Assignment 4

GCM 2010

Instructions. Answer the following, and be prepared to present and discuss your answers in class. This assignment is due March 17.

In their Chapter 8, Singer and Willett present a brief introduction to the LISREL model, structural equation modeling, and, eventually, to its connection with growth curve modeling. Although the material is presented in terms of the somewhat outdated LISREL approach, the data and program files at UCLA unfortunatelyally do not seem to include materials for fitting the models in Chapter 8 with LISREL! Moreover, the treatment fails to emphasize in much detail the connections between this material and the material in previous chapters. Some of these connections are interesting, so let's pursue them in a couple of examples, making some technical points as we go.

Here are some input commands that, if used with LISREL, will generate the MODEL A output on p. 289. I've added some comments, using the comment delimiter (!), which can be used at any point in a line to exclude subsequent characters from processing. It is a good idea to include lots of comments in your LISREL command files while you are learning the LISREL syntax.

```
Growth Curve Model 1 -- Unconditional Model
!                               DA --> DAta
!                               NI --> Number of Input variables
!                               NO --> Number of Observations
DA NI=7 NO=1122
!                               LA --> LAbels for the manifest variables
LA
FEMALE ALC1 ALC2 ALC3 PEER1 PEER2 PEER3
!                               RA --> data file is a RAw data file
!                               FI --> FIle name of the data file
RA FI=alcohol2_noname.txt
!                               SE --> SElection order of Variables
!                               Note, the first 3 variables are
!                               Y-variables, and must be specified first
SE
2 3 4 1 /
!                               MO --> Model specification
!                               NY --> Number of Y variables
!                               NE --> Number of Eta variables
!                               TE --> Theta-Epsilon is DIagonal, FRee
!                               AL --> Alpha is FRee
!                               LY --> Lambda-Y is FIxed
!                               PS --> Psi is SYmmetric, FRee
```

```
MO NY=3 NE=2 TE=DI,FR AL=FR LY=FI PS=SY,FR
!                                LE --> Labels for the Etas
LE
INTERCEPT SLOPE
!                                MA --> Lambda-Y will be input in matrix form
!                                Since it has been specified as fixed, the
!                                fixed values are given
MA LY
1 0
1 0.75
1 1.75
!                                PD --> Path Diagram
PD
!                                OU --> Output
!                                ND --> Give 5 decimal places of output
OU ND=5
```

1. *Model A, pages 288–290.* This model is unconditional, in that growth is predicted with no covariates. A similar model is discussed on page 90, and can be fit with R. Let's fit the model with R. In order to do this, you are going to have to load the person-period data file *alcohol2_pp_newtime.txt*, because the original TIME variable is coded 0,1,2, and the time measure actually used is 0.00, 0.75, 1.75. Instead of using the TIME variable, use the NEWTIME variable so that you have an analysis that corresponds to the path diagram.

   (a) Fit the unconditional growth model with R, remembering to include the proviso `REML=FALSE` so that you get a maximum likelihood estimateion. This is a standard random-slope, random-intercept model *with no covariates*, and the assumption that the ϵ_{ij} have covariance matrix $\sigma^2 \boldsymbol{I}$. Remember to use NEWTIME, not TIME!

   (b) Use LISREL to fit the unconditional growth model A from page 288, using the commands above. (You can copy them to the clipboard, paste them into a newly opened syntax file in LISREL, and run them as they are.)

   (c) Look at the LISREL and R output, and construct a table comparing the coefficients. You will notice that the number of parameters is not the same and the values are not the same, because the models are not the same.

   (d) There is an important difference between Model A in Figure 8.2 and the unconditional growth model. What is it? (Hint: Look carefully at the covariance structure of the residuals in the two models.)

   (e) The path diagram of Model A is all too typical, in that, contrary to the entreaties in my 1988 *Multivariate Behavioral Research* article on standards in such diagrams, it fails to portray accurately the actual model being fit. Name two ways that the diagram leaves out important information (there are more than two).

(f) Can you fix up the LISREL model so that it is actually the same as the R model? There are several ways you can do that. One very easy way is to include a PAttern command in your syntax file. The documentation for this command is a bit sketchy, but it works something like this. The standard PA command is followed by a matrix of 0's and 1's, with a 0 indicating a fixed parameter value in that position, and a 1 indicating a free parameter. If you use that approach, LISREL will automatically assign a new parameter number to each free parameter, and they will be assumed to be different parameters. However, you have another option. If your PA matrix has some values other than 1, they are interpreted as parameter number codes. This allows you to constrain elements in a matrix to be equal to each other, because any parameter given a particular number will automatically be constrained to be equal to any parameter with the same number. Here is an example. Suppose that, in a Theta-Epsilon is diagonal and free. If you had the following command, you would constrain all its elements to be equal

```
PA TE
20
20
20
```

On the other hand, the following would allow the 3rd error variance to differ from the first two, while forcing the first two to be equal.

```
PA TE
20
20
21
```

(g) After changing the LISREL model to agree with the model in R, refit the model. You should now see coefficients that are very close to being exactly equal to the corresponding coefficients in R. Take a look at the standard errors as well.

2. Now, consider Model B. We are going to compare it (after a modification similar to what we did in the previous item) to a corresponding R model. The R model is a standard mixed model with NEWTIME as a level-1 predictor, and FEMALE as a level-2 predictor of both level-1 slopes and level-1 intercepts. The two-level model setup (accompanied by the

standard assumptions) is

$$
\begin{aligned}
Y_{ij} &= \pi_{0i} + \pi_{1i} TIME_{ij} + \epsilon_{ij} \\
\pi_{0i} &= \gamma_{00} + \gamma_{01} FEMALE_i + \zeta_{0i} \\
\pi_{1i} &= \gamma_{10} + \gamma_{11} FEMALE_i + \zeta_{1i}
\end{aligned}
$$

(a) Derive the composite model and set it up in R. (Contact me if you feel stumped.) Then fit it using LMER remembering to use ML estimation.

(b) Set up Model B in LISREL first the way it is in the textbook. In other words, reproduce the textbook results in the second column of Table 8.2.

(c) Then, modify Model B so that it is the same model as the R composite model. Run LISREL again.

(d) Compare the LISREL output with the R output. You should be able to identify the corresponding parameters, which should match to about 3 decimals, at least.