STRUCTURAL EQUATION MODELLING

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Structural Equation Modeling (SEM) is a powerful technique that can combine complex path or simultaneous equation models with latent variables measured by a factor analysis model. This general approach includes Confirmatory Factor Analysis Models and Simultaneous Regression Models as special cases and can be extended to multiple populations, hierarchical data structures and non-metric variables. Thurstone or Maxwell and Lawley's Factor Analysis and Sewall Right's Path analysis can be considered as forerunners of these models. The general model was the result of a conference summoned by Goldberger in 1971 where for the first time measurement relationships between observable indicators and their underlying constructs –psychometrics– received the same attention as the substantive relationship between constructs –econometrics.

Since the late seventies, a group of researchers in Barcelona, all of them disciples and colleagues of Professor W. E. Saris (University of Amsterdam) has been working on this model mainly from its measurement perspective. Nowadays, research in this area revolves around Universitat de Barcelona (A. Maydeu-Olivares), Universitat de Girona (G. Coenders), Universitat Rovira i Virgili (P. J. Ferrando, U. Lorenzo-Seva), Universitat Pompeu Fabra (A. Satorra), and ESADE-URL (J. M. Batista-Foguet). Several research agendas are also under way. One of them is robust estimation and testing techniques (See Latent Variable Models by A. Satorra in this same issue). The remaining areas are outlined below, together with the major publications.

Multitrait-Multimethod Models: Special cases of SEM are not only used for reliability and validity assessment of measurement instruments in the social sciences, but also in the physical sciences. Their scope ranges from comparing different answer modes in a questionnaire to comparing different blood pressure measurement protocols. There have been contributions to generalise these models for different patterns of method effects, for bias evaluation instead of only reliability and validity, and for planned missing data designs (Batista-Foguet and Saris, 1988; Batista-Foguet, and Saris, 1992; Coenders, Batista-Foguet and Satorra, 1995; Coenders and Saris, 1998; Coenders and Saris, 2000*a*; Coenders and Saris, 2000*b*; Batista-Foguet, Coenders and Artés, 2001; Kogovšek *et al.*, in press; Corten *et al.*, in press).

Quasi simplex models: Special cases of SEM, they are used for reliability assessment in panel designs and quantification of change over time, specifically for evaluating stability of attitudes. There have been contributions in studying their statistical properties, their robustness and in generalising the analysis to mean structures instead of only analysing covariance structures (Batista-Foguet and Saris, 1997; Coenders *et al.*, 1999).

SEM for categorical ordered dependent variables: Since SEM has been established to deal with normally distributed variables, measures other than covariances are required in the ordinal case. A series of studies has been made concerning the robustness of alternative measures of association, comparing their properties with those of covariances, concerning the measurement implications of treating the observed variables as categorical or as continuous, and on using parametric or non-parametric approaches (Maydeu-Olivares, 1994; Coenders and Saris, 1995; Ferrando, 1996; Coenders, Satorra and Saris, 1997; Ferrando, 2000).

Development of new estimation methods and test statistics in SEM with non-metric and censored variables: Current estimation methods in SEM for non-metric dependent variables use a three-stage approach. A two-stage approach has been proposed and compared with the existing approach. In addition, new test statistics have been proposed for extremely sparse contingency tables and for dealing with censored data (Ferrando and Lorenzo-Seva, 1999; Maydeu-Olivares, 2001*a*; Maydeu-Olivares, in press).

Random utility modeling using a SEM approach: An overall model for fitting random utility models has been proposed that encompasses as special models, models for paired comparisons data and ranking (permutation) data. A SEM approach which relies on limited information estimation and testing procedures has been found to compare very favourably to full information approaches based on the EM algorithm or Gibbs sampling.

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