Appendix (Supplemental Material)

Specification of Multi-Level Models and Results

Using GRE-V scores as the only predictor as an example, we specified the 3-level model as the following.

Level 1 (Student Level):



Level 2 (Major Level):



Level 3 (Institution Level)



Here in Level 1 model,  stands for first year graduate GPA for student *i* in major *j* at institution *k*;  and  stand for the regression intercept, and regression coefficient associated with GRE-V scores respectively, represents the prediction error for student *i* in major *j* at institution *k*, ~ N (0,),

In Level 2 model,  (m = 0, 1) represents the mean of the intercept and slopes estimated in the Level 1 model respectively across all majors within a particular institution k, represents the unique component of intercept and slope associated with a particular major (j) at a particular institution (m), ~N (0,).

In Level 3, (m = 0 and 1) represents the grand mean of intercept and slope across majors and institutions;  represents the unique components of the intercept and slope associated with a particular institution *k*. ~N (0,).

All the multilevel model analyses were performed using HLM 7.01 (Raudenbush, Bryk, & Congdon, 2013), where the predictors were group centered on the mean in each major of a particular institution for each variable. For interpretation purposes, we rescaled the GRE section scores (GRE-V and GRE-Q) on a 1 to 4 scale, so that the estimated regression coefficients were on the same scale as UGPA. Using GRE-V as an example, SGREV is the rescaled variable, where SGREV = (GREV-130)/10. The transformed GRE section scores were rounded up to two decimal places. The empirical-Bayesian residuals at level-1 were used directly to compute residual means for the three student groups, ND, D1, and D2.

We also compared the models based on their model-data fit statistics, deviance, as reported in HLM 7.0 (Raudenbush, Bryk, Cheong, & Congdon, 2004). The deviance differences between two nested models (e.g., Model 2 and the baseline model) were tested against a  distribution, with the degrees of freedom equal to the difference of number of parameters between the two models (Raudenbush et al., 2004).

Table A1

*Multilevel Analysis Results for Each Model*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Baseline Model (no predictor)** |  | |  | | | |  | |  | | |  | | |  | |
| Fixed Effect |  | | Coefficient Est. | | | | *se* | | *df* | | | *t* Ratio | | | *p*-value | |
| Intercept FYGPA |  | | 3.680 | | | | .018 | | 9 | | | 202.879 | | | < .001 | |
| Random Effect (Levels 1 & 2) |  | | Variance Est. | | | |  | | df | | | χ2 | | | p-value | |
| Intercept FYGPA |  | | 0.017 | | | |  | | 203 | | | 1518.677 | | | < .001 | |
| Residual |  | | 0.175 | | | |  | |  | | |  | | |  | |
| Random Effects (Level 3) |  | |  | | | |  | |  | | |  | | |  | |
| Intercept FYGPA |  | | 0.002 | | | |  | | 9 | | | 26.336 | | | < .001 | |
| **Model 1 –UGPA Only** |  | |  | | | |  | |  | | |  | | |  | |
| Fixed Effects |  | | Coefficient Est. | | | | *se* | | *df* | | | *t* Ratio | | | *p*-value | |
| Intercept FYGPA |  | | 3.676 | | | | .017 | | 9 | | | 211.978 | | | < .001 | |
| Slope UGPA |  | | 0.144 | | | | .027 | | 9 | | | 5.366 | | | < .001 | |
| Random Effects (Levels 1 & 2) |  | | Variance Est. | | | |  | | df | | | *χ2* | | | *p*-value | |
| Intercept FYGPA |  | | 0.017 | | | |  | | 191 | | | 1536.223 | | | < .001 | |
| Slope UGPA |  | | 0.0004 | | | |  | | 191 | | | 247.716 | | | .004 | |
| Residual |  | | 0.173 | | | |  | |  | | |  | | |  | |
| Random Effects (Level 3) |  | |  | | | |  | |  | | |  | | |  | |
| Intercept FYGPA |  | | 0.002 | | | |  | | 9 | | | 26.565 | | | .002 | |
| Intercept UGPA |  | | 0.006 | | | |  | | 9 | | | 281.191 | | | < .001 | |
| **Model 2. GRE Only** |  | |  | | | |  | |  | | |  | | |  | |
| Fixed Effect |  | | Coefficient Est. | | | | *se* | | *df* | | | *t* Ratio | | | *p*-value | |
| Intercept FYGPA |  | | 3.682 | | | | .018 | | 9 | | | 204.506 | | | < .001 | |
| Slope GRE-V |  | | 0.040 | | | | .008 | | 201 | | | 4.812 | | | < .001 | |
| Slope GRE-Q |  | | 0.078 | | | | .013 | | 201 | | | 6.187 | | | < .001 | |
| Slope GRE-AW |  | | 0.033 | | | | .005 | | 201 | | | 6.546 | | | < .001 | |
| Random Effects (Levels 1 and 2) | |  | | Variance Est. | | | |  | | | *df* | | *χ2* | | | *p*-value | | |
| Intercept FYGPA |  | | 0.018 | | | |  | | 185 | | | 1530.222 | | | < .001 | |
| Slope GRE-V |  | | 0.002 | | | |  | | 194 | | | 283.69 | | | < .001 | |
| Slope GRE-Q |  | | 0.007 | | | |  | | 194 | | | 340.668 | | | < .001 | |
| Residual |  | | 0.168 | | | |  | |  | | |  | | |  | |
| Random Effects (Level 3) |  | |  | | | |  | |  | | |  | | |  | |
| Intercept FYGPA |  | | 0.001 | | | |  | | 9 | | | 20.276 | | | .016 | |
| **Model 3. GRE & UGPA** | | | | |  |  | | | |  | |  | |  | | | |
| Fixed Effect | | | | | Coefficient Est. | *se* | | | | *df* | | *t* Ratio | | *p*-value | | | |
| Intercept FYGPA | | | | | 3.680 | .017 | | | | 9 | | 212.949 | | < .001 | | | |
| Slope UGPA | | | | | 0.119 | .023 | | | | 201 | | 5.263 | | .001 | | | |
| Slope GRE-V | | | | | 0.035 | .008 | | | | 201 | | 4.579 | | < .001 | | | |
| Slope GRE-Q | | | | | 0.071 | .012 | | | | 201 | | 5.927 | | < .001 | | | |
| Slope GRE-AW | | | | | 0.029 | .004 | | | | 201 | | 7.971 | | < .001 | | | |
| Random effect (Levels 1 and 2) | | | | | Variance Est. |  | | | | *df* | | *χ2* | | *p*-value | | | |
| Intercept FYGPA | | | | | 0.018 |  | | | | 185 | | 1543.219 | | < .001 | | | |
| Slope GRE-V | | | | | 0.002 |  | | | | 194 | | 289.959 | | < .001 | | | |
| Slope GRE-Q | | | | | 0.007 |  | | | | 194 | | 344.292 | | < .001 | | | |
| Residual | | | | | 0.166 |  | | | |  | |  | |  | | | |
| Random Effects (Level 3) | | | | |  |  | | | |  | |  | |  | | | |
| Intercept FYGPA | | | | | 0.001 |  | | | | 9 | | 23.372 | | .006 | | | |
| Slope UGPA | | | | | 0.005 |  | | | | 9 | | 304.189 | | < .001 | | | |

Table A2

*Summary of Model Fit*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | | Number of Parameters | | Deviance | |
| Baseline Model | | 4 | | 18112.59 | |
| Model 1 (UGPA) | | 9 | | 17901.49 | |
| Model 2 (GRE) | | 12 | | 17573.63 | |
| Model 3 (GRE & UGPA) | | 15 | | 17441.50 | |
| Model Comparison | | | | | | |
|  | *df*  (*N* Parameter Difference) | | (Deviance Difference) | | *p*-value | |
| Model 1 vs. Baseline | 5 | | 211.10 | | < .001 | |
| Model 2 vs. Baseline | 8 | | 538.96 | | < .001 | |
| Model 3 vs. Baseline | 11 | | 671.09 | | < .001 | |
| Model 3 vs. Model 1 | 6 | | 459.99 | | < .001 | |