Low-Income Engineering Students: Considering Financial Aid and Differential Tuition

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This paper explores the relationship between tuition differentials and low-income students in Engineering fields at two public, research-intensive universities. Although current reports indicate the need for increased participation within the Science, Technology, Engineering, and Mathematics (STEM) fields, rising tuition prices at the university and program levels may deter low-income students to enroll and persist within STEM, specifically Engineering. The findings reveal that increased costs due to tuition differentials policies are initially offset by financial aid, but over time costs increase, particularly for low-income students. The results highlight the need for comprehensive, time-sensitive financial aid packages that provide students opportunities to complete their postsecondary degrees, particularly in fields with higher tuition rates.

President Obama's 2010 Graduation Initiative, a goal to restore the United States as the leading producer of college degrees, sets the stage to increase the proportion of overall college degrees awarded by 2020 in order to ensure the nation's research and innovation, economic prosperity, and global competitiveness. Simultaneously, several reports have outlined the need to increase the number of Science, Technology, Engineering, and Mathematics (STEM) degrees awarded to domestic students within the U.S., specifically underrepresented students (e.g., women, low-income, and underrepresented racial and ethnic minorities) in STEM[1]. In response, recent legislation such as the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act of 2007 and of 2010 and the American Recovery and Reinvestment Act of 2009 have invested in early childhood education, improving K-12 Math and Science education, and increasing the maximum Federal Pell Grant award, the latter of which directly affects low-income students in higher education.

While the impact of federal efforts may positively affect students enrollment and degree production, colleges and universities are engaging in practices that may undermine such efforts. Specifically, charging higher

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[1] See Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline (2010); National Science Foundation (2010); President's Council of Advisors on Science and Technology (2012).

tuition rates for specific majors and courses through the use of *differential tuition* policies is practiced by many colleges and universities across the nation, and particularly by the STEM disciplines. The practice is based on the higher costs associated with education delivery and training in certain fields, as well as the assumption that students are willing to invest in higher-cost STEM degrees due to expected financial returns upon graduation (George-Jackson, Kienzl & Trent, 2008). Multiple sub-groups who earn a higher education degree stand to benefit from entering the STEM workforce and the higher earnings associated with STEM majors, particularly low-income students. (Jacobson & Mokher, 2008).

Despite the use of tuition differentials, there is a lack of research on the impact of tuition differentials within STEM, which can be 45% higher than base tuition at some public institutions (Nelson, 2008). Given this current knowledge gap, empirically-based research is needed to inform the potential effects on access and retention within STEM fields for underrepresented, low-income students. This study seeks to investigate the impact of differential tuition policies on low-income undergraduate students' entrance into and persistence in Engineering baccalaureate programs at two public, research universities. Furthermore, this paper seeks to expand current understandings of underrepresented groups in STEM fields—specifically within Engineering and by socio-economic status. As the nation seeks to expand its STEM workforce, it is important to examine the implications of differential tuition policies on student's educational opportunities and outcomes in STEM, particularly in times of economic hardship.

Theoretical Framework and Literature Review

The theoretical framework that informs this study is derived from human capital theory. Human capital theory relates to the means of production, by which additional investment produces extra output. Human capital is interchangeable, but not transferable like land, labor, or fixed capital (Becker, 1964). Within education, this theory suggests that a college degree increases the earning potential of an individual over their life course (Goldrick-Rab, Harris, & Trostel, 2009). Human capital theory has been used to explore how differences in opportunities within higher education are contingent on access to financial resources, including financial aid (Becker, 1964, 1975, 1994; St. John & Starkey, 1995). Specifically, human capital theory suggests that a reduction in the net price (i.e., the sticker price minus grant aid) of college would improve access to higher education for some student populations. At the same time, low-income students are characterized as having a greater level of price sensitivity as compared to their high-income peers (St. John & Starkey, 1995). Price sensitivity occurs when individuals or groups are more likely to respond negatively to increases in the net price of a product or service. In this case, low-income students are less likely to enroll in higher education due to net price increases, while the same increases have less effect on the enrollment decisions of other students.

Although human capital theory has its own limitations, a net-price theory focuses primarily on the direct cost of college (Leslie & Brinkman, 1987) and can be used to explain how reducing the financial burden of higher education will allow more students to persist to graduation (Goldrick-Rab et al., 2009). St. John and Starkey (1995) recommend that a "high-tuition, high student-aid strategy," through a net-price theory approach, be the "optimal public finance strategy" (p. 158). Both human capital and net-price theory allows for examination of financial aid and tuition policies that can facilitate retention for low-income students.

Low-Income Students in Higher Education

Since the inception of Pell Grants as a federal financial aid program in the early 1970s, Pell Grants have sought to increase access to higher education by providing low-income students with access to a postsecondary education, regardless of institution type. Pell Grants are unique in that they operate as a voucher aid program, whereby the funds are awarded directly to the student and are portable. In the last two decades, the maximum amount of the Pell Grant has not kept pace with increasing tuition costs or with inflation (Cook & King, 2007). This is mostly attributable to the recent financial burden experienced by many public institutions due to reduced state and federal support which is often transferred to the student via tuition and fee increases (Heller & Rogers, 2006). Subsequently, low- and middle-income students are finding it increasingly hard to gain access to even public universities which were at one time considered to be more affordable (Mumpher, 2003). Heller (2002) suggests that financial aid plays a pivotal role in student's expectations, plans, and enrollment decisions prior to students applying or enrolling in higher education. This is especially true for lower income students who are more likely to attend college if they expect to receive financial aid (King, 1996). Similarly, the Advisory Committee on Student Financial Assistance (2010) found that 73% of low-income students who graduated from high school in 2004 indicated financial aid was very important, as compared to 30% of their high-income peers. Financial support is also critical for students majoring in STEM fields, specifically highlighting the importance of need-based financial aid that targets low-income students in STEM (e.g., SMART grants) (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2010).

There is a need to closely examine the context and profile of students who attend highly selective public research institutions. It is important to note that the low-income and racial and ethnic minority populations who self-select out of such institutions may do so because they believe they cannot afford to it, or are reluctant to place an additional financial burden on their families (Gandara & Contreras, 2009). Furthermore, low-income students who attend these institutions may be disproportionately affected by increasing tuition levels and thus burdened with having to seek additional sources of aid, mainly loans, to fund their education. For most low-income students, the cost of tuition alone does not account for the added economic burden of foregone income or negate the need to work during college (Gandara & Contreras, 2009).

As stated above, low-income students who may benefit the most from earnings associated with occupations in STEM may be the most sensitive to increases in net price. Low-income students' price sensitivity to changes in the overall costs of higher education negatively impacts their postsecondary enrollment at a greater rate than for students from other socio-economic backgrounds (Heller, 1997; Lassila, 2012; McPherson & Shapiro, 1991). Higher-costs programs could also result in low-income students' decision to not enroll in college or a specific program at a particular university due to the higher costs associated with pursing that degree. Callender and Jackson (2008) found that fear of debt disproportionately impacted debt-averse students' degree choice within math, engineering, and technology when controlling for other factors. Debt-averse students typically include those who have accumulated disadvantages such as low-income, first-generation and minority populations (Burdman, 2005).

Tuition Differentials

The practice of tuition differentials charges different rates of tuition to different groups of students, by class status, level of education, specific courses, and most important to this study, by major. Nelson (2008) highlights several reasons why universities choose to adopt tuition differentials, including the cost of program delivery, changes in tuition charges at peer institutions, and reduced state support. Little, O'Toole, & Wetzel (1997) and Wetzel (1995) suggest that departmental or program-based differentials are more equitable for lower income students because only students in high cost- high return fields carry the differential tuition burden. According to the authors' logic, differential tuition policies would reduce the net cost for low-income students within non-STEM fields, as opposed to having a flat-price or cross-subsidy which is a burden for all students regardless of the earning potential of students' chosen field. However, it is unclear if 1) sufficient aid is provided to low-income students in programs that feature differential tuition; or 2) if tuition differentials in high cost-high return STEM majors, such as Engineering, deter or prevent low-income students from entering and persisting in these majors. Furthermore, Wetzel (1995) argues that if tuition differentials are applied during the upper division courses of costly programs, the financial burden in the early years is reduced. As a result, students who may stop out, dropout, or transfer out do so with less debt. Consequently, the higher tuition would come at a time when financial rewards from a particular career decision are closer.

Wetzel (1995) indicates that enrollment impacts on a 5% tuition differential are minor, but impacts of tuition differential over time were not examined. Although tuition differentials for engineering programs at a set of 48 public research institutions averaged about 14% above base tuition in 2007-2008, the lowest differential was only 2% over the base tuition, while the highest differential was 45% above the base tuition (Nelson, 2008). In a time of skyrocketing tuition prices, these differences may impact a students' decision to enroll or persist in STEM majors. Findings from the report also indicate the need to examine the impacts of tuition differentials among low-income students, many of which are also underrepresented racial and ethnic minorities (Wetzel, 1995).

A review of the current literature related to low-income students in higher education and differential tuition reveals a gap in the literature in terms of how such tuition policies can impact low-income students, both in terms of enrollment and persistence to graduation. This paper attempts to contribute to the existing literature by examining the role of tuition differentials in Engineering, one of the STEM fields. Specifically, this study examines the enrollment, financial aid, and degree completion patterns of baccalaureate-seeking, low-income Engineering students at two research universities.

Research Objectives and Data

The study presented here is part of a larger research effort which is funded by the National Science Foundation. Project STEP-UP (STEM Trends in Enrollment and Persistence for Underrepresented Populations) is located at University of Illinois at Urbana-Champaign. The project utilizes three different data components to investigate individual, institutional, and contextual factors that impact underrepresented students in the STEM fields at public, research universities. For the overall project, underrepresented groups of focus include women, students of color, low-income students, and first-generation students. The first component of the project draws on semester-by-semester institutional data of undergraduate students who entered college in Fall 1999. The second component uses qualitative data gathered through interviews with directors and administrators of recruitment and retention programs in the STEM fields. The third component of the project uses online survey data of undergraduate students.

This study utilizes data from the first study component—namely longitudinal data on first-time, full-time, in-state freshmen who matriculated to one of two public, research universities located in two different Midwestern states in the Fall of 1999 and filed a Free Application for Federal Student Aid (FAFSA) for the 1999-2000 award year (n=6,307). The data were originally compiled as part of a larger collection effort of several public institutions' data coordinated by the Andrew W. Mellon Foundation's Public University Database project. The two universities in this study were selected due to their similarity to one another and the fact that differential tuition policies in each campus's Engineering program existed prior to 1999, the year that student-level observations begin in the dataset. Information on students' socio-demographic background, academic preparation, major, and financial aid is featured in the dataset. The data follow students for up to six academic years, beginning in 1999-2000, and with observations ending when students complete a bachelor's degree or when they leave the institution.[2] Archived tuition data, including differential charges by major, was obtained from the institutions' websites and were merged with the Mellon data file.

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[2] Students who drop out, stop out, or transfer out cannot be distinguished in this dataset.

The following research questions guide this study:

1. What are the rates of participation in Engineering undergraduate programs at two public, research universities by socio-economic status?

2. What is the actual cost of pursuing a degree in Engineering at two public, research universities by socio-economic status?

3. How does financial aid (e.g., Pell Grants, state aid, institutional aid) fluctuate over time for low-income and other students in Engineering and non-Engineering fields?

4. What are the graduation rates for students in Engineering and non-Engineering majors, by socio-economic status?

Approximately 11,500 students enrolled in the two universities in Fall 1999, but in order to answer the research questions central to this study, the data are restricted in two important ways. First, the data are restricted to students who filed the FAFSA for the 1999-2000 academic year (n=7,607). The data obtained from students who filed for FAFSA provided information on students' financial aid including whether or not a student received a Pell Grant, which serves as an indicator of low-income status. Both of these pieces of information were crucial to conducting this study. Second, of the students who filed the FAFSA, 83% paid in-state tuition and had complete financial aid information (n=6,307). Given that there was a large difference in the out-of-state tuition rates between the two universities and that the majority of FAFSA-filers were in-state students, the researchers restricted the analysis to in-state students. Rather than conducting separate analyses to examine institution-specific differential tuition rates, the data from the two institutions were merged to increase the number of low-income students in Engineering, particularly as the profiles of the universities and the in-state tuition rates were comparable.

The two universities featured in the study both charged differential tuition for Engineering majors, as compared to other majors, for each academic year featured in the dataset. The average 1999-2000 tuition and fees for in-state students majoring in Engineering was $6,400, as compared to $5,938 for students in other majors. The average 2004-2005 tuition and fees for in-state students majoring in Engineering was $8,818, as compared to $8,266 for their peers.

Results and Discussion

Descriptive statistics were used to create a profile of the students in the database (see Table 1). Of the 6,307 students in the data, 51.8% were female. Both campuses are Predominantly White Institutions, with the racial and ethnic composition of the two campuses as follows: 69.2% White, 11% Asian, 10.6% Black, 6.8% Latino, 0.5% Native American, and 1.8% of another race or ethnicity. Over 80% of students graduated within six years. In addition, 19.7% of students of all students initially majored in Engineering. Nearly 20% (n=1,217) of students received a Pell Grant,

Table 1. Socio-demographic Information, 1999-2000

	All Students		**Pell Recipients**	
Variables	**N**	**%**	**N**	**%**
Gender				
Male	3,043	48.2	546	44.9
Female	3,264	51.8	671	55.1
Total	6,307	100.0	1,212	100.0
Race and Ethnicity				
Asian	695	11.0	199	16.4
African American	670	10.6	314	25.8
Latino	429	6.8	125	10.3
Native American	34	0.5	6	0.5
Other	112	1.8	16	1.3
White	4,367	69.2	557	45.8
Citizenship Status				
U.S. Citizen	5,999	95.1	1,077	88.5
Permanent Resident	308	4.9	140	11.5
Graduation Status				
Graduated	5,262	83.4	913	75.0
Still Enrolled (Fall 2005)	38	0.6	16	1.3
Did Not Graduate, Not Enrolled	1	16.0	288	23.7
Initial Major				
Engineering	1,245	19.7	186	15.3
Non-Engineering	5,062	80.3	1,031	84.7
Pell Grant Status (1999-2000)				
Recieved Pell	1,217	19.3		
Did Not Receive Pell	5,090	80.7		

Source: Project STEP-UP, 2011; Authors' Calculations

indicating low-income status. Of the Pell students, 55.1% were female. African American students are overrepresented within Pell Grant recipients: 45.8% were White, 25.8% were African American, 16.4% were Asian, 10.3% were Latino, 0.5% were Native American, and 1.3% were of another race/ethnicity. Seventy-five percent of Pell recipients graduated within six-years.

Table 2 provides information on students' initial choice of major by whether or not they received a Pell Grant in their first year of study. In comparison to Non-Engineering students, slightly fewer Pell Grant recipients initially declared a major in Engineering (20.8% versus 15.3%, respectively). In other words, nearly 85% of Pell Grant recipients initially entered a Non-Engineering field. The difference in the type of initial major pursued by socio-economic status could be due to a variety of reasons, including students' concerns about or sensitivity to the higher cost of pursuing a degree in Engineering, students' educational and career goals, and/or limited access to adequate academic preparation in math and science at the high school level. Unfortunately, the dataset does not provide information on the motivations for students' choice of major.

Net price was computed by adding major-specific tuition, books, room and board[3] and other known costs, minus total grant aid, which includes Pell Grants, Supplemental Educational Opportunity Grants (SEOG), state grants, institutional grants, and other aid. Table 3 summarizes the average net price for students for each academic year by their initial major and Pell Grant status, the associated standard deviations, and the percent change from the previous year's net price. The number of observations decreases each academic year due to students not filing for FAFSA, and changes in students' status (i.e., transferring out, stopping out, or dropping out of the two universities featured in the study).

The net price for each category of students was lowest in their first year of study (1999–2000), and in general, students' net price increased each academic year for the first four years of study, and then reduces considerably in the fifth year, before increasing dramatically in the sixth

Table 2. Initial Major by Pell Status

	No Pell	Pell	Total
Engineering	1,059	186	1,245
% Within Major	85.1	14.9	100.0
% Within Pell Status	20.8	15.3	19.7
Non-Engineering	4,031	1,031	5,062
% Within Major	79.6	20.4	100.0
% Within Pell Status	79.2	84.7	80.3
Total	5,090	1,217	6,037
% of Total	80.7	19.3	100.0

Source: Project STEP-UP, 2011; Authors' Calculations

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[3] The appropriate on-campus or off-campus room and board values, obtained from IPEDS, were used in the calculation of net price, according to whether or not the student lived in a residence hall each academic year.

Table 3. Net Price by Initial Major and Pell Status

	Engineering				Non-Engineering			
	No Pell		Pell Recipient		No Pell		Pell Recipient	
	N	Mean (Std. Dev) % Change from Prior Year	N	Mean (Std. Dev) % Change from Prior Year	N	Mean (Std. Dev) % Change from Prior Year	N	Mean (Std. Dev) % Change from Prior Year
1999-2000	1,061	$12,287 ($3,426) —	188	$6,058 ($3,210) —	4,038	$12,529 ($2,943) —	1,049	$5,962 ($2,727) —
2000-2001	653	$14,272 ($4,059) 16.2%	169	$8,628 ($4,169) 42.4%	2,480	$14,673 ($3,629) 17.1%	961	$8,633 ($3,991) 44.8%
2001-2002	604	$16,734 ($4,242) 17.3%	150	$11,404 ($4,992) 32.2%	2,261	$16,480 ($3,855) 12.3%	858	$10,786 ($4,371) 24.9%
2002-2003	596	$18,187 ($4,549) 8.7%	142	$13,312 ($4,936) 16.7%	2,213	$17,902 ($4,021) 8.6%	823	$12,660 ($4,386) 17.4%
2003-2004	187	$13,307 ($6,781) -26.8%	69	$8,136 ($6,671) -38.9%	460	$12,570 ($6,134) -29.8%	269	$8,224 ($5,276) -35.0%
2004-2005	11	$22,515 ($3,442) 69.2%	2	$22,321 ($1,785) 174.3%	25	$19,454 ($4,910) 54.8%	7	$19,758 ($2,307) 140.2%

Source: Project STEP-UP, 2011; Authors' Calculations

year of study. While the majority of students graduated after the fourth year of study, their final academic year was their most expensive year in terms of net price. As expected, low-income students' net price, regardless of major, was lower than other students' net price for each academic year, except for 2004–2005, when non-Pell recipients not majoring in Engineering had the lowest net price. Pell Grant recipients who majored in Non-Engineering fields had the lowest average net price for the academic years 1999–2000, 2001–2002, and 2002–2003. For 2000–2001 and 2003–2004, Pell Grant recipients majoring in Engineering had the lowest net price of all groups of students. By 2003-2004 Engineering Pell students' net price was $6,040, or 30% of the average family income ($19,460) for Pell recipients during the 2003-2004 academic year (U.S. Department of Education, 2004). In the final year of observations, students majoring in Non-Engineering who did not receive a Pell Grant had the lowest net price; however caution should be used when interpreting this finding due to the low number of observations for the 2004–2005 academic year (n=45).

In terms of percent changes from the prior year of study, low-income students experience a greater percent change in net price than other students in the first four years of study. For instance, Pell Grant recipients' net price in 2000–2001 was over 40% higher than the previous year, whereas non-Pell Grant recipients experienced an increase in net price of less than 20%. In real-dollar amounts, Pell Grant Engineering students' net price increased $2,570 between 1999–2000 and 2000–2001, compared to $1,985 for other students majoring in Engineering. As shown by the difference in net price, financial aid fluctuated each year for all students; however even incremental increases for low-income students can have negative impacts on their postsecondary outcomes.

Financial Aid Sources and Amounts

Table 4 summarizes financial aid sources and amounts by initial major and Pell status for 1999–2000. As expected, the average Expected Family Contribution (EFC)—which is used to calculate financial need—of Pell recipients was much lower than that of other students, with the average EFC for Pell Recipients being $1,086 versus $18,817 for non-Pell Recipients. As such, the average financial need of low-income students was more than $12,500 higher than the financial need of other students. On average, Pell recipients received more financial aid, specifically grants, scholarships, and work study from federal, state, and institutional sources as compared to their counterparts. Students from higher income backgrounds took out slightly more loans, on average, than low-income students ($2,385 versus $1,971, respectively). The amount of aid awarded to Pell recipients on top of the Pell Grant suggests that additional tuition charges for Engineering majors at the two institutions in this study is not burdensome at the time of initial enrollment. However, the data only includes students who enrolled at the two universities and does not contain information about applicants or admitted students who did not enroll.

Examining financial aid sources and amounts by initial major for the first year of study reveals additional and important details about variations in aid by source, Pell Grant status, and major. Financial need for those who initially majored in Engineering and did not receive a Pell Grant was negative for the first year of study. Despite the lack of demonstrated financial need, Engineering majors who did not receive a Pell Grant still received over $4,500 in financial aid, with the majority coming from Grants and Scholarships ($2,566) and Loans ($1,933). Comparatively, non-Pell Grant recipients who majored in Non-Engineering received $1,863 in

Table 4. Financial Aid Information by Initial Major and Pell Status (1999-2000)

	All Students				Engineering				Non-Engineering			
	No Pell		Pell Recipient		No Pell		Pell Recipient		No Pell		Pell Recipient	
	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)
Expected Family Contribution	4,653	$18,817 ($17,004)	1,271	$1,086 ($1,575)	945	$19,822 ($17,173)	186	$1,217 ($1,028)	3,708	$18,561 ($16,954)	1,031	$1,062 ($1,654)
Student Need	4,653	$261 ($11,716)	1,271	$12,738 ($1,799)	945	-$650 ($12,653)	186	$12,888 ($1,123)	3,708	$493 ($11,455)	1,031	$12,711 ($18,894)
Total Aid Awarded	4,998	$4,466 ($4,332)	1,271	$10,813 ($2,254)	1,031	$4,548 ($4,219)	186	$10,845 ($2,569)	3,967	$4,445 ($4,361)	1,031	$10,807 ($2,193)
Grants & Scholarships	4,998	$2,008 ($2,690)	1,271	$8,134 ($2,355)	1,031	$2,566 ($2,954)	186	$8,720 ($2,777)	3,967	$1,863 ($2,599)	1,031	$8,029 ($2,256)
Loans	4,998	$2,385 ($3,690)	1,271	$1,971 ($1,721)	1,031	$1,933 ($3,320)	186	$1,606 ($1,715)	3,967	$2,503 ($3,772)	1,031	$2,037 ($1,714)
Work Study	4,998	$72 ($292)	1,271	$707 ($513)	1,031	$49 ($237)	186	$519 ($490)	3,967	$79 ($304)	1,031	$741 ($509)
Total Federal Aid	4,998	$2,371 ($3,626)	1,271	$4,795 ($2,011)	1,031	$1,814 ($3,122)	186	$3,937 ($1,884)	3,967	$2,516 ($3,732)	1,031	$4,950 ($1,995)
Total State Aid	4,998	$381 ($744)	1,271	$3,183 ($1,748)	1,031	$488 ($744)	186	$3,223 ($1,768)	3,967	$353 ($742)	1,031	$3,175 ($1,745)
Total Institutional Aid	4,998	$1,273 ($2,252)	1,271	$2,425 ($2,679)	1,031	$1,724 ($2,539)	186	$3,126 ($2,887)	3,967	$1,156 ($2,156)	1,031	$2,299 ($2,621)
Total Other Aid	4,998	$441 ($1,231)	1,271	$410 ($997)	1,031	$522 ($1,282)	186	$559 ($1,163)	3,967	$420 ($1,217)	1,031	$383 ($962)
Total Pell Aid	4,998	$0 ($0)	1,271	$2,062 ($929)	1,031	$0 ($0)	186	$1,887 ($932)	3,967	$0 ($0)	1,031	$2,094 ($925)
Total SEOG Aid	4,998	$21 ($177)	1,271	$141 ($479)	1,031	$10 ($118)	186	$68 ($355)	3,967	$24 ($189)	1,031	$154 ($498)

Source: Project STEP-UP, 2011; Authors' Calculations

Grants and Scholarships. Pell Grant recipients majoring in Engineering had the lowest amount of loans in 1999–2000, at $1,606. Although specific information on grants and scholarships is not available in the dataset, some of the awards may be comprised of merit-based scholarships, particularly for middle and upper-income students who are more likely to have had resources and curricula in their high schools that would create opportunities for them to excel on merit-based measures. Engineering students, regardless of income status, had fewer loans as compared to non-Engineering students. Non-Pell Engineering majors received the least amount of federal aid ($1,814), compared to other students.

At $12,888, Pell Recipients majoring in Engineering had the highest calculated financial need, while Pell Recipients in other majors had the second highest calculated student need ($12,711). Pell Recipients in Engineering also receive the highest amount of financial aid ($10,845), of which grants and scholarships make up $8,720, state aid comprises $3,223, and institutional aid comprises $3,126. However, it is important to note that Pell Recipients in non-Engineering majors received the second-highest amount in each of these categories. Pell Recipients in Non-Engineering majors had the lowest EFC and received the most in Pell and total federal aid. The difference in institutional aid offered to Pell Recipients in Engineering suggests a concerted effort by the universities featured in the study to recruit and provide support for low-income students in Engineering; however a specific program at either institution at the time is unknown. The results show that Pell Recipients, regardless of major, received more state aid than non-Pell students, which may be the results of need-based financial aid programs offered by the states where the two universities are located.

Table 5 provides additional information for Pell Grant recipients in Engineering and non-Engineering by highlighting fluctuations in financial aid across the first four years of study.[4] Student need of low-income students remains approximately the same across all four years of study, as was the total aid awarded. However, the mix of financial aid varied from year to year. Total Pell Aid declines slightly for both groups of students between the first and second academic year, but then increases for the final two years of study. Perhaps most troubling is the increasing amount of loans taken out each year by all low-income students, regardless of their major, which doubles across the four academic year. Non-Engineering low-income students' loans are greater than low-income students in Engineering, suggesting that the differential tuition featured in Engineering majors may not result in these Pell Grant recipients relying on student loans to cover the differential tuition. However, it is important to keep in mind that other sources, such as federal aid, may help to make up the difference in cost of attendance for Engineering majors.

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[4] As the number of observations of Pell Grant recipients in Engineering decreases in 2003–2004 and 2004–2005, this table is restricted to the first four years of observations. The authors can be contacted for the results of the full analysis.

Table 5. Financial Aid Information for Pell Grant Recipients (1999-2003)

	1999-2000				2000-2001				2001-2002				2002-2003			
	Engineering		Non-Engineering		Engineering		Non-Engineering		Engineering		Non-Engineering		Engineering		Non-Engineering	
	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)	N	Mean (Std. Dev)
Expected Family Contribution	186	$1,217 ($1,028)	1,031	$1,062 ($1,654)	167	$2,655 ($3,574)	942	$2,048 ($3,926)	145	$3,148 ($4,214)	842	$2,486 ($4,365)	139	$3,673 ($5,059)	810	$2,636 ($3,391)
Student Need	186	$12,888 ($1,123)	1,031	$12,711 ($1,894)	167	$12,547 ($2,856)	942	$12,383 ($3,051)	145	$12,986 ($4,251)	842	$13,167 ($3,500)	139	$13,547 ($5,004)	810	$13,542 ($3,534)
Total Aid Awarded	186	$10,845 ($2,569)	1,031	$10,807 ($2,193)	168	$10,490 ($3,467)	944	$10,811 ($3,108)	148	$11,363 ($5,294)	844	$12,093 ($4,628)	141	$11,985 ($5,738)	815	$12,203 ($4,590)
Grants & Scholarships	186	$8,720 ($2,777)	1,031	$8,029 ($2,256)	168	$7,754 ($3,521)	944	$7,334 ($2,985)	148	$7,901 ($4,617)	844	$7,708 ($3,618)	141	$7,962 ($4,7307)	815	$7,672 ($3,788)
Loans	186	$1,606 ($1,715)	1,031	$2,037 ($1,714)	168	$2,038 ($1,950)	944	$2,661 ($1,994)	148	$2,917 ($2,606)	844	$3,688 ($2,909)	141	$3,710 ($3,317)	815	$4,076 ($3,286)
Work Study	186	$519 ($490)	1,031	$741 ($509)	168	$697 ($691)	944	$816 ($698)	148	$545 ($1,063)	844	$696 ($1,131)	141	$313 ($855)	815	$454 ($1,019)
Total Federal Aid	186	$3,937 ($1,884)	1,031	$4,950 ($1,995)	168	$4,465 ($2,386)	944	$5,474 ($2,376)	148	$5,438 ($3,703)	844	$6,515 ($3,533)	141	$5,738 ($3,837)	815	$6,581 ($3,766)
Total State Aid	186	$3,223 ($1,768)	1,031	$3,175 ($1,745)	168	$2,773 ($1,889)	944	$2,934 ($1,872)	148	$2,655 ($2,101)	844	$3,061 ($1,947)	141	$2,465 ($1,973)	815	$2,818 ($1,950)
Total Institutional Aid	186	$3,126 ($2,887)	1,031	$2,299 ($2,621)	168	$2,960 ($2,867)	944	$2,175 ($2,583)	148	$2,846 ($3,426)	844	$2,253 ($3,011)	141	$3,282 ($3,576)	815	$2,505 ($2,796)
Total Other Aid	186	$559 ($1,163)	1,031	$383 ($962)	168	$293 ($1,021)	944	$228 ($935)	148	$423 ($1,188)	844	$265 ($1,068)	141	$499 ($1,478)	815	$300 ($1,1742)
Total Pell Aid	186	$1,887 ($932)	1,031	$2,094 ($925)	168	$1,611 ($1,265)	944	$1,853 ($1,268)	148	$1,749 ($1,520)	844	$2,046 ($1,473)	141	$1,724 ($1,642)	815	$2,022 ($1,607)
Total SEOG Aid	186	$68 ($355)	1,031	$154 ($498)	168	$182 ($579)	944	$228 ($608)	148	$279 ($890)	844	$236 ($814)	141	$141 ($626)	815	$185 ($700)

Source: Project STEP-UP, 2011; Authors' Calculations

Graduation Status

The final descriptive analysis performed investigates differences in persistence and degree completion by first and last major, and Pell Grant status (see Table 6). The vast majority (83.4%) of students completed their degrees within six academic years. Few differences are found between the six-year graduation rates of students by socio-economic status, and whether or not they initially majored in Engineering or completed a degree in Engineering. Minimal movements between Engineering and Non-Engineering majors provides further evidence that the net price of completing a degree in Engineering was not burdensome to low-income students at the two institutions featured in this study. Thirteen percent of students who initially majored in Engineering or who received a degree in Engineering were low-income students, as compared to approximately 18% in non-Engineering fields. Slightly fewer Pell Recipients completed a degree in Engineering as compared to those who initially declared this major. Only 38 students of the original 6,356 remained enrolled at the original institution of study after six academic years. Over 80% of these students were pursuing degrees in Non-Engineering majors. However, given the low number of observations, this result should be interpreted with caution.

An additional 1,007 students of the original set of students had not completed a degree within six academic years and were no longer enrolled. Unfortunately, the data used in the study does not allow for students who transfer out, drop out, or stop out to be distinguished. Despite this limitation, the results show that of the students who did not graduate, were no longer enrolled, and majored in Engineering, approximately 25% were Pell Recipients as compared to 30% Pell Recipients in non-Engineering.

Limitations

The data used for this study only utilizes data from two public, four-year, predominantly white, doctoral-granting, research universities, thus generalizations should be made with caution. The researchers also restricted the sample in a number of ways, including the decision to only examine in-state residents and students who filed for FAFSA. In addition, using Pell as a proxy for low-socio-economic status excludes other low-income students who did not file for financial aid or those who may be ineligible to apply for FAFSA, such as undocumented students, but who would likely also be adversely affected by differential tuition policies. Detailed sources and amounts of financial aid, within each category highlighted in Tables 4 and 5, was not available in the original dataset, limiting our understanding the exact mix of funding that each student received.

Given that the data represents a cohort of students who entered in the 1999–2000 academic school year, the study does not capture the impact of the most recent tuition increases, which have been exacerbated by higher tuition differentials. For instance, the difference between base tuition and tuition in Engineering fields at one of the two universities featured in the study was nearly $5,000 for the 2011–2012 academic year, an increase in approximately 900% since 1999–2000. The data used in this study does not

Table 6. Six-year Graduation Status by First Major, Last Major, and Pell Status

	First Major			Last Major		
	No Pell	Pell Recipient	Total	No Pell	Pell Recipient	Total
Graduated Within Six Years						
Engineering	916	137	1,053	745	111	856
% Within Major	87.0	13.1	100.0	87.0	13.0	100.0
% Within Pell Status	21.1	15.0	20.0	17.1	12.2	16.3
Non-Engineering	3,433	776	4,209	3,604	802	4,406
% Within Major	81.6	18.6	100.0	81.8	18.2	100.0
% Within Pell Status	78.9	85.0	80.0	82.9	87.8	83.7
Total	4,349	913	5,262	4,349	913	5,262
% of Total	82.6	17.4	100.0	82.6	17.4	100.0
Still Enrolled						
Engineering	4	3	7	4	2	6
% Within Major	57.1	42.9	100.0	66.7	33.3	100.0
% Within Pell Status	18.2	18.8	18.4	3.0	12.5	15.8
Non-Engineering	18	13	31	18	14	32
% Within Major	58.1	41.9	100.0	56.3	43.8	100.0
% Within Pell Status	81.8	81.3	81.6	81.8	87.5	84.2
Total	22	16	38	22	16	38
% of Total	57.9	42.1	100.0	57.9	42.1	100.0
Did Not Graduate, Not Enrolled						
Engineering	139	46	185	114	41	155
% Within Major	75.1	24.9	100.0	73.5	26.5	100.0
% Within Pell Status	19.3	16.0	18.4	15.9	14.2	15.4
Non-Engineering	580	242	822	605	247	852
% Within Major	70.6	29.4	100.0	71.0	29.0	100.0
% Within Pell Status	80.7	84.0	81.6	84.1	85.8	84.6
Total	719	288	1,007	719	288	1,007
% of Total	71.4	28.6	100.0	71.4	28.6	100.0

Source: Project STEP-UP, 2011; Authors' Calculations

include comparisons to other STEM fields, such as the Physical Sciences, nor the proliferation of tuition differentials in other (non-STEM) fields in recent years (e.g., Architecture, Business, Honors Programs, and Education).

Furthermore, even though the purchasing power of the Pell Grant has not kept up with the rate of tuition increases or inflation, the maximum award has increased in value over the last decade. In 1999–2000, when the maximum Pell Grant was $3,125, 9.8 million students applied for the Pell Grant and 3.7 million students received the grant (U.S. Department of Education, 2000). Ten years later, in 2009–2010, the maximum Pell Grant was $5,350, nearly 20 million students applied for the grant, and 8.1 million students received the grant. Recent legislation has increased the maximum Pell Grant amount further to $5,550 for the 2011–2012 academic year (U.S. Department of Education, 2011).

Implications and Conclusion

Despite these limitations, this study explores how differential tuition pricing may impact low-income students' postsecondary degree completion in Engineering, with a focus on how the source and amount of financial aid can reduce the financial burden to completing postsecondary degrees, even in higher costs majors. The results suggest that the higher cost of enrolling in Engineering programs that feature tuition differentials may be offset by the amount of financial aid awarded to low-income students, but that the source of aid varies across the course of undergraduate study. It is important to note that the net price of attendance to pursue Engineering at the two institutions featured in this study still required a significant amount of low-income students' household incomes, and given changes in financial aid, the net price of attendance does fluctuate over time, particularly for students who do not complete a degree in four years. While a high-tuition, high-aid strategy may offset the higher cost of majoring in Engineering for low-income students, Hu and Hossler (2000) encourage us to rethink this strategy at both public and private institutions of higher education, by considering both students' willingness and ability to pay for their college degree. Furthermore, high-tuition, high-aid strategies are rarely carried out with sufficient funding, which limits the affordability of higher education for low-income students, who are most sensitive to increases in costs of postsecondary education. The latter is likely to impact students' entrance into the universities like the ones featured in this study, as well as their declaration of Engineering majors.

Several practical implications are offered based on the results of this study. In relation to human capital theory and low-income students' price sensitivity levels, the findings draw attention to the need for higher education institutions to examine policies of differential tuition pricing to ensure that adequate financial aid is offered to students interested in pursuing those majors. Postsecondary institutions are encouraged to review their tuition and financial aid policies to determine the benefits and consequences of charging differential tuition rates, particularly for students that are likely to be adversely impacted by differential tuition policies. If possible, funds may be allocated towards need-based financial aid programs at the department, college, and/or institutional level to strengthen financial aid packages in addition to Pell Grant aid, particularly as costs continue to increase in relation to the value of the Pell Grant award.

Specific to increasing underrepresented students entrance into Engineering, adopting new or modifying existing recruitment programs, including programs aimed at low-income students should be considered. Recruitment into Engineering remains critical to increasing current representation levels of students of color and low-income students. While providing retention services to undergraduate students continues to be important, recruitment and outreach programs such as bridge programs, middle and high school science competitions, and Engineering awareness programs may be key to increasing representation, and ultimately degree completion in Engineering for some underrepresented groups. Finally, the current downward trend of admitting low-income students at four-year institutions further reinforces the need to focus on increasing educational opportunities and creating pathways of access to selective institutions for low-income and minority students (Swail, Cabrera, & Lee, 2004).

Given the complex uses and forms of tuition differential policies and practices, the widening gap between base and differential tuitions, and an overall increase in tuition costs, examining data that is able to capture these recent changes is necessary to understand how differential tuitions may be pricing out low-income students from enrolling in high-cost, high-return fields. There is also a need to explore whether tuition differentials impact low-income students' postsecondary decision and actions, such as whether or not to attend college, pursue a STEM degree, enroll in a less selective institution or program which may be perceived as being more affordable, or attend a community college.

Given that low-income students are debt averse and have higher levels of price sensitivity than other types of students, researchers and university administrators should investigate students' willingness and ability to pay given differential tuition rates and fluctuations in financial aid over the course of a college degree. In this sense, the results of the study lend themselves to future research on how high school students and their families perceive and react to tuition rates, including differential tuition, and the costs of college attendance. In addition to possible empirical investigations, universities should evaluate their current pre-college financial aid counseling and information provided to students and families to assess the extent to which differential tuition charges are understood, as well as to identify ways to reduce potential sticker shock. Without knowing how students and their families perceive, understand, and react to tuition differentials during the college selection process, institutions may remain at a disadvantage in terms of recruiting low-income students into high-cost fields such as Engineering. High schools, particularly high school counselors, may wish to incorporate a college financial literacy component into their repertoire of services for high school students. A program of this nature could help educate students and their families about potential tuition differentials and how to negotiate these complex policies while reducing short-term and long-term financial burdens.

Changes in federal and state support of higher education have produced an uncertain economic climate which may disproportionately impact populations who are likely to benefit the most from additional training and education. As such, any gains made in improving representation among traditionally underrepresented populations within STEM may have been stifled if not completely eradicated within the last decade. Future analysis should be aimed at contextualizing tuition differential policies to determine the economic landscape that the institution and students are operating in. Through contextualization and analysis of tuition and financial aid policies, researchers can work towards highlighting any unintended consequences or impacts of institutional practices.

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