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: λ > 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 !**

1. 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):

1. 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.

1. 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):

1. 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.**

1. 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

1. 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

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

**# 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.**