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Concerns regarding access to and economic diversity in U.S. higher education are increasingly on the public policy agenda. Although the combination of increasing tuition and decreasing state support has made this issue most pressing for public institutions, qualified students from middle- and lower-income families are facing a financial squeeze that limits their access to both public and private higher education. Indeed, evidence shows that the distribution of higher educational opportunities in the United States has become increasingly concentrated on students from families with high income and wealth (Haveman & Wilson, 2007).

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The private and social benefits of a college education are well documented. For the individual, additional educational attainment leads to higher earnings as well as a variety of other nonmarketed benefits, including improved consumer choices and better health. At the societal level, additional investment in higher education is associated with greater community involvement, reduced unemployment, reduced crime, and increased charitable contributions of time and money.[1] These social and private benefits, in turn, are of value to governments at all levels; because of these gains, tax revenues are increased and expenditures on welfare and assistance programs are reduced (Couturier, 2006).

Although the goal of expanding access to college for youths from middle- and lower-income families is high on the agenda of higher education policymakers, limited availability of data regarding the income distribution of students in specific colleges and universities has resulted in relatively little information about the participation rate of low-income students in U.S. higher education institutions.

This paper addresses this information gap by focusing on the prevalence of low-income U.S. undergraduate students attending four-year colleges and universities. We measure the economic diversity of institutions by the prevalence of students among the undergraduate student body who are supported by a Pell Grant—a universal grant targeted to low-income students. Pell Grants are directed to students with financial need who have not received their first bachelor's degree or who are enrolled in certain post-baccalaureate programs that lead to teacher certification or licensure. The amounts depend on the student's expected family contribution (EFC), the cost of attending the institution, whether the student attends full-time or part-time, and whether the student attends for a full academic year or less. An applicant may receive only one Pell Grant in an award year and may not receive Pell Grant funds from more than one school at a time. The EFC is the number given to a college applicant, based on the applicant's financial strength (as indicated by such factors as family income, net assets, and household size) which is combined with the applicant's educational cost and enrollment status (full time, three-quarters time, half time, or less than half time) to determine the applicant's grant level. In addition, a student must complete the FAFSA (Free Application for Federal Student Aid) to be eligible for a Pell Grant. While the variation in the prevalence of Pell Grant recipients has been well documented elsewhere (Heller, 2004; Mortenson, 2004), we are not aware of studies that have provided an analytical framework in which

[1]Ashenfelter, Harmon, and Osterbeek (1999) summarize the research evidence regarding the earnings effects of marginal investments in education. Evidence on the nonmarketed, external, and public goods effects of a college-educated citizenry is found in Haveman and Wolfe (1984) and Wolfe and Haveman (2003).

to interpret this value as an indicator of the extent of economic diversity among U.S. higher education institutions.

In this paper, we identify independent institution- and state-specific factors potentially related to the prevalence of Pell recipients among U.S. colleges and universities. We find that a substantial portion of the variation in the share of students with Pell Grants among higher education students can be explained by these factors. The results of these estimated relationships provide insight into factors that influence the patterns of low-income student prevalence among both public and private institutions.

In the following section, we review the prior research on student enrollment and access in higher education, then spell out the primary research questions that we address in this article. The next section describes the sample of institutions included in the empirical analysis. Then we present the model and describe the explanatory variables on which we concentrate. After presenting the empirical results, we then conclude with some observations.

Literature Review

A substantial literature has addressed the determinants of student choice regarding college enrollment and the patterns of student access to postsecondary schooling. We first discuss research on the effect of student-borne costs (e.g., tuition and financial aid) on attendance, as prior research has concentrated on this relationship. We then summarize research on the effects of non-economic variables. The findings from this literature guide both the research question that we pose in this paper, and the empirical estimates that we present.

State Government Institutional Grants and Direct Student Assistance

Although a more educated citizenry conveys both private (marketed and nonmarketed) and social benefits, recent trends in the cost and the financing of higher education have constrained the realization of these benefits.

Perna and Titus (2004) study the responsiveness of college choice to several state public policies, including direct institutional assistance, financial aid to students, tuition, and policies related to academic preparation at the elementary and secondary levels. We first consider direct state institutional assistance. All state government budgets include allocations for core support of in-state colleges and universities. With few exceptions, this state support for public post-secondary schooling has failed to keep pace with the increases in costs faced by these institutions over the past few decades. Institutions have used tuition and fee increases to make up for the growing shortfall. In 2007–2008, a college student attending a public four-year in-state

institution paid an average of $6,185 in tuition and fees. This compares to inflation-adjusted costs (constant 2007$) of $4,022 in 1997–1998, and $2,699 in 1987–1988. (College Board, 2007a). In 1980–1981, approximately half the revenues of public institutions came from state and local appropriations. However, by 1999–2000 this proportion had declined to nearly one-third (Couturier, 2006). In addition, state and local appropriations per student declined in inflation-adjusted dollars in fiscal years 1981–1983, 1989–1993, and 2002–2005; these annual intervals correspond to the years of the largest increases in tuition and fees at public four-year colleges and universities (College Board, 2007a). Clearly, public colleges and universities have been particularly affected by these developments. These trends, together with the growing inequality of family income, have raised the cost of attending college far more for students from low-income families than for those in well-to-do families.[2] In addition to providing direct financial support to public universities, states provide direct assistance to students attending in-state institutions. During 2005–2006, state governments awarded approximately $8.5 billion in need- and non-need-based student financial aid; the majority of these funds came in the form of direct student grants (NASSGAP, 2005–2006). Over time, however, the composition of state financial aid to students has shifted away from need-based grant aid toward non-need (merit) based aid. In 1995–1996, 85% of state aid was in the form of need-based grant aid. Over the succeeding decade, the proportion of total aid accounted for by need-based grant aid has decreased to 72%. While total need-based grant aid grew by 56% over this decade, non-need-based grant aid increased by 259% (NASSGAP, 2005–2006). McPherson and Schapiro (2002) emphasize that most individual aid packages are a combination of need- and merit-based aid.

Federal Government Higher Education Assistance

The federal government also provides financial support in the form of loans and grants to qualified undergraduate and graduate students. During the 2007–2008 school year, approximately $83 billion in new federal loan and grant aid was provided to nearly 10 million postsecondary students and their families (U.S. Department of Education, 2008–2009). However, since the early 1980s, federal loans have replaced grant aid as the primary means of federal student assistance (Clinedinst, 2004). In addition, federal grant

[2]In the early 1970s, paying for a child to attend a public four-year college absorbed 42% of the income of a low-income family; by the 2000s, it took nearly 60%; for students from high-income families, the increase in income share was from 5% to 6% (Haveman & Smeeding, 2006). Moreover, students from lower-income families are more sensitive to tuition increases than students from higher-income families (Avery & Hoxby, 2004; Heller, 1997; Kane, 1995, 1999).

assistance has shifted toward merit-based aid and away from need-based assistance. As direct need-based aid to students has increasingly been replaced by merit-based aid at both the federal and state level, the federal Pell Grant remains the one form of grant aid guaranteed to low-income students. With few exceptions, a Pell Grant (in some amount) is guaranteed to dependent students from families with household incomes less than $40,000. Indeed, 86% of dependent undergraduates with Pell Grants during the 2005–2006 school year came from families with incomes less than $40,000. During the 2006–2007 academic year, more than a quarter of all undergraduate students received Pell Grants, totaling $12.9 billion awarded to approximately 5.2 million students, with average grant amounts of $2,494 (College Board, 2007b). For the 2007–2008 academic year, the maximum Pell Grant award increased from $4,050, where it had stood in nominal terms from 2003–2004 to 2006–2007, to $4,310.

College and University Student Financial Assistance

To meet their goals for student quality, colleges and universities have used their own, often limited, financial aid funds to assist lower-income students in meeting the costs of attendance and to seek the highest quality students possible. Where merit plays a role, the students targeted have tended to be from higher-income families. Both need-based assistance and merit-based aid have increased over time, but the largest gains have been in non-need-based assistance, benefiting students from more affluent families (McPherson & Schapiro, 1994, 2002). Ehrenberg, Zhang, and Levin (2006) document the negative relationship between college and university access to National Merit Scholarships and the share of students from low-income families—a drop of four Pell Grant recipients for every 10 additional institutionally funded National Merit Scholarship enrollees. This result appears to be mainly driven by patterns in private institutions.

In part because of these developments, the probability that qualified youths from lower-income families will enroll in postsecondary schooling has decreased; and if enrolled, the probability of their choosing a two-year rather than a four-year college is increased. Meanwhile, college-age youth from higher-income families have become concentrated in the nation's four-year institutions (Haveman & Smeeding, 2006). About 85% of eighth-grade students in the United States aspire to a college degree. But in 2001, only 44% of high school graduates from the bottom quintile of the income distribution were enrolled in college in the October after they graduated from high school, as opposed to almost 80% of those in the upper quintile. Kane (1995, 1999) reports that even among students with similar test scores, class ranks, and identical schools, those from higher-income families are significantly more likely than those from lower-income families to attend college, particularly four-year colleges. Indeed, since the 1970s, students

from lower-income families have increasingly clustered in public two-year postsecondary institutions, which often turn out to be the end of their formal education (Haveman & Wilson, 2007).

These national trends have adversely affected the college opportunities of prospective postsecondary students from low-income families and have contributed to stagnation in the percentage of American youths who earn four-year degrees. Indeed, there has been virtually no change over the past two decades in the share of cohort-specific youth who have been awarded a postsecondary degree. Figure 1 compares schooling for two cohorts in 2002—one ages 25–34, the second 45–54—in 14 industrialized nations. With a few exceptions—most notably the United States—the share of adults with a postsecondary degree has increased in every country. Although the older U.S. cohort ranked second in the share of adults with a postsecondary degree (about 40%), the younger cohort ranked fifth. Four countries had gained parity with the United States or forged ahead, with Canada and Japan outpacing the United States by 10 percentage points; another five countries had closed the gap to less than 5 percentage points.

In part, these patterns reflect the competitive struggle in which colleges and universities have been engaged to hold or to gain ground in national rankings; to meet the norms of these ranking exercises, they have competed for the nation's best and brightest students (Carnevale & Rose, 2003). This competition to succeed in institutional rankings in prominent publications (e.g., *U.S. News and World Report*) reflects the tastes of faculty and other institutional stakeholders, as well as the pursuit of financial gains associated with the rapid increases in federal merit-based assistance that have targeted students from higher-income families.

Other Determinants of College Access and Choice

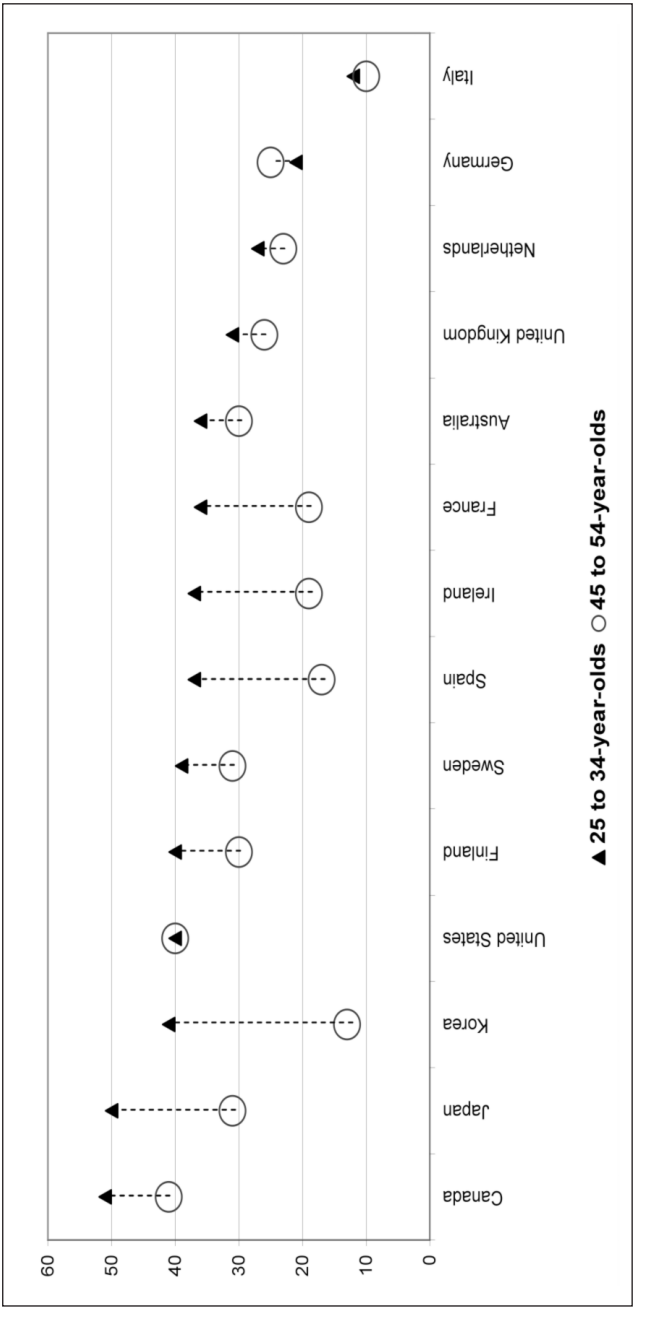
In addition to this research on college access and the implications of changing public support for both students and higher education institutions, researchers have also studied the effects of a variety of other potential determinants of college choice and access. Perna (2006) presents a four-tiered conceptual model of college choice—moving from "habitus" (social and cultural capital), to school and community context, to institutional characteristics (e.g., institutional selectivity, costs, recruitment, aid), to social and economic factors (e.g., economic conditions, policy changes)—and reviews the empirical findings of studies of this process. Some support is found for each of these potential determinants of access and choice.

The responsiveness of student enrollment patterns to the full range of opportunity costs of attending college (e.g., foregone income, tuition, available financial aid) has been studied extensively (Avery & Hoxby, 2004; Heller, 1997; Hill, Winston, & Boyd, 2005; Kane, 1999; Long, 2004). Several of these studies find that the enrollment decision of youths from low-income families

Figure 1.

Percentage of the Population that has Attained Post-secondary Education, 2002

(percentage points)



Source: Pilat (2005) and OECD (2004, Table A3.3, p 71).

is especially sensitive to all of these components of attendance costs. The choice of two-year versus four-year institutions and in-state versus out-of-state institutions is also related to attendance costs (Dynarski, 2004; Perna & Titus, 2004). Numerous researchers find the state unemployment rate (a proxy for foregone income during college years) to be positively related to the enrollment decision and to the type of institution chosen (Long, 2004; Heller, 1999; Kane, 1999; Rouse, 1994), while Berger and Kostal (2002) found a negative correlation between the unemployment rate and college enrollment. In addition, Perna, Steele, Woda, and Hibbert (2005) examined changes during the 1990s in the racial/ethnic stratification of college access and choice in Maryland and explored state public policies that may have influenced changes in the demand for and supply of higher education for students of different racial/ethnic groups during this period.

Several studies have also found that parental income and educational attainment (as proxies for cultural knowledge and values) are positively related to the enrollment decision. Capacity constraints affecting the various types of state higher education institutions are also related to the distribution of state students among institutions (Perna, 2000; Perna & Titus, 2004).

Research Objective and Motivation

The primary goal of this study is to understand the patterns of variation in the prevalence of students from low-income families in the undergraduate student bodies of U.S. colleges and universities. As such, our study is in the line of existing analyses of the determinants of student choice and access reviewed above. However, rather than using individuals or states as the unit of observation, our analysis uses individual higher education institutions.[3]

We measure the prevalence of low-income students in individual colleges and universities as the percentage of the undergraduate student body in these schools who are receiving a Pell Grant; we refer to this variable as the Pell Prevalence Ratio (PPR). In modeling the determinants of this low-income prevalence measure, we employ variables that characterize both the supply and demand sides of the market in which individual students and higher education institutions are participants; these variables are similar to those used in both individual- and state-based research on student access and choice. As such, our study extends the existing literature on student choices among higher education institutions and, hence, student access to postsecondary schooling.

[3]The unit of observation of most of the studies cited—especially those focusing on individual behavioral responses to incentives and opportunities—is the individual student. Nearly all studies that model enrollment patterns employ states as the unit of observation. Ehrenberg, Zhang, and Levin (2006) and Curs, Singell, and Waddell (2005) are among the few studies that analyze access and choice patterns among individual higher education institutions.

Our framework—which incorporates and extends considerations discussed in Perna's (2006) conceptual model—includes variables that reflect economic considerations (e.g., tuition, financial aid, foregone potential earnings), institutional and state characteristics and policies, and student characteristics that are likely to affect the distribution of low-income students across colleges and universities.

Tebbs and Turner (2005) have identified a number of factors that might contribute to differences among universities in the PPR low-income prevalence measure. These factors include: (a) differences among schools in market conditions (the cost of attending a public versus a private university); (b) program offerings (e.g., adult education programs for non-degree-seeking students); (c) the demographic characteristics of Pell-eligible students among potential applicants (such as the relative number of academically qualified low-income students in a state); (d) the pattern of term enrollment (the turnover rate, measured by the number of incoming mid-year transfer students); and (e) the prevalence of international (nonresident alien) students. In addition to these factors, an institution's capacity to provide grant aid to students, as well as the universe of enrollment options within a state might affect the PPR. Our analysis focuses on the extent to which these and other a priori factors are related to the prevalence of low-income students attending U.S. postsecondary institutions.

A second objective of our research is to explore the extent to which an institution's actual PPR deviates from the value of PPR predicted from our model. For any given institution, this deviation is attributable to factors not included in the model. This residual indicates the extent to which an institution succeeds in enrolling low-income students, relative to what we would expect, given the institution's characteristics and the environment in which it operates. Given the extensive set of control variables that we include in our estimation model, these residuals should contribute to the search for explanations for the observed deviation of actual from expected performance and prompt institutional and state public policy initiatives that might improve success in attracting and retaining low-income students.

Institutional Research Sample

Our analysis focuses exclusively on the variation in the prevalence of Pell Grant recipients among 846 colleges and universities offering graduate-level education beyond the baccalaureate degree. These universities are defined by one of four Carnegie classifications and identify U.S. institutions of higher education by their degree-granting activities. (See Table 1.)

Across these 846 schools, the pattern of low-income participation (PPR) varies substantially. Table 2 shows this variation for a selection of large, high-

TABLE 1

DESCRIPTIVE STATISTICS FOR INSTITUTIONAL RESEARCH SAMPLE, 2003–2004

Descriptive Statistic	*Full Sample*	*Publics Only*	*Privates Only*
Number of Schools	846	438	408
Number of States	54	54 [a]	50 [b]
Enrollment [c]	8,159 (7,809)	12,214 (8,423)	3,816 (3,729)
Cost of Attendance [d]	$19,875 $23,540 ($8,967) ($7,073)	$13,015 $20,072 ($3,109) ($4,905)	$27,267 ($7,159)
Median SAT Score	1,065 (117)	1,040 (101)	1,092 (127)
Number of Pell Recipients	2,053 (1,989)	3,196 (2,068)	850 (898)
PPR	27.6% (11.9%)	29.5% (12.4%)	25.7% (11.1%)

Notes: Calculations by authors using IPEDS data. Standard deviations in parentheses.
[a] Of the 54 states represented among all the public doctoral and master's universities, one school is located in Washington D.C., one in the U.S. Virgin Islands, two in Puerto Rico, and one in Guam.
[b] Of the 50 states represented among all the private doctoral and master's universities, eight schools are located in Washington, D.C., and seven in Puerto Rico. The only states without a private university are Nevada and Wyoming.
[c] Enrollment equals the 12-month unduplicated undergraduate-student count, less the number of international and non-degree-seeking students for 2003–2004.
[d] Cost of attendance equals the sum of tuition and fees, room and board, books and supplies, and all other expenses (for a student living on-campus). For the full sample and the publics only, the left half of the cell includes in-state tuition and fees in the calculation, while the right half of the cell includes out-of-state tuition and fees in the calculation.

quality institutions for the 2003–2004 school year. Our analysis distinguishes between four-year public and four-year private universities, as differences in their mission may yield substantially different student selection processes and, hence, variation in Pell Grant participation. Most importantly, public and private universities recruit from different applicant pools, a function of fundamentally different institutional mandates. Since public universities are often required to enroll a minimum percentage of students from their home states, they face geographically constrained pools of applicants; private universities can recruit students without these geographic considerations. For example, in 2003–2004, the University of Wisconsin-Madison enrolled 63.0% of first-time undergraduates from within Wisconsin; the University

Table 2

Variation in Pell Prevalence among Select Research Universities

State	*University*	*Percent with Pell Grants (2003–2004)*
California	University of California - Los Angeles	35.9%
California	University of California - Berkeley	30.9%
Florida	Florida State University	24.2%
Florida	University of Florida	22.1%
Texas	University of Texas - Austin	20.3%
Michigan	Michigan State University	19.1%
Indiana	Purdue University	17.7%
Illinois	University of Illinois - Urbana-Champaign	17.6%
Minnesota	University of Minnesota - Twin Cities	16.6%
Iowa	University of Iowa	16.4%
Maryland	University of Maryland - College Park	16.0%
Indiana	Indiana University - Bloomington	14.9%
California	Stanford University	14.7%
Michigan	University of Michigan - Ann Arbor	13.9%
Wisconsin	University of Wisconsin - Madison	12.1%
Pennsylvania	University of Pennsylvania	10.6%
North Carolina	Duke University	10.1%
Illinois	Northwestern University	10.1%

Notes: Percent with Pell Grants calculated by the authors. Data used in calculation from IPEDS and Economic Diversity of Colleges (www.economicdiversity.org). Private universities are shaded.

of Virginia enrolled 67.5% from Virginia; and the University of California-Berkeley enrolled 90.6% from California (IPEDS data). Moreover, as a result of state requirements to enroll a minimum percentage of in-state students at public universities, differences in the demographic characteristics among states might affect the percentage of students at public universities receiving a Pell Grant. These demographic factors include (a) the income distribution of the state with particular emphasis on the percentage of low-income, college-eligible students in the state, (b) the academic preparedness of a state's low-income, college-eligible population as measured by scores on norm-referenced standardized exams such as the National Assessment of Educational Progress (NAEP) or college entrance exams such as the SAT or ACT, (c) the racial composition of the low-income state population with particular emphasis on the variation in the mix of minority populations, and (d) state-level expenditures on need-based and non-need-based grant aid for higher education.

Tebbs and Turner's (2005) study of California and Virginia identified differences in the relative academic performance of Asian and African American students with incomes of less than $50,000; they found that Asian students performed better in both states. They also identified differences in the composition of the low-income minority populations in these two states, noting that 27.2% of low-income test-takers in California were Asian, while 9.2% identified themselves as African American; in Virginia, 28.1% of all low-income test takers were African American, while 8.3 identified themselves as Asian.

Research Strategy

To address the two objectives of our research, we estimated an empirical model designed to reveal the relationship between a set of independent exogenous variables and the incidence of Pell Grant recipients for both the public and private institutions in our research sample. We obtained the number of Pell Grant recipients at each undergraduate institution from the Economic Diversity of Colleges online database; this database provided the numbers for the 2003–2004 academic year, as supplied by the U.S. Department of Education (2008–2009). We divided these correlates into those that describe the characteristics of the universities (institutional-level variables) and those that describe the environment in which each university operates (state-level variables).

The model that we estimate is:

$$\boldsymbol{\rho}_i = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \boldsymbol{I}_i + \boldsymbol{\beta}_2 \boldsymbol{S}_i + \boldsymbol{\varepsilon}_i$$

where ρ_i is the share of Pell Grant recipients at institution "*i*" during the 2003–2004 academic year; I_i is a vector of institutional-level variables for institution "*i*" in 2003–2004; and S_i is a vector of state-level variables for each institution's state jurisdiction in 2003–2004.

The presence of both institution- and state-level predictors in our model introduces the question of the most appropriate estimation strategy. When the data have a clustered structure, multilevel modeling is one possible estimation option, as standard multivariate models may violate the assumption of identically and independently distributed observations. While the estimation of a single level, multivariable linear regression model over nested data does not bias the parameter estimates, the extent to which samples are clustered affects the sampling variance and, hence, causes bias in statistical significance tests. While the standard significance tests can be adjusted for the clustered nature of the data, multilevel models are more general. In fact, they are designed to analyze variables from different levels simultaneously, using a framework that explicitly models the various dependences.

In decomposing the sources of variation in the prevalence of Pell Grant recipients across the institutions in our sample, we found evidence of limited clustering. The variation of Pell recipients among institutions within states is clearly the largest component in the total variance. Hence, we chose an OLS regression (adjusting the standard errors for intra-group correlation) as our preferred estimation strategy. This estimation approach also yields results that are relatively straightforward to interpret. However, given the presence of some residual variability across the 50 states in the incidence of Pell Grant recipients (after controlling for institution-level characteristics), we also estimated a hierarchical linear model (HLM) to test the robustness of our base model results. Results from this estimation (available on request) are virtually identical to those reported.

To reflect fundamental differences between private and public research universities, we organized the research sample into four-year public research institutions and four-year private (not-for-profit) research institutions.[4] We then fit the same model over the samples of both public universities and private universities. Of the 846 universities in our data set, 795 had available Pell Grant data. We excluded 86 universities because of missing information on one or more variables, leaving a sample of 355 public universities and 354 private universities. We controlled for an extensive set of variables at both the institutional and the state level. Given the specification of our model, we interpret the residuals from our regressions as values that should prompt institutional discussion and further investigation into the factors that may explain where an institution is positioned relative to expectations.

Our dependent variable is the Pell Prevalence Ratio (PPR). The measure that we use differs from that which is often reported by universities and other publications. Typically, the value reported is calculated by dividing the number of Pell recipients in an academic year (numerator) by the undergraduate enrollment in the fall term of the academic year (denominator).

[4]In order to support the estimation of separate regression equations for public and private universities within our sample of national research universities, we ran an F-test of the significance of the difference in estimated coefficients between public and private universities. In particular, we estimated both an unrestricted and a restricted model (no variable for the institution's sector). The parameter estimates to be tested were interacted with a dummy variable indicating the sector of the institution (1 = public; 0 = private). We then tested the joint restriction that the parameter estimates on all of the interacted variables were zero. The resulting F-statistic is 15.52, with an accompanying p-value = 0.0000. We therefore conclude that the underlying processes are distinctly and statistically different between public and private institutions in the recruitment and enrollment of low-income students. The estimation of separate regression models for the public universities and the private universities allows us to make valid cross-institutional comparisons of the PPR (as predicted by our model).

Concerning this formulation, Tebbs and Turner (2005) note that the share of institutional Pell Grant recipients will likely be inaccurately calculated as a result of the differential presence of adult education programs for non-degree-seeking students, the turnover rate resulting from incoming midyear transfer students, and the prevalence of international (non-resident alien) students. Following Tebbs and Turner (2005), this analysis uses the 12-month unduplicated undergraduate enrollment for the 2003–2004 academic year and nets out international and non-degree-seeking students to arrive at the total "Pell-eligible" undergraduate population. While not all undergraduate students are indeed eligible for a Pell Grant (ineligibility is a function of high family income as much as a result of a student not completing the FAFSA), the enrollment variable allows us to most accurately capture the denominator in the calculation of the PPR.

We have divided our explanatory variables into two categories: institutional- and state-level variables. The institutional- and state-level variables discussed in this section are those included in the base model. However, we considered a number of other variables in refining the base model specification. The appendix summarizes these variables.

Institutional-Level Variables

Total Cost of Attendance. We calculated the total cost of attendance for each institution for the 2003–2004 school year. The total cost of attendance equals the sum of tuition and fees, the price of room and board for a student who lives on-campus, books, supplies, and other expenses related to on-campus residence. For private universities, tuition and fees are the same for resident in-state students as well as for out-of-state students. However, for public universities, tuition and fees differ between resident and out-of-state students. Following Kane (1994) and Schwartz (1985), we include in-state tuition and fees for the public universities. The inclusion of in-state tuition and fee costs reflects the greater propensity of first-year students to attend in-state universities (Perna, 2000). In fact, 75% of freshmen entering four-year schools in the fall of 2004 attended college in their home state (NCES, 2005).

As the cost of attendance increases, the prevalence of Pell Grant recipients can be expected to decrease. While higher tuition and fees tend to discourage attendance by students from all economic backgrounds, those from lower-income families tend to be more responsive to higher costs than do those from higher income families, as discussed above.

Median SAT Score. We calculated the median SAT score for the fall 2003 incoming freshmen class at each institution. As Long (2004) notes, the median SAT score is the most common measure of institutional quality and selectivity in the literature on returns to college quality on labor market outcomes (Brewer, Eide, & Ehrenberg, 1999; Dale & Krueger, 2002). For

institutions where more than 50% of students submitted their SAT scores on their application, we included the median SAT score. For institutions where more than 50% of students submitted their ACT scores on their application, we converted the median ACT score into an SAT composite score.[5] For institutions that did not fall into either of these two categories, we calculated the median for the standardized exam with the greatest percentage submitted (and converted to SAT where appropriate).

The median SAT score measures both the selectivity of the institution and the applicants' academic quality. Given the correlation between parental income and test scores, we expected an inverse relationship between the median SAT score and the percentage of students at a university with a Pell Grant (Haveman & Wilson, 2007).

Total Institutional Grant Aid. We calculated the total grant aid per enrollee provided by an institution during the 2003–2004 academic year. This variable accounts for the amount of university-specific funds awarded to students for scholarships and fellowships. The source of these funds includes (but is not limited to) university endowments, the institutional matching portion of federal, state, or local grants, plus funds supplied by businesses, foundations, private individuals, and in some case foreign governments. Ehrenberg, Zhang, and Levin (2006) modeled the relationship between institutional aid and low-income participation; however, they measured institutional aid as the share of institutionally funded National Merit Scholars at an institution. Our analysis employs the amount of institutional aid across a number of institutional sources.

McPherson and Schapiro (2002) note that there is often an interaction between merit- and need-based aid in the offers that institutions make to students. As such, since institutional grant aid is not necessarily need-specific, the sign on this variable could be either positive or negative. A negative relationship could emerge if the effect of funds provided on a purely merit-only basis is dominant.

Total Undergraduate Enrollment. We included a variable for the total undergraduate enrollment at the institution. As explained above, we calculated total enrollment using the 12-month unduplicated undergraduate enrollment for the 2003–2004 academic year, from which we subtracted the number of non-degree-seeking students (an average of the fall 2003 and fall 2004 totals) and international students. The rationale for including this explanatory variable is to control for a "size effect" in the enrollment of low-income students.

Carnegie Classification. Our analysis identifies each university in the research sample by its Carnegie Classification, a common means of identifying

[5]Conversion of ACT to SAT scores follows Dorans, Houston, Lyu, and Pommerich (1997).

institutional diversity in U.S. higher education. The Carnegie Classifications we employed are from the 2000 edition and include schools identified as: (a) Doctoral/Research Universities-Extensive, which offer a wide range of baccalaureate programs, are committed to graduate education through the doctorate, and award 50 or more doctoral degrees per year in at least 15 disciplines; (b) Doctoral/Research Universities-Intensive, which offer a wide range of baccalaureate programs, are committed to graduate education through the doctorate, and award at least 10 doctoral degrees per year in three or more disciplines, or at least 20 doctoral degrees per year over all; (c) Master's Colleges and Universities I, which offer a wide range of baccalaureate programs, are committed to graduate education through the master's degree, and award 40 or more master's degrees per year in three or more disciplines; and (d) Master's Colleges and Universities II, which offer a wide range of baccalaureate programs, are committed to graduate education through the master's degree, and award 20 or more master's degrees per year.

The inclusion of this variable allows us to control for differences in low-income enrollment across universities that have different institutional mandates.

Two-Year College Enrollment. We also considered the extent to which the level of two-year college enrollment opportunities in the state is related to the prevalence of Pell Grant recipients at a given institution. Ehrenberg (2005) notes that access to two-year colleges is an important consideration in understanding access to higher education, as these schools provide an entry point into higher education that often results in transfer to four-year schools. St. John, Musoba, and Chung (2004) further found that the capacity of a state's higher education system appears to matter to the extent that a state's college enrollment rates increase with the share of students enrolled in public two-year and private institutions. The interaction of enrollment options within a state and the prevalence of low-income students (as measured by the PPR) at four-year institutions has previously been explored by McPherson and Schapiro (1994). They found that, between 1980 and 1993, lower-income students became more clustered in community colleges (e.g., public two-year schools). Moreover, Curs, Singell, and Waddell (2005) found that, as the generosity of the Pell Grant program increased between 1989 and 2002, it expanded access to less selective institutions; the share of Pell Grant revenues going to two-year institutions rose from approximately 25% of total Pell disbursement in 1989 to more than 40% in 2002.

To address the relationship between in-state enrollment options and low-income access to four-year institutions, we constructed a two-year college enrollment variable to capture the universe of in-state two-year institutional options that Ehrenberg (2005) identifies as an avenue into higher education. The two-year college enrollment variable considers both public and private

institutions in each state and equals the total two-year college enrollment in a given state divided by the difference between the total college (two- and four-year public and private schools) enrollment in that state and the total enrollment for each institution in question. While the findings in the studies cited above do not provide a clear prediction for the anticipated direction of the coefficient on this variable with respect to PPR, the presence of two-year enrollment options presents two potentially competing effects. These effects may be describes as "gateway" and "crowd-out" effects.

Having a greater relative inventory of two-year college slots in any state will likely relieve the demand for attending four-year colleges by low-income students. It follows that the greater the number of two-year slots in a given state relative to total enrollment, the lower the PPR at four-year institutions is likely to be. In essence, the presence of two-year colleges will "crowd-out" the share of low-income students attending larger four-year institutions.

However, having a greater relative inventory of two-year college slots is likely to increase the total number of a state's youths who enroll in college at any level. This higher overall rate of college enrollment is likely to be associated with a concentration of lower income students in two-year institutions (see above). With some rate of transfer from two-year colleges into state four-year colleges in years three and four, the level of two-year college enrollment may be positively related to the PPR at four-year institutions. This is the "gateway" effect which is described in Ehrenberg (2005).

Given these competing effects of the presence of two-year enrollment options on the PPR at four-year institutions, the sign of the coefficient on this variable will depend on the relative strengths of the "crowd-out" and "gateway" effects. If the "crowd-out" effect dominates, the sign on the coefficient would be negative; however, if the "gateway" effect dominates, the coefficient will have a positive sign.

State-Level Variables

To control for relevant differences in the economic environment within which institutions operate, we calculated a series of state-based socio-demographic control variables.

Low-Income Recruitment Pool. To control for the size of the low-income student population from which universities recruit, we calculated the low-income K–12 student population as the percentage of students ages 6–18 in each state living at or below 200% of the federal poverty level. The poverty threshold for a couple with two children in 2003 was $18,660 (U.S. Bureau of the Census, n.d.) This variable serves as a proxy for the percentage of students in a state from low-income families and for the share of students eligible to receive a federal Pell Grant at the time of application to a post-secondary institution.

Percent of Minorities. We calculated the percentage of minorities in each state—that is, the percentage of the state population represented by Blacks,

Hispanics, Asians, and Native Americans. Tebbs and Turner (2005) note that the percentage of an undergraduate population receiving a Pell Grant is influenced by the proportion of these groups in the state, particularly as each group is often disproportionately overrepresented among the state's low-income population.

State Unemployment Rate. We included the state unemployment rate for 2003. Following much of the prior work on student enrollment in higher education (Heller, 1999; Kane, 1994, 1999; Perna, 2000; Perna & Titus, 2002), a state's unemployment rate is a proxy for within-state labor market opportunities. Empirical research has found that, as a state's unemployment rate increases, the opportunity cost of attending college declines. A positive relationship between the unemployment rate and the probability that a student will attend a two-year or four-year institution is documented by both Long (2004) and Rouse (1994); Heller (1999) found a positive relationship between the unemployment rate and enrollment in public colleges and universities in a state; an exception is Berger and Kostal (2002), who found a negative relationship. However, since this analysis considers only enrollment at four-year institutions, increases in the state unemployment rate may correspond with declines in enrollment, as lost family earnings due to unemployment might prevent dependent students from attending larger, more expensive universities.

State Grant Aid. We calculated the state-level capacity to provide grant aid to undergraduate students as the sum of need-based grant aid and non-need-based grant aid awarded by the state as a proportion of the 18–24-year-old population (Heller, 1999; Perna & Titus, 2004). Need-based grant aid is the total grant aid available to students who meet some standard of need, as determined by the state of residence (e.g., expected family contribution, the remaining costs of college attendance, or some maximum income level). Non-need-based grant aid is the total grant aid available to students who are not required to demonstrate financial need to be eligible for an award; in most cases, this aid is based largely on measures of academic merit (NASSGAP, 2005–2006).

Some state grants are based only on need and some only on merit; however, many state grants are based on a combination of these need and merit criteria. Furthermore, since some states (e.g., California, Pennsylvania, Texas) have identified their grant provisions as need-based only, it is unclear whether this grant aid is based solely on the financial need of undergraduate students in their state or some combination of need and merit criteria (NASSGAP, 2005–2006).

Longanecker (2002) describes the interaction between need and merit-based aid at the state level, noting that, in states without a formal merit-based aid program (e.g., California), students are required to achieve above certain academic standards to qualify for need-based aid. McPherson and Schapiro

(2002) similarly note that there is often an interaction between need and merit-based aid, or "merit within need" in disbursements to low-income students. Because of the ambiguity associated with eligibility criteria for receiving need-based grant aid, we included a measure of total grant aid, rather than variables for both need-based and a non-need-based grant aid.

Low-Income NAEP Scores. We also included the eighth-grade NAEP scores of low-income students per state. This variable is a composite of math and reading scores for students eligible for the free and reduced-price lunch program (2003) in each state. This variable is included to control for variation across states in the degree of academic preparedness of low-income students. It can be argued that higher education institutions may benefit from being located in states that, on average, succeed in providing a better-prepared pool of low-income students. While the NAEP is given to a representative sample of students in grades 4, 8 and 12, only the fourth- and eighth-grade NAEP is representative by state; the 12th grade test is given to a nationally representative sample of students. As such, we can include only the eighth-grade exam to estimate across-state differences in the academic preparedness of low-income students (e.g., students receiving free or reduced-price lunch who took the NAEP in the eighth grade).

Empirical Results

Estimation Results for Base Case Model

To investigate the relationship between the Pell Grant recipient variable and those factors that we expect are related to low-income prevalence, we estimated a base case regression model with the same set of independent variables fit separately over public and private institutions. Table 3 summarizes the coefficient estimates for this model. We interpret our results separately for public and private universities.

Public Sector Institutions

The median SAT variable is a significant and substantive predictor of the number of Pell Grant recipients at public institutions. We found that a 1% increase in the median SAT score of an institution's incoming freshman class corresponds to a 0.81% decrease in the percentage of Pell Grant recipients. The negative coefficient on this variable is consistent with our hypothesis of a negative relationship between school selectivity (median SAT score for incoming freshmen) and the number of Pell-eligible students.

The amount of institutional grant aid (per enrollee) at public institutions was also significantly correlated with the prevalence of Pell Grant recipients. The effect is in a positive direction; more aid is associated with greater low-income participation. While statistically significant, the magnitude of the

TABLE 3

BASE CASE MODEL

DEPENDENT VARIABLE: SHARE OF PELL GRANT RECIPIENTS (2003–2004)

	Independent Variables		*Public*	*Private*
INSTITUTIONAL-LEVEL	Total cost of attendance (logged) [a]		-.0014 (.0282)	-.1891 *** (.0500)
	Median SAT (logged)		-.8072 *** (.0762)	-.4325 *** (.0557)
	Institutional grant aid per enrollment (logged)		.0119 *** (.0044)	.0325 ** (.0126)
	Enrollment (logged)		-.0516 *** (.0099)	-.0238 *** (.0073)
	Two-year college enrollment		.1034 * (.0577)	.0540 (.0511)
	Carnegie Classification[b]	Doctoral - Intensive	-.0395 *** (.0137)	-.00001 (.0186)
		Master's I	-.0476 *** (.0145)	-.0357 ** (.0148)
		Master's II	-.0707 *** (.0224)	-.0307 (.0219)
STATE-LEVEL	Low-Income K-12 Student Population		.7324 *** (.0979)	.2654 ** (.1068)
	Minority Population	% Black	.0413 (.0593)	.0300 (.0647)
		% Hispanic	-.1146 (.0959)	.0279 (.0748)
		% Native American	.2474 (.4039)	-.2943 (.2264)
		% Asian	.4884 (.3861)	.1033 (.1392)
	Total grant aid per 18-24 (logged)		.0134 ** (.0063)	.0094 (.0056)
	State unemployment rate		-1.3856 *** (.4231)	-.3759 (.4875)

Table 3, cont.

	Independent Variables	*Public*	*Private*
State-Level	8th grade NAEP (logged)	-.1615 (.3729)	.2502 (.2908)
	Constant	6.9419 *** (2.122)	3.6148 * (1.956)
	Universities	355	354
	R-Squared	.6575	.4692

Notes: Coefficients are statistically significant at the *10%, **5%, , or ***1% level. Standard errors are in parentheses.
[a] In-state tuition and fees are included for the public universities. Tuition and fees are the same for in-state and out-of-state students attending private universities.
[b] The reference category for the Carnegie Classification indicator variables is *doctoral-extensive*.

estimated coefficient suggests that institutional aid is not quantitatively important in understanding the prevalence of lower-income students among institutions.

Our analysis found a negative relationship between the size of the undergraduate population at public institutions and the share of Pell Grant recipients. A 1% increase in the total undergraduate enrollment (adjusted for non-degree-seeking and international students) yields a 0.05% decrease in our dependent variable. We conclude that there is a marginal "size effect" on low-income participation at public institutions; as the size of a public institution increases, the percentage of Pell Grant recipients falls.

The coefficient on the two-year college enrollment indicates a positive relationship between the extent of total two-year college enrollment opportunities and the percentage of Pell Grant recipients at a four-year institution. The positive coefficient is evidence that the "gateway" effect dominates the "crowd-out" effect. As the relative share of two-year college enrollment slots increases by 1%, holding constant the number of institutional enrollment seats, the PPR increases by .10%.

We find that, after controlling for observable institutional and state characteristics, the largest research universities (e.g., Doctoral/Research-Extensive) enroll a larger share of Pell Grant recipients. However, given the small effect size on the coefficients for the Carnegie Classification indicator variables (Doctoral-Intensive, Master's I, and Master's II), we cannot conclude that a meaningfully substantive difference exists with respect to PPR across Carnegie classes.

The percentage of students ages 6–18 from low-income families in each state (the low-income K–12 student population variable) is a significant predictor of the prevalence of Pell Grant recipients. A 1% increase in this variable implies a 0.73% increase in the share of Pell Grant recipients, indicating that the public institutions are responsive to state demographics among the college-eligible (and Pell-eligible) population.

Contrary to our expectations, the coefficient on the unemployment rate indicates that the higher the state unemployment rate, the lower the share of Pell Grant recipients at four-year colleges; that is, a 1% increase in the state unemployment rate corresponds to a 1.39% decrease in PPR. This finding differs from much of the established literature. This result may result from including only four-year institutions in our sample; students may be choosing to attend less expensive two-year colleges given weaker state economic conditions, as captured by the state's unemployment rate.

Total grant aid provided to in-state students is positively related to institutional PPR. While this relationship is statistically significant, the size of the relationship is quite small in magnitude. We believe that the limited effect size of the state total grant aid variable may be explained by the ambiguity in the definition of aid at the state level. We also estimated the model separately for need- and merit-based aid. For the public institutions, the coefficients were statistically and practically insignificant. For private institutions, both coefficients had a negative sign but limited size, though the coefficient for need aid was statistically significant.

The remaining variables included in the model do not show a significant relationship with our dependent variable. The cost of attendance for public institutions does not seem to be a fundamental factor in determining low-income participation at public institutions. We also fail to find significant coefficients for the minority groups.

Private Sector Institutions

Unlike the model results for public institutions, the cost of attendance variable is a significant predictor of Pell Grant prevalence. A 1% increase in the cost of attendance yields a 0.19% decrease in the percentage of Pell Grant recipients. This finding suggests that increases in the total cost of attendance discourage application to four-year private institutions for low-income students. In other words, price acts as a form of "sticker shock" leading low-income students to self-select out of the application process.

The coefficient on the median SAT variable in the private-only specification also indicates a negative and statistically significant effect. However, the effect size is smaller than it is under the public-only specification. A 1% increase in the median SAT score variable leads to a 0.43% decrease in the share of Pell Grant recipients.

Like Ehrenberg, Zhang, and Levin (2006), who found that an increase in the selectivity of the undergraduate population (as measured by the number

of National Merit Scholarship winners) was related to declines in the share of Pell Grant recipients at the institutional level, we also found this relationship, using median SAT score as a proxy for institutional selectivity.

The enrollment size effect on Pell Grant prevalence is also significant for the private institutions. Our analysis found that a 1% increase in total undergraduate enrollment led to a 0.02% decrease in the PPR.

Interestingly, among the state-level variables, only the low-income K–12 student population variable was statistically significant in the private-only specification. This finding is consistent with the above-mentioned difference between public and private institutions in their applicants' geographic market.

Across institutional sectors, we saw evidence of a differential response by public and private universities to in-state demographics. For example, the coefficient on the share of low-income students in a state is three times greater for public universities than for private universities. Additionally, the share of Pell Grant recipients at public universities is very sensitive to the state's unemployment rate, while the PPR at private universities is unrelated to state economic dynamics, as measured by the unemployment rate.

Private universities seem to experience a greater response in the prevalence of Pell Grant recipients to available institutional assets than public universities. A 1% increase in institutional grant aid (per enrollee) yields nearly a three-fold increase in PPR among private universities relative to public universities. This result may indicate that low-income students have greater price sensitivity to the cost of private universities; this result is reinforced by the significant (and negative) coefficient on the cost of attendance variable at private universities.

Finally, the coefficient on the median SAT variable for public universities is nearly twice as great as the coefficient for the private universities. Efforts to increase selectivity by public universities appear to be related to larger reductions in the PPR than similar efforts by private institutions, perhaps because of the relatively greater diversity in family economic circumstances (and, hence, academic preparation) of the pool of potential applicants to public relative to private schools.

Sensitivity Tests of Base Case Results

We have estimated a number of alternative models for both the public and private institutions as robustness tests to our primary analysis and summarize their results here. (Full estimates available on request.)

Additional Institutional and State-Level Variables

The additional variables that we explored in the context of our primary analysis are described in the appendix. First, we added an indexed measure

of institutional selectivity—the *Barron's Profiles of American Colleges* (2001) rankings of major universities.[6] Our analysis found these selectivity controls highly correlated with the median SAT variable.

We also identified and explored the effect of the undergraduate-age poverty population (the percentage of young adults ages 18–24 per state in 2003 living at or below 100% of federal poverty threshold) on Pell Grant prevalence. This variable was highly correlated with the K–12 low-income variable.

We estimated a model which included each state's per capita income (in 2003 inflation-adjusted dollars) and the total number of 18–24 year olds in each state in 2003 to the set of institutional- and state-level variables already included in our primary model. For both the public-only and private-only estimations, the alternative model provided very little increase in total explanatory power. Furthermore, the additional control variables affected the size (and, in some cases, the direction) of only a few parameter estimates. In the public-only estimation, the coefficients on the percentage of Native Americans and Hispanics become statistically significant (at the 10% and 5% level, respectively), while the coefficient on state total grant aid loses its significance. The coefficient on the total number of 18–24 year olds is 0.029. It is statistically significant, while the coefficient on state per capita income is insignificant. For the private-only estimation, the K–12 low-income variable became insignificant. Both the total number of 18–24 year olds in the state and the state per-capita income variables are insignificant.

HLM Estimation

As noted above, the structure of our data set calls into question the assumption of independent observations in standard multivariate regressions. A hierarchical linear model (HLM) can incorporate individual-level and state-level data in a framework that accounts for different units of analysis (Raudenbush & Bryk, 2002). Perna and Titus (2004) applied a multilevel model to analyze the role of state public policies on a student-level outcome (type of institution enrolled).

We first specified a model at each of the institutional and state levels, then derived a single equation. The first-level model includes only the

[6]Barron's rankings designate the selectivity of a university through a categorical rating system. The categories are: not competitive, low competitive, competitive, competitive+, very competitive, very competitive+, highly competitive, highly competitive+, and most competitive. We converted the Barron's selectivity measure in two ways; first, we collapsed the categories from nine to three, creating the following categorical variables: (a) high selectivity; (b) medium selectivity; and (c) low selectivity. We also converted the Barron's selectivity rankings into an indicator variable, which we called high selectivity, assigning the value of one (1) to Barron's rankings of highly competitive, highly competitive+, and most competitive. We assigned zero (0) value to the remaining Barron's rankings.

institutional-level explanatory variables. We then allowed the parameters from the first-level regressions to vary across states and modeled them on the state-level covariates. Combining the models at the two levels yielded a single prediction equation for the PPR. This equation differs from a standard regression model because the errors are not independent (some components are common to every institution within a certain state) and do not have equal variances. Because the standard OLS assumptions are not met, the model can be estimated by iterative maximum likelihood procedures (Raudenbush & Bryk, 2002). The maximum likelihood estimations commonly used in multilevel models are computationally demanding, especially when applied to unbalanced data (i.e., different group sizes) and require sufficiently large sample sizes. Because of the limited number of cases at the state level (n = 50), we allow variations across states only in the intercepts of the within-state regression lines. That is, we let the overall level of the PPR vary across states only after controlling for institution-level covariates. The effects of the covariates themselves are constrained to be the same for all the states (Perna & Titus, 2004).

The results from our multilevel analysis are consistent with and similar to the findings from the multivariate regression. For both the public and the private university models, we found no major differences in the estimated parameters. All coefficients had the same size and approximately the same magnitude in both estimations. While there were no changes in the significance level of the parameters for the private universities, we observed some deviations at the state level in the public-schools estimation. Specifically, the coefficient on the state unemployment rate and the two-year college enrollment variable lost significance, even as they maintained a similar magnitude of the effect.

Residual Value Analysis

To evaluate the patterns by which an institution's actual PPR deviates from the value of the Pell ratios predicted by our model, we conducted a residual value analysis. From the coefficient results of the base case regression model, we calculated the predicted PPR value. We then subtracted the predicted PPR from the institution's actual PPR to arrive at a residual value. A negative residual value indicates that the university is performing below expectations relative to our model, while a positive residual value indicates above-expected performance with respect to enrolling Pell Grant recipients.

Table 4 summarizes our residual value estimates for the selection of institutions in Table 2; we include actual and predicted PPR, the residual value, an institution's relative position among either the public or private universities, and an institution's relative position among all of the sample institutions. (A comprehensive set of institution-specific PPRs, predicted and actual, and residual values is available on request.) The rankings are in

TABLE 4

PPR RESIDUAL VALUE ANALYSIS

State	*University*	*PPR (Actual)*	*PPR (Predicted)*	*Residual*	*Within-Sector Residual Ranking (higher %ile rank => better Pell performance)*	*Overall Residual Ranking (higher %ile rank => better Pell performance)*
California	University of California - Los Angeles	35.9%	18.8%	17.1%	4/355 (99%)	12/709 (98%)
California	University of California - Berkeley	30.9%	17.4%	13.5%	13/355 (96%)	27/709 (96%)
Florida	Florida State University	24.2%	20.9%	3.3%	101/355 (72%)	194/709 (73%)
Florida	University of Florida	22.1%	13.8%	8.3%	38/355 (89%)	71/709 (90%)
Texas	University of Texas - Austin	20.3%	16.9%	3.3%	99/355 (72%)	192/709 (73%)
Michigan	Michigan State University	19.1%	15.6%	3.5%	97/355 (73%)	185/709 (74%)

State	University	PPR (Actual)	PPR (Predicted)	Residual	Within-Sector Residual Ranking (higher %ile rank => better Pell performance)	Overall Residual Ranking (higher %ile rank => better Pell performance)
Indiana	Purdue University	17.7%	15.4%	2.2%	120/355 (66%)	234/709 (67%)
Illinois	University of Illinois - Urbana-Champaign	17.6%	11.9%	5.7%	61/355 (83%)	119/709 (83%)
Minnesota	University of Minnesota - Twin Cities	16.6%	13.5%	3.1%	107/355 (70%)	205/709 (71%)
Iowa	University of Iowa	16.4%	19.6%	-3.2%	246/355 (31%)	485/709 (32%)
Maryland	University of Maryland - College Park	16.0%	8.2%	7.8%	41/355 (89%)	81/709 (89%)
Indiana	Indiana University - Bloomington	14.9%	18.8%	-3.9%	263/355 (26%)	513/709 (27%)
California	Stanford University	14.7%	14.4%	0.3%	162/354 (54%)	326/709 (55%)
Michigan	University of Michigan - Ann Arbor	13.9%	9.2%	4.7%	78/355 (78%)	150/709 (79%)

Table 4, cont.

State	*University*	*PPR (Actual)*	*PPR (Predicted)*	*Residual*	*Within-Sector Residual Ranking (higher %ile rank => better Pell performance)*	*Overall Residual Ranking (higher %ile rank => better Pell performance)*
Wisconsin	University of Wisconsin – Madison	12.1%	9.4%	2.7%	112/355 (69%)	219/709 (69%)
Pennsylvania	University of Pennsylvania	10.6%	7.4%	3.2%	98/354 (72%)	204/709 (71%)
North Carolina	Duke University	10.1%	12.9%	-2.8%	233/354 (34%)	473/709 (33%)
Illinois	Northwestern University	10.1%	11.6%	-1.5%	197/354 (44%)	403/709 (43%)

Note: Percent with Pell Grants calculated by the authors. Data used in calculation from IPEDS and Economic Diversity of colleges (www.economicdiversity.org). Private universities are shaded.

both percentage and numerical terms. For example, an institution with a 95th percentile within-sector ranking indicates that that institution has a higher actual PPR score relative to its predicted score than 95% of its sector peers.

The residual value analysis indicates an interesting intra-state variation in predicted performance, particularly among the public universities in the sample. For example, in California, UC-Berkeley, UCLA, and UC-San Diego are each in the top 10% of public schools based on residual performance, while UC-Santa Barbara and UC-Santa Cruz are in the bottom quartile. Other states where we observe significant intra-state variations include Alabama, Arkansas, Florida, Georgia, Illinois, Iowa, Kansas, Kentucky, Louisiana, Michigan, Mississippi, New York, North Carolina, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and Wisconsin. This pattern appears to reveal a form of "institutional stratification" among public universities within the same state. These intra-state differences in enrollment patterns suggest the need for further investigation into the nature of institutional admission policies.

Conclusions

Our analysis has yielded insight into those factors that appear to influence the variation in Pell Grant recipients among our sample of major public and private colleges and universities. We are able to explain a substantial proportion of the variation among both the public and private universities in the prevalence of low-income students. Furthermore, we have identified those factors that are statistically significantly related to the prevalence of Pell Grant recipients.

A key finding is the very large and negative relationship between the median SAT score of incoming freshmen students and the prevalence of Pell recipients for both public and private institutions. This variable is an important measure of institutional selectivity and reflects the drive for high institutional rank exercised in varying degrees by all of the institutions. This conclusion raises clear concerns regarding the role of institutional selectivity on the economic diversity of the undergraduate student body. However, more work is necessary to fully understand how recruitment practices might crowd out low-income students in the process of seeking high institutional rank.

Our analysis provides a framework that allows the identification of each university's performance in terms of the prevalence of students from low-income families—as proxied by PPR—relative to the prevalence one would expect, given the institution's characteristics and the characteristics of the student population from which it is likely to draw. The detailed assessment

of each university's relative success in enrolling Pell Grant recipients should serve as the basis for additional study of the reasons why some institutions exceed expectations while others fall short of their predicted level of low-income students. We believe that this analysis can inform discussion of low-income access to higher education among policymakers, university officials, researchers, and other interested parties.

Common to most empirical analyses, our study is constrained by imperfect statistical measures of the variables we seek to study. For example, our state-level indicators are only imperfect indicators of the economic and social environment in which institutions operate. Moreover, our analysis is not based on an explicit structural model of the nature of market and enrollment competition that public and private universities face in each state. While we are able to use our cross-sectional data to model the relationship between institutional and state environmental variables and the PPR, we are not able to make causal claims about these relationships. A related limitation is that we are unable to reliably test prior hypotheses regarding specific admission and recruitment policies. Hence, caution is necessary in attempts to infer policy prescriptions from these findings. Future research efforts based on longitudinal data that permit estimates across time may provide better estimates of causal relationships.

Our analysis, however, should encourage colleges and universities to understand more clearly the effects of alternative policies designed to increase the economic diversity of their student bodies. What practices do successful institutions (e.g., those whose performance exceeds expectations) pursue in attracting qualified students from low-income families? Can these practices increase the efficacy of efforts to increase student economic diversity by the underperforming institutions?

Appendix: Summary of Explanatory Variables

The tables below detail the institutional and state-level variables considered in the analysis for each of the 846 institutions in the research sample.

Institutional-Level Variables

Variable	*Description*	*Data Source*
Pell Grant recipients	The number of Pell Grant recipients at each undergraduate institution in 2003–2004.	Economic Diversity of Colleges[1]
Sector	The sector identifies a university as a public or private (not-for-profit) four-year degree-granting institution.	IPEDS
Enrollment	The 12-month unduplicated undergraduate enrollment for the 2003-2004 academic year, less non-degree-seeking students (average of fall 2003 and fall 2004) and international students).	IPEDS
Cost of attendance	The 2003-2004 academic year cost of includes: attendance tuition and fees, room and board, books and supplies, other expenses (on campus).	IPEDS
Median SAT score	The median (50%) SAT score for the 2003 entering freshman class at each university.	IPEDS
Selectivity rankings	*The Barron's Profiles of American Colleges* (2001) rankings of major universities.	*Barron's Profiles of American Colleges* (2001)
Two-year college enrollment	Total two-year college enrollment relative to total state college enrollment aside from the institution in question.	IPEDS

[1]This database provides the number of federal Pell Grants awarded at each college for the 2003–2004 academic year, supplied by the U.S. Department of Education (www.economicdiversity.org).

Appendix, cont.

Variable	*Description*	*Data Source*
Institutional grant aid	The total amount of institutional grant aid provided for scholarships and fellowships.	IPEDS

STATE-LEVEL VARIABLES

Variable	*Description*	*Data Source*
Low-income K–12 student population	The percentage of age 6–18 population per state in 2003 living at or below 200% of federal poverty threshold. (The poverty threshold for a family of four with two children was $19,157 in 2004 and $18,660 in 2003.)	National Center for Children in Poverty[2]
Under-graduate-age poverty population	The percentage of young adults age 18 to 24 per state in 2003 living at or below 100% of federal poverty threshold. (The poverty threshold for a family of four with two children was $19,157 in 2004 and $18,660 in 2003.)	Casey Foundation Kids Count State-Level Data.[3]
Race/ethnicity variables	The percentage of Blacks, Asians, Hispanics, and Native Americans per state population in 2003.	U.S. Census
Unemployment rate	The percentage of unemployed population per state in 2003.	U.S. Census
Per capita income	State per capita income for 2003.	U.S. Census
Total grant aid	The total amount of need- and non-need-based aid provided by a state to individual students attending public and private in-state universities.	NASSGAP[4]

[2]A leading public policy center dedicated to promoting the economic security, health, and well-being of America's low-income families and children, located at the Mailman School of Public Health at Columbia University.

[3]Kids Count is a project of the Annie E. Casey Foundation in the effort to track the status of children in the United States.

[4]National Association of State Student Grant and Aid Programs. NASSGAP completes an annual survey documenting state-funded expenditures for postsecondary student financial aid.

Appendix, cont.

Variable	*Description*	*Data Source*
Low-income student college preparedness (NAEP)	8th grade NAEP scores per state–a composite of math and reading scores for students eligible for free and reduced lunch program (2003).	IPEDS
18-24-year-old population	The total number of 18-24 year olds in the state (2003).	U.S. Census

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