#### Modeling change: A gentle introduction to crosslagged and latent growth curve approach: course materials

#### Štulhofer, Aleksandar; Ružojčić, Mitja

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# Cross-lagged models and mediation analysis

Modeling change: A gentle introduction to cross-lagged and latent growth curve approach

Mitja Ružojčić

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### When do we need cross-lagged?

- Primary reason we want to investigate causal directionality of the relationships between variables.
- Needed for mediational models where causality is implied.
- Next best thing for determining causality after...
- ...experiments.

## First building block of cross-lagged model is **autoregressive model**



### Adding the first cross-lagged effect



### Adding the second cross-lagged effect



## What about cross-lagged with latent variables?

- Before specifying the model, we need to check measurement invariance
  - psychometric equivalence of a construct across groups or across time.
  - demonstrates that a construct has the same meaning across groups or repeated measurements.
- Levels of invariance
  - 1. Configural same pattern of loadings
  - 2. Metric (weak factorial) equal loadings
  - 3. Scalar (strong factorial) equal loadings and intercept
  - 4. Residual (strict factorial) equal loadings, intercepts and item error variances

## Configural invariance – same pattern of loadings

Group 1





### Metric invariance – equal loadings

Group 1





### Scalar invariance – equal loadings and intercept (<u>a</u> precondition for comparing latent means across groups)

Group 1





### Residual invariance – equal loadings, intercepts and item errors

Group 1





#### Measurement invariance across time



Time 2



### Measurement invariance across time

- Metric invariance is necessary, scalar is ideal.
- If scalar is not achieved, we can opt for partial scalar invariance constraining only some (not less than 50%) intercepts to be equal across groups/time points
- Little (2013) suggests that residual invariance is an unrealistic assumption – one should always expect some variation in item indicator errors stemming from random noise/error.

#### Cross-lagged model with latent variables



### Cross-lagged model with three time points



### Mediation analysis



- Indirect effect = a\*b
- Direct effect = c'
- Total effect (c) = Indirect + direct effect (a\*b + c')

The moderator-**mediator** variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. RM Baron, <u>DA Kenny</u> - Journal of personality and social ..., 1986 - psycnet.apa.org In this article, we attempt to distinguish between the properties of moderator and **mediator** variables at a number of levels. First, we seek to make theorists and researchers aware of the ... ☆ Save 匆 Cite Cited by 121684 Related articles All 46 versions Web of Science: 52428

### Mediation analysis

- Baron and Kenny (1986) classic approach to mediation-testing
  - 1. Check if the relationship between x and y is significant
    - No -> no mediation.
    - Yes -> step 2
  - 2. Check if the relationship between x and m is significant
    - No -> no mediation.
    - Yes -> step 3
  - 3. Check if the relationship between m and y is significant
    - No -> no mediation.
    - Yes -> step 3
  - 4. If we control for m, does the relationship between x and y become nonsignificant (full mediation) or decreases (partial mediation)

### Mediation analysis

- Baron and Kenny's approach was created when computers were not accessible to everyone.
- In addition, some of its assumptions are too restrictive and probably led to the non-detection of some mediation effects (Lebreton et al., 2008).
- It is much more efficient and accurate to estimate the significance of mediation by simply multiplying the effects of a and b and estimating their significance, i.e., estimating significance of indirect effects.

### Indirect effect inference

- The distribution of the a\*b effect is mostly not normal.
- Significance of the indirect effect needs to be assessed using the empirically derived distribution of indirect effects.
- Bootstrap method creates a distribution of an indirect effect through resampling process - if the confidence interval obtained using this method does not include 0, the indirect effect is statistically significant.

### Mediation analysis

- For mediation in general, a great source is A. F. Hayes and his book Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach
- It is accompanied by PROCESS macro which is great for mediation analyses without autoregressive effects and cross-lagged relationships.
- <u>http://afhayes.com/introduction-to-mediation-moderation-and-conditional-process-analysis.html</u>
- For cross-lagged mediations, we need SEM.





Full longitudinal mediation



Full longitudinal mediation



Full longitudinal mediation



### References

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