A Data-Driven Approach to Promoting Innovation and Excellence in Teaching at Higher Education Institutions

Kameryn Denaro, Ph.D.

UC Irvine

Content

- Quantile regression methods for evaluating student equity in STEM
- Data access for senate faculty
- Academic Success Research Fellows Program

Evaluating Student Equity in STEM
Introduction

Primary Goal: Use Institutional Data to Identify Faculty Superstars

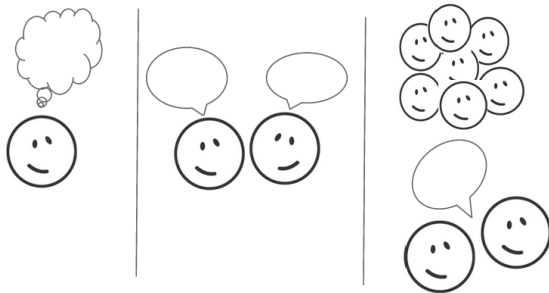## Data

- Department
- Term
- Student Grades
- Student Demographics
- Previous Academic Performance
- Faculty Demographics

Evaluating Student Equity in STEM
Think-pair-share

- Can you think of any other potentially important variables that you would like to include in a model?
- What are some statistical challenges you foresee with identifying faculty superstars?

Evaluating Student Equity in STEM

Quantile Regression Model for the τth Quantile

$$y_i = x_i^T \beta_\tau + \epsilon_i. \tag{1}$$

τ^{th} conditional quantile

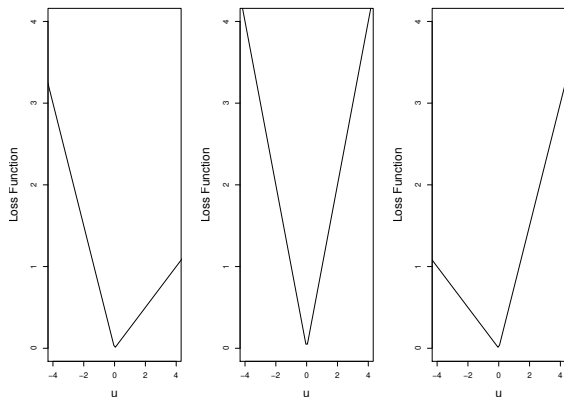$$Q_\tau(y_i | x_i) = x_i^T \beta_\tau. \tag{2}$$

Parameter estimates

$$\arg \min_{\beta_\tau} \sum_{i=1}^{n} \rho_\tau(y_i - x_i^T \beta_\tau), \tag{3}$$

where the loss function is $\rho_\tau(u) = u(\tau - I(u < 0))$ and $I(\cdot)$ is the indicator function, ϵ_i's are i.i.d. asymmetric Laplace random variables, and $Q_\tau(\epsilon_i | x_i) = 0$.

Evaluating Student Equity in STEM

Loss Function

Figure: Loss Function for $\tau = 0.25$, 0.50, and 0.75; on the left is $\rho_{\tau=.25}(u)$, in the middle is $\rho_{\tau=.5}(u)$, and on the right is $\rho_{\tau=.75}(u)$.

Evaluating Student Equity in STEM
Regression rankscores

- Fit quantile regression lines for a set of $\tau \in (0, 1)$
- Use the rank generating function to calculate quantile regression rankscores for each observation
- Calculate the normalized regression rankscores for each faculty member

The normalized regression rankscores serve as continuous measure of student equity.

Evaluating Student Equity in STEM
Regression rankscores equations

Let $(Y_1, \ldots, Y_n)$ be the response and let $(R_1, \ldots, R_n)$ be the associated ranks. The rank generating function is given by:

$$\hat{a}_i(\tau) = \begin{cases} 1 & \text{if } \tau < \frac{R_i - 1}{n} \\ R_i - \tau n & \text{if } \frac{R_i - 1}{n} \leq \tau \leq \frac{R_i}{n} \\ 0 & \text{if } \tau > \frac{R_i}{n} \end{cases} . \tag{4}$$

The normalized regression rankscores are given by:

$$\hat{b}_i = - \int_0^1 \Phi^{-1}(\tau) d\hat{a}_i(\tau), \tag{5}$$

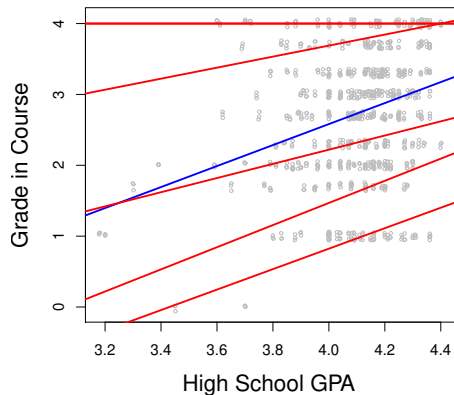where $\Phi^{-1}(\cdot)$ is the inverse standard normal distribution.

Figure: Quantile regression (median regression in blue).

Evaluating Student Equity in STEM
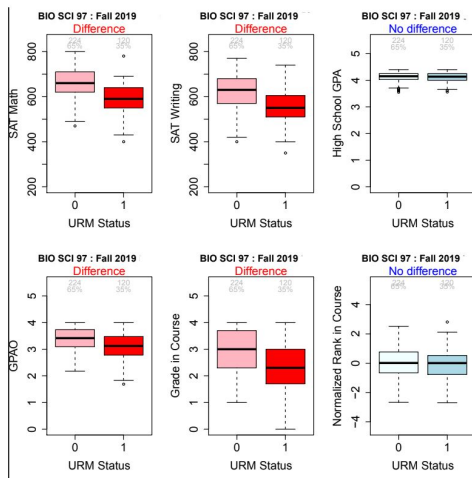
Results

Figure: Example of Equity Evaluation in a single STEM course.

Evaluating Student Equity in STEM
Next Steps

- Interview Faculty Members
- Identify common teaching practices and pedagogy
- Identify common themes around diversity and inclusion

Data Access

Target population: Senate faculty members who are conducting education research projects with an intent to publish or present the results.

Goals

- Expanding University data capabilities
- Leveraging institutional data to inform efforts to improve student success
- Effective collaborations to build interest in research on teaching and learning

Data Access

IRB

Letter of Legitimate Educational Interest
(signed by chair or dean)

online FERPA training through the UC
Learning Center

Academic Success Research Fellows Program

- Support faculty interested in studying issues of undergraduate student success
- Provide data and analytic support to explore those issues
- No formal statistical or analytic training is expected from participants
- $2,000 award to participants

Academic Success Research Fellows Program

Goals

- Identify actionable insights to help students.
- Help students learn
- Increase retention or graduation rates
- Close gaps between groups of students

Academic Success Research Fellows Program

Requirements

- A short online application
- Monthly meetings with researcher support staff
- Present findings at Teach Week
- Make evidence based recommendations back to home department

ASR Application

Undergraduate Student Success

Describe an issue related to undergraduate student success or teaching and learning you would like to explore. List your specific research questions you would like to address.

Importance

What can you say about how that issue impacts you, students in your courses or your department? Why is that issue important?

Data

What data would be helpful to address the question(s) above, and how might you consider analyzing it?

Departmental Change

What changes might result based upon the findings of this work?

Ongoing Research

Improving statistical methodology for discipline-based education research

- Linear Quantile Mixed Effects Models
- Algorithms to Account for Self-Selection
- Identification of Institutional Barriers to Success in STEM
- Building models to identify how student characteristics correspond to course engagement, learning, and STEM completion

Improving student success and teaching at UCI and beyond

- Evaluating current programs
- Repeating studies across disciplines
- Expanding the use of data science across disciplines
- Evaluating teaching through COPUS and DART

Thank you!

kdenaro@uci.edu