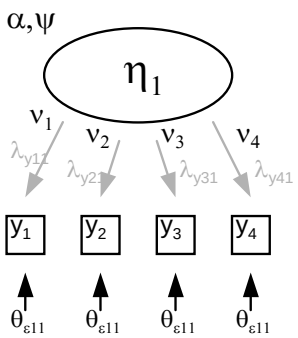
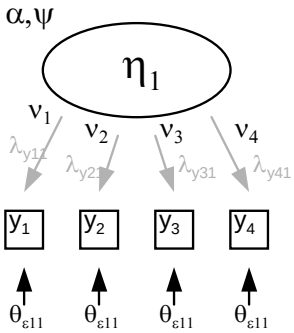
Invariance Tests in Multigroup SEM
Illustration using Meredith's (1993) Terminology

Weak Factorial Invariance

Group A

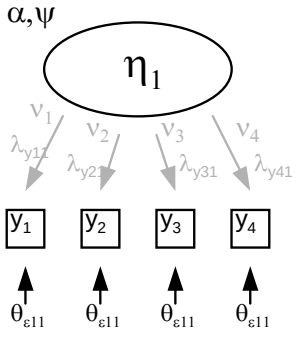


Group B

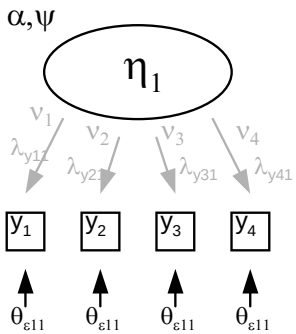


Strong Factorial Invariance

Group A

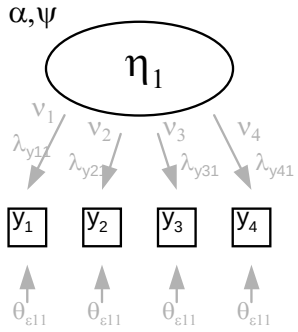


Group B

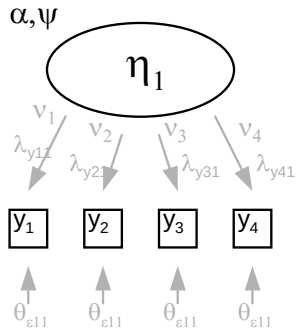


Strict Factorial Invariance

Group A

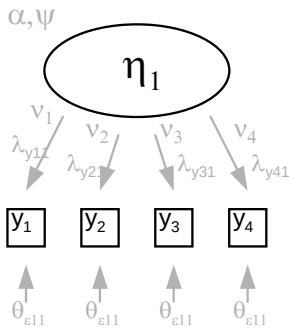


Group B

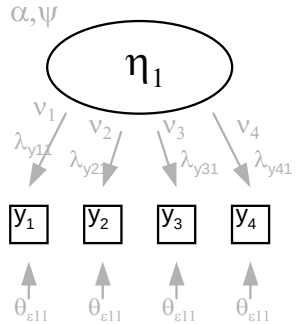


Structural Invariance

Group A

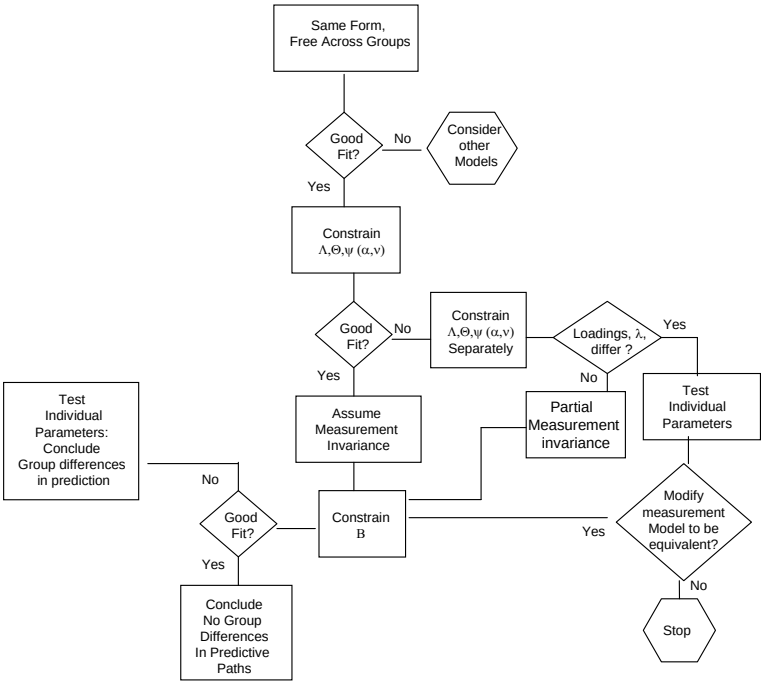


Group B



Note: Grayed elements represent equality constraints across groups. η is the factor, α is the factor mean, ψ is the factor variance, ν is the loading intercept, λ is the factor loading, θ_ε is the measurement error.

Overview of a Suggested Process for Testing for Group Differences in SEM



Comments: Generally speaking, comparisons should be made to the same form/free parameters model or the previously tested model with fewer constraints (Bentler, 2000). The basic idea is to establish measurement equivalence before comparing predictive paths across groups. In practice, researchers are often willing to live with partial measurement invariance (Byrne, Shavelson, & Muthen, 1989) in which only loadings are equivalent across groups (strong or weak factorial invariance depending on the interest in intercepts) if SEM is used to assess differences in prediction across groups. Strict measurement invariance will be required, however, if the goal is to compare groups in subsequent analyses using a composite index of the items, because group differences in the amount of measurement error across groups can impact the results (Millsap & Kwok, 2004). Mean comparisons (of factors, α, or intercepts, ν) may not always be of interest. Two cases in which mean comparisons certainly should be made: 1) bias may be introduced because groups are combined or assumed equivalent in later analyses, and 2) mean differences between groups are of substantive interest (analogous to t-test or ANOVA comparisons). In other cases, in which the researcher is interested in examining predictive differences between groups, one would not necessarily assume that group differences on the mean of an independent or dependent variable would affect associations with other variables within a group. Multifactor models present additional complications. Structural relations between a set of predictors and an outcome will depend on correlations among the predictors, for example. So, in order to meaningfully interpret differences in prediction across groups, one would normally want to assume equivalence in the correlations among the predictors. Finally, with large sample sizes, significant differences may be found for very small magnitude differences, and the researcher needs to decide which differences are important.

References

Bentler, P.M. (2000). Rites, wrongs, and gold in model testing. *Structural Equation Modeling, 7*, 82-91.

Meredith, W. (1993). Measurement invariance, factor analysis, and factorial invariance. *Psychometrika, 58*, 525-543.

Suggested Reading

Byrne, B.M., Shavelson, R.J., & Muthen, B. (1989). Testing for the equivalence of factorial covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin, 105*, 456-466.

Bontempo, D. E., & Hofer, S. M. (2007). Assessing factorial invariance in cross-sectional and longitudinal studies. In A.D. Ong & M. van Dulmen (Eds.), *Handbook of methods in positive psychology* (pp. 153-175). Oxford University Press.

Cheung, G.W. & Rensvold, R.B. (1999). Testing factorial invariance across groups: A reconceptualization and proposed new method. Journal of Management, 25, 1-27.

Werts, C.E., Rock, D.A., Linn, R.L., & Joreskog, K.G. (1977). Validating psychometric assumptions within and between several populations. *Educational and Psychological Measurement, 37, 863-872.*

Kim, J. O., & Ferree, G. D., Jr. (1981). Standardization in causal analysis. *Sociological Methods and Research, 10*, 187-210.

Millsap, R. E, & Yun-Tein, J. (2004). Assessing Factorial Invariance in Ordered-Categorical Measures. *Multivariate Behavioral Research., 39, 479-515.*

Millsap, R. E., & Kwok, O.M. (2004). Evaluating the impact of partial measurement invariance on selection in two populations. Psychological Methods, 9, 93-115.

Millsap, R. E. (1998). Group differences in regression intercepts: Implications for factorial invariance. *Multivariate Behavioral Research, 33, 403-424.*

Vandenberg, R.J., & Lance, C.E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational Research Methods, 3,* 4-69.