**Appendix: Mplus code for invariance testing**

**TITLE:** Configural invariance; !This model establishes configural invariance

**DATA:** FILE IS dat.csv; **VARIABLE:** NAMES ARE school p1-pp4 g1-gp4;

!items p1-p4 and g1-g4 are from the first administration.

!items pp1-pp4 and gp1-gp4 are from the second administration.

! there are four indicators for peer factor (p1-p4) and four indicators for growth factor (g1-g4) pp and gp indicate

! time 2 measures,

CLUSTER = school; !this defines the variable that is used for clustering MISSING = ALL(-999); !because the survey is anonymously taken, there is missingness across administrations

ANALYSIS: TYPE = TWOLEVEL; ESTIMATOR=ML;

**MODEL:** %WITHIN% !within level is saturated and all item covariances are estimated within administration

p1 with p2-p3 g1-g3 p4 g4; p2 with p3 g1-g3 p4 g4; p3 with g1-g3 p4 g4; g1 with g2 g3 p4 g4; g2 with g3 p4 g4; g3 with p4 g4; p4 with g4; pp1 with pp2-pp3 gp1-gp3 pp4 gp4; pp2 with pp3 gp1-gp3 pp4 gp4; pp3 with gp1-gp3 pp4 gp4; gp1 with gp2 gp3 pp4 gp4; gp2 with gp3 pp4 gp4; gp3 with pp4 gp4; pp4 with gp4;

p1 with pp1-pp4@0; p1 with gp1-gp4@0; p2 with pp1-pp4@0; p2 with gp1-gp4@0; p3 with pp1-pp4@0; p3 with gp1-gp4@0; p4 with pp1-pp4@0; p4 with gp1-gp4@0; g1 with pp1-pp4@0; g1 with gp1-gp4@0; g2 with pp1-pp4@0; g2 with gp1-gp4@0; g3 with pp1-pp4@0; g3 with gp1-gp4@0; g4 with pp1-pp4@0; g4 with gp1-gp4@0;!within schools, items are forced to be uncorrelated across time because teachers cannot be linked across administrations

%BETWEEN%

!PEER factor has four items, and PEER\_P (time 2) has four items.

PEER by p1\* (a) p2 p3 p4; PEER\_P by pp1\* (a) pp2 pp3 pp4;

!PEER and PEER\_P factor variance set to 1

PEER@1; PEER\_P@1;!residual correlations across administrations

p1 with pp1; p2 with pp2; p3 with pp3; p4 with pp4;!GROW factor has four items, and GROW\_P (time 2) has four items.

GROW by g1\* (b) g2 g3 g4; GROW\_P by gp1\* (b) gp2 gp3 gp4;

! GROW and GROW\_P factor variance set to 1

GROW@1; GROW\_P@1;!factor means for PEER and GROW fixed to 0, and PEER\_P and GROW\_P freely estimated

[PEER@0 GROW@0]; [PEER\_P GROW\_P];!residual correlations across administrations

g1 with gp1; g2 with gp2; g3 with gp3; g4 with gp4;!item means are freely estimated

[p1 pp1]; [p2 pp2]; [p3 pp3]; [p4 pp4]; [g1 gp1]; [g2 gp2]; [g3 gp3]; [g4 gp4]; **OUTPUT**: SampStat; Stand;!Output options to output sample statistics and standardized estimates

**TITLE**: Metric invariance; **DATA**: FILE IS dat.csv; VARIABLE: NAMES ARE school p1-pp4 g1-gp4;

! there are four indicators for peer factor (p1-p4) and four indicators for growth factor (g1-g4) pp and gp indicate

! time 2 measures,

**CLUSTER** = school; **MISSING** = ALL(-999); **ANALYSIS**: TYPE = TWOLEVEL; ESTIMATOR=ML;

**MODEL**: %WITHIN% !within level is saturated and all covariances are estimated

p1 with p2-p3 g1-g3 p4 g4; p2 with p3 g1-g3 p4 g4; p3 with g1-g3 p4 g4; g1 with g2 g3 p4 g4; g2 with g3 p4 g4; g3 with p4 g4; p4 with g4; pp1 with pp2-pp3 gp1-gp3 pp4 gp4; pp2 with pp3 gp1-gp3 pp4 gp4; pp3 with gp1-gp3 pp4 gp4; gp1 with gp2 gp3 pp4 gp4; gp2 with gp3 pp4 gp4; gp3 with pp4 gp4; pp4 with gp4; p1 with pp1-pp4@0; p1 with gp1-gp4@0; p2 with pp1-pp4@0; p2 with gp1-gp4@0; p3 with pp1-pp4@0; p3 with gp1-gp4@0; p4 with pp1-pp4@0; p4 with gp1-gp4@0; g1 with pp1-pp4@0; g1 with gp1-gp4@0; g2 with pp1-pp4@0; g2 with gp1-gp4@0; g3 with pp1-pp4@0; g3 with gp1-gp4@0; g4 with pp1-pp4@0; g4 with gp1-gp4@0;!within schools, items are forced to be uncorrelated across time because teachers cannot be linked across administrations

%BETWEEN%! Labels here constrain factor loadings to be equal across occasions

PEER by p1\* (e) p2 (f) p3 (g) p4 (h);

PEER\_P by pp1 \* (e) pp2 (f) pp3 (g) pp4 (h);

PEER@1; PEER\_P@1; p1 with pp1; p2 with pp2; p3 with pp3; p4 with pp4;

! Labels here constrain factor loadings to be equal across administrations

GROW by g1\*(a) g2(b) g3(c) g4(d); GROW\_P by gp1\*(a) gp2 (b) gp3 (c) gp4 (d); GROW@1; GROW\_P@1; g1 with gp1; g2 with gp2; g3 with gp3; g4 with gp4; [PEER@0 GROW@0]; [PEER\_P GROW\_P]; [p1 pp1]; [p2 pp2]; [p3 pp3] ; [p4 pp4]; [g1 gp1]; [g2 gp2] ; [g3 gp3] ; [g4 gp4]; **OUTPUT**:SampStat; Stand;

**TITLE**: Scalar invariance; **DATA**: FILE IS dat.csv; **VARIABLE**: NAMES ARE school p1-pp4 g1-gp4;

! there are four indicators for peer factor (p1-p4) and four indicators for growth factor (g1-g4) pp and gp indicate

! time 2 measures,

CLUSTER = school; MISSING = ALL(-999); ANALYSIS: TYPE = TWOLEVEL; ESTIMATOR=ML;

**MODEL**: %WITHIN% !within level is saturated and all covariances are estimated

p1 with p2-p3 g1-g3 p4 g4; p2 with p3 g1-g3 p4 g4; p3 with g1-g3 p4 g4; g1 with g2 g3 p4 g4; g2 with g3 p4 g4; g3 with p4 g4; p4 with g4; pp1 with pp2-pp3 gp1-gp3 pp4 gp4; pp2 with pp3 gp1-gp3 pp4 gp4; pp3 with gp1-gp3 pp4 gp4; gp1 with gp2 gp3 pp4 gp4; gp2 with gp3 pp4 gp4; gp3 with pp4 gp4; pp4 with gp4; p1 with pp1-pp4@0; p1 with gp1-gp4@0; p2 with pp1-pp4@0; p2 with gp1-gp4@0; p3 with pp1-pp4@0; p3 with gp1-gp4@0; p4 with pp1-pp4@0; p4 with gp1-gp4@0; g1 with pp1-pp4@0; g1 with gp1-gp4@0; g2 with pp1-pp4@0; g2 with gp1-gp4@0; g3 with pp1-pp4@0; g3 with gp1-gp4@0; g4 with pp1-pp4@0; g4 with gp1-gp4@0;!within schools, items are forced to be uncorrelated across time because teachers cannot be linked across administrations

%BETWEEN% PEER by p1\* (e) p2 (f) p3 (g) p4 (h); PEER\_P by pp1 \* (e) pp2 (f) pp3 (g) pp4 (h); PEER@1; PEER\_P@1; p1 with pp1; p2 with pp2; p3 with pp3; p4 with pp4; GROW by g1\*(a) g2(b) g3(c) g4(d); GROW\_P by gp1\*(a) gp2 (b) gp3 (c) gp4 (d); GROW@1; GROW\_P@1; g1 with gp1; g2 with gp2; g3 with gp3; g4 with gp4; [PEER@0 GROW@0 PEER\_P GROW\_P];! Labels here constrain item means to be equal across administrations

[p1 pp1](j); [p2 pp2] (k); [p3 pp3] (l); [p4 pp4] (m); [g1 gp1](n); [g2 gp2] (p); [g3 gp3] (q); [g4 gp4] (r);

**OUTPUT**: SampStat; Stand;

**TITLE**: Strict invariance; **DATA**: FILE IS dat.csv; **VARIABLE**: NAMES ARE school p1-pp4 g1-gp4;

! there are four indicators for peer factor (p1-p4) and four indicators for growth factor (g1-g4) pp and gp indicate

! time 2 measures,

CLUSTER = school; MISSING = ALL(-999); ANALYSIS: TYPE = TWOLEVEL; ESTIMATOR=ML;

**MODEL**: %WITHIN% !within level is saturated and all covariances are estimated

p1 with p2-p3 g1-g3 p4 g4; p2 with p3 g1-g3 p4 g4; p3 with g1-g3 p4 g4; g1 with g2 g3 p4 g4; g2 with g3 p4 g4; g3 with p4 g4; p4 with g4; pp1 with pp2-pp3 gp1-gp3 pp4 gp4; pp2 with pp3 gp1-gp3 pp4 gp4; pp3 with gp1-gp3 pp4 gp4; gp1 with gp2 gp3 pp4 gp4; gp2 with gp3 pp4 gp4; gp3 with pp4 gp4; pp4 with gp4; p1 with pp1-pp4@0; p1 with gp1-gp4@0; p2 with pp1-pp4@0; p2 with gp1-gp4@0; p3 with pp1-pp4@0; p3 with gp1-gp4@0; p4 with pp1-pp4@0; p4 with gp1-gp4@0; g1 with pp1-pp4@0; g1 with gp1-gp4@0; g2 with pp1-pp4@0; g2 with gp1-gp4@0; g3 with pp1-pp4@0; g3 with gp1-gp4@0; g4 with pp1-pp4@0; g4 with gp1-gp4@0;!within schools, items are forced to be uncorrelated across time because teachers cannot be linked across administrations

%BETWEEN% PEER by p1\* (e) p2 (f) p3 (g) p4 (h); PEER\_P by pp1 \* (e) pp2 (f) pp3 (g) pp4 (h);

PEER@1; PEER\_P@1;

p1 with pp1; p2 with pp2; p3 with pp3; p4 with pp4;

GROW by g1\*(a) g2(b) g3(c) g4(d); GROW\_P by gp1\*(a) gp2 (b) gp3 (c) gp4 (d);

GROW@1; GROW\_P@1;

g1 with gp1; g2 with gp2; g3 with gp3; g4 with gp4;

[PEER@0 GROW@0]; [PEER\_P GROW\_P]; [p1 pp1](j); [p2 pp2] (k); [p3 pp3] (l); [p4 pp4] (m); [g1 gp1](n); [g2 gp2] (p); [g3 gp3] (q); [g4 gp4] (r);

! Labels here constrain residual variances to be equal across administrations

p1 (s); p2 (t); p3 (u); p4 (v); g1 (w); g2 (x); g3 (y); g4 (z); pp1 (s); pp2 (t); pp3 (u); pp4 (v); gp1 (w); gp2 (x); gp3 (y); gp4 (z);

**OUTPUT**: SampStat; Stand;