The Use of Structural Equation Modelling with Panel Data

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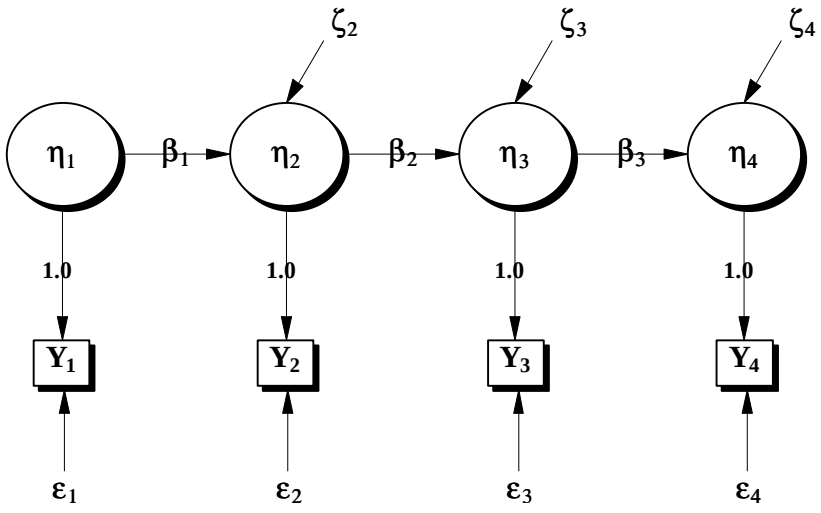
- IS researchers are often interested in explaining changes in variables such as beliefs, attitudes, and intentions about an IT over time.
- Panel Designs represent observations collected for a number of individuals at two or more points in time with the individual as the unit of analysis
- Panel Designs are useful in exploring questions related to the processes that generate attitude change or stability.
- Panel Designs can help examine the reliability and stability of key variables.

- One way of analyzing panel data is examining the test-retest correlations for measures of key variables.
- Yet limitations include:
  - can be affected by random measurement errors and temporal instability
  - no distinction between observations and latent variables (thus observed scores may differ even when true scores do not change)
  - few statistical tests for the adequacy of any hypothesized structural relationships among variables.

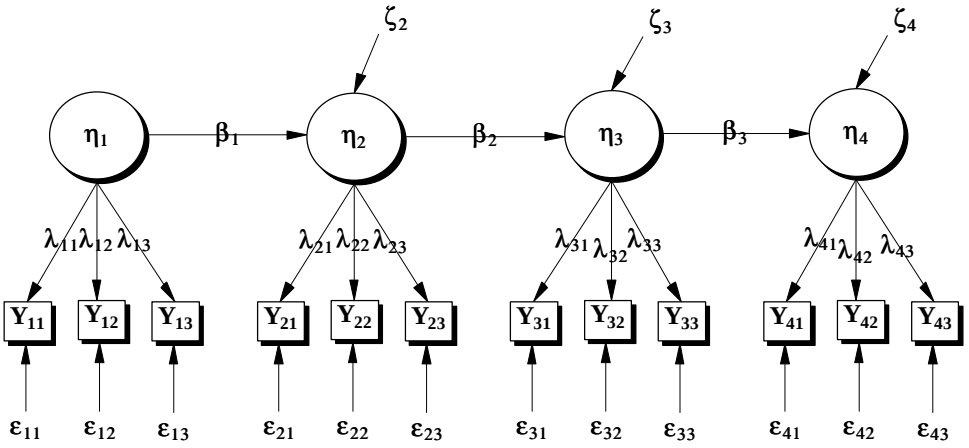
Single-indicator Multiple-wave model (SIMW)



- We can assess the temporal stability by examining the beta coefficients since each beta represents the degree to which a latent variable at time t + 1 is a function of a latent variable at time t.
- The beta, thus, represents the stability of a variable after measurement errors have been taken into account.
- Reliability of the observed measures can be obtained as a ratio of true score variance and observed variance (Lord and Novick, 1968).

- The SIMW is unfortunately not identified without additional assumptions (constraints).
- Our example has 10 variances/covariance, yet attempting to estimate 11 unknown parameters.
- Various proposed modifications:
  - have the same error variance for adjacent variables.
  - assume all error terms have identical error variances (true score variances can still vary)
  - equal error variances and betas
  - equal error variance, betas, and residual errors in the structural model

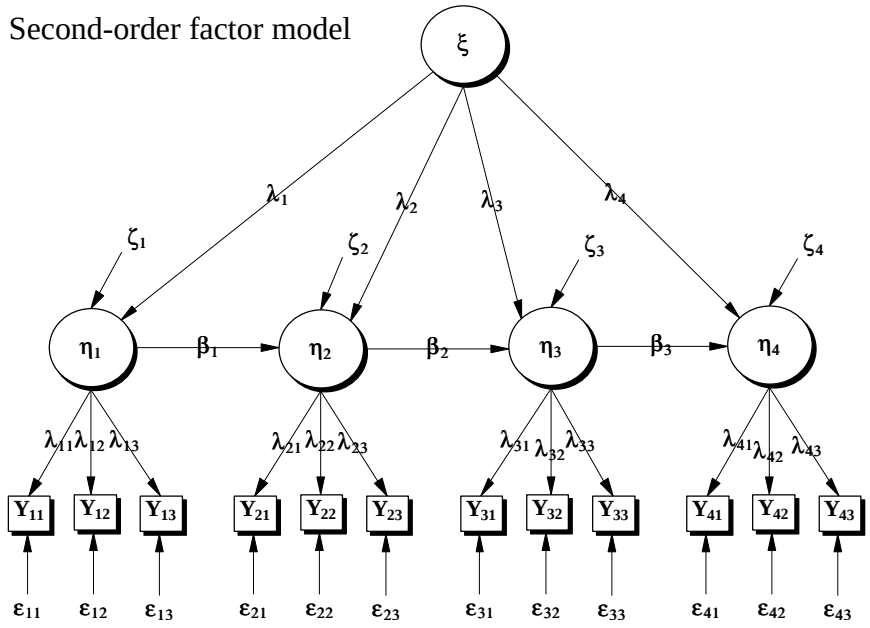
Multiple-indicator Multiple-wave model (MIMW)



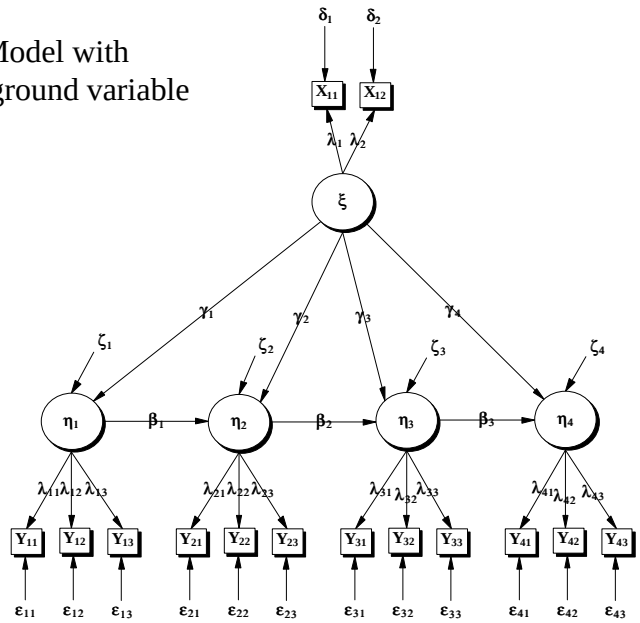
- Issues to consider for this model are:
  - which measurement model to specify?
    - parallel (most restrictive - identical factor loadings and error variances)
    - tau-equivalent (factor loadings are equal)
    - congeneric (measurements are assume to measure the same thing - similar pattern).
  - are there serially correlated errors? what order?
  - what are the consequences of correlated errors and how do we explain the processes underlying this?
  - Do the variables change or remain stable over time? If so, are they uniform across all time points?

- first order autocorrelation involves correlating the error terms of the same items for adjacent occasions.
- second order involves the errors for the same item across three waves.
- Models that may explain the correlated errors include:
  - Higher-order latent construct model
  - Model with an omitted background variable
  - Multiple-lag model
  - Model with a simplex error structure
  - Model with method factors

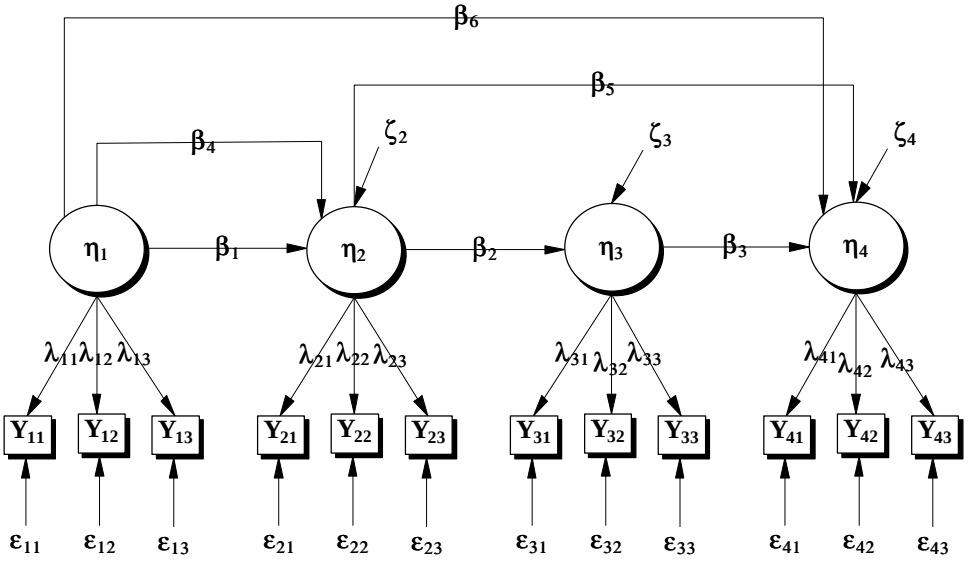
Second-order factor model



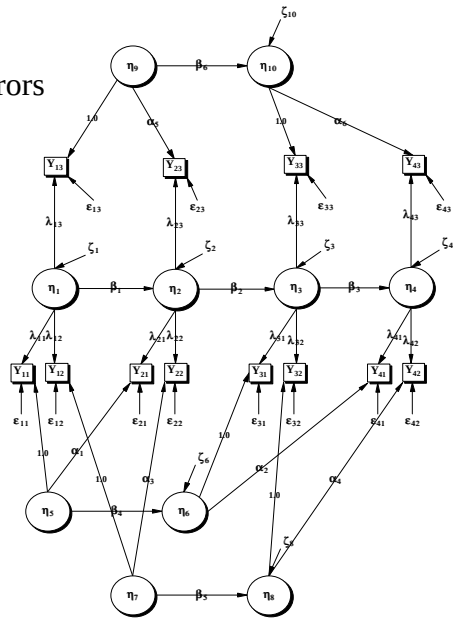
Model with background variable



Multiple-lag model (lag-3 example)



Model with Simplex Errors



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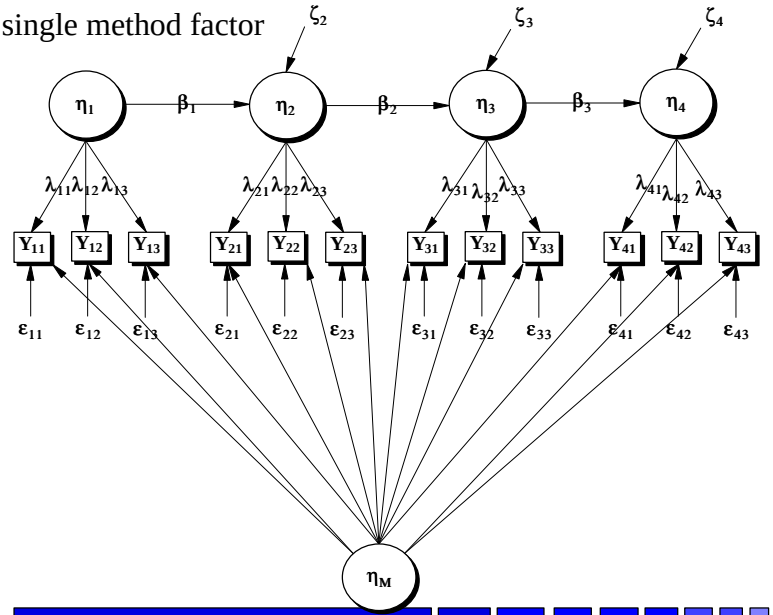
Model with a single method factor



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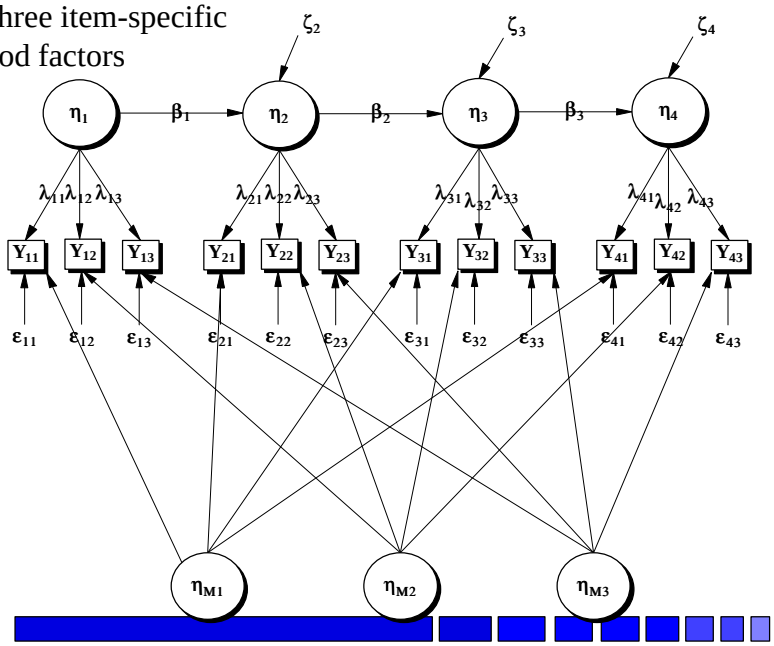
Model with three item-specific method factors



- Caveats
  - assumed we are using continuous (or interval level) variables
  - we ignore the first moments (means) by assuming the latent variable at time t is centered at mean centered.
  - Perfect stability (betas all equal to 1) implies the expected value of all observed or latent variables between time t and t +1 are equal to each other
  - assumed homogeneity of individual (otherwise include subgroup analysis)