

# Results Financial Inclusion

Juan C. Correa

22/11/2020

```
setwd("/home/juan/Documents/GitHub/Fin-Tech")
```

Let's open the data

```
library(readr)
Brandstat <- read_delim("RawDataBrandstat.csv", ",", escape_double = FALSE, trim_ws = TRUE)
```

```
## Rows: 478 Columns: 20
```

```
## -- Column specification -----
## Delimiter: ","
## dbl (20): City, Sex, Strata, Age, Occupation, Education, Civic_Status, Home_...
```

```
##
## i Use 'spec()' to retrieve the full column specification for this data.
## i Specify the column types or set 'show_col_types = FALSE' to quiet this message.
```

```
variable.names(Brandstat)
```

```
## [1] "City"      "Sex"      "Strata"   "Age"
## [5] "Occupation" "Education" "Civic_Status" "Home_Structure"
## [9] "Income_Level" "TD1"      "TD2"      "TD3"
## [13] "TD4"      "Aut1"     "Aut2"     "Aut3"
## [17] "Aut4"     "Aut5"     "Aut6"     "Aut7"
```

```
automation <- Brandstat[14:20]
TechDisp <- Brandstat[10:13]
```

## Sample Description

```
library(psych)
describe.by(Brandstat$Age, group = Brandstat$Sex, mat = TRUE, digits = 2)
```

```
## Warning: describe.by is deprecated. Please use the describeBy function
```

```
##      item group1 vars    n mean    sd median trimmed   mad min max range skew
## X11      1      1    1 248 32.69 11.76    29   31.64 11.86  18  61    43 0.65
## X12      2      2    1 230 32.97 11.87    29   31.84 11.86  18  69    51 0.73
##      kurtosis    se
## X11      -0.77 0.75
## X12      -0.59 0.78
```

```
summary(Brandstat$Age)
```

```
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.
##    18.00   23.00   29.00   32.82   42.75   69.00
```

```
library(ggplot2)
```

```
##
## Attaching package: 'ggplot2'
```

```
## The following objects are masked from 'package:psych':
##
##      %+%, alpha
```

```
library(ggrridges)
```

```
s1 <- ggplot(Brandstat, aes(x=Age, y=as.factor(Sex))) + geom_density_ridges(fill="green", alpha = 0.4) +
  theme_ridges() + ylab("Sex")
```

```
s2 <- ggplot(Brandstat, aes(x=Age, y=as.factor(Strata))) + geom_density_ridges(fill="green", alpha = 0.4) +
  theme_ridges() + ylab("Economic Strata")
```

```
s3 <- ggplot(Brandstat, aes(x=Age, y=as.factor(Education))) + geom_density_ridges(fill="green", alpha = 0.4) +
  theme_ridges() + ylab("Education")
```

```
s4 <- ggplot(Brandstat, aes(x=Age, y=as.factor(Home_Structure))) + geom_density_ridges(fill="green", alpha = 0.4) +
  theme_ridges() + ylab("Home Structure")
```

```
library(ggpubr)
```

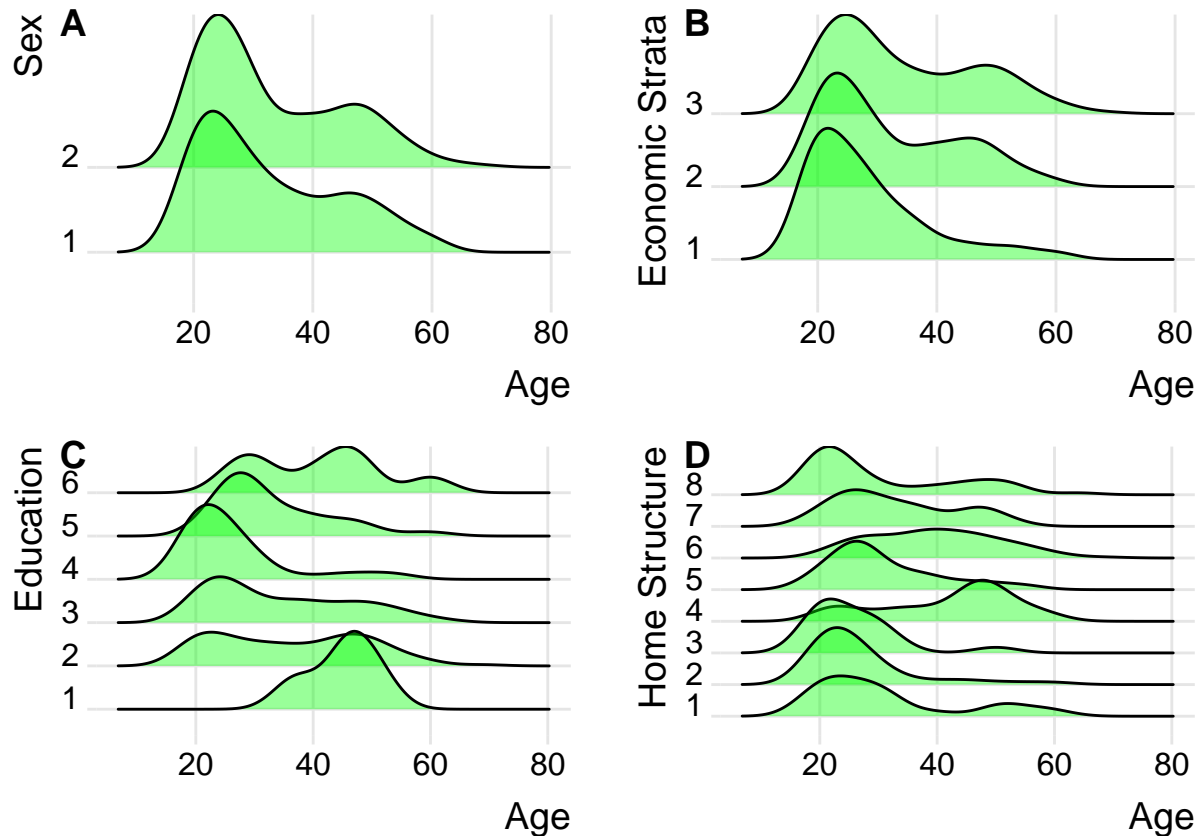
```
ggarrange(s1, s2, s3, s4, ncol = 2, nrow = 2, labels = c("A", "B", "C", "D"))
```

```
## Picking joint bandwidth of 3.56
```

```
## Picking joint bandwidth of 3.56
```

```
## Picking joint bandwidth of 3.75
```

```
## Picking joint bandwidth of 3.75
```



## Measurement Model of Automation

To examine the factor structure of all the scales employed, we proceed by testing the overall sampling adequacy of the items. These items are susceptible to factorization ( $KMO = 0.92$ ), and the most probable psychometric structure consists of a one-factor model with freely estimated factor loadings. This emerging solution is evident through the statistical significance of the homogeneous items test ( $F = 1.763$ ;  $p = 0.0415$ ) which proved to be better than a psychometric structure of a one-factor model with equal factor loadings for all items captured by the tau-equivalence test ( $F = 1.563$ ;  $p = 0.0575$ ).

```
library(psych)
KMO(automation)
```

```
## Kaiser-Meyer-Olkin factor adequacy
## Call: KMO(r = automation)
## Overall MSA = 0.92
## MSA for each item =
## Aut1 Aut2 Aut3 Aut4 Aut5 Aut6 Aut7
## 0.89 0.94 0.93 0.93 0.90 0.93 0.94
```

```
library(coefficientsalpha)
```

```
## Loading required package: rsem
```

```
## Loading required package: MASS

## Loading required package: lavaan

## This is lavaan 0.6-9
## lavaan is FREE software! Please report any bugs.

##
## Attaching package: 'lavaan'

## The following object is masked from 'package:psych':
##
##      cor2cov

##
## Attaching package: 'coefficientsalpha'

## The following object is masked from 'package:ggplot2':
##
##      alpha

## The following objects are masked from 'package:psych':
##
##      alpha, omega
```

```
tau.test(automation)
```

```
## Warning: Setting row names on a tibble is deprecated.

## Test of tau equivalent
## The robust F statistic is  1.563
## with a p-value  0.0575
##
## Test of homogeneous items
## The robust F statistic is  1.763
## with a p-value  0.0415
```

The results of the confirmatory factor analysis reveal a reasonable goodness-of-fit for the scale of automation (CFI = 0.950; TLI = 0.926; RMSEA = 0.142; SRMR = 0.037)

```
library(lavaan)
aut.model <- "aut =~ Aut1 + Aut2 + Aut3 + Aut4 + Aut5 + Aut6 + Aut7"
fit1 <- lavaan::cfa(aut.model, data=Brandstat, std.lv=TRUE)
summary(fit1, fit.measures=T, standardized=T)
```

```
## lavaan 0.6-9 ended normally after 17 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters    14
```

```

##
##   Number of observations                478
##
## Model Test User Model:
##
##   Test statistic                149.084
##   Degrees of freedom              14
##   P-value (Chi-square)           0.000
##
## Model Test Baseline Model:
##
##   Test statistic                2741.418
##   Degrees of freedom              21
##   P-value                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)      0.950
##   Tucker-Lewis Index (TLI)        0.926
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)    -7248.230
##   Loglikelihood unrestricted model (H1) -7173.688
##
##   Akaike (AIC)                    14524.460
##   Bayesian (BIC)                   14582.834
##   Sample-size adjusted Bayesian (BIC) 14538.400
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                          0.142
##   90 Percent confidence interval - lower 0.122
##   90 Percent confidence interval - upper 0.163
##   P-value RMSEA <= 0.05             0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                          0.037
##
## Parameter Estimates:
##
##   Standard errors                Standard
##   Information                    Expected
##   Information saturated (h1) model Structured
##
## Latent Variables:
##
##           Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   aut =~
##     Aut1           2.812    0.114   24.714    0.000    2.812    0.891
##     Aut2           2.612    0.122   21.421    0.000    2.612    0.815
##     Aut3           2.371    0.123   19.234    0.000    2.371    0.758
##     Aut4           2.387    0.115   20.760    0.000    2.387    0.799
##     Aut5           2.870    0.120   23.986    0.000    2.870    0.876

```

```
##      Aut6      2.296    0.113    20.237    0.000    2.296    0.785
##      Aut7      2.668    0.115    23.241    0.000    2.668    0.859
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .Aut1      2.045    0.173    11.796    0.000    2.045    0.205
##      .Aut2      3.440    0.253    13.595    0.000    3.440    0.335
##      .Aut3      4.164    0.293    14.196    0.000    4.164    0.426
##      .Aut4      3.238    0.235    13.807    0.000    3.238    0.362
##      .Aut5      2.510    0.203    12.351    0.000    2.510    0.233
##      .Aut6      3.283    0.235    13.954    0.000    3.283    0.384
##      .Aut7      2.534    0.198    12.805    0.000    2.534    0.263
##      aut        1.000

```

```
library(semTools)
```

```
##

## #####

## This is semTools 0.5-5

## All users of R (or SEM) are invited to submit functions or ideas for functions.

## #####

##

## Attaching package: 'semTools'

## The following objects are masked from 'package:psych':
##
##      reliability, skew

## The following object is masked from 'package:readr':
##
##      clipboard

```

```
reliability(fit1)
```

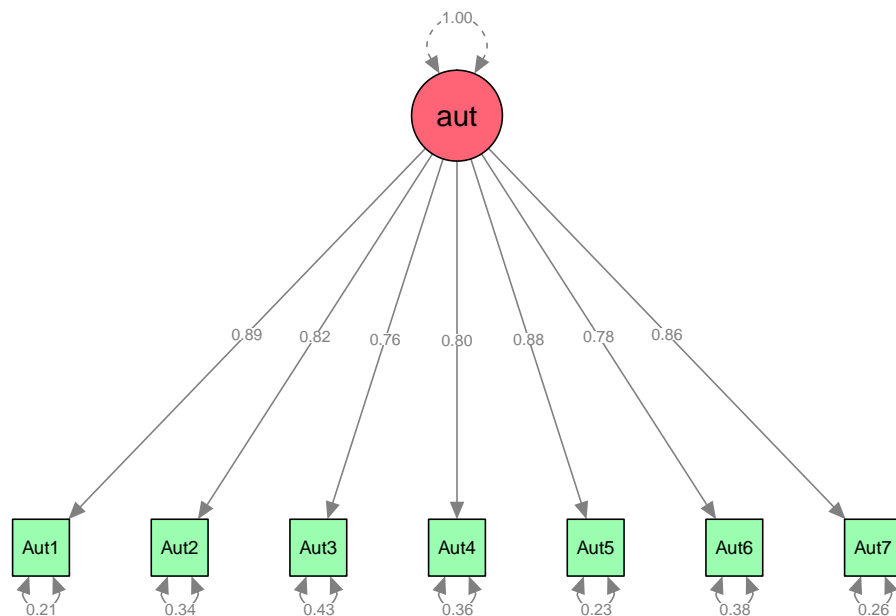
```
##      aut
## alpha 0.9380854
## omega 0.9386485
## omega2 0.9386485
## omega3 0.9366932
## avevar 0.6875174

```

The emerging psychometric structure is depicted in the following picture.

```
library(semPlot)
semPaths(fit1, whatLabels = "stand", layout = "tree", color = list(
  lat = rgb(255, 100, 118, maxColorValue = 255),
  man = rgb(155, 253, 175, maxColorValue = 255)),
  mar = c(10, 5, 10, 5), intercepts = FALSE, residuls = FALSE, nCharNodes = 0)
```

```
## Warning in qgraph::qgraph(Edgelist, labels = nLab, bidirectional = Bidir, : The
## following arguments are not documented and likely not arguments of qgraph and
## thus ignored: residuls
```



## Measurement Model of Technology Disposition

The items of the scale of Technology Disposition are also susceptible to factorization ( $KMO = 0.67$ ), and the most probable psychometric structure consists of a one-factor model.

```
library(psych)
KMO(TechDisp)
```

```
## Kaiser-Meyer-Olkin factor adequacy
## Call: KMO(r = TechDisp)
## Overall MSA = 0.67
## MSA for each item =
```

```
## TD1 TD2 TD3 TD4
## 0.65 0.74 0.73 0.64
```

```
library(coefficients)
tau.test(TechDisp)
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Test of tau equivalent
## The robust F statistic is 7.37
## with a p-value 0
##
## Test of homogeneous items
## The robust F statistic is 0.427
## with a p-value 0.6528
```

The Measurement model of technology disposition reveals also a reasonable goodness-of-fit, as can be seen in the following results (CFI = 0.996; TLI = 0.987; RMSEA = 0.034; SRMR = 0.018)

```
library(lavaan)
TD.model <- "TD =~ TD1 + TD2 + TD3 + TD4"
fit2 <- lavaan::cfa(TD.model, data=Brandstat, std.lv=TRUE)
summary(fit2, fit.measures=T, standardized=T)
```

```
## lavaan 0.6-9 ended normally after 27 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters      8
##
##      Number of observations          478
##
## Model Test User Model:
##
##      Test statistic                  3.113
##      Degrees of freedom              2
##      P-value (Chi-square)            0.211
##
## Model Test Baseline Model:
##
##      Test statistic                  266.994
##      Degrees of freedom              6
##      P-value                        0.000
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)      0.996
##      Tucker-Lewis Index (TLI)        0.987
##
## Loglikelihood and Information Criteria:
##
##      Loglikelihood user model (H0)    -4365.125
```



```

## Loglikelihood unrestricted model (H1) -4363.568
##
## Akaike (AIC) 8746.249
## Bayesian (BIC) 8779.606
## Sample-size adjusted Bayesian (BIC) 8754.215
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.034
## 90 Percent confidence interval - lower 0.000
## 90 Percent confidence interval - upper 0.103
## P-value RMSEA <= 0.05 0.543
##
## Standardized Root Mean Square Residual:
##
## SRMR 0.018
##
## Parameter Estimates:
##
## Standard errors Standard
## Information Expected
## Information saturated (h1) model Structured
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## TD =~
## TD1 1.668 0.128 13.013 0.000 1.668 0.696
## TD2 0.620 0.170 3.651 0.000 0.620 0.196
## TD3 1.374 0.127 10.826 0.000 1.374 0.554
## TD4 1.607 0.120 13.408 0.000 1.607 0.725
##
## Variances:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## .TD1 2.957 0.344 8.604 0.000 2.957 0.515
## .TD2 9.665 0.635 15.215 0.000 9.665 0.962
## .TD3 4.269 0.340 12.563 0.000 4.269 0.693
## .TD4 2.334 0.305 7.661 0.000 2.334 0.475
## TD 1.000 1.000 1.000

```

```
inspect(fit2, "rsquare")
```

```

## TD1 TD2 TD3 TD4
## 0.485 0.038 0.307 0.525

```

```

library(semTools)
reliability(fit2)

```

```

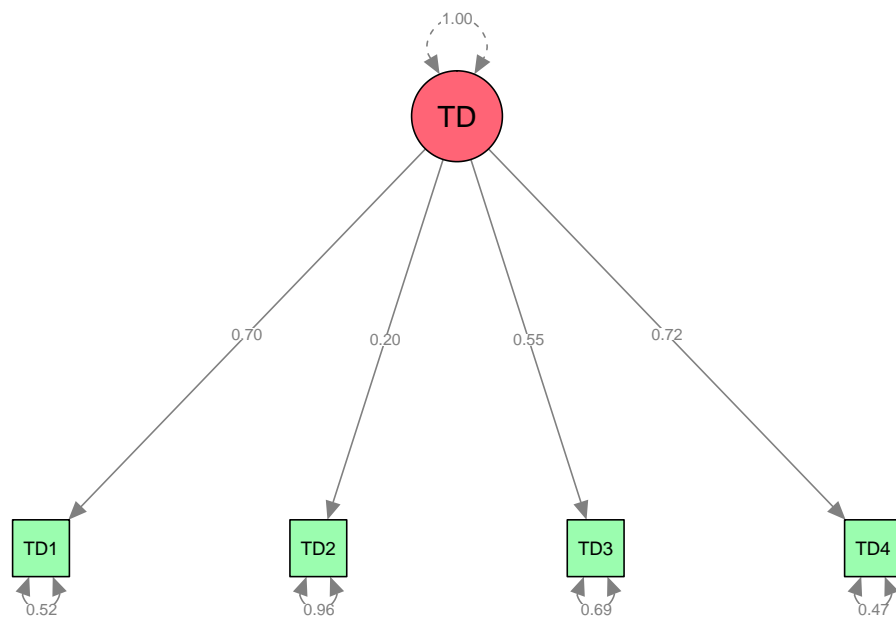
## TD
## alpha 0.5714467
## omega 0.5908010
## omega2 0.5908010
## omega3 0.5905017
## avevar 0.2842474

```

The emerging psychometric structure is depicted in the following picture.

```
library(semPlot)
semPaths(fit2, whatLabels = "stand", layout = "tree", color = list(
  lat = rgb(255, 100, 118, maxColorValue = 255),
  man = rgb(155, 253, 175, maxColorValue = 255)),
  mar = c(10, 5, 10, 5), intercepts = FALSE, residuls = FALSE, nCharNodes = 0)
```

```
## Warning in qgraph::qgraph(Edgelist, labels = nLab, bidirectional = Bidir, : The
## following arguments are not documented and likely not arguments of qgraph and
## thus ignored: residuls
```



## Structural Model: Technology Disposition as Predictor of Automation

Our structural model posits that technology disposition predicts the acceptance of technology through the automation of financial processes. This set of relationships are summarized and illustrated as follows

```
library(lavaan);
modelData <- Brandstat
model<-"
! regressions
Automation=~Aut__Aut1*Aut1
```

```

Automation=~Aut__Aut2*Aut2
Automation=~Aut__Aut3*Aut3
Automation=~Aut__Aut4*Aut4
Automation=~Aut__Aut5*Aut5
Automation=~Aut__Aut6*Aut6
Automation=~Aut__Aut7*Aut7
TD=~TD__TD1*TD1
TD=~TD__TD4*TD4
TD=~TD__TD2*TD2
TD=~TD__TD3*TD3
TD=~TD__Automation*Automation
! residuals, variances and covariances
Automation ~~ 1.0*Automation
Aut1 ~~ VAR_Aut1*Aut1
Aut2 ~~ VAR_Aut2*Aut2
Aut3 ~~ VAR_Aut3*Aut3
Aut4 ~~ VAR_Aut4*Aut4
Aut5 ~~ VAR_Aut5*Aut5
Aut6 ~~ VAR_Aut6*Aut6
Aut7 ~~ VAR_Aut7*Aut7
TD ~~ 1.0*TD
TD1 ~~ VAR_TD1*TD1
TD4 ~~ VAR_TD4*TD4
TD2 ~~ VAR_TD2*TD2
TD3 ~~ VAR_TD3*TD3
! observed means
Aut1~1;
Aut2~1;
Aut3~1;
Aut4~1;
Aut5~1;
Aut6~1;
Aut7~1;
TD1~1;
TD4~1;
TD2~1;
TD3~1;
";
result<- sem(model, data=modelData);
summary(result, fit.measures=TRUE);

```

```
## lavaan 0.6-9 ended normally after 33 iterations
```

```
##
```

##	Estimator	ML
##	Optimization method	NLMINB
##	Number of model parameters	32
##		
##	Number of observations	478
##		
##	Model Test User Model:	
##		
##	Test statistic	574.732
##	Degrees of freedom	45

```

##      P-value (Chi-square)                0.000
##
## Model Test Baseline Model:
##
##      Test statistic                3117.042
##      Degrees of freedom                55
##      P-value                0.000
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)                0.827
##      Tucker-Lewis Index (TLI)                0.789
##
## Loglikelihood and Information Criteria:
##
##      Loglikelihood user model (H0)                -11770.307
##      Loglikelihood unrestricted model (H1)                -11482.941
##
##      Akaike (AIC)                23604.615
##      Bayesian (BIC)                23738.042
##      Sample-size adjusted Bayesian (BIC)                23636.478
##
## Root Mean Square Error of Approximation:
##
##      RMSEA                0.157
##      90 Percent confidence interval - lower                0.146
##      90 Percent confidence interval - upper                0.169
##      P-value RMSEA <= 0.05                0.000
##
## Standardized Root Mean Square Residual:
##
##      SRMR                0.169
##
## Parameter Estimates:
##
##      Standard errors                Standard
##      Information                Expected
##      Information saturated (h1) model                Structured
##
## Latent Variables:
##
##      Estimate Std.Err z-value P(>|z|)
##
##      Automation =~
##      Aut1 (A__A1) 1.000
##      Aut2 (A__A2) 1.948 0.109 17.934 0.000
##      Aut3 (A__A3) 1.828 0.108 16.939 0.000
##      Aut4 (A__A4) 1.825 0.101 18.047 0.000
##      Aut5 (A__A5) 2.101 0.108 19.395 0.000
##      Aut6 (A__A6) 1.769 0.099 17.792 0.000
##      Aut7 (A__A7) 2.031 0.102 19.997 0.000
##
##      TD =~
##      TD1 (TD__TD1) 1.000
##      TD4 (TD__TD4) 1.435 0.126 11.353 0.000
##      TD2 (TD__TD2) 0.682 0.179 3.815 0.000
##      TD3 (TD__TD3) 1.323 0.137 9.642 0.000

```

```

##      Atmt      (TD__A)      0.597      0.078      7.618      0.000
##
## Intercepts:
##              Estimate Std.Err z-value P(>|z|)
##      .Aut1           4.977   0.113  44.215   0.000
##      .Aut2           5.073   0.135  37.566   0.000
##      .Aut3           4.339   0.133  32.680   0.000
##      .Aut4           4.228   0.126  33.570   0.000
##      .Aut5           5.103   0.137  37.282   0.000
##      .Aut6           4.105   0.123  33.256   0.000
##      .Aut7           4.757   0.129  36.832   0.000
##      .TD1           7.709   0.101  76.419   0.000
##      .TD4           8.130   0.099  81.897   0.000
##      .TD2           6.816   0.145  47.116   0.000
##      .TD3           7.255   0.112  64.858   0.000
##      .Automation     0.000
##      TD              0.000
##
## Variances:
##              Estimate Std.Err z-value P(>|z|)
##      .Atmt           1.000
##      .Aut1 (VAR_A1)   4.700   0.312  15.058   0.000
##      .Aut2 (VAR_A2)   3.573   0.269  13.270   0.000
##      .Aut3 (VAR_A3)   3.895   0.284  13.695   0.000
##      .Aut4 (VAR_A4)   3.062   0.232  13.215   0.000
##      .Aut5 (VAR_A5)   2.966   0.240  12.377   0.000
##      .Aut6 (VAR_A6)   3.039   0.228  13.338   0.000
##      .Aut7 (VAR_A7)   2.379   0.201  11.864   0.000
##      TD              1.000
##      .TD1 (VAR_TD1)   3.865   0.277  13.931   0.000
##      .TD4 (VAR_TD4)   2.651   0.310   8.561   0.000
##      .TD2 (VAR_TD2)   9.538   0.634  15.040   0.000
##      .TD3 (VAR_TD3)   4.230   0.364  11.629   0.000

```

```
standardizedSolution(result)
```

```

##      lhs op      rhs      label est.std  se      z pvalue ci.lower
## 1 Automation == Aut1      Aut__Aut1  0.473 0.018 26.664      0  0.438
## 2 Automation == Aut2      Aut__Aut2  0.768 0.021 36.151      0  0.727
## 3 Automation == Aut3      Aut__Aut3  0.733 0.024 31.167      0  0.687
## 4 Automation == Aut4      Aut__Aut4  0.772 0.021 36.779      0  0.731
## 5 Automation == Aut5      Aut__Aut5  0.818 0.018 45.619      0  0.783
## 6 Automation == Aut6      Aut__Aut6  0.763 0.022 35.377      0  0.721
## 7 Automation == Aut7      Aut__Aut7  0.838 0.017 50.512      0  0.805
## 8 TD == TD1      TD__TD1  0.453 0.013 35.072      0  0.428
## 9 TD == TD4      TD__TD4  0.661 0.049 13.474      0  0.565
## 10 TD == TD2     TD__TD2  0.216 0.055  3.902      0  0.107
## 11 TD == TD3     TD__TD3  0.541 0.049 11.008      0  0.445
## 12 TD == Automation TD__Automation  0.513 0.050 10.333      0  0.415
## 13 Automation == Automation      0.737 0.051 14.495      0  0.638
## 14 Aut1 == Aut1      VAR_Aut1  0.776 0.017 46.196      0  0.743
## 15 Aut2 == Aut2      VAR_Aut2  0.410 0.033 12.553      0  0.346
## 16 Aut3 == Aut3      VAR_Aut3  0.462 0.035 13.393      0  0.395
## 17 Aut4 == Aut4      VAR_Aut4  0.404 0.032 12.459      0  0.340

```

## 18	Aut5	~~	Aut5	VAR_Aut5	0.331	0.029	11.301	0	0.274
## 19	Aut6	~~	Aut6	VAR_Aut6	0.417	0.033	12.672	0	0.353
## 20	Aut7	~~	Aut7	VAR_Aut7	0.298	0.028	10.738	0	0.244
## 21	TD	~~	TD		1.000	0.000	NA	NA	1.000
## 22	TD1	~~	TD1	VAR_TD1	0.794	0.012	67.769	0	0.771
## 23	TD4	~~	TD4	VAR_TD4	0.563	0.065	8.670	0	0.436
## 24	TD2	~~	TD2	VAR_TD2	0.953	0.024	39.979	0	0.907
## 25	TD3	~~	TD3	VAR_TD3	0.707	0.053	13.294	0	0.603
## 26	Aut1	~1			2.022	0.071	28.540	0	1.883
## 27	Aut2	~1			1.718	0.072	24.030	0	1.578
## 28	Aut3	~1			1.495	0.066	22.568	0	1.365
## 29	Aut4	~1			1.535	0.067	22.881	0	1.404
## 30	Aut5	~1			1.705	0.071	23.999	0	1.566
## 31	Aut6	~1			1.521	0.067	22.774	0	1.390
## 32	Aut7	~1			1.685	0.070	23.898	0	1.546
## 33	TD1	~1			3.495	0.110	31.876	0	3.280
## 34	TD4	~1			3.746	0.129	29.095	0	3.494
## 35	TD2	~1			2.155	0.083	25.851	0	1.992
## 36	TD3	~1			2.967	0.106	27.978	0	2.759
## 37	Automation	~1			0.000	0.000	NA	NA	0.000
## 38	TD	~1			0.000	0.000	NA	NA	0.000
##	ci.upper								
## 1					0.508				
## 2					0.810				
## 3					0.779				
## 4					0.813				
## 5					0.853				
## 6					0.806				
## 7					0.870				
## 8					0.479				
## 9					0.757				
## 10					0.324				
## 11					0.637				
## 12					0.610				
## 13					0.837				
## 14					0.809				
## 15					0.474				
## 16					0.530				
## 17					0.467				
## 18					0.389				
## 19					0.482				
## 20					0.353				
## 21					1.000				
## 22					0.817				
## 23					0.690				
## 24					1.000				
## 25					0.811				
## 26					2.161				
## 27					1.858				
## 28					1.625				
## 29					1.667				
## 30					1.845				
## 31					1.652				
## 32					1.823				

```
## 33    3.710
## 34    3.998
## 35    2.318
## 36    3.174
## 37    0.000
## 38    0.000
```

```
inspect(result, "rsquare")
```

```
## Automation      Aut1      Aut2      Aut3      Aut4      Aut5      Aut6
##      0.263      0.224      0.590      0.538      0.596      0.669      0.583
##      Aut7      TD1      TD4      TD2      TD3
##      0.702      0.206      0.437      0.047      0.293
```

```
library(semPlot)
semPaths(result, whatLabels = "std", layout = "spring", color = list(
  lat = rgb(255, 100, 118, maxColorValue = 255),
  man = rgb(155, 253, 175, maxColorValue = 255)),
  mar = c(10, 5, 10, 5), intercepts = FALSE, residuls = FALSE, nCharNodes = 0)
```

```
## Warning in qgraph::qgraph(Edgelist, labels = nLab, bidirectional = Bidir, : The
## following arguments are not documented and likely not arguments of qgraph and
## thus ignored: residuls
```

