



Latent growth curves for dyadic data

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1. Introduction

Another application of latent growth curves is to dyadic data. Dyadic data analysis refers to the analysis of data from pairs of people, called dyads, using statistical methods. A typical example is the case of couples, where the same data is available for both persons.

In this example, we consider data collected by Larry Kurdek. The topic of interest here is the quality of marriage. For the couples in the study, quality of marriage ratings made using Spanier’s Dyadic Adjustment Scale were made over five annual assessments. Measurements on Spanier’s scale range between 0 and 151.

The first few lines of the data are shown below. Missing data are indicated using the code -9.

	HQUAL1	HQUAL2	HQUAL3	HQUAL4	HQUAL5	WQUAL1	WQUAL2	WQUAL3	WQUAL4	WQUAL5
1	110.00	108.00	109.00	118.00	117.00	111.00	106.00	101.00	109.00	104.00
2	117.00	-9.00	-9.00	-9.00	-9.00	141.00	-9.00	-9.00	-9.00	-9.00
3	131.00	-9.00	-9.00	-9.00	-9.00	131.00	-9.00	-9.00	-9.00	-9.00
4	125.00	121.00	118.00	118.00	117.00	116.00	109.00	96.00	112.00	107.00
5	135.00	126.00	126.00	126.00	120.00	136.00	126.00	132.00	120.00	130.00
6	120.00	109.00	101.00	109.00	105.00	116.00	107.00	106.00	121.00	106.00
7	115.00	-9.00	-9.00	-9.00	-9.00	117.00	-9.00	-9.00	-9.00	-9.00
8	106.00	-9.00	-9.00	-9.00	-9.00	90.00	-9.00	-9.00	-9.00	-9.00
9	111.00	109.00	114.00	114.00	99.00	108.00	113.00	112.00	100.00	106.00
10	117.00	-9.00	-9.00	-9.00	-9.00	129.00	-9.00	-9.00	-9.00	-9.00

To investigate possible decreases in responses over the study period, we first perform data screening using the **Data Screening** option from the **Statistics** menu:

Number of Missing Values	0	1	2	3	4	5	6	7	8
Number of Cases	239	0	33	0	47	0	87	0	132

Effective Sample Sizes
 Univariate (in Diagonal) and Pairwise Bivariate (off Diagonal)

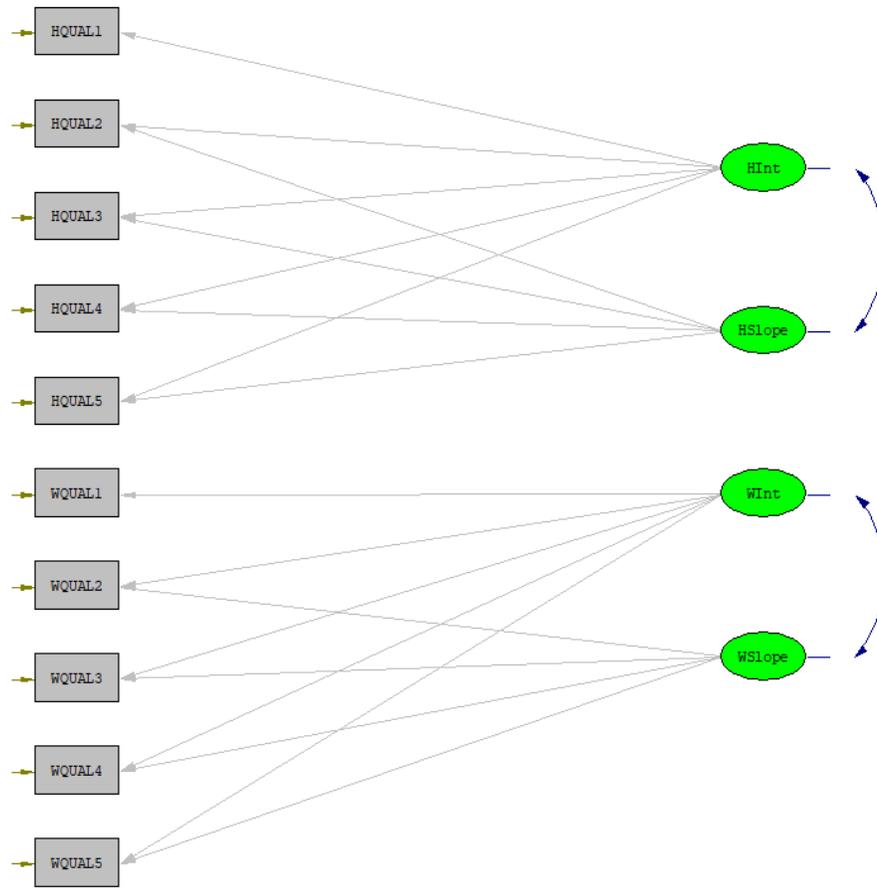
	HQUAL1	HQUAL2	HQUAL3	HQUAL4	HQUAL5	WQUAL1
	-----	-----	-----	-----	-----	-----
HQUAL1	538					
HQUAL2	406	406				
HQUAL3	319	319	319			
HQUAL4	272	272	272	272		
HQUAL5	239	239	239	239	239	
WQUAL1	538	406	319	272	239	538
WQUAL2	406	406	319	272	239	406
WQUAL3	319	319	319	272	239	319
WQUAL4	272	272	272	272	239	272
WQUAL5	239	239	239	239	239	239

	WQUAL2	WQUAL3	WQUAL4	WQUAL5
	-----	-----	-----	-----
WQUAL2	406			
WQUAL3	319	319		
WQUAL4	272	272	272	
WQUAL5	239	239	239	239

We note that roughly half of the original respondents participated at the end of the study. While noting that this is probably not due to missingness at random, as this decrease is likely linked to the quality of marriage, we assume MAR here in order to illustrate the fitting of latent curves to dyadic data.

2. Latent growth curve

The model we want to fit to these data is shown below. For each member of the couple, we want to estimate an intercept and a slope. We assume that the variables Hint and HSlope (Husband's intercept and slope) are correlated. The same assumption is made regarding Wint and WSlope.



The syntax for this model is given below. Note that there all covariances between the husband's intercept and slope and that of the wife are set to 0. We also fix all the paths from the latent variables to the observed variables. In the case of the intercepts, the paths are fixed to 1, and in the case of the slopes to 0, 1, 2, 3, and 4. Finally, we assume equal error variances between measurements for the husband over the study period, and the same applies to the wife's measurements.

```

L dyad1a.sp1
Quality of Marriages
Raw Data from File dyad.lsf
Latent Variables: HInt HSlope WInt WSlope

Relationships

HQUAL1 = 1*HInt 0*HSlope
HQUAL2 = 1*HInt 1*HSlope
HQUAL3 = 1*HInt 2*HSlope
HQUAL4 = 1*HInt 3*HSlope
HQUAL5 = 1*HInt 4*HSlope

WQUAL1 = 1*WInt 0*WSlope
WQUAL2 = 1*WInt 1*WSlope
WQUAL3 = 1*WInt 2*WSlope
WQUAL4 = 1*WInt 3*WSlope
WQUAL5 = 1*WInt 4*WSlope

Equal Error Variances HQUAL1 - HQUAL5
Equal Error Variances WQUAL1 - WQUAL5

Set the covariance between HInt and WInt to 0
Set the covariance between HInt and WSlope to 0
Set the covariance between HSlope and WInt to 0
Set the covariance between HSlope and WSlope to 0

HInt HSlope WInt WSlope = CONST

Path Diagram

End of Problem

```

Partial output is given below. The estimated error variance for husbands is 49.297, lower than that for wives at 54.945. We note a monotone increase in R^2 for wives.

LISREL Estimates (Maximum Likelihood)

Measurement Equations

HQUAL1 = 1.000*HInt, Errorvar.= 49.297, $R^2 = 0.734$
Standerr (2.295)
Z-values 21.484
P-values 0.000
HQUAL2 = 1.000*HInt + 1.000*HSlope, Errorvar.= 49.297, $R^2 = 0.728$
Standerr (2.295)
Z-values 21.484
P-values 0.000
HQUAL3 = 1.000*HInt + 2.000*HSlope, Errorvar.= 49.297, $R^2 = 0.738$
Standerr (2.295)
Z-values 21.484
P-values 0.000
HQUAL4 = 1.000*HInt + 3.000*HSlope, Errorvar.= 49.297, $R^2 = 0.760$
Standerr (2.295)
Z-values 21.484
P-values 0.000

HQUAL5 = 1.000*HInt + 4.000*HSlope, Errorvar.= 49.297, R² = 0.788
 Standerr (2.295)
 Z-values 21.484
 P-values 0.000

WQUAL1 = 1.000*WInt, Errorvar.= 54.945, R² = 0.684
 Standerr (2.563)
 Z-values 21.437
 P-values 0.000

WQUAL2 = 1.000*WInt + 1.000*WSlope, Errorvar.= 54.945, R² = 0.706
 Standerr (2.563)
 Z-values 21.437
 P-values 0.000

WQUAL3 = 1.000*WInt + 2.000*WSlope, Errorvar.= 54.945, R² = 0.743
 Standerr (2.563)
 Z-values 21.437
 P-values 0.000

WQUAL4 = 1.000*WInt + 3.000*WSlope, Errorvar.= 54.945, R² = 0.784
 Standerr (2.563)
 Z-values 21.437
 P-values 0.000

WQUAL5 = 1.000*WInt + 4.000*WSlope, Errorvar.= 54.945, R² = 0.822
 Standerr (2.563)
 Z-values 21.437
 P-values 0.000

Turning to the results for the estimated slopes and intercept, we see significant variation in both intercept and slope for both partners.

Covariance Matrix of Independent Variables

	HInt	HSlope	WInt	WSlope
HInt	136.227 (10.597) 12.855			
HSlope	-4.605 (2.547) -1.808	5.238 (0.929) 5.638		
WInt	- -	- -	119.153 (9.846) 12.102	
WSlope	- -	- -	2.992 (2.653) 1.128	6.928 (1.130) 6.133

Mean Vector of Independent Variables

HInt	HSlope	WInt	WSlope
118.903 (0.565)	-2.435 (0.185)	120.687 (0.544)	-2.858 (0.207)
210.320	-13.164	222.003	-13.837

From the mean vector of independent variables, we see a slightly higher intercept for the wives but a larger decline in reported quality over the study period. The goodness-of-fit statistics indicate that the model does not fit the data.

Global Goodness of Fit Statistics, FIML case

-2ln(L) for the saturated model =	26001.296
-2ln(L) for the fitted model =	26779.410

Degrees of Freedom = 53

Full Information ML Chi-Square

778.114 (P = 0.0000)

Root Mean Square Error of Approximation (RMSEA)

0.159

90 Percent Confidence Interval for RMSEA

(0.150 ; 0.169)

P-Value for Test of Close Fit (RMSEA < 0.05)

0.000

3. Quadratic latent growth curve

To explore whether a quadratic growth curve is more appropriate, we use the LISREL syntax given below.

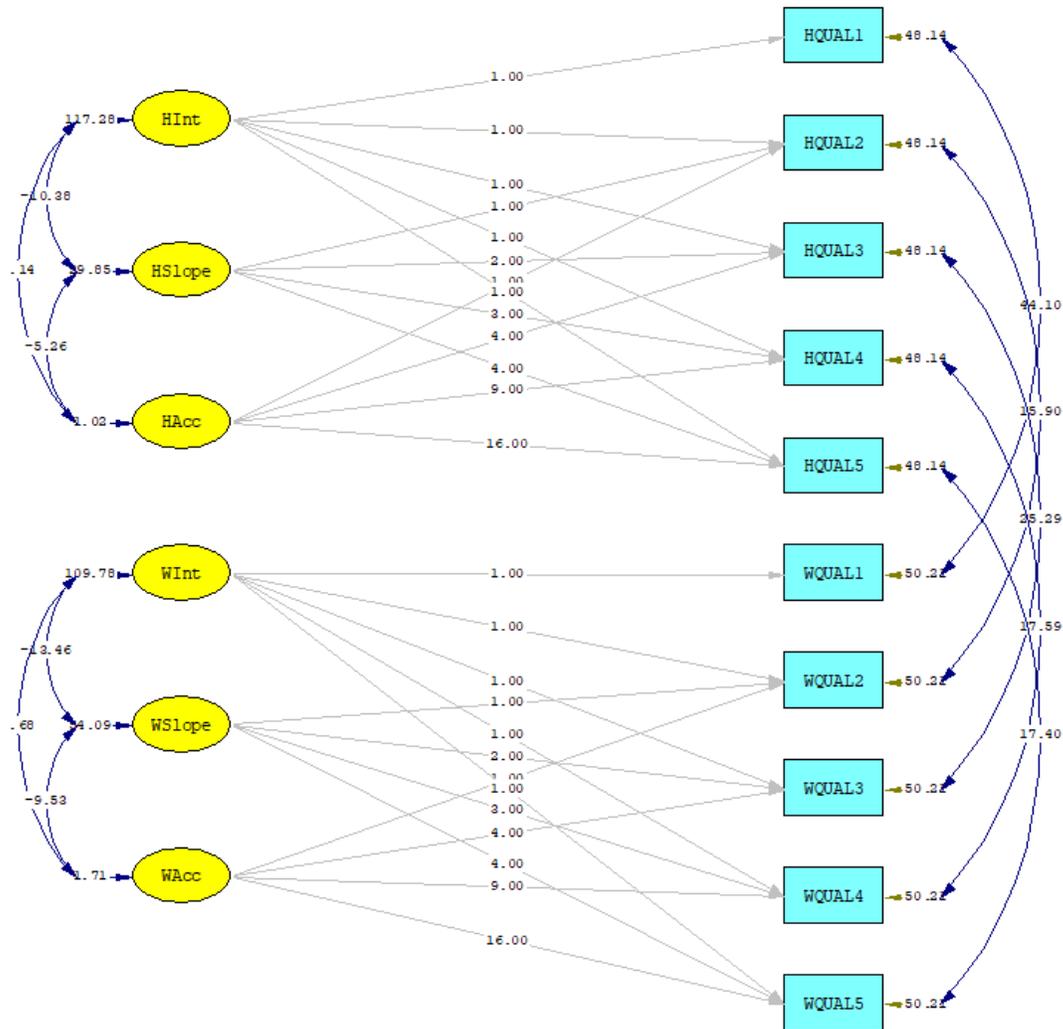
Note that for each partner a section of Λ_x is specified as

$$\Lambda_x = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 2 & 4 \\ 1 & 3 & 9 \\ 1 & 4 & 16 \end{bmatrix} .$$

In this model, we also allow some correlated measurement errors.

```
dyad1bb.lis
Quality of Marriages
da ni=10
ra=dyad.lsf
mo ny=10 ne=6 ps=sy,fr te=sy,fi al=fr
lk
HInt HSlope HAcc WInt WSlope WAcc
ma ly
1 0 0 0 0 0
1 1 1 0 0 0
1 2 4 0 0 0
1 3 9 0 0 0
1 4 16 0 0 0
0 0 0 1 0 0
0 0 0 1 1 1
0 0 0 1 2 4
0 0 0 1 3 9
0 0 0 1 4 16
pa ps
1
1 1
1 1 1
0 0 0 1
0 0 0 1 1
0 0 0 1 1 1
fr te(1,1) te(2,2) te(3,3) te(4,4) te(5,5)
fr te(6,6) te(7,7) te(8,8) te(9,9) te(10,10)
fr te(6,1) te(7,2) te(8,3) te(9,4) te(10,5)
eq te(1,1) te(2,2) te(3,3) te(4,4) te(5,5)
eq te(6,6) te(7,7) te(8,8) te(9,9) te(10,10)
pd
ou
```

The fitted path diagram for this model is



The goodness-of-fit measures indicate that this model is an improvement on the previous model fitted.

Global Goodness of Fit Statistics, FIML case

-2ln(L) for the saturated model = 26001.296
 -2ln(L) for the fitted model = 26391.405

Degrees of Freedom = 40
 Full Information ML Chi-Square 390.109 (P = 0.0000)
 Root Mean Square Error of Approximation (RMSEA) 0.128
 90 Percent Confidence Interval for RMSEA (0.116 ; 0.139)
 P-Value for Test of Close Fit (RMSEA < 0.05) 0.000

4. Hypothesis testing

Another question of interest here is whether the average intercepts and slopes are equal over partners. We illustrate how to test the hypotheses of equal average intercept and equal average slopes in this section, using the linear growth curve discussed in Section 2 as a starting point.

To test the hypothesis of equal average intercept, we use the syntax

```
dyad2b.lis
Quality of Marriages
da ni=10
ra=dyad.lsf
mo nx=10 nk=4 ph=sy,fr ka=fr
lk
HInt HSlope WInt WSlope
ma lx
1 0 0 0
1 1 0 0
1 2 0 0
1 3 0 0
1 4 0 0
0 0 1 0
0 0 1 1
0 0 1 2
0 0 1 3
0 0 1 4
pa ph
1
1 1
0 0 1
0 0 1 1
eq td(1,1)-td(5)
eq td(6)-td(10)
eq ka(1) ka(3)
pd
ou
```

in which the line

eq ka(1) ka(3)

has been added. To test the hypothesis of equal average slope, we use the syntax

```
dyad3b.lis
Quality of Marriages
da ni=10
ra=dyad.lsf
mo nx=10 nk=4 ph=sy,fr ka=fr
lk
HInt HSlope WInt WSlope
ma lx
1 0 0 0
1 1 0 0
1 2 0 0
1 3 0 0
1 4 0 0
0 0 1 0
0 0 1 1
0 0 1 2
0 0 1 3
0 0 1 4
pa ph
1
1 1
0 0 1
0 0 1 1
eq td(1,1)-td(5)
eq td(6)-td(10)
eq ka(2) ka(4)
pd
ou
```

in which the line

$$\text{eq } \alpha(1) \quad \alpha(3)$$

has been amended to refer to the slopes:

$$\text{eq } \alpha(2) \quad \alpha(4)$$

For more on the various hypotheses that can be tested in a similar way, the reader is referred to the *Multivariate Analysis in LISREL* text.