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Overview of Structural Equation Modeling (SEM)

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Objectives

To understand SEM as an extension of the general linear model, and recognize this extension as a fundamental advancement in our ability to construct theory.

To know the steps in constructing and testing structural equation models.

To appreciate the generality and flexibility of structural equation modeling.

I. What is SEM?

A. SEM extends correlation, regression, factor analysis, and path analysis.

1. SEM is a statistical methodology to represent and test the "causal" processes inherent in our theories.

B. SEM is a fundamental advancement in theory construction.

1. Most important, it integrates measurement with substantive theory. Measurement error is estimated and theoretical parameters are adjusted accordingly.

2. Focus is on testing theory or confirming theoretical constructs. This is particularly important because the distinction between sample and population parameters has often been ignored in practice.

3. There is always more than one model that fits the data. Thinking about these alternative models and testing them helps to refine your theory.

4. The one-to-one correspondence between path diagrams and sets of structural equations facilitates communication and clarification of all parameters and their inter-relationships.

5. The simultaneous estimation used in SEM is more accurate than the piecemeal approaches traditionally employed with path analysis, and also more accurate than the technical solutions employed in factor analysis.

C. SEM accommodates regression; measurement (factor analysis), correlation, multiple regression; "bivariate" regression; path analysis; and complete models of observed and latent variables.

1. The generality and flexibility of SEM allows estimation of many different kinds of models, including recursive and non-recursive models.

II. Constructs in SEM.

A. Define concepts.

B. Clarify dimensions of concept.

C. Form measures of the dimensions.

D. Specify the expected empirical relationships between the measures and construct.

III. Testing SEM Models.

A. Four steps to testing models.

1. Specification. Hypothesize relationships every pair of variables including pairs not associated.

2. Identification. Ensure sufficient data to enable unique estimates of model parameters. Discuss in several weeks.

3. Estimation. Select procedure to estimate free parameters. Maximum likelihood most commonly used. Discuss next week.

4. Assess fit. Examine degree of fit between sample data and implied covariance matrix, or compare fit indices across alternative models.

a. If test fails, re-specifying the model may give direction for revising theory. The model that is eventually fit has *not* been tested.

B. Three patterns in the translation of a theory to a statistical model.

1. Strictly confirmatory. Model specified, data obtained, model estimated, theory accepted or rejected. Rare.

2. Alternative models. Several alternative or competing models specified, data obtained, models estimated and compared, and one model accepted. Strongest test, but not yet widely practiced.

3. Model generating. Model specified, data obtained, model estimated, and, if model fails to fit, it is re-specified and re-estimated. Search for model that fits the data well and, most importantly, that is substantively meaningful. Most common.

C. Two-Step Approach.

1. First test measurement models, then structural models. Validity of theory depends on the validity of the constructs.

2. Useful to distinguish degree to which model fit is a function of measurement parameters.

3. Current fit measures do not distinguish between measurement and theoretical parameters.

Summary