**Web Appendix A:**

**results simulation study 1**

Factors involved in the first simulation study

|  |  |
| --- | --- |
| **Factor** | **Levels** |
| Number of substantive indicators per factor (“nind”) | 4 |
| 8 |
| 12 |
| Magnitude substantive loadings  (“loading”) | .4 |
| .6 |
| Magnitude of the cross-loadings  (“minor”) | -.3 |
| -.2 |
| -.1 |
| 0 |
| .1 |
| .2 |
| .3 |
| True factor correlation (“corr”) | -.5 |
| -.3 |
| -.1 |
| .1 |
| .3 |
| .5 |
| Model | UFA |
| CFA |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ANOVA on 504 conditions**  **Tests of Between-Subjects Effects** | | | | | | |
| **Dependent Variable:** absolute bias = |estimated - true factor correlation| | | | | | | |
| **Source** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Corrected Model | 7.123a | 443 | .016 | 316.957 | .000 |
| Intercept | 4.403 | 1 | 4.403 | 86787.348 | .000 |
| nind | .001 | 2 | .000 | 8.136 | .001 |
| loading | .194 | 1 | .194 | 3817.962 | .000 |
| minor | 1.594 | 6 | .266 | 5238.098 | .000 |
| corr | .121 | 5 | .024 | 475.412 | .000 |
| model | 3.015 | 1 | 3.015 | 59424.966 | .000 |
| corr \* model | .105 | 5 | .021 | 412.190 | .000 |
| loading \* model | .113 | 1 | .113 | 2217.725 | .000 |
| minor \* model | 1.284 | 6 | .214 | 4219.517 | .000 |
| nind \* model | .000 | 2 | .000 | 3.076 | .053 |
| loading \* corr | .019 | 5 | .004 | 76.710 | .000 |
| minor \* corr | .189 | 30 | .006 | 124.365 | .000 |
| nind \* corr | .002 | 10 | .000 | 4.351 | .000 |
| loading \* minor | .073 | 6 | .012 | 240.683 | .000 |
| nind \* loading | .000 | 2 | .000 | 1.055 | .354 |
| nind \* minor | .002 | 12 | .000 | 2.783 | .004 |
| loading \* corr \* model | .019 | 5 | .004 | 75.454 | .000 |
| minor \* corr \* model | .285 | 30 | .009 | 187.256 | .000 |
| nind \* corr \* model | .002 | 10 | .000 | 4.340 | .000 |
| loading \* minor \* model | .048 | 6 | .008 | 157.245 | .000 |
| nind \* loading \* model | .000 | 2 | .000 | .034 | .967 |
| nind \* minor \* model | .001 | 12 | .000 | 1.001 | .459 |
| loading \* minor \* corr | .019 | 30 | .001 | 12.353 | .000 |
| nind \* loading \* corr | .001 | 10 | .000 | 2.490 | .014 |
| nind \* minor \* corr | .005 | 60 | .000 | 1.620 | .032 |
| nind \* loading \* minor | .000 | 12 | .000 | .077 | 1.000 |
| loading \* minor \* corr \* model | .022 | 30 | .001 | 14.452 | .000 |
| nind \* loading \* corr \* model | .001 | 10 | .000 | 2.598 | .011 |
| nind \* minor \* corr \* model | .005 | 60 | .000 | 1.610 | .034 |
| nind \* loading \* minor \* model | .000 | 12 | .000 | .128 | 1.000 |
| nind \* loading \* minor \* corr | .003 | 60 | .000 | 1.037 | .444 |
| Error | .003 | 60 | .000 |  |  |
| Total | 11.528 | 504 |  |  |  |
| Corrected Total | 7.126 | 503 |  |  |  |

R Squared = 1.000

The table below shows the actual estimated factor correlation for the various experimental conditions, averaged across number of indicators per factor and magnitude of the substantive loadings. Table 3 in the main text provides the bias in the factor correlation, i.e., the entry in cell in each column (estimated ρ) minus the column heading (true ρ).

**Estimated versus true factor correlations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Panel A: CFA | | | | | | | |
|  | true ρ | | | | | | cross-  loadings |
| -.5 | -.3 | -.1 | .1 | .3 | .5 |
| estimated ρ | -.80 | -.68 | -.51 | -.26 | .05 | .35 | -.3 |
| -.69 | -.53 | -.34 | -.11 | .13 | .38 | -.2 |
| -.59 | -.40 | -.21 | .00 | .21 | .43 | -.1 |
| -.50 | -.30 | -.10 | .10 | .30 | .50 | .0 |
| -.43 | -.21 | .00 | .21 | .40 | .59 | .1 |
| -.38 | -.13 | .11 | .34 | .53 | .69 | .2 |
| -.35 | -.05 | .26 | .51 | .68 | .80 | .3 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Panel B: UFA | | | | | | | |
|  | true ρ | | | | | | cross-  loadings |
| -.5 | -.3 | -.1 | .1 | .3 | .5 |
| estimated ρ | -.51 | -.31 | -.12 | .07 | .27 | .47 | -.3 |
| -.51 | -.31 | -.12 | .08 | .28 | .48 | -.2 |
| -.51 | -.31 | -.11 | .08 | .28 | .48 | -.1 |
| -.50 | -.30 | -.10 | .10 | .30 | .50 | .0 |
| -.48 | -.28 | -.08 | .11 | .31 | .51 | .1 |
| -.48 | -.28 | -.08 | .12 | .31 | .51 | .2 |
| -.47 | -.27 | -.07 | .12 | .31 | .51 | .3 |

**Web appendix B**

**Results Simulation study 2**

Factors involved in simulation study 2:

|  |  |
| --- | --- |
| **Factor** | **Levels** |
| Magnitude substantive loadings  (“loading”) | .4 |
| .6 |
| Approximation to simple structure  (“struct”) | nearly pure |
| good |
| moderate |
| Factor corr  (“corr”) | .1 |
| .3 |
| .5 |
| Sample size  (“sample”) | 200 |
| 600 |
| 1000 |
| Number of substantive indicators per factor  (“nind”) | 4 |
| 8 |
| Model | UFA |
| CFA |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ANOVA on 216 conditions**  **Tests of Between-Subjects Effects** | | | | | | |
| **Dependent Variable:** bias = |estimated - true factor correlation| | | | | | | |
| **Source** | **Type III Sum of Squares** | **Df** | **Mean Square** | **F** | **Sig.** |
| Corrected Model | 9.772 | 171 | .057 | 207.028 | .000 |
| Intercept | 7.422 | 1 | 7.422 | 26888.278 | .000 |
| loading | .251 | 1 | .251 | 910.439 | .000 |
| struct | 1.561 | 2 | .781 | 2827.901 | .000 |
| corr | .141 | 2 | .071 | 255.804 | .000 |
| sample | .014 | 2 | .007 | 25.255 | .000 |
| nind | .005 | 1 | .005 | 17.887 | .000 |
| model | 5.868 | 1 | 5.868 | 21258.841 | .000 |
| loading \* struct | .033 | 2 | .016 | 58.912 | .000 |
| loading \* corr | .003 | 2 | .002 | 5.591 | .007 |
| loading \* sample | .014 | 2 | .007 | 25.627 | .000 |
| loading \* nind | .003 | 1 | .003 | 9.330 | .004 |
| loading \* model | .053 | 1 | .053 | 192.672 | .000 |
| struct \* corr | .042 | 4 | .011 | 38.409 | .000 |
| struct \* sample | .004 | 4 | .001 | 3.526 | .014 |
| struct \* nind | .001 | 2 | .000 | 1.494 | .236 |
| struct \* model | 1.219 | 2 | .610 | 2208.687 | .000 |
| corr \* sample | .012 | 4 | .003 | 10.663 | .000 |
| corr \* nind | .001 | 2 | .001 | 2.568 | .088 |
| corr \* model | .270 | 2 | .135 | 488.676 | .000 |
| sample \* nind | .002 | 2 | .001 | 2.928 | .064 |
| sample \* model | .017 | 2 | .009 | 31.025 | .000 |
| nind \* model | .003 | 1 | .003 | 10.496 | .002 |
| loading \* struct \* corr | .001 | 4 | .000 | 1.070 | .383 |
| loading \* struct \* sample | .004 | 4 | .001 | 3.417 | .016 |
| loading \* struct \* nind | .000 | 2 | .000 | .694 | .505 |
| loading \* struct \* model | .004 | 2 | .002 | 6.440 | .004 |
| loading \* corr \* sample | .013 | 4 | .003 | 11.473 | .000 |
| loading \* corr \* nind | .003 | 2 | .001 | 5.151 | .010 |
| loading \* corr \* model | .034 | 2 | .017 | 61.273 | .000 |
| loading \* sample \* nind | .002 | 2 | .001 | 3.451 | .041 |
| loading \* sample \* model | .015 | 2 | .007 | 26.521 | .000 |
| loading \* nind \* model | .004 | 1 | .004 | 14.476 | .000 |
| struct \* corr \* sample | .004 | 8 | .000 | 1.718 | .121 |
| struct \* corr \* nind | .000 | 4 | .000 | .270 | .896 |
| struct \* corr \* model | .096 | 4 | .024 | 86.797 | .000 |
| struct \* sample \* nind | .000 | 4 | .000 | .364 | .833 |
| struct \* sample \* model | .004 | 4 | .001 | 3.478 | .015 |
| struct \* nind \* model | .001 | 2 | .000 | 1.464 | .242 |
| corr \* sample \* nind | .003 | 4 | .001 | 2.580 | .050 |
| corr \* sample \* model | .011 | 4 | .003 | 10.396 | .000 |
| corr \* nind \* model | .003 | 2 | .002 | 5.601 | .007 |
| sample \* nind \* model | .002 | 2 | .001 | 4.406 | .018 |
| loading \* struct \* corr \* sample | .004 | 8 | .001 | 1.873 | .089 |
| loading \* struct \* corr \* nind | .001 | 4 | .000 | .887 | .480 |
| loading \* struct \* corr \* model | .013 | 4 | .003 | 11.684 | .000 |
| loading \* struct \* sample \* nind | .000 | 4 | .000 | .324 | .860 |
| loading \* struct \* sample \* model | .003 | 4 | .001 | 3.068 | .026 |
| loading \* struct \* nind \* model | .001 | 2 | .001 | 1.933 | .157 |
| loading \* corr \* sample \* nind | .003 | 4 | .001 | 2.455 | .060 |
| loading \* corr \* sample \* model | .012 | 4 | .003 | 11.236 | .000 |
| loading \* corr \* nind \* model | .002 | 2 | .001 | 3.834 | .029 |
| loading \* sample \* nind \* model | .002 | 2 | .001 | 3.560 | .037 |
| struct \* corr \* sample \* nind | .002 | 8 | .000 | .709 | .682 |
| struct \* corr \* sample \* model | .004 | 8 | .000 | 1.650 | .138 |
| struct \* corr \* nind \* model | .001 | 4 | .000 | .844 | .505 |
| struct \* sample \* nind \* model | .000 | 4 | .000 | .294 | .880 |
| corr \* sample \* nind \* model | .003 | 4 | .001 | 2.386 | .066 |
| Error | .012 | 44 | .000 |  |  |
| Total | 17.207 | 216 |  |  |  |
| Corrected Total | 9.785 | 215 |  |  |  |
| R Squared = .999 | | | | | | | |

**Average bias estimate per experimental condition**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Simple structure** | **Sample size** | **Factor correlation** | **Magnitude substantive loadings** | **Number of substantive loadings per factor** | **Average bias (Estimated minus true factor correlation)** | |
|  |  |  |  |  | UFA | CFA |
| Nearly pure | 200 | .1 | .4 | 4 | .04 | .19 |
| Good | 200 | .1 | .4 | 4 | .02 | .53 |
| Moderate | 200 | .1 | .4 | 4 | -.03 | .74 |
| Nearly pure | 600 | .1 | .4 | 4 | .02 | .20 |
| Good | 600 | .1 | .4 | 4 | .04 | .54 |
| Moderate | 600 | .1 | .4 | 4 | .04 | .74 |
| Nearly pure | 1000 | .1 | .4 | 4 | .01 | .19 |
| Good | 1000 | .1 | .4 | 4 | .02 | .53 |
| Moderate | 1000 | .1 | .4 | 4 | .02 | .74 |
| Nearly pure | 200 | .3 | .4 | 4 | <.01 | .17 |
| Good | 200 | .3 | .4 | 4 | -.07 | .44 |
| Moderate | 200 | .3 | .4 | 4 | -.15 | .59 |
| Nearly pure | 600 | .3 | .4 | 4 | .02 | .18 |
| Good | 600 | .3 | .4 | 4 | .03 | .45 |
| Moderate | 600 | .3 | .4 | 4 | .01 | .60 |
| Nearly pure | 1000 | .3 | .4 | 4 | .01 | .18 |
| Good | 1000 | .3 | .4 | 4 | .01 | .45 |
| Moderate | 1000 | .3 | .4 | 4 | .01 | .60 |
| Nearly pure | 200 | .5 | .4 | 4 | -.09 | .14 |
| Good | 200 | .5 | .4 | 4 | -.29 | .33 |
| Moderate | 200 | .5 | .4 | 4 | -.37 | .43 |
| Nearly pure | 600 | .5 | .4 | 4 | <.01 | .14 |
| Good | 600 | .5 | .4 | 4 | -.03 | .34 |
| Moderate | 600 | .5 | .4 | 4 | -.11 | .44 |
| Nearly pure | 1000 | .5 | .4 | 4 | <.01 | .14 |
| Good | 1000 | .5 | .4 | 4 | -.01 | .34 |
| Moderate | 1000 | .5 | .4 | 4 | -.04 | .44 |
| Nearly pure | 200 | .1 | .6 | 4 | <.01 | .13 |
| Good | 200 | .1 | .6 | 4 | .01 | .37 |
| Moderate | 200 | .1 | .6 | 4 | .01 | .57 |
| Nearly pure | 600 | .1 | .6 | 4 | <.01 | .13 |
| Good | 600 | .1 | .6 | 4 | .01 | .38 |
| Moderate | 600 | .1 | .6 | 4 | .01 | .57 |
| Nearly pure | 1000 | .1 | .6 | 4 | <.01 | .13 |
| Good | 1000 | .1 | .6 | 4 | <.01 | .37 |
| Moderate | 1000 | .1 | .6 | 4 | <.01 | .57 |
| Nearly pure | 200 | .3 | .6 | 4 | <.01 | .12 |
| Good | 200 | .3 | .6 | 4 | <.01 | .32 |
| Moderate | 200 | .3 | .6 | 4 | .01 | .48 |
| Nearly pure | 600 | .3 | .6 | 4 | <.01 | .12 |
| Good | 600 | .3 | .6 | 4 | <.01 | .33 |
| Moderate | 600 | .3 | .6 | 4 | .01 | .49 |
| Nearly pure | 1000 | .3 | .6 | 4 | <.01 | .12 |
| Good | 1000 | .3 | .6 | 4 | <.01 | .33 |
| Moderate | 1000 | .3 | .6 | 4 | <.01 | .48 |
| Nearly pure | 200 | .5 | .6 | 4 | <.01 | .10 |
| Good | 200 | .5 | .6 | 4 | <.01 | .25 |
| Moderate | 200 | .5 | .6 | 4 | <.01 | .37 |
| Nearly pure | 600 | .5 | .6 | 4 | <.01 | .10 |
| Good | 600 | .5 | .6 | 4 | <.01 | .26 |
| Moderate | 600 | .5 | .6 | 4 | <.01 | .37 |
| Nearly pure | 1000 | .5 | .6 | 4 | <.01 | .10 |
| Good | 1000 | .5 | .6 | 4 | <.01 | .25 |
| Moderate | 1000 | .5 | .6 | 4 | <.01 | .37 |
| Nearly pure | 200 | .1 | .4 | 8 | .02 | .19 |
| Good | 200 | .1 | .4 | 8 | .05 | .53 |
| Moderate | 200 | .1 | .4 | 8 | .06 | .74 |
| Nearly pure | 600 | .1 | .4 | 8 | .01 | .19 |
| Good | 600 | .1 | .4 | 8 | .01 | .53 |
| Moderate | 600 | .1 | .4 | 8 | .02 | .74 |
| Nearly pure | 1000 | .1 | .4 | 8 | <.01 | .19 |
| Good | 1000 | .1 | .4 | 8 | .01 | .53 |
| Moderate | 1000 | .1 | .4 | 8 | .01 | .74 |
| Nearly pure | 200 | .3 | .4 | 8 | .02 | .17 |
| Good | 200 | .3 | .4 | 8 | .01 | .44 |
| Moderate | 200 | .3 | .4 | 8 | -.01 | .60 |
| Nearly pure | 600 | .3 | .4 | 8 | <.01 | .17 |
| Good | 600 | .3 | .4 | 8 | .01 | .44 |
| Moderate | 600 | .3 | .4 | 8 | .02 | .60 |
| Nearly pure | 1000 | .3 | .4 | 8 | <.01 | .18 |
| Good | 1000 | .3 | .4 | 8 | .01 | .45 |
| Moderate | 1000 | .3 | .4 | 8 | .01 | .60 |
| Nearly pure | 200 | .5 | .4 | 8 | <.01 | .14 |
| Good | 200 | .5 | .4 | 8 | -.12 | .34 |
| Moderate | 200 | .5 | .4 | 8 | -.19 | .44 |
| Nearly pure | 600 | .5 | .4 | 8 | <.01 | .14 |
| Good | 600 | .5 | .4 | 8 | <.01 | .34 |
| Moderate | 600 | .5 | .4 | 8 | <.01 | .44 |
| Nearly pure | 1000 | .5 | .4 | 8 | <.01 | .14 |
| Good | 1000 | .5 | .4 | 8 | <.01 | .34 |
| Moderate | 1000 | .5 | .4 | 8 | .01 | .44 |
| Nearly pure | 200 | .1 | .6 | 8 | <.01 | .13 |
| Good | 200 | .1 | .6 | 8 | <.01 | .37 |
| Moderate | 200 | .1 | .6 | 8 | .01 | .55 |
| Nearly pure | 600 | .1 | .6 | 8 | <.01 | .13 |
| Good | 600 | .1 | .6 | 8 | <.01 | .37 |
| Moderate | 600 | .1 | .6 | 8 | <.01 | .55 |
| Nearly pure | 1000 | .1 | .6 | 8 | <.01 | .13 |
| Good | 1000 | .1 | .6 | 8 | <.01 | .37 |
| Moderate | 1000 | .1 | .6 | 8 | <.01 | .55 |
| Nearly pure | 200 | .3 | .6 | 8 | <.01 | .12 |
| Good | 200 | .3 | .6 | 8 | <.01 | .32 |
| Moderate | 200 | .3 | .6 | 8 | <.01 | .48 |
| Nearly pure | 600 | .3 | .6 | 8 | <.01 | .12 |
| Good | 600 | .3 | .6 | 8 | <.01 | .32 |
| Moderate | 600 | .3 | .6 | 8 | <.01 | .48 |
| Nearly pure | 1000 | .3 | .6 | 8 | <.01 | .12 |
| Good | 1000 | .3 | .6 | 8 | <.01 | .32 |
| Moderate | 1000 | .3 | .6 | 8 | <.01 | .48 |
| Nearly pure | 200 | .5 | .6 | 8 | <.01 | .10 |
| Good | 200 | .5 | .6 | 8 | <.01 | .25 |
| Moderate | 200 | .5 | .6 | 8 | <.01 | .37 |
| Nearly pure | 600 | .5 | .6 | 8 | <.01 | .10 |
| Good | 600 | .5 | .6 | 8 | <.01 | .25 |
| Moderate | 600 | .5 | .6 | 8 | <.01 | .37 |
| Nearly pure | 1000 | .5 | .6 | 8 | <.01 | .10 |
| Good | 1000 | .5 | .6 | 8 | <.01 | .25 |
| Moderate | 1000 | .5 | .6 | 8 | <.01 | .37 |

**Web Appendix C**

**measurement instruments svs application**

|  |  |  |
| --- | --- | --- |
| Construct | Label in data file | Items |
| Power  Achievement  Hedonism  Stimulation  Self-direction  Concern for nature  Social concern  Benevolence  Tradition/  Conformity  Security | q140  q157  q146  q160  q181  q171  q163  q168  q141  q176  q144  q166  q155  q149  q142  q160b  q179  q170  q158  q154  q167  q164  q156  q159  q139  q150  q175  q173  q180  q162  q178  q165  q172  q177  q151  q161  q145  q174  q152  q169  q153  q147  q143  q182  q148 | SOCIAL POWER (control over others, dominance)  AUTHORITY (the right to lead or command)  WEALTH (material possessions, money)  PRESERVING MY PUBLIC IMAGE (protecting my face)  SUCCESSFUL (achieving goals)  CAPABLE (competent, effective, efficient)  AMBITIOUS (hard-working, aspiring)  INFLUENTIAL (having an impact on people and events)  PLEASURE (gratification of desires)  ENJOYING LIFE (enjoying food, sex, leisure, etc.)  AN EXCITING LIFE (stimulating experiences)  DARING (seeking adventure, risk)  A VARIED LIFE (filled with challenge, novelty and change)  CREATIVITY (uniqueness, imagination)  FREEDOM (freedom of action and thought)  INDEPENDENT  CURIOUS (interested in everything, exploring)  CHOOSING OWN GOALS (selecting own purposes)  A WORLD OF BEAUTY (beauty of nature and the arts)  UNITY WITH NATURE (fitting into nature)  PROTECTING THE ENVIRONMENT (preserving nature)  BROADMINDED (tolerant of different ideas and beliefs)  WISDOM (a mature understanding of life)  SOCIAL JUSTICE (correcting injustice, care for the weak)  EQUALITY (equal opportunity for all)  A WORLD AT PEACE (free of war and conflict)  HELPFUL (working for the welfare of others)  HONEST (genuine, sincere)  FORGIVING (willing to pardon others)  LOYAL (faithful to my friends, group)  RESPONSIBLE (dependable, reliable)  HUMBLE (modest, self-effacing)  ACCEPTING MY PORTION IN LIFE (submitting to life's circumstances)  DEVOUT (holding to religious faith and belief)  RESPECT FOR TRADITION (preservation of time-honored customs)  MODERATE (avoiding extremes of feeling and action)  POLITENESS (courtesy, good manners)  OBEDIENT (dutiful, meeting obligations)  SELF-DISCIPLINE (self-restraint, resistance to temptation)  HONORING OF PARENTS AND ELDERS (showing respect)  FAMILY SECURITY (safety for loved ones)  NATIONAL SECURITY (protection of my nation from enemies)  SOCIAL ORDER (stability of society)  CLEAN (neat, tidy)  RECIPROCATION OF FAVORS (avoidance of indebtedness) |
| Materialism2) | q68  q73  q83  q92  q96  q103 | I admire people who own expensive homes, cars, and clothes.  Some of the most important achievements in life include acquiring material possessions.  I don't place much emphasis on the amount of material objects people own as a sign of success. (r)  The things I own say a lot about how well I am doing in life.  I like to own things that impress people.  I don't pay much attention to the material objects other people own. (r) |
| Satisfaction with life | q43  q44  q45  q46  q47 | In most ways my life is close to ideal  The conditions of my life are excellent  I am satisfied with my life  So far I have gotten the most important things I want in life  If I could live my life over, I would change almost nothing |

Note: Schwartz values were offered in random order. Following Schwartz and Sagiv (1995), the values were in capitals and their elaboration in parentheses as shown above. Materialism items were presented in random order, together with other items. Satisfaction with life items were presented together. Following Schwartz and Sagiv (1995), values were scored on 9 point scale from -1 to 7, with labels Opposed to my values (-1), Not important (0), Important (3) , Very important (6), and Of supreme importance (7). Materialism and satisfaction with life were scored on a five point scale with labels strongly disagree (1), disagree (2), neither agree not disagree (3), agree (4), and strongly agree (5). (r) = reverse coded item.

**Web appendix D**

**factor loadings and factor correlations for ufa and cfa without method factor**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Value type** | **Power** | **Achievement** | **Hedonism** | **Stimula-**  **tion** | **Self-direction** | **Concern for nature** | **Social concern** | **Benevolence** | **Tradition/**  **Conformity** | **Security** |
| Power |  | .13 | .17 | .31 | .09 | .08 | .08 | -.02 | .21 | .04 |
| Achievement | .55 |  | .36 | .24 | .19 | .26 | .19 | .38 | .44 | .10 |
| Hedonism | .57 | .72 |  | .19 | .23 | .12 | .27 | .11 | .16 | .09 |
| Stimulation | .55 | .71 | .77 |  | .31 | .44 | .29 | .20 | .16 | .04 |
| Self-direction | .38 | .96 | .74 | .86 |  | .28 | .30 | .31 | .23 | .15 |
| Concern for nature | .28 | .53 | .52 | .72 | .70 |  | .50 | .37 | .41 | .17 |
| Social concern | .22 | .71 | .55 | .67 | .82 | .85 |  | .39 | .39 | .23 |
| Benevolence | .20 | .82 | .54 | .46 | .77 | .58 | .81 |  | .64 | .26 |
| Tradition/Conformity | .39 | .77 | .43 | .45 | .64 | .58 | .72 | .90 |  | .35 |
| Security | .53 | .83 | .58 | .49 | .69 | .57 | .79 | .84 | .93 |  |

Note: CFA factor correlations are below the diagonal, UFA factor correlations are above the diagonal. We omitted 1’s on the diagonal for readability.

**web Appendix E**

**esem within SEM (ewSEM) to estimate more complex latent variable structural equation models**

As currently developed in psychometrics, models that include interactions between latent variables, quadratic effects of latent variables, dependent variables that are categorical (requiring logistic regression), censored (requiring Tobit regression), or are count data (requiring Poisson or negative binomial regression) can be estimated without difficulty in Mplus using CFA/SEM but not with ESEM. However, as any ESEM model can be reformulated as an EwSEM model—which is in fact a highly saturated CFA/SEM model, these complex models can also be estimated if UFA turns out to be the preferred measurement model.

Recall that in ESEM items are grouped in sets (1, 2, etc.) Suppose we use 3 sets (groups) of items: items loading on independent constructs, items loading on mediating constructs, and items loading on dependent constructs. Within each UFA group of items, there are *m2* identification constraints among the model parameters, with *m* being the number of factors in this group (independent, mediating, or dependent) (Jöreskog 1969).[[1]](#footnote-1) The researcher needs to fix *m2* parameters within each UFA group to their estimated values as follows: 1) constrain the *m* factor variances to 1; 2) select a reference indicator for each factor that has a large substantive loading and small cross-loadings; fix the small cross-loadings to their estimated values as obtained in the set-UFA solution. This introduces *m*(*m-1*) additional model constraints. The other factor loadings are freely estimated. With this model specification, there is no target rotation involved – in fact it is a highly saturated CFA model, which can be seamlessly integrated into SEM. The resulting SEM model, referred to as ESEM within SEM (EwSEM) can be used to estimate structural relations in more complex research contexts.

For *purely illustrative purposes*, we show how some key modifications to the linear main-effects SEM model can be implemented in the context of the second empirical illustration. Let us suppose we are interested in testing certain quadratic and interaction effects of the E-S-QUAL dimensions on value and loyalty. More specifically, let us just assume that we hypothesize that the effect of system availability and privacy on value shows diminishing returns (suggesting a quadratic effect that is negative), and that efficiency and system availability exhibit a synergistic effect on both value and loyalty (suggesting a positive interaction term). The structural part of this extended model is given by:

VALUE = b1\*EFFIC + b2\*AVAIL + b3\*FULFILL + b4\*PRIV + b5 EFFIC\*AVAIL + b6AVAIL2 + b7\*PRIV2

LOYALTY = b1\*EFFIC + b2\*AVAIL + b3\*FULFILL + b4\*PRIV + b5 EFFIC\*AVAIL

Extension to more quadratic and interaction effects is immediate. These effects cannot be estimated with ESEM but can be estimated with EwSEM.

For E-S-Qual, we already used an EwSEM model, so you just add the quadratic and interaction effects. Estimation will take longer as it requires numerical integration. You now have interactions and quadratic effects among latent variables, unbiased by measurement error. See Mplus input file 1 below.

This procedure can be used when the dependent variable is non-metric. Again, reformulate ESEM as EwSEM and the implementation is straightforward. In another study, we collected data on susceptibility to normative influence (SNI), consumer ethnocentrism (CET), and environmental consciousness (ECO), as well as consumer attitudes toward consumer culture (ALCC). ALCC was measured using six consumption domains: entertainment, home furnishing, clothing, food, lifestyle and brands. Respondents selected one out of four response options. ALCC is operationalized as the number of times that the respondent chose the response option that expressed a strong, exclusive preference for the local consumption. Thus, ALCC is measured as a count variable, ranging from 0 to 6. We are interested in the effects of SNI, CET, and ENV on ALCC. The three predictors were modeled with UFA. However, since ALCC is a count variable, the appropriate model is Poisson regression or negative binomial regression, which is not possible with ESEM. Therefore, we reformulated the measurement model as EwSEM—constraining the \*variances to one. Mplus input file 2 below provides the input file for the negative binomial regression model. Again, for illustrative purposes, we also include the interaction effects between the predictors.

**Mplus input file 1**[[2]](#footnote-2)

TITLE: Interaction and quadratic effects EwSEM analysis E-S-QUAL

DATA:

FILE IS esqual amazon.csv;

VARIABLE: NAMES ARE EFF1-EFF8 SYS1-SYS4 FUL1-FUL7 PRI1-PRI3

VAL1-VAL4 LOY1-LOY5;

ANALYSIS:

TITLE: EwSEM normative constructs with quadratic and interaction effects

DATA: FILE IS second illustration.DAT;

VARIABLE:

NAMES ARE SNI1-SNI8 CET1-CET4 ENV1-ENV3 NA1-NA10 ALCC;

usevariables are SNI1-SNI8 CET1-CET4 ENV1-ENV3 NA1-NA10 alcc;

ANALYSIS:

! Note in this case, the ANALYSIS command is much different as estimating

! quadratic effects and interactions between latent variables requires

! numerical integration

ESTIMATOR = MLR;

TYPE = RANDOM;

ALGORITH = INTEGRATION;

ITERATIONS=1000;

MITERATIONS = 1000;

MODEL:

! The measurement part is the same as in the file EwSEM analysis E-S QUAL scale !(Appendix F). We will not repeat that here.

VALUE LOYALTY ON EFFIC-PRIVACY; !Straightforward linear effects

AVAILSQ | AVAIL XWITH AVAIL;

! Latent variable interactions are specified by using the | statement in

! combination with the XWITH option of the MODEL command. The name on the

! left-hand side of the | symbol names the latent variable interaction.

! The XWITH statement on the right-hand side of the | symbol defines the

! latent variable interaction, in this case the interaction of AVAIL with

! itself, which is the quadratic effect

PRIVSQ | PRIVACY XWITH PRIVACY;

EFFIXAV | EFFIC XWITH AVAIL; ! Interaction term

VALUE ON EFFIXAV AVAILSQ PRIVSQ;

!specifies interactions and quadratic effects on VALUE

LOYALTY ON EFFIXAV;

!specifies interactions and quadratic effects on VALUE

OUTPUT: STDYX;

**Mplus input file 2**

TITLE: EwSEM alcc on SNI, CET ECO using negative binomial regression

DATA: FILE IS ALCC.DAT;

VARIABLE:

NAMES ARE SNI1-SNI8 CET1-CET4 ENV1-ENV3 NA1-NA10 ALCC;

usevariables are SNI1-SNI8 CET1-CET4 ENV1-ENV3 ALCC;

count is alcc (NB);

! By defining the dependent variable in the structural model as count

! variable, Mplus automatically uses Poisson regression. By adding (nb)

! in parentheses, Mplus uses negative binomial regression

ANALYSIS:

ESTIMATOR = MLR;

TYPE = RANDOM;

ALGORITH = INTEGRATION;

ITERATIONS = 1000;

MITERATIONS = 1000;

MODEL:

sni BY SNI1\*0.47578;

sni BY SNI2\*0.58093;

sni BY SNI3\*0.39956;

sni BY SNI4\*0.53748;

sni BY SNI5\*0.62815;

sni BY SNI6\*0.54007;

sni BY SNI7\*0.56226;

sni BY SNI8\*0.54274;

sni BY CET1\*0.05066;

sni BY CET2\*0.00752;

sni BY CET3@-0.01609;

sni BY CET4\*-0.01987;

sni BY ENV1\*0.00236;

sni BY ENV2@-0.01980;

sni BY ENV3\*0.01993;

cet BY SNI1\*-0.02102;

cet BY SNI2\*-0.05138;

cet BY SNI3\*0.01961;

cet BY SNI4\*-0.02540;

cet BY SNI5@-0.01960;

cet BY SNI6\*0.05694;

cet BY SNI7\*-0.00331;

cet BY SNI8\*0.04815;

cet BY CET1\*0.51836;

cet BY CET2\*0.65097;

cet BY CET3\*0.75036;

cet BY CET4\*0.77027;

cet BY ENV1\*-0.00922;

cet BY ENV2@-0.00803;

cet BY ENV3\*0.01844;

eco BY SNI1\*-0.03539;

eco BY SNI2\*0.02923;

eco BY SNI3\*0.06532;

eco BY SNI4\*0.00673;

eco BY SNI5@-0.01515;

eco BY SNI6\*0.03105;

eco BY SNI7\*0.00445;

eco BY SNI8\*-0.03785;

eco BY CET1\*-0.03039;

eco BY CET2\*0.01887;

eco BY CET3@0.00516;

eco BY CET4\*0.00009;

eco BY ENV1\*0.51408;

eco BY ENV2\*0.84274;

eco BY ENV3\*0.81818;

sni@1;

cet@1;

eco@1;

alcc ON SNI-ECO; ! main effects

SNIxCET | SNI XWITH CET;

! SPECIFIES LATENT VARIABLE interaction BETWEEN SNI AND ECO

SNIxECO | SNI XWITH ECO;

CETxECO | CET XWITH ECO;

alcc ON SNIxSCET SNIxECO CETxECO; ! interaction effects

OUTPUT:

1. These identification constraints are automatically implemented by Mplus. The researcher can review them by inserting the command TECH1 on the OUTPUT line. [↑](#footnote-ref-1)
2. Explanatory comments in green and preceded by an exclamation point (!). [↑](#footnote-ref-2)