Contribution ID: **51** Type: **Oral Presentation**

Commensurable indicators - finding potentially metric invariant indicators

Wednesday 23 July 2025 18:15 (15 minutes)

Oral presentation

Commensurable indicators - finding potentially metric invariant indicators

Author

Eric Klopp, Stefan Klößner

Affiliation

Saarland University

Abstract

In multi-group confirmatory factor analysis, it is important to test for metric measurement invariance (MMI), and searching for invariant indicators may be demanding. We present a method to find metric invariant indicators using some mathematical properties of invariant indicators.

We start with introducing an example provided by Yoon and Millsap (2007, Structural Equation Modeling, 14, 435-463) and introduce the notion of proportional factor loadings and the concept of change of scale (Klopp and Klößner, Methodology, 19, 192-227). From this, we derive and formally define the concept of commensurable indicators. The loadings of commensurable indicators are multiples of each other and conform to an equivalence relation. We show that when two indicators are commensurable, either both or none fulfill metric invariance. Each equivalence class with respect to commensurability forms a commensurable indicator subset (CIS), and correspondingly, the set of CIS will be called a partition of commensurable indicator subsets (PCIS).

Using the notion of a loading profile, i.e., a vector containing the loadings of a factor's indicator over the groups, it is possible to define an average loading profile and a static indicator loading for a given CIS. We derive the proposition that the loading profile can be multiplicatively decomposed into a static component and a second component, which within a CIS does not depend on the particular indicator but only on the corresponding CIS's average loadings profile. Metric invariance of the indicators belonging to a CIS can be read off the average loadings profile: If and only if this loadings profile is constant, i.e., if and only if it is a non-zero multiple of the vector of ones, then metric invariance of all indicators belonging to the CIS is fulfilled. Thus, the average loadings profile of CIS reveals whether its indicators fulfill MMI.
This mathematical framework provides the possibility of inferring the CIS structure from data using a second-order factor model with certain constraints to implement the decomposition of the loadings profiles from our proposition and find the partition with invariant indicators by systematically considering all partitions of the indicator set. The framework, therefore, enables finding sets with possible metric invariant indicators. The optimal partition can be inferred from estimating these models and using information criteria like the AIC, BIC, or sBIC.

Using the initial example, we conducted a Monte Carlo simulation with 10.000 repetitions with sample sizes of N=150, N=300, and N=500. For N=150, most of the time, the AIC and sBIC detected the correct partition, whereas the BIC failed to find the correct partition. However, for N=300 and N=500, the method selected the correct partition in most cases. In particular, the AIC and sBIC performed the best.

Although considering all partitions is a brute-force method, the simulation demonstrated that the method derived from the mathematical properties of the CIS structure has the potential for applied MMI analysis.

Lastly, we want to mention that the same considerations and the method to find the partitions also apply in longitudinal invariance settings.

Keywords

measurement invariance, metric, loadings

Primary author: KLOPP, Eric (Saarland University)

Co-author: Dr KLÖSSNER, Stefan (Saarland University)

Presenter: KLOPP, Eric (Saarland University)

Session Classification: Session 13 : ”Longitudinal models and Individual variability”

Track Classification: Statistical analyses: Statistical analyses