**day 2 - Solutions**

***Exercise 1: replicate SAPI results***

For most of the replicated analyses, the results are shown in today's lecture slides, so you can compare your answers with the lecture slides. Below, some results are shown that cannot be checked with the lecture slides. The answers provided for question e and f provided below, are based on input where the variables Q196, Q98 were deleted.

**c)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scaling Method** | Chi-square value, df, p-value | Factor loading Q77 | Factor loading  Q84 | Factor loading  Q170 | Factor loading  Q196 | Factor variance |
| Reference Group | 57.075, 2, ~0.000 | 0.835 | 0.591 | 0.473 | 0.619 | 1 |
| Marker Variable – Q | 57.075, 2, ~0.000 | 1 | .708 | .567 | .742 | .696 |
| Marker Variable Bonus – Q | 57.075, 2, ~0.000 | 1.347 | 0.953 | .764 | 1 | .384 |

The first thing you will notice is that all chi-square fit results are exactly the same across the models. This is because the different ways of scaling all result in equivalent statistical models. You don’t estimate anything more or less with any of the three scaling methods.

The second thing you may notice is that the values of the loadings have changed. However, loadings that are relatively large (or small) in one model, are also relatively large (or small) in the other models. For example, in each model, the loading for Q77 is ~1.4 times as large as the loading of Q84.

The take home message is that it does not matter how you scale, the information that you get is the same.

**e) EFA Note:** The answers provided for question e and f provided below, are based on input where the variables Q196, Q98 were deleted (question d & e).

GEOMIN ROTATED LOADINGS (\* significant at 5% level)

1 2

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Q77 0.981\* 0.000

Q84 0.381\* 0.245\*

Q170 0.208\* 0.256\*

Q44 -0.162\* 0.634\*

Q63 0.030 0.532\*

Q76 0.005 0.542\*

GEOMIN FACTOR CORRELATIONS (\* significant at 5% level)

1 2

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

1 1.000

2 0.476\* 1.000

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.000

90 Percent C.I. 0.000 0.042

Probability RMSEA <= .05 0.980

CFI/TLI

CFI 1.000

TLI 1.004

GEOMIN FACTOR CORRELATIONS (\* significant at 5% level)

1 2

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

1 1.000

2 0.476\* 1.000

**f) CFA Note:** The answers provided for question e and f provided below, are based on input where the variables Q196, Q98 were deleted.

MODEL FIT INFORMATION

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.061

90 Percent C.I. 0.042 0.081

Probability RMSEA <= .05 0.155

CFI/TLI

CFI 0.962

TLI 0.929

MODEL RESULTS

Two-Tailed

Estimate S.E. Est./S.E. P-Value

FUN BY

Q77 1.000 0.000 999.000 999.000

Q84 0.821 0.066 12.408 0.000

Q170 0.496 0.050 9.972 0.000

LIKED BY

Q44 1.000 0.000 999.000 999.000

Q63 1.411 0.148 9.507 0.000

Q76 1.455 0.156 9.357 0.000

FUN WITH

LIKED 0.228 0.025 9.083 0.000

Variances

FUN 0.667 0.069 9.692 0.000

LIKED 0.206 0.033 6.176 0.000

Exercise 2 – multigroup

2a. See the most relevant standardized output below. The effect of covert on sw appears to be stronger for females (-0.478) than males (-0.438) and reverse for the effect of overt (-0.161 for males compared to -0.112 for females). However, the confidence intervals for SW on Covert and Overt show a large overlap for males and females. Additionally, the regression coefficients for the males are included in the confidence intervals for the females and vice versa. With this in mind, in the next question we are going to test whether the differences between "SW on Covert" and "SW on Overt" are statistically significant.

MODEL RESULTS

Group MALE

SW ON

COVERT **-0.497** 0.039 -12.818 0.000

OVERT **-0.278** 0.059 -4.719 0.000

Group FEMALE

SW ON

COVERT **-0.558** 0.045 -12.295 0.000

OVERT **-0.232** 0.081 -2.871 0.004

STANDARDIZED MODEL RESULTS

STDYX Standardization

Two-Tailed

Estimate S.E. Est./S.E. P-Value

Group MALE

SW ON

COVERT **-0.438** 0.031 -13.920 0.000

OVERT **-0.161** 0.034 -4.759 0.000

Group FEMALE

SW ON

COVERT **-0.478** 0.035 -13.600 0.000

OVERT **-0.112** 0.039 -2.882 0.004

CONFIDENCE INTERVALS OF STANDARDIZED MODEL RESULTS

STDYX Standardization

Lower .5% Lower 2.5% Lower 5% Estimate Upper 5% Upper 2.5% Upper .5%

Group MALE

SW ON

COVERT -0.519 **-0.500** -0.490 -0.438 -0.386 **-0.377** -0.357

OVERT -0.249 **-0.228** -0.217 -0.161 -0.106 **-0.095** -0.074

Group FEMALE

SW ON

COVERT -0.569 **-0.547** -0.536 -0.478 -0.420 **-0.409** -0.388

OVERT -0.211 **-0.188** -0.175 -0.112 -0.048 **-0.036** -0.012

2b

Chi-Square Test of Model Fit

Value 0.000

Degrees of Freedom 0

P-Value 0.0000

Chi-Square Contribution From Each Group

MALE 0.000

FEMALE 0.000

Wald Test of Parameter Constraints

Value 2.014

Degrees of Freedom 1

P-Value 0.1559

The wald-test tests whether the constraint holds (so whether b1 and b2 are equivalent). This test is insignificant, so we conclude that there is no evidence for a difference among b1 and b2.

exercise 3

***3a.***There are 571 subjects.

MODEL FIT INFORMATION

Log likelihood

H0 Value -3237.059

H1 Value -3232.858

Information Criteria

Akaike (AIC) 6504.117

Bayesian (BIC) 6569.328

Sample-Size Adjusted BIC 6521.710

(n\* = (n + 2) / 24)

Chi-Square Test of Model Fit

Value 8.401

Degrees of Freedom 5

P-Value 0.1355

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.035

90 Percent C.I. 0.000 0.074

Probability RMSEA <= .05 0.693

CFI/TLI

CFI 0.996

TLI 0.991

SRMR (Standardized Root Mean Square Residual)

Value 0.016

Using the rules of thumb provided in yesterday's lecture slides, we can conclude that the fit of the model is acceptable (RMSEA < .06, SRMR < .08, CFI/TLI > .95).

Item 2 has the weakest contribution to the factor. Its standardized factor loading is 0.494, the factor explains 24.4% of its variance.

***3b.*** There are 190 subjects in the group ELSE and 379 in the group PARTNER.

The configural model fits the data (chi-square = 11.329, *p* = .33 ). From there on, you evaluate whether the more constrained model does not fit the data worse than the less constrained model. The statistics below show that the metric invariance model does not fit worse than the configural model, and after that, that the scalar model does not fit worse than respectively the configural and the metric model.

In SEM, we always prefer *parsimony*: the model with the most df. Thus, we prefer the scalar invariance model, where both factor loadings and intercepts are constrained . Since the latent variable in the scalar model means the same thing across the two groups, we can compare values on the latent variable.

Degrees of

Models Compared Chi-square Freedom P-value

Metric against Configural 8.088 4 0.0884

Scalar against Configural 12.968 8 0.1130

Scalar against Metric 4.880 4 0.2998

***3c.*** Constraining the residual variances can be achieved with the following syntax:

model partner:

b1pss1(a);

b2pss2(b);

b3pss3(c);

b4pss4(d);

b5pss5(e);

model else:

b1pss1(a);

b2pss2(b);

b3pss3(c);

b4pss4(d);

b5pss5(e);

This yields the following Chi-Square Test of Model Fit

Value 34.565

Degrees of Freedom 23

P-Value 0.0574

Akaike (AIC) 6485.343

Bayesian (BIC) 6559.189

The scalar model (see 3b.) yields the following statistics

Information Criteria

Akaike (AIC) 6485.075

Bayesian (BIC) 6580.640

Chi-Square Test of Model Fit

Value 24.297

Degrees of Freedom 18

P-Value 0.1455

Delta chi-square (5) = 10.268, *p*= 0.0622, so the model is not significantly worse. Residual variances are also equal. We always prefer a more parsimonious model (= more df) when we compare two models.

You can use <http://www.fourmilab.ch/rpkp/experiments/analysis/chiCalc.html> to obtain the p-value for the Chi-square difference test.

***Bonus Exercise 1: EFA***

Run an EFA that provides you with a 1 factor and 2 factor solution. Interpret the results for the 2 factor solution.

From the output, we can conclude that the 2 factor structure fits well to the data (Chi-Square Test of Model Fit is not significant, CFI/TLI is > 0.95, and RMSEA is < 0.05) .

Chi-Square Test of Model Fit

Value 4.721

Degrees of Freedom 4

P-Value 0.3172

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.012

90 Percent C.I. 0.000 0.044

Probability RMSEA <= .05 0.979

CFI/TLI

CFI 0.999

TLI 0.996

GEOMIN ROTATED LOADINGS

1 2

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C1 0.533 0.020

C2 0.721 -0.012

C3 0.496 0.183

O1 0.010 0.619

O2 -0.151 0.338

O3 -0.041 0.327

FACTOR STRUCTURE

1 2

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

C1 0.542 0.259

C2 0.716 0.311

C3 0.578 0.405

O1 0.287 0.624

O2 0.000 0.271

O3 0.105 0.308

GEOMIN FACTOR CORRELATIONS

1 2

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

1 1.000

1. 0.448 1.000

**Bonus Exercise 2**

**Model fit of the one-factor model:**

*Information Criteria*

*Akaike (AIC) 14441.007*

*Bayesian (BIC) 14534.668*

*Chi-Square Test of Model Fit*

*Value 88.907*

*Degrees of Freedom 9*

*P-Value 0.0000*

*STDYX Standardization*

*Two-Tailed*

*Estimate S.E. Est./S.E. P-Value*

*ANTI BY*

*C1 0.541 0.028 19.214 0.000*

*C2 0.659 0.028 23.370 0.000*

*C3 0.623 0.028 22.058 0.000*

*O1 0.360 0.032 11.421 0.000*

*O2 0.069 0.034 2.027 0.043*

*O3 0.167 0.033 5.006 0.000*

Examining the 2 factor model the following results are arrived at:

**Model fit of the two-factor model:**

*Information Criteria*

*Akaike (AIC) 14379.829*

*Bayesian (BIC) 14478.694*

*Chi-Square Test of Model Fit*

*Value 25.730*

*Degrees of Freedom 8*

*P-Value 0.0012*

*STDYX Standardization*

*Two-Tailed*

*Estimate S.E. Est./S.E. P-Value*

*COVERT BY*

*C1 0.542 0.028 19.338 0.000*

*C2 0.675 0.029 23.495 0.000*

*C3 0.618 0.029 21.410 0.000*

*OVERT BY*

*O1 0.774 0.086 9.036 0.000*

*O2 0.205 0.037 5.605 0.000*

*O3 0.261 0.043 6.077 0.000*

*OVERT WITH*

*COVERT 0.431 0.055 7.806 0.000*

Comparing the two models (1 and 2 factor) by looking at the AIC/BIC, the two factor solution is preferred: The AIC/BIC of the two factor model is lower than the AIC/BIC of the one-factor model.

The correlation between OVERT and COVERT is 0.431 with a standard error of 0.055. So, the proportion of shared variance is 0.4312 = 0.186 = 18,6%. Note that in the output above we find this in the ‘standardized results’. Whether the unstandardized ‘OVERT WITH COVERT’ can be interpreted as a correlation or a covariance, depends on how the latent variable was scaled. If the factor variances are fixed to 1 (scaling is done via the factor variances), then the ‘unstandardized’ result reflects the factor correlation, otherwise they reflect the covariance.

**Bonus Exercise 3**

Comparing the standardized estimates of the categorical and non-categorical results, we see (in this example) fairly similar results when we treat the variables as categorical rather than continuous. You can see that the loadings and factor correlations (the estimates) appear to be larger. We also see that the O2 variable loads relatively strong on the OVERT variable now compared to the model with continuous indicators.

Remember: the decision to choose for categorical or non-categorical should be theory driven.

*STDYX Standardization*

*Two-Tailed*

*Estimate S.E. Est./S.E. P-Value*

*COVERT BY*

*C1 0.599 0.030 19.939 0.000*

*C2 0.771 0.028 27.574 0.000*

*C3 0.671 0.028 23.924 0.000*

*OVERT BY*

*O1 0.905 0.102 8.882 0.000*

*O2 0.494 0.093 5.321 0.000*

*O3 0.332 0.054 6.173 0.000*

*OVERT WITH*

*COVERT 0.499 0.063 7.929 0.000*