Nonlinear Modeling – Traditional Approaches

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June 05, 2017

1 Constrained product indicator approaches

The example is based on the Kenny-Judd data from their 1984 article on constrained pi approaches. It includes the following variables:

- Two indicators for voter's position on an issue (v_1, v_2)
- Two indicators for voter's liking or sentiment toward the candidate (s_1, s_2)
- Two indicators for voter's judgment of the candidate's position (c_1, c_2)

The hypothesis of "assimilation and contrast" assumes that impact of the voter's position on an issue on the judgment of the candidates position is moderated by their sentiment toward the candidate.
"If the candidate is disliked, a negative relation between V and C is consistent with contrast. If the candidate is liked, a positive V-C relation is consistent with assimilation." (Kenny & Judd, 1984).

1. Draw a path diagram for the model, assuming that v and s are latent predictors and c is a latent dependent variable. Include a latent product term $v \cdot s$ and form two indicators for this variable.

2. Indicate all estimated parameters and necessary constraints to scale the latent variables. Remember that a model with two indicators in a measurement model might need some more identifying restrictions.

3. Write down the measurement equations for all indicator variables including the pi's. Can you derive the constraints in this case? [This is actually very complicated and we will go through that together].

4. Use the provided code to run the model: Is there an indication of an interaction effect? How would you test it?

2 Unconstrained product indicator approach 1

1. Use the same data set as before from Kenny and Judd. Relax the model constraints and rerun the model.

2. How many parameters do you add by relaxing the model constraints? Where do you see consequences for this reduced parsimony?

3 Unconstrained product indicator approach 2

The next data set was taken from PISA 2009 (OECD, 2010) It consists of an Australian subsample of $N = 1,019$ students who took part in a reading test.
The constructs are

- *Predictor 1:* Reported online activities (*Onl*; i.e., read emails or chat online)
- *Predictor 2:* Students' attitude towards reading (*Att*)
- *Dependent variable:* Reading skills (*Read*)

For each latent construct 3 item parcels were constructed that are saved in the file `pisa_online.dat`.

The hypotheses are:

- The attitude towards reading moderates the relationship between online activities and reading skills.
- The attitude and the online activities have a (linear and) quadratic relationship with reading skills (e.g., a saturation effect).

1. Draw a path diagram for a model that includes two linear, one interaction and two quadratic effects. Use pi's of non-redundant indicators for each latent product term (e.g., x_1^2, x_2^2 but not x_1x_2 for ξ_1^2). Remember to include all necessary residual covariances.

2. Extend the code from the example above to run the example. Do not forget to center the variables before creating the product indicators.

3. Investigate the hypotheses: Is there an indication for nonlinear effects?

4. Illustrate the results. Use the code provided (it might need some adjustment in order to extract the results).

   The code uses a correct standardization for the interaction effects based on Wen et al. (2010)/Brandt et al. (2015).

4 LMS

We will now use the same data sets (Kenny-Judd and pisa) to run some analyses with the package nlsem. The first part will be a demonstration, the second part will be an exercise.

1. Specify the interaction model for the Kenny-Judd data. Constrain the latent intercept and means to zero and the factor loadings to 1 for identification. Use both coding possibilities to set up the model (i.e., nlsem coding and lavaan coding) to get familiar with the package. [We do that together, step by step.]

2. Use the pisa data set to re-analyze the model including quadratic and interaction effects. Use a subset of $N = 300$ students for this exercise (otherwise the computation time might be very long).

   To keep the model comparable to the pi approaches, center the data and set the latent intercepts and means to zero.

3. Compare the model to a data set with uncentered variable that a) the first indicator with a zero latent intercept (ν_x) or b) have latent zero means (τ). What difference do you see?

4. Include the two quadratic effects. Test if online activities is significant using a model difference test.

5 2SMM (tentative)

In order to see a last typical approach, we now turn to 2SMM. This approach has two steps and we will use a demonstration (because coding it is not feasible during this workshop).
We are again using the pisa-data set. The code includes the following steps

1. Run the cfa model to obtain estimates for the measurement model.

2. Calculate the factor scores (Bartlett factor scores) and extract other relevant parameter estimates.

3. Calculate the regression coefficients using the corrected sum-of-squares-and-cross-products matrices.

4. Calculate the (uncorrected) standard errors.