

Latent Variable Cross-lagged Panel Model of Positive and Negative Social Exchanges

Without Correlated Errors Over Time

title: Latent Cross-lag panel model of positive and negative exchanges;

data: file=c:\jason\mplus\semclass\long2.dat; format=28f9.6;
listwise=on;

variable: names = trust emo info tang social comm se
trustf emof infof tangf socialf commf sef
ntrust nemo ninfo ntang nsocial ncomm nse
ntrustf nemof ninfof ntangf nsocialf ncommf nsef;
missing=blank;

analysis: type=general;
estimator=mlm;
!model=nomeanstructure; information=expected;

model: pos by trust (1)
emo (2)
info (3)
tang (4)
social (5)
comm (6)
se (7);
posf by trustf (1)
emof (2)
infof (3)
tangf (4)
socialf (5)
commf (6)
sef (7);
neg by ntrust (8)
nemo (9)
ninfo (10)
ntang (11)
nsocial (12)
ncomm (13)
nse (14);
negf by ntrustf (8)
nemof (9)
ninfof (10)
ntangf (11)
nsocialf (12)
ncommf (13)
nsef (14);
negf on neg pos;
posf on neg pos;
neg with pos;
negf with posf;

output: stdyx;

SUMMARY OF ANALYSIS

Number of groups	1
Number of observations	138
Number of dependent variables	28
Number of independent variables	0
Number of continuous latent variables	4

Estimator	MLM
Information matrix	EXPECTED
Maximum number of iterations	1000
Convergence criterion	0.500D-04
Maximum number of steepest descent iterations	20

TESTS OF MODEL FIT

Chi-Square Test of Model Fit

Value	848.058*
Degrees of Freedom	356
P-Value	0.0000
Scaling Correction Factor for MLM	1.134

* The chi-square value for MLM, MLMV, MLR, ULMSV, WLSM and WLSMV cannot be used for chi-square difference tests. MLM, MLR and WLSM chi-square difference testing is described in the Mplus Technical Appendices at www.statmodel.com. See chi-square difference testing in the index of the Mplus User's Guide.

Chi-Square Test of Model Fit for the Baseline Model

Value	3593.044
Degrees of Freedom	378
P-Value	0.0000

CFI/TLI

CFI	0.847
TLI	0.837

Loglikelihood

H0 Value	-2717.221
H1 Value	-2236.215

Information Criteria

Number of Free Parameters	78
Akaike (AIC)	5590.442
Bayesian (BIC)	5818.768
Sample-Size Adjusted BIC	5572.002
(n* = (n + 2) / 24)	

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.100
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SRMR (Standardized Root Mean Square Residual)

Value	0.079
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WRMR (Weighted Root Mean Square Residual)

Value	1.049
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STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
POS BY				
TRUST	0.829	0.022	37.544	0.000
EMO	0.892	0.017	51.928	0.000
INFO	0.786	0.025	31.897	0.000
TANG	0.706	0.032	22.170	0.000
SOCIAL	0.813	0.026	31.043	0.000
COMM	0.923	0.015	61.471	0.000
SE	0.898	0.015	58.575	0.000
POSF BY				
TRUSTF	0.822	0.026	31.106	0.000
EMOF	0.893	0.015	60.388	0.000
INFOF	0.667	0.033	20.266	0.000
TANGF	0.642	0.036	17.851	0.000
SOCIALF	0.784	0.025	31.782	0.000
COMMF	0.872	0.017	50.738	0.000
SEF	0.842	0.021	39.863	0.000
NEG BY				
NTRUST	0.687	0.043	15.820	0.000
NEMO	0.844	0.025	33.761	0.000
NINFO	0.748	0.025	29.927	0.000
NTANG	0.773	0.032	23.931	0.000
NSOCIAL	0.750	0.028	26.621	0.000
NCOMM	0.892	0.018	50.523	0.000
NSE	0.833	0.026	31.506	0.000
NEGF BY				
NTRUSTF	0.805	0.021	37.724	0.000
NEMOF	0.867	0.017	51.328	0.000
NINFOF	0.792	0.027	29.401	0.000
NTANGF	0.811	0.019	41.762	0.000
NSOCIALF	0.842	0.022	37.736	0.000
NCOMMF	0.921	0.014	63.823	0.000

NSEF		0.864	0.021	41.664	0.000
NEGF	ON				
NEG		0.661	0.061	10.927	0.000
POS		-0.071	0.061	-1.169	0.243
POSF	ON				
NEG		-0.154	0.082	-1.881	0.060
POS		0.650	0.057	11.413	0.000
NEG	WITH				
POS		-0.492	0.081	-6.090	0.000
NEGF	WITH				
POSF		-0.488	0.084	-5.812	0.000

With Correlated Errors Over Time

```

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analysis: type=general;
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          !model=nomeanstructure; information=expected;

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       emo (2)
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       tang (4)
       social (5)
       comm (6)
       se (7);
       posf by trustf (1)
              emof (2)
              infof (3)
              tangf (4)
              socialf (5)
              commf (6)
              sef (7);
       neg by ntrust (8)
              nemo (9)
              ninfo (10)
              ntang (11)
              nsocial (12)
              ncomm (13)
              nse (14);
       negf by ntrustf (8)
              nemof (9)
              ninfof (10)
              ntangf (11)
              nsocialf (12)
              ncommf (13)
              nsef (14);
       negf on neg pos;

       posf on neg pos;
       neg with pos;
       negf with posf;

       trust-se pwith trustf-sef;
       ntrust-nse pwith ntrustf-nsef;

output: stdyx;

```

SUMMARY OF ANALYSIS

Number of groups	1
Number of observations	138
Number of dependent variables	28
Number of independent variables	0
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Estimator	MLM
Information matrix	EXPECTED
Maximum number of iterations	1000
Convergence criterion	0.500D-04
Maximum number of steepest descent iterations	20

TESTS OF MODEL FIT

Chi-Square Test of Model Fit

Value	597.926*
Degrees of Freedom	342
P-Value	0.0000
Scaling Correction Factor for MLM	1.136

* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference tests. MLM, MLR and WLSM chi-square difference testing is described in the Mplus Technical Appendices at www.statmodel.com. See chi-square difference testing in the index of the Mplus User's Guide.

Chi-Square Test of Model Fit for the Baseline Model

Value	3593.044
Degrees of Freedom	378
P-Value	0.0000

CFI/TLI

CFI	0.920
TLI	0.912

Loglikelihood

H0 Value	-2575.867
H1 Value	-2236.215

Information Criteria

Number of Free Parameters	92
Akaike (AIC)	5335.734
Bayesian (BIC)	5605.041
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	5313.984

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.074
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SRMR (Standardized Root Mean Square Residual)

Value	0.076
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WRMR (Weighted Root Mean Square Residual)

Value	0.998
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STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
POS BY				
TRUST	0.829	0.023	36.555	0.000
EMO	0.895	0.017	51.501	0.000
INFO	0.792	0.028	28.353	0.000
TANG	0.693	0.033	21.093	0.000
SOCIAL	0.806	0.030	27.251	0.000
COMM	0.923	0.015	60.844	0.000
SE	0.896	0.017	52.336	0.000
POSF BY				
TRUSTF	0.823	0.026	31.397	0.000
EMOF	0.903	0.014	63.469	0.000
INFOF	0.673	0.035	19.478	0.000
TANGF	0.630	0.037	17.167	0.000
SOCIALF	0.780	0.027	29.095	0.000
COMMF	0.871	0.018	49.659	0.000

SEF	0.838	0.022	37.742	0.000
NEG BY				
NTRUST	0.694	0.042	16.623	0.000
NEMO	0.852	0.026	32.926	0.000
NINFO	0.743	0.028	26.240	0.000
NTANG	0.774	0.036	21.776	0.000
NSOCIAL	0.752	0.031	24.209	0.000
NCOMM	0.886	0.020	44.422	0.000
NSE	0.833	0.028	30.256	0.000
NEGF BY				
NTRUSTF	0.809	0.021	38.696	0.000
NEMOF	0.873	0.017	52.646	0.000
NINFOF	0.788	0.030	26.427	0.000
NTANGF	0.807	0.025	32.891	0.000
NSOCIALF	0.846	0.023	36.534	0.000
NCOMMF	0.919	0.016	58.394	0.000
NSEF	0.865	0.022	39.563	0.000
NEGF ON				
NEG	0.623	0.061	10.182	0.000
POS	-0.098	0.062	-1.582	0.114
POSF ON				
NEG	-0.162	0.082	-1.987	0.047
POS	0.627	0.058	10.834	0.000
NEG WITH				
POS	-0.501	0.080	-6.229	0.000
NEGF WITH				
POSF	-0.460	0.081	-5.663	0.000
TRUST WITH				
TRUSTF	0.238	0.053	4.466	0.000
EMO WITH				
EMOF	0.183	0.070	2.622	0.009
INFO WITH				
INFOF	0.549	0.045	12.118	0.000
TANG WITH				
TANGF	0.480	0.056	8.549	0.000
SOCIAL WITH				
SOCIALF	0.479	0.060	7.996	0.000
COMM WITH				
COMMF	0.084	0.078	1.077	0.282
SE WITH				
SEF	0.295	0.071	4.149	0.000
NTRUST WITH				
NTRUSTF	0.399	0.059	6.725	0.000
NEMO WITH				
NEMOF	0.308	0.065	4.725	0.000
NINFO WITH				
NINFOF	0.462	0.066	6.986	0.000
NTANG WITH				
NTANGF	0.523	0.058	9.076	0.000
NSOCIAL WITH				
NSOCIALF	0.395	0.059	6.685	0.000
NCOMM WITH				
NCOMMF	0.353	0.068	5.206	0.000
NSE WITH				
NSEF	0.385	0.066	5.849	0.000

Latent Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
POSF	0.522	0.060	8.705	0.000
NEGF	0.459	0.064	7.213	0.000

Lavaan (output omitted to save space, and I only include the model with correlated measurement residuals)

```
model = '  
#measurement model parameters with equality constraints over time  
pos =~ ly1*trust + ly2*emo + ly3*info + ly4*tang + ly5*social + ly6*comm + ly7*se  
posf =~ ly1*trustf + ly2*emof + ly3*infof + ly4*tangf + ly5*socialf + ly6*commf + ly7*sef  
neg =~ ly8*ntrust + ly9*nemo + ly10*ninfo + ly11*ntang + ly12*nsocial + ly13*ncomm + ly14*nse  
negf =~ ly8*ntrustf + ly9*nemof + ly10*ninfof + ly11*ntangf + ly12*nsocialf + ly13*ncommf + ly14*nsef  
  
#structural model parameters  
negf ~ neg + pos;  
posf ~ neg + pos;  
neg ~~ pos;  
negf ~~ posf;  
  
#correlated measurement residuals  
trust ~~ trustf  
emo ~~ emof  
info ~~ infof  
tang ~~ tangf  
social ~~ socialf  
comm ~~ commf  
se ~~ sef  
ntrust ~~ ntrustf  
nemo ~~ nemof  
ninfo ~~ ninfof  
ntang ~~ ntangf  
nsocial ~~ nsocialf  
ncomm ~~ ncommf  
nse ~~ nsef  
,  
  
#note: including the correlations between the exogenous variables  
# and endogenous disturbances causes an error, so omit (still estimated by default)  
  
fit = sem(model, data = mydata, missing = 'listwise', estimator="MLM")  
summary(fit, fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)  
#note: listwise deletion and robust estimation used
```

Comments

To save space and paper, I have eliminated testing of invariance constraints. A good first step is to test longitudinal measurement invariance (see Newsom, 2024 for a detailed discussion). I compared a model with loadings not constrained to the second model and found a small but significant difference between the fit of the two models, scaled $\chi^2_{\text{diff}}(12) = 14.433$, $p < .05$, Cohen's $w = .038$, $\Delta\text{NCI} = -.001$. Considering the complexity of the model this lack of invariance is most likely not practically important. It is also important to note in this example that the fit of the model is not quite to recommended levels of the CFI, SRMR, and RMSEA. In subsequent research we modified this measure.

References

Newsom, J.T. (2024). *Longitudinal structural equation modeling: A comprehensive introduction, second edition*. Routledge.