

Board 47: College Engineering Attainment among Rural Students

Mr. Jean Felix Ndashimye, University of Missouri-Columbia

Jean Felix Ndashimye is a doctoral student in the Truman School of Public Affairs at the University of Missouri-Columbia. Ndashimye holds a Master's in Public Affairs from the University of Missouri. His main research interests are program evaluation and education policy.

Dr. Rajeev Darolia, University of Kentucky

Rajeev Darolia is Associate Professor of Public Policy and Economics at the University of Kentucky. He holds a PhD in Public Policy from George Washington University.

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Introduction

Attracting more and diverse students into science, technology, engineering, and mathematics (STEM) majors has been identified as one of the strategies for achieving the overall national goal of increasing the number of STEM graduates needed in the United States workforce [1]. However, research shows that barriers to entry and high dropout rates for students in engineering programs pose a challenge to achieving this goal [2]. Although much attention has been given to the gap in engineering degree attainment across racial and gender groups (for example, see [3], [4], [5]), there has been relatively little attention paid to geographic differences. Enhancing rural students' engineering program participation is one way to expand the engineering workforce, and has the potential to enhance diversity in the field, albeit on a dimension infrequently considered in extant research.

In this paper, using data on students from Missouri, we ask the following research questions:

- (1) What is the extent of the rural-nonrural gap in postsecondary engineering degree attainment and major choice?
- (2) How much of this rural-nonrural gap is explained by school- and student-level factors and how much is unexplained?

Brief Background

Gaps in engineering attainment by students' demographic background are well documented (for example, see [3], [4], [5]). However, students' geographic background (e.g. rural, urban, or suburban) has been less of a focus of prior research. Our focus in this study is on rural students, who face many challenges that are believed to impede postsecondary success. For example, many rural students come from relatively low socioeconomic backgrounds or are the first in their families to attend college – both factors that are related to lower engineering attainment (for example see [3], [6], [7]). Moreover, rural students often have less exposure to advanced math and science course work during high school [8], [9], yet research has documented that high school math and science course taking is linked to students' postsecondary choices and experiences [10], [11], [12]. For these reasons, and for others, rural students' average college outcomes can lag behind those of their counterparts from non-rural settings (i.e., urban and suburban locales) [13], [14].

Data and Context

The context of our study is students' transitions from high school to college in the state of Missouri. The primary data we use comes from administrative data from the Missouri Department of Higher Education (MDHE). Our data set contains records of 14 cohorts (1996-2009) of Missouri public high school graduates entering each of the 13 public four-year institutions in the Missouri system until they graduate (or leave the system). Once students enter the system, we observe the university entered, their first declared major, whether and when the student graduated, and conditional on graduation, the field of their degree. These data also

contain student-level demographic information and academic measures that are commonly used in college admissions decisions. For the purposes of this study, we define engineering to include both engineering and computer science (ECS), and identify these fields based on standard Classification of Instructional Program (CIP) codes (two-digit CIP codes equal to 11 or 14). We link the postsecondary data to administrative data on students' high schools. We classify each high school as either rural, urban, or suburban, based on the designation by the National Center of Education Statistics at the US Department of Education (see https://nces.ed.gov/programs/edge/docs/LOCALE_CLASSIFICATIONS.pdf).

To understand the link between students' high schools and their college experiences and choices, we limit the sample to students who enter as first-time, full-time students. This means that future work is needed to understand the pathways of students who enroll in college part-time or do not go to a 4-year college directly from high school. Moreover, because of data availability, our sample is limited to students who graduate from Missouri public high schools and enter a public 4-year university in Missouri; therefore, we do not observe in these data students who attend a 2-year, private, or out-of-state college/university, or who graduate from private high schools or from high schools outside of Missouri. The analytic sample includes 145,147 students.

In Table 1, we display summary statistics for our sample. While the gender ratios are similar across settings, students from rural settings are less likely to identify as a non-white race/ethnicity. ACT scores are roughly similar across geographies, though rural students among our public college sample are likely to have achieved a higher high school class rank. Compared to students from urban and suburban high schools, students from rural high schools attended schools with larger share of students who qualified for the free and reduced lunch program.

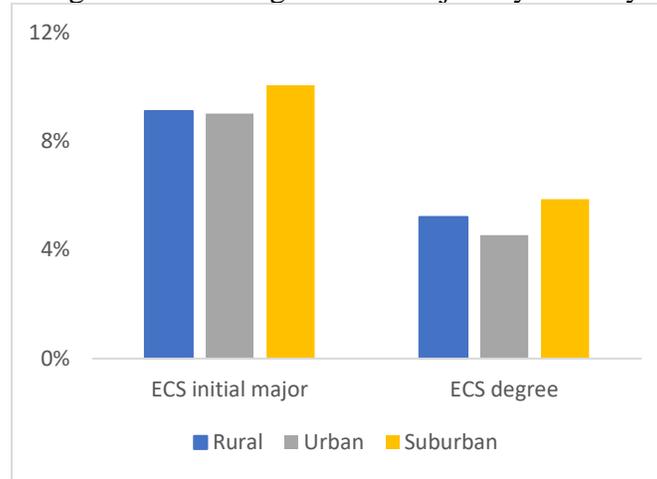
Table 1: Sample descriptive statistics

| | Rural | Urban | Suburban |
|----------------------|--------------|--------------|--------------|
| Female | 0.56 | 0.56 | 0.55 |
| Black | 0.02 | 0.15 | 0.12 |
| Asian | 0.01 | 0.03 | 0.03 |
| Hispanic | 0.01 | 0.02 | 0.02 |
| ACT Math | 22.83 (4.64) | 22.09 (5.01) | 23.13 (4.81) |
| ACT English | 23.56 (5.04) | 22.77 (5.55) | 23.63 (5.10) |
| HS rank (percentile) | 0.74 (0.22) | 0.69 (0.23) | 0.68 (0.23) |
| # of Students | 72,640 | 25,361 | 47,146 |

Notes: Standard deviations included continuous variables in parentheses.

In Figure 1, we display the rate of engineering degree attainment and initial major declaration. About nine percent of rural students initially major in engineering, a similar rate as urban students, but about one percentage point less than suburban students. While this differential might ostensibly seem small in magnitude, it represents a gap of over ten percent. Similarly, the rural-suburban gap in ECS degree attainment is about twelve percent, though more rural students earn an engineering degree than students who attended urban high schools. Conditional on initially declaring an ECS major, rural students are about six percent less likely and ten percent more likely to attain an ECS degree as compared to suburban and rural students, respectively.

Figure 1: ECS Degrees and Majors by Rurality



Empirical Strategy

To understand how much of the rural-nonrural gap is explained by observed individual and high school factors, we use linear probability models to estimate the outcome, Y , of student i who graduated from high school j in year t as a function of an indicator for being rural and other covariates:

$$(1) \quad Y_{itj} = \beta_0 + \beta_1 \text{Urban}_j + \beta_2 \text{Suburban}_j + \beta_3 X_i + \beta_4 A_i + \beta_5 H_j + d_t + e_{itj}$$

We consider two outcomes. In the first outcome, Y is equal to one if the student obtained a ECS degree after six years and zero otherwise. In the second outcome, Y is equal to one if the student's first declared major is ECS, and zero otherwise. Our key variable of interest is the parameter estimate on the *Rural* variable, β_1 . All high schools in our data are classified as either rural or nonrural (nonrural includes suburban and urban locales; in future analyses we will consider finer geographic classifications, including splitting out urban and rural, as well as subcategories of rural: town, fringe, and remote). In a model without any additional covariates, β_2 and β_3 represent the outcome differential for students who come from urban and suburban high schools as compared to those who come from rural high schools, respectively.

In all estimates we account for the year a student graduated high school through a cohort year fixed effect, d_t . We then iteratively add groups of covariates for observed demographics in the X -vector, individual academic measures in the A -vector, and high school factors in the H -vector. Specifically, student-level controls include student race/ethnicity and gender; academic measures include high school class rank, ACT math, and ACT English scores; and high-school level controls include the math and science course availability, enrollment, and the proportion of the student body that is free and reduced price lunch eligible. In future analyses, we will further consider the intersection of student race, ethnicity and gender with geographic background, the role of the racial/ethnic composition of students' high schools, and differences across universities entered within the public system.

Preliminary Findings

In Table 2, we display results from estimates of the rural-nonrural gaps in ECS major choice and ECS degree attainment with various covariates shown in equation (1). Differences with urban students are generally small and not precisely estimated. While accounting for students' demographic characteristics, rural students are less likely than their suburban peers to choose an ECS major and to complete an ECS degree by 0.9 percentage points (about 10 percent of the rural mean; column 1) and 0.8 percentage points (about 16 percent of the rural mean; column 4), respectively. After academic controls are included, the rural-suburban gaps in ECS major choice and degree attainment attenuate to close to zero and are neither practically substantive nor statistically different than zero. The amount of variation in ECS initial major and ECS degree explained by just locale and observed demographics is about seven and four percent, respectively. Adding academic measures increases the explained variation to about twelve and nine percent, respectively, though the high school controls included in these specifications add only marginal explanatory power.

Table 2: Estimates of ECS Initial Major and Degree Attainment

| | Initial Major | | | Degree | | |
|----------------------|----------------------|--------------------|---------------------|----------------------|----------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Urban | -0.0007 (0.0021) | 0.0021 (0.0020) | -0.0003 (0.0025) | -0.0034* (0.0016) | -0.0001 (0.0016) | -0.0034 (0.0019) |
| Suburban | 0.0087** (0.0017) | 0.0009 (0.0017) | 0.0004 (0.0022) | 0.0082** (0.0013) | 0.0047** (0.0013) | -0.0006 (0.0017) |
| R-Squared | 0.0674 | 0.1226 | 0.1227 | 0.0367 | 0.0923 | 0.0926 |
| Demographic Controls | X | X | X | X | X | X |
| Academic Controls | | X | X | | X | X |
| High School Controls | | | X | | | X |

Notes: All estimates control for cohort year. See text for model specifications and data source. *p<.05; ** p<0.01

Discussion and Future Direction

Engineering and science professions have among the highest labor market returns and are expected to experience much greater job growth than other professions [15]. Increasing the number of engineers from rural communities might be one component of a broader strategy to meet future workforce demands. It also has the potential to bring benefits to rural communities, many of which have faced economic challenges in recent years.

In this project, we document that rural students are less likely than their suburban peers to choose an ECS major and to graduate with an ECS degree, and that individual factors alone do not explain this gap. College outcomes among students who attend rural and urban high schools are largely similar. In future work, we will continue to investigate the extent to which high school and other factors (including differences in community resources, proximity to engineering programs, culture, and preparation) explain remaining rural-nonrural engineering gaps.

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