8th class — Part I ~~NICT~~

Change models

Depart from our focus on strong quasi-experimental studies and turn to longitudinal models of the kind used by everyone until the 1990s

and by developmental psychologists since then

What we will cover

(1) Simple change models

(2) Residualized changed models

AKA: lagged dependent variable models
cross-lagged panel models

(3) latent growth models
(very briefly)

But let's start with theory!

<u>Simple change</u>: $Y_1 - Y_0 = a + b_1 X + b_2$ controls

<u>Residualized change</u>: $Y_1 = a + b_1 X + b_2$ controls $+ c_1 Y_0$

if you have X_1 X_2

$$\begin{tikzcd} X_0 \arrow[r] \arrow[dr] & X_1 \\ Y_0 \arrow[r] \arrow[ur] & Y_1 \end{tikzcd}$$

The y_1 equation is $y_1 = b_1 X_0 + b_2 Y_0$ -- can be same as

~~Residualized change~~

<u>Latent growth</u>: slope-based change in Y $= a + b_1 X + b_2$ controls

<u>Greg's instantaneous change model</u> $\Delta Y = a + b_1 \Delta X$

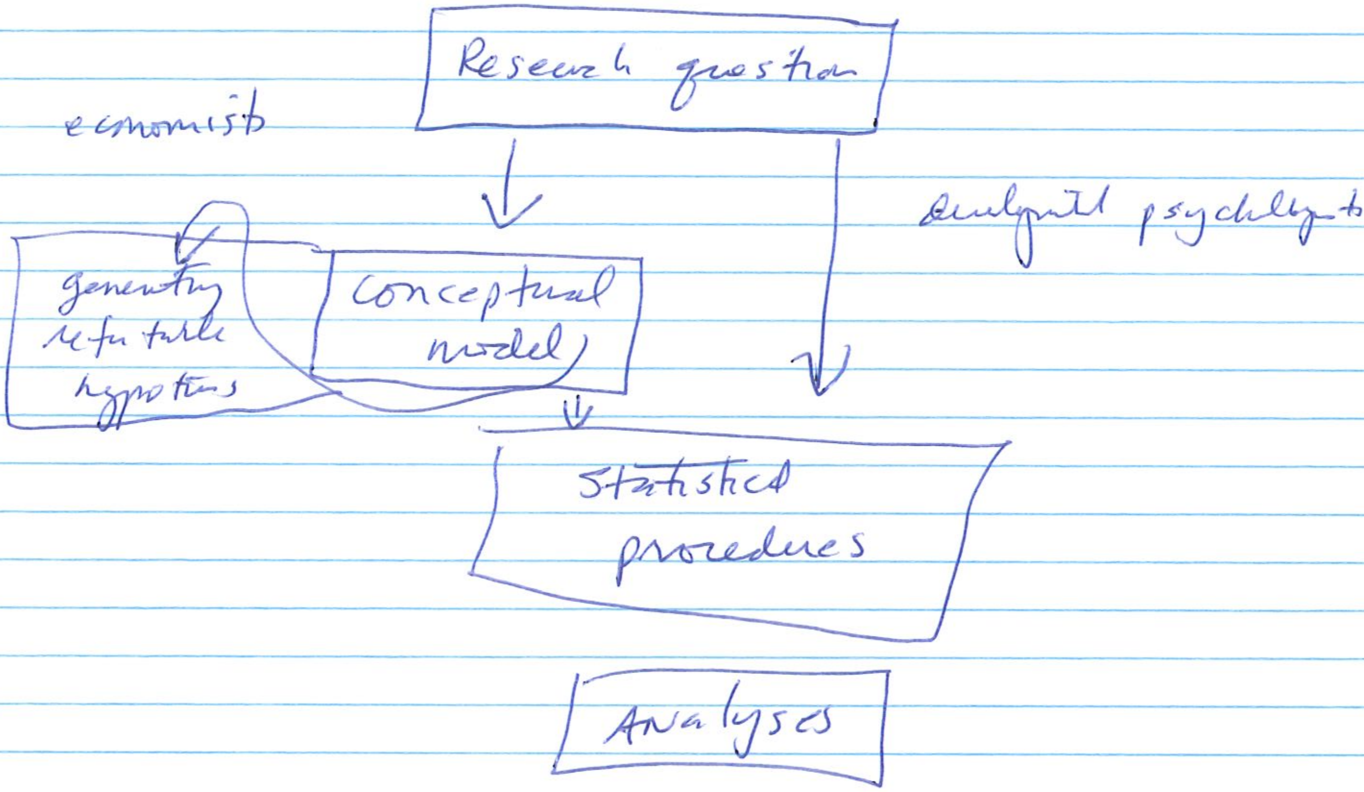
$(y_1 - y_0) = a + b_1 (X_1 - X_0)$

<u>Greg's accumulation of inputs model</u>:

$y_1 - y_0 = a + b_1$ average level of X between 0 and 1 $+ b_2$ controls

Issues: ~~chg~~ chg on left or initial level on right?

what X's are best (vague up above)



Conceptual models — of course these are developmental models but very vague ones

Economists develop models based on simplifying assumptions that yield concrete predictions

What kind of conceptual models might make sense in understanding child development

"Instantaneous change" VS "accumulation of inputs"

8th class Part I

1. Instantaneous change — suppose Temperamental children don't do well in group center care

Suppose t = age 5

(1) Child behav problems$_t$ = $a + b_1$ ~~Fac~~ CC$_5$ + b_2 Fam$_t$ + $b_3 Z_t + b_4 Zp$

income → stress → sensitive parenting → behav problems

Fam$_t$ = observed family characteristics

Z_t = unobserved family & child ~~characteristics~~ determinants at time t

Zp = unobserved persistent determinants
(no subscript)

contrast to:

II "Accumulation of inputs" model — e.g. in income: child ed article

(2) child achievement$_t$ = $a + b_1 \sum_{birth}^{5}$ ~~Income~~ CC +

b_2 Σ Family observed + $b_3 Z_t + b_4 Z_p$

if t=5 then $\sum_{birth}^{5}$ ~~Fac~~ CC = $\frac{\text{CC}_1 + \text{CC}_2 + \text{CC}_3 + \text{CC}_4 + \text{CC}_5}{5}$

You could estimate both (1) and (2) and worry about bias from Z_t and Z_p in both

How to ~~go~~ reduce bias? ⇒ Take first differences

$\boxed{\text{II Instead change}}$

$$(1)\ CBP_t = a + b_1 \, Inc_t + b_2 \, \overset{cc}{Fam_t} + b_3 Z_t + b_4 Z_p$$

suppose $(2')\ CBP_3 = a + b_1 \, Inc_5 + b_2 \, \overset{cc}{Fam_5} + b_3 Z_5 + b_4 Z_p$

say 5 = age 3

subtract to get

$$3''\ CBP_5 - CBP_3 = b_1 (\overset{cc}{Inc_5} - \overset{cc}{Inc_3}) + b_2 (Fam_t - Fam_5) + b_3 (Z_5 - Z_3) + b_4 \boxed{0}$$

Note: (1) b_1 in 1'' has the same interpretation as b_1 in (1) and (2)

(2) you've eliminated omitted variable bias from Z_p ⇒ HUGE

so, change equation 3 is potentially much stronger than ~~old~~ level equations 1 or 2

→ apply to temperament and child behavior problems example

II what about the change version of the $\boxed{\text{accumulation of inputs}}$ model

(1) $Ach_5 = a + b_1 \sum_0^5 CC + b_2 \sum_0^5 Family + b_3 Z_t + b_4 Z_p$

if holds at age 3 then:

(2) $Ach_3 = a + b_1 \sum_0^3 CC + b_2 \sum_0^3 Family + b_3 Z_t + b_4 Z_p$

subtract:

(3) $Ach_5 - Ach_3 = b_1 \sum_4^5 CC + b_2 \sum_4^5 Family + b_3 \Delta Z_t + \underline{\underline{0}}$

Again, b_1 in (3) has the same interpretation as b_1 in (1) and (2)

AND you've eliminated omitted variable bias from Z_p

So, accumulation of inputs model leads to estimating

Δ Cognitive Score 3–5 $= a + b_1 \sum_{3-5} \text{Care} + b_2 \text{controls} + 0 \leftarrow$ effect of persistent conditions

$\log_5 - \log_3$

$\boxed{\text{Break out}}$ → come up with an accumulation of inputs + instability change model with ECLS-K

Simple change:

(1) $Cog_5 - Cog_3 = a + b_1 \sum_3^5 + \text{controls}$

Compare with lagged dependent variable model

$$\begin{tikzcd} Cog_3 \arrow[r] \arrow[dr] & Cog_5 \\ CC_3 \arrow[r] \arrow[ur] & CC_5 \end{tikzcd}$$

(2) $Cog_5 = a + b_1 \sum_3^5 cc + b_2 Cog_3 + \text{controls}$

almost the same

add Cog_3 to both sides of (1)

$$Cog_5 = a + b_1 \sum_3^5 + 1\, Cog_3 + \text{controls}$$

(3) 2 wave panel model

$$\begin{tikzcd} Cog_3 \arrow[r] \arrow[dr] & Cog_5 \\ CC_3 \arrow[r] \arrow[ur] & CC_5 \end{tikzcd}$$

two equations

$$\boxed{Cog_5 = a + b_1 Cog_3 + CC_3}$$

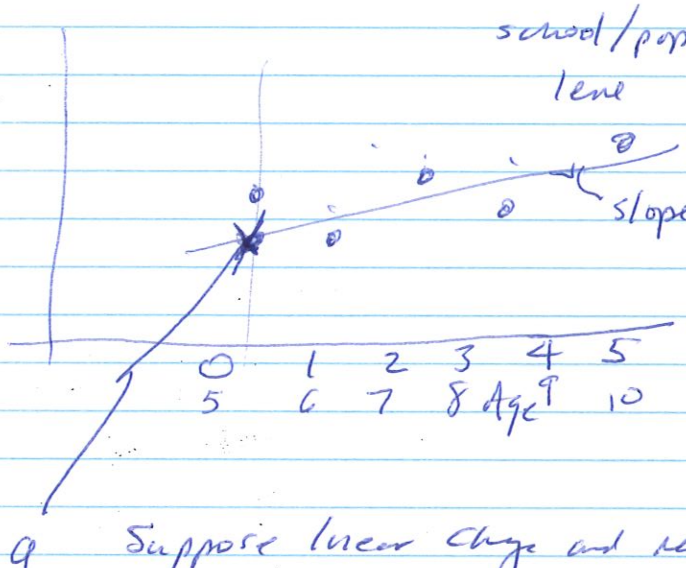
$$CC_5 = c + d_1 Cog_3 + d_2 CC_3$$

not at all the same CC_3 rather than the CC from 3-5

$\boxed{\text{Go to article}}$

latent growth models

HLM-style   child level: (1) $Cog = a + b_1 Age \left(+ b_2 Age^2\right)$



school/population level (2) $a = c_1 Fam + c_2 School + c_3 other$

(3) $b_1 = d_1 Fam + d_2 School + d_3 Other$

smooth $b_2 =$ ..

Suppose linear change and rescale age so that $0 =$ kindergarten

(2) predicts starting level as a fn of Family, School + Other

Just a hopelessly bias cross-sectional equation!

(fit to the projection of the slope back to 0)

~ linear change

concentrate on ~~Concentrate~~ on (3) $b_1 = d_1$ Fam $+ b_2$ School $+ b_3$ Other

if age is centered at zero and 5 points then

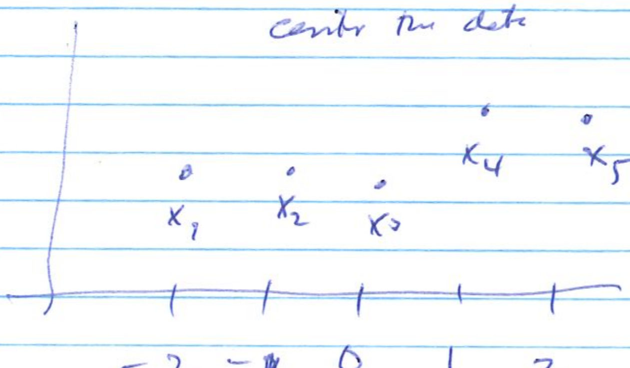
$$\frac{\sum_{t=-2}^{+2} (X_t - \bar{X})(y_t - \bar{y})}{\sum (X_t - \bar{X})^2} \quad !$$

b_1 is the slope of a bivariate regression --
WE'VE seen THIS BEFORE!

Think about

linear change $= d_1$ Fam $+ d_2$ School $+ d_3$ Other

center the data



slope is $-2 \cdot X_1 - 1 \cdot X_2 + 0 + 1 \cdot X_4 + 2 \cdot X_5$

Simple change $X_5 - X_1$

$\Rightarrow -1 X_1 + 1 X_5$

same except no weight to $X_2 - X_4$

express X's in deviation form

so, for latent growth model,

the level equation is just a cross-sectional regression but doesn't take advantage of the longitudinal data

the change equation is just a simple change equation

$$\Delta y = d_1 \text{ Fam} + d_2 \text{ School} + d_3 \text{ other}$$

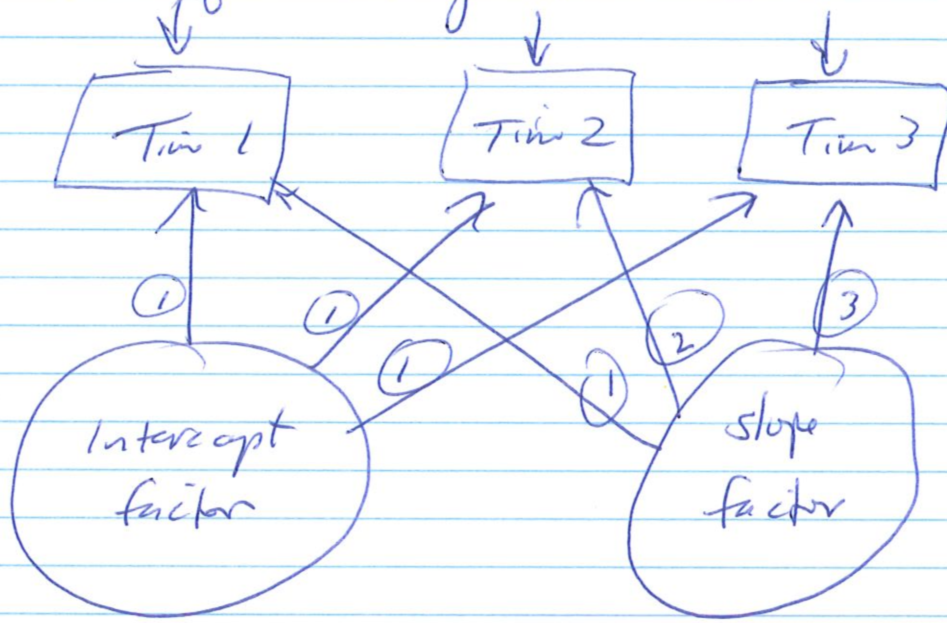
(measured as slope)

What theoretical model does this correspond to?

Not instantaneous change $\Delta y = \Delta X$

not accumulation of inputs $\Delta y =$ average X between beginning and end of change period.

SEM version of latent growth model



gives you the same thing

see Curran slides