HW17

We will keep working on the model from our last assignment, though we will now remove factors that were insignificant in our prior study: Reputation (REP) + Policies (POL) + Perceived Website Investment (INV) + Familiarity (FAML) → Perceived Security (SEC) → Trust (TRUST) Note: REP, POL, INV, and FAML are antecedents ; SEC is a mediator ; and TRUST is the outcome

```
library(seminr)
```

```
##
## Attaching package: 'seminr'
```

```
## The following object is masked from 'package:base':
##
##     structure
```

```
sec = read.csv("security_data.csv")

# Measurement Model
sec_mm <- measure(
  form("REP",multi_items("PREP",1:4)),
  reflect("INV", multi_items("PINV",1:3)),
  reflect("POL", multi_items("PPSS",1:3)),
  reflect("FAML","FAML1"),
  reflect("TRUST", multi_items("TRST", 1:4)),
  reflect("SEC",multi_items("PSEC",1:4))
)


#Structural Model
sec_sm <- structure(
```

```
  paths(from = c("REP","INV","POL","FAML"), to = "SEC"),
  paths(from = "SEC", to = "TRUST")
)

#run PLS

sec_pls <- estimate_model(data = sec,
                          measurement_model = sec_mm,
                          structural_model = sec_sm)

## Generating the plsm model
```

Question 1) Let's check the measurement quality criteria for our model.

a). Check item reliability of all factors: i. Reflective factors: $\lambda > 0.70$ " Do items individually share variance with their proper constructs?"

```
sec_pls$outer_loadings

##              REP       INV       POL FAML       SEC     TRUST
## PREP1 0.5620886 0.0000000 0.0000000    0 0.0000000 0.0000000
## PREP2 0.8722937 0.0000000 0.0000000    0 0.0000000 0.0000000
## PREP3 0.9126436 0.0000000 0.0000000    0 0.0000000 0.0000000
## PREP4 0.7501044 0.0000000 0.0000000    0 0.0000000 0.0000000
## PINV1 0.0000000 0.9034395 0.0000000    0 0.0000000 0.0000000
## PINV2 0.0000000 0.9248588 0.0000000    0 0.0000000 0.0000000
## PINV3 0.0000000 0.8546347 0.0000000    0 0.0000000 0.0000000
## PPSS1 0.0000000 0.0000000 0.8677997    0 0.0000000 0.0000000
## PPSS2 0.0000000 0.0000000 0.8931731    0 0.0000000 0.0000000
## PPSS3 0.0000000 0.0000000 0.9110949    0 0.0000000 0.0000000
## FAML1 0.0000000 0.0000000 0.0000000    1 0.0000000 0.0000000
## TRST1 0.0000000 0.0000000 0.0000000    0 0.0000000 0.8997543
## TRST2 0.0000000 0.0000000 0.0000000    0 0.0000000 0.9092064
## TRST3 0.0000000 0.0000000 0.0000000    0 0.0000000 0.9045681
```

```
## TRST4 0.0000000 0.0000000 0.0000000    0 0.0000000 0.8381937
## PSEC1 0.0000000 0.0000000 0.0000000    0 0.8109212 0.0000000
## PSEC2 0.0000000 0.0000000 0.0000000    0 0.8647103 0.0000000
## PSEC3 0.0000000 0.0000000 0.0000000    0 0.8677364 0.0000000
## PSEC4 0.0000000 0.0000000 0.0000000    0 0.8100562 0.0000000
```

From the above table, we can find out most of the variable share variance with their proper constructs. However, the loadins of PREP1 did not exceed 0.7 !

ii. Formative factors: VIF of items < 5 "Do items individually contribute substantially meaningful variance to their constructs?

```
sec_pls$outer_weights[multi_items("PREP",1:4),"REP"]
```

```
##      PREP1      PREP2      PREP3      PREP4
## -0.2439983  0.4421127  0.5142640  0.3761566
```

Check VIF if formaticve items

```
prep1_regr <-lm(sec$PREP1 ~ sec$PREP2 + sec$PREP3 + sec$PREP4)
prep1_r2 <-summary(prep1_regr)$r.squared
prep1_vif <-1 / (1 -prep1_r2)

prep2_regr <-lm(sec$PREP2 ~ sec$PREP1 + sec$PREP3 + sec$PREP4)
prep2_r2 <-summary(prep2_regr)$r.squared
prep2_vif <-1 / (1 -prep2_r2)


prep3_regr <-lm(sec$PREP3 ~ sec$PREP2 + sec$PREP1 + sec$PREP4)
prep3_r2 <-summary(prep3_regr)$r.squared
prep3_vif <-1 / (1 -prep3_r2)


prep4_regr <-lm(sec$PREP4 ~ sec$PREP2 + sec$PREP3 + sec$PREP1)
prep4_r2 <-summary(prep4_regr)$r.squared
```

```
prep4_vif <-1 / (1 -prep4_r2)

cat("prep1",prep1_vif,"\nprep2",prep2_vif,"\nprep3",prep3_vif,"\nprep4",prep4_vif)

## prep1 2.105557
## prep2 3.77549
## prep3 3.284694
## prep4 1.390946
```

VIF of each items didn't exceed 5.

b). Convergent validity (reflective factors only):

i. Composite Reliability (CR) of factors: CR > 0.70 "How much do the items of a reflect factor agree with one another?"

```
#INV
INV_items<-multi_items("PINV", 1:3)
INV_loadings<-sec_pls$outer_loadings[INV_items, "INV"]
INV_CR <-sum(INV_loadings)^2 / (sum(INV_loadings)^2 + sum(1-INV_loadings)^2)

#POL
POL_items<-multi_items("PPSS",1:3)
POL_loadings<-sec_pls$outer_loadings[POL_items, "POL"]
POL_CR <-sum(POL_loadings)^2 / (sum(POL_loadings)^2 + sum(1-POL_loadings)^2)

FAML_items<-"FAML1"
FAML_loadings<-sec_pls$outer_loadings[FAML_items, "FAML"]
FAML_CR <-sum(FAML_loadings)^2 / (sum(FAML_loadings)^2 + sum(1-FAML_loadings)^2)

cat("INV CR",INV_CR,"\nPOL CR", POL_CR, "\nFAML CR", FAML_CR)

## INV CR 0.986226
## POL CR 0.9851618
## FAML CR 1
```

All of the reflective fators' convergent validity are greater than 0.7.

ii. Average Variance Extracted (AVE) of factors: AVE > 0.50 “How much variance, on average, does a reflective factor explain of its own items?”

```
INV_AVE <-sum(INV_loadings^2) / (sum(INV_loadings^2) + sum(1-INV_loadings^2) )
POL_AVE <-sum(POL_loadings^2) / (sum(POL_loadings^2) + sum(1-POL_loadings^2) )
FAML_AVE <-sum(FAML_loadings^2) / (sum(FAML_loadings^2) + sum(1-FAML_loadings^2) )

cat("INV AVE",INV_AVE,"\nPOL AVE", POL_AVE, "\nFAML AVE", FAML_AVE)
```

```
## INV AVE 0.8006557
## POL AVE 0.7936428
## FAML AVE 1
```

All of them are greater than 0.5!

c). Discriminant Validity (reflective factors only):

i. Loadings of all items on own factors greater than cross-loadings with other factors “Are items more correlated with their own factors than other factors?”

```
cat("INV cor\n")
```

```
## INV cor
```

```
cor(sec[,INV_items], sec_pls$fscores)
```

```
##              REP       INV       POL      FAML       SEC     TRUST
## PINV1 0.4825032 0.9034395 0.3899877 0.4248400 0.4318293 0.4531307
## PINV2 0.5373182 0.9248588 0.4017241 0.4548418 0.4694484 0.4854840
## PINV3 0.5150648 0.8546347 0.3714397 0.3592786 0.4262517 0.4086009
```

```
cat("\nPOL cor\n")
```

```
##
## POL cor

cor(sec[,POL_items], sec_pls$fscores)

##             REP       INV       POL      FAML       SEC     TRUST
## PPSS1 0.4711953 0.4434606 0.8677997 0.5482328 0.4620539 0.3607678
## PPSS2 0.4077189 0.3544732 0.8931731 0.4757737 0.5060946 0.3880309
## PPSS3 0.3779259 0.3642729 0.9110949 0.4610160 0.4709152 0.3415018

cat("\nFAML cor\n")

##
## FAML cor

cor(sec[,FAML_items], sec_pls$fscores)

##            REP       INV       POL FAML       SEC    TRUST
## [1,] 0.5138542 0.4628376 0.5547363    1 0.4236474 0.449587
```

According to the correlation matrix above, all of the items are more correlated with their own factors.

ii. Correlation of factor with other factors smaller than factor's square root of AVE "Is a factor more related to its own items than it is to other factors?"

```
sqrt(INV_AVE)

## [1] 0.8947937

sqrt(POL_AVE)

## [1] 0.8908663

sqrt(FAML_AVE)

## [1] 1
```

```
cor(sec_pls$fscores)
```

```
##             REP       INV       POL      FAML       SEC     TRUST
## REP   1.0000000 0.5722299 0.4695867 0.5138542 0.5531181 0.6408000
## INV   0.5722299 1.0000000 0.4335571 0.4628376 0.4951637 0.5029062
## POL   0.4695867 0.4335571 1.0000000 0.5547363 0.5392827 0.4086373
## FAML  0.5138542 0.4628376 0.5547363 1.0000000 0.4236474 0.4495870
## SEC   0.5531181 0.4951637 0.5392827 0.4236474 1.0000000 0.6056371
## TRUST 0.6408000 0.5029062 0.4086373 0.4495870 0.6056371 1.0000000
```

Yes, the factors are more related to their own items.

Question 2) Does SEC really mediate relationships between REP, POL, INV → TRUST?

a). With each of the three factors (REP, POL, INV), check the four parts of the mediation analysis we discussed in class

i. Try using three models to test for mediation:

- the proposed model

```
# Measurement Model
sec_mm <- measure(
  form("REP",multi_items("PREP",1:4)),
  reflect("INV", multi_items("PINV",1:3)),
  reflect("POL", multi_items("PPSS",1:3)),
  reflect("FAML","FAML1"),
  reflect("TRUST", multi_items("TRST", 1:4)),
  reflect("SEC",multi_items("PSEC",1:4))
)


#Structural Model
sec_sm <- structure(
  paths(from = c("REP","INV","POL","FAML"), to = "SEC"),
  paths(from = "SEC", to = "TRUST")
```

```
)

#run PLS

boot_sec <- bootstrap_model(data = sec,
                            measurement_model = sec_mm,
                            structural_model = sec_sm)

## Bootstrapping model using simplePLS...

print_paths(boot_sec)

##      SEC PLS Est. SEC Boot Mean SEC Boot SE t value Pr(>|t|)
## REP          0.29          0.30        0.05    5.49     0.00
## INV          0.19          0.18        0.06    3.31     0.00
## POL          0.31          0.32        0.05    6.03     0.00
## FAML         0.01          0.01        0.05    0.22     0.83
## SEC          0.00          0.00        0.00    0.00     0.00
##      TRUST PLS Est. TRUST Boot Mean TRUST Boot SE t value Pr(>|t|)
## REP            0.00            0.00          0.00    0.00        0
## INV            0.00            0.00          0.00    0.00        0
## POL            0.00            0.00          0.00    0.00        0
## FAML           0.00            0.00          0.00    0.00        0
## SEC            0.61            0.61          0.04   17.37        0
```

- the proposed model without the mediator

```
# Measurement Model
sec_mm <- measure(
  form("REP",multi_items("PREP",1:4)),
  reflect("INV", multi_items("PINV",1:3)),
  reflect("POL", multi_items("PPSS",1:3)),
  reflect("FAML","FAML1"),
  reflect("TRUST", multi_items("TRST", 1:4))
)
```

```
#Structural Model
sec_sm <- structure(
  paths(from = c("REP","INV","POL","FAML"), to = "TRUST")
)

#run PLS

boot_sec <- bootstrap_model(data = sec,
                            measurement_model = sec_mm,
                            structural_model = sec_sm)

## Bootstrapping model using simplePLS...

print_paths(boot_sec)

##       TRUST PLS Est. TRUST Boot Mean TRUST Boot SE t value Pr(>|t|)
## REP             0.49            0.49          0.06    8.88     0.00
## INV             0.15            0.15          0.05    2.95     0.00
## POL             0.07            0.07          0.05    1.32     0.19
## FAML            0.09            0.09          0.05    1.69     0.09
```

- the proposed model with paths from antecedents to outcomes

```
# Measurement Model
sec_mm <- measure(
  form("REP",multi_items("PREP",1:4)),
  reflect("INV", multi_items("PINV",1:3)),
  reflect("POL", multi_items("PPSS",1:3)),
  reflect("FAML","FAML1"),
  reflect("TRUST", multi_items("TRST", 1:4)),
  reflect("SEC",multi_items("PSEC",1:4))
)
```

```
#Structural Model
sec_sm <- structure(
  paths(from = c("REP","INV","POL","FAML"), to = "SEC"),
   paths(from = c("REP","INV","POL","FAML"), to = "TRUST"),
  paths(from = "SEC", to = "TRUST")
)

#run PLS

boot_sec <- bootstrap_model(data = sec,
                            measurement_model = sec_mm,
                            structural_model = sec_sm)

## Bootstrapping model using simplePLS...

print_paths(boot_sec)

##      SEC PLS Est. SEC Boot Mean SEC Boot SE t value Pr(>|t|)
## REP          0.29          0.29        0.06    4.81     0.00
## INV          0.19          0.18        0.06    3.28     0.00
## POL          0.32          0.32        0.06    5.78     0.00
## FAML         0.01          0.01        0.06    0.23     0.82
## SEC          0.00          0.00        0.00    0.00     0.00
##      TRUST PLS Est. TRUST Boot Mean TRUST Boot SE t value Pr(>|t|)
## REP            0.39            0.40          0.06    6.69     0.00
## INV            0.09            0.09          0.05    1.59     0.11
## POL           -0.04           -0.04          0.06   -0.68     0.50
## FAML           0.09            0.09          0.05    1.86     0.06
## SEC            0.33            0.33          0.05    6.16     0.00
```

ii. When testing each of the three factors (REP, POL, INV), remove the other two factors, but keep FAML as a control

```r
# test REP to SEC
# Measurement Model
sec_mm <- measure(
  form("REP",multi_items("PREP",1:4)),
  reflect("FAML","FAML1"),
  reflect("SEC",multi_items("PSEC",1:4))
)


#Structural Model
sec_sm <- structure(
  paths(from = c("REP","FAML"), to = "SEC")
)

#run PLS

boot_sec <- bootstrap_model(data = sec,
                            measurement_model = sec_mm,
                            structural_model = sec_sm)

## Bootstrapping model using simplePLS...

print_paths(boot_sec)

##      SEC PLS Est. SEC Boot Mean SEC Boot SE t value Pr(>|t|)
## REP          0.46          0.47        0.05    9.49        0
## FAML         0.19          0.19        0.05    3.91        0

# test POL
# Measurement Model
sec_mm <- measure(
  reflect("POL", multi_items("PPSS",1:3)),
  reflect("FAML","FAML1"),
  reflect("SEC",multi_items("PSEC",1:4))
```

```
)


#Structural Model
sec_sm <- structure(
  paths(from = c("POL","FAML"), to = "SEC")
)

#run PLS

boot_sec <- bootstrap_model(data = sec,
                            measurement_model = sec_mm,
                            structural_model = sec_sm)

## Bootstrapping model using simplePLS...

print_paths(boot_sec)

##      SEC PLS Est. SEC Boot Mean SEC Boot SE t value Pr(>|t|)
## POL          0.44          0.44        0.05    8.38        0
## FAML         0.18          0.18        0.06    3.02        0

# test INV
# Measurement Model
sec_mm <- measure(
  reflect("INV", multi_items("PINV",1:3)),
  reflect("FAML","FAML1"),
  reflect("SEC",multi_items("PSEC",1:4))
)


#Structural Model
sec_sm <- structure(
```

```
  paths(from = c("INV","FAML"), to = "SEC")
)

#run PLS

boot_sec <- bootstrap_model(data = sec,
                            measurement_model = sec_mm,
                            structural_model = sec_sm)

## Bootstrapping model using simplePLS...

print_paths(boot_sec)

##      SEC PLS Est. SEC Boot Mean SEC Boot SE t value Pr(>|t|)
## INV          0.38          0.39        0.05    7.49        0
## FAML         0.25          0.24        0.05    4.67        0
```

b). Which factors are fully mediated by SEC, which are partially mediated by SEC, and which are not at all mediated by SEC?

From the above model testing, we can conclude that:

POL is fully mediated by SEC. INV and FAML is partially mediated by SEC. REP is not at all mediated by SEC.