Symposium
"Testing Structural Equation Models"

Thursday, September 4th 2008, 16:00 – 18:00

Convenors: Cor van Dijkum, Willem Saris, Han Oud
Chair: Han Oud
Participants: Albert Satorra, Ulf Olsson, Vincenzo Esposito Vinzi, William van der Veld, Willem Saris

As we know from the literature and SEM programs manuals, evaluating the fit of a SEM model on the basis of the chi-square has serious disadvantages, as the chi-square depends on the *df* involved (*df* = 0 necessarily leading to a perfect fit) and on the sample size (with large sample sizes, significant chi-square can come from relatively trivial failures of the model). Many other fit measures (e.g., AIC and RMSEA) are proposed and some of the SEM programs give long lists of alternatives to choose from. However, most of these alternatives have been criticized too. The long lists, offering often at least something in favor of the model, lead to extreme confusion on the side of the practitioner and to the topic of model testing taken less and less seriously. With regard to structural equation model testing, Willem Saris developed the radical standpoint that we should not use fit indices or "intervals of close fit" at all but concentrate on misspecification and use instead the Expected Parameter Change (EPC), Modification Index (MI) and the power of the test for the detection of misspecifications. The problems and possible solutions in structural equation model testing will be discussed from different perspectives.

16:00-16:20 **Albert Satorra**
Theoretical and Practical Issues for Testing in Structural Equation Models

16:20-16:40 **Ulf Olsson**
Testing Structural Equation Models: The Effect of Kurtosis

16:40-17:00 **Vincenzo Esposito Vinzi**
Current Issues and Future Challenges in Component-based Structural Equation Modeling

17:00-17:20 **William van der Veld**
Judging Misspecifications in Structural Equation Models using JRule

17:20-18:00 *Panel discussion*

Theoretical and Practical Issues for Testing in Structural Equation Models
Albert Satorra (*Universitat Pompeu Fabra, Barcelona*)

Central issues in structural equation modeling (SEM) are model fit assessment and testing specific sets of restrictions. In this talk we survey theoretical and practical aspects of testing in SEM. Specifically, we discuss chi-square goodness of fit test and testing under restricted alternatives, for a general distribution of the data and conditions on the model. The role of the modification index (MI) and power analysis for assessing the validity of the model will also be discussed. The actual implementation of the methods under general distribution conditions is surveyed. Empirical and Monte Carlo Illustrations will be provided.

Testing Structural Equation Models: The Effect of Kurtosis
Ulf Olsson (*Norwegian School of Management BI, Sandvika*)

There are several different chi-square statistics offered in typically SEM soft wares to deal with non-normal data. In this paper we examine the power of two such chi-square statistics, namely the SB statistic (Satorra & Bentler, 1988) and the ADF statistic (Browne, 1984). The SB statistic corrects the normal theory chi-square with a scale factor which is estimated from the sample and involves the estimated asymptotic covariance matrix (ACM). The scale factor is estimated so that the SB statistic has an asymptotically correct mean. The ADF statistic under the assumption of correct model has an asymptotic chi-square distribution. Following the notation of Jöreskog, Sörbom, Du Toit, & Du Toit (2003), these chi-square statistics are denoted c_3 and c_4 while the normal theory chi-square statistic is denoted c_2. In this study we will demonstrate how the power of c_3 and c_4 varies with increasing kurtosis in a homogeneous – and non-homogenous way. Since c_3 and c_4 depend on the ACM and the ACM depends on kurtosis, c_3 and c_4 are affected by kurtosis.

Current Issues and Future Challenges in Component-Based Structural Equation Modeling
Vincenzo Esposito Vinzi (*ESSEC Business School, Paris*)

The component-based approach to Structural Equation Modeling (SEM) was initiated by Herman Wold under the name "PLS" (Partial Least Squares). Hwang and Takane (Psychometrika, 2004) have recently proposed a new component-based SEM method named Generalized Structured Component Analysis. Generally speaking, component-based SEM can be considered as a generalized data analysis approach to multiple tables connected by a network of "causal" relationships. As such, this approach is mainly used for scores computation and privileges a prediction oriented discovery process to the statistical testing of causal hypotheses. More specifically, PLS is a limited information two-step method essentially based on a set of interdependent simple and multiple OLS regressions both for the measurement and the structural model. The simplicity of the PLS algorithm makes it feasible also for (very) small samples. The recently proposed GSCA is, instead, a full information method that optimizes a global criterion. A few comparisons between covariance-based and component-based SEM have shown reasons in favour of one approach or the other depending on different factors such as, for instance, the nature of the model, the research objective, the sample size, the definition of latent variables by means of reflective or formative manifest variables, the estimation and practical meaning of factor scores. With reference to component-based SEM and, specifically, to PLS Path Modeling, we wish to focus on current important issues such as the optimization of a criterion, the measurement model misspecification, the treatment of formative relationships between manifest and latent variables, the estimation and the intepretation of scores in presence of strongly correlated latent variables, the possibility of constraining parameter estimates as well as on some other open issues representing interesting themes for current and future researches.

Judging misspecifications in Structural Equation Models using JRule

William van der Veld (*Radboud University Nijmegen*)

Model evaluating is very important in the process of theory development and testing in structural equation modeling. The judgment rules to use for the evaluation are, however, not clear. That is, except for when the CHI2 test is used, because the distribution of this test statistic is known. Unfortunately, the power of the CHI2 test increases with sample size, so that eventually even the smallest residual becomes significant. This sensitivity to sample size is the cause of the development of a plethora of fit indices to judge structural equation models. These fit indices have no known distribution, hence we cannot control for type I and type II errors which makes model evaluation very fuzzy. Nevertheless, fit indices have become the norm using among others Hu and Bentler's (1999) suggestions for critical values of these fit indices. Rejected models are commonly 'improved' using the modification indices that indicate which constrained parameters are misspecified. A striking detail is that that those researchers who use fit indices, because they see their models always being rejected by the CHI2 test, are willing to use the modification index. It is striking because the modification index suffers the same problems as the CHI2 for the whole model, i.e. dependence on sample size. On top of that - the icing on the cake - Saris, Satorra, and Sörbom (1987) have shown that the modification index as well as the CHI2 test statistic are also sensitive to the size of parameter estimates. In summary, the CHI2 test, the modification index, but also fit indices based on the CHI2 test statistic (as we have shown recently) are all sensitive to sample size and the size of parameters. That is, when sample size is high and/or parameters estimates are large, the power of the test increases so that even the smallest residual can become significant. The other side of the coin is just as worse; when sample size is small and/or parameters estimates are small, the power of the test decreases so that even the largest misspecification goes undetected. Therefore, the situation with respect to model evaluation seems rather hopeless. It is time for change. We have developed an alternative procedure to judge whether constrained parameters are misspecified or not. So, we change from model evaluation to the detection of misspecifications. The idea is that if a model is without misspecification, it is a good model. The evaluation takes into account the expected parameter change, the modification index, and the power of the test. The evaluation procedure is implemented in JRule, a software package that reads SEM output and provides judgment rules for each constrained parameter. In this presentation we will illustrate how this procedure works and how it can result in different conclusions than current practice.