

title: categorical ri-clpm using the hat approach

u categorical-ordinal with 5 categories, x binary

WLSMV estimation, probit link

Reference: Muthén, B., Asparouhov, T. & Witkiewitz, K. (2024).

Cross-lagged panel modeling with binary and ordinal outcomes.

Psychological Methods

data: file = riclpm_catbin.dat;

variable:

names = u1-u5 x1-x5;

categorical = u1-x5;

analysis:

estimator = wlsmv;

parameterization = theta;

model:

! random intercepts (correlated by default):

ry by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

! ARs using par-wise ON:

u2^-u5^ pon u1^-u4^;

$x2^{\wedge}-x5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

! cross-lagged effects:

$u2^{\wedge}-u5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

$x2^{\wedge}-x5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}$;

! (residual) variances cannot all be identified for categorical

! covariance:

$u1^{\wedge}$ with $x1^{\wedge}$;

! residual covariances using pair-wise WITH:

$u2^{\wedge}-u5^{\wedge}$ pwith $x2^{\wedge}-x5^{\wedge}$;

output:

tech1 tech10;

title: categorical ri-clpm using the hat approach

u categorical-ordinal with 5 categories, x binary

Bayes estimation, probit link, theta parameterization

Reference: Muthén, B., Asparouhov, T. & Witkiewitz, K. (2024).

Cross-lagged panel modeling with binary and ordinal outcomes.

Psychological Methods

data: file = riclpm_catbin.dat;

variable:

names = u1-u5 x1-x5;

categorical = u1-x5;

analysis:

estimator = bayes;

biterations = (5000);

thin = 10;

proc = 12;

model:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

! ARs using par-wise ON:

$u2^{\wedge}-u5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}$;

$x2^{\wedge}-x5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

! cross-lagged effects:

$u2^{\wedge}-u5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

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! (residual) variances cannot all be identified for categorical

! covariance:

$u1^{\wedge}$ with $x1^{\wedge}$;

! residual covariances using pair-wise WITH:

$u2^{\wedge}-u5^{\wedge}$ pwith $x2^{\wedge}-x5^{\wedge}$;

output:

tech8;

title: categorical ri-clpm using the hat approach

u categorical-ordinal with 5 categories, x continuous

WLSMV estimation, probit link, theta parameterization

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Cross-lagged panel modeling with binary and ordinal outcomes.

Psychological Methods

data:

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file = riclpm_catcont.dat;
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variable:

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names = u1-u5 x1-x5;
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categorical = u1-u5;
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analysis:

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estimator = wlsmv;
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parameterization = theta;
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model:

```
! random intercepts (correlated by default):
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```
riy by u1@1 u2@1 u3@1 u4@1 u5@1;
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```
rix by x1@1 x2@1 x3@1 x4@1 x5@1;
```

! ARs using par-wise ON:

$u2^{\wedge}-u5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}$;

$x2^{\wedge}-x5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

! cross-lagged effects:

$u2^{\wedge}-u5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

$x2^{\wedge}-x5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}$;

! residual variances:

! covariance:

$u1^{\wedge}$ with $x1^{\wedge}$;

! residual covariances using pair-wise WITH:

$u2^{\wedge}-u5^{\wedge}$ pwith $x2^{\wedge}-x5^{\wedge}$;

output:

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Psychological Methods

data:

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file = riclpm_catcont.dat;
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names = u1-u5 x1-x5;
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analysis:

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estimator = bayes;
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biterations = (5000);
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thin = 10;
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proc = 8;
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model:

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! random intercepts (correlated by default):
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riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

! ARs using par-wise ON:

$u2^{\wedge}-u5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}$;

$x2^{\wedge}-x5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

! cross-lagged effects:

$u2^{\wedge}-u5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}$;

$x2^{\wedge}-x5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}$;

! (residual) variances cannot all be identified for u

! covariance:

$u1^{\wedge}$ with $x1^{\wedge}$;

! residual covariances using pair-wise WITH:

$u2^{\wedge}-u5^{\wedge}$ pwith $x2^{\wedge}-x5^{\wedge}$;

output:

tech8;

title: categorical ri-clpm using the hat approach

u categorical-ordinal, x binary

montecarlo:

names = u1-u5 x1-x5;

nobs = 1000;

nreps = 1;

generate = u1-u5(4) x1-x5(1);

categorical = u1-u5 x1-x5;

save = riclpm_catbin.dat;

model population:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

u2^-u5^ pon u1^-u4^*0.2;

x2^-x5^ pon x1^-x4^*0.2;

! cross-lagged effects:

u2^-u5^ pon x1^-x4^*.1;

x2^-x5^ pon u1^-u4^*.1;

! residual variances:

u1^*1; x1^*1;

u2^-u5^*1; x2^-x5^*1;

! covariance:

u1^ with x1^*0.2;

! residual covariances using pair-wise WITH:

u2^-u5^ pwith x2^-x5^*0.1;

[u1\$1*-1 u1\$2*-0.5 u1\$3*0 u1\$4*1];

[u2\$1*-1 u2\$2*-0.5 u2\$3*0 u2\$4*1];

[u3\$1*-1 u3\$2*-0.5 u3\$3*0 u3\$4*1];

[u4\$1*-1 u4\$2*-0.5 u4\$3*0 u4\$4*1];

[u5\$1*-1 u5\$2*-0.5 u5\$3*0 u5\$4*1];

[x1\$1-x5\$1*0];

analysis:

estimator = wlsmv;

parameterization = theta;

model:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

$u2^u - u5^u$ pon $u1^u - u4^{*0.2}$;

$x2^u - x5^u$ pon $x1^u - x4^{*0.2}$;

! cross-lagged effects:

$u2^u - u5^u$ pon $x1^u - x4^{*.1}$;

$x2^u - x5^u$ pon $u1^u - u4^{*.1}$;

! residual variances:

! $u1^{*1}$; ! hard to identify

! $x1^{*1}$;

! $u2^u - u5^{*1}$; ! all (residual) variances can't be identified

! $x2^u - x5^{*1}$;

! covariance:

$u1^u$ with $x1^{*0.2}$;

! residual covariances using pair-wise WITH:

$u2^u - u5^u$ pwith $x2^u - x5^{*0.1}$;

[$u1^1 -1$ $u1^2 -0.5$ $u1^3 *0$ $u1^4 *1$];

[$u2^1 -1$ $u2^2 -0.5$ $u2^3 *0$ $u2^4 *1$];

[$u3^1 -1$ $u3^2 -0.5$ $u3^3 *0$ $u3^4 *1$];

[$u4^1 -1$ $u4^2 -0.5$ $u4^3 *0$ $u4^4 *1$];

[$u5^1 -1$ $u5^2 -0.5$ $u5^3 *0$ $u5^4 *1$];

[$x1^1 -x5^1 *0$];

output:

tech8;

title: categorical ri-clpm using the hat approach

u categorical-ordinal, x binary

montecarlo:

names = u1-u5 x1-x5;

nobs = 1000;

nreps = 1;

generate = u1-u5(4) x1-x5(1);

categorical = u1-u5 x1-x5;

save = riclpm_catbin.dat;

model population:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

u2^-u5^ pon u1^-u4^*0.2;

x2^-x5^ pon x1^-x4^*0.2;

! cross-lagged effects:

u2^-u5^ pon x1^-x4^*.1;

x2^-x5^ pon u1^-u4^*.1;

! residual variances:

u1^*1; x1^*1;

u2^-u5^*1; x2^-x5^*1;

! covariance:

u1^ with x1^*0.2;

! residual covariances using pair-wise WITH:

u2^-u5^ pwith x2^-x5^*0.1;

[u1\$1*-1 u1\$2*-0.5 u1\$3*0 u1\$4*1];

[u2\$1*-1 u2\$2*-0.5 u2\$3*0 u2\$4*1];

[u3\$1*-1 u3\$2*-0.5 u3\$3*0 u3\$4*1];

[u4\$1*-1 u4\$2*-0.5 u4\$3*0 u4\$4*1];

[u5\$1*-1 u5\$2*-0.5 u5\$3*0 u5\$4*1];

[x1\$1-x5\$1*0];

analysis:

estimator = bayes;

biterations = (2000);

thin = 10;

proc = 12;

model:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with $\text{rix}^{*0.5}$;

! ARs using par-wise ON:

$u2^{\wedge}-u5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge*0.2}$;

$x2^{\wedge}-x5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge*0.2}$;

! cross-lagged effects:

$u2^{\wedge}-u5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge*.1}$;

$x2^{\wedge}-x5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge*.1}$;

! residual variances:

! $u1^{\wedge*1}$; ! hard to identify

! $x1^{\wedge*1}$;

! $u2^{\wedge}-u5^{\wedge*1}$; ! all (residual) variances can't be identified

! $x2^{\wedge}-x5^{\wedge*1}$;

! covariance:

$u1^{\wedge}$ with $x1^{\wedge*0.2}$;

! residual covariances using pair-wise WITH:

$u2^{\wedge}-u5^{\wedge}$ pwith $x2^{\wedge}-x5^{\wedge*0.1}$;

[$u1^{\wedge}1^{\wedge*1}$ -1 $u1^{\wedge}2^{\wedge*0.5}$ $u1^{\wedge}3^{\wedge*0}$ $u1^{\wedge}4^{\wedge*1}$];

[$u2^{\wedge}1^{\wedge*1}$ -1 $u2^{\wedge}2^{\wedge*0.5}$ $u2^{\wedge}3^{\wedge*0}$ $u2^{\wedge}4^{\wedge*1}$];

[$u3^{\wedge}1^{\wedge*1}$ -1 $u3^{\wedge}2^{\wedge*0.5}$ $u3^{\wedge}3^{\wedge*0}$ $u3^{\wedge}4^{\wedge*1}$];

[$u4^{\wedge}1^{\wedge*1}$ -1 $u4^{\wedge}2^{\wedge*0.5}$ $u4^{\wedge}3^{\wedge*0}$ $u4^{\wedge}4^{\wedge*1}$];

[$u5^{\wedge}1^{\wedge*1}$ -1 $u5^{\wedge}2^{\wedge*0.5}$ $u5^{\wedge}3^{\wedge*0}$ $u5^{\wedge}4^{\wedge*1}$];

[$x1^{\wedge}1^{\wedge}$ - $x5^{\wedge}1^{\wedge*0}$];

output:

tech8;

title: categorical ri-clpm using the hat approach

u categorical, x continuous

montecarlo:

names = u1-u5 x1-x5;

nobs = 1000;

nreps = 1;

generate = u1-u5(4);

categorical = u1-u5;

save = riclpm_cat.dat;

model population:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

u2^-u5^ pon u1^-u4^*0.2;

x2^-x5^ pon x1^-x4^*0.2;

! cross-lagged effects:

u2^-u5^ pon x1^-x4^*.1;

x2^-x5^ pon u1^-u4^*.1;

! residual variances:

u1^*1; x1^*1;

u2^-u5^*1; x2^-x5^*0.8;

! covariance:

u1^ with x1^*0.2;

! residual covariances using pair-wise WITH:

u2^-u5^ pwith x2^-x5^*0.1;

[u1\$1*-1 u1\$2*-0.5 u1\$3*0 u1\$4*1];

[u2\$1*-1 u2\$2*-0.5 u2\$3*0 u2\$4*1];

[u3\$1*-1 u3\$2*-0.5 u3\$3*0 u3\$4*1];

[u4\$1*-1 u4\$2*-0.5 u4\$3*0 u4\$4*1];

[u5\$1*-1 u5\$2*-0.5 u5\$3*0 u5\$4*1];

analysis:

estimator = wlsmv;

parameterization = theta;

model:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

u2^-u5^ pon u1^-u4^*0.2;

$x2^{\wedge}-x5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}0.2$;

! cross-lagged effects:

$u2^{\wedge}-u5^{\wedge}$ pon $x1^{\wedge}-x4^{\wedge}.1$;

$x2^{\wedge}-x5^{\wedge}$ pon $u1^{\wedge}-u4^{\wedge}.1$;

! residual variances:

! $u1^{\wedge}1$; ! hard to identify

$x1^{\wedge}1$;

! $u2^{\wedge}-u5^{\wedge}1$; ! all (residual) variances can't be identified

$x2^{\wedge}-x5^{\wedge}0.8$;

! covariance:

$u1^{\wedge}$ with $x1^{\wedge}0.2$;

! residual covariances using pair-wise WITH:

$u2^{\wedge}-u5^{\wedge}$ pwith $x2^{\wedge}-x5^{\wedge}0.1$;

[$u1^{\wedge}1^*-1$ $u1^{\wedge}2^*-0.5$ $u1^{\wedge}3^*0$ $u1^{\wedge}4^*1$];

[$u2^{\wedge}1^*-1$ $u2^{\wedge}2^*-0.5$ $u2^{\wedge}3^*0$ $u2^{\wedge}4^*1$];

[$u3^{\wedge}1^*-1$ $u3^{\wedge}2^*-0.5$ $u3^{\wedge}3^*0$ $u3^{\wedge}4^*1$];

[$u4^{\wedge}1^*-1$ $u4^{\wedge}2^*-0.5$ $u4^{\wedge}3^*0$ $u4^{\wedge}4^*1$];

[$u5^{\wedge}1^*-1$ $u5^{\wedge}2^*-0.5$ $u5^{\wedge}3^*0$ $u5^{\wedge}4^*1$];

output:

tech9;

title: categorical ri-clpm using the hat approach

u categorical, x continuous

montecarlo:

names = u1-u5 x1-x5;

nobs = 1000;

nreps = 1;

generate = u1-u5(4);

categorical = u1-u5;

save = riclpm_catcont.dat;

model population:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

u2^-u5^ pon u1^-u4^*0.2;

x2^-x5^ pon x1^-x4^*0.2;

! cross-lagged effects:

u2^-u5^ pon x1^-x4^*.1;

x2^-x5^ pon u1^-u4^*.1;

! residual variances:

u1^*1; x1^*1;

u2^-u5^*1; x2^-x5^*0.8;

! covariance:

u1^ with x1^*0.2;

! residual covariances using pair-wise WITH:

u2^-u5^ pwith x2^-x5^*0.1;

[u1\$1*-1 u1\$2*-0.5 u1\$3*0 u1\$4*1];

[u2\$1*-1 u2\$2*-0.5 u2\$3*0 u2\$4*1];

[u3\$1*-1 u3\$2*-0.5 u3\$3*0 u3\$4*1];

[u4\$1*-1 u4\$2*-0.5 u4\$3*0 u4\$4*1];

[u5\$1*-1 u5\$2*-0.5 u5\$3*0 u5\$4*1];

analysis:

estimator = bayes;

biterations = (2000);

thin = 10;

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model:

! random intercepts (correlated by default):

riy by u1@1 u2@1 u3@1 u4@1 u5@1;

rix by x1@1 x2@1 x3@1 x4@1 x5@1;

riy-rix*1;

riy with rix*0.5;

! ARs using par-wise ON:

$u2^u - u5^u \text{ pon } u1^u - u4^{*0.2};$

$x2^u - x5^u \text{ pon } x1^u - x4^{*0.2};$

! cross-lagged effects:

$u2^u - u5^u \text{ pon } x1^u - x4^{*.1};$

$x2^u - x5^u \text{ pon } u1^u - u4^{*.1};$

! residual variances:

! $u1^{*1};$! hard to identify

$x1^{*1};$

! $u2^u - u5^{*1};$! all (residual) variances can't be identified

$x2^u - x5^{*0.8};$

! covariance:

$u1^u \text{ with } x1^{*0.2};$

! residual covariances using pair-wise WITH:

$u2^u - u5^u \text{ pwith } x2^u - x5^{*0.1};$

$[u1\$1^{*-1} \ u1\$2^{*-0.5} \ u1\$3^{*0} \ u1\$4^{*1}];$

$[u2\$1^{*-1} \ u2\$2^{*-0.5} \ u2\$3^{*0} \ u2\$4^{*1}];$

$[u3\$1^{*-1} \ u3\$2^{*-0.5} \ u3\$3^{*0} \ u3\$4^{*1}];$

$[u4\$1^{*-1} \ u4\$2^{*-0.5} \ u4\$3^{*0} \ u4\$4^{*1}];$

$[u5\$1^{*-1} \ u5\$2^{*-0.5} \ u5\$3^{*0} \ u5\$4^{*1}];$

output:

tech8;