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 |