



Evaluating the Effectiveness of Engineering Programs in Saudi Arabia Based on Learning Outcomes

Khaleel Al-Harbi, PhD

Yong Luo, PhD

NCA, Riyadh, SA

Global Context

- The focus of evaluation of educational institutions is shifting from input to output.
- Holding higher education institutions (HEI) accountable is becoming a trend.
 - Holding schools accountable in K-12 settings is already popular.
 - It is picking up momentum globally in the context of higher education.

Methods Used to Evaluate HEIs

- Data Structure Limitation (no longitudinal design)
- Two Popular Value-Added Modeling (VAM: The contribution of HEIs to students' academic growths toward prescribed objectives; OECD, 2008) Methods Based on a Cross-Sectional Design
 - Difference in Residual Model (DIRM) Based on Ordinary Least Square (OLS) Linear Regression
 - Difference in Residual Model (DIRM) Based on Hierarchical Linear Model (HLM)

OLS-Based DIRM

- $\overline{y_{jf}} = \beta_0 + \beta_1 X_j + \varepsilon_{jf}$
- $\overline{y_{js}} = \beta_0 + \beta_1 X_j + \varepsilon_{js}$
- $VA_j = \varepsilon_{js} - \varepsilon_{jf}$
 - $\overline{y_{jf}}$: the mean test score of HEI j at freshman year
 - $\overline{y_{js}}$: the mean test score of HEI j at senior year
 - X_j : mean incoming achievement test score at HEI j
 - VA_j : the contribution of HEI j

HLM-Based DIRM

- $y_{ijf} = \beta_{0j} + \beta_{1j}X_{ij} + \varepsilon_{ijf}$
- $\beta_{0j} = \gamma_{00} + \gamma_{0s}W_{sj} + \mu_{0jf}$
- $\beta_{1j} = \gamma_{10}$
- $y_{ijs} = \beta_{0j} + \beta_{1j}X_{ij} + \varepsilon_{ijs}$
- $\beta_{0j} = \gamma_{00} + \gamma_{0s}W_{sj} + \mu_{0js}$
- $\beta_{1j} = \gamma_{10}$
- $VA_j = \mu_{0js} - \mu_{0jf}$

Out Data

- A General Engineering Knowledge Test Consisting of 105 items that Covers 5 Domains
- Students' GAT and SAAT scores
- The University Type (Old vs New)
- 1,609 Students from 21 Universities with Complete Records

Methods Used in Our Study

- Data are available at only the senior year
- The aforementioned methods are infeasible
- We proposed two methods (Status vs VAM) and used R package lme4 to implement them.
- We Chose Domain 2 (Fundamental Science and Engineering) as Our Learning Outcome Scores due to Its Highest Correlation with GAT and SAAT
- Item responses were calibrated using 3PL IRT model and student scores were transformed to the NCA scale score (mean = 65, sd = 10)

Status vs VAM

- **Status**

- $y_{ij} = \beta_{0j} + \varepsilon_{ij}$

- $\beta_{0j} = \gamma_{00} + \mu_{0j}$

- **VAM**

- $y_{ij} = \beta_{0j} + \beta_{1j}(G_{ij} - \bar{G}_j) + \beta_{2j}(S_{ij} - \bar{S}_j) + \varepsilon_{ij}$

- $\beta_{0j} = \gamma_{00} + \gamma_{01}T_j + \gamma_{02}(\bar{G}_j - \bar{G}) + \gamma_{03}(\bar{S}_j - \bar{S}) + \mu_{0j}$

- $\beta_{1j} = \gamma_{10}$



μ_{0j} is our estimate of VA for university j

Research Questions

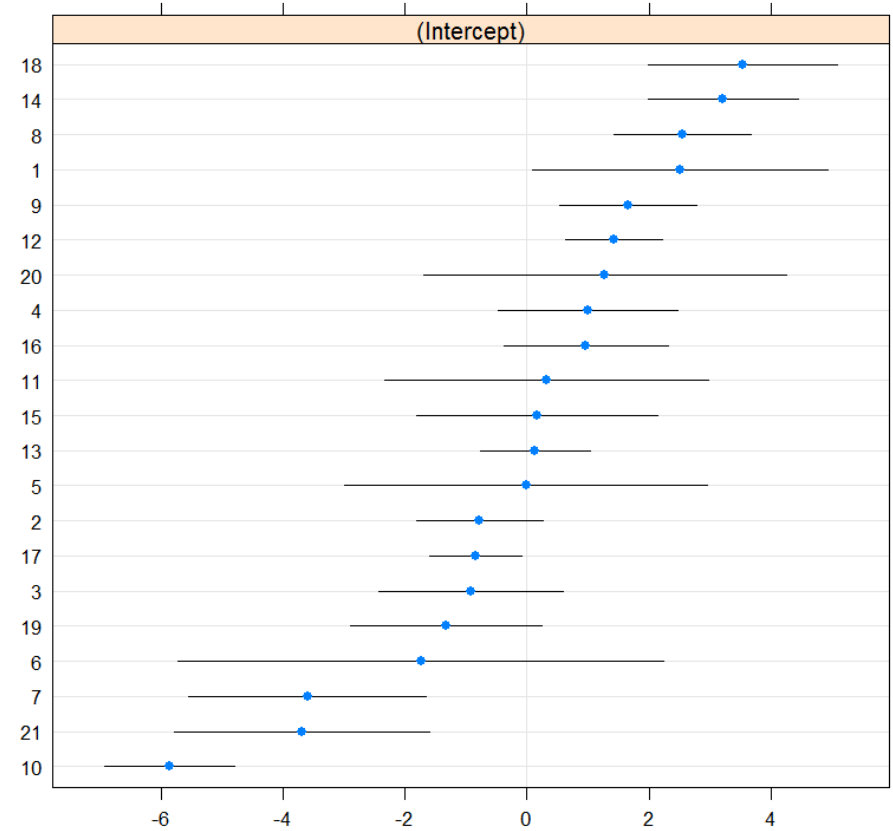
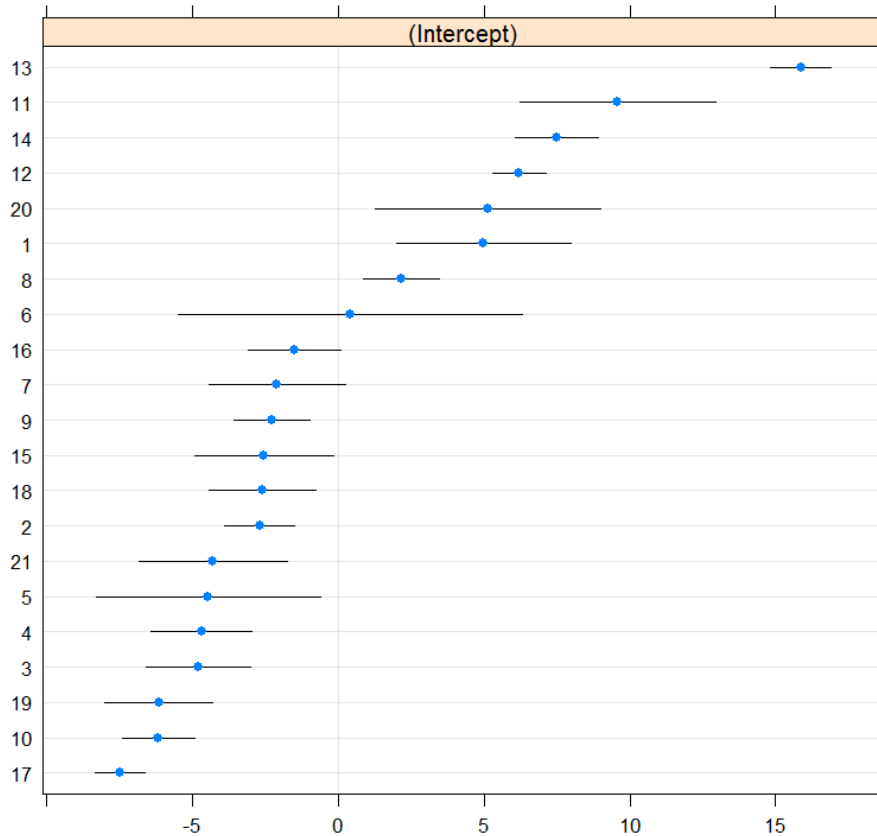
- How do those two methods affect university classifications based on the contribution to students' growth in fundamental science and engineering?
- Which institutional characteristics are associated with the added-value to students' academic growth?

Results

Status (left panel) vs VAM (right panel)

university

university



Impact upon Classification

Classification	Status		VAM	
	ID	Counts	ID	Counts
Effective	U13, U11, U14, U12, U20, U1, U8	6	U18, U14, U8, U1, U9, U12	6
Average	U6, U16, U7	3	U20, U4, U16, U11, U15, U13, U5, U2, U3, U19, U6	11
Ineffective	U9, U15, U18, U2, U21, U5, U4, U3, U19, U10, U17	12	U17, U7, U21, U10	4

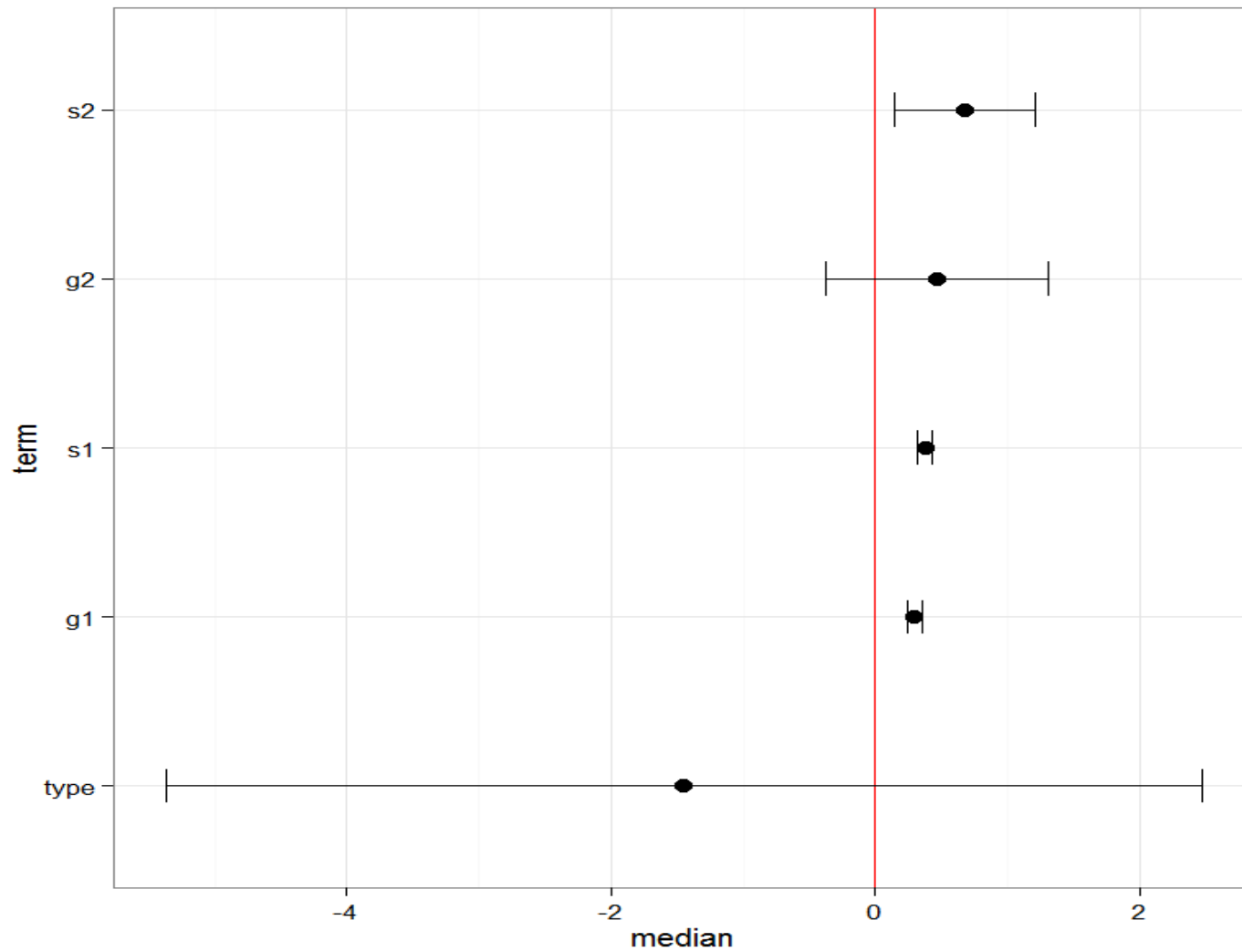
Results

Fixed Effect Estimates

Parameter	Estimate	SE	t value
Intercept	65.74*	1.49	44.07
g1	0.29*	0.03	10.09
s1	0.37*	0.03	12.59
g2	0.47	0.42	1.12
s2	0.69*	0.28	2.45
type	-1.33	1.92	-0.69

Results

Fixed Effect Estimates Visualization



Interpretations

- After controlling for mean SAAT and GAT score, University Type (Old coded as 0, New coded as 1) is not statistically significant.
- After controlling for University Type and mean GAT score, 1 point higher in the mean SAAT score is related to 0.69 points increase in learning outcome scores.
- After controlling for University Type and mean SAAT score, mean GAT score is not statistically significant.

Conclusions

- The choice of model has a substantial impact upon university classifications based on the contribution to learning outcomes in fundamental science and engineering. We believe the VAM method is fairer than the Status method.
- University Type has no statistically significant effect upon students' learning outcome scores, after controlling for SAAT and GAT scores.
- If the mean SAAT score of a university a student attends increases by 1 point, his learning outcome score is expected to increase by 0.69 points.

