SC705: Advanced Statistics
Instructor: Natasha Sarkisian
Class notes: Longitudinal models using SEM

Longitudinal models are very useful when we are interested in reciprocal relationships, but they also have value when all the relationships are specified as unidirectional. Their value lies in the ability to examine both stability and change of variables (and relationships between variables) over time. Panel data are especially useful when we have repeat measures of the same variables (if they do not, then these data are analyzed the same way cross-sectional data would be).

Types of relationships in panel models:
1. Correlation between X1 and Y1 = synchronous correlation
2. Correlation between X1 and X2 and between Y1 and Y2 = autocorrelations, or stabilities.
3. Correlation between X1 and Y2 and between Y1 and X2 = cross-lagged correlations
4. The paths between measurement errors = autocorrelated error terms.

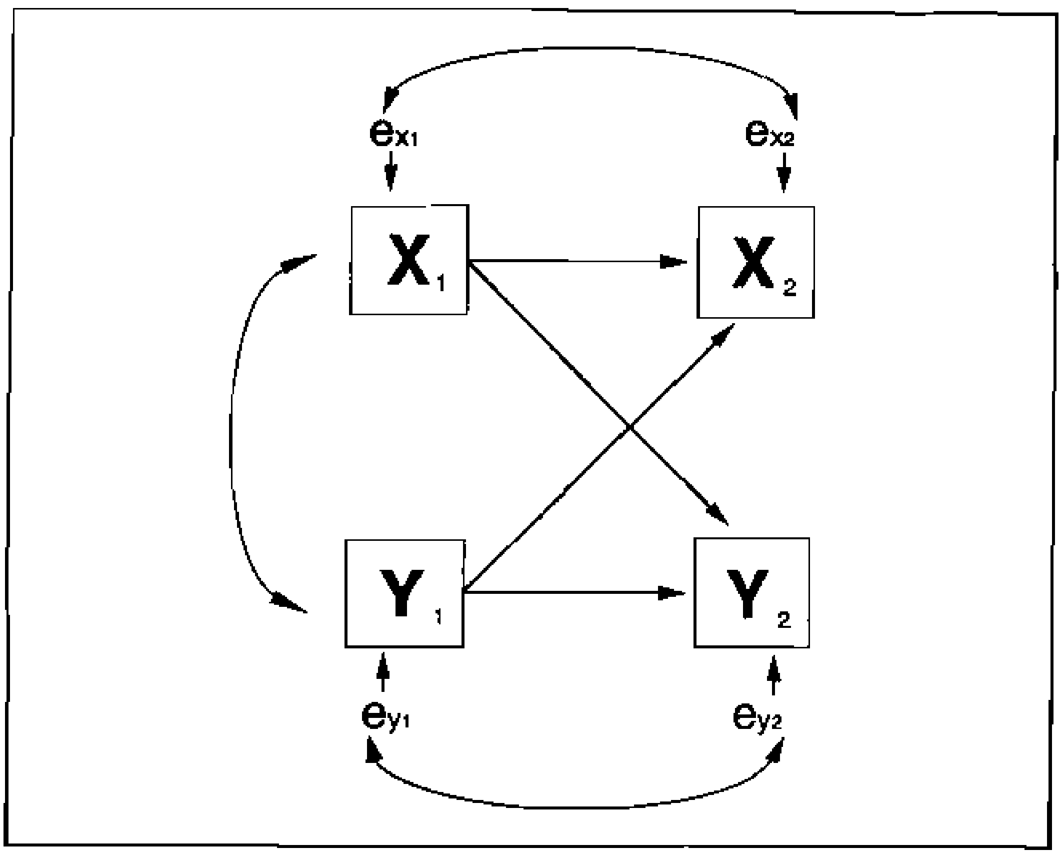

Figure 6.3. Two-Variable, Two-Wave Panel Model

Stability of measures

Stability is the most important concept added by panel models. If a variable is perfectly stable, that means that Y2 is perfectly determined by Y1 and has no other causes but itself. In this context, if we add some predictors at time 1, e.g. X1, we will find no causal relationship between

X1 and Y2. Note that, in this situation, we would omit Y1 (or the relationship between Y1 and Y2) from the model, we would probably observe a relationship between X1 and Y2, but it would probably be erroneous to assume that X1 caused Y2 even though X1 happened prior to Y2 – the reason for their correlation lies in the correlation between X1 and the omitted Y1, and there may be many possible reasons for that correlation. So such a model can be misspecified, and, of course, if we don't have data on Y1, such a misspecification will likely go undetected.

E.g. if school achievement at time 2 is strongly related to school achievement at time 1, we cannot omit that relationship – if we do, we will witness many time1 predictors of time 2 school achievement, but they all may be misleading.

Note, that high stability for a variable means we will find very little in terms of causal antecedents for this variable. Low stability, in contrast, suggests that a variable is changing rapidly, and although this gives us an opportunity to find the causes for that change, it also may indicate low reliability of the measure or possibly even a change in that variable's meaning.

Note, that when working with longitudinal SEM models, you should use covariances and at all costs avoid using correlations as these remove differences in variability across time, and therefore ignore growth/change.

<u>Autocorrelated error terms</u>

These reflect the fact that when a measure is administered at different times, a substantial amount of variance may be shared not because, but because same method of data collection is used, or because respondents remember their earlier answers. We can only include these in the models if we have more than one indicator of X1 and X2, and Y1 and Y2 – otherwise, the model will not be identified. So if we suspect autocorrelated measurement errors, we need multiple-indicator models. Otherwise, to keep the model identified, we drop these paths, but by doing so, we incorporate any measure-specific correlations into our measure of stability.

Note that in order to model these in LISREL, we need to be able to correlate elements of
This is done using an additional matrix – Theta Delta Epsilon (TH). By default, this matrix is a fixed matrix (all zeros) and we cannot free is on MO line, but we can free its elements (usually want we want to free is its diagonal elements) using FR command.

<u>Stability of causal processes</u>

Stability of causal processes is different from stability of measures – it means that the effects of X on Y is stable over time – i.e. is the same for every time interval of the same length. Typically, if we are interested in the effect of X on Y, it would be desirable for that effect to be stable, unless we predict that it varies over time for a certain reason. We can check such stability if we have more than two time points.

Also, we need to consider the issue of temporal lag – i.e., how long of a time interval do we have between time 1 and time 2. If that interval is too short, we might have not observed the effect of X on Y yet; if it's too long, that effect might have decayed from its maximum. This is even more complicated if we think that the optimum time lag would be different for the relationship X→Y vs. Y→X. This is important to consider if one is collecting data; with secondary data, we usually have no choice.

Causal predominance

When examining reciprocity using panel data, we are often interested in evaluating causal predominance – i.e., which causal relationship is stronger, X→Y or Y→X. To evaluate that, we need to first evaluate a model that estimates both freely, then constrain them to be equal (using EQ command), and see if there was a significant decrease in fit by evaluating chi-square change the same way we did in a multigroup situation. If there was no decrease, none of the causal relationships dominates. If the fit decreases significantly, the relationships are different, and the one with the larger standardized coefficient indicates the causally predominant relationship.

Example of panel data SEM (p. 215 in Maruyama):

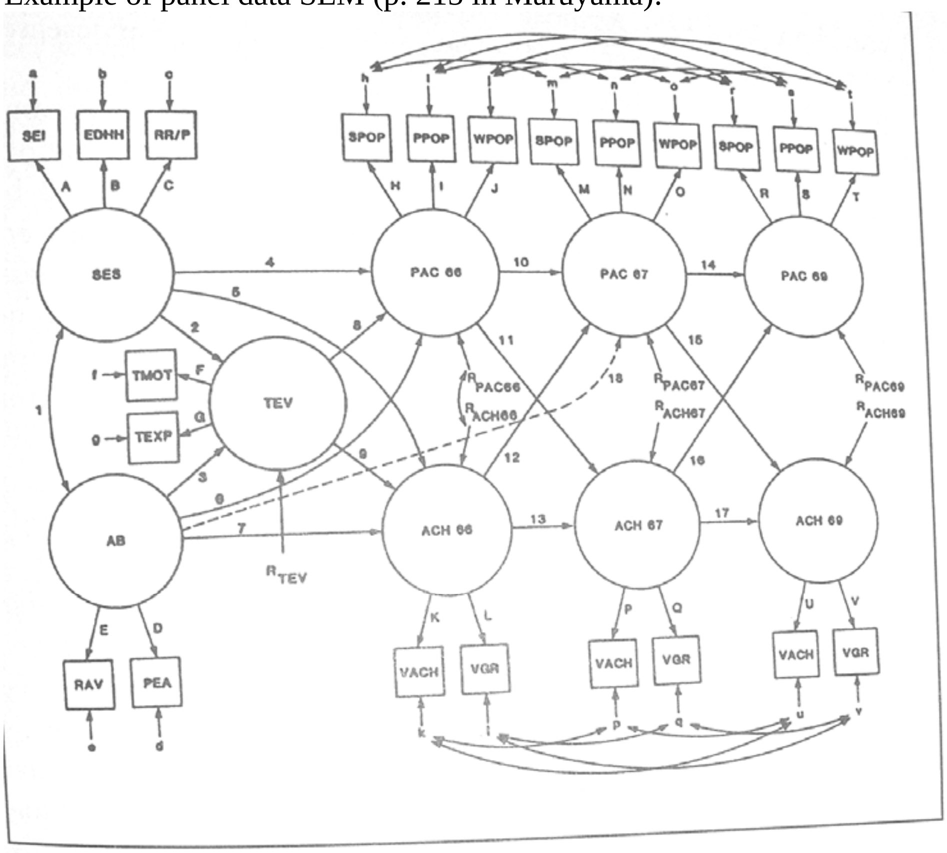

Figure 9.3. Latent Variable Panel Structural Equation Model
SOURCE: Maruyama, Miller, and Holtz (1986). Copyright 1986 by the American Psychological Association; reprinted by permission.
NOTE: The panel model is for examining the relation between peer popularity and achievement. SES = socioeconomic status, measured by SEI (Duncan Socioeconomic Index of Occupations); EDHH = educational attainment of head of household; RR/P = ratio of rooms in home to people living in home; AB = academic ability, measured by RAV (Raven's Progressive Matrices) and PEA (Peabody Picture Vocabulary Test); TEV = teachers' evaluations of students, measured by TMOT (teachers' ratings of students' motivation) and TEXP (teachers' expectations of students' eventual educational attainment); PAC = acceptance by peers, measured by SPOP (seating popularity), PPOP (playground popularity), and WPOP (schoolwork popularity); ACH = school achievement, measured by VACH (verbal standardized test performance) and VGR (verbal grades).