

$$y_{it} = 0 + \varepsilon_{it}$$

$$\mathbf{y}_i = \mathbf{0} + \boldsymbol{\varepsilon}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{\alpha i} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} & \\ & \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix} \right)$$

$$\mathbf{y}_i = \mathbf{0} + \boldsymbol{\varepsilon}_i$$

$$y_{it} = 0 + \varepsilon_{it}$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH
int with linear@0;

! Intercepts
[y8-y11@0];
[int@0];
[linear@0];

! Residual Variances
y8-y11(epsilon);
int@0;
linear@0;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \delta_2 \text{TVC}_{it} + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \gamma_{01} \text{TIC}_i + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \gamma_{11} \text{TIC}_i + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\eta}_i + \Delta \mathbf{z}_{it} + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\Gamma} \mathbf{w}_i + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \delta_{i8} \\ \delta_{i9} \\ \delta_{i10} \\ \delta_{i11} \end{pmatrix} (\text{TVC}_{it}) + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \gamma_{01} \\ \gamma_{11} \end{pmatrix} (\text{TIC}_i) + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \\ \psi_{\alpha\beta 1} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_{\varepsilon 8} & & & \\ & \theta_{\varepsilon 9} & & \\ & & \theta_{\varepsilon 10} & \\ & & & \theta_{\varepsilon 11} \end{pmatrix} \right)$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\mu}_\eta + \Lambda \boldsymbol{\zeta}_i + \Lambda \boldsymbol{\Gamma} \mathbf{w}_i + \Delta \mathbf{z}_{it} + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \delta_2 \text{TVC}_{it} + \varepsilon_{it}$$

$$+ \zeta_{ai} + \gamma_{01} \text{TIC}_i$$

$$+ \zeta_{\beta 1i} \text{age}_t + \gamma_{11} \text{TVC}_{it} \times \text{TIC}_i$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

Int on TIC;

linear on TIC;

y8 on TVC;

y9 on TVC;

y10 on TVC;

y11 on TVC;

! Correlated WITH

int with linear;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11;

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \delta_{2t} \text{TVC}_{it} + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \gamma_{01} \text{TIC}_i + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \gamma_{11} \text{TIC}_i + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\eta}_i + \Delta \mathbf{z}_{it} + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\Gamma} \mathbf{w}_i + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \delta_i \\ \delta_i \\ \delta_i \\ \delta_i \end{pmatrix} (\text{TVC}_{it}) + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \gamma_{01} \\ \gamma_{11} \end{pmatrix} (\text{TIC}_i) + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \\ \psi_{\alpha\beta 1} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_{\varepsilon 8} & & & \\ & \theta_{\varepsilon 9} & & \\ & & \theta_{\varepsilon 10} & \\ & & & \theta_{\varepsilon 11} \end{pmatrix} \right)$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\mu}_\eta + \Lambda \boldsymbol{\zeta}_i + \Lambda \boldsymbol{\Gamma} \mathbf{w}_i + \Delta \mathbf{z}_{it} + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \delta_{2t} \text{TVC}_{it} + \varepsilon_{it}$$

$$+ \zeta_{ai} + \gamma_{01} \text{TIC}_i$$

$$+ \zeta_{\beta 1i} \text{age}_t + \gamma_{11} \text{TVC}_{it} \times \text{TIC}_i$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

Int on TIC;

linear on TIC;

y8 on TVC (delta);

y9 on TVC (delta);

y10 on TVC (delta);

y11 on TVC (delta);

! Correlated WITH

int with linear;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11;

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \gamma_{01} \text{TIC}_i + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \gamma_{11} \text{TIC}_i + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\Gamma} \mathbf{w}_i + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \gamma_{01} \\ \gamma_{11} \end{pmatrix} (\text{TIC}_i) + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \\ \psi_{\alpha\beta 1} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_{\varepsilon 8} & & & \\ & \theta_{\varepsilon 9} & & \\ & & \theta_{\varepsilon 10} & \\ & & & \theta_{\varepsilon 11} \end{pmatrix} \right)$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\mu}_\eta + \mathbf{\Lambda} \boldsymbol{\zeta}_i + \mathbf{\Lambda} \boldsymbol{\Gamma} \mathbf{w}_i + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it}$$

$$+ \zeta_{ai} + \gamma_{01} \text{TIC}_i$$

$$+ \zeta_{\beta 1i} \text{age}_t + \gamma_{11} \text{TVC}_{it} \times \text{TIC}_i$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

Int on TIC;

linear on TIC;

! Correlated WITH

int with linear;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11;

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \gamma_{01} \text{TIC}_i + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\Gamma} \mathbf{w}_i + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \gamma_{01} \end{pmatrix} (\text{TIC}_i) + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \\ \psi_{\alpha\beta 1} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_{\varepsilon 8} & & & \\ & \theta_{\varepsilon 9} & & \\ & & \theta_{\varepsilon 10} & \\ & & & \theta_{\varepsilon 11} \end{pmatrix} \right)$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\mu}_\eta + \mathbf{\Lambda} \boldsymbol{\zeta}_i + \mathbf{\Lambda} \boldsymbol{\Gamma} \mathbf{w}_i + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it} \\ + \zeta_{ai} + \gamma_{01} \text{TIC}_i \\ + \zeta_{\beta 1i} \text{age}_t$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

Int on TIC;

! Correlated WITH

int with linear;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11;

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \\ \psi_{\alpha\beta 1} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_{\varepsilon 8} & & & \\ & \theta_{\varepsilon 9} & & \\ & & \theta_{\varepsilon 10} & \\ & & & \theta_{\varepsilon 11} \end{pmatrix} \right)$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\mu}_\eta + \mathbf{\Lambda} \boldsymbol{\zeta}_i + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it} + \zeta_{ai} + \zeta_{\beta 1i} \text{age}_t$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH

int with linear;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11;

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \psi_{\alpha\beta 1} \\ \psi_{\beta 1\alpha} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix} \right)$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\mu}_\eta + \Lambda \boldsymbol{\zeta}_i + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it} + \zeta_{ai} + \zeta_{\beta 1i} \text{age}_t$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH

int with linear;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11(epsilon);

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} + \zeta_{\beta 1i}$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta + \boldsymbol{\zeta}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} & \psi_{\alpha\beta 1} \\ \psi_{\beta 1\alpha} & \psi_{\beta 1\beta 1} \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix} \right)$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\mu}_\eta + \mathbf{\Lambda} \boldsymbol{\zeta}_i + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it} + \zeta_{ai} + \zeta_{\beta 1i} \text{age}_t$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH

int with linear@0;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11(epsilon);

int;

linear;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha + \zeta_{ai}$$

$$\beta_{1i} = \mu_{\beta 1} +$$

$$y_i = \Lambda \eta_i + \varepsilon_i$$

$$\eta_i = \mu_\eta + \zeta_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix} + \begin{pmatrix} \zeta_{ai} \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{ai} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \psi_{\alpha\alpha} \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix} \right)$$

$$y_i = \Lambda \mu_\eta + \Lambda \zeta_i + \varepsilon_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it} + \zeta_{ai}$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH

int with linear@0;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11(epsilon);

int;

linear@0;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \beta_{1i} \text{age}_t + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha$$

$$\beta_{1i} = \mu_{\beta 1}$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ \mu_{\beta 1} \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{\alpha i} \\ \zeta_{\beta 1 i} \end{bmatrix} \sim N \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} & \\ & \end{pmatrix}$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix}$$

$$\mathbf{y}_i = \mathbf{\Lambda} \boldsymbol{\mu}_\eta + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \mu_{\beta 1} \text{age}_t + \varepsilon_{it}$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH

int with linear@0;

! Intercepts

[y8-y11@0];

[int];

[linear];

! Residual Variances

y8-y11(epsilon);

int@0;

linear@0;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = \alpha_i + \varepsilon_{it}$$

$$\alpha_i = \mu_\alpha$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\eta}_i + \boldsymbol{\varepsilon}_i$$

$$\boldsymbol{\eta}_i = \boldsymbol{\mu}_\eta$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} (\alpha_i) + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{li} \end{pmatrix} = \begin{pmatrix} \mu_\alpha \\ 0 \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{\alpha i} \\ \zeta_{\beta li} \end{bmatrix} \sim N \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix}$$

$$\mathbf{y}_i = \Lambda \boldsymbol{\mu}_\eta + \boldsymbol{\varepsilon}_i$$

$$y_{it} = \mu_\alpha + \varepsilon_{it}$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH

int with linear@0;

! Intercepts

[y8-y11@0];

[int];

[linear@0];

! Residual Variances

y8-y11(epsilon);

int@0;

linear@0;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null

$$y_{it} = 0 + \varepsilon_{it}$$

$$\mathbf{y}_i = \mathbf{0} + \boldsymbol{\varepsilon}_i$$

$$\begin{pmatrix} y_{i8} \\ y_{i9} \\ y_{i10} \\ y_{i11} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{pmatrix}$$

$$\begin{pmatrix} \alpha_i \\ \beta_{1i} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$$\begin{bmatrix} \zeta_{\alpha i} \\ \zeta_{\beta 1i} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} & \\ & \end{pmatrix} \right)$$

$$\begin{bmatrix} \varepsilon_{i8} \\ \varepsilon_{i9} \\ \varepsilon_{i10} \\ \varepsilon_{i11} \end{bmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \theta_\varepsilon & & & \\ & \theta_\varepsilon & & \\ & & \theta_\varepsilon & \\ & & & \theta_\varepsilon \end{pmatrix} \right)$$

$$\mathbf{y}_i = \mathbf{0} + \boldsymbol{\varepsilon}_i$$

$$y_{it} = 0 + \varepsilon_{it}$$

MODEL:

! Grows BY

Int by y8@1 y9@1
y10@1 y11@1;

linear by y8@0 y9@1
y10@2 y11@3;

! Regressed ON

! Correlated WITH
int with linear@0;

! Intercepts
[y8-y11@0];
[int@0];
[linear@0];

! Residual Variances
y8-y11(epsilon);
int@0;
linear@0;

Add unique TVC for each time

Add same TVC for all times

Add TIC of slope

Add TIC of intercept

Make residual variances ≠

Have intercept & slope covary

Make slope random

Make intercept random

Add fixed slope

Add fixed intercept

Null