Performance of the Weighted Root Mean Square Residual with Categorical and Continuous Data

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Abstract

In structural equation modeling, global model fit is typically assessed by examining a variety of fit indices, such as the Chi-squared ratio test, Root Mean Squared Error of Approximation, and the Comparative Fit Index.

The Weighted Root Mean Square Residual (WRMR) is a relatively new index, and increasingly used for support of model-data fit by many applied researchers. However, limited study has been conducted on the performance of WRMR.

This study investigated the performance of the WRMR under a variety of situations through a simulation study.

Two primary research questions are investigated:

1. How does performance of the WRMR differ when categorical or continuous data are analyzed?
2. How does WRMR perform relative to other fit indices for both categorical and continuous data?

Introduction & Related Literature

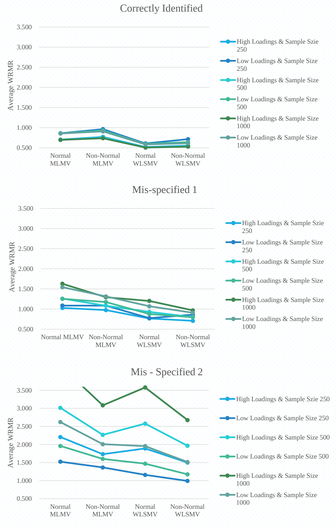
- To provide advice about what values constitute "good fit" for an index, many investigations concerning the performance of fit indices have been conducted. Factors such as model size, loading size, model misspecification, and estimators have been examined (e.g. Hu & Bentler, 1998; Fan & Sivo, 2007).
- Among the fit indices, WRMR is a relatively new fit statistic, (Muthen, 2001). The is currently available in Mplus and the laavaan package (R software program).
- WRMR was developed for use with ordinal data, but it is also available when categorical data and continuous data are analyzed.
- Currently, only two studies have investigated the performance of the WRMR (Yu,2002; DiStefano, Liu , Jiang & Shi, 2017).
  - Both studies recommended WRMR may indicate acceptable fit with values 1 or lower.
  - Mplus recommends that WRMR is an experimental fit index and may not be trustworthy.

Methods

- Monte Carlo simulation conducted with Mplus (v. 7.4).
  - Population CFA model – 3 factors, 15 items; two cross loading items.
  - Ordinal & Continuous Data: 5 category;
  - ➢ Item distributions - normal distribution (s/k = 0/0) & non-normal distribution (s/k);
  - ➢ Estimation method: WLSMV & MLMV;
  - ➢ Loading size: all 0.5 or all 0.8; Cross loading (.25);
  - ➢ Estimated Models: Correctly specified model;
    Mild misspecification (no cross loadings);
    Severe misspecification (no cross & factors 2 and 3 collapsed);
  - ➢ Sample size: 250, 500, 1000.
  - 2 × 2 × 2 × 3 ×3 = 72 conditions; 1000 replications per cell.

Results –1. Performance of WRMR

Sample Size: 6,5142 (due to improper/nonconverged solutions)



POPULATION MODEL

- Correctly specified: WRMR values showed good fit regardless of item distribution; values of .5 to .91.
- Mild Misspecification: WRMR values close to 1.0 (values of .71 to 1.63).
  - At larger N, WRMR is actually better with non-normal data.
- Severe misspecification: all WRMR values equal or higher than 1.0.
  - Values close to 1 with WLSMV estimation and low loading values.

HIGH/LOW LOADING CONDITIONS

- Higher loadings provided better WRMR values.
- WRMR values similar for correct or mild misspecification.
- As misspecification and N increased, WRMR looks *better* with higher loadings.

ESTIMATIONS/CONTINOUS VS. CATEGORICAL DATA

- Noted convergence problems with 5 category using estimation WLSMV, low N (500 and 250) and nonnormal data
- MLMV estimation provided higher WRMR values than WLSMV estimation.
  - regardless of population model, sample size, or level of non-normality.

LEVEL OF NON-NORMALITY

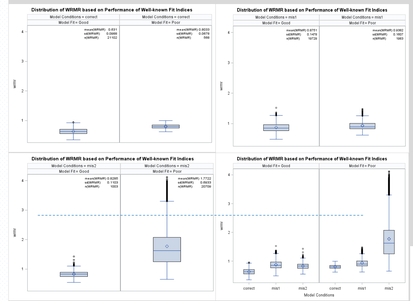
- WRMR: Within guidelines for normal data if models were correct or slightly misspecified.
  - Non-normal conditions, WRMR looked better as misspecification became severer.

SAMPLE SIZE

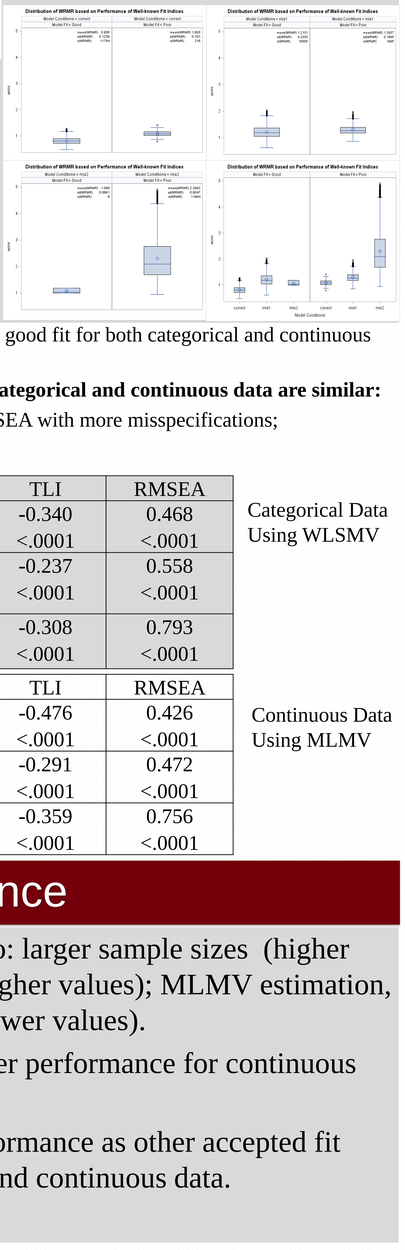
- WRMR increases as N increases regardless of population model, sample size, or level of non-normality.

Results –2. WRMR vs Other Fit Indices

Good Fit: (TLI or CFI >=.95) AND RMSEA <=.06 (WLSMV)



Good Fit: (TLI or CFI >=.95) AND RMSEA <=.06 (MLMV)



WRMR is lower when other indices also show good fit for both categorical and continuous data.

Correlations with other fit indices for both categorical and continuous data are similar:

Stronger correlations with Chi-square and RMSEA with more misspecifications;

Weak correlations with CFI and TLI.

WRMR	Chi-Square	CFI	TLI	RMSEA
Correctly Specified	0.545 <.0001	-0.389 <.0001	-0.340 <.0001	0.468 <.0001
Mild Misspecification	0.843 <.0001	-0.185 <.0001	-0.237 <.0001	0.558 <.0001
Severe Misspecification	0.960 <.0001	-0.306 <.0001	-0.308 <.0001	0.793 <.0001

Categorical Data Using WLSMV

WRMR	Chi-Square	CFI	TLI	RMSEA
Correctly Specified	0.476 <.0001	-0.537 <.0001	-0.476 <.0001	0.426 <.0001
Mild Misspecification	0.897 <.0001	-0.287 <.0001	-0.291 <.0001	0.472 <.0001
Severe Misspecification	0.968 <.0001	-0.359 <.0001	-0.359 <.0001	0.756 <.0001

Continuous Data Using MLMV

Summary & Significance

- WRMR showed sensitivity to: larger sample sizes (higher values) ; misspecification (higher values); MLMV estimation, and higher loading values (lower values).
- WRMR showed slightly better performance for continuous data than categorical data.
- WRMR showed similar performance as other accepted fit indices for both categorical and continuous data.

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