Latent Structure and Model Comparison

Number of Factors, Latent Structure, and Mediation

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Structural Equation Modeling
Psyc–8501–001

Overview

- Latent Structure.
- Examples of Latent Structure.
  1. Correlated Factors
  2. Structural Regression Models.
- Mediation.
  1. Manifest Variable Mediation.
  2. Latent Mediation.
- Constraints.
- Model Comparisons.

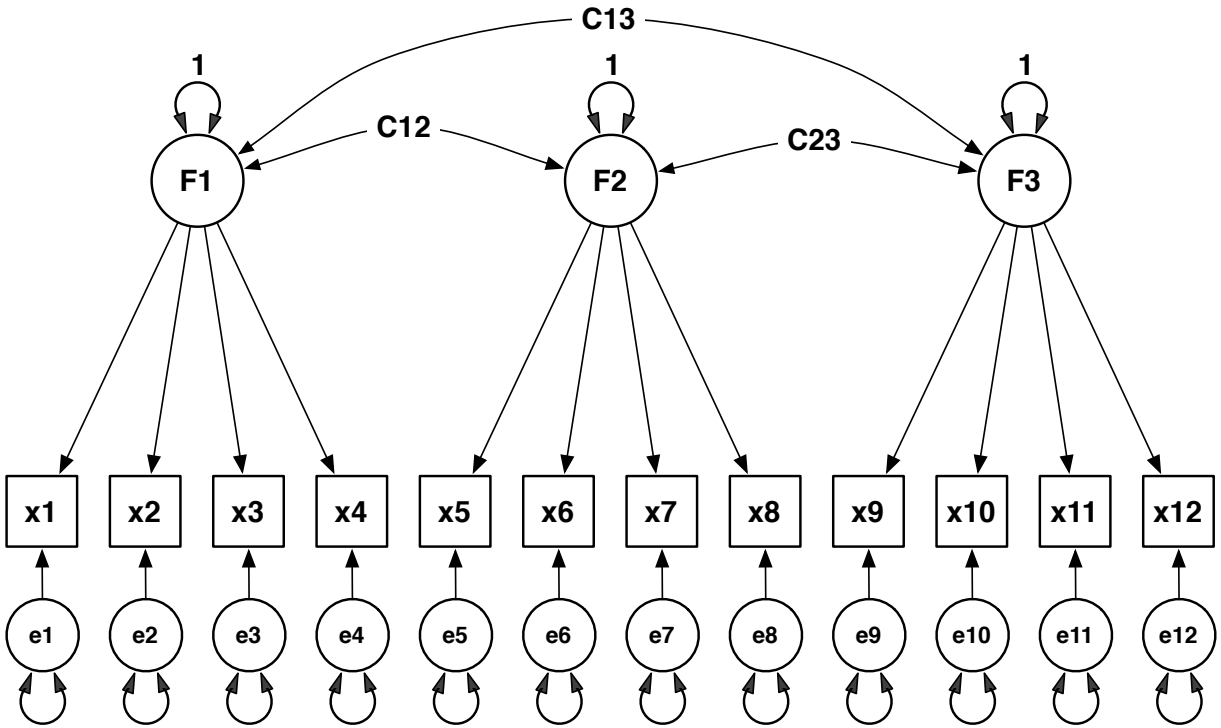
Latent Structure

- Latent constructs are identified from manifest variables.
- Theories can often be represented as a set of relations between latent variables.
- These relations may have characteristics such as
  1. Covariances between latent variables.
  2. Regression coefficients.
  3. Additional measurement models: Latent variables can be indicators for other latent variables.
- Path tracing rules apply to latent variables as well as manifest variables.
- The same **A** and **S** matrices may be constructed in order to fit the models.

Latent Structure

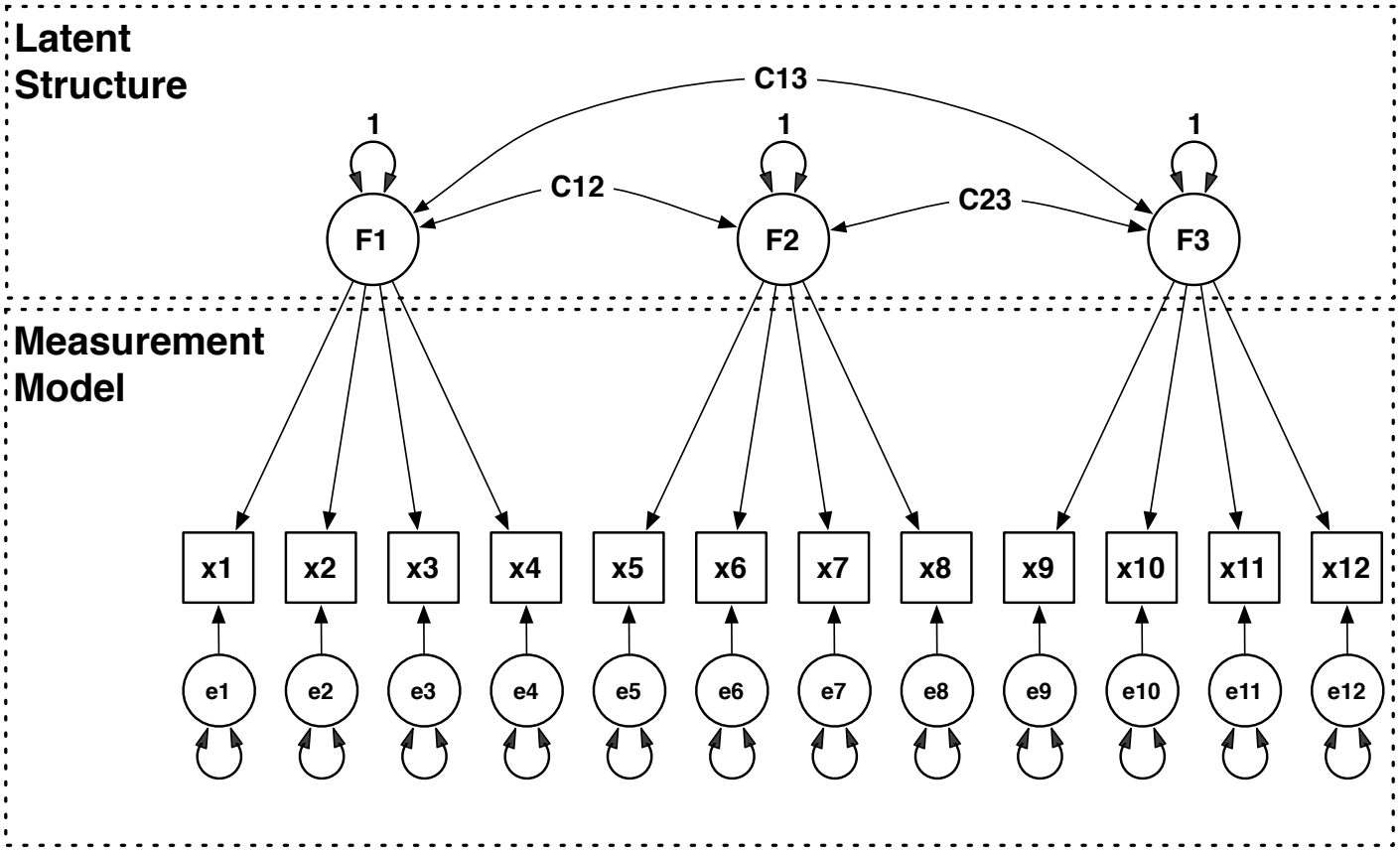
- In order to turn your theories into structural models:
  1. Decide on **several** ways your latent constructs may interrelate.
  2. Decide how your measured variables indicate the latent variables.
- Notice the emphasis on several models.
- This allows you to perform model comparisons.
- These comparisons are made between models with different constraints on the latent structure.
- A good strategy is to find a minimally complex and maximally complex model as well as the theories you are actually interested in.

Latent Structure



Three latent constructs each identified by four variables.

Latent Structure

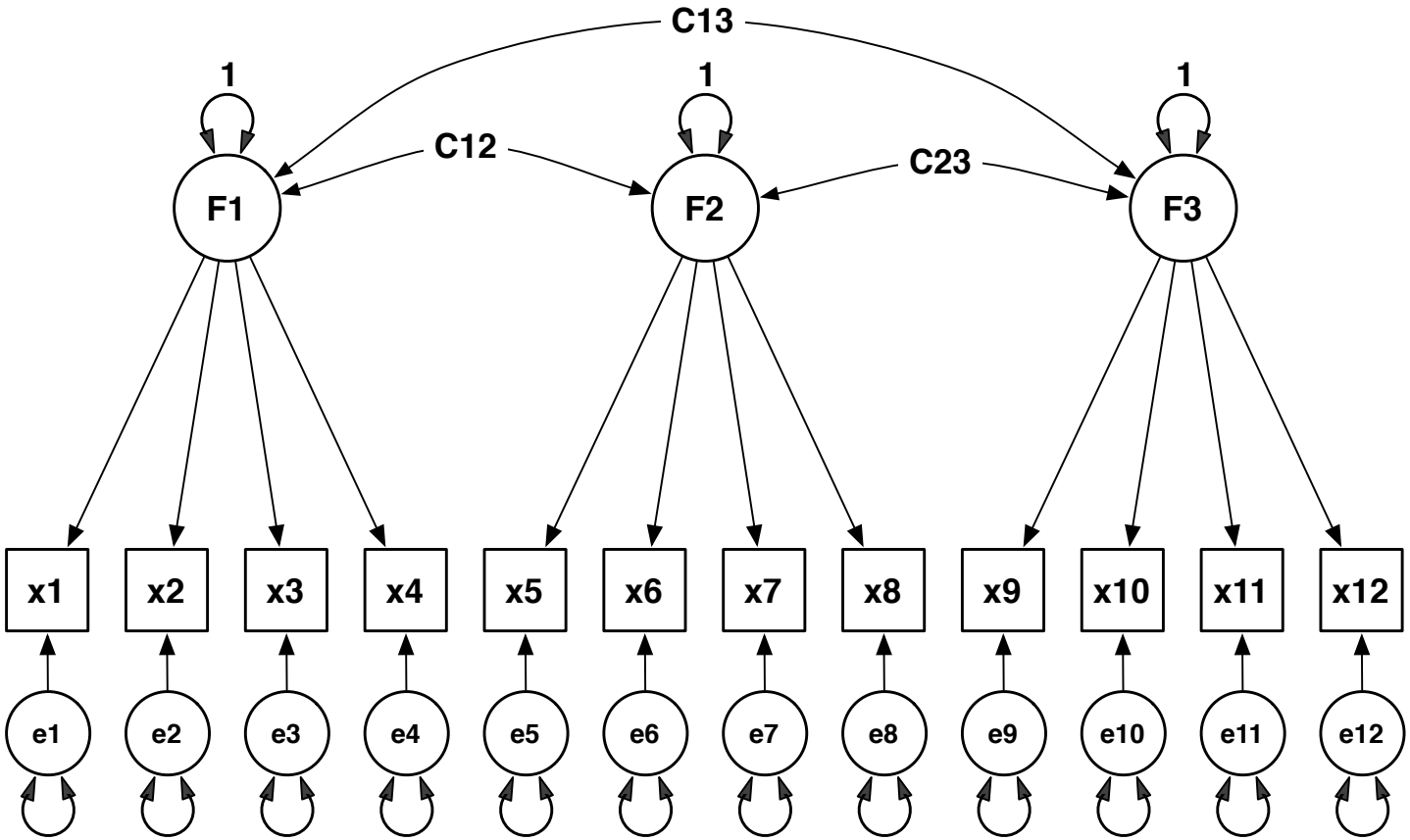


There is a covariance structure between the latent constructs.

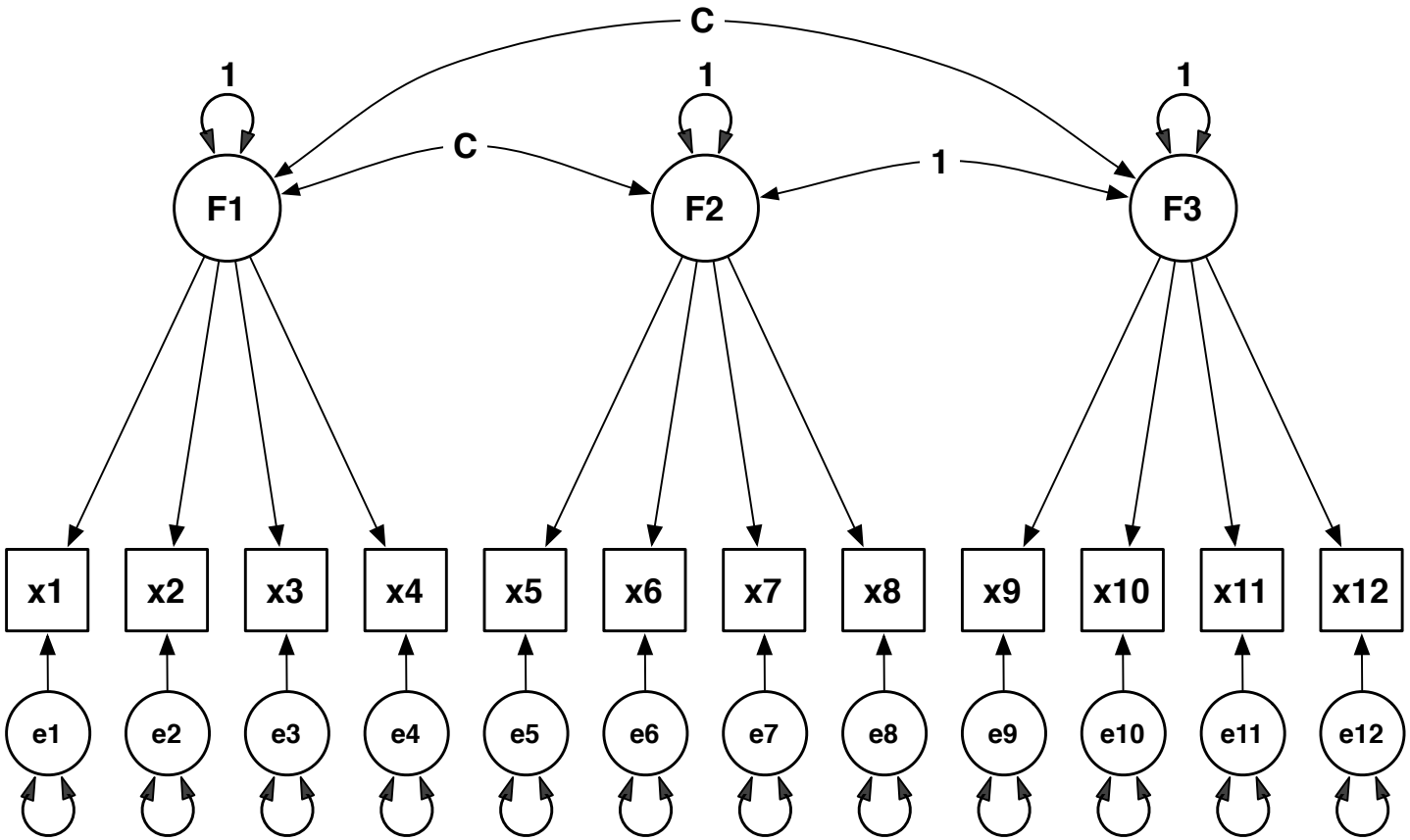
Latent Structure: Combining Scales

- Suppose you have three measurement scales that you have identified as each having a single factor.
- You may wonder how the factors for these scales are correlated.
- You may also wonder if you can collapse two scales into a single factor.
- One way to examine this is by placing constraints on the factor intercorrelations.

Latent Structure: Combining Scales



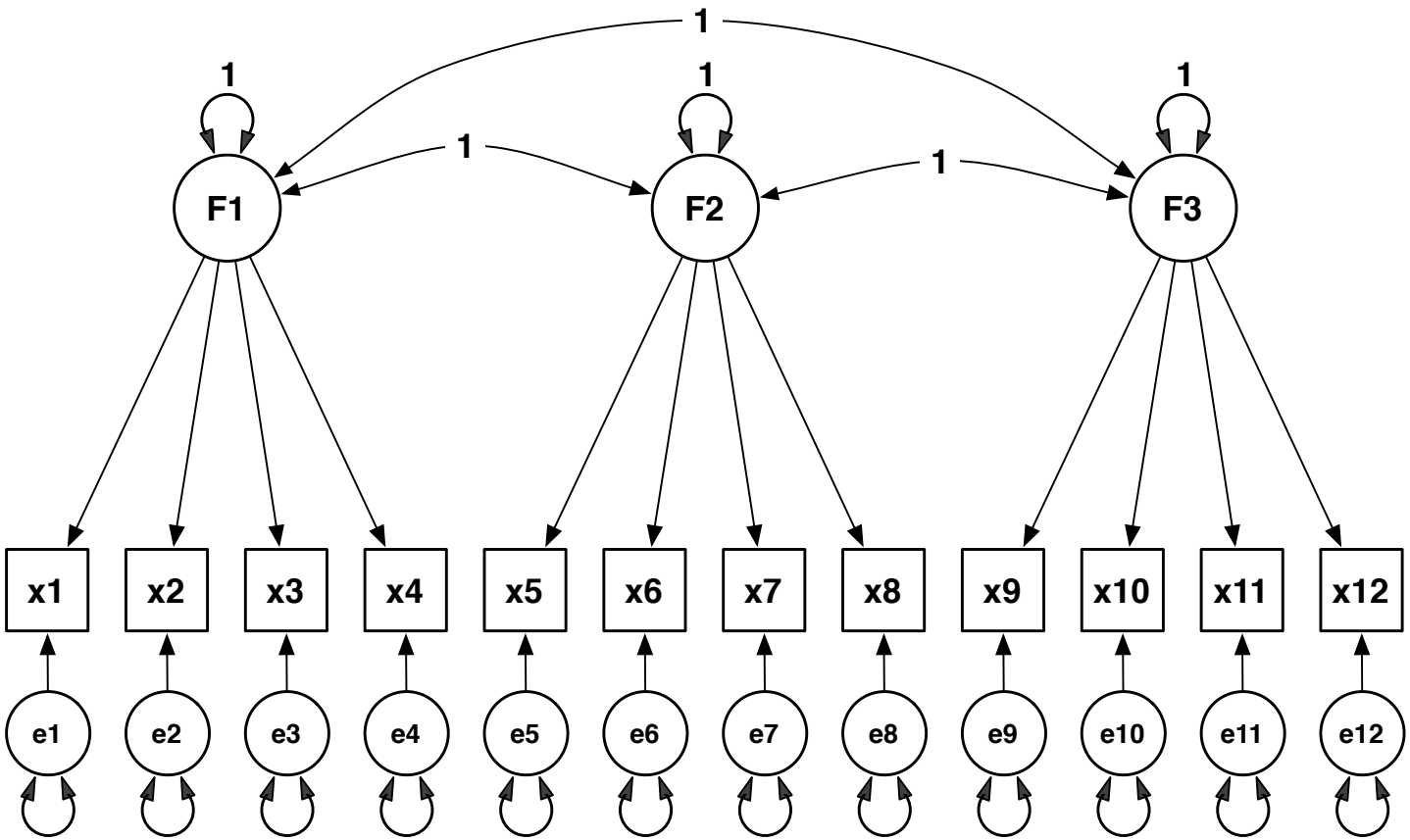
Latent Structure: Combining Scales



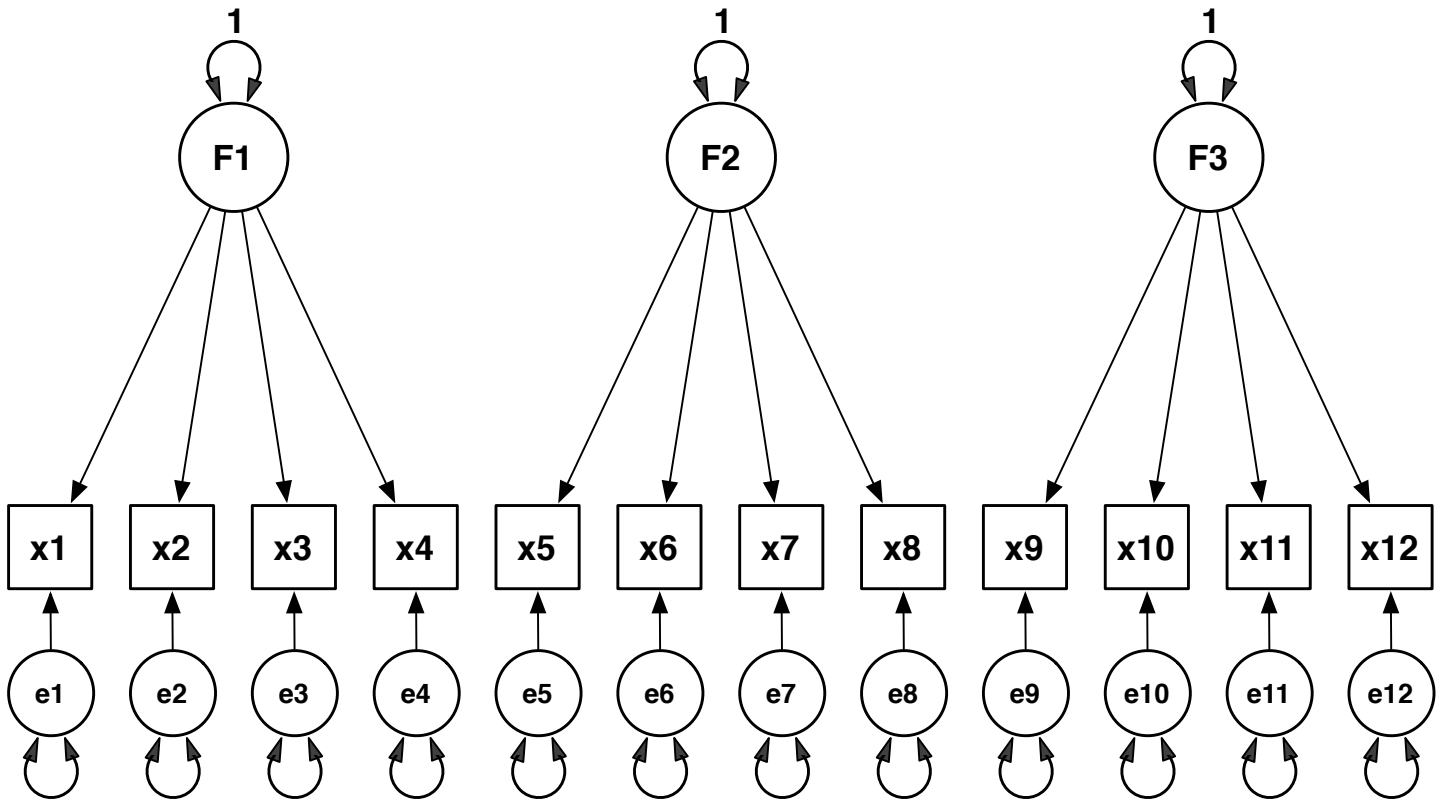
Example R Scripts

- We will test two data sets to see if scales can be combined:
  - ThreeFactorScale1Test.R
  - ThreeFactorScale2Test.R.

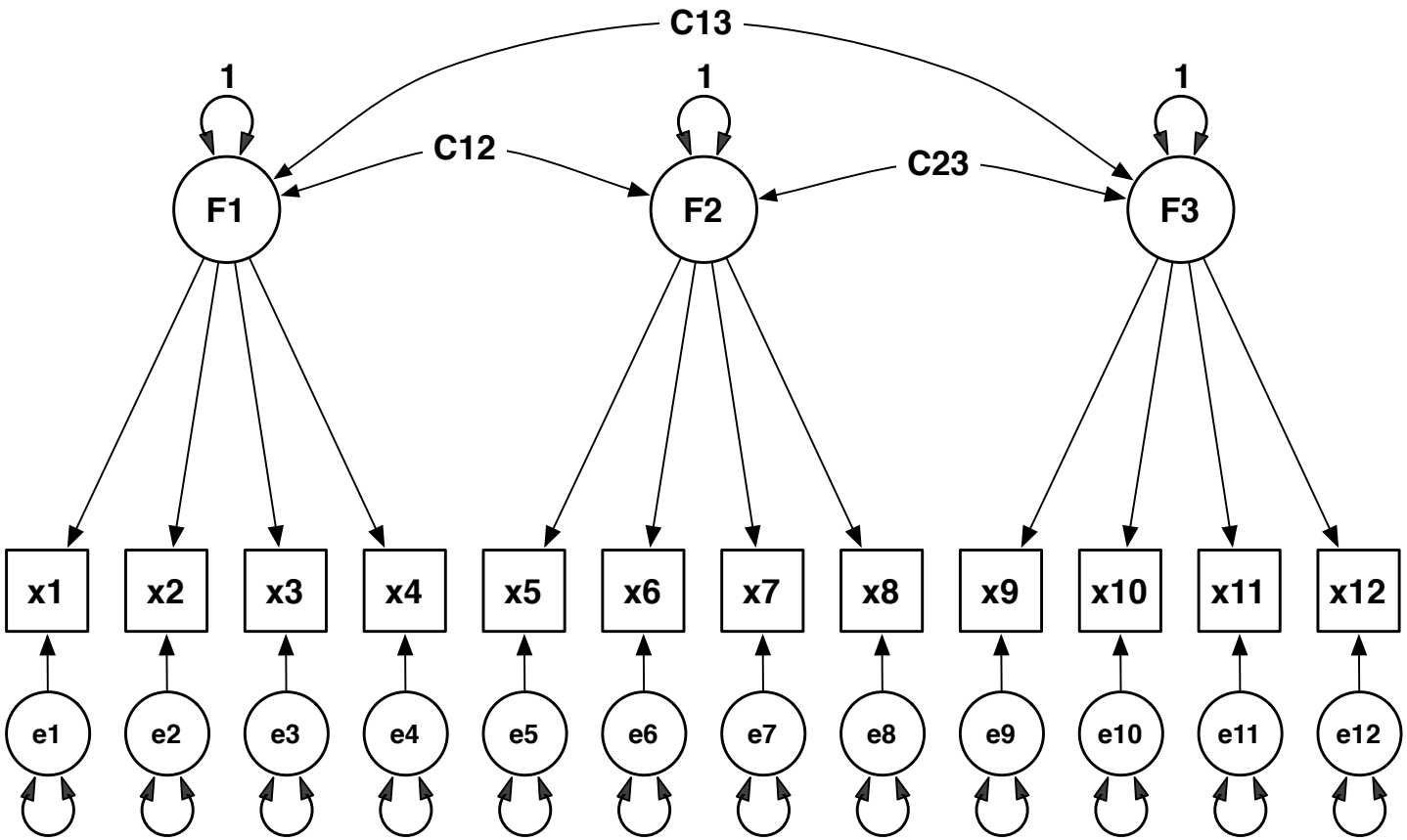
Latent Structure: One Factor



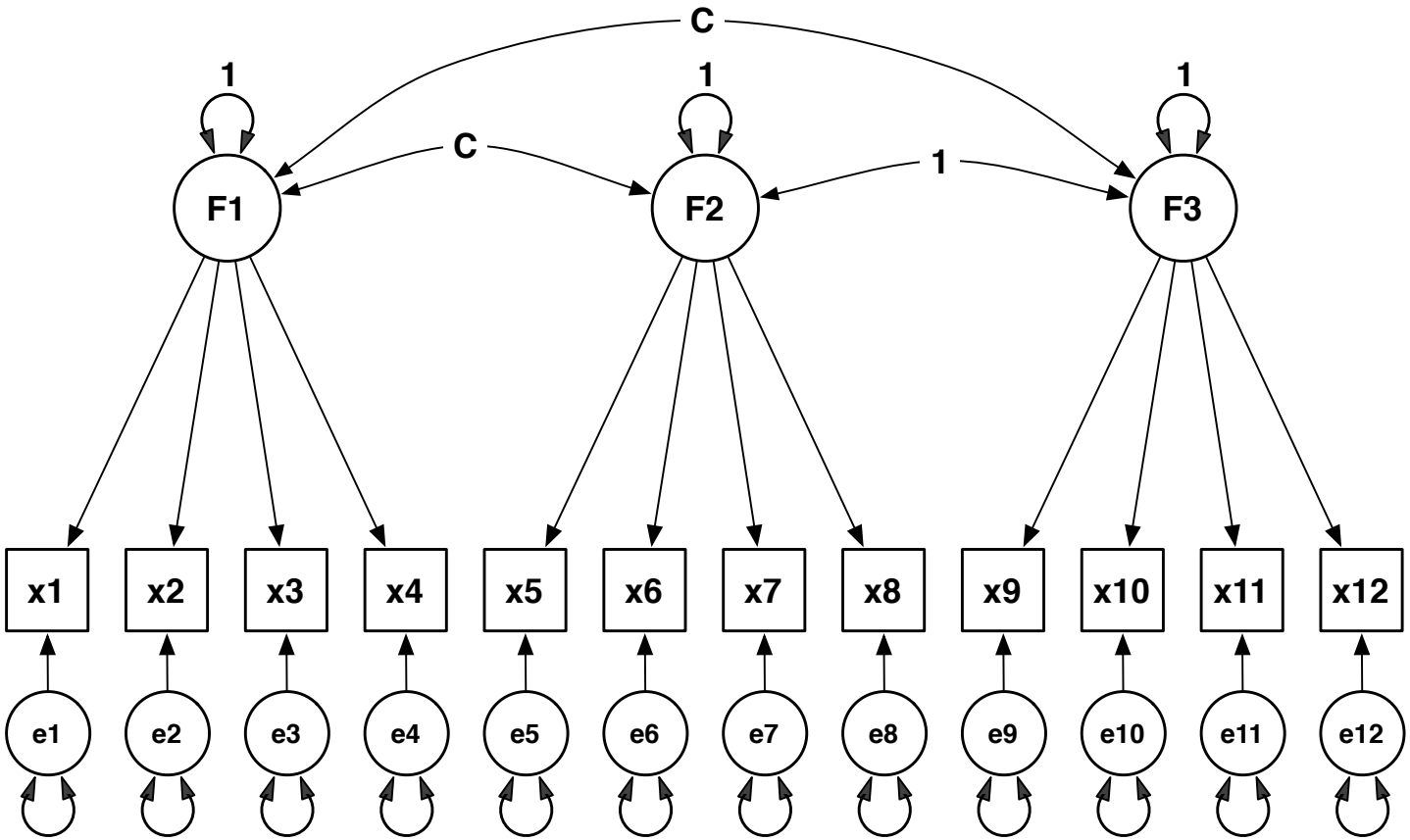
Latent Structure: Three Orthogonal Factors



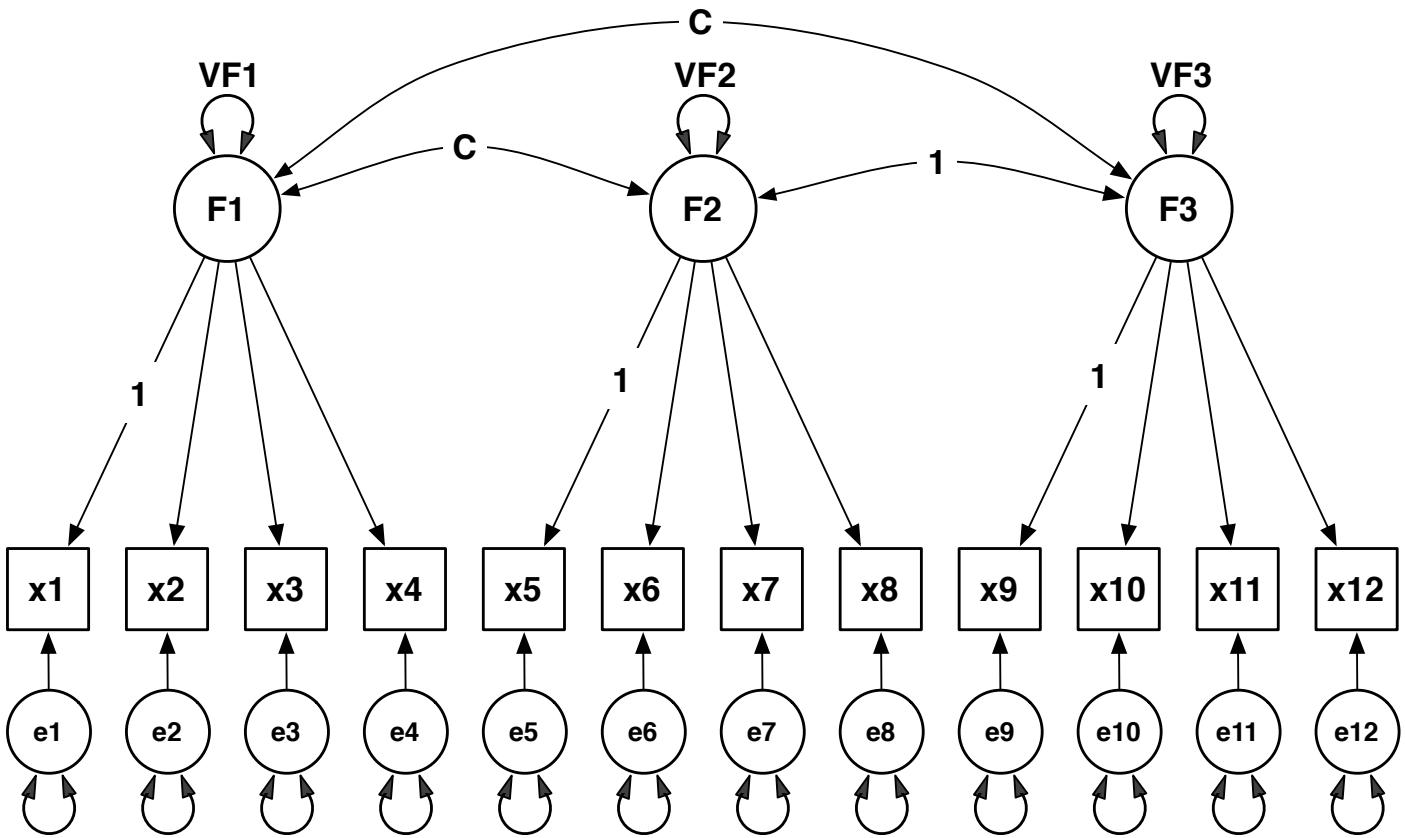
Latent Structure: Three Correlated Factors



Latent Structure: Combining Factors 2 and 3



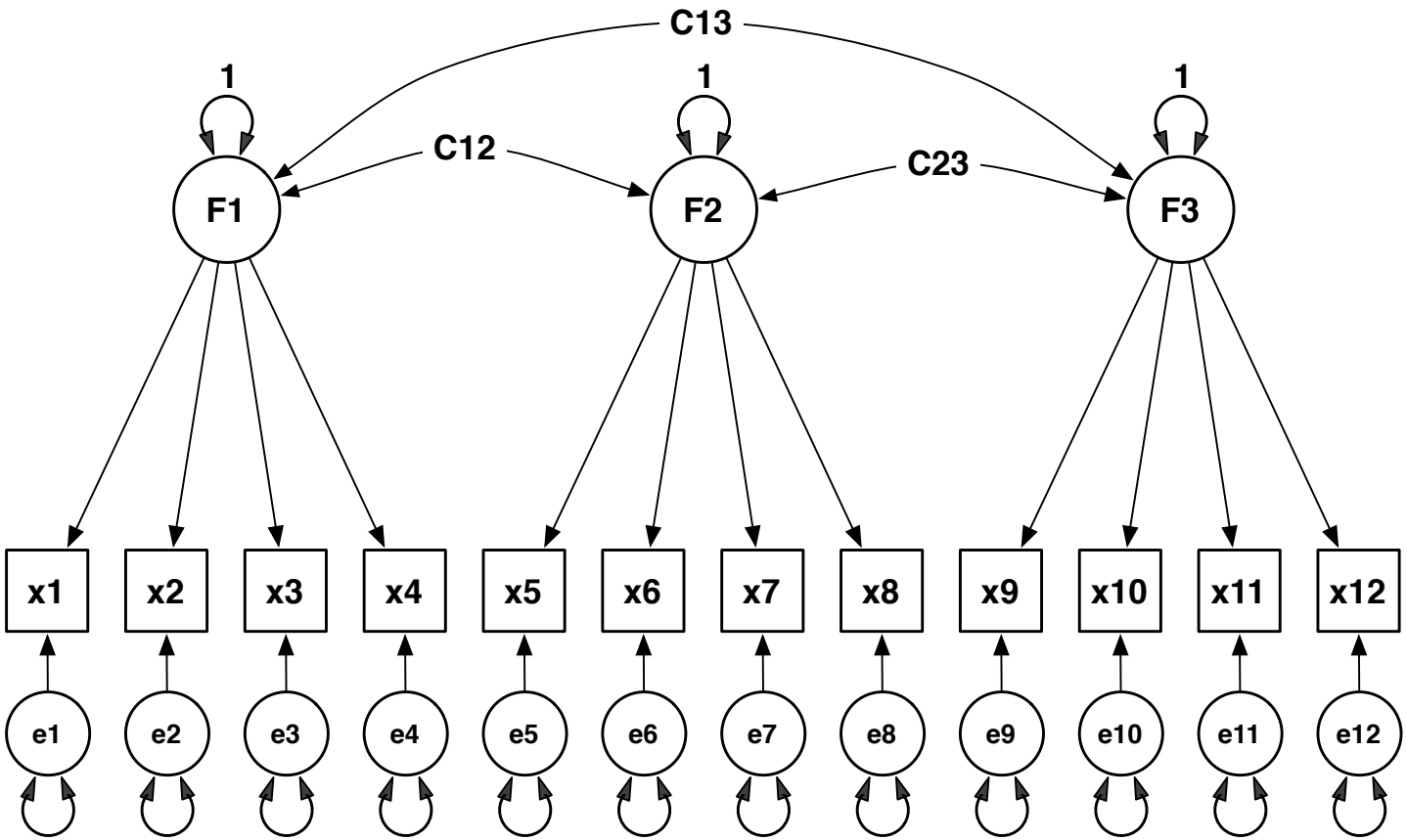
What is Wrong with This Diagram?



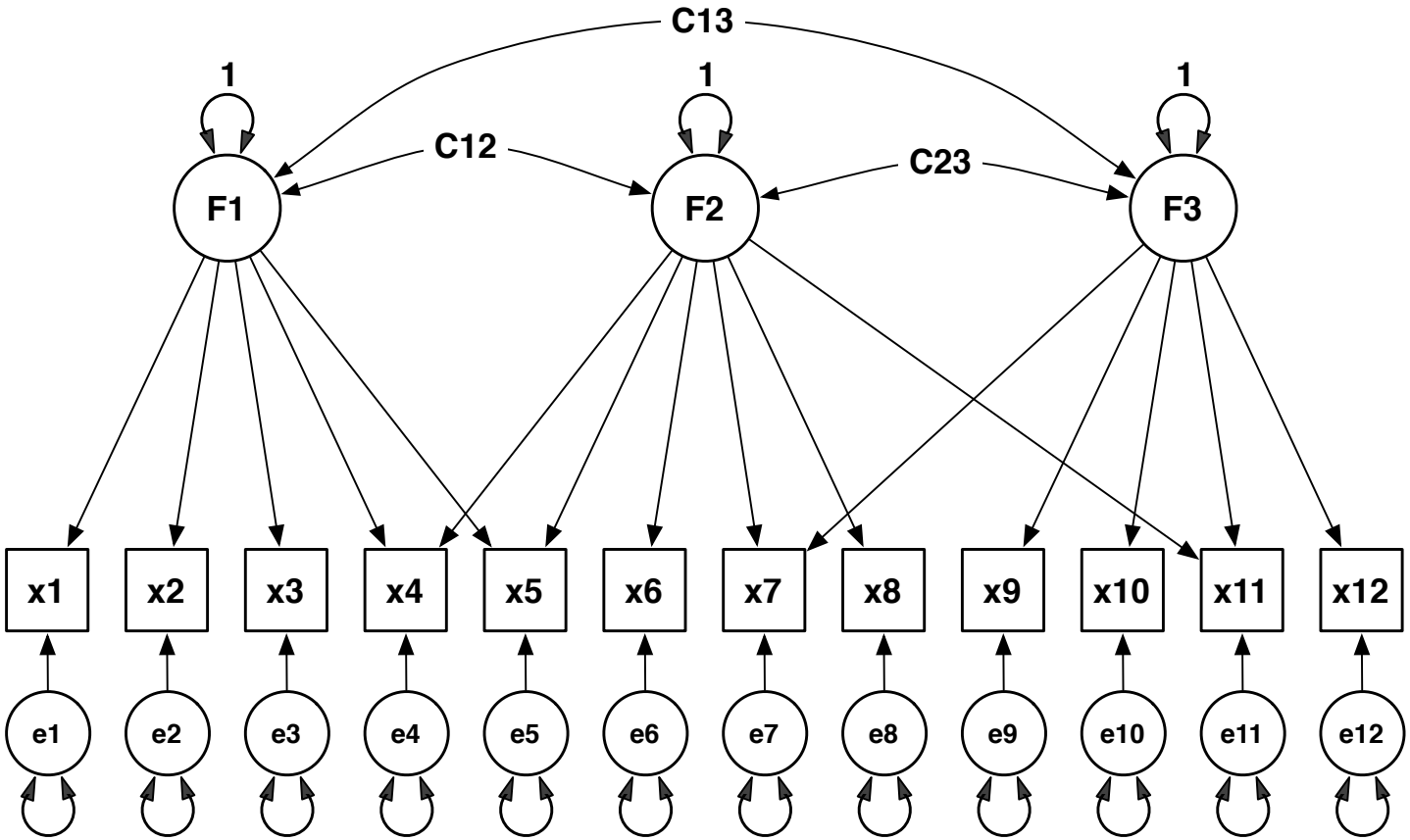
Latent Structure: Crossed Loadings

- Some times simple structure is not obtainable.
- In this case we might have *crossed loadings*.
- The idea is that some indicators have a special relationship with more than one factor.
- This can be specified, but it leads to more complicated patterns of covariance between indicators.

Latent Structure: Crossed Loadings



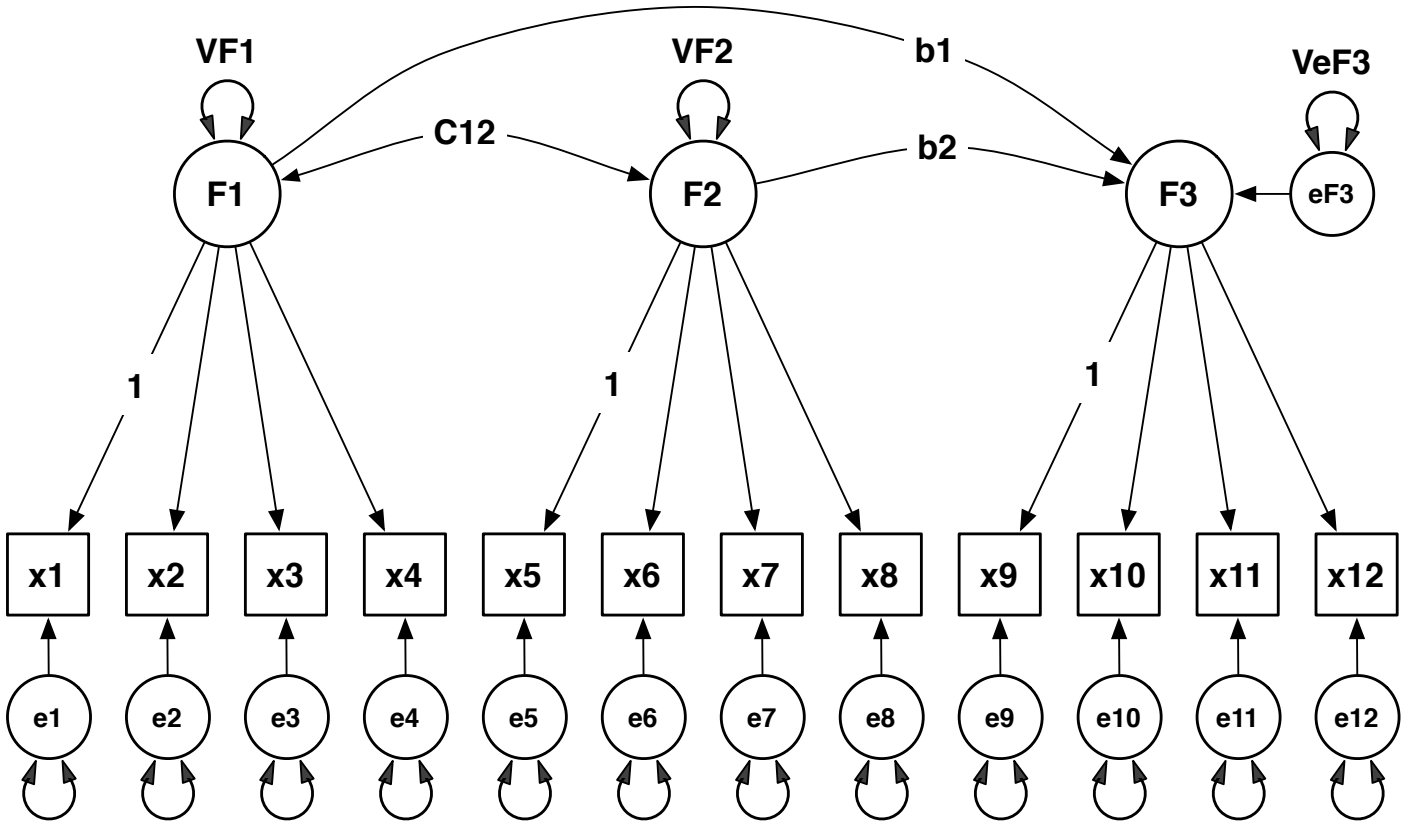
Latent Structure: Crossed Loadings



Latent Structure: Structural Regression Models

- One of the most common models is where one latent construct is predicted by one or more other latent constructs.
- There are many variants on this type of model.
- Let's consider latent structural multiple regression.

Latent Structure: Structural Regression Models



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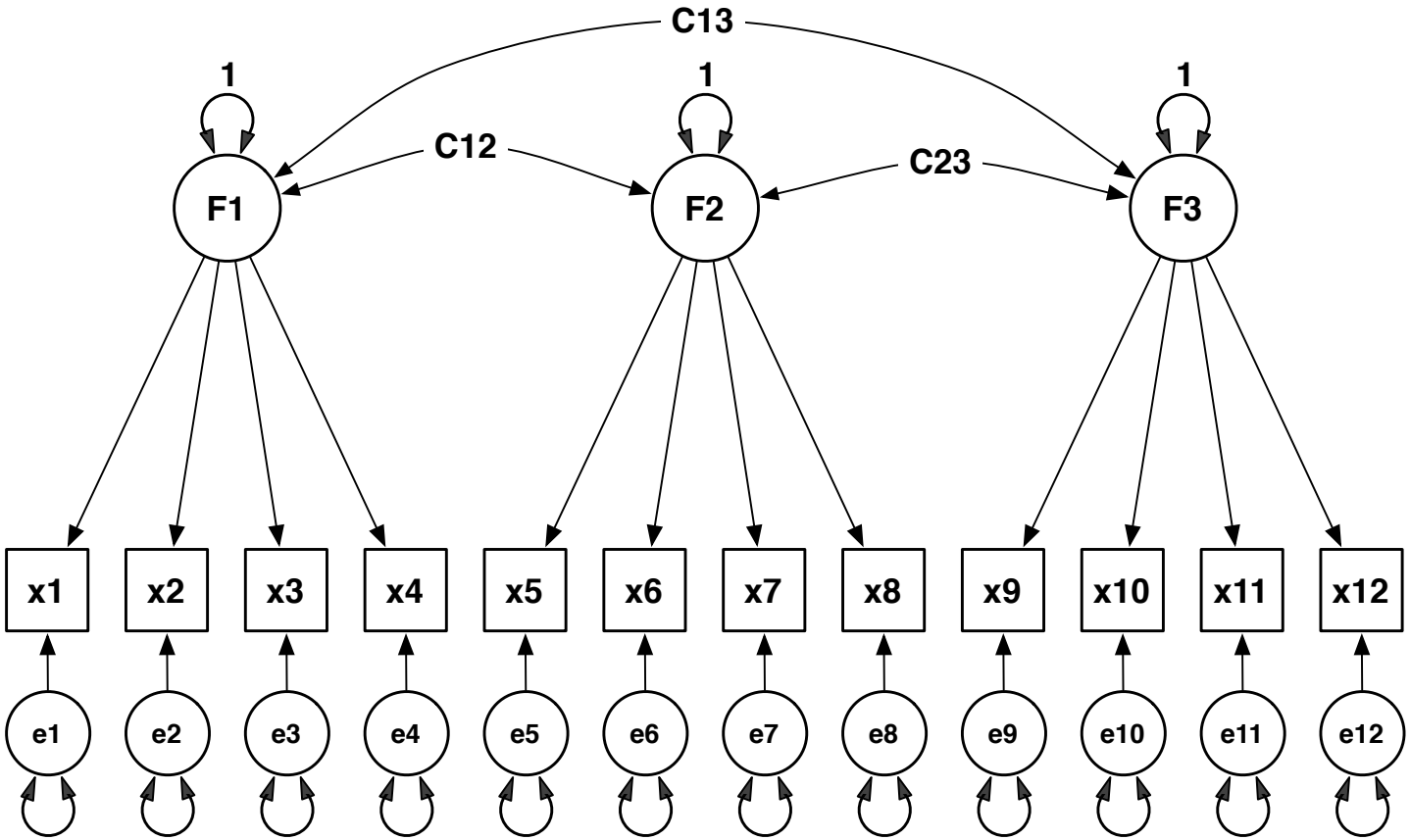

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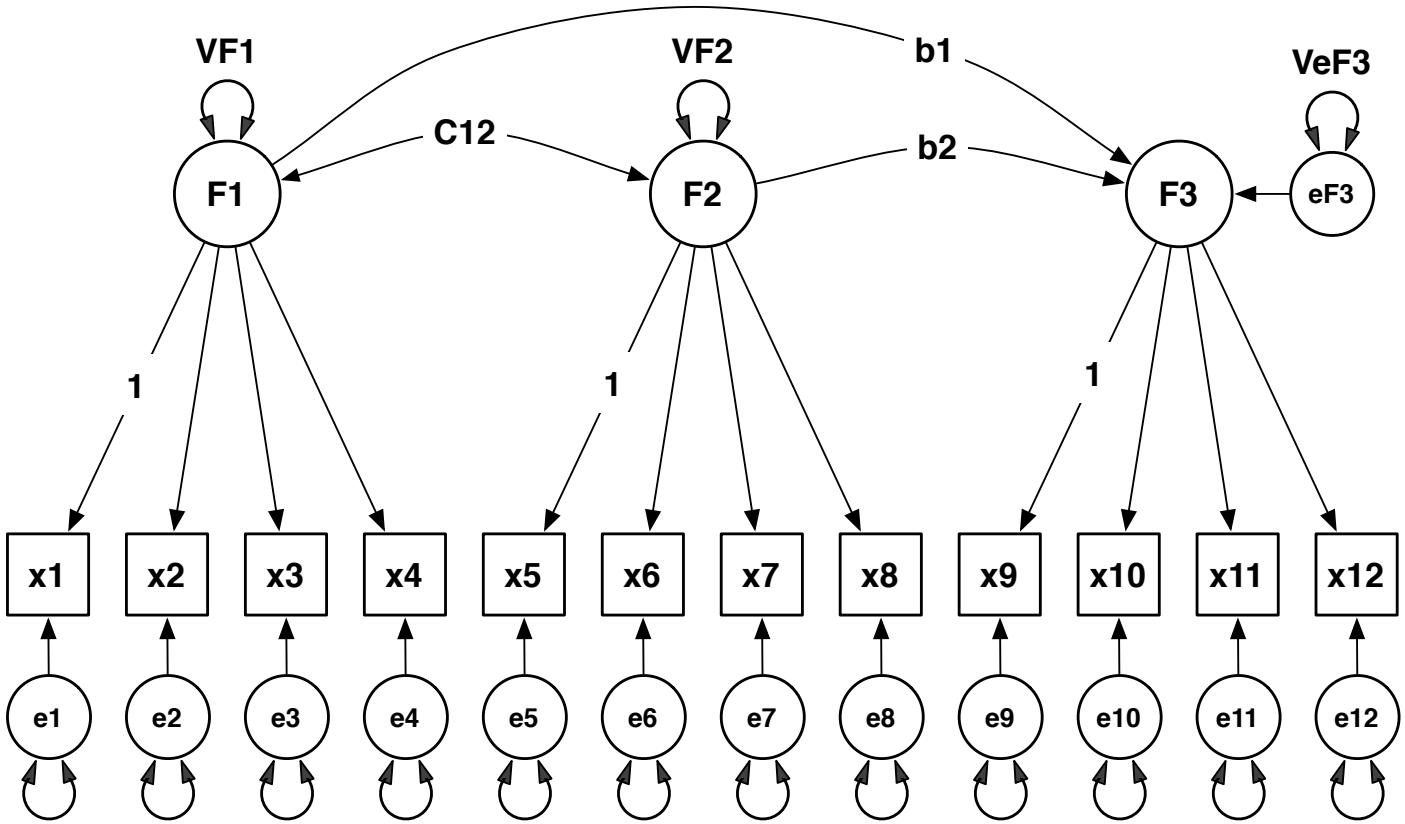
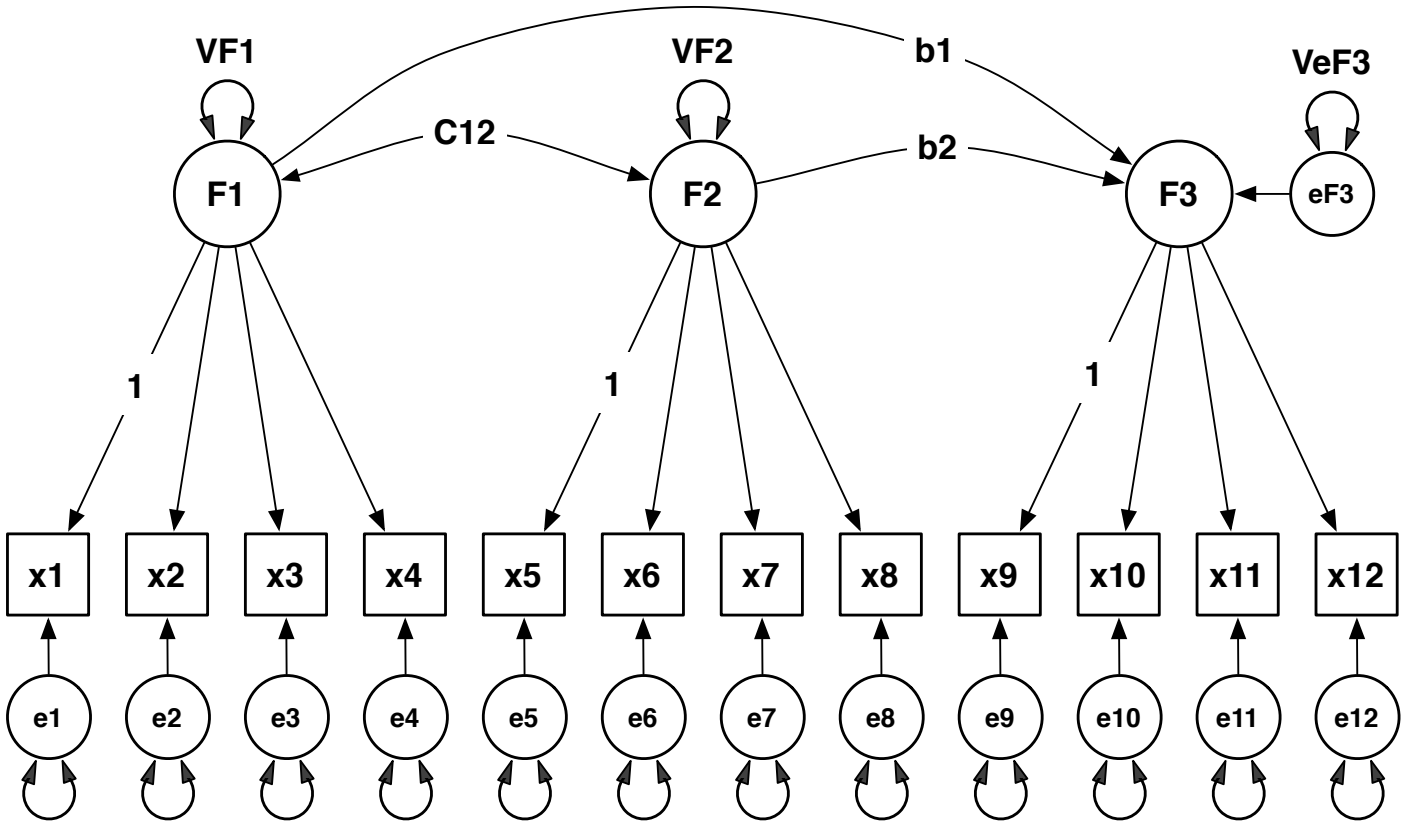


Example R Scripts

- We will test two data sets to see how latent multiple regression works:
  - ThreeLatentMultipleRegTest1.R
  - ThreeLatentMultipleRegTest2.R.

Latent Structure: Structural Regression Models



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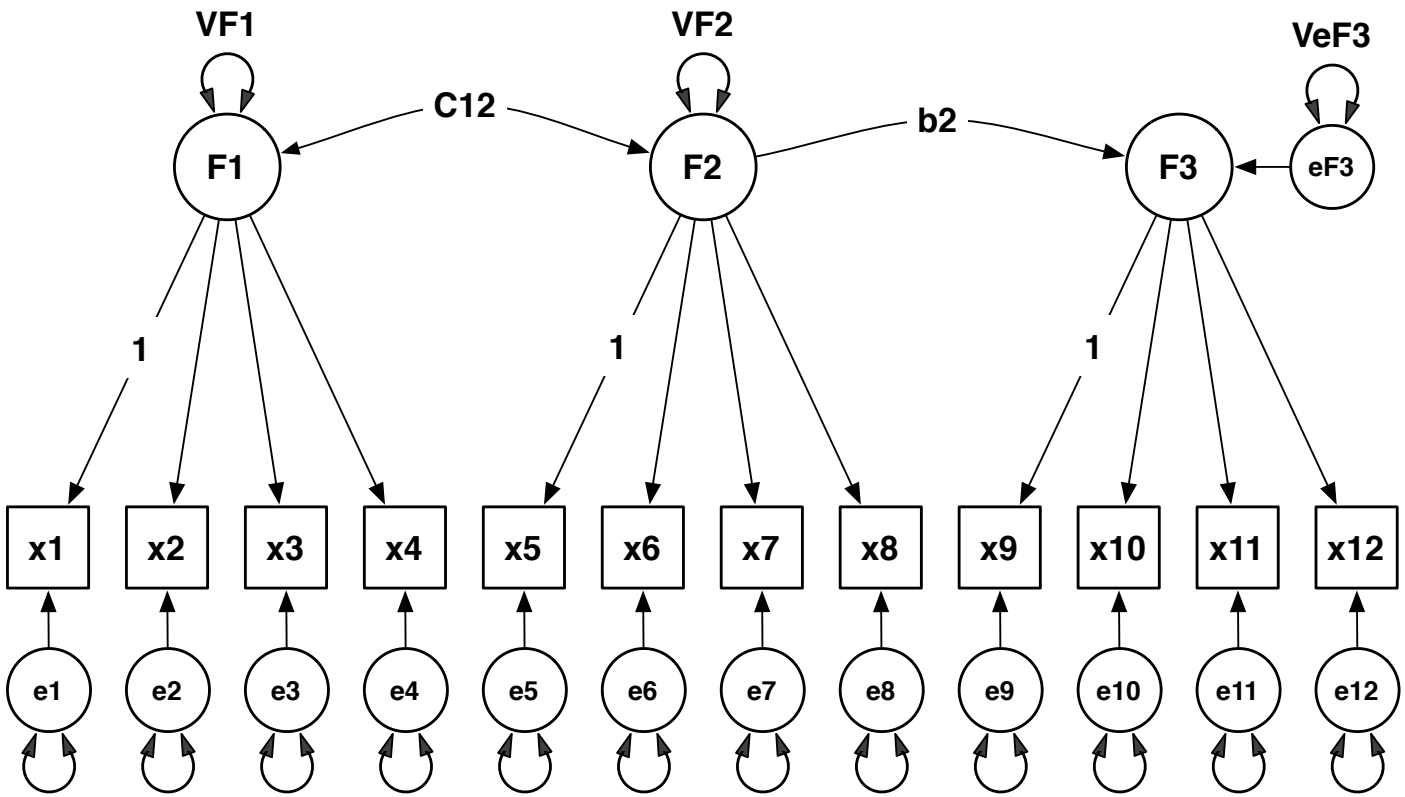
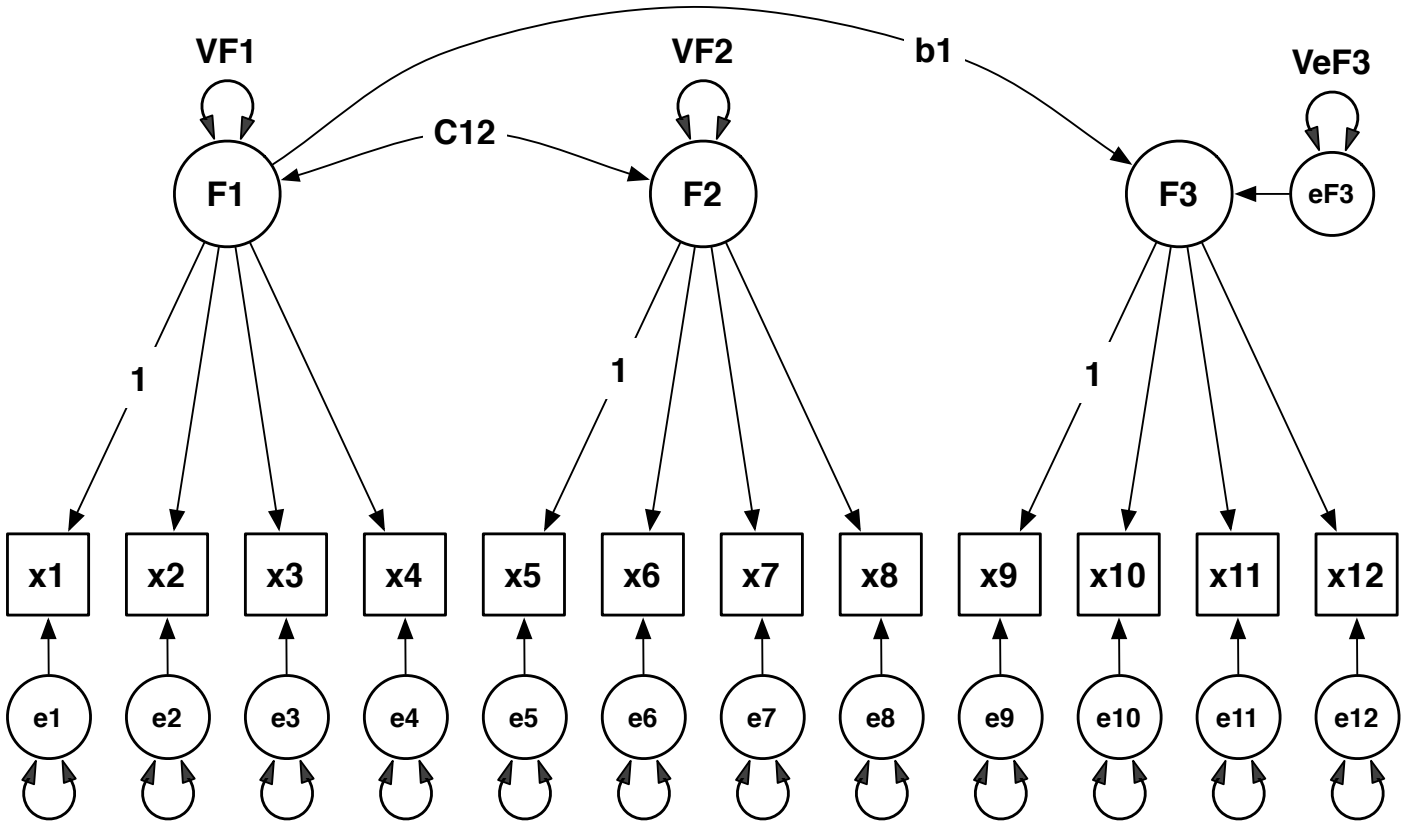


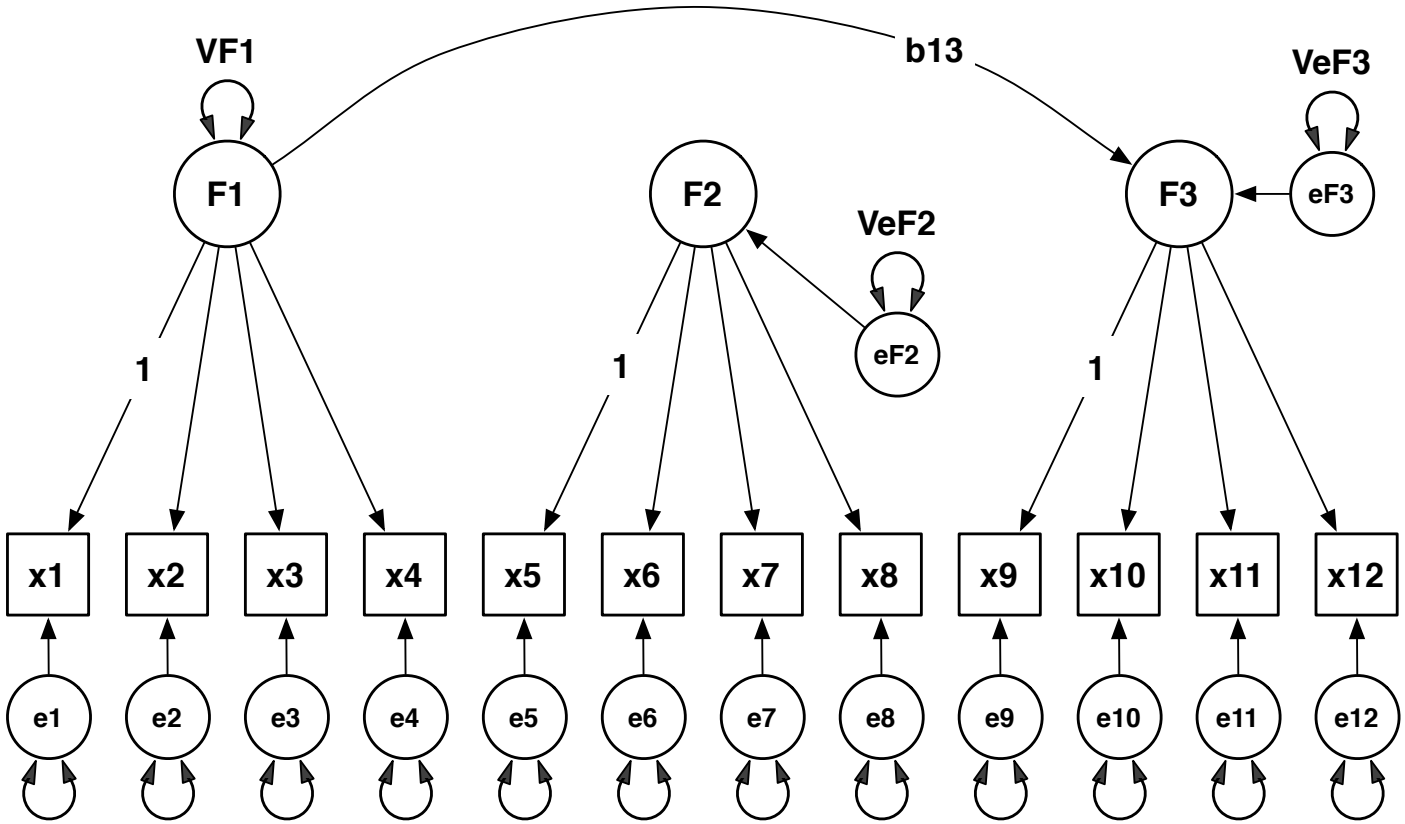
Latent Structure: Structural Regression Models



Mediation Models

- Mediation suggests that the effect of a variable X on Y is indirect through an intermediate variable Z.
- This is a very appealing type of model as it fits many theories.
- One of the most cited papers of all time is about this idea (Baron & Kenny, 1986).
- But you should also read a cautionary tale about mediation (Cole & Maxwell, 2003).
- Let's see how a mediation model is constructed.

Latent Structure: Latent Mediation Models



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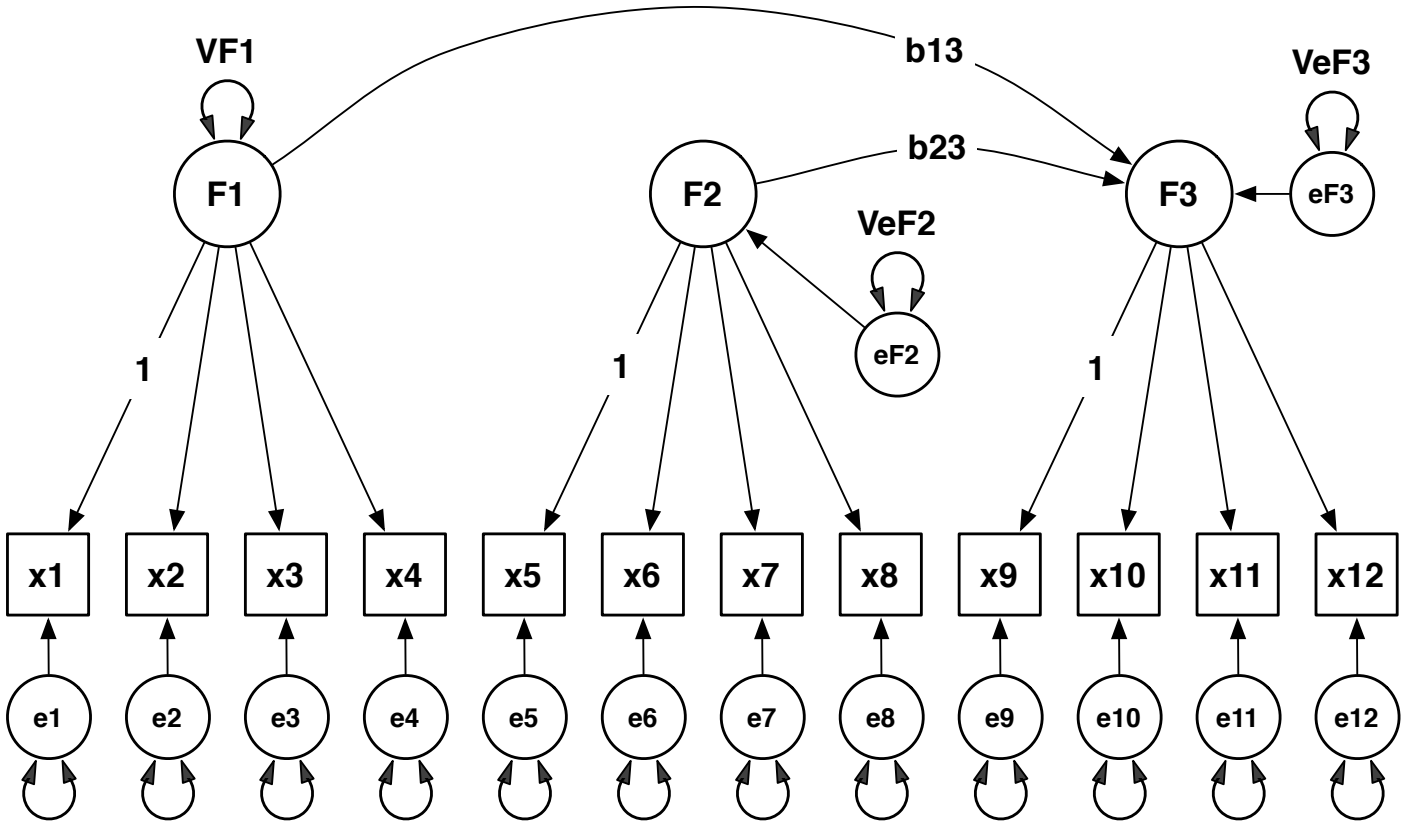
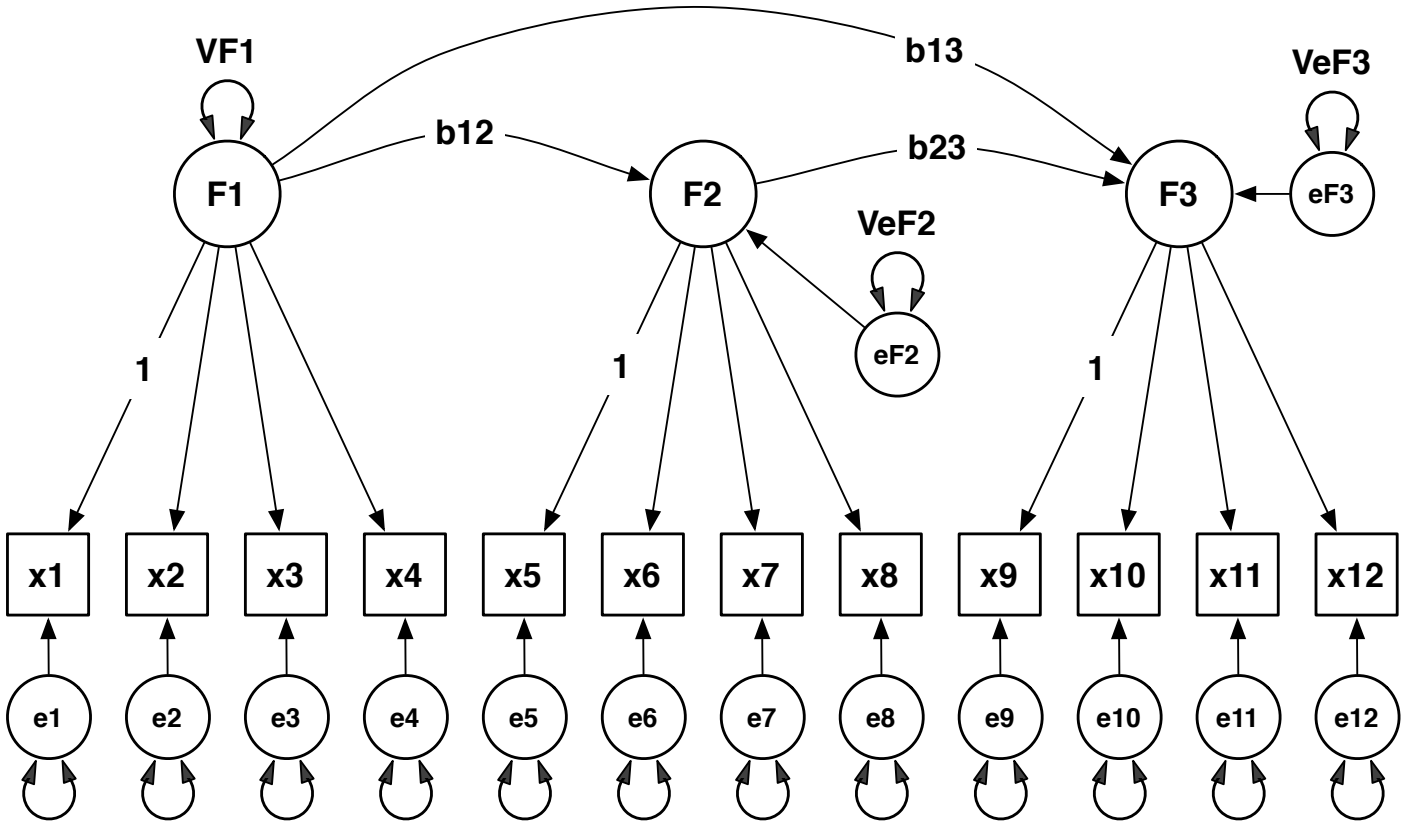
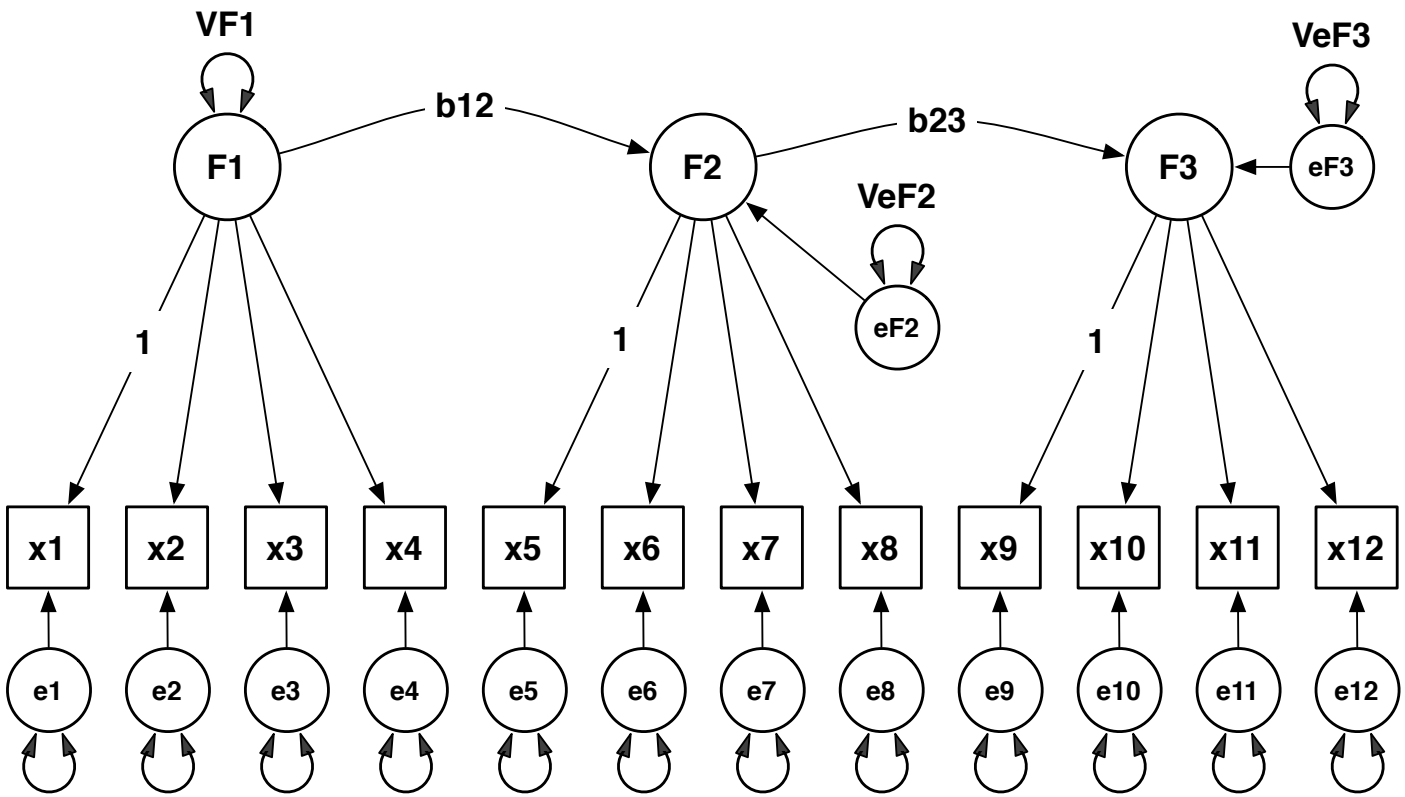


Latent Structure: Partial Mediation



Latent Structure: Full Mediation



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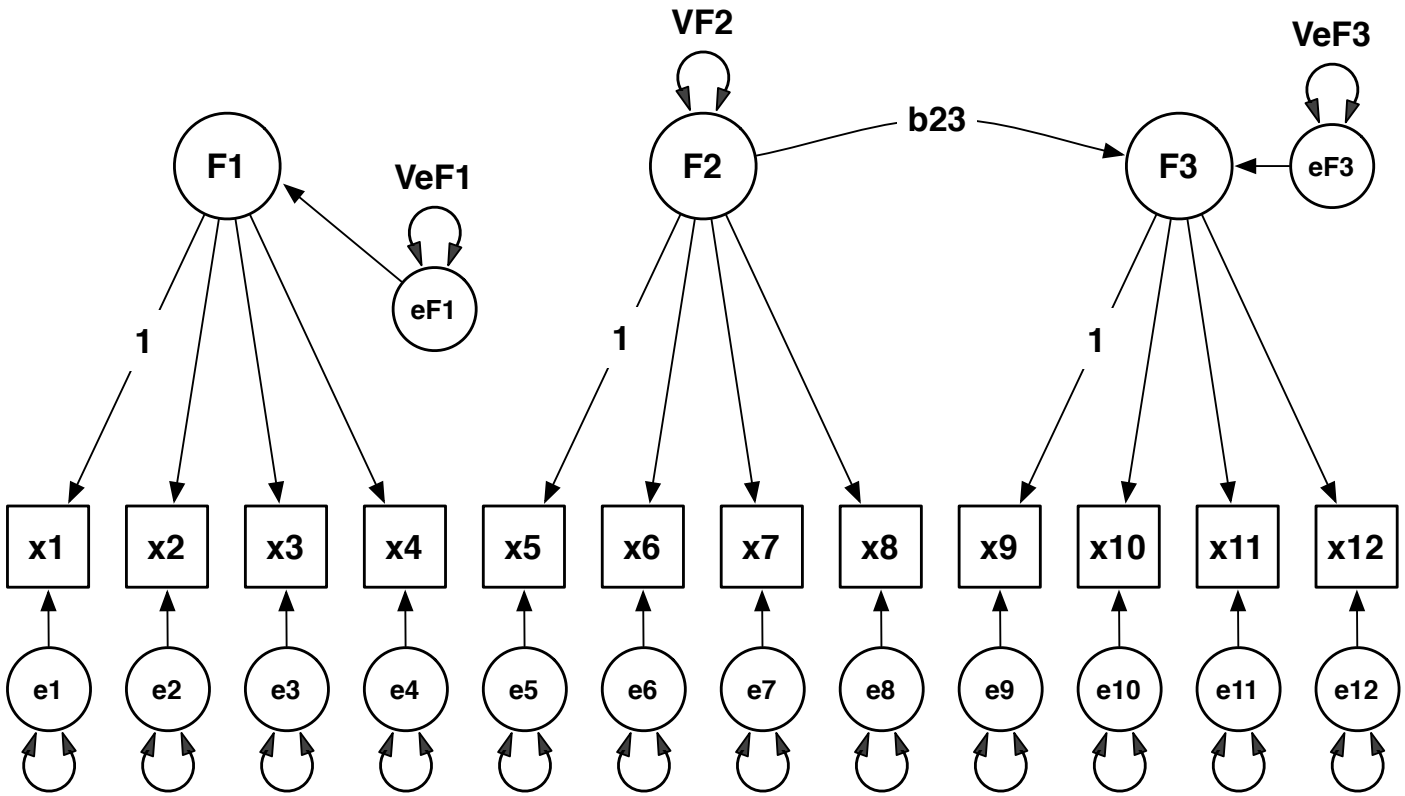
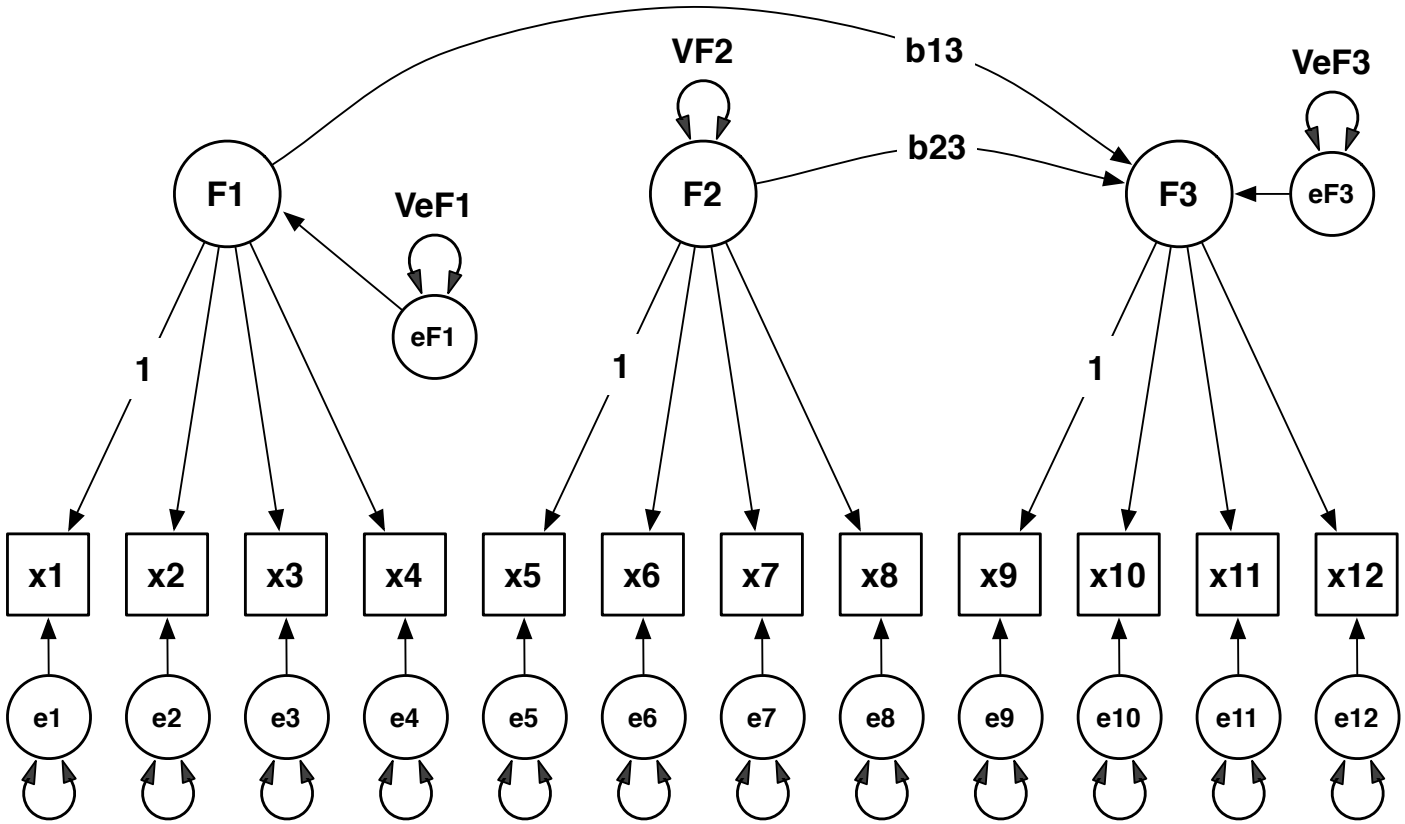


Latent Structure: Latent Mediation Models



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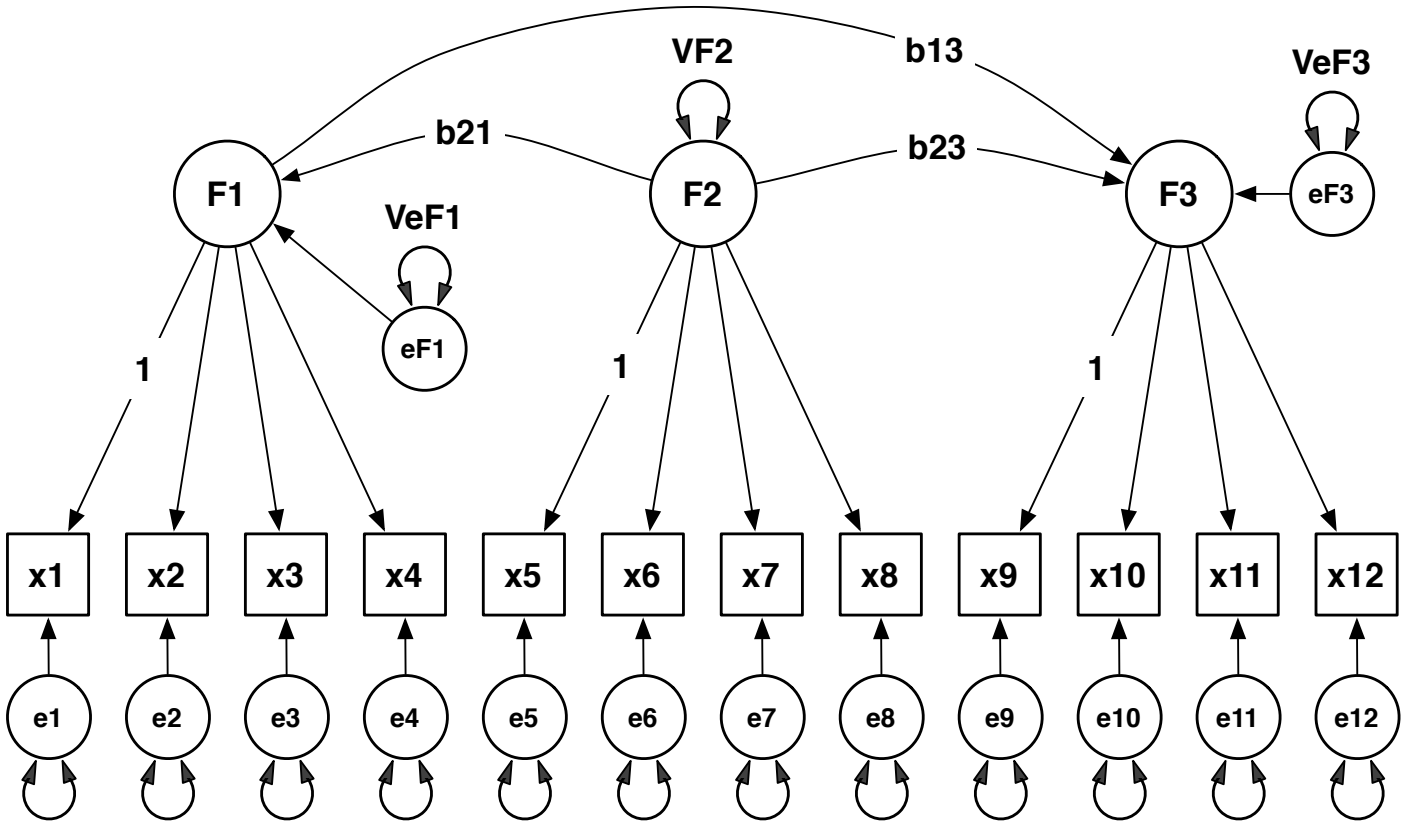
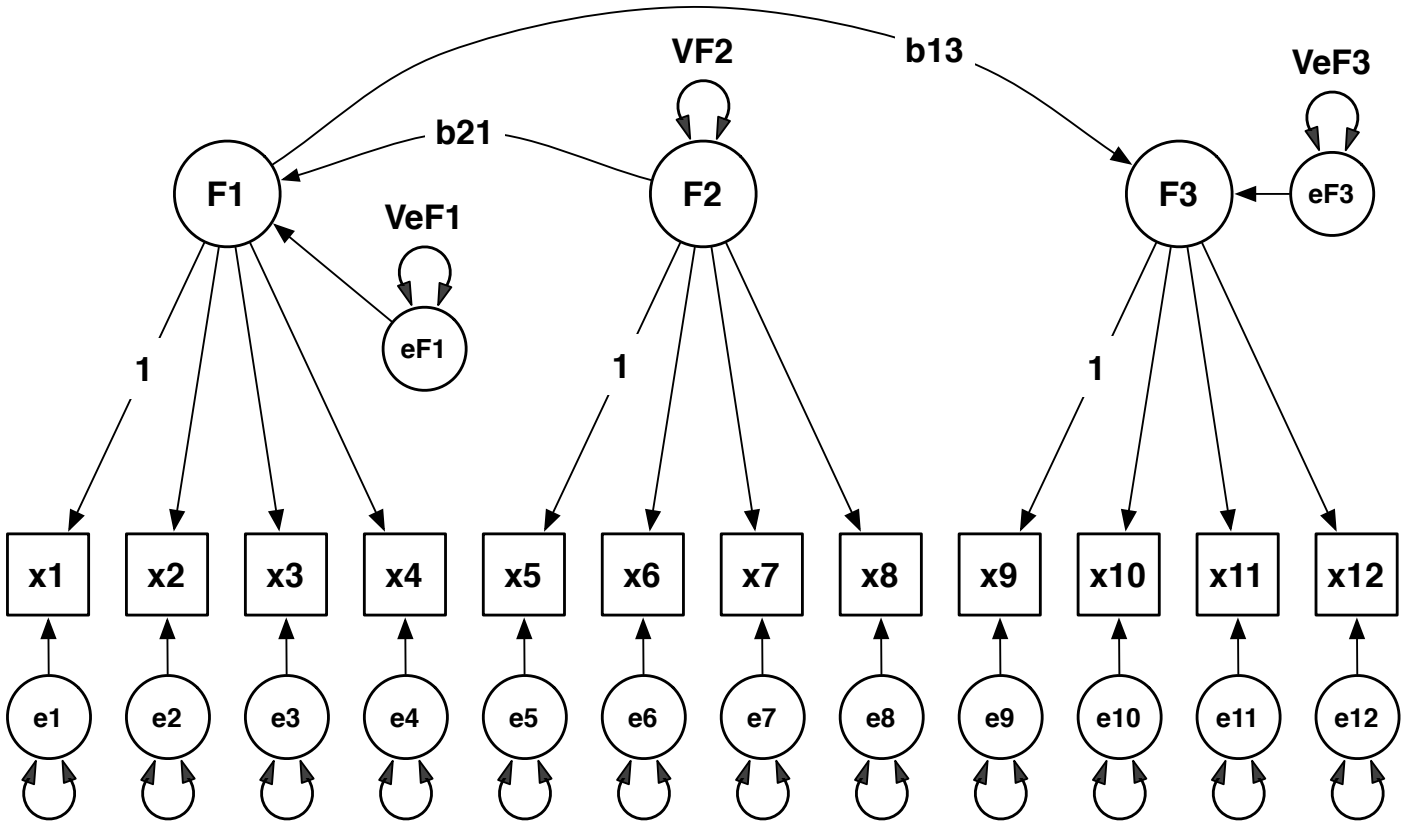


Latent Structure: Full Mediation



Parameter Constraints

- There are a variety of types of constraints that can be applied to model parameters.
  1. Fixing a parameter to be equal to a value.
  2. Fixing two parameters to be equal to one another.
  3. Boundary constraints.
  4. Nonlinear functions.
- Fixing parameters will change the degrees of freedom.
- Boundary and nonlinear functional constraints do not change the degrees of freedom.

Model Comparison

- As you change model constraints, you can compare models.
- This is the main technique we use to test theories.
- By setting up your models to express explicit differences between theories, you can test for inclusion of parameters or variables.
- This method is preferred over looking at confidence intervals of parameters.
  1. When a parameter is removed (is set equal to zero), other parameters may adjust themselves.
  2. So, it is frequently dangerous to look at a parameter in isolation.

Next Week

- Maximum Likelihood.
- Fit Functions.
- Diagnostics.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182.

Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology*, *29*(4), 409–454.