those with an EFC of $4,000 to $10,000, neither the likelihood of receiving gift aid nor

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[3] EFC-based groupings correspond to the institution's need to better understand how a change in aid may influence retention of freshmen at the selected EFC levels.
[4] Second-order interaction regression results are not listed in tables, but available from the author.

the *amount* or *type* of aid correlates with second-year persistence net of GPA and math experience. However, after taking into account aid self-selection bias, doing well in advanced math tends to improve (alpha 0.08; Table 4) their retention probability by almost 10% over non-remedial students of similar income, who only pass a college algebra course. As with low-income students, retention of middle-income freshmen is positively associated with first-year grades, with an estimated 10% change in the probability of second-year return corresponding to a one letter-grade change in the GPA.

Freshmen benefiting from grant and/or scholarship aid are those faced with more than \$10,000 (\$9,700 in adjusted 2005-\$) in EFC and are typically ineligible for need-based financial assistance. Gift aid may improve their persistence chance by 18% (6 x 3.01), after controlling for GPA and math experience (Table 3), and for every \$1,000 in Millennium scholarship aid, retention of such students is estimated to rise on average by almost 3% (2.91, Table 4). The counterfactual proposition suggests that without the gift aid, recipients would have experienced a slightly greater drop in persistence than students on average (3.26 vs. 3.01, Table 3). The average *potential* decline in persistence is only minimally affected by the *amount* of gift aid high-EFC students received (3.26 vs. 2.98 in Tables 3 and 4). Curiously, high-EFC freshmen who managed to complete only remedial math in their first year were 11% more likely to persist vis-à-vis those with the typical math experience (i.e., who pass a first-year college algebra course).

Retention of freshmen with an unknown EFC shows no correlation with the propensity for receiving grants and/or scholarships. A one letter-grade rise in GPA is associated with a 15% increase in their persistence (Table 3), and performing well in math may further improve their chance to return for the second year (alpha 0.79, Table 4). Notably, a regression-based analysis without propensity score matching suggests a negative correlation between receipt of gift aid and retention, a result that is not supported when matching aided and unaided students on the likelihood of receiving such aid (Table 3).

To test whether these findings on the linkage between ability to pay (EFC) and the influence of gift aid on retention are an artifact stemming from the choice of EFC groupings, separate estimates based on the remaining financial need freshmen faced (i.e. the amount calculated after subtracting the EFC from the total cost of attendance) were calculated. Accordingly, students with no remaining need could not qualify for need-based financial aid, as their EFC covered the entire cost of attendance; those with remaining need were eligible for such aid due to their limited ability to pay for the cost of attendance. A student's financial burden is assessed more accurately after factoring in all aid received. Therefore, grouping freshmen by remaining need controls for the *net* cost based on all aid received. Freshmen with no remaining need after the EFC exhibit a significant positive relationship between the likelihood of receiving gift aid and second-year retention, net of aid self-selection bias and academic experience. In turn, the propensity for receiving grants and/or scholarships shows no significant association with retention of students with remaining need (Table 5). But, doing well in math correlates with a 9% to 12% increase in retention for those with remaining need; in contrast, freshmen with no remaining need fail to show an association between doing well in math and second-year persistence. Together, these results parallel the correlations found along EFC-grouped students in Tables 3 and 4. Similarly, the finding that remedial math students with a high EFC are more likely to persist is echoed in Table 5, where remedial freshmen with no remaining need are 18% more likely to persist after failing first-year math compared to the typical freshman who passed first-year college algebra.

To extend the analysis to students who borrowed money in order to matriculate, the impact of aid on second-year retention of freshmen with loans in their aid package is estimated in Tables 6 and 5. As is the case with students supported by gift aid only, the probability of receiving aid that includes loan money has no bearing on second-year return of low-EFC freshmen, whether unmatched or matched on propensity for aid support (Table 6). Though institutional grant aid for low-income students is positively correlated with their persistence (a 7% rise per $1,000), as is Millennium scholarship[5] aid and other merit-based aid, the amount and type of aid no longer matters after taking into account first-year grades (GPA) and math experience (Table 7). As before, retention of low-EFC students is significantly associated with GPA and math experience; the latter correlated with a 12% decline in persistence if the student was in need of math remediation and failed to pass a first-year math course, or a 22% decline if the student failed to complete *any* math course (matched average effect in Table 7). In contrast,

[5] The Millennium scholarship is available to all in-state high school graduates with a 3.0 GPA (on a 4-point scale). The scholarship covers tuition only and is the largest source of merit-based aid to in-state students.

math experience does not weigh in on retention of high-EFC students. Both high and low-EFC students are affected similarly by the GPA. Only middle-income students (EFC of $4,000 to $10,000) appear to be influenced by the amount of aid they received. Namely, state-funded grants designed to facilitate university access for needy students are estimated to raise persistence by almost 8% (per $1,000) net of self-selection bias associated with receiving aid that includes loan money (Table 7). Such grants are typically awarded to cover unmet need after receipt of federal grants. Like high and low-EFC students, those in the middle tier exhibit a significant correlation between GPA and retention.

DISCUSSION

The pattern of correlations that emerges from this study suggests that the influence of financial aid on freshmen persistence is very much a function of both need level and academic experience. The findings also indicate that matching students on the propensity of receiving aid likely renders a more accurate picture of the significance of aid in student retention. Conditioning on observable student characteristics ensures that the aided do not systematically differ from the unaided, producing a state of ignorable treatment assignment (Rubin, 1977) under the assumption that unobservable factors not included in the score estimation play no role in who gets aid. The possibility of the omitted variable bias is difficult to gauge in this study due to the paucity of similar observational studies that use quasi-randomization techniques (e.g., Titus, 2007; and Alon, 2007; Singell, 2004). Propensity score-matching has been applied in other fields and may even improve estimation of treatment effects in randomized experiments (Imai and Van Dyk, 2004; D'Agostino, 1998; Zhou and Lam, 2007; Mocan and Tekin, 2006).

Results show that regression based on unmatched students fails to identify the positive impact of gift aid on retention when academic experience is not considered (Table 3). This estimation bias persists even after controlling for first-year grades and math experience of high-EFC students. Selection bias is present also when gauging the influence of aid that includes loans. That type of aid package appears as a negative correlate in retention (change in p = -7.66) without knowing a student's EFC, propensity for receiving aid, or amount of aid received (Table 6).

A propensity score approach also offers testing of the counterfactual hypothesis on the *potential* effect of aid, which cannot be ascertained with standard regression. Results reveal that had aided freshmen with a high EFC received no gift aid in the form of grants and scholarships, their probability to return for a second year of study would be lower than students on average (Tables 3 and 4). This potential loss in enrollment persistence is estimated after taking into account first-year grades and math experience. Yet, no potential loss exists for students with gift aid that did not complete a FAFSA (and, hence, for whom the EFC remains unknown), had they not received such aid. This insight contrasts with the finding based on *unmatched* students without an EFC that shows a significant negative correlation between aid and retention (Table 3). The negative relationship may indicate statistical bias associated with aid selection.

Separate estimates by EFC and remaining need, controlling for first-year grades and math experience, together with propensity score-matched students provides a framework to gauge more accurately the financial aid-retention nexus. Among aided freshmen with no need for loans, those from low-income background (i.e., low EFC) accrue greater retention benefits from academic success than higher-income students (i.e., higher EFC), while the latter are more likely to benefit from financial aid than the former. The data do not suggest allocating more aid to low-income students would result in improved retention; for example, the amount of federal grants to low-EFC freshmen (i.e., those eligible for federal Pell grants) is negatively correlated with retention *prior* to factoring in their first-year academic experience, and neither the amount nor the type of aid shows any correlation with retention *after* accounting for academic experience (Table 4). Adding loans into the aid package likewise does not significantly affect the persistence of low-income students. If freshmen retention is an important institutional goal, a dual strategy that emphasizes academic success for low-income students coupled with greater financial assistance to higher income students is estimated to maximize overall retention.

This finding stands in contrast with the cumulative research that indicates aid benefits needy students the most, and where the absence of a positive impact is interpreted as the result of *insufficient* support (Pascarella and Terenzini, 2005; Carter, 2006; Somers, 1995). Results here are consistent, however, with the moral hazard theory that links asymmetry of information on academic progress between student and donor and the limited cost associated with failure to depressed motivation to excel academically (Bodvarsson and Walker, 2004). Accordingly, grant aid, which does not entail a payback obligation and which is usually not tied to academic merit (e.g., Pell Grant or Supplemental Education Opportunity Grant [SEOG]), reduces a student's cost of investment in the event of failure and hence increases the incentive to engage in academically risky behavior; conversely, scholarships are expected to reduce such risks, as eligibility is a function of academic performance. The absence of a positive retention correlation associated with grant aid for low-EFC students (i.e., less than $4,000) may not be surprising; similarly, the positive association of state grants with retention of students with an EFC of $4,000 to $10,0000 (i.e. those facing higher cost of failure) is consistent with the risk-taking rationale. In turn, students with no loans facing the highest cost of failure (i.e., EFC greater than $10,000) rely principally on scholarship aid that requires satisfactory academic progress, since they are ineligible for low-income grants. It is precisely that group of students, which accrues a significant retention benefit from merit-based aid, lending further credence to the moral hazard explanation. The latter is steeped in contract theory (Mirrlees, 1999; Arrow, 1968; Pauly, 1968), where the assumption of expected utility maximization in people is conditioned by the presence of unobservable behavior, which gives rise to the influence of asymmetric information in an exchange relationship, in this case between donor and student aid recipient.[6]

The finding that money fails to have a significant positive impact on the academic outcome of needy students is echoed in other studies. Examining the effect of short-run credit constraints on college dropout via detailed panel data on students' financial condition, Stinebrickner and Stinebrickner (2004) estimate that 85% of enrollment attrition is caused by factors unrelated to availability of financial resources. Using a nationally representative sample of college-age youth, Keane (2002) finds that easing of financial constraints would have a marginal effect on educational attainment of low-income students. Earlier, Cameron and Heckman (1998) arrived at the same conclusion, stressing that family environmental factors largely account for differences in college outcome. Similar findings emerge in more recent studies that gauge the effect of

[6] Zeckhauser's (1970) formal model of contingent contracts in medical insurance, where payments are a function of expenditures, provides the intellectual foundation of moral hazard theory (Mirrlees, 1999).

scholarship support on college participation and completion (Bergin, Cooks, and Bergin, 2007; DesJardins and McCall, 2006; Dynarski, 2005).

In addition to Bodvarsson and Walker (2004), who show that self-financed students are less likely to experience academic failure than those with little or no personal investment, the moral hazard rationale underpins results from Van Long and Shimomura (1999). They argue that anticipation of financial support by the needy, coupled with the aleatory nature of education outcomes—being a product of both innate ability and effort that is largely unobservable—reduces the incentive to excel academically and thus lowers the college completion rate of low-income students. Moral hazard due to low personal investment risk is also cited in Dávila and Mora (2004), who discovered that the level of academic effort among students with self-employed entrepreneurial parents correlated inversely with the level of anticipation to secure employment in a family-owned business.

Though the findings in this study may be limited due to lack of data on students' affective well-being during the freshmen year—information that is typically collected with survey questionnaires, but unavailable here—empirical research shows that actuarial data from institutional databases, as used here, gauge a student's persistence odds more accurately (Caison, 2007). Failure to produce a positive link between financial aid and retention of low-income students does not suggest a lessening of support. Instead, the latter may be procured more effectively in form of academic interventions, given the evidence presented. Second, the results are based on the experience of students at a moderately selective public research university with a sizable segment of first-year commuter students who live off campus. These, and other aspects of the academic and social climate, may vary significantly across institutions. Caution should be exercise, therefore, in drawing inferences about the effect of aid at institutions enrolling distinctly different types of students.

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TABLE 1. Variables Used in Propensity Score Generation via Multinomial Logit Model

		N	Marginal Percentage
Aid package (DV)	Grants/S'ship combination	2646	43.80%
	Millennium Scholarship only[a]	1226	20.30%
	Aid Package with Loans	1712	28.30%
	No aid	464	7.70%
Ethnicity/race	Unknown	510	8.40%
	African/Hispanic American	702	11.60%
	Asian American	468	7.70%
	Caucasian	4368	72.20%
Parental income	< $30K	829	13.70%
	$30-50K	1071	17.70%
	$50-80K	1756	29.00%
	> $80K	2392	39.60%
Gender	Female	3509	58.00%
	Male	2539	42.00%
Academic preparation quartile	First	1385	22.90%
(HS GPA - ACT/SAT 100-point index)	Second	1463	24.20%
	Third	1522	25.20%
	Fourth	1678	27.70%
Age	19 or older	433	7.20%
	18 or younger	5615	92.80%
Academic major status	Undeclared	1559	25.80%
	Declared	4489	74.20%
ATC/SAT test date	Took ACT/SAT as HS Senior	3467	57.30%
	Took ACT/SAT as HS Junior	2581	42.70%
AP credits	yes	1512	25.00%
	no	4536	75.00%
First semester credit load	less than 15 credits	2856	47.20%
	15 or more credits	3192	52.80%
Lived on campus	no	2869	47.40%
	yes	3179	52.60%
Recreation facilities use	no	2949	48.80%
	yes	3099	51.20%
Valid cases		6048	100.00%
Missing		170	
Total		6218	

[a] Excluded from the subsequent analysis due to lack of variation in aid type

Table 2: Within-Stratum Statistics of New Full-Time Freshmen, 2001-2005

	Matched Size (N)		Percent Retained			Balance	
With Grants and/or Scholarships (No loans)	No aid	Aided	No aid	Aided	Sig. Diff. (*p* value)	Rejected in X-vector[a]	Sig. Diff. in Propensity Score (*p* value)
Stratum 1	68	103	76	76	0.91	0	0.16
Stratum 2	52	248	88	78	0.05	0	0.18
Stratum 3	36	305	78	81	0.61	1	0.32
Stratum 4	74	768	86	89	0.50	2	0.95
Stratum 5	99	829	90	90	0.93	2	0.20
Stratum 6	43	288	93	90	0.52	0	0.72
With Loans in Aid Package							
Stratum 1	86	199	81	70	0.04	0	0.76
Stratum 2	109	458	88	82	0.08	0	0.23
Stratum 3	63	290	83	80	0.69	3	0.55
Stratum 4	32	290	75	81	0.39	3	0.30
Stratum 5	35	327	83	79	0.61	3	0.13

[a]Number of variables based on Bonferroni adjusted *t*-test level

Figure 1

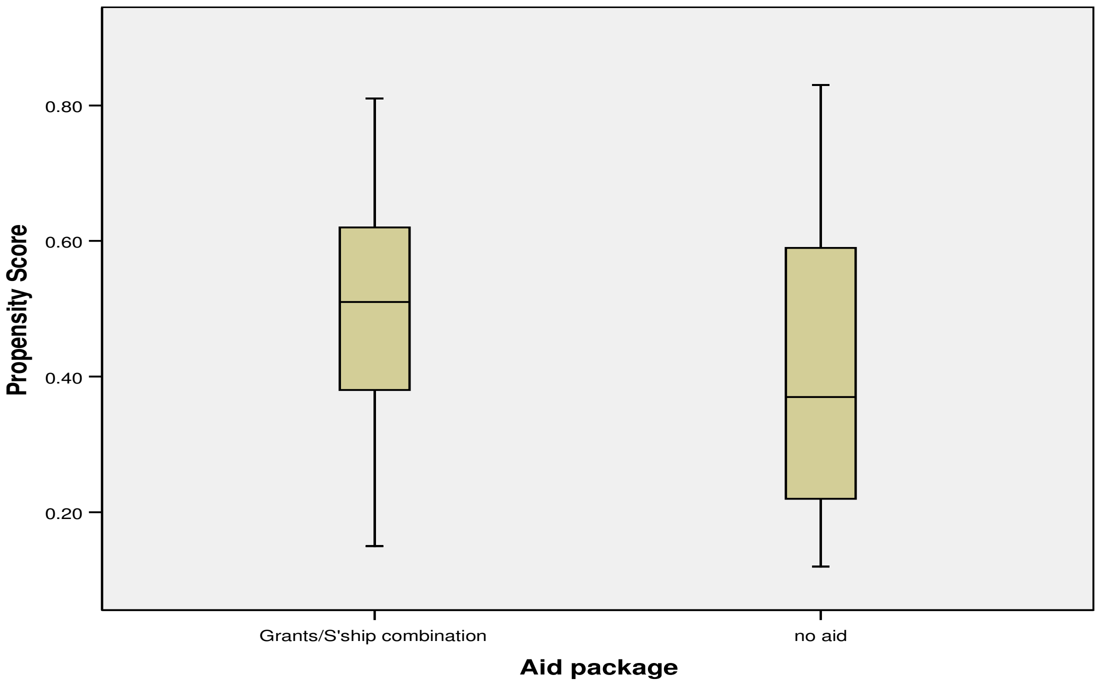

Figure 2

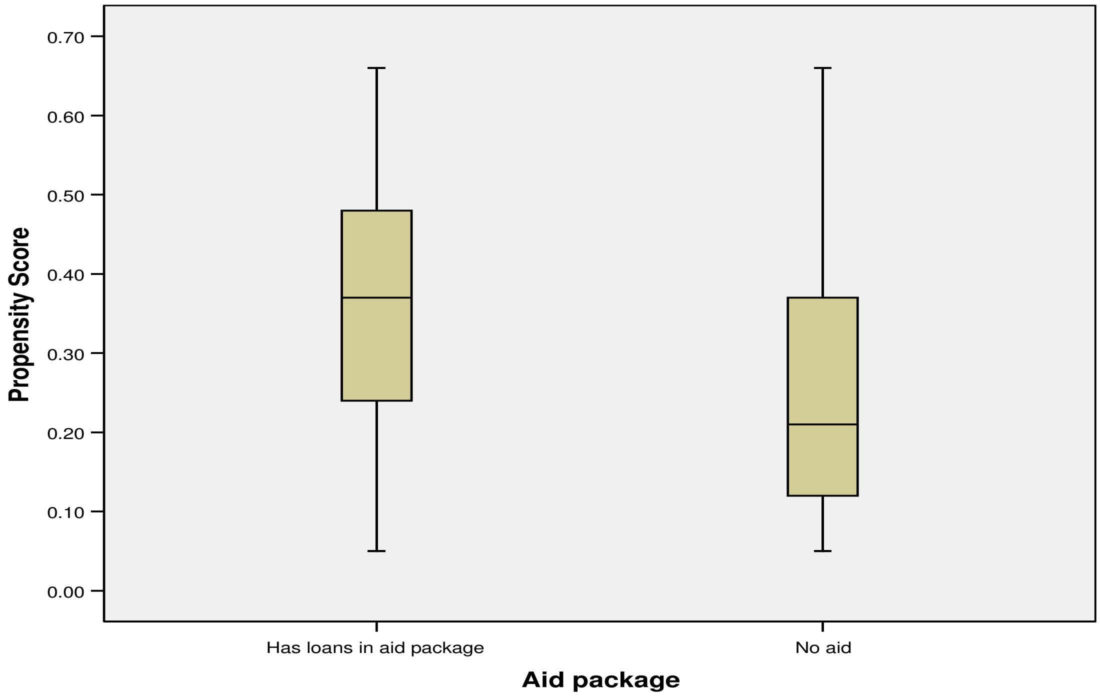
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Propensity Score
Has loans in aid package
No aid
Aid package

Table 3: Parameter Estimates of Second-Year Enrollment of New Full-Time Freshmen with Grants/Scholarships (No Loans), 2001-2005

	Unmatched			Matched Avg Effect			Matched Avg Treated			Matched Avg Untreated	
Percentage change in probability of second-year enrollment:		Δ - p	Sig.		Δ - p	Sig.		Δ - p	Sig.	Δ - p	Sig.
All *(Unmatched N = 3,109)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS		2.94	***		3.06	***	2.76	**
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)		-3.99	*			NS			NS		NS
GPA (1/10 of one letter grade increment)		1.31	***		1.22	***		1.27	***	1.15	***
Math experience[a]	Adv	4.58	*	Adv	5.20	**	Adv	4.73	*		
% of cases matched				93.67							
Estimated Family Contribution (EFC) < $4K *(N = 708)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS		2.11	*		2.13	*		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
GPA (1/10 of one letter grade increment)		1.60	***		1.36	***		1.53	***		
Math experience[a]	Adv	8.23	0.090	Adv	10.00	*					
% of cases matched				96.61							
Estimated Family Contribution (EFC) $4 - 9.7K *(N = 393)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS		2.94	*		2.70	*		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
GPA (1/10 of one letter grade increment)		1.18	***		1.07	***		1.03	***		
Math experience[a]	Adv	10.37	0.089				Adv	9.20	0.097		
% of cases matched				96.94							
Estimated Family Contribution (EFC) > $9.7K *(N = 1,026)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS		4.14	***		4.34	***		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS		3.01	**		3.26	**		
GPA (1/10 of one letter grade increment)		1.09	***		1.00	***		1.00	***		
Math experience[a]	Rem	9.55	*	Rem	11.02	*	Rem	11.88	*		
% of cases matched				92.49							
Estimated Family Contribution N/A *(N = 982)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS		2.60	**		2.53	**		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)		-9.13	**			NS			NS		
GPA (1/10 of one letter grade increment)		1.57	***		1.46	***		1.62	***		
Math experience[a]											
% of cases matched				91.44							

*** p ≤ .001; **p ≤ .01; *p ≤ .05; standard errors were generated via 1,000 bootstrapping iterations and are available from the author

[a]Reference category: Non-remedial student passing first-year college algebra

Legend: NS = not significant; Adv = B or higher grade in advanced math (beyond algebra); Rem = remedial math student

Table 4: Parameter Estimates of Second-Year Enrollment of New Full-Time Freshmen with Grants/Scholarships (No Loans), 2001-2005

	Unmatched			Matched Avg Effect			Matched Avg Treated		
Percentage change in probability of second-year enrollment:		Δ - p	Sig.		Δ - p	Sig.		Δ - p	Sig.
All *(Unmatched N = 3,109)*									
Propensity score (matched)					1.99	***		1.66	***
Financial aid type (per $1K)	Mill	3.50	***	FG	-1.22	*	Mill	6.13	***
				Mill	3.80	***	OM	0.70	*
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)				FG	-1.03	0.054			
				Mill	1.43	0.056	Mill	2.72	**
GPA (1/10 of one letter grade increment)		1.28	***		1.17	***		1.15	***
Math experience[a]	Adv	4.77	*	Adv	5.42	**	Adv	4.71	*
% of cases matched				93.67					
Estimated Family Contribution (EFC) < $4K *(N = 708)*									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)	Mill	4.14	**	FG	-1.88	*			
				Mill	3.71	***	Mill	6.90	***
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)									
GPA (1/10 of one letter grade increment)		1.52	***		1.36	***		1.53	***
Math experience[a]	Adv	8.68	0.082	Adv	10.26	*			
% of cases matched				96.61					
Estimated Family Contribution (EFC) $4 - 9.7K *(N = 393)*									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)	Mill	6.77	***	Mill	6.43	**	Mill	6.76	**
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)									
GPA (1/10 of one letter grade increment)		1.14	***		1.00	***		1.00	***
Math experience[a]	Adv	10.89	0.074	Adv	10.06	0.080	Adv	9.57	0.088
% of cases matched				96.94					
Estimated Family Contribution (EFC) > $9.7K *(N = 1,026)*									
Propensity score (matched)					2.92	***		3.46	***
Financial aid type (per $1K)	Mill	4.32	***	Mill	4.31	***	Mill	5.18	***
Controlling for first-year GPA and math experience									
Propensity score (matched)					2.45	*		2.98	**
Financial aid type (per $1K)	Mill	2.94	*	Mill	2.91	**	Mill	3.65	**
GPA (1/10 of one letter grade increment)		1.00	***		0.08	***		0.75	***
Math experience[a]	Rem	9.45	*	Rem	10.70	*	Rem	11.54	*
% of cases matched				92.49					
Estimated Family Contribution N/A *(N = 982)*									
Propensity score (matched)					1.75	*			NS
Financial aid type (per $1K)				Mill	2.95	*	Mill	8.04	***
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)									
GPA (1/10 of one letter grade increment)		1.62	***		1.53	***		1.59	***
Math experience[a]							Adv	8.14	0.079
% of cases matched				91.44					

*** p ≤ .001; **p ≤ .01; *p ≤ .05; standard errors were generated via 1,000 bootstrapping iterations and are available from the author

[a]Reference category: Non-remedial student passing first-year college algebra

Legend: NS = not significant; Adv = B or higher grade in advanced math (beyond algebra); Rem = remedial math student; FG = federal low-income grant (e.g. Pell, SEOG, TRIO); Mill = state-funded Millennium Scholarship; OM = other merit-based aid; NC = incomplete, withdrawal, or no math

Table 5: Parameter Estimates of Second-Year Enrollment of New Full-Time Freshmen with Grants/Scholarships (No Loans), 2001-2005

	Matched Avg Effect			Matched Avg Treated		
Percentage change in probability of second-year enrollment:		Δ - p	Sig.		Δ - p	Sig.
Remaining Need after EFC: Zero						
Propensity score		3.62	***		4.64	***
Controlling for first-year GPA and math experience						
Propensity score			NS		3.76	**
GPA (1/10 of one letter grade increment)		1.00	***		1.00	***
Math experience[a]	RemF	10.60	*	RemF	17.60	**
Number of cases (N)	901			702		
Remaining Need after EFC: < $6K						
Propensity score		3.02	***			NS
Controlling for first-year GPA and math experience						
Propensity score			NS			NS
GPA (1/10 of one letter grade increment)		1.08	***		0.09	**
Math experience[a]				Adv	8.70	0.081
Number of cases (N)	274			259		
Remaining Need after EFC: > $6K						
Propensity score		2.55	**		2.58	**
Controlling for first-year GPA and math experience						
Propensity score			NS			NS
GPA (1/10 of one letter grade increment)		1.34	***		1.40	***
Math experience[a]	Adv	10.66	**	Adv	11.57	**
				RemP	7.60	0.080
Number of cases (N)	839			822		
Remaining Need after EFC: N/A (no FAFSA)						
Propensity score		2.60	***		2.53	**
Controlling for first-year GPA and math experience						
Propensity score		1.74	0.091			NS
GPA (1/10 of one letter grade increment)		1.46	***		1.62	***
Math experience[a]	NC	10.28	*	Adv	8.21	0.075
				NC	14.67	**
Number of cases (N)	898			757		

*** p ≤ .001; **p ≤ .01; *p ≤ .05; standard errors were generated via 1,000 bootstrapping iterations and are available from the author

[a]Reference category: Non-remedial student passing first-year college algebra

Legend: Adv = B or higher grade in advanced math (beyond algebra); RemF = remedial math student failed course; RemP = remedial math student passed course; NC = incomplete, withdrawal, or no math

Table 6: Parameter Estimates of Second-Year Enrollment of New Full-Time Freshmen with Loans in Aid Package, 2001-2005

	Unmatched			Matched Avg Effect			Matched Avg Treated			Matched Avg Untreated	
Percentage change in probability of second-year enrollment:		Δ - p	Sig.		Δ - p	Sig.		Δ - p	Sig.	Δ - p	Sig.
All *(Unmatched N = 2,176)*											
Received grant/scholarship (unmatched); propensity score (matched)		-8.14	***			NS			NS		NS
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)		-7.66	**			NS			NS		NS
GPA (1/10 of one letter grade increment)		1.74	***		1.50	***		1.58	***	1.21	***
Math experience[a]	RemF	-9.37	**	RemF	-4.89	0.090	RemF	5.35	0.103		
% of cases matched				86.76							
Estimated Family Contribution (EFC) < $4K *(N = 617)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
GPA (1/10 of one letter grade increment)		1.60	***		1.40	***		1.70	***		
Math experience[a]	RemF	-16.01	**	RemF	-12.64	*	RemF	-10.27	0.079		
							NC	-21.28	**		
% of cases matched				82.82							
Estimated Family Contribution (EFC) $4 - 9.7K *(N = 471)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
GPA (1/10 of one letter grade increment)		2.02	***		1.42	***		1.46	***		
Math experience[a]											
% of cases matched				93.20							
Estimated Family Contribution (EFC) > $9.7K *(N = 886)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS			NS		
GPA (1/10 of one letter grade increment)		1.90	***		1.74	***		1.66	***		
Math experience[a]											
% of cases matched				89.16							
Estimated Family Contribution N/A *(N = 201)*											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS					
Controlling for first-year GPA and math experience											
Received grant/scholarship (unmatched); propensity score (matched)			NS			NS					
GPA (1/10 of one letter grade increment)		1.88	***		1.26	**					
Math experience[a]	RemF	-33.01	*	RemF	-17.62	0.109					
% of cases matched				73.63							

*** p ≤ .001; **p ≤ .01; *p ≤ .05; standard errors were generated via 1,000 bootstrapping iterations and are available from the author

[a]Reference category: Non-remedial student passing first-year college algebra

Legend: NS = not significant; Adv = B or higher grade in advanced math (beyond algebra); Rem = remedial math student; FG = federal low-income grant (e.g. Pell, SEOG, TRIO, SLEP); Mill = state-funded Millennium Scholarship; OM = other merit-based aid; NC = incomplete, withdrawal, or no math

Table 7: Parameter Estimates of Second-Year Enrollment of New Full-Time Freshmen with Loans in Aid Package, 2001-2005

	Unmatched			Matched Avg Effect			Matched Avg Treated		
Percentage change in probability of second-year enrollment:		Δ - p	Sig.		Δ - p	Sig.		Δ - p	Sig.
All *(Unmatched N = 2,176)*									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)	SG	3.62	*	SG	3.81	*	SG	4.28	*
				Mill	1.96	*	Mill	4.06	***
				OM	2.81	***	OM	3.56	***
				SL	-1.80	*	UL	0.05	*
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS		1.39	0.096
Financial aid type (per $1K)	SG	4.56	*	SG	4.18	*	SG	4.60	**
				Mill	2.04	*			
				SL	-1.86	*			
GPA (1/10 of one letter grade increment)		1.79	***		1.51	***		1.60	***
Math experience[a]	RemF	-10.08	***	RemF	-5.24	0.076	RemF	-5.39	0.108
% of cases matched				86.76					
Estimated Family Contribution (EFC) < $4K *(N = 617)*									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)	Mill	3.96	*	Mill	4.13	*	IG	7.25	*
							Mill	6.91	***
							OM	2.99	*
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)									
GPA (1/10 of one letter grade increment)		1.60	***		1.37	***		1.65	***
Math experience[a]	RemF	-15.73	**	RemF	-12.29	*	RemF	-11.84	0.087
	NC	-13.44	0.080	NC	-15.49	*	NC	-21.83	**
% of cases matched				82.82					
Estimated Family Contribution (EFC) $4 - 9.7K *(N = 471)*									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)	SG	8.68	**	SG	7.78	**	SG	8.04	**
	OM	4.09	*	OM	3.94	*	OM	4.09	*
Controlling for first-year GPA and math experience									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)	SG	10.24	**	SG	7.69	**	SG	7.89	*
	OM	3.72	0.061						
GPA (1/10 of one letter grade increment)		2.03	***		1.39	***		1.41	***
Math experience[a]									
% of cases matched				93.20					
Estimated Family Contribution (EFC) > $9.7K *(N = 886)*									
Propensity score (matched)						NS			NS
Financial aid type (per $1K)				OM	3.27	**	OM	3.73	**
							Mill	2.75	0.063
							UL	0.07	**
Controlling for first-year GPA and math experience									
Propensity score (matched)					2.37	0.090			NS
Financial aid type (per $1K)									
GPA (1/10 of one letter grade increment)		2.00	***		1.77	***		1.68	***
Math experience[a]									
% of cases matched				89.16					

*** p ≤ .001; **p ≤ .01; *p ≤ .05; standard errors were generated via 1,000 bootstrapping iterations and are available from the author

[a]Reference category: Non-remedial student passing first-year college algebra

Legend: Adv = B or higher grade in advanced math (beyond algebra); RemF = remedial math student failed course; NC = incomplete, withdrawal, or no math;

FG = federal low-income grant (e.g. Pell, SEOG, TRIO, SLEP); SG = state low-income grant; IG = institutional low-income grant; Mill = state-funded Millennium Scholarship;

OM = other merit-based aid; SL = subsidized loan; UL = unsubsidized loan

Table 8: Average Aid and Need ($) by Estimated Family Contribution (EFC) for New Full-Time Freshmen, 2001-2005

		Estimated Family Contribution			
With Grants and/or Scholarships (No loans)	All (N=2,541)	< $4, 015 (N=539)	$4,016 - 9,768 (N=371)	> $9,769 (N=873)	Unkown (N=758)
Low-income federal grants	469	2,212	0	0	0
Low-income state grants	119	223	471	9	0
Low-income institutional grants	77	129	287	22	0
Other grants	189	146	117	215	226
Millennium scholarship	2,003	1,881	2,132	1,965	2,070
Other merit-based aid	2,146	2,270	2,471	2,280	1,745
Need after EFC[a]	4,225	11,945	9,019	1,075	118
Need after all awarded aid[a]	2,007	6,053	4,179	309	23
With Loans in Aid Package	(N=1,563)	(N=434)	(N=428)	(N=689)	(N=12)
Low-income federal grants	809	2,910	5	0	0
Low-income state grants	243	370	475	24	0
Low-income institutional grants	241	320	398	97	0
Other grants	164	130	222	152	0
Millennium scholarship	1,397	1,365	1,474	1,366	1,631
Other merit-based aid	1,024	1,154	974	983	490
Unsubsidized loans	3,560	1,284	2,483	5,652	9,128
Subsidized loans	1,760	2,812	2,532	648	0
Need after EFC[a]	8,115	15,320	10,198	2,159	15,142
Need after all awarded aid[a]	2,895	5,787	3,778	496	4,562

* Based on federal aid application information (FAFSA)