MIXED_FIT: A SAS® Macro to Assess Model Fit and Adequacy for Two-Level Linear Models

Mihaela Ene, Whitney Smiley, & Bethany A. Bell
University of South Carolina

Introduction

- Multilevel models (MLMs) are useful in understanding relationships existent in hierarchical data structures.
- In order to draw meaningful conclusions from MLMs, researchers need to make sure that the model fits the data.
- Bardenheier (2009) developed a macro that allowed researchers using PROC MIXED to obtain the test statistic for the difference in -2LL along with the *p*-value of the Likelihood Ratio Test (LRT).
- This updated macro provides comprehensive fit information for MLMs that incorporates changes in model fit statistics (-2LL, AIC and BIC) as well as change in pseudo-R^2 .

Model Fit

Nested Models

- To test for statistically significant change in model fit between two nested linear models use the Likelihood Ratio Test (LRT).
- To test for practically significant difference in model fit between two nested linear models use the change in Pseudo- R^2 between the larger and smaller model.

Non-nested models

- LRT and Pseudo- R^2 cannot be used.
- Instead researchers must rely on other fit indices such as Akaike Information Criterion (AIC) and Schwarz's Bayesian Information Criterion (BIC).

Macro MIXED_FIT

In order to create a more comprehensive macro that provides fit information for both nested and non-nested models, we developed the Macro MIXED_FIT. This macro uses information from ODS tables generated from PROC MIXED to produce numeric output consisting of a table that includes:

- the difference in -2 log likelihood values along with the *p*-value of the LRT ,
- the difference in the AIC and BIC,
- the change in pseudo - R^2.

Example of ODS statement used after the PROC MIXED statement:

```
ods output Fitstatistics=FS_Model_1 SolutionF=SF_Model_1;
ods output CovParms=CovModel_1; run;
```

Example

Data: Using student characteristics (level-1) and school characteristics (level-2), two-level nested linear models are used to investigate the relationship between math achievement and these various characteristics at the student and school level.

Question: Is the model that contains level-1 and level-2 predictors a better fitting model than the model that contains only level-1 predictors?

The macro statement used after the PROC MIXED and ODS statements:

```
%Mixed_Fit(fullmodel=FS_Model_3,redmodel=FS_Model_2,DFfull=SF_Model_3,
   DFred=SF_Model_2, CovarianceUnconditionalModel=CovModel_1,
   CovarianceReducedModel=CovModel_2, CovarianceFullModel=CovModel_3); run;
```

Model Fit Statistics for Changes in Fixed Effects

Obs	Change in AIC Reduced-Full Useful with non-nested models	Change in BIC Reduced-Full Useful with non-nested models	Change in -2LL Reduced-Full For nested models only	p-value LRT For nested models only
1	57.193	51.043	61.1933	0.0000

Change in Pseudo-R2

Obs	Full-Reduced For nested models only
1	0.15951

Figure 1. Output from MIXED_FIT Summary Table

Conclusion

MIXED_FIT is a useful tool that facilitates the process of examining model fit for two-level linear models by:

• providing the changes in all fit indices necessary for comparison of both nested and non-nested models;

• making this information accessible for the researcher interested in examining model fit in terms of both statistical and practical significance.

References

• Bardenheier, B. H. (2009). Proc Mixed: Macro to assess fixed and random effects for significance using the Likelihood Ratio test and the approximate Mixture Method. *SESUG 2009: The Proceedings of the SouthEast SAS Users Group*.

• Kwok, O., Underhill, A. T., Berry, J. W., Luo, W., Elliott, T. R., & Yoon, M. (2008). Analyzing longitudinal data with multilevel models: An example with individuals living with lower extremity intra-articular fractures. *Rehabilitative Psychology, 53 (3)*, 370-386.

• McCoach, D. B. & Black, A. C. (2008). Evaluation of model fit and adequacy. In A. A. O'Connell & D. B. McCoach (Eds.), *Multilevel modeling of educational data* (245-272). Charlotte, NC: Information Age Publishing, Inc.

• Singer, J. D. & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence* (1st ed.). New York, NY: Oxford University Press, Inc.

• Snijders, T. A. B. & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). Thousand Oaks, CA: Sage.

Contact Us!

Mihaela Ene
ene@email.sc.edu

Whitney Smiley
smileyw@mailbox.sc.edu

Bethany A. Bell
babell@sc.edu

The most recent version of the MIXED_FIT macro is available for download from http://www.ed.sc.edu/bell/.