

# Science jam: To detrend or not?

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March 29, 2018

# Problem

**A central question in the social and behavioral sciences is:**

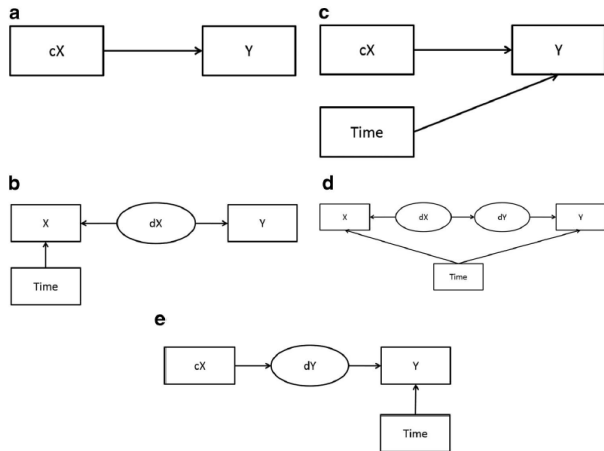
How is change in one domain related to change in another?

For instance, we may want to know:

- do deviant friends lead to delinquency, or vice versa?
- how do maternal depression and children's externalizing behavior affect each other?
- does feminization of professions lead to lower salaries, or do lower salaries lead to more women in a profession?
- are increases in language skills necessary for increases in math performance?
- does having more friends come before being more sociable or is it the other way around?

This requires **causal inference** based on **longitudinal data**.

# Wang and Maxwell (2015)



## Five options:

- a.** doing nothing
- b.** detrend  $X$
- c.** include  $t$
- d.** detrend  $X$  and  $Y$
- e.** detrend  $Y$

Figure 1. Illustrations of different detrending actions: (a) no detrending, or the person-mean centering approach ( $cx_{it} = x_{it} - \bar{x}_i$ ); (b) detrend  $X$  only by the two-stage approach in Curran and Bauer (2011); (c) add time as a covariate; (d) detrend both  $X$  and  $Y$ ; and (e) detrend  $Y$  only.  $cX$  = the person-mean centered  $X$ ;  $dX$  = the detrended  $X$ ;  $dY$  = the detrended  $Y$ .

# Results from Wang and Maxwell (2015)

Table 6

*Ordinary Least Squares Estimates of Individual Within-Person Effects for Five Selected Individuals*

ID	P-centering (Action a)	Detrend X, two step (Action b)	Add time as covariate (Action c)	Detrend both X and Y (Action d)	Detrend Y (Action e)
10	1.250	0.750	0.750	0.750	0.686
11	1.587	-0.981	-0.981	-0.981	-0.257
14	1.098	-0.573	-0.573	-0.573	-0.425
110	0.781	0.432	0.432	0.432	0.497
116	1.297	0.720	0.720	0.720	0.666

*Note.* Action labels correspond to the labels in [Figure 1](#). ID = participant number; P-centering = person-mean centering approach.

Conclusion: It does not matter whether you detrend X, include time as a covariate, or detrend both X and Y.

## Two models that include time as a covariate

Curran et al. (2013) discuss the **ALT model** and an **alternative**.

Bivariate ALT model

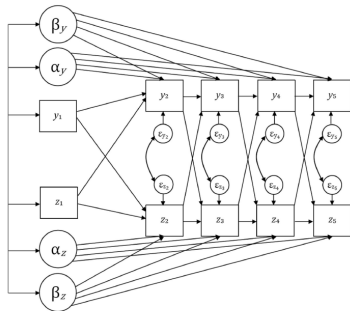


Figure 5. Bivariate unconditional autoregressive latent trajectory model for five repeated measures.

LGC model with structure residuals

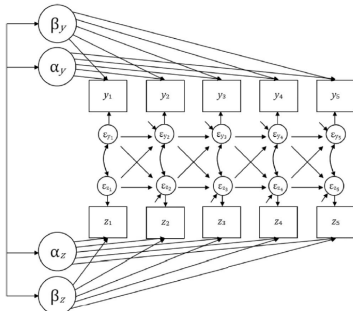
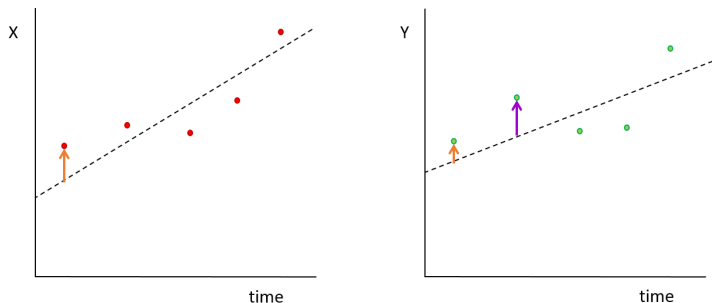


Figure 7. Bivariate unconditional linear latent curve model with structured residuals for five repeated measures.

Hamaker (2005) has shown that under stationarity constraints these models are statistically equivalent.

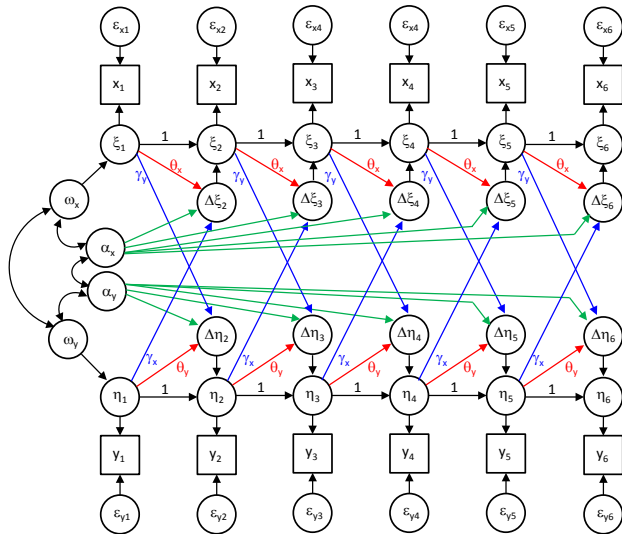
# Cross-lagged relationships after detrending



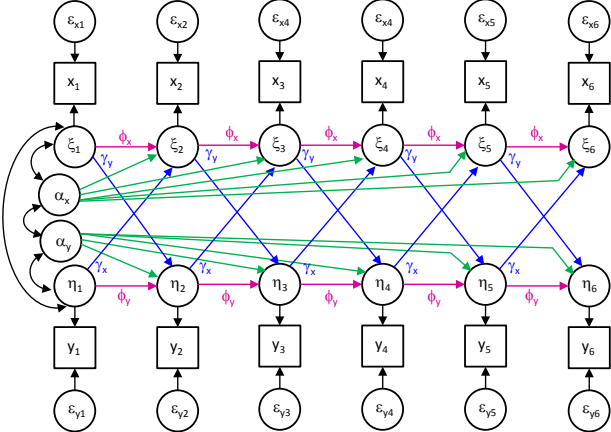
Lagged relationships are concerned with:

- cross-lagged relationships concern *residuals* (no more development)
- cross-lagged relationships concern *temporary* deviations

# Including trends in the dynamics: LCS model



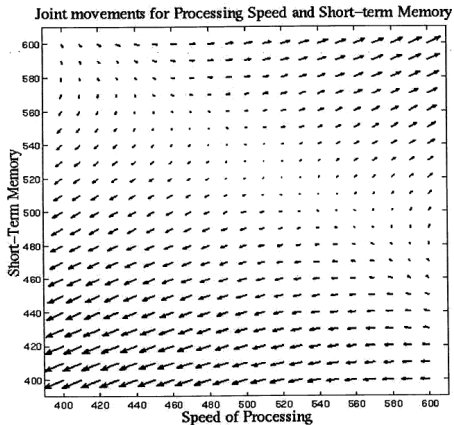
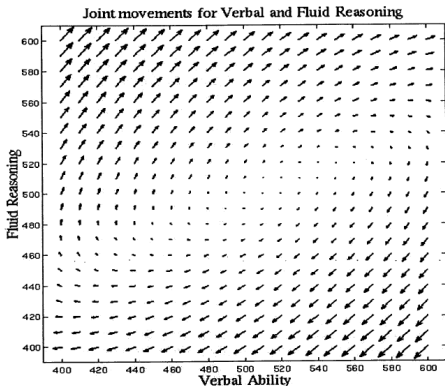
# Equivalent bivariate model





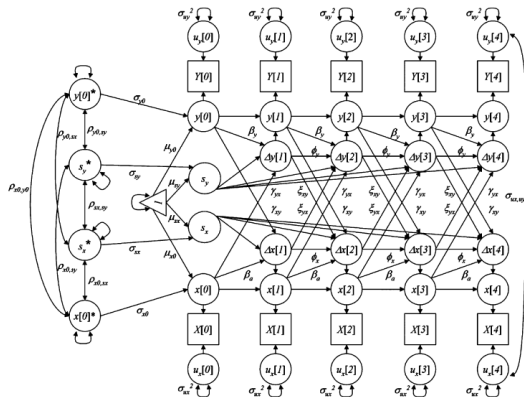
# Vector fields resulting from LCS model

The results from a LCS model are often presented using **vector fields**, which illustrate the **underlying dynamics**.



# Adaption of the LCS model

Grimm et al. (2012) present a model that relates **change to change**:



# Questions

When is detrending sensible?

When do we assume the short-term fluctuations and the long-term changes depend on the same underlying dynamics?