2019R2 STAT6108 Assignment 5

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```r
# import data
male_cov <- getCov(scan('hw5_male(2020).cov'))
female_cov <- getCov(scan('hw5_female(2020).cov'))
```

Model Setup

```r
n_male <- 204
n_female <- 201

sample.cov <- list(male = male_cov, female = female_cov)
sample.nobs <-  list(n_male, n_female)

model <- "
# measurment model
Motivation =~ V1 + V2;
JobCommitment =~ V3 + V4;
JobSatisfaction =~ V5 + V6 + V7;

# structural model
JobCommitment ~  Motivation;
JobSatisfaction ~ JobCommitment +  Motivation;
"
```

a)

multiple group model fitting

```
base_syntax <- measEq.syntax(configural.model = model,
                             sample.cov = sample.cov,
                             sample.nobs = sample.nobs,
                             auto.var = TRUE,
                             ID.fac = "auto.fix.first")

# user-defined parameters
indirect_male <- "indirect_male := beta.2_1.g1 * beta.3_2.g1"
indirect_female <- "indirect_female := beta.2_1.g2 * beta.3_2.g2"

# add user-defined parameters to the @constraints slot
base_syntax@constraints <- c(base_syntax@constraints, indirect_male, indirect_female)

# train model
base_model <- lavaan(model = as.character(base_syntax),
                     sample.cov = sample.cov,
                     sample.nobs = sample.nobs)

# goodness-of-fit measures and parameter estimates
fits_base <- fitMeasures(base_model,
                         fit.measures = c("chisq", "pvalue", "tli", "cfi", "rmsea", "srmr"))
para_base <- parameterEstimates(base_model)
```

- H_0: $\Sigma = \Sigma(\theta)$
- χ^2 test statistics: 34.756; p-value: 0.041.
- H_0 is rejected at $\alpha = .05$.
- Male test statistic: 16.525
- Female test statistic: 18.232

Female test statistic slightly bigger. This indicates the proposed structure does not fit the female sample as well on as the male sample.

We evaluate the indicies according to Hooper, Coughlan, & Mullen (2008).

- NNFI: $0.970 > 0.95$
- CFI: $0.984 > 0.95$
- RMSEA: $0.054 < 0.07$
- SRMR: $0.036 < 0.08$

Goodness-of-fit indices pass threashold across all four major measures

b)

- Wald test p-value for male direct effect $B_{31}^{(F)}$: 0.773
- Wald test p-value for female direct effect $B_{31}^{(M)}$: 0.217
- neither are sigificant at $\alpha = .05$

c)

- Wald test p-value for male indirect effect $B_{21}^{(M)} \cdot B_{32}^{(M)}$: 0.005
- Wald test p-value for female indirect effect $B_{21}^{(F)} \cdot B_{32}^{(F)}$: 0.004
- Both are sigificant at $\alpha = .05$.

For both groups, since only indirect effects are statistically sigificant, the proposed structure is fully mediated.

d)

```r
invariance_syntax <- measEq.syntax(configural.model = base_model,
                                   sample.cov = sample.cov,
                                   sample.nobs = sample.nobs,
                                   ID.fac = "auto.fix.first",
                                   group.equal = "loadings") # fix factor loadings

# user-defined parameters
variance_diff <- "variance_diff := psi.1_1.g1 - psi.1_1.g2"
direct_diff <- "direct_diff := beta.3_1.g1 - beta.3_1.g2"
indirect_diff <- "indirect_diff := indirect_male - indirect_female"

# add user-defined parameters to the @constraints slot
invariance_syntax@constraints <- c(base_syntax@constraints,
                                   variance_diff,
                                   direct_diff,
                                   indirect_diff)

# train model
invariance_model <- lavaan(model = as.character(invariance_syntax),
                     sample.cov = sample.cov,
                     sample.nobs = sample.nobs)

# goodness-of-fit measures and parameter estimates
fits_invar <- fitMeasures(invariance_model,
                        fit.measures = c("chisq", "pvalue", "tli", "cfi", "rmsea", "srmr"))
para_invar <- parameterEstimates(invariance_model)
```

Liklihood ratio test

```r
li_test <- compareFit(base_model, invariance_model)
li_test
```

```
## ################### Nested Model Comparison ########################
## Chi-Squared Difference Test
##
##                  Df    AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## base_model       22 8321.1 8457.2 34.756
## invariance_model 26 8314.2 8434.3 35.879     1.1226       4     0.8907
##
## ####################### Model Fit Indices ###########################
##                   chisq df pvalue   cfi   tli       aic       bic rmsea  srmr
## base_model       34.756† 22   .041 .984  .970  8321.052  8457.184  .054  .036†
## invariance_model 35.879  26   .094 .988† .980† 8314.175† 8434.291† .043† .039
##
## ################## Differences in Fit Indices #######################
##                                df   cfi  tli    aic     bic rmsea  srmr
## invariance_model - base_model  4 0.004 0.01 -6.877 -22.893 -0.01 0.003
```

The χ^2 value is the likelihood-ratio test statistic

- H_0: $\Lambda^{(M)} = \Lambda^{(F)}$
- p-value for likelihood ratio test is: 0.891
- At $\alpha = .05$, H_0 not rejected; weak invariance holds.

Goodness-of-fit of weak invariance model

- H_0: $\Sigma = \Sigma(\theta)$
- χ^2 test statistics: 35.879; p-value: 0.094. H_0 is not rejected at $\alpha = .05$.
- NNFI: $0.980 > 0.95$
- CFI: $0.988 > 0.95$
- RMSEA: $0.043 < 0.07$
- SRMR: $0.039 < 0.08$

The weak invariance model has goodness-of-fit indices pass threashold across all four major measures. χ^2 test of differences is not sigificant. The proposed structure fits the data well and better than the configural model.

e)

- H_0: $\psi_{11}^{(F)} \leq \psi_{11}^{(M)}$
- Point estimate of male variance is greater than that of female by: 0.448
- One sided Wald test p-value for point estimate of difference in motivation variance: 0.012
- At $\alpha = .05$, H_0 rejected.
- There is sigificant evidence indicating male employees are more heterogeneous in terms of their motivation than their female counterparts.

f)

- H_0: $B_{31}^{(M)} = B_{31}^{(F)}$
- Wald test p-value for point estimate of difference in direct effect: 0.257
- At $\alpha = .05$, H_0 not rejected.
- There is no sigificant evidence indicating direct effect of motivation on job satisfaction is not the same in the two groups.

g)

- H_0: $B_{21}^{(M)} \cdot B_{32}^{(M)} = B_{21}^{(F)} \cdot B_{32}^{(F)}$
- Wald test p-value for point estimate of difference in direct: 0.935
- At $\alpha = .05$, H_0 not rejected.
- There is no sigificant evidence indicating mediation effect is moderated by gender.