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

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Cross-lagged models and mediation analysis

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

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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…
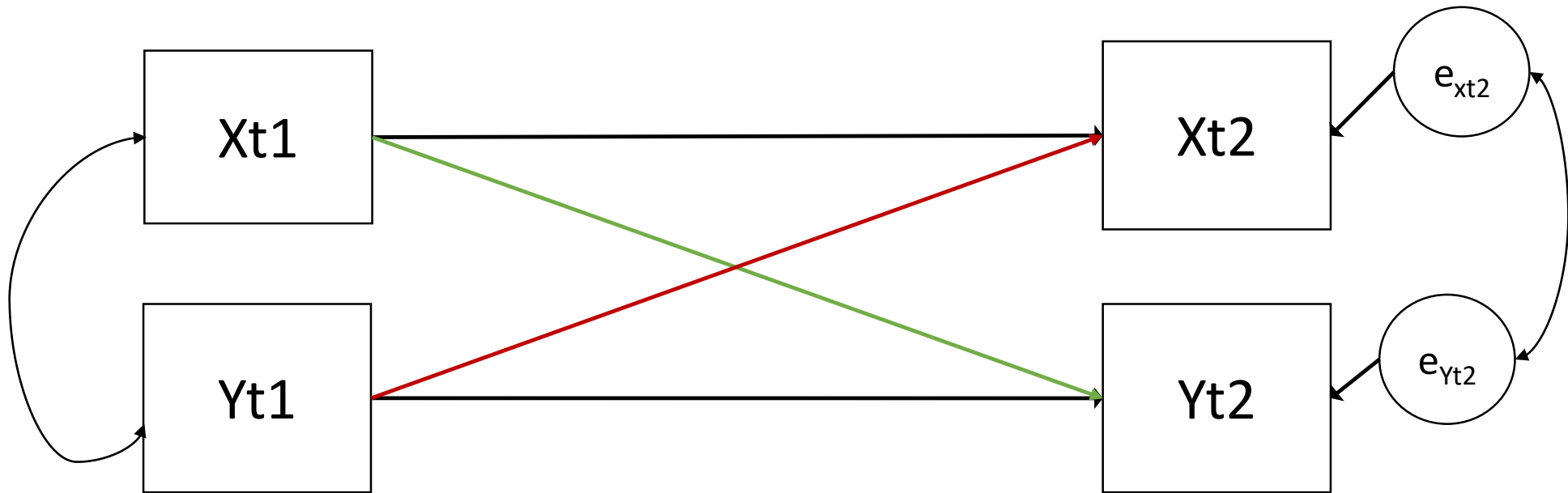
- …experiments.

First building block of cross-lagged model is **autoregressive model**
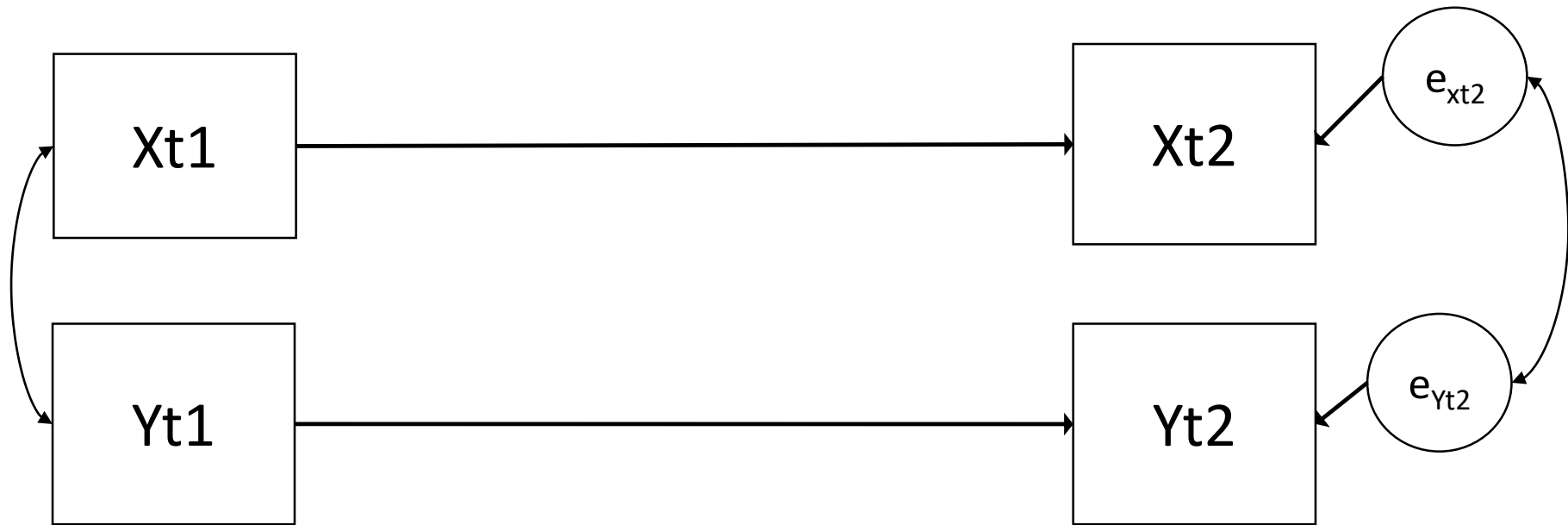
Adding the first cross-lagged effect
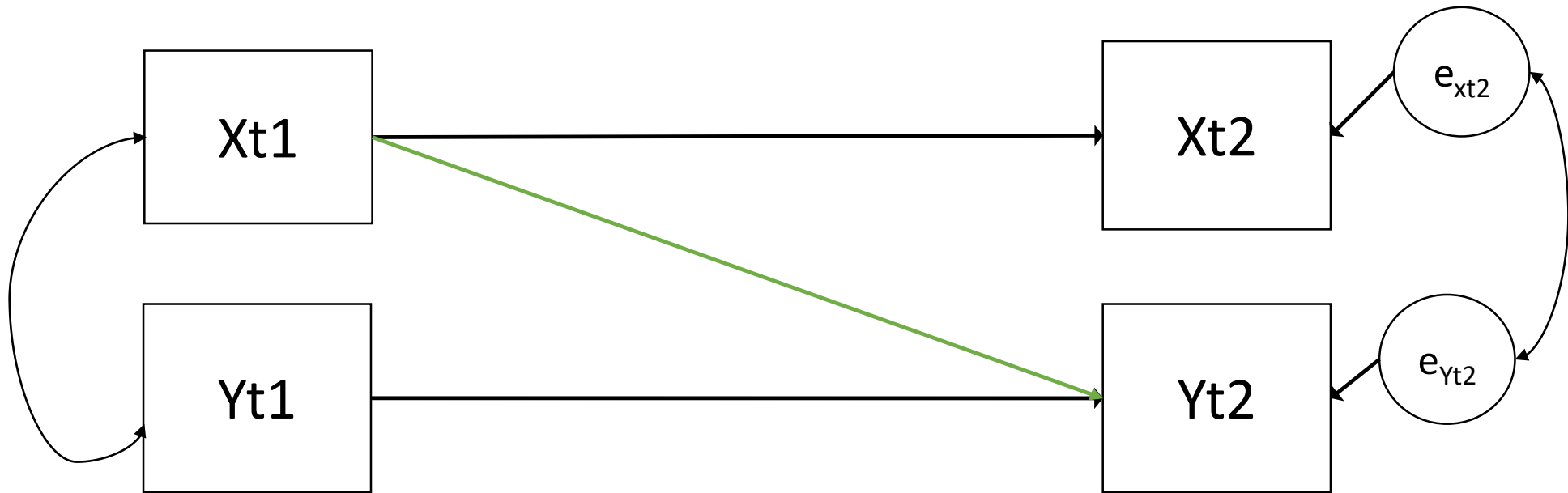
# Adding the second cross-lagged effect

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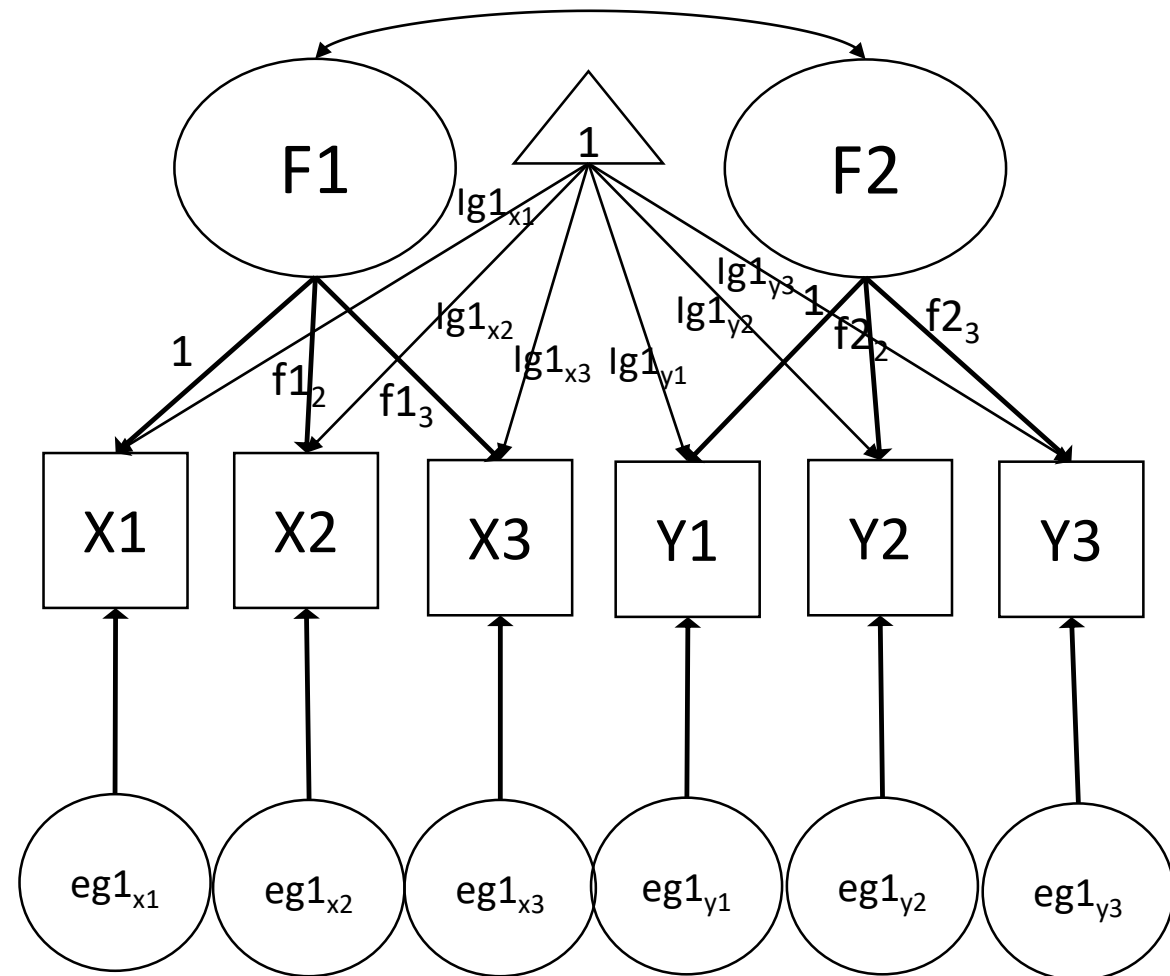
Configural invariance – same pattern of loadings
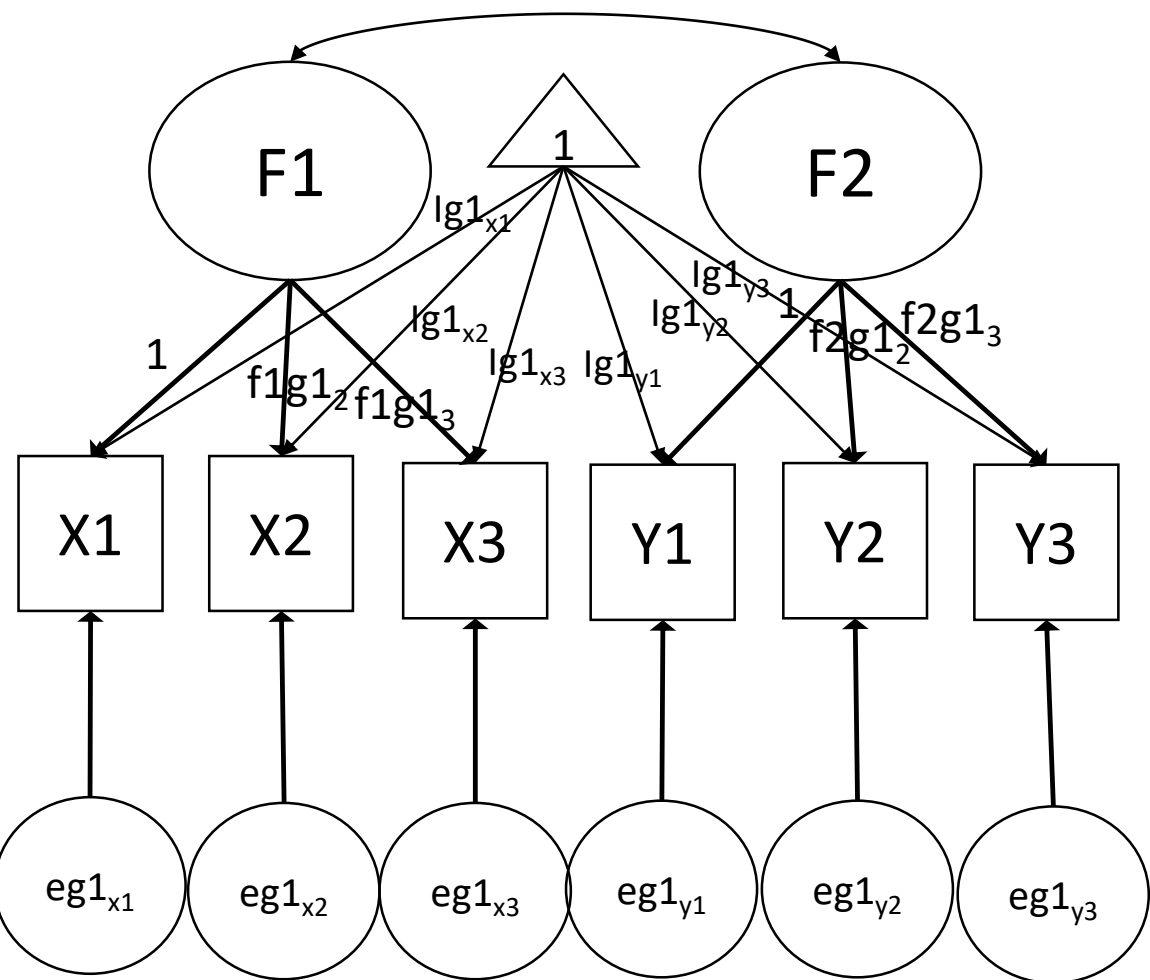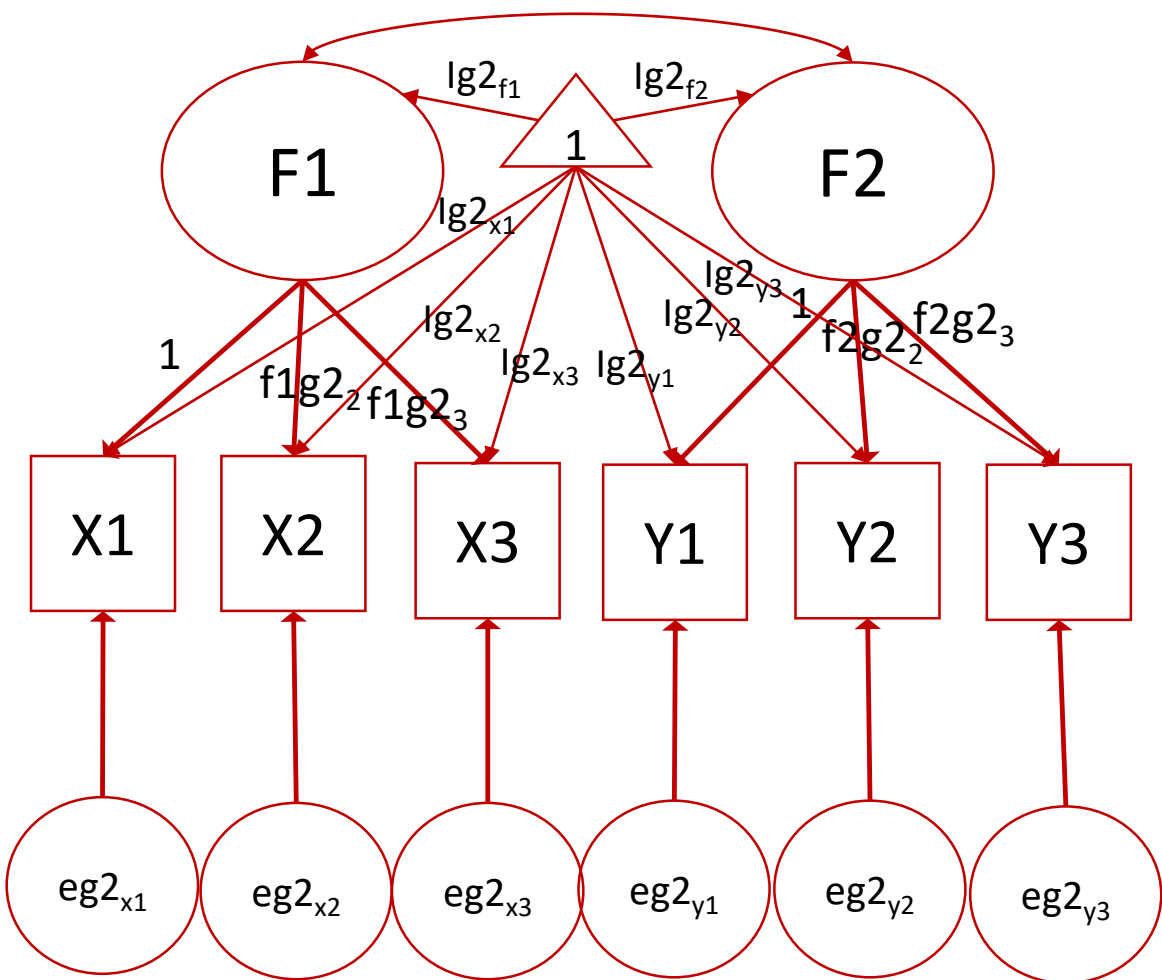
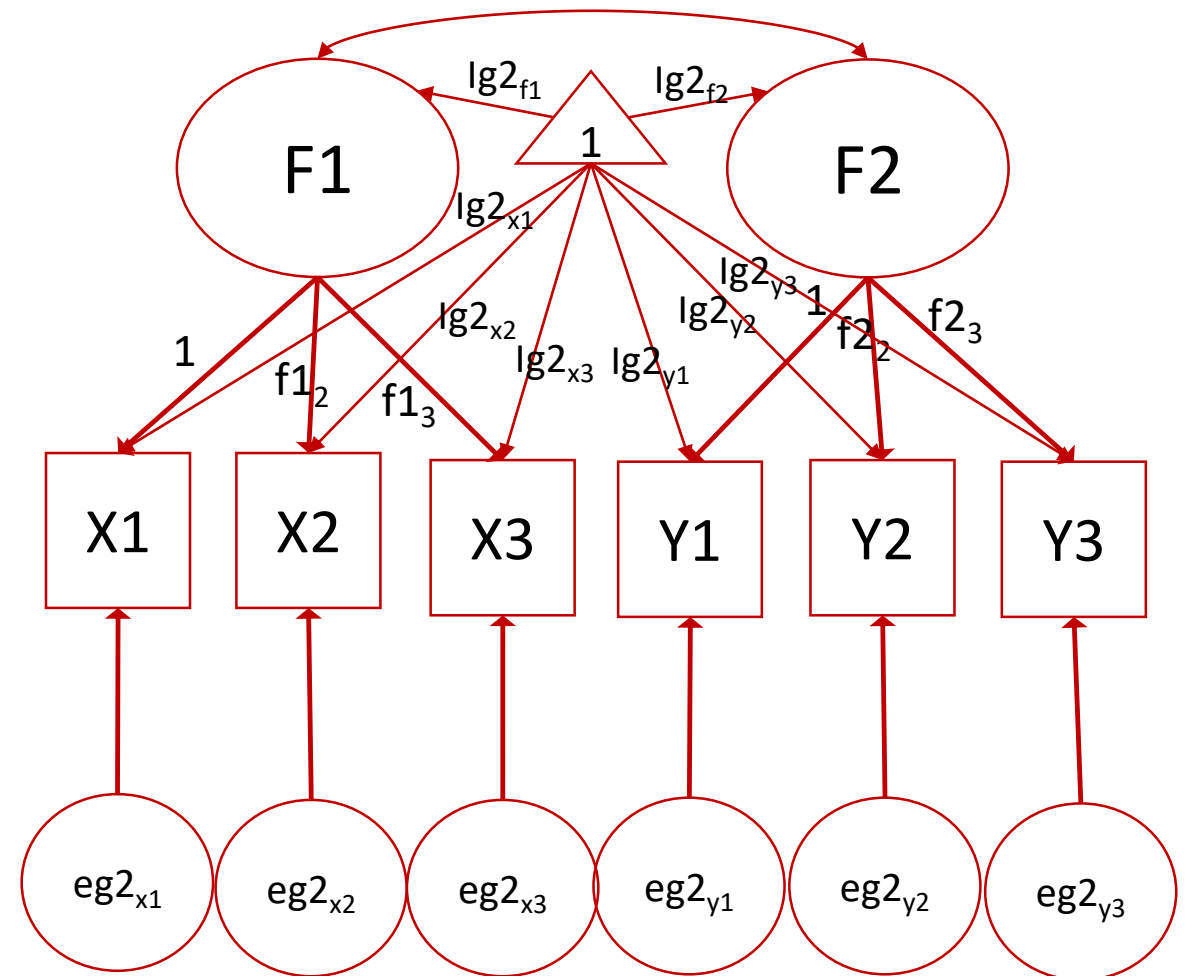# Metric invariance – equal loadings
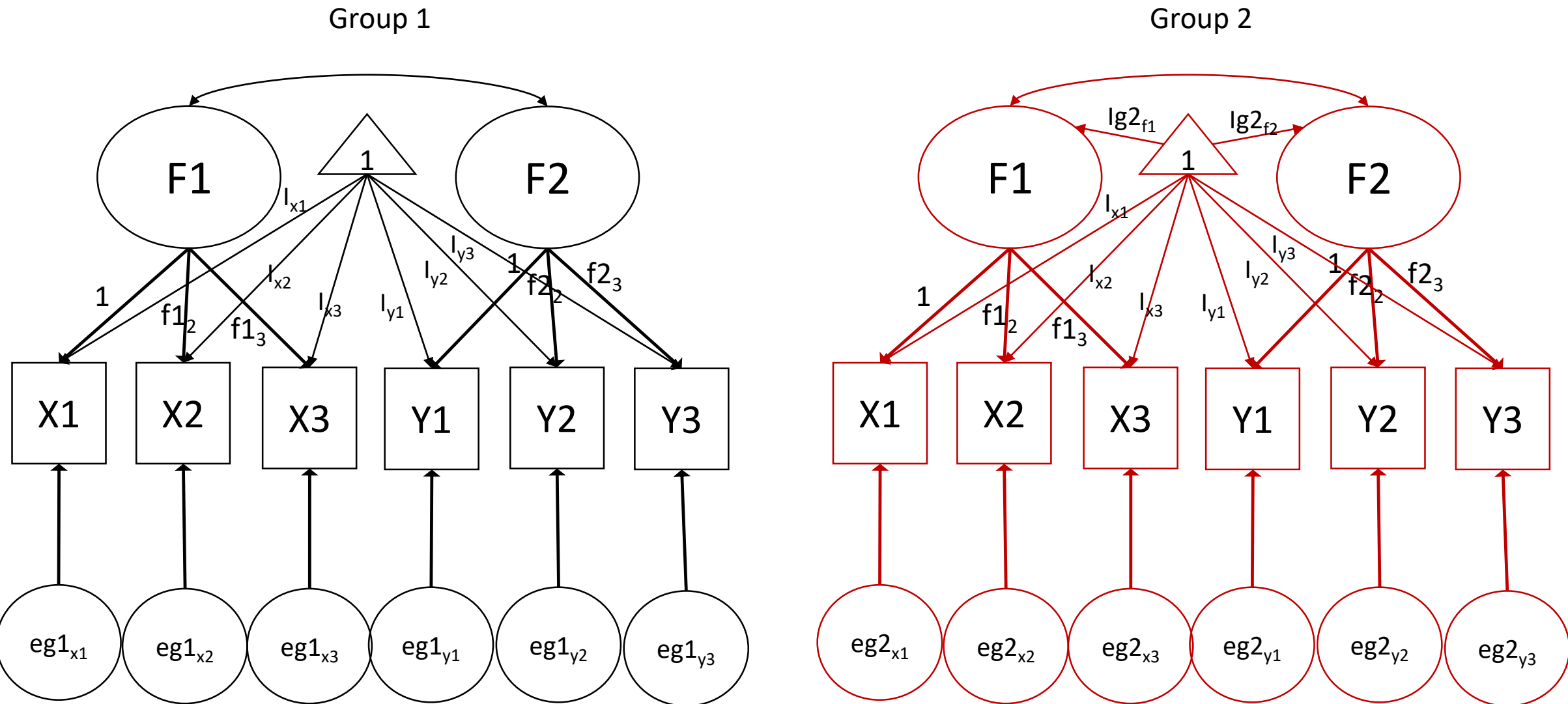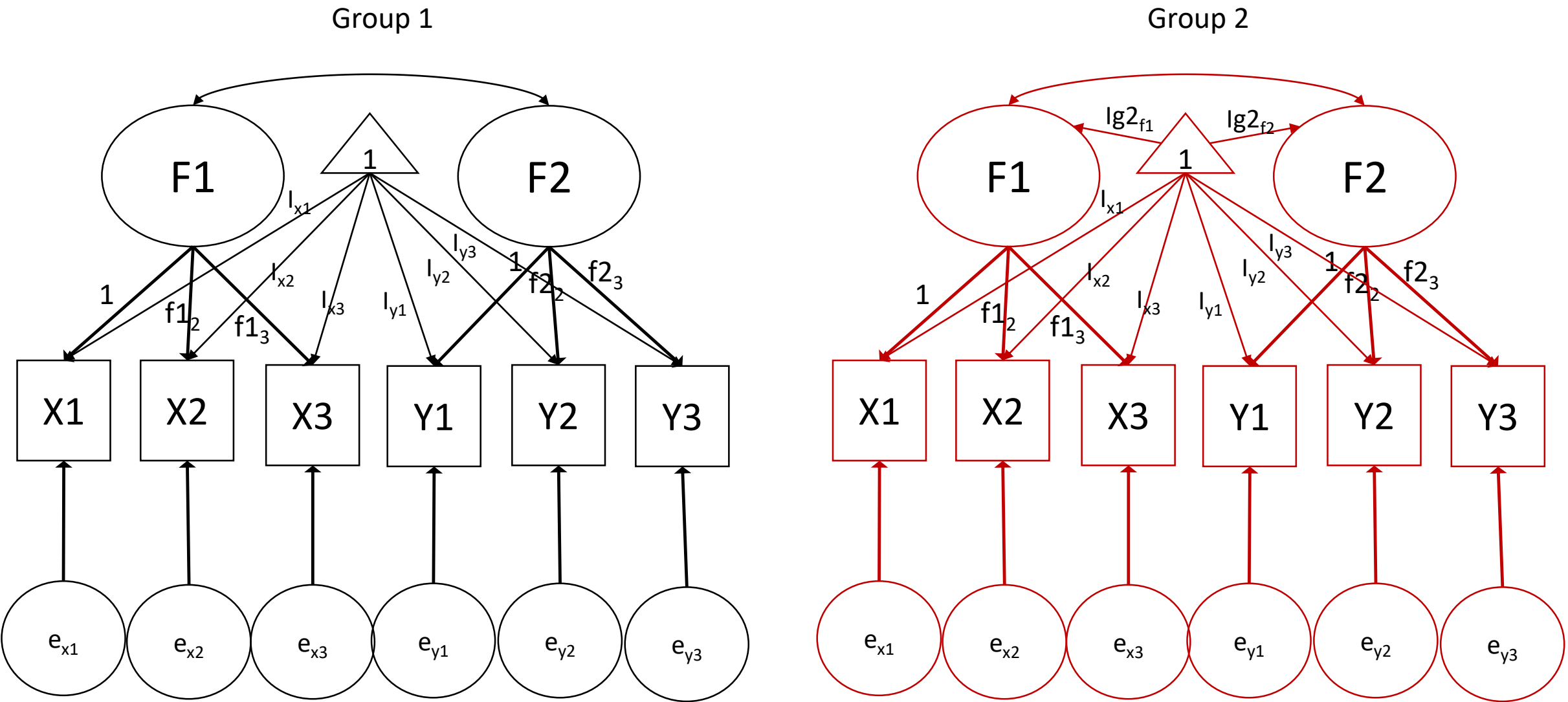
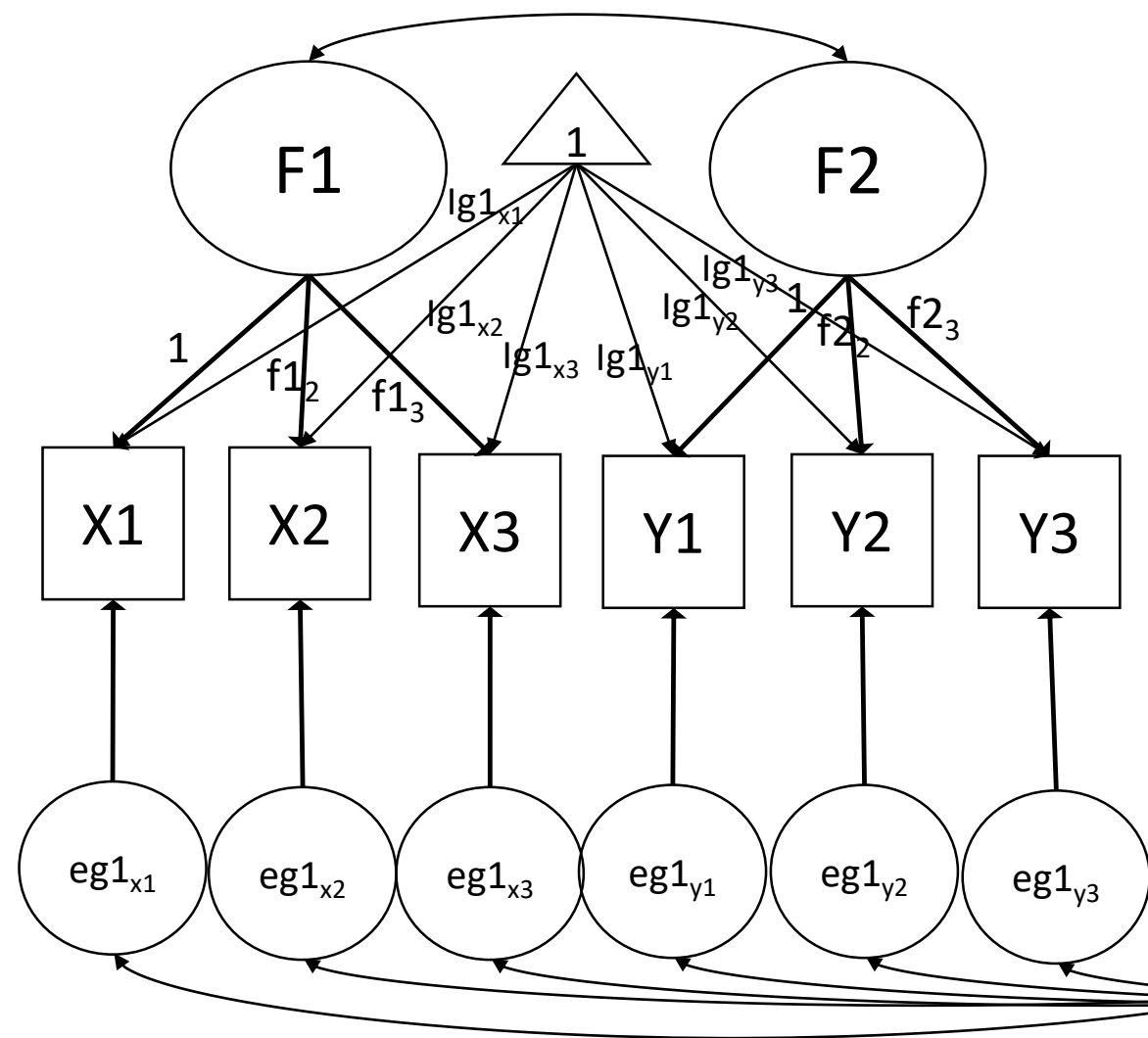# Scalar invariance – equal loadings and intercept (<u>a</u> precondition for comparing latent means across groups)

Residual invariance – equal loadings, intercepts and item errors

Measurement invariance across time
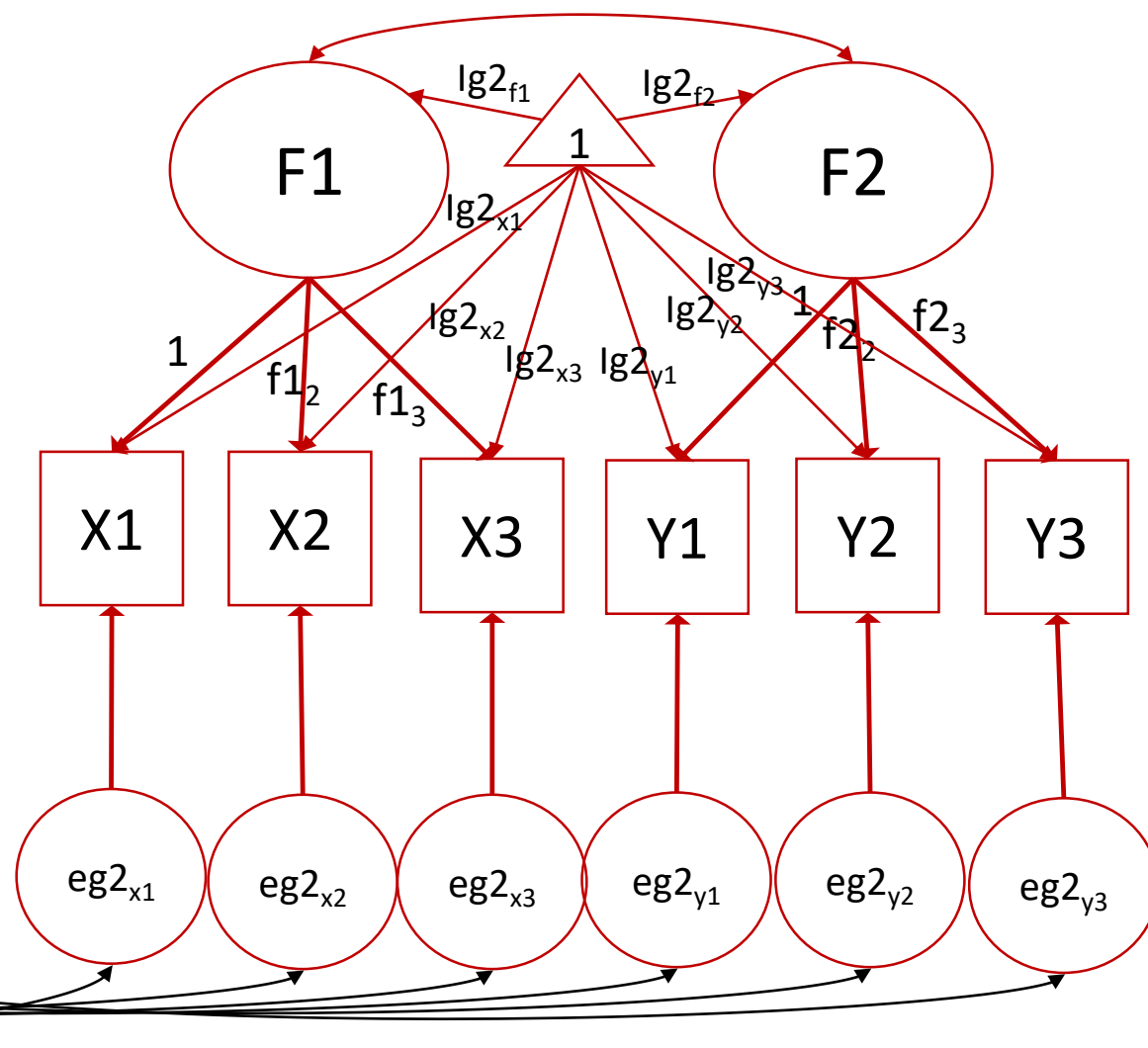
Measurement invariance across time

- 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
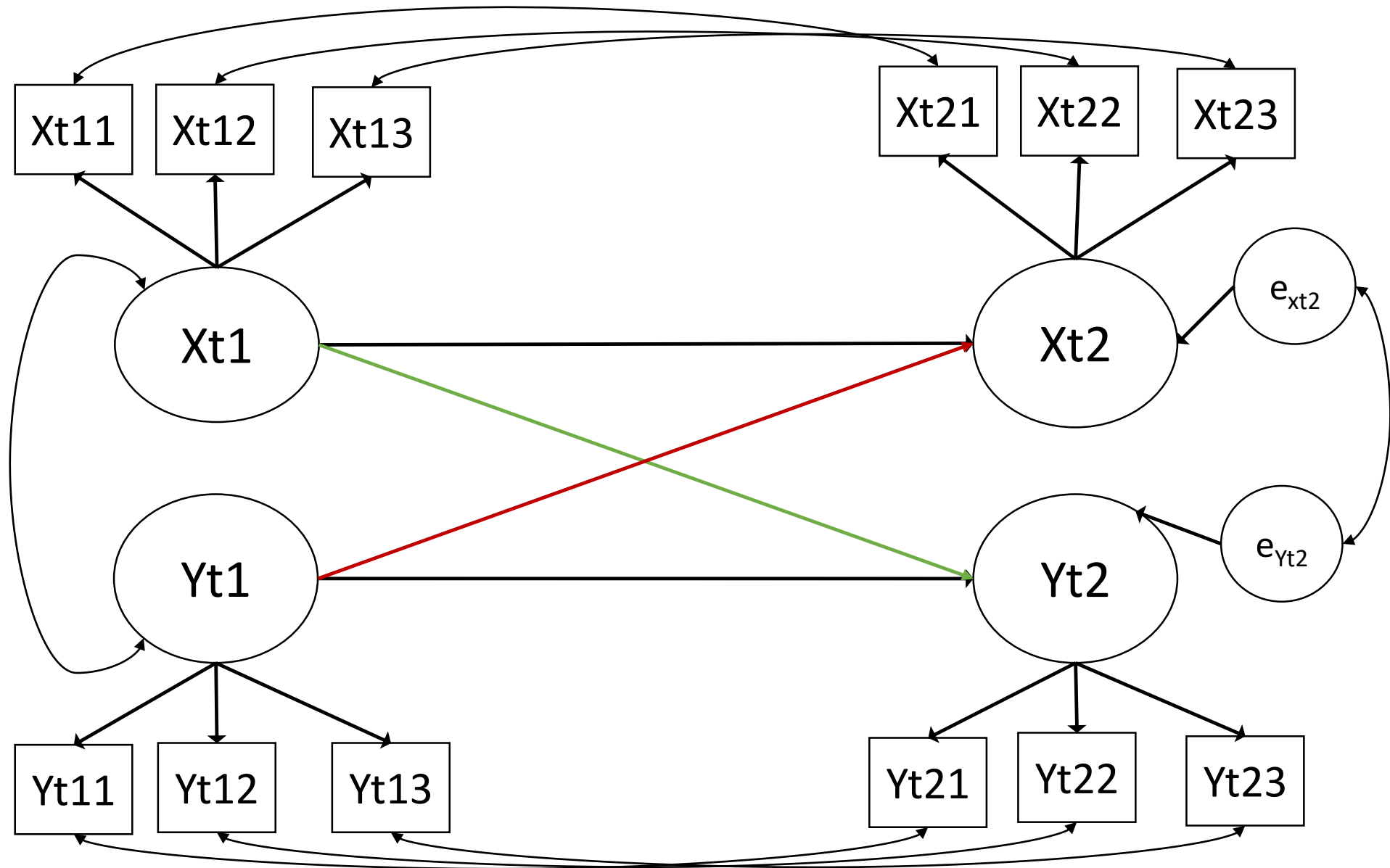
Cross-lagged model with three time points
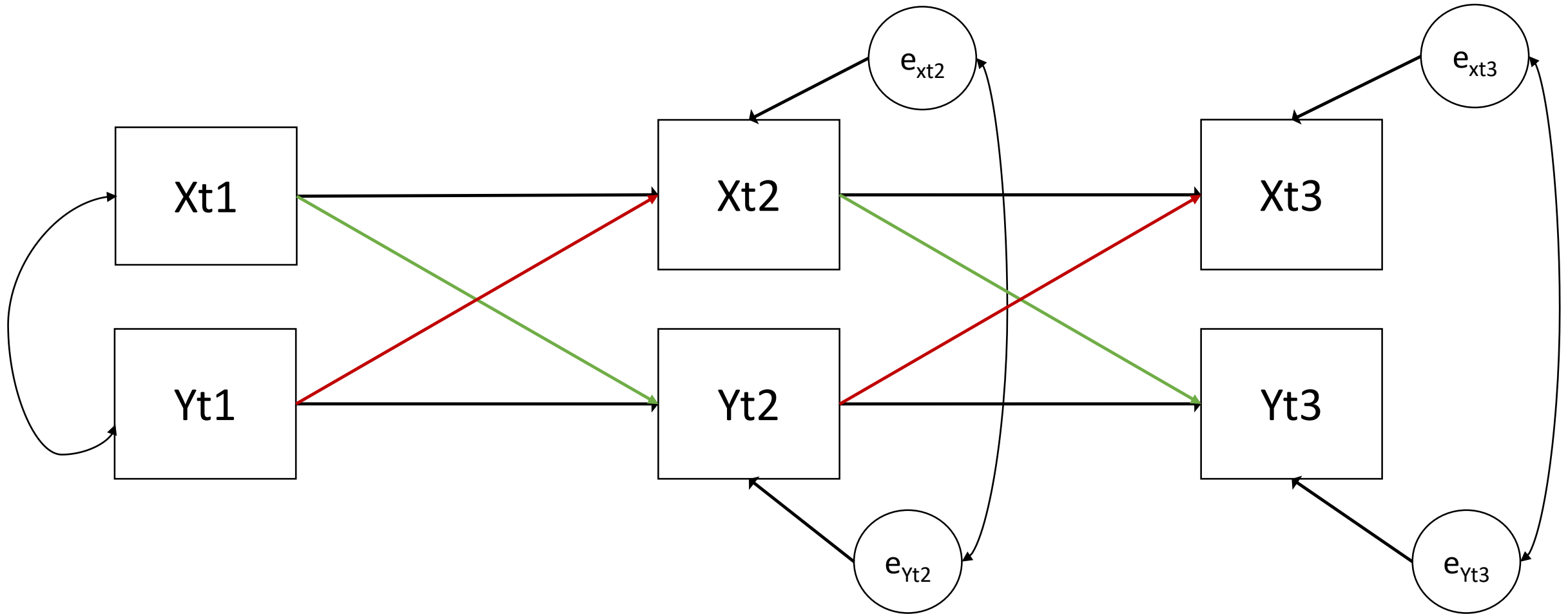
Mediation analysis

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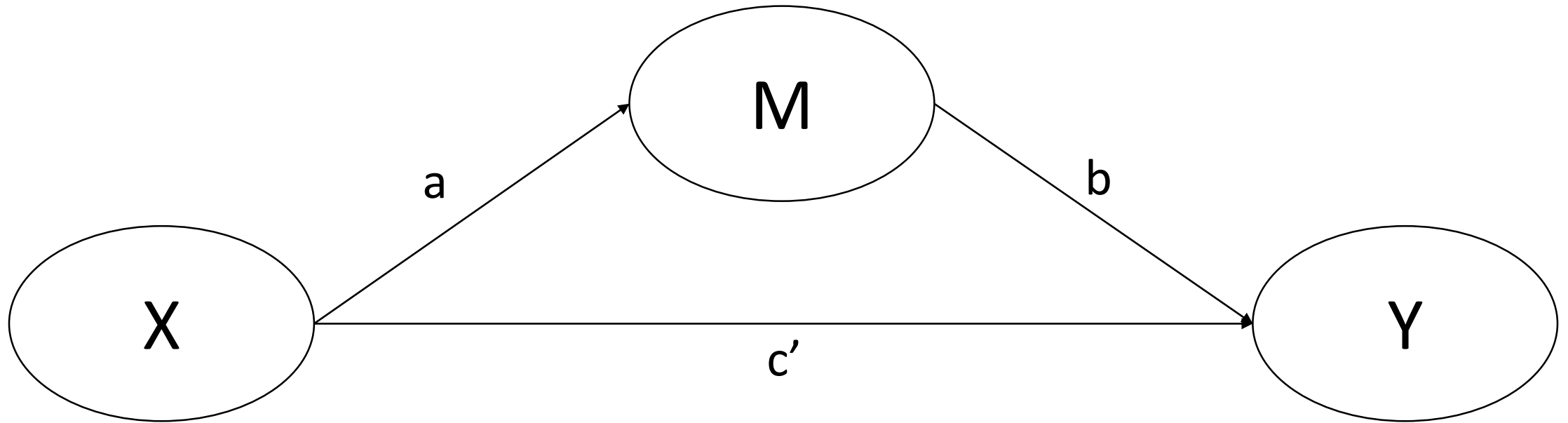
- Indirect effect = a*b
- Direct effect = c'
- Total effect (c) = Indirect + direct effect (a*b + c')

The moderator–**mediator** variable distinction in social psychological research: Conceptual, strategic, and statistical considerations.

RM Baron, DA Kenny - 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 ...

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 non-significant (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.

- http://afhayes.com/introduction-to-mediation-moderation-and-conditional-process-analysis.html

- For cross-lagged mediations, we need SEM.
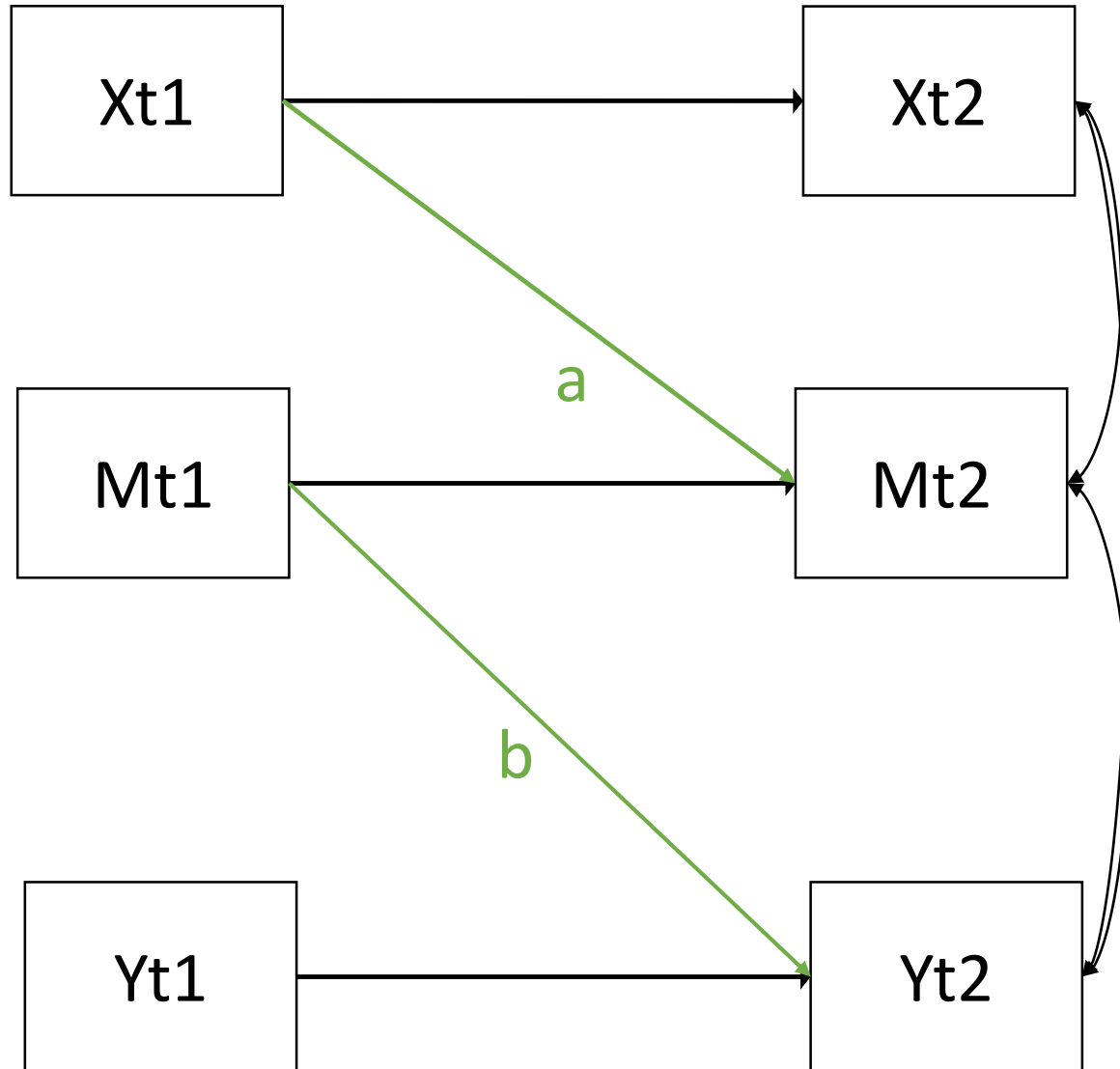
Half longitudinal model of mediation
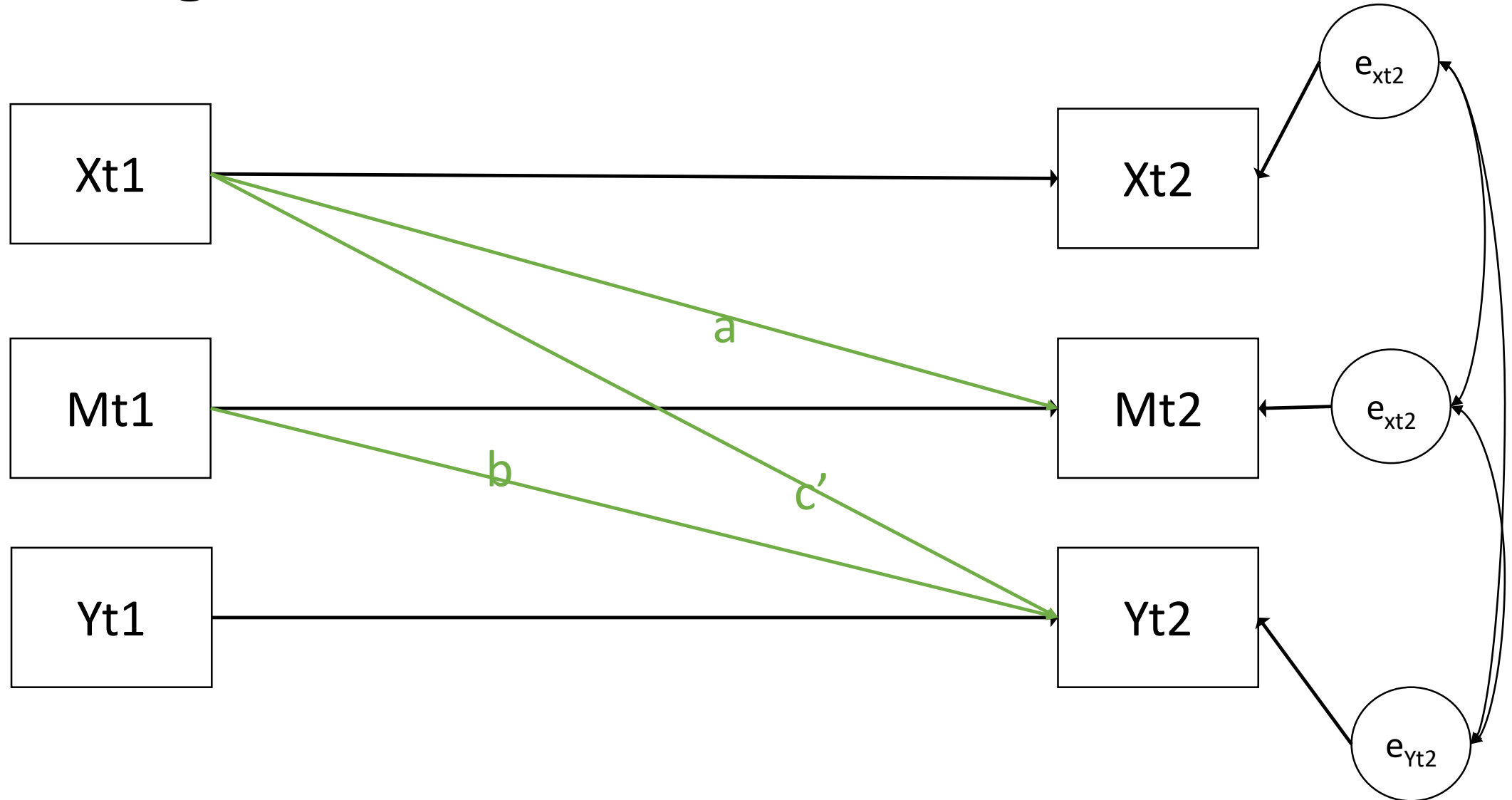
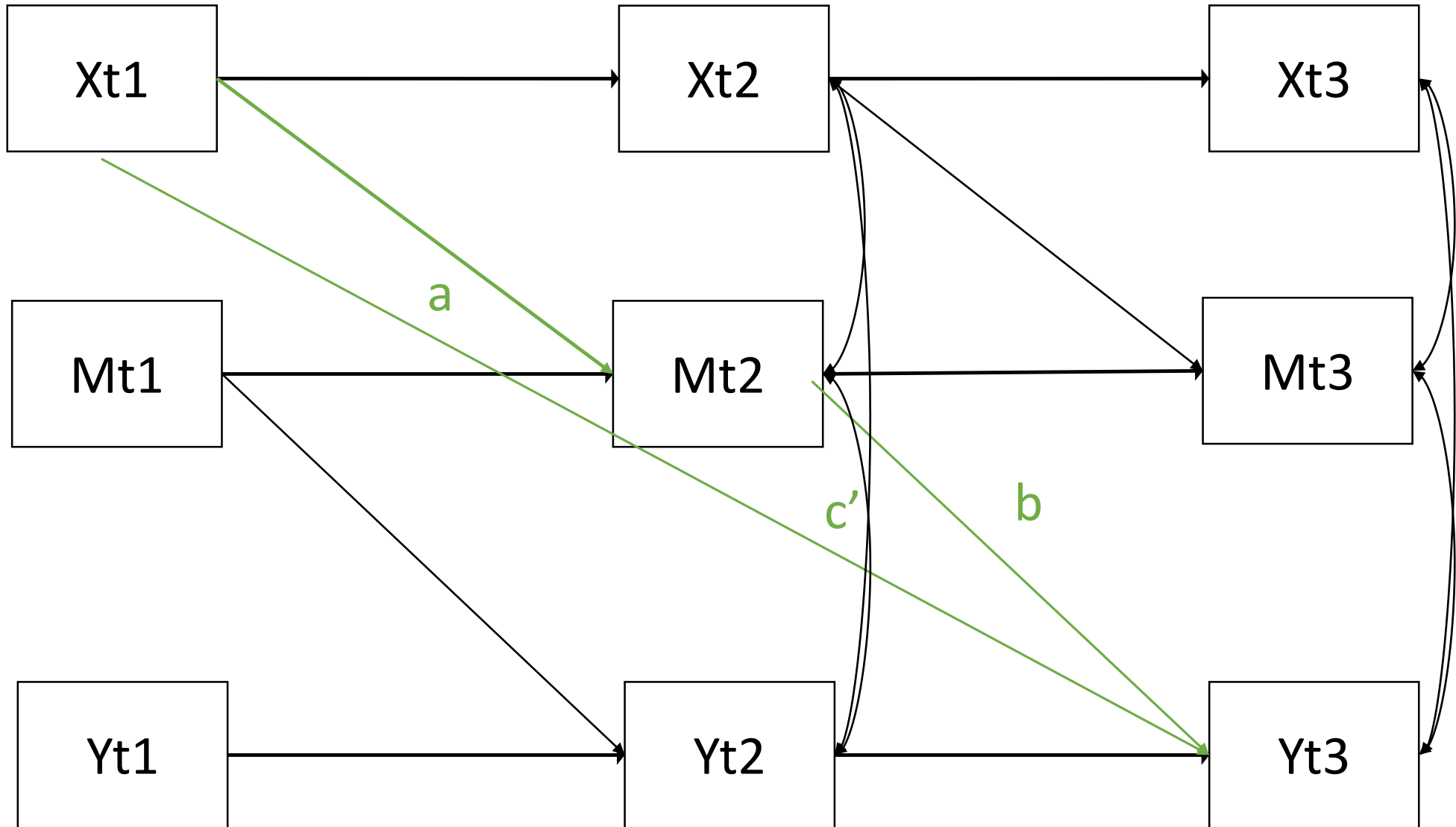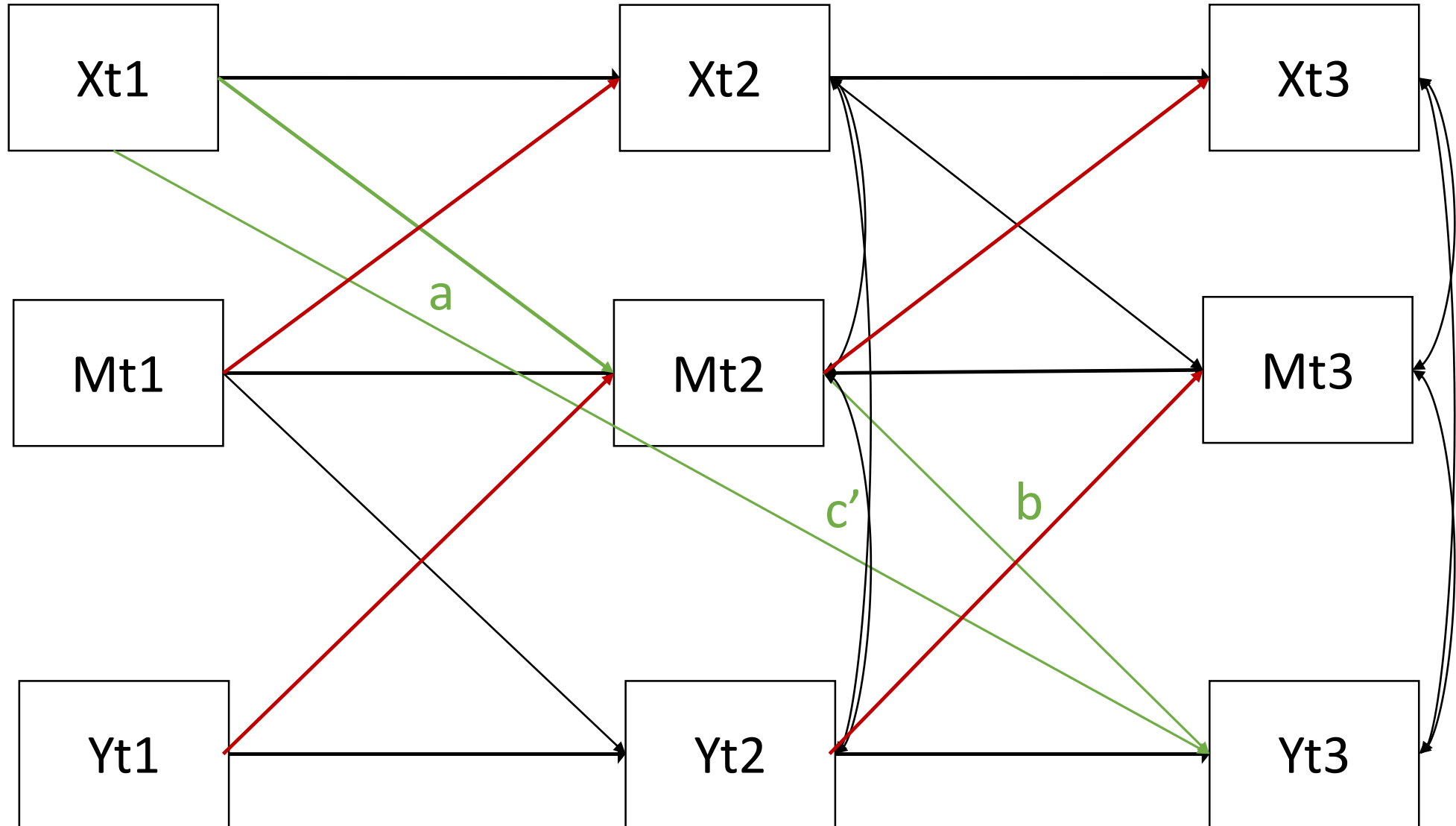Half longitudinal model of mediation
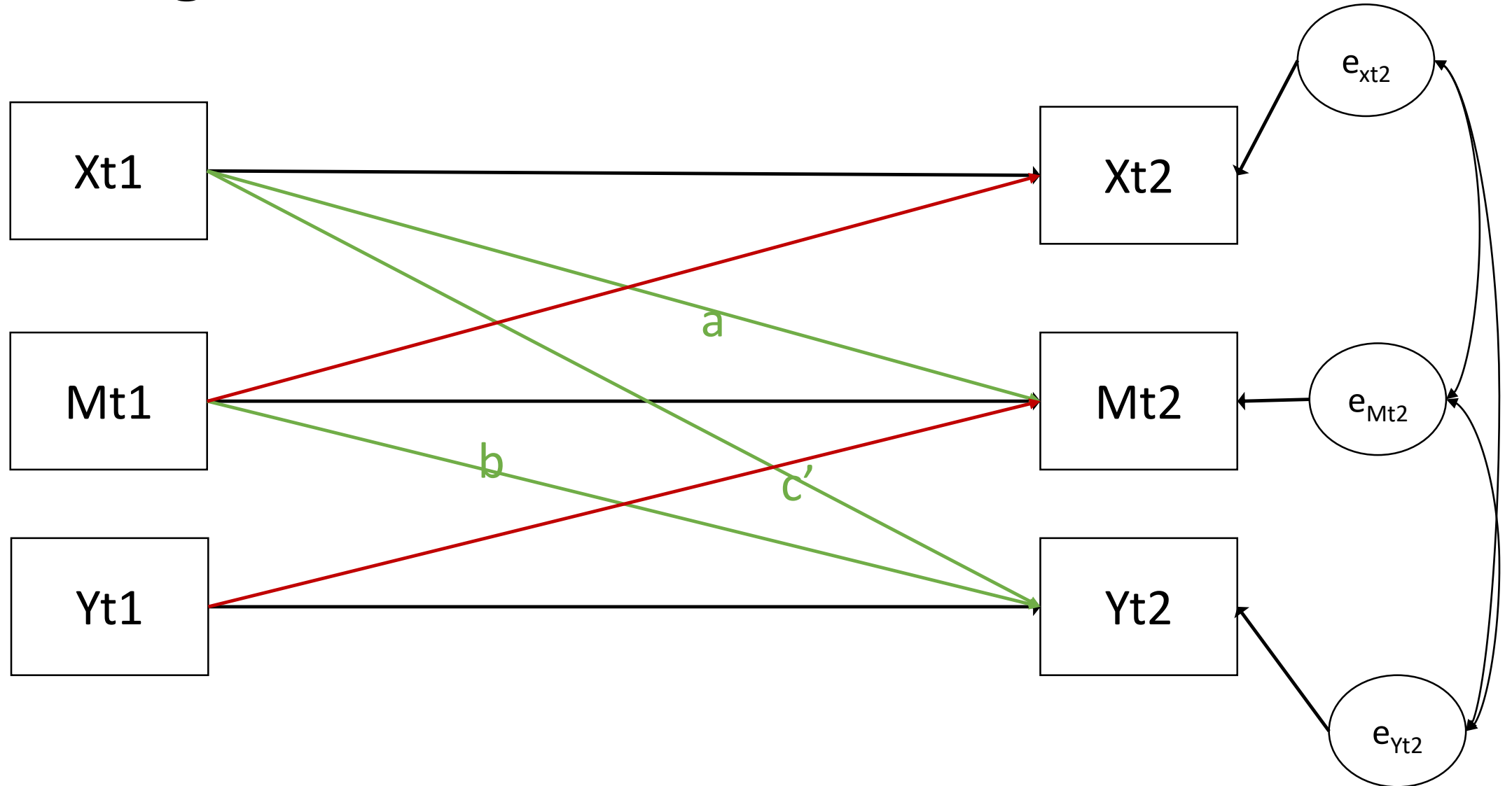
Full longitudinal mediation

Full longitudinal mediation

Full longitudinal mediation

References

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- Little, T. D., Bovaird, J. A., & Widaman, K. F. (2006). On the Merits of Orthogonalizing Powered and Product Terms: Implications for Modeling Interactions Among Latent Variables. *Structural Equation Modeling: A Multidisciplinary Journal, 13*(4), 497–519. https://doi.org/10.1207/s15328007sem1304_1

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