

## Latent Variable Cross-lag 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 inof tangf socialf commf sef  
ntrust nemo ninfo ntang nsocial ncomm nse  
ntrustf nemof ninof 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)  
inof (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)  
ninof (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<br>for MLM | 1.134    |

\* 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](http://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 |
|----------|-------|

SRMR (Standardized Root Mean Square Residual)

|       |       |
|-------|-------|
| Value | 0.079 |
|-------|-------|

WRMR (Weighted Root Mean Square Residual)

|       |       |
|-------|-------|
| Value | 1.049 |
|-------|-------|

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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      listwise=on;

variable: names = trust emo info tang social comm se
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          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;

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         |
| 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                                | 597.926* |
| Degrees of Freedom                   | 342      |
| P-Value                              | 0.0000   |
| Scaling Correction Factor<br>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](http://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<br>(n* = (n + 2) / 24) | 5313.984 |

RMSEA (Root Mean Square Error Of Approximation)

|          |       |
|----------|-------|
| Estimate | 0.074 |
|----------|-------|

SRMR (Standardized Root Mean Square Residual)

|       |       |
|-------|-------|
| Value | 0.076 |
|-------|-------|

WRMR (Weighted Root Mean Square Residual)

|       |       |
|-------|-------|
| Value | 0.998 |
|-------|-------|

STANDARDIZED MODEL RESULTS

STDYX Standardization

|      |         | Estimate | S.E.  | Est./S.E. | Two-Tailed<br>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              |

## Comments

To save space and paper, I have eliminated testing of invariance constraints. A good first step is to test longitudinal measurement invariance test longitudinal invariance. 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,  $\chi^2_{diff}(12) = 14.433, p < .05$ . 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.