

The Effects of Institutional Merit-Based Aid On the Enrollment Decisions of Needy Students

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Abstract

Recently, both states and institutions have implemented merit-based financial aid packages to compete for the best students. This analysis explores the adoption of a merit-based aid program at the University of Oregon to assess the impact of merit-based aid in needy-student financial aid packages. Using a unique empirical approach in which the decisions of University of Oregon applicants to apply for federal financial aid and/or enroll at the University of Oregon are modeled jointly, results indicate that \$1000 in merit-based aid increases the probability of enrollment by 6.8%. However, while the effect of merit-based aid is found to be positive, the results suggest that the effect may be overstated without controlling for the potential correlation of merit-based aid with the error term.

The state budget crises that began in the 1990s have forced many states to lower their support of higher education, as indicated by a decline in appropriations per full-time equivalent student (College Board, 2007). These budget crises have been particularly troubling for public institutions, whose budgets depend on state funding, and generally are the low-cost option in a student's choice set. As a result, from 1997 through 2007, the average tuition and fees at a public four-year institution have risen by 99%, from \$3,111 to \$6,185, far outpacing the 29% growth in the Consumer Price Index (College Board, 2007). To combat the rising tuition costs, both states and institutions have implemented merit-based financial aid packages to compete for the best students. While the marginal effects of merit-based aid on college access are expected to be positive, it is unclear whether the effects of merit-based aid are asymmetric across income classes. In particular, it is important to understand whether merit-based aid relatively benefits the financially well-to-do, simply because awards are based on merit and not need.

In the late 1990s, the University of Oregon implemented the Dean's Scholarship, which awarded grants up to \$2000 for in-state students with high school GPAs in excess of 3.6, and up to \$5000 for similar out-of-state students. This major shift in a large public university's financial aid policy toward a merit-based approach was adopted to combat rising competition for the best and brightest students. Prior to the 1999-2000 academic year, merit-based aid awards were negligible at the University of Oregon, but by the 2002-2003 year, over \$5 million in merit-based aid was awarded. This adoption of a merit-based aid program at the University of Oregon, combined with the availability of a detailed administrative dataset on all University of Oregon applicants, provides an excellent opportunity to study how merit-based grants affect the college choice of low-income students. Two primary research questions are addressed within this paper. First, what effect does merit-based financial aid have on the enrollment decisions of applicants to a large public university? Second, is the estimated effect of merit-based aid potentially biased when unobserved (with respect to the researcher) student attributes, such as the specific desire to attend the University of Oregon or educational ambition, are omitted from college choice regressions? Specifically, this paper makes a unique contribution to the financial aid literature by explicitly modeling the decision to apply for financial aid and enroll at a particular institution jointly, which allows the researcher to control for both observed and unobserved attributes in the enrollment decision model. The increasing prominence of merit-based grants programs at public institutions of higher education makes understanding the true effects of merit-based aid on needy students an important inquiry.

Literature Review

With the introduction of federal need-based aid to students in 1973 (i.e., the Pell grant), the earliest analyses in higher education were motivated in an attempt to quantify simple student choice models. The models predicted that financial aid would affect both student access and enrollment choice. For example, Jackson (1978) posits that the college-entry decision depends on both sociological factors such as family background, high-school peers, or the desire to interact with similar persons and economic factors such as the investment (human capital) and consumption values of college. Such a framework suggests that empirical analysis can potentially identify both the

predisposition of students to attend college and how financial aid affects college attendance controlling for this predisposition.

The early financial aid studies typically estimated the probability of enrollment based upon the existence or level of financial aid, price measures, and a set of individual characteristics (Ehrenberg & Sherman, 1984; Jackson, 1978; Manski & Wise, 1983). Individual attributes found to matter in college choice include race, gender, financial situation, parental educational experiences, and a student's peer group. Institutional attributes found to influence college choice include quality of the institutions, program offerings, distance, and pricing. Surprisingly, despite substantial variation in both the degree of aggregation and the time period of the data, enrollment elasticity estimates are consistently found to be less than one (Heller, 1997; Leslie & Brinkman, 1987).

More recent theoretical college choice frameworks describe a potential student's higher education choices as a multistage process for potential students. The most general of these models posits a three-stage model that includes the development of aspirations in the first stage, the identification and selection of a choice set of institutions to which to apply in the second stage, and the ultimate choice based upon student and institutional attributes in the final stage (Hossler, Braxton, & Coopersmith, 1989; Hossler & Gallagher, 1987; Jackson, 1982).

Despite this multistage college-choice theoretical model, the majority of empirical research focuses on one stage at a time. Typically, those who have modeled multiple stages find that price responsiveness measures may be understated when models focus on only the enrollment stage, as price may affect aspiration and application decisions as well as the ultimate college choice decision (Abraham & Clark, 2006; Curs & Singell, 2002; DesJardins, Ahlburg, & McCall, 2006). Using a multistage framework, this paper builds on previous empirical literature by modeling the decision to apply for federal financial aid and the decision to enroll at a public institution jointly.

A large number of studies have also documented enrollment and persistence differences for students of varying need and ability. For example, Manski and Wise (1983) find that students with high academic ability and those from families in which parents have higher income and more education are more likely to enroll in and complete college. Overall, the literature across a number of disciplines provides a significant amount of evidence that student responsiveness to tuition and aid differ with need and ability (e.g. Ehrenberg & Sherman, 1984; Dynarski, 2003; Jackson, 1990; Linsenmeier, Rosen, & Rouse, 2002; McPherson & Schapiro, 1991; Singell & Stone, 2002).

There is evidence in the higher education literature that a potential student's enrollment probability responds asymmetrically to changes in tuition and financial aid. For example, St. John (1990) finds that grants, loans, and work-study each increase the likelihood of college enrollment, while tuition decreases enrollment. Further, he finds that students are more price-responsive to changes in financial aid as opposed to changes in tuition, the effects of grants decline with income, and the effects of loans rise with income. Likewise, other research has found evidence that students are more responsive to merit-based versus needs-based aid, grants versus loans, and grants versus tuition (Singell & Stone, 2002; St. John, 1993; St. John, 2003; St. John & Starkey, 1995).

A standard problem with estimating the effect of student aid is the fact that financial aid offers are not distributed randomly. Generally, financial aid offers are based upon student attributes such as ability, ambition, and need. While financial aid administrators typically are able to observe the majority of these attributes, often some of these attributes may be unobservable to the researcher. In a critique of techniques of the National Center for Educational Statistics, both Heller (2004) and Becker (2004) document how a failure to model unobserved attributes may understate the importance of a student's financial attributes in their college-going decisions. When financial aid is correlated with unobserved attributes, financial aid is said to be endogenous, or in other words, correlated with the error term. When independent variables are endogenous standard linear regression techniques produce biased estimates

of the relationship between the independent and dependent variables—in this case the relationship between financial aid and enrollment.

A rich array of empirical techniques has been used to identify the effects of financial aid given the potential endogeneity of financial aid packages. Generally, there are two approaches to estimating how financial aid affects college choice when it is potentially endogenous. The first approach uses detailed data sources to estimate the college choice model with as many control variables as possible. One such structural technique models multiple choices of potential college students simultaneously. For example, college choice is a multistage process where potential students must choose which institutions to apply to and then, conditional on acceptance, which institution to attend. Through modeling the application and enrollment decisions simultaneously, Curs and Singell (2002) found that models which ignore the application decision may understate the true price responsiveness of potential students. Singell and Stone (2002) found that wealthier students were more responsive to merit-based financial aid, most likely because of an increase in their ability to take advantage of the offers. DesJardins, Ahlburg, and McCall (2006) model multiple stages of the college choice process, including application, admission, financial aid, and enrollment. They find that a student's expectations of admittance and financial aid offers are important factors in their application decisions. This study will use the correlation between unobservables in the decision of a student to apply for financial aid and unobservables in the enrollment decision to control for the unobserved attributes of needy students that may be correlated with their financial aid package.

A second approach to estimating the effect of financial aid is to rely on exogenous changes to broad financial aid programs and estimate the effect of these changes on whether a student chooses to enroll in college or not (Dynarski, 2002; Linsenmeier, Rosen, & Rouse, 2002). This technique, typically estimated through the difference-in-difference approach, has been used to investigate the Federal Pell Grant Program. However, little evidence has been found to indicate changes in student behavior due to the Pell grant, except in the case of nontraditional students (Hansen, 1983; Kane, 1994; Kane, 1995; Seftor & Turner, 2002). However, similar studies have shown large enrollment effects of merit-based grants programs, such as the Georgia Hope Scholarship

(Cornwell, Mustard, & Sridhar, 2002; Dynarski, 2000; Dynarski, 2004). Van der Klauuw (2002) uses regression discontinuity design to exploit discontinuities in the financial aid formula, which offers different financial aid awards to otherwise similar students, to identify the effect of financial aid on enrollment.

The benefit of the natural experiment methodology is the ability to identify the effect of financial aid based on exogenous changes in financial aid programs. However, they typically do not model individual choice in great detail as they lack the individual controls to investigate the effects of financial aid on subsets of the population, such as low-income students. Where the approach has attempted to estimate the effects of financial aid on needy students, typically identification has indirectly relied on differences in social categories such as race. The evidence suggests that the impact of merit-based aid programs may be larger among relatively higher income groups and among institutions that attract relatively well-to-do students (Cornwell, Mustard, & Sridhar, 2002; Dynarski, 2004).

Research Design

The primary objective of this research is to estimate how merit-based aid changes the probability of a needy student enrolls at a large public university, the University of Oregon. The specific question that will be asked is: how does a \$1000 increase in merit-based aid change the probability that a needy student will enroll at the University of Oregon? A secondary objective of this research is to investigate whether information on unobserved attributes in the decision to apply for financial aid can be used to better estimate the effects of financial aid. Given the potential for financial aid to be correlated with unobserved attributes in the error term (i.e., is endogenous), it is important to investigate alternative estimation strategies with the potential to minimize the associated bias.

The Free Application for Federal Student Aid (FAFSA) is the primary gateway for students to access the various forms of financial aid the federal government offers, including Pell grants and both subsidized and unsubsidized loans. By completing the FAFSA students are essentially declaring themselves in need of financial aid. Thus, for the purposes of this analysis, students who complete

the FAFSA will be defined as needy. The term needy was chosen within the context of this research to describe a student who has made a conscious effort to seek financial aid from the federal government. While low-income students are more likely to file a FAFSA in pursuit of financial help for college, it has been calculated that up to 20% of the nonfilers nationwide come from low-or middle-income families (King, 2004). Thus, the results should be taken with caution as this definition of needy does not necessarily translate to low-income.

Previous research has shown that the decision of a needy student to enroll at a particular institution is dependent on many factors (Heller, 1997; Hossler, Braxton, & Coopersmith, 1989; Leslie & Brinkman, 1987). Factors deemed important in this choice include a student's financial capability, their academic ability, opportunity costs of attending college, as well as an overall taste for attending an institution of higher education. Many of these attributes are observable and can be directly included in models of each decision. However, there are many attributes that are unobserved to the econometrician, such as tastes for higher education and indirect financial resources (e.g., wealthy grandparents). It is these unobservable attributes that often lead variables of interest, like financial aid, to be correlated with the error term. Thus, any empirical investigation into the effects of financial aid must account for these unobservables to obtain unbiased estimates of the true effects of financial aid.

By modeling the decision to apply for financial aid and enroll jointly, unobservables in the financial aid equation can be used to help identify the true effect of financial aid in the needy. To estimate the effects of financial aid on needy students, with the possibility that financial aid offers may be endogenous, a random utility approach is specified. Specifically, applicant i 's decision to fill out a FAFSA and/or enroll at the University of Oregon is observed if the utility of his decision exceeds the utility of the next best opportunity. Although the net utility for applicant i to fill out the FAFSA (F_i) and enroll (E_i) is not directly observed, the student's ultimate decision is observed.

Thus, the decisions to apply for federal financial aid and enroll at the University of Oregon are modeled as linear index functions:

$$[1] \quad F_i = \alpha' EA_i + \beta' X_i + \varepsilon_i^f \quad F = \begin{cases} 1 & \text{if filled out FAFSA} \\ 0 & \text{if not} \end{cases}$$

$$[2] \quad E_i = \alpha' A_i + \beta' X_i + \varepsilon_i^e \quad E = \begin{cases} 1 & \text{if enrolled} \\ 0 & \text{if not} \end{cases}$$

where X_i is a vector of observed individual attributes assumed to affect both the application for federal financial aid and enrollment equations including: family income, personal characteristics (sex, race); academic ability (SAT scores, high school GPA); background (high school characteristics, local demographics) and a linear time trend. The unobservables in the FAFSA application and enrollment processes, ε_i^f and ε_i^e respectively, are assumed to be bivariate normal $[0,0,1,1,\rho]$.

In addition to the individual attributes X_i , the decision to apply for federal financial aid (F_i) is assumed to depend on the student's expectation of their federal financial aid offer EA_i . Specifically, EA_i contains the average Pell grant and subsidized Stafford loan received by students who applied to the University of Oregon from individual i 's high school in the previous year. These measures are assumed to capture the student's perception of the financial aid package they may receive given observations from the previous year at their high school. Students who observe their peers receiving generous financial aid offers are expected to be more likely to apply for federal financial aid. Also contained in EA_i is the level of the maximum Pell grant in the application year to capture the potential for increased participation in federal aid due to increases in its generosity.

Likewise, in addition to personal attributes represented by X_i , the decision of a needy student to enroll at the University of Oregon (E_i) is assumed to depend on the student's actual aid levels A_i . Specifically, A_i is a vector of attributes describing the student's financial aid package at the University of Oregon, including the level of merit-based grants, need-based grants, and loans.

To understand the effect of financial aid on needy students, the enrollment equation (E_i) is restricted to those applicants who filled out a FAFSA (i.e., $F_i = 1$). Rewriting [1] as $F_i = \alpha'X_i^f + \varepsilon_i^f$ and [2] as $E_i = \beta'X_i^e + \varepsilon_i^e$, the likelihood function for N applicants as specified by Meng and Schmidt (1985) is:

$$\begin{aligned}
 \ln L(\alpha, \beta, \rho) = & \sum_{i=1}^N F_i E_i \ln \Phi_2(\alpha'X_i^f, \beta'X_i^e, \rho) \\
 [3] \quad & + F_i(1-E_i) \ln [\Phi(\alpha'X_i^f) - \Phi_2(\alpha'X_i^f, \beta'X_i^e; \rho)] \\
 & + (1-F_i) \ln [1 - \Phi(\alpha'X_i^f)]
 \end{aligned}$$

where Φ_2 and Φ respectively denote the bivariate standard normal cumulative density function and the univariate standard normal density function for the errors in [1] and [2]. Estimates of the parameters from maximizing $\ln L(\alpha, \beta, \rho)$ offers efficiency gains over those obtained by separate estimation of equations [1] and [2], because the joint approach corrects for the potential correlation between the FAFSA and enrollment decisions¹. More importantly, this approach corrects for the possible sample selection bias that could result from estimating the effects of financial aid solely on the restricted sample of needy students. As described in King (2004), the decision to file a FAFSA is not random and likely correlated with both the financial aid offer and the decision to enroll. Thus, arbitrarily restricting the sample to FAFSA filers would potentially bias the estimated relationship between financial aid and enrollment.

The decision to apply for federal financial aid happens prior to a student's enrollment choice, thus identification of F_i and E_i can be achieved through the sequential nature of the two choices which causes elements of each decision to differ. Specifically, the decision to apply for federal aid contains variables describing a student's expected level of federal financial aid, while the enrollment equation contains the student's actual financial aid package at the University of Oregon.

¹Within Stata 9.0 the command `heckprob` can be used to calculate a bivariate probit model with sample selection through a maximum-likelihood estimation process.

Data and Sample Characteristics

The empirical analysis uses data from the University of Oregon admissions office for fall-term freshman applicants for the academic years 1996-1997 through 2004-2005. The analysis focuses on fall-term freshman applicants because they are the majority of persons who apply and enroll and because winter and spring applicants tend to be nontraditional/transfer students who differ distinctly from new students.

The dependent variables for equations [1] and [2] are binary variables that equal 1 if an applicant applies for federal financial aid and if the applicant enrolls at the University of Oregon. Thus, the parameters in the model measure the responsiveness of University of Oregon applicants to their attributes and financial aid packages. Curs and Singell (2002) indicate that the unconditional price elasticity of enrollment may be understated when the empirical model does not control for the application decision. However, because institutional merit-based aid is only awarded to students who have applied for admission, the parameter of interest is most likely to be the effect of merit-based aid on the conditional probability of enrollment given application.

Following prior work, the explanatory variables include financial aid variables, family income, personal attributes, attributes of the student's high school peer group, labor market conditions, and a linear time trend (Ehrenberg & Sherman, 1984; Leslie & Brinkman, 1987). Financial aid has been broken down into three broad categories: merit-based grants, need-based grants, and loans. Merit-based grants consist primarily of the University of Oregon's Deans Scholarship, but may also contain other financial aid for which need is not the primary award criterion. Need-based grants include the Pell grant and other smaller grant programs for which financial considerations are the primary factor in award determination. Loans are the combination of both subsidized and unsubsidized federal student loans.

Family income is measured as their financial aid eligibility as determined by federal financial aid regulations. Specifically, as this measure increases in value a student becomes eligible for larger amounts of federal financial aid, such as the Pell grant and subsidized Stafford loans. Negative values indicate the

student has sufficient personal and family income that they do not qualify for grant aid. As this variable is only available for FAFSA filers, it is only included in the enrollment equation.

Race and gender dummies are included as their responses may be different, given that the University of Oregon is located in a white, middle-class, moderately-sized city. The age of contact and application to the University of Oregon are included as controls for interest in the institution. Academic ability is measured through high school GPA, math and verbal SAT scores, as well as their squares to allow for nonlinearity.

The median household income for the ZIP code of the recruit's parents is used as a proxy of peer income, which may be correlated with the likelihood a student enrolls at the University of Oregon. Indicators for private secular and private religious high schools are included to control for possible differences between those who attend public and private high schools. The per capita disposable income and unemployment rate in the applicant's state are included to control for the parent's ability to pay for college as well as the opportunity cost of attending college for the student.

The overall University of Oregon admissions data contains complete information on 56,895 applicants over the years 1996-1997 through 2004-2005. As the effect of financial aid is only valid for those students who are able to attend, the sample is restricted to only qualified applicants, which removes 3,458 applicants, or 6% of the data. Further, 131 students on athletic scholarship have been removed, as students on athletic scholarship may respond very differently to financial incentives compared to the typical student. This yields a sample of 25,599 in-state students, of which 18,647 filed a FAFSA, and 27,707 out-of-state students, of which 13,577 filed the FAFSA. Sample characteristics can be found for in-state and out-of-state students in Tables 1 and 2, respectively.

TABLE 1 | Sample Characteristics—In-state Students

Characteristics are reported for the sample of 18,647 FAFSA filers and 6,952 nonfilers.

	FAFSA Filers		Non-FAFSA Filers	
	Mean	Standard deviation	Mean	Standard deviation
Enrolled at the University of Oregon	0.57	0.49	0.53	0.50
Merit-based aid	703.9	1,161.9	379.1	801.1
Need-based aid	868.4	1,513.9	0.15	5.9
Loans	3,773.2	2,782.2	14.7	320.0
Financial eligibility	-629.7	12,812.8	--	--
Female	0.60	0.49	0.54	0.50
Nonwhite	0.21	0.41	0.16	0.37
Age at first contact	17.3	0.7	17.4	0.7
Age at application	17.9	0.5	17.9	0.5
Math SAT	563.6	87.0	563.2	87.7
Verbal SAT	565.7	90.7	560.6	89.9
High school GPA	3.6	0.4	3.4	0.4
Attended private secular high school	0.01	0.06	0.02	0.13
Attended private religious high school	0.07	0.25	0.12	0.32
Median household income	23,011.5	6,073.7	25,451.1	7,155.0

TABLE 2 | Sample Characteristics—Out-of-State Students

Characteristics are reported for the sample of 13,577 FAFSA filers and 14,130 nonfilers.

	FAFSA Filers		Non-FAFSA Filers	
	Mean	Standard deviation	Mean	Standard deviation
Enrolled at the University of Oregon	0.24	0.42	0.16	0.37
Merit-based aid	1,056.5	1,684.6	568.6	1,230.6
Need-based aid	377.0	914.0	0.0	0.0
Loans	8,145.5	6,561.3	17.8	425.72
Financial eligibility	1,402.2	16,351.5	--	--
Female	0.62	0.49	0.53	0.50
Nonwhite	0.31	0.46	0.20	0.40
Age at first contact	17.3	0.6	17.4	0.6
Age at application	17.8	0.5	17.8	0.4
Math SAT	578.9	80.3	580.0	77.2
Verbal SAT	580.1	81.8	572.7	76.3
High school GPA	3.5	0.4	3.3	0.4
Attended private secular high school	0.08	0.27	0.13	0.35
Attended private religious high school	0.14	0.34	0.17	0.37
Median household income	31,358.6	11,454.1	38,319.5	14,904.0

TABLE 3 | Bivariate Probit Results for the Probability of Enrollment

Marginal effects calculated at median values are reported.

Independent variable	Enrolled at the University of Oregon			
	In-state		Out-of-state	
Merit-based aid	0.084 (0.005)***	0.068 (0.004)***	0.024 (0.003)***	0.025 (0.005)***
Need-based aid	0.005 (0.003)	0.004 (0.002)	0.011 (0.004)***	0.012 (0.005)**
Loans	0.002 (0.002)	0.001 (0.001)	-0.005 (0.001)***	-0.006 (0.001)***
Financial eligibility	0.001 (0.000)***	0.001 (0.000)***	-0.000 (0.000)	-0.001 (0.001)
Tuition at the University of Oregon	0.102 (0.036)***	0.052 (0.033)	0.013 (0.012)	0.014 (0.013)
Housing at the University of Oregon	0.089 (0.068)	0.063 (0.058)	-0.208 (0.064)***	-0.225 (0.089)**
Female	-0.039 (0.008)***	-0.037 (0.007)***	-0.011 (0.008)	-0.013 (0.011)
Nonwhite	-0.061 (0.009)***	-0.074 (0.008)***	-0.056 (0.008)***	-0.062 (0.032)*
Age at first contact	-0.012 (0.006)*	0.004 (0.007)	-0.024 (0.008)***	-0.025 (0.012)*
Age at application	0.003 (0.009)	-0.002 (0.008)	0.021 (0.011)*	0.021 (0.013)*
Math SAT	0.297 (0.044)***	0.217 (0.051)***	-0.086 (0.045)*	-0.091 (0.049)*
Math SAT squared	-0.031 (0.004)***	-0.022 (0.005)***	0.003 (0.004)	0.003 (0.004)
Verbal SAT	0.245 (0.041)***	0.181 (0.042)***	0.005 (0.045)	0.006 (0.049)
Verbal SAT squared	-0.024 (0.004)***	-0.018 (0.004)***	-0.002 (0.004)	-0.002 (0.004)
High school GPA	0.761 (0.173)***	0.685 (0.147)***	-0.742 (0.131)***	-0.798 (0.215)***
High school GPA squared	-0.153 (0.026)***	-0.143 (0.022)***	0.079 (0.019)***	0.085 (0.026)***
Attended private secular high school	-0.162 (0.059)***	0.006 (0.071)	-0.090 (0.012)***	-0.097 (0.014)***
Attended private religious high school	-0.118 (0.015)***	-0.050 (0.027)*	-0.030 (0.010)***	-0.031 (0.012)***
Median household income	-0.003 (0.001)***	0.001 (0.001)	-0.002 (0.000)***	-0.002 (0.001)
Per capita disposable income within state	0.017 (0.015)	-0.014 (0.015)	-0.008 (0.002)***	-0.009 (0.003)***
Lagged state unemployment rate	-0.024 (0.011)**	-0.020 (0.010)**	-0.002 (0.003)	-0.002 (0.004)
Linear time trend	-0.021 (0.009)**	-0.007 (0.009)	--	0.037 (0.013)***
Rho a	--	-0.740 (0.207)*	--	-0.023 (0.283)
Observations	18,647	18,647	13,577	13,577

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

*Correlation between unobservables in FAFSA and enrollment equations

Results

The enrollment equation

Table 3 reports the estimated results of a probit estimation of the enrollment equation (eq. [2]) on separate samples of needy in-state (column 1) and out-of-state students (column 3). All statistics presented are marginal effects (delta-p statistic), thus, they can be interpreted as the change in the probability on enrollment associated with a one unit change in the independent variable². With respect to merit-based aid, a \$1000 increase increases the likelihood of enrollment at the University of Oregon by 8.4% for in-state and 2.4% for out-of-state students. However, need-based grants appear to have no effect on the likelihood of the enrollment of an in-state student, and a very small positive effect, roughly 1.1%, on out-of-state students. Likewise, the presence of loans in a financial aid package has no effect on the enrollment of in-state students while it has a small negative effect on out-of-state students.

The patterns suggest that merit-based aid is an effective tool for enrollment management, likely because it is targeted at specific students and is institution specific. The lack of an effect of need-based grants on enrollment may be explained by the fact that the majority of need-based grants are student specific, i.e., Pell grants, and can be used wherever a student ultimately enrolls. These estimates should be viewed with caution as financial aid is likely to be correlated with the error term in the enrollment equation. This potential for endogeneity bias on the financial aid variables is examined in subsequent specifications.

Overall, the empirical relationships with regard to the non-aid-related controls generally confirm prior expectations. For example, in-state applicants with high financial aid eligibility (i.e., students with fewer resources to spend on college) or those who have peers with a relatively low median household income are more likely to attend the University of Oregon. The results would indicate that students from the state of Oregon, who choose to enroll at the University of Oregon, are not likely to be from the highest income groups.

²All marginal effects have been calculated at the median values of the remaining independent variables.

The estimated marginal effects of the academic merit control indicate that the University of Oregon attracts in-state students of average academic ability. Specifically, the probability of enrollment for in-state students increases with SAT scores for students below the average SAT score (roughly 1000 combined) and lowers for those students with above average SAT scores. Likewise, in-state applicants are less likely to attend the University of Oregon as GPA increases (over the range of 2.5 - 4.0, which is required for admittance). This is indicative that in-state students would prefer to attend private or out-of-state colleges if they have the scholarly ability and/or financial capabilities. Out-of-state students are less likely to attend the University of Oregon as academic merit increases over the full relevant range of all ability measures.

With respect to race and gender, it appears that in-state females and nonwhite students are less likely to attend the University of Oregon, while only out-of-state nonwhite students appear to be less likely to attend. For brevity, the remainder of the discussion focuses on the measures of financial aid generosity that are of primary interest, as other than in a few cases the marginal effects of the control variables are relatively robust to specifications.

Modeling the enrollment and FAFSA decision jointly

While equations [1] and [2] are modeled jointly through the maximization of equation [3], the results are presented separately. The residual correlation between the FAFSA decision and the enrollment decision is estimated to be -0.74, indicating that unobservable attributes that make an in-state student more likely to fill out the FAFSA also make them less likely to enroll at the University of Oregon. This is consistent with a student who has unobserved need or other attributes that make them more likely to apply for financial aid, but whose need prohibits them from enrolling at the University of Oregon and perhaps leads them to enroll in a two-year institution. The FAFSA and enrollment decisions appear to be uncorrelated for out-of-state students, which indicates that out-of-state students may choose the University of Oregon based on attributes other than need.

Column 2 of Table 3 presents the marginal effects, when controlling for the FAFSA equation, from the enrollment equation for in-state students, while column 4 presents the corresponding estimates for the out-of-state sample.

The results indicate that a \$1000 increase in merit-based financial aid increases the likelihood that an in-state student enrolls by 6.8%. When controlling for the unobserved attributes associated with students declaring themselves needy, the effect of merit-based aid is roughly 20% smaller than the baseline case. Thus, it appears unobservables in the FAFSA equation that are positively correlated with enrollment are also positively correlated with merit-based aid. The same increase in merit-based aid is associated with an increase in the likelihood of enrollment of 2.5% for out-of-state students.

Contrary to the strong effect of merit-based grants, need-based grants do not appear to have as large of an effect on the enrollment margin. Specifically, a \$1000 increase in need-based grants increases the likelihood of enrollment by less than 1%. However, out-of-state students appear to have a small but significant response to need-based grants, approximately 1.2% for a \$1000 dollar increase in need-based grants. The apparent disparity between the marginal effects of merit- and need-based grants can be explained by the fact that merit-based aid is generally institution specific, whereas need-based grants generally follow the student to wherever they enroll.

Loans do not appear to enter into the student's decision to enroll at the University of Oregon for in-state students, and enter negatively for out-of-state students. As tuition is approximately three times higher for out-of-state students, having to finance college through loans may be a deterrent to choosing to enroll out-of-state.

The FAFSA application equation

The FAFSA application results are reported for both in-state and out-of-state students in Table 4. Although not directly important to studying the effects of financial aid on needy students, there are some interesting empirical regularities in the FAFSA application model. As expected for both samples, an increase in the average Pell grant and subsidized loan of previous-year applicants to the University of Oregon at a student's high school has a positive effect on the likelihood a student applies for federal financial aid. Likewise, increases in the maximum Pell award increase the probability an applicant applies for financial aid, but only at a statistically significant level for in-state students. Females and minorities are more likely to apply for financial aid. As expected,

TABLE 4 | Bivariate Probit Results for the Probability of Completing a FAFSA
Marginal effects calculated at median values are reported.

Independent variable	Enrolled at the University of Oregon	
	In-state	Out-of-state
Average Pell grant at student's high school	0.158	0.082
in previous year	(0.035)***	(0.024)***
Average subsidized loan at student's high school	0.055	0.023
in previous year	(0.021)**	(0.010)**
Federal maximum Pell grant	0.580	0.022
	(0.147)***	(0.097)
Tuition at the University of Oregon	0.233	-0.029
	(0.090)***	(0.026)
Housing at the University of Oregon	-0.530	0.367
	(0.212)**	(0.145)**
Female	0.052	0.073
	(0.019)***	(0.017)***
Nonwhite	0.208	0.403
	(0.022)***	(0.018)***
Age at first contact	-0.121	-0.238
	(0.015)***	(0.018)***
Age at application	0.058	0.177
	(0.021)***	(0.024)***
Math SAT	0.143	-0.154
	(0.101)	(0.103)
Math SAT squared	-0.019	0.009
	(0.009)**	(0.009)
Verbal SAT	0.122	-0.125
	(0.093)	(0.102)
Verbal SAT squared	-0.008	0.016
	(0.008)	(0.009)*
High school GPA	-0.752	0.288
	(0.357)**	(0.270)
High school GPA squared	0.187	0.028
	(0.053)***	(0.040)
Attended private secular high school	-0.775	-0.325
	(0.095)***	(0.027)***
Attended private religious high school	-0.271	-0.146
	(0.031)***	(0.023)***
Median household income	-0.026	-0.020
	(0.001)***	(0.001)***
Per capita disposable income within state	0.375	-0.029
	(0.054)***	(0.006)***
Lagged state unemployment rate	0.094	0.026
	(0.036)**	(0.008)***
Linear time trend	-0.111	-0.040
	(0.023)***	(0.020)*
Rho a	-0.740	-0.023
	(0.207)*	(0.283)
Observations	25,599	27,707

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%
*Correlation between unobservables in FAFSA and enrollment equations

it appears students from disadvantaged backgrounds are more likely to apply for financial aid, as evidenced by a negative coefficient on median income in the student's ZIP code and negative coefficients associated with attending a private high school.

Discussion

This analysis investigates the introduction of a merit-based aid program at the University of Oregon in 1999 to study the enrollment effects of merit-based aid on needy students. Specifically, an individual-level dataset of applicants to the University of Oregon for the years 1996-2004 which contains detailed financial and individual information is used to identify the effects of financial aid on the college access of low-income students. To control for the potential that financial aid is correlated with the error term, the decision to apply for federal financial aid and the enrollment decision are modeled jointly.

The results provide some of the first formal estimates of the effect of financial aid on needy students. While positive, particularly for in-state students, I also note that the effect of merit-based aid may be overstated without controlling for the potential correlation of merit-based aid with the error term.

This is consistent with the fact that there are unobserved factors related to a student's ultimate need that are both correlated with their financial aid packages and likelihood of enrollment. While this is a first step toward understanding the effects of financial aid on needy students, further inquiry is needed. Specifically, further work is required to investigate how merit-based aid affects the needy student's college choice across institutional selectivity. In particular, it would be of keen interest to know whether merit-based aid is simply redistributing these needy students across like institutions, or if it is helping them access more selective institutions. Similarly, given the fact that Pell money is transferable with the student, to fully understand the effects of need-based aid on the college choice of needy students, data containing choice sets are needed.

It is important for enrollment managers to target those students for which their financial aid dollars will have the largest effect. Merit-based aid is an attractive enticement for needy students.

The implications of this research for practitioners of enrollment management are twofold. First, the estimated effects of financial aid, when calculated through standard linear regression techniques, may be overstated. In general, this is true as larger financial aid offers often go to students with high enrollment probabilities in the first place (Martin, Campbell, & Rizzo, 2007). Thus, it is important for enrollment managers to target those students for which their financial aid dollars will have the largest effect on a potential student's collegiate choice.

The second implication for practitioners of this research is that merit-based aid is an attractive enticement for needy students. Despite research that indicates that merit-based aid has larger effects on wealthy students (Singell & Stone, 2002), this research indicates that merit-aid is associated with increases in the enrollment probabilities for needy students that are economically significant. However, more research is needed to better understand how financial aid policies can be optimized to attract low-income students to institutions they otherwise would not attend for financial reasons. Given that low-income students are less responsive to merit-based aid, perhaps the answer is to find larger awards for these students that surpass tuition and cover living expenses as well.

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