HW16

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Question 1. Composite Path Models using PLS-PM

```
sec <- read.csv("security_data_sem.csv")
library(seminr)
```

a. Create a PLS path model using SEMinR

i. Measurement Model

```
sec_mm <- constructs(
  composite("TRUST",multi_items("TRST",1:4)), ##1.
  composite("SEC",multi_items("PSEC",1:4)), ##2.
  composite("REP",multi_items("PREP",1:4)), ##3.
  composite("INV",multi_items("PINV",1:3)), ##4.
  composite("POL",multi_items("PPSS",1:3)),##5.
  composite("FAML","FAML1"),##6.
  interaction_term("REP","POL",method = orthogonal)##7.
)
```

ii. Structural Model

```
sec_sm <- relationships(
  paths(from = c("REP","INV","POL","FAML","REP*POL"),to = "SEC"),
  paths(from = "SEC",to = "TRUST")
)
```

b. Show Results

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

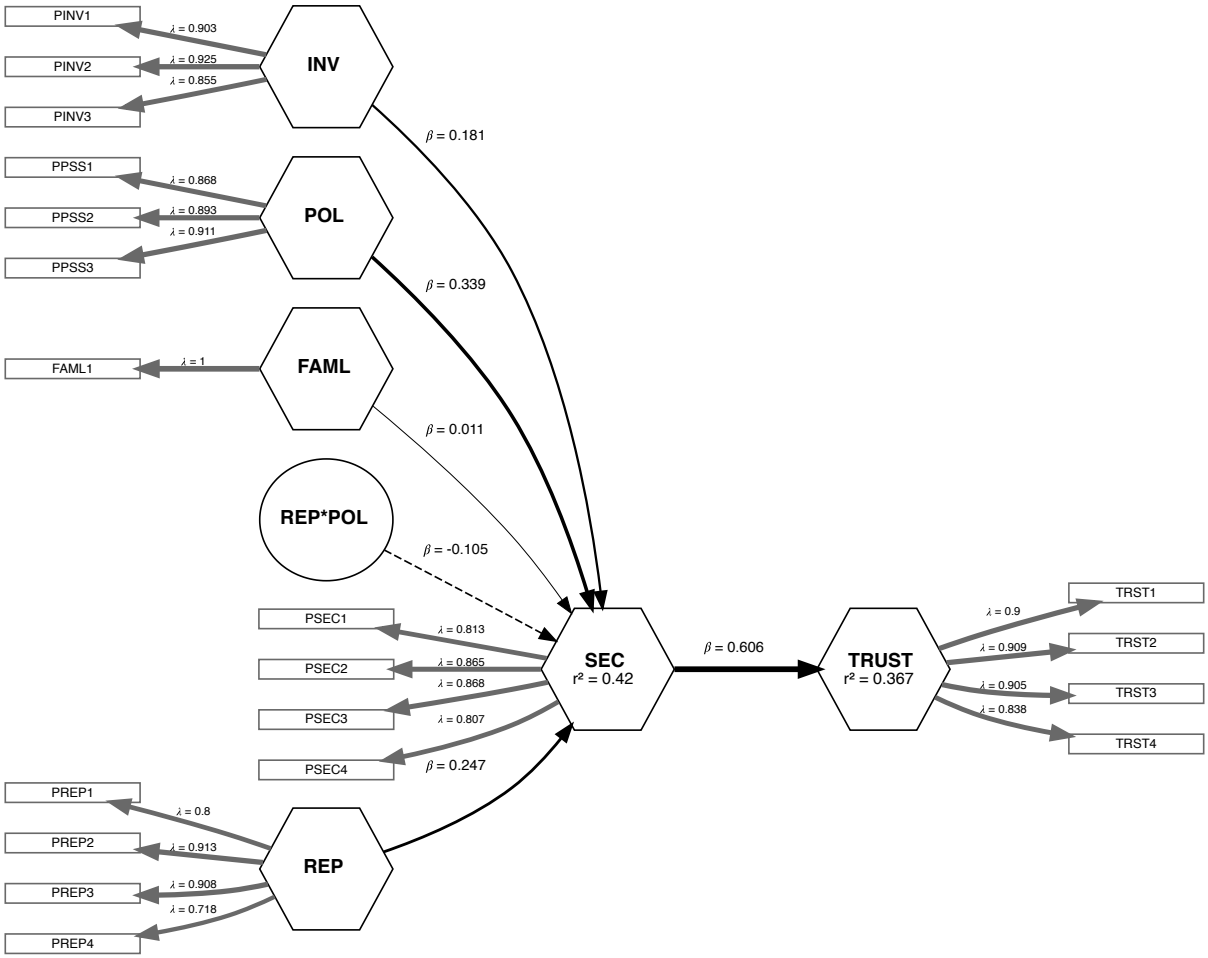
```
## Generating the seminr model
```

```
## All 405 observations are valid.
```

```
sec_report <- summary(sec_pls)
```

i.Plot estimated model

```
plot(sec_pls)
```



ii. Weights and Loadings of Composites

```
sec_report$weights
```

```
##                REP   INV   POL  FAML REP*POL   SEC TRUST
## TRST1        0.000 0.000 0.000 0.000   0.000 0.000 0.282
## TRST2        0.000 0.000 0.000 0.000   0.000 0.000 0.280
## TRST3        0.000 0.000 0.000 0.000   0.000 0.000 0.286
## TRST4        0.000 0.000 0.000 0.000   0.000 0.000 0.278
## PSEC1        0.000 0.000 0.000 0.000   0.000 0.277 0.000
## PSEC2        0.000 0.000 0.000 0.000   0.000 0.315 0.000
## PSEC3        0.000 0.000 0.000 0.000   0.000 0.307 0.000
## PSEC4        0.000 0.000 0.000 0.000   0.000 0.292 0.000
## PREP1        0.215 0.000 0.000 0.000   0.000 0.000 0.000
## PREP2        0.334 0.000 0.000 0.000   0.000 0.000 0.000
## PREP3        0.349 0.000 0.000 0.000   0.000 0.000 0.000
## PREP4        0.287 0.000 0.000 0.000   0.000 0.000 0.000
## PINV1        0.000 0.363 0.000 0.000   0.000 0.000 0.000
## PINV2        0.000 0.395 0.000 0.000   0.000 0.000 0.000
## PINV3        0.000 0.358 0.000 0.000   0.000 0.000 0.000
## PPSS1        0.000 0.000 0.360 0.000   0.000 0.000 0.000
## PPSS2        0.000 0.000 0.395 0.000   0.000 0.000 0.000
## PPSS3        0.000 0.000 0.367 0.000   0.000 0.000 0.000
## FAML1        0.000 0.000 0.000 1.000   0.000 0.000 0.000
## PREP1*PPSS1 0.000 0.000 0.000 0.000   0.239 0.000 0.000
## PREP1*PPSS2 0.000 0.000 0.000 0.000   0.031 0.000 0.000
## PREP1*PPSS3 0.000 0.000 0.000 0.000   0.021 0.000 0.000
## PREP2*PPSS1 0.000 0.000 0.000 0.000   0.046 0.000 0.000
## PREP2*PPSS2 0.000 0.000 0.000 0.000  -0.104 0.000 0.000
## PREP2*PPSS3 0.000 0.000 0.000 0.000  -0.228 0.000 0.000
## PREP3*PPSS1 0.000 0.000 0.000 0.000  -0.341 0.000 0.000
## PREP3*PPSS2 0.000 0.000 0.000 0.000   0.095 0.000 0.000
## PREP3*PPSS3 0.000 0.000 0.000 0.000   0.108 0.000 0.000
## PREP4*PPSS1 0.000 0.000 0.000 0.000   0.443 0.000 0.000
## PREP4*PPSS2 0.000 0.000 0.000 0.000   0.382 0.000 0.000
## PREP4*PPSS3 0.000 0.000 0.000 0.000   0.271 0.000 0.000
```

```
sec_report$loadings
```

```
##                REP    INV    POL   FAML REP*POL    SEC  TRUST
## TRST1        0.000  0.000  0.000  0.000  -0.000  0.000  0.900
## TRST2        0.000  0.000  0.000  0.000  -0.000  0.000  0.909
## TRST3        0.000  0.000  0.000  0.000  -0.000  0.000  0.905
## TRST4        0.000  0.000  0.000  0.000  -0.000  0.000  0.838
## PSEC1        0.000  0.000  0.000  0.000  -0.000  0.813  0.000
## PSEC2        0.000  0.000  0.000  0.000  -0.000  0.865  0.000
## PSEC3        0.000  0.000  0.000  0.000  -0.000  0.868  0.000
## PSEC4        0.000  0.000  0.000  0.000  -0.000  0.807  0.000
## PREP1        0.800  0.000  0.000  0.000   0.000  0.000  0.000
## PREP2        0.913  0.000  0.000  0.000   0.000  0.000  0.000
## PREP3        0.908  0.000  0.000  0.000   0.000  0.000  0.000
## PREP4        0.718  0.000  0.000  0.000   0.000  0.000  0.000
## PINV1        0.000  0.903  0.000  0.000  -0.000  0.000  0.000
## PINV2        0.000  0.925  0.000  0.000  -0.000  0.000  0.000
## PINV3        0.000  0.855  0.000  0.000  -0.000  0.000  0.000
## PPSS1        0.000  0.000  0.868  0.000   0.000  0.000  0.000
## PPSS2        0.000  0.000  0.893  0.000   0.000  0.000  0.000
## PPSS3        0.000  0.000  0.911  0.000   0.000  0.000  0.000
## FAML1        0.000  0.000  0.000  1.000  -0.000  0.000  0.000
## PREP1*PPSS1 -0.000 -0.000 -0.000 -0.000   0.581 -0.000 -0.000
## PREP1*PPSS2 -0.000 -0.000  0.000 -0.000   0.510 -0.000 -0.000
## PREP1*PPSS3 -0.000 -0.000 -0.000 -0.000   0.506 -0.000 -0.000
## PREP2*PPSS1 -0.000 -0.000 -0.000 -0.000   0.509 -0.000 -0.000
## PREP2*PPSS2 -0.000 -0.000  0.000 -0.000   0.421  0.000  0.000
## PREP2*PPSS3 -0.000 -0.000 -0.000  0.000   0.336  0.000  0.000
## PREP3*PPSS1 -0.000 -0.000 -0.000  0.000   0.236  0.000  0.000
## PREP3*PPSS2 -0.000 -0.000  0.000 -0.000   0.555 -0.000 -0.000
## PREP3*PPSS3 -0.000 -0.000 -0.000  0.000   0.466 -0.000 -0.000
## PREP4*PPSS1  0.000 -0.000  0.000  0.000   0.900 -0.000 -0.000
## PREP4*PPSS2 -0.000 -0.000 -0.000 -0.000   0.836 -0.000  0.000
## PREP4*PPSS3  0.000 -0.000  0.000  0.000   0.859 -0.000  0.000
```

iii. Regression coefficients of path between factors

```
sec_report$paths
```

```
##             SEC TRUST
## R^2       0.420 0.367
## AdjR^2    0.412 0.365
## REP       0.247     .
## INV       0.181     .
## POL       0.339     .
## FAML      0.011     .
## REP*POL -0.105     .
## SEC           . 0.606
```

iv. Bootstrapped path coefficients: t-values, 95% CI

```
boot_pls <- bootstrap_model(sec_pls,nboot = 1000)
```

```
## Bootstrapping model using seminr...
```

```
## SEMinR Model successfully bootstrapped
```

```
summary(boot_pls)
```

```
##
## Results from Bootstrap resamples:  1000
##
## Bootstrapped Structural Paths:
##                  Original Est. Bootstrap Mean Bootstrap SD T Stat. 2.5% CI
## REP  ->  SEC             0.247          0.246        0.059   4.160   0.126
## INV  ->  SEC             0.181          0.182        0.058   3.129   0.066
## POL  ->  SEC             0.339          0.343        0.056   6.074   0.235
## FAML  ->  SEC            0.011          0.010        0.061   0.173  -0.105
## REP*POL  ->  SEC        -0.105         -0.020        0.128  -0.819  -0.197
## SEC  ->  TRUST           0.606          0.610        0.034  17.799   0.539
##                  97.5% CI
## REP  ->  SEC        0.355
## INV  ->  SEC        0.292
## POL  ->  SEC        0.455
## FAML  ->  SEC       0.132
## REP*POL  ->  SEC    0.188
## SEC  ->  TRUST      0.673
##
## Bootstrapped Weights:
##                          Original Est. Bootstrap Mean Bootstrap SD T Stat.
## TRST1  ->  TRUST                 0.282          0.282        0.014  19.484
## TRST2  ->  TRUST                 0.280          0.280        0.015  18.351
## TRST3  ->  TRUST                 0.286          0.285        0.016  17.465
## TRST4  ->  TRUST                 0.278          0.277        0.021  13.553
## PSEC1  ->  SEC                   0.277          0.277        0.015  18.747
## PSEC2  ->  SEC                   0.315          0.314        0.017  18.658
## PSEC3  ->  SEC                   0.307          0.307        0.016  18.888
## PSEC4  ->  SEC                   0.292          0.290        0.017  16.851
## PREP1  ->  REP                   0.215          0.212        0.027   7.909
## PREP2  ->  REP                   0.334          0.333        0.019  17.851
## PREP3  ->  REP                   0.349          0.350        0.022  15.780
## PREP4  ->  REP                   0.287          0.289        0.026  11.006
## PINV1  ->  INV                   0.363          0.363        0.025  14.452
## PINV2  ->  INV                   0.395          0.394        0.025  15.670
## PINV3  ->  INV                   0.358          0.359        0.029  12.411
## PPSS1  ->  POL                   0.360          0.360        0.023  15.672
## PPSS2  ->  POL                   0.395          0.396        0.024  16.617
## PPSS3  ->  POL                   0.367          0.367        0.019  19.788
## FAML1  ->  FAML                  1.000          1.000        0.000       .
## PREP1*PPSS1  ->  REP*POL         0.239          0.087        0.161   1.488
## PREP1*PPSS2  ->  REP*POL         0.031          0.063        0.094   0.334
## PREP1*PPSS3  ->  REP*POL         0.021          0.058        0.115   0.184
## PREP2*PPSS1  ->  REP*POL         0.046          0.071        0.109   0.423
## PREP2*PPSS2  ->  REP*POL        -0.104          0.057        0.161  -0.646
## PREP2*PPSS3  ->  REP*POL        -0.228          0.039        0.245  -0.931
## PREP3*PPSS1  ->  REP*POL        -0.341          0.015        0.315  -1.081
## PREP3*PPSS2  ->  REP*POL         0.095          0.086        0.133   0.714
## PREP3*PPSS3  ->  REP*POL         0.108          0.085        0.132   0.820
## PREP4*PPSS1  ->  REP*POL         0.443          0.123        0.289   1.532
## PREP4*PPSS2  ->  REP*POL         0.382          0.109        0.278   1.377
## PREP4*PPSS3  ->  REP*POL         0.271          0.098        0.189   1.435
##                          2.5% CI 97.5% CI
## TRST1  ->  TRUST           0.254    0.310
## TRST2  ->  TRUST           0.249    0.310
## TRST3  ->  TRUST           0.255    0.318
## TRST4  ->  TRUST           0.237    0.319
## PSEC1  ->  SEC             0.249    0.307
## PSEC2  ->  SEC             0.281    0.346
```

```
## PSEC3  ->  SEC             0.277    0.341
## PSEC4  ->  SEC             0.256    0.326
## PREP1  ->  REP             0.155    0.259
## PREP2  ->  REP             0.300    0.373
## PREP3  ->  REP             0.306    0.395
## PREP4  ->  REP             0.240    0.343
## PINV1  ->  INV             0.312    0.410
## PINV2  ->  INV             0.346    0.443
## PINV3  ->  INV             0.301    0.416
## PPSS1  ->  POL             0.312    0.400
## PPSS2  ->  POL             0.354    0.450
## PPSS3  ->  POL             0.330    0.401
## FAML1  ->  FAML            1.000    1.000
## PREP1*PPSS1  ->  REP*POL  -0.309    0.374
## PREP1*PPSS2  ->  REP*POL  -0.153    0.224
## PREP1*PPSS3  ->  REP*POL  -0.218    0.264
## PREP2*PPSS1  ->  REP*POL  -0.183    0.251
## PREP2*PPSS2  ->  REP*POL  -0.287    0.343
## PREP2*PPSS3  ->  REP*POL  -0.417    0.455
## PREP3*PPSS1  ->  REP*POL  -0.594    0.668
## PREP3*PPSS2  ->  REP*POL  -0.193    0.331
## PREP3*PPSS3  ->  REP*POL  -0.214    0.315
## PREP4*PPSS1  ->  REP*POL  -0.474    0.542
## PREP4*PPSS2  ->  REP*POL  -0.437    0.575
## PREP4*PPSS3  ->  REP*POL  -0.301    0.400
##
## Bootstrapped Loadings:
##                          Original Est. Bootstrap Mean Bootstrap SD T Stat.
## TRST1  ->  TRUST                 0.900          0.900        0.016  57.729
## TRST2  ->  TRUST                 0.909          0.910        0.020  45.148
## TRST3  ->  TRUST                 0.905          0.905        0.021  43.374
## TRST4  ->  TRUST                 0.838          0.838        0.033  25.773
## PSEC1  ->  SEC                   0.813          0.814        0.025  32.268
## PSEC2  ->  SEC                   0.865          0.867        0.025  34.435
## PSEC3  ->  SEC                   0.868          0.869        0.021  41.692
## PSEC4  ->  SEC                   0.807          0.806        0.026  31.623
## PREP1  ->  REP                   0.800          0.796        0.040  19.776
## PREP2  ->  REP                   0.913          0.913        0.017  54.795
## PREP3  ->  REP                   0.908          0.909        0.020  46.105
## PREP4  ->  REP                   0.718          0.718        0.033  21.726
## PINV1  ->  INV                   0.903          0.904        0.025  36.204
## PINV2  ->  INV                   0.925          0.925        0.021  43.034
## PINV3  ->  INV                   0.855          0.854        0.027  32.024
## PPSS1  ->  POL                   0.868          0.866        0.025  34.871
## PPSS2  ->  POL                   0.893          0.894        0.015  61.415
## PPSS3  ->  POL                   0.911          0.910        0.016  56.201
## FAML1  ->  FAML                  1.000          1.000        0.000       .
## PREP1*PPSS1  ->  REP*POL         0.581          0.563        0.264   2.196
## PREP1*PPSS2  ->  REP*POL         0.510          0.550        0.250   2.041
## PREP1*PPSS3  ->  REP*POL         0.506          0.559        0.269   1.877
## PREP2*PPSS1  ->  REP*POL         0.509          0.596        0.284   1.796
## PREP2*PPSS2  ->  REP*POL         0.421          0.567        0.297   1.418
## PREP2*PPSS3  ->  REP*POL         0.336          0.566        0.352   0.953
## PREP3*PPSS1  ->  REP*POL         0.236          0.484        0.348   0.677
## PREP3*PPSS2  ->  REP*POL         0.555          0.594        0.284   1.953
## PREP3*PPSS3  ->  REP*POL         0.466          0.572        0.307   1.519
## PREP4*PPSS1  ->  REP*POL         0.900          0.574        0.369   2.437
## PREP4*PPSS2  ->  REP*POL         0.836          0.501        0.367   2.278
## PREP4*PPSS3  ->  REP*POL         0.859          0.549        0.345   2.490
##                          2.5% CI 97.5% CI
```

```
## TRST1  ->  TRUST           0.867    0.928
## TRST2  ->  TRUST           0.863    0.941
## TRST3  ->  TRUST           0.858    0.938
## TRST4  ->  TRUST           0.768    0.894
## PSEC1  ->  SEC             0.757    0.858
## PSEC2  ->  SEC             0.810    0.909
## PSEC3  ->  SEC             0.825    0.907
## PSEC4  ->  SEC             0.749    0.853
## PREP1  ->  REP             0.710    0.864
## PREP2  ->  REP             0.876    0.940
## PREP3  ->  REP             0.861    0.940
## PREP4  ->  REP             0.646    0.775
## PINV1  ->  INV             0.848    0.943
## PINV2  ->  INV             0.878    0.960
## PINV3  ->  INV             0.795    0.899
## PPSS1  ->  POL             0.812    0.906
## PPSS2  ->  POL             0.864    0.920
## PPSS3  ->  POL             0.873    0.938
## FAML1  ->  FAML            1.000    1.000
## PREP1*PPSS1  ->  REP*POL  -0.067    0.916
## PREP1*PPSS2  ->  REP*POL  -0.043    0.872
## PREP1*PPSS3  ->  REP*POL  -0.105    0.888
## PREP2*PPSS1  ->  REP*POL  -0.078    0.935
## PREP2*PPSS2  ->  REP*POL  -0.173    0.910
## PREP2*PPSS3  ->  REP*POL  -0.312    0.961
## PREP3*PPSS1  ->  REP*POL  -0.333    0.934
## PREP3*PPSS2  ->  REP*POL  -0.095    0.932
## PREP3*PPSS3  ->  REP*POL  -0.228    0.936
## PREP4*PPSS1  ->  REP*POL  -0.307    0.978
## PREP4*PPSS2  ->  REP*POL  -0.360    0.932
## PREP4*PPSS3  ->  REP*POL  -0.307    0.948
##
## Bootstrapped HTMT:
##                   Original Est. Bootstrap Mean Bootstrap SD 2.5% CI 97.5% CI
## REP  ->  INV              0.705          0.705        0.049   0.605    0.797
## REP  ->  POL              0.543          0.541        0.056   0.426    0.646
## REP  ->  FAML             0.599          0.600        0.052   0.491    0.696
## REP  ->  REP*POL          0.000          0.000        0.000   0.000    0.000
## REP  ->  SEC              0.595          0.594        0.045   0.502    0.673
## REP  ->  TRUST            0.682          0.682        0.042   0.591    0.761
## INV  ->  POL              0.498          0.497        0.055   0.390    0.597
## INV  ->  FAML             0.494          0.494        0.055   0.388    0.598
## INV  ->  REP*POL          0.085          0.103        0.032   0.053    0.180
## INV  ->  SEC              0.568          0.567        0.049   0.466    0.656
## INV  ->  TRUST            0.563          0.564        0.052   0.462    0.659
## POL  ->  FAML             0.596          0.596        0.051   0.487    0.684
## POL  ->  REP*POL          0.000          0.000        0.000   0.000    0.000
## POL  ->  SEC              0.622          0.623        0.051   0.519    0.717
## POL  ->  TRUST            0.458          0.458        0.060   0.337    0.576
## FAML  ->  REP*POL         0.046          0.067        0.026   0.033    0.128
## FAML  ->  SEC             0.455          0.456        0.051   0.355    0.550
## FAML  ->  TRUST           0.471          0.471        0.052   0.361    0.566
## REP*POL  ->  SEC          0.059          0.081        0.018   0.052    0.124
## REP*POL  ->  TRUST        0.044          0.071        0.017   0.045    0.110
## SEC  ->  TRUST            0.685          0.687        0.035   0.612    0.753
##
## Bootstrapped Total Paths:
##                   Original Est. Bootstrap Mean Bootstrap SD 2.5% CI 97.5% CI
## REP  ->  SEC              0.247          0.246        0.059   0.126    0.355
## REP  ->  TRUST            0.150          0.150        0.038   0.074    0.225
```

```
## INV  ->  SEC              0.181          0.182        0.058   0.066    0.292
## INV  ->  TRUST            0.109          0.111        0.036   0.039    0.181
## POL  ->  SEC              0.339          0.343        0.056   0.235    0.455
## POL  ->  TRUST            0.205          0.209        0.036   0.138    0.284
## FAML  ->  SEC             0.011          0.010        0.061  -0.105    0.132
## FAML  ->  TRUST           0.006          0.006        0.037  -0.064    0.081
## REP*POL  ->  SEC         -0.105         -0.020        0.128  -0.197    0.188
## REP*POL  ->  TRUST       -0.063         -0.012        0.078  -0.124    0.116
## SEC  ->  TRUST            0.606          0.610        0.034   0.539    0.673
```

Question 2. Common-Factor Models using CB-SEM

a. Create a common factor model using SEMinR

```
sec_cf_mm <- constructs(
  reflective("TRUST",multi_items("TRST",1:4)), ##1.
  reflective("SEC",multi_items("PSEC",1:4)), ##2.
  reflective("REP",multi_items("PREP",1:4)), ##3.
  reflective("INV",multi_items("PINV",1:3)), ##4.
  reflective("POL",multi_items("PPSS",1:3)),##5.
  reflective("FAML","FAML1"),##6.
  interaction_term("REP","POL",method = orthogonal))##7.
```

b. Show us the following results in table or figure formats

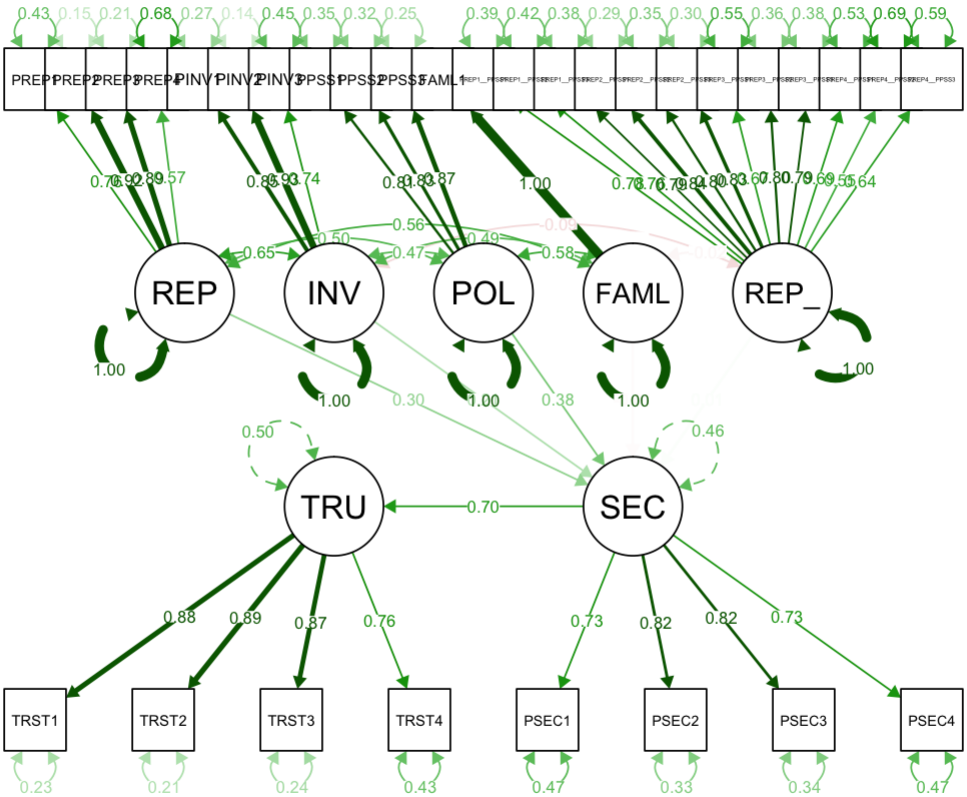
```
sec_cf_pls <- estimate_cbsem(data = sec,
                             measurement_model = sec_cf_mm,
                             structural_model = sec_sm)
```

```
## Generating the seminr model for CBSEM
```

i.Plot a figure of the estimated model

```
plot(sec_cf_pls)
```

```
## Plotting of lavaan models using semPlot.
```




```
## NULL
```

ii. Loadings of composites

```
sec_cf_report <- summary(sec_cf_pls)
sec_cf_report$loadings
```

```
##            TRUST        SEC        REP        INV        POL FAML
## TRST1 0.8800240         NA         NA         NA         NA   NA
## TRST2 0.8886342         NA         NA         NA         NA   NA
## TRST3 0.8690644         NA         NA         NA         NA   NA
## TRST4 0.7575988         NA         NA         NA         NA   NA
## PSEC1         NA 0.7308766         NA         NA         NA   NA
## PSEC2         NA 0.8173481         NA         NA         NA   NA
## PSEC3         NA 0.8151708         NA         NA         NA   NA
## PSEC4         NA 0.7260444         NA         NA         NA   NA
## PREP1         NA         NA 0.7551328         NA         NA   NA
## PREP2         NA         NA 0.9199208         NA         NA   NA
## PREP3         NA         NA 0.8871362         NA         NA   NA
## PREP4         NA         NA 0.5650059         NA         NA   NA
## PINV1         NA         NA         NA 0.8520004         NA   NA
## PINV2         NA         NA         NA 0.9257476         NA   NA
## PINV3         NA         NA         NA 0.7388750         NA   NA
## PPSS1         NA         NA         NA         NA 0.8051533   NA
## PPSS2         NA         NA         NA         NA 0.8272576   NA
## PPSS3         NA         NA         NA         NA 0.8674335   NA
## FAML1         NA         NA         NA         NA         NA    1
```

iii.Regression coefficients of paths between factors, and their p-values

```
sec_cf_report$paths
```

```
## $coefficients
##                     SEC     TRUST
## R^2         0.540381651 0.4951084
## REP         0.299536782        NA
## INV         0.214253245        NA
## POL         0.376401499        NA
## FAML       -0.008837653        NA
## REP_x_POL   0.008355287        NA
## SEC                  NA 0.7036394
##
## $pvalues
##                     SEC TRUST
## REP        3.817182e-05    NA
## INV        3.534482e-03    NA
## POL        4.380975e-09    NA
## FAML       8.996836e-01    NA
## REP_x_POL  8.516847e-01    NA
## SEC                  NA     0
```