

## MODELOS LONGITUDINALES CON VARIABLES LATENTES PARA LA INVESTIGACIÓN EN PSICOLOGÍA

Modelos de Curva de Crecimiento Latente (LGCM): modelos condicionales

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### Paquetes a utilizar en esta sesión.

- lavaan*: Un paquete para la estimación de modelos de variables latentes como CFA, además permite realizar path analysis, modelación de ecuaciones estructurales, curvas de crecimiento latente, etc.
- psych*: Paquete que incluye funciones útiles para la investigación en psicología. *ggplot2*: Paquete que incluye funciones útiles gráficos
- MVN*: Paquete que usaremos para evaluar normalidad multivariada.

Durante esta sesión trabajaremos con una base de datos Tallerclase6.csv (extraídos de Hoffman, 2015). Esta contiene los datos de 200 adolescentes (12 a 18 años de edad) en los que se midieron, anualmente, sus conductas de riesgo (Risky12 a Risky18), su percepción de monitoreo materno (Monit12 a Monit18) y la actitud de sus madres hacia el consumo de alcohol y tabaco (Attitude12). El rango de respuesta de las conductas de riesgo va de 10 a 50 puntos y de 1 a 5 para el monitoreo materno (centrada en 3) y para las actitudes maternas (centrada en 4).

### Análisis descriptivos e inspección de datos

```
## seteamos ambiente de trabajo
setwd("/Users/fa/Dropbox/Docencia/2024/Doctorado/Optativo Doctorado UTalca/Clases/Clase

## cargamos la base de datos
base<-read.csv("Taller_clase6.csv", header = T, sep = ";")

names(base)

## [1] "id"          "actitud12" "age12"      "age13"      "age14"      "age15"
## [7] "age16"      "age17"      "age18"      "riesgo12"   "riesgo13"   "riesgo14"
## [13] "riesgo15"   "riesgo16"   "riesgo17"   "riesgo18"   "monit12"    "monit13"
## [19] "monit14"    "monit15"    "monit16"    "monit17"    "monit18"

library(psych)
describe(base, skew = F)
```

##	vars	n	mean	sd	median	min	max	range	se
## id	1	200	100.50	57.88	100.50	1.0	200.0	199.0	4.09
## actitud12	2	200	3.95	0.60	3.90	2.4	5.0	2.6	0.04
## age12	3	200	11.99	0.17	12.00	11.5	12.4	0.9	0.01
## age13	4	200	13.02	0.17	13.00	12.4	13.4	1.0	0.01
## age14	5	200	14.01	0.18	14.00	13.5	14.8	1.3	0.01
## age15	6	200	15.01	0.18	15.00	14.5	15.6	1.1	0.01
## age16	7	200	15.96	0.18	16.00	15.4	16.4	1.0	0.01
## age17	8	200	17.01	0.17	17.00	16.5	17.4	0.9	0.01
## age18	9	200	18.00	0.15	18.00	17.6	18.3	0.7	0.01
## riesgo12	10	200	16.72	4.58	16.10	10.0	33.1	23.1	0.32
## riesgo13	11	200	17.18	4.43	17.00	10.0	29.2	19.2	0.31
## riesgo14	12	200	17.86	4.51	17.75	10.0	31.9	21.9	0.32
## riesgo15	13	200	18.98	4.57	19.20	10.0	29.6	19.6	0.32
## riesgo16	14	200	19.78	4.69	19.50	10.0	33.0	23.0	0.33
## riesgo17	15	200	21.65	5.22	21.95	10.1	32.0	21.9	0.37
## riesgo18	16	200	23.52	5.42	23.85	10.2	36.3	26.1	0.38
## monit12	17	200	3.08	0.81	3.15	1.0	5.0	4.0	0.06
## monit13	18	200	3.09	0.76	3.20	1.2	5.0	3.8	0.05
## monit14	19	200	3.07	0.67	3.10	1.0	5.0	4.0	0.05
## monit15	20	200	3.10	0.61	3.05	1.1	4.6	3.5	0.04
## monit16	21	200	3.07	0.54	3.10	1.3	4.6	3.3	0.04
## monit17	22	200	3.06	0.52	3.00	1.1	4.4	3.3	0.04
## monit18	23	200	3.07	0.56	3.00	1.3	4.4	3.1	0.04

## Estimación de Modelos

### *Modelo Nulo*

La estimación de un modelo nulo permite evaluar la pertinencia de modelar el cambio

```
library(lavaan)

## This is lavaan 0.6-19
## lavaan is FREE software! Please report any bugs.

##
## Attaching package: 'lavaan'

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

### Especificación del modelo para monitoreo materno
modelo0<- "i=~ 1*monit12 + 1*monit13+ 1*monit14 + 1*monit15 +
          1*monit16 + 1*monit17+ 1*monit18
          "
fit0<- growth(modelo0, data = base,
              missing="fiml", se="robust", estimator="mlr",
              mimic = "mplus")
summary(fit0, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 41 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters          9
##
##      Number of observations          200
##      Number of missing patterns          1
##
## Model Test User Model:
##
##      Standard      Scaled
##      Test Statistic    288.152    287.264
##      Degrees of freedom      26      26
##      P-value (Chi-square)    0.000    0.000
##      Scaling correction factor      1.003
##      Yuan-Bentler correction (Mplus variant)
```

```

##
## Model Test Baseline Model:
##
## Test statistic 1339.191 1395.375
## Degrees of freedom 21 21
## P-value 0.000 0.000
## Scaling correction factor 0.960
##
## User Model versus Baseline Model:
##
## Comparative Fit Index (CFI) 0.801 0.810
## Tucker-Lewis Index (TLI) 0.839 0.846
##
## Robust Comparative Fit Index (CFI) 0.801
## Robust Tucker-Lewis Index (TLI) 0.839
##
## Loglikelihood and Information Criteria:
##
## Loglikelihood user model (H0) -810.998 -810.998
## Scaling correction factor 0.961
## for the MLR correction
## Loglikelihood unrestricted model (H1) -666.922 -666.922
## Scaling correction factor 0.992
## for the MLR correction
##
## Akaike (AIC) 1639.997 1639.997
## Bayesian (BIC) 1669.682 1669.682
## Sample-size adjusted Bayesian (SABIC) 1641.169 1641.169
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.225 0.224
## 90 Percent confidence interval - lower 0.202 0.201
## 90 Percent confidence interval - upper 0.248 0.248
## P-value H_0: RMSEA <= 0.050 0.000 0.000
## P-value H_0: RMSEA >= 0.080 1.000 1.000
##
## Robust RMSEA 0.225
## 90 Percent confidence interval - lower 0.202
## 90 Percent confidence interval - upper 0.248
## P-value H_0: Robust RMSEA <= 0.050 0.000
## P-value H_0: Robust RMSEA >= 0.080 1.000

```

```

##
## Standardized Root Mean Square Residual:
##
##    SRMR                                0.312        0.312
##
## Parameter Estimates:
##
##    Standard errors                    Sandwich
##    Information bread                  Observed
##    Observed information based on      Hessian
##
## Latent Variables:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##    i =~
##      monit12      1.000                0.519    0.762
##      monit13      1.000                0.519    0.772
##      monit14      1.000                0.519    0.841
##      monit15      1.000                0.519    0.876
##      monit16      1.000                0.519    0.879
##      monit17      1.000                0.519    0.840
##      monit18      1.000                0.519    0.792
##
## Intercepts:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##    i           3.076    0.038   81.146    0.000    5.924    5.924
##
## Variances:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##    .monit12      0.195    0.025    7.856    0.000    0.195    0.419
##    .monit13      0.183    0.019    9.563    0.000    0.183    0.405
##    .monit14      0.111    0.013    8.328    0.000    0.111    0.293
##    .monit15      0.082    0.010    8.074    0.000    0.082    0.233
##    .monit16      0.079    0.010    7.953    0.000    0.079    0.227
##    .monit17      0.112    0.013    8.828    0.000    0.112    0.294
##    .monit18      0.160    0.016    9.714    0.000    0.160    0.372
##    i             0.270    0.031    8.698    0.000    1.000    1.000

```

## Modelo Lineal

En este modelo el parámetro de cambio lineal es la pendiente o slope

```
modelo1<- "i=~ 1*monit12 + 1*monit13+ 1*monit14 + 1*monit15 +
           1*monit16 + 1*monit17+ 1*monit18
           s=~ 0*monit12 + 1*monit13+ 2*monit14 + 3*monit15 +
           4*monit16 + 5*monit17+ 6*monit18
           "
fit1<- growth(modelo1, data = base,
              missing="fiml", se="robust", estimator="mlr")
summary(fit1, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 69 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters    12
##
##      Number of observations        200
##      Number of missing patterns    1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      19.600    19.766
##      Degrees of freedom      23      23
##      P-value (Chi-square)    0.666    0.656
##      Scaling correction factor      0.992
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      1339.191    1395.375
##      Degrees of freedom      21      21
##      P-value      0.000    0.000
##      Scaling correction factor      0.960
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)      1.000    1.000
##      Tucker-Lewis Index (TLI)      1.002    1.002
##
##      Robust Comparative Fit Index (CFI)      1.000
```

```

## Robust Tucker-Lewis Index (TLI) 1.002
##
## Loglikelihood and Information Criteria:
##
## Loglikelihood user model (H0) -676.722 -676.722
## Scaling correction factor 0.993
## for the MLR correction
## Loglikelihood unrestricted model (H1) -666.922 -666.922
## Scaling correction factor 0.992
## for the MLR correction
##
## Akaike (AIC) 1377.445 1377.445
## Bayesian (BIC) 1417.024 1417.024
## Sample-size adjusted Bayesian (SABIC) 1379.007 1379.007
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.000 0.000
## 90 Percent confidence interval - lower 0.000 0.000
## 90 Percent confidence interval - upper 0.048 0.049
## P-value H_0: RMSEA <= 0.050 0.959 0.956
## P-value H_0: RMSEA >= 0.080 0.001 0.001
##
## Robust RMSEA 0.000
## 90 Percent confidence interval - lower 0.000
## 90 Percent confidence interval - upper 0.048
## P-value H_0: Robust RMSEA <= 0.050 0.958
## P-value H_0: Robust RMSEA >= 0.080 0.001
##
## Standardized Root Mean Square Residual:
##
## SRMR 0.040 0.040
##
## Parameter Estimates:
##
## Standard errors Sandwich
## Information bread Observed
## Observed information based on Hessian
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all

```

```

##      i =~
##      monit12      1.000      0.765      0.959
##      monit13      1.000      0.765      1.022
##      monit14      1.000      0.765      1.125
##      monit15      1.000      0.765      1.242
##      monit16      1.000      0.765      1.361
##      monit17      1.000      0.765      1.454
##      monit18      1.000      0.765      1.440
##      s =~
##      monit12      0.000      0.000      0.000
##      monit13      1.000      0.104      0.138
##      monit14      2.000      0.207      0.305
##      monit15      3.000      0.311      0.504
##      monit16      4.000      0.414      0.737
##      monit17      5.000      0.518      0.984
##      monit18      6.000      0.621      1.170
##
## Covariances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i ~~
##      s      -0.065   0.009  -7.616   0.000  -0.818  -0.818
##
## Intercepts:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i      3.085   0.055  55.634   0.000   4.032   4.032
##      s     -0.003   0.008  -0.405   0.685  -0.032  -0.032
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .monit12   0.051   0.010   5.128   0.000   0.051   0.081
##      .monit13   0.094   0.012   8.076   0.000   0.094   0.168
##      .monit14   0.093   0.011   8.684   0.000   0.093   0.202
##      .monit15   0.086   0.010   8.767   0.000   0.086   0.228
##      .monit16   0.077   0.009   8.860   0.000   0.077   0.245
##      .monit17   0.072   0.010   7.329   0.000   0.072   0.258
##      .monit18   0.088   0.012   7.245   0.000   0.088   0.313
##      i      0.585   0.061   9.535   0.000   1.000   1.000
##      s      0.011   0.001   7.408   0.000   1.000   1.000

```



## Modelo cuadrático

En este modelo el parámetro de cambio cuadrático es el más relevante

```
modelo2<- "i=~ 1*monit12 + 1*monit13+ 1*monit14 + 1*monit15 +
            1*monit16 + 1*monit17+ 1*monit18
            s=~ 0*monit12 + 1*monit13+ 2*monit14 + 3*monit15 +
            4*monit16 + 5*monit17+ 6*monit18
            q=~ 0*monit12 + 1*monit13+ 4*monit14 + 9*monit15 +
            16*monit16 + 25*monit17+ 36*monit18
            "
fit2<- growth(modelo2, data = base,
              missing="fiml", se="robust", estimator="mlr")
summary(fit2, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 107 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters    16
##
##      Number of observations        200
##      Number of missing patterns    1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      11.344    11.264
##      Degrees of freedom      19      19
##      P-value (Chi-square)    0.912    0.915
##      Scaling correction factor      1.007
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      1339.191    1395.375
##      Degrees of freedom      21      21
##      P-value      0.000    0.000
##      Scaling correction factor      0.960
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)      1.000    1.000
##      Tucker-Lewis Index (TLI)      1.006    1.006
```

```

##
## Robust Comparative Fit Index (CFI) 1.000
## Robust Tucker-Lewis Index (TLI) 1.007
##
## Loglikelihood and Information Criteria:
##
## Loglikelihood user model (H0) -672.594 -672.594
## Scaling correction factor 0.975
## for the MLR correction
## Loglikelihood unrestricted model (H1) -666.922 -666.922
## Scaling correction factor 0.992
## for the MLR correction
##
## Akaike (AIC) 1377.188 1377.188
## Bayesian (BIC) 1429.961 1429.961
## Sample-size adjusted Bayesian (SABIC) 1379.271 1379.271
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.000 0.000
## 90 Percent confidence interval - lower 0.000 0.000
## 90 Percent confidence interval - upper 0.024 0.023
## P-value H_0: RMSEA <= 0.050 0.993 0.994
## P-value H_0: RMSEA >= 0.080 0.000 0.000
##
## Robust RMSEA 0.000
## 90 Percent confidence interval - lower 0.000
## 90 Percent confidence interval - upper 0.023
## P-value H_0: Robust RMSEA <= 0.050 0.993
## P-value H_0: Robust RMSEA >= 0.080 0.000
##
## Standardized Root Mean Square Residual:
##
## SRMR 0.027 0.027
##
## Parameter Estimates:
##
## Standard errors Sandwich
## Information bread Observed
## Observed information based on Hessian
##
## Latent Variables:

```

```

##               Estimate   Std.Err   z-value   P(>|z|)   Std.lv   Std.all
##   i =~
##   monit12           1.000           0.786       0.974
##   monit13           1.000           0.786       1.050
##   monit14           1.000           0.786       1.181
##   monit15           1.000           0.786       1.313
##   monit16           1.000           0.786       1.428
##   monit17           1.000           0.786       1.473
##   monit18           1.000           0.786       1.437
##   s =~
##   monit12           0.000           0.000       0.000
##   monit13           1.000           0.148       0.197
##   monit14           2.000           0.295       0.443
##   monit15           3.000           0.443       0.739
##   monit16           4.000           0.590       1.072
##   monit17           5.000           0.738       1.382
##   monit18           6.000           0.885       1.618
##   q =~
##   monit12           0.000           0.000       0.000
##   monit13           1.000           0.016       0.022
##   monit14           4.000           0.065       0.098
##   monit15           9.000           0.146       0.245
##   monit16          16.000           0.260       0.473
##   monit17          25.000           0.407       0.762
##   monit18          36.000           0.586       1.071
##
## Covariances:
##               Estimate   Std.Err   z-value   P(>|z|)   Std.lv   Std.all
##   i ~~
##   s          -0.091     0.017    -5.498     0.000    -0.788    -0.788
##   q           0.004     0.002     2.171     0.030     0.343     0.343
##   s ~~
##   q          -0.002     0.001    -1.906     0.057    -0.703    -0.703
##
## Intercepts:
##               Estimate   Std.Err   z-value   P(>|z|)   Std.lv   Std.all
##   i           3.082     0.057    54.165     0.000     3.920     3.920
##   s          -0.000     0.015    -0.018     0.985    -0.002    -0.002
##   q          -0.000     0.002    -0.202     0.840    -0.028    -0.028
##
## Variances:

```

##		Estimate	Std.Err	z-value	P(> z )	Std.lv	Std.all
##	.monit12	0.033	0.016	2.079	0.038	0.033	0.051
##	.monit13	0.098	0.012	8.361	0.000	0.098	0.175
##	.monit14	0.091	0.011	8.598	0.000	0.091	0.206
##	.monit15	0.084	0.010	8.653	0.000	0.084	0.234
##	.monit16	0.076	0.009	8.600	0.000	0.076	0.251
##	.monit17	0.074	0.010	7.621	0.000	0.074	0.259
##	.monit18	0.065	0.016	4.049	0.000	0.065	0.216
##	i	0.618	0.067	9.292	0.000	1.000	1.000
##	s	0.022	0.007	3.313	0.001	1.000	1.000
##	q	0.000	0.000	1.974	0.048	1.000	1.000

### Comparación de modelos

```
anova(fit0, fit1, fit2)

##
## Scaled Chi-Squared Difference Test (method = "satorra.bentler.2001")
##
## lavaan->lavTestLRT():
##   lavaan NOTE: The "Chisq" column contains standard test statistics, not the
##   robust test that should be reported per model. A robust difference test is
##   a function of two standard (not robust) statistics.
##   Df    AIC    BIC   Chisq Chisq diff Df diff Pr(>Chisq)
## fit2 19 1377.2 1430.0  11.344
## fit1 23 1377.4 1417.0  19.600      8.993    4   0.06128 .
## fit0 26 1640.0 1669.7 288.152    246.140    3   < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### *Modelo para conductas de riesgo*

```
modelo0<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
          1*riesgo16 + 1*riesgo17 + 1*riesgo18
          "
fit0<- growth(modelo0, data = base,
              missing="fiml", se="robust", estimator="mlr")
summary(fit0, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 44 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters          9
##
##      Number of observations          200
##      Number of missing patterns          1
##
## Model Test User Model:
##
##              Standard          Scaled
##      Test Statistic          522.231          532.009
##      Degrees of freedom          26          26
##      P-value (Chi-square)          0.000          0.000
##      Scaling correction factor          0.982
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic          730.186          753.359
##      Degrees of freedom          21          21
##      P-value          0.000          0.000
##      Scaling correction factor          0.969
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)          0.300          0.309
##      Tucker-Lewis Index (TLI)          0.435          0.442
##
##      Robust Comparative Fit Index (CFI)          0.300
##      Robust Tucker-Lewis Index (TLI)          0.434
##
## Loglikelihood and Information Criteria:
##
```

```

## Loglikelihood user model (H0) -4064.120 -4064.120
## Scaling correction factor 0.889
## for the MLR correction
## Loglikelihood unrestricted model (H1) -3803.004 -3803.004
## Scaling correction factor 0.958
## for the MLR correction
##
## Akaike (AIC) 8146.240 8146.240
## Bayesian (BIC) 8175.924 8175.924
## Sample-size adjusted Bayesian (SABIC) 8147.412 8147.412
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.309 0.312
## 90 Percent confidence interval - lower 0.286 0.289
## 90 Percent confidence interval - upper 0.332 0.336
## P-value H_0: RMSEA <= 0.050 0.000 0.000
## P-value H_0: RMSEA >= 0.080 1.000 1.000
##
## Robust RMSEA 0.309
## 90 Percent confidence interval - lower 0.287
## 90 Percent confidence interval - upper 0.332
## P-value H_0: Robust RMSEA <= 0.050 0.000
## P-value H_0: Robust RMSEA >= 0.080 1.000
##
## Standardized Root Mean Square Residual:
##
## SRMR 0.280 0.280
##
## Parameter Estimates:
##
## Standard errors Sandwich
## Information bread Observed
## Observed information based on Hessian
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## i =~
## riesgo12 1.000 3.432 0.614
## riesgo13 1.000 3.432 0.677
## riesgo14 1.000 3.432 0.739

```

```

##      riesgo15      1.000      3.432      0.778
##      riesgo16      1.000      3.432      0.763
##      riesgo17      1.000      3.432      0.599
##      riesgo18      1.000      3.432      0.482
##
## Intercepts:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i      18.941   0.293  64.704   0.000   5.519   5.519
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .riesgo12   19.483   2.022   9.637   0.000  19.483   0.623
##      .riesgo13   13.894   1.477   9.404   0.000  13.894   0.541
##      .riesgo14    9.816   1.087   9.031   0.000   9.816   0.455
##      .riesgo15    7.705   0.932   8.264   0.000   7.705   0.395
##      .riesgo16    8.443   1.251   6.750   0.000   8.443   0.417
##      .riesgo17   21.077   2.279   9.250   0.000  21.077   0.641
##      .riesgo18   38.900   3.705  10.498   0.000  38.900   0.768
##      i      11.780   1.309   9.000   0.000   1.000   1.000

```

### Modelo Lineal

```
modelo1<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
            1*riesgo16 + 1*riesgo17 + 1*riesgo18
            s=~ 0*riesgo12 + 1*riesgo13+ 2*riesgo14 + 3*riesgo15 +
            4*riesgo16 + 5*riesgo17 + 6*riesgo18
            "
fit1<- growth(modelo1, data = base,
              missing="fiml", se="robust", estimator="mlr")
summary(fit1, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 58 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters      12
##
##      Number of observations          200
##      Number of missing patterns       1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      72.232    75.178
##      Degrees of freedom        23         23
##      P-value (Chi-square)      0.000     0.000
##      Scaling correction factor      0.961
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      730.186    753.359
##      Degrees of freedom        21         21
##      P-value              0.000     0.000
##      Scaling correction factor      0.969
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)      0.931    0.929
##      Tucker-Lewis Index (TLI)        0.937    0.935
##
##      Robust Comparative Fit Index (CFI)      0.929
##      Robust Tucker-Lewis Index (TLI)        0.935
##
```



```

## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)          -3839.120   -3839.120
##   Scaling correction factor              0.952
##   for the MLR correction
##   Loglikelihood unrestricted model (H1)    -3803.004   -3803.004
##   Scaling correction factor              0.958
##   for the MLR correction
##
##   Akaike (AIC)                          7702.240   7702.240
##   Bayesian (BIC)                        7741.820   7741.820
##   Sample-size adjusted Bayesian (SABIC)   7703.803   7703.803
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                0.103       0.107
##   90 Percent confidence interval - lower   0.077       0.080
##   90 Percent confidence interval - upper   0.131       0.134
##   P-value H_0: RMSEA <= 0.050            0.001       0.001
##   P-value H_0: RMSEA >= 0.080            0.929       0.948
##
##   Robust RMSEA                          0.105
##   90 Percent confidence interval - lower   0.079
##   90 Percent confidence interval - upper   0.131
##   P-value H_0: Robust RMSEA <= 0.050      0.000
##   P-value H_0: Robust RMSEA >= 0.080      0.944
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                0.067       0.067
##
## Parameter Estimates:
##
##   Standard errors                      Sandwich
##   Information bread                    Observed
##   Observed information based on        Hessian
##
## Latent Variables:
##           Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   i =~
##   riesgo12          1.000          3.530    0.751
##   riesgo13          1.000          3.530    0.797

```

```

##      riesgo14      1.000      3.530      0.791
##      riesgo15      1.000      3.530      0.783
##      riesgo16      1.000      3.530      0.757
##      riesgo17      1.000      3.530      0.695
##      riesgo18      1.000      3.530      0.613
##  s =~
##      riesgo12      0.000      0.000      0.000
##      riesgo13      1.000      0.730      0.165
##      riesgo14      2.000      1.459      0.327
##      riesgo15      3.000      2.189      0.485
##      riesgo16      4.000      2.918      0.626
##      riesgo17      5.000      3.648      0.718
##      riesgo18      6.000      4.377      0.759
##
## Covariances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##  i ~~
##  s      -0.847   0.325  -2.609   0.009  -0.329  -0.329
##
## Intercepts:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##  i      16.042   0.296  54.245   0.000   4.544   4.544
##  s       1.094   0.070  15.644   0.000   1.500   1.500
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##  .riesgo12     9.645   1.238   7.791   0.000   9.645   0.436
##  .riesgo13     8.314   0.880   9.445   0.000   8.314   0.424
##  .riesgo14     8.726   0.899   9.709   0.000   8.726   0.438
##  .riesgo15     8.160   0.939   8.687   0.000   8.160   0.401
##  .riesgo16     7.542   0.929   8.121   0.000   7.542   0.347
##  .riesgo17     8.501   1.250   6.802   0.000   8.501   0.330
##  .riesgo18    11.761   1.649   7.133   0.000  11.761   0.354
##  i     12.463   2.094   5.952   0.000   1.000   1.000
##  s      0.532   0.093   5.734   0.000   1.000   1.000

```

## Paréntesis

### *Modelo Lineal: parametrización no ordinal*

```
modelo1.1<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 +
            1*riesgo16 + 1*riesgo17 + 1*riesgo18
            s=~ -1*riesgo12 + 0*riesgo13+ 1*riesgo14 + 3*riesgo16 +
            4*riesgo17 + 5*riesgo18
            "
fit1.1<- growth(modelo1.1, data = base,
                missing="fiml", se="robust", estimator="mlr")
summary(fit1.1, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 52 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters          11
##
##      Number of observations          200
##      Number of missing patterns          1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      54.742      56.675
##      Degrees of freedom          16          16
##      P-value (Chi-square)          0.000          0.000
##      Scaling correction factor          0.966
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      556.314      589.626
##      Degrees of freedom          15          15
##      P-value          0.000          0.000
##      Scaling correction factor          0.944
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)          0.928          0.929
##      Tucker-Lewis Index (TLI)          0.933          0.934
##
##      Robust Comparative Fit Index (CFI)          0.927
```

```

## Robust Tucker-Lewis Index (TLI)                                0.932
##
## Loglikelihood and Information Criteria:
##
## Loglikelihood user model (H0)                                -3329.939    -3329.939
## Scaling correction factor                                    0.926
## for the MLR correction
## Loglikelihood unrestricted model (H1)                        -3302.568    -3302.568
## Scaling correction factor                                    0.950
## for the MLR correction
##
## Akaike (AIC)                                                6681.878    6681.878
## Bayesian (BIC)                                              6718.159    6718.159
## Sample-size adjusted Bayesian (SABIC)                      6683.310    6683.310
##
## Root Mean Square Error of Approximation:
##
## RMSEA                                                        0.110      0.113
## 90 Percent confidence interval - lower                      0.079      0.081
## 90 Percent confidence interval - upper                      0.143      0.146
## P-value H_0: RMSEA <= 0.050                                0.001      0.001
## P-value H_0: RMSEA >= 0.080                                0.944      0.956
##
## Robust RMSEA                                                0.111
## 90 Percent confidence interval - lower                      0.081
## 90 Percent confidence interval - upper                      0.143
## P-value H_0: Robust RMSEA <= 0.050                        0.001
## P-value H_0: Robust RMSEA >= 0.080                        0.955
##
## Standardized Root Mean Square Residual:
##
## SRMR                                                        0.068      0.068
##
## Parameter Estimates:
##
## Standard errors                                             Sandwich
## Information bread                                           Observed
## Observed information based on                               Hessian
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all

```

```

##      i =~
##      riesgo12      1.000      3.391      0.720
##      riesgo13      1.000      3.391      0.776
##      riesgo14      1.000      3.391      0.748
##      riesgo16      1.000      3.391      0.727
##      riesgo17      1.000      3.391      0.671
##      riesgo18      1.000      3.391      0.596
##      s =~
##      riesgo12     -1.000     -0.731     -0.155
##      riesgo13      0.000      0.000      0.000
##      riesgo14      1.000      0.731      0.161
##      riesgo16      3.000      2.193      0.470
##      riesgo17      4.000      2.924      0.579
##      riesgo18      5.000      3.655      0.642
##
## Covariances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i ~~
##      s      -0.397    0.282   -1.407    0.159   -0.160   -0.160
##
## Intercepts:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i      17.210    0.272   63.301    0.000    5.076    5.076
##      s       1.095    0.069   15.779    0.000    1.499    1.499
##
## Variances:
##      Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .riesgo12     9.383    1.270    7.387    0.000    9.383    0.423
##      .riesgo13     7.583    0.838    9.048    0.000    7.583    0.397
##      .riesgo14     9.304    0.954    9.751    0.000    9.304    0.453
##      .riesgo16     7.829    0.997    7.854    0.000    7.829    0.360
##      .riesgo17     8.659    1.185    7.306    0.000    8.659    0.339
##      .riesgo18    11.497    1.619    7.101    0.000   11.497    0.355
##      i      11.497    1.710    6.724    0.000    1.000    1.000
##      s       0.534    0.092    5.783    0.000    1.000    1.000

```

Volvamos a nuestro ejemplo

### *Modelo cuadrático*

```
modelo2<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
            1*riesgo16 + 1*riesgo17 + 1*riesgo18
            s=~ 0*riesgo12 + 1*riesgo13+ 2*riesgo14 + 3*riesgo15 +
            4*riesgo16 + 5*riesgo17 + 6*riesgo18
            q=~ 0*riesgo12 + 1*riesgo13+ 4*riesgo14 + 9*riesgo15 +
            16*riesgo16 + 25*riesgo17 + 36*riesgo18
            "
fit2<- growth(modelo2, data = base,
               missing="fiml", se="robust", estimator="mlr")
summary(fit2, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 77 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters    16
##
##      Number of observations        200
##      Number of missing patterns    1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      25.719    26.381
##      Degrees of freedom      19        19
##      P-value (Chi-square)    0.138     0.120
##      Scaling correction factor
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      730.186    753.359
##      Degrees of freedom      21        21
##      P-value              0.000     0.000
##      Scaling correction factor
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)      0.991    0.990
##      Tucker-Lewis Index (TLI)        0.990    0.989
```

```

##
## Robust Comparative Fit Index (CFI) 0.989
## Robust Tucker-Lewis Index (TLI) 0.988
##
## Loglikelihood and Information Criteria:
##
## Loglikelihood user model (H0) -3815.864 -3815.864
## Scaling correction factor 0.937
## for the MLR correction
## Loglikelihood unrestricted model (H1) -3803.004 -3803.004
## Scaling correction factor 0.958
## for the MLR correction
##
## Akaike (AIC) 7663.728 7663.728
## Bayesian (BIC) 7716.501 7716.501
## Sample-size adjusted Bayesian (SABIC) 7665.811 7665.811
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.042 0.044
## 90 Percent confidence interval - lower 0.000 0.000
## 90 Percent confidence interval - upper 0.080 0.082
## P-value H_0: RMSEA <= 0.050 0.592 0.559
## P-value H_0: RMSEA >= 0.080 0.048 0.059
##
## Robust RMSEA 0.045
## 90 Percent confidence interval - lower 0.000
## 90 Percent confidence interval - upper 0.080
## P-value H_0: Robust RMSEA <= 0.050 0.557
## P-value H_0: Robust RMSEA >= 0.080 0.053
##
## Standardized Root Mean Square Residual:
##
## SRMR 0.033 0.033
##
## Parameter Estimates:
##
## Standard errors Sandwich
## Information bread Observed
## Observed information based on Hessian
##
## Latent Variables:

```

```

##               Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   i =~
##   riesgo12          1.000              3.608    0.799
##   riesgo13          1.000              3.608    0.802
##   riesgo14          1.000              3.608    0.801
##   riesgo15          1.000              3.608    0.785
##   riesgo16          1.000              3.608    0.768
##   riesgo17          1.000              3.608    0.706
##   riesgo18          1.000              3.608    0.663
##   s =~
##   riesgo12          0.000              0.000    0.000
##   riesgo13          1.000              1.335    0.297
##   riesgo14          2.000              2.669    0.593
##   riesgo15          3.000              4.004    0.871
##   riesgo16          4.000              5.338    1.137
##   riesgo17          5.000              6.673    1.306
##   riesgo18          6.000              8.007    1.471
##   q =~
##   riesgo12          0.000              0.000    0.000
##   riesgo13          1.000              0.174    0.039
##   riesgo14          4.000              0.698    0.155
##   riesgo15          9.000              1.569    0.341
##   riesgo16         16.000              2.790    0.594
##   riesgo17         25.000              4.359    0.853
##   riesgo18         36.000              6.278    1.153
##
## Covariances:
##               Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   i ~~
##   s          -1.447    0.892   -1.622    0.105   -0.301   -0.301
##   q           0.059    0.121    0.490    0.624    0.094    0.094
##   s ~~
##   q          -0.191    0.090   -2.120    0.034   -0.819   -0.819
##
## Intercepts:
##               Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   i          16.773    0.307   54.710    0.000    4.649    4.649
##   s           0.228    0.165    1.383    0.167    0.171    0.171
##   q           0.148    0.025    5.881    0.000    0.847    0.847
##
## Variances:

```



##		Estimate	Std.Err	z-value	P(> z )	Std.lv	Std.all
##	.riesgo12	7.361	1.499	4.911	0.000	7.361	0.361
##	.riesgo13	8.556	0.896	9.546	0.000	8.556	0.423
##	.riesgo14	8.025	0.912	8.800	0.000	8.025	0.396
##	.riesgo15	7.546	0.891	8.471	0.000	7.546	0.357
##	.riesgo16	6.840	0.862	7.937	0.000	6.840	0.310
##	.riesgo17	8.728	1.220	7.155	0.000	8.728	0.334
##	.riesgo18	8.543	2.006	4.259	0.000	8.543	0.288
##	i	13.015	2.318	5.614	0.000	1.000	1.000
##	s	1.781	0.638	2.791	0.005	1.000	1.000
##	q	0.030	0.015	2.043	0.041	1.000	1.000

### Comparación de modelos

```
anova(fit0, fit1, fit2)

##
## Scaled Chi-Squared Difference Test (method = "satorra.bentler.2001")
##
## lavaan->lavTestLRT():
##   lavaan NOTE: The "Chisq" column contains standard test statistics, not the
##   robust test that should be reported per model. A robust difference test is
##   a function of two standard (not robust) statistics.
##   Df    AIC    BIC   Chisq Chisq diff Df diff Pr(>Chisq)
## fit2 19 7663.7 7716.5  25.719
## fit1 23 7702.2 7741.8  72.232      52.03      4 1.358e-10 ***
## fit0 26 8146.2 8175.9 522.231     394.34      3 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## Paréntesis

### *Modelo cuadrático: Parametrización ordinal más espaciada*

```
modelo2.1<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
              1*riesgo16 + 1*riesgo17 + 1*riesgo18
              s=~ 0*riesgo12 + 3*riesgo13+ 6*riesgo14 + 9*riesgo15 +
              12*riesgo16 + 15*riesgo17 + 18*riesgo18
              q=~ 0*riesgo12 + 9*riesgo13+ 36*riesgo14 + 81*riesgo15 +
              144*riesgo16 + 625*riesgo17 + 324*riesgo18
              "
fit2.1<- growth(modelo2.1, data = base,
                 missing="fiml", se="robust", estimator="mlr")
summary(fit2.1, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 166 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters    16
##
##      Number of observations        200
##      Number of missing patterns    1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      65.282    67.962
##      Degrees of freedom      19      19
##      P-value (Chi-square)    0.000    0.000
##      Scaling correction factor      0.961
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      730.186    753.359
##      Degrees of freedom      21      21
##      P-value      0.000    0.000
##      Scaling correction factor      0.969
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)    0.935    0.933
##      Tucker-Lewis Index (TLI)      0.928    0.926
```

```

##
## Robust Comparative Fit Index (CFI) 0.933
## Robust Tucker-Lewis Index (TLI) 0.926
##
## Loglikelihood and Information Criteria:
##
## Loglikelihood user model (H0) -3835.645 -3835.645
## Scaling correction factor 0.954
## for the MLR correction
## Loglikelihood unrestricted model (H1) -3803.004 -3803.004
## Scaling correction factor 0.958
## for the MLR correction
##
## Akaike (AIC) 7703.291 7703.291
## Bayesian (BIC) 7756.064 7756.064
## Sample-size adjusted Bayesian (SABIC) 7705.374 7705.374
##
## Root Mean Square Error of Approximation:
##
## RMSEA 0.110 0.114
## 90 Percent confidence interval - lower 0.082 0.085
## 90 Percent confidence interval - upper 0.140 0.144
## P-value H_0: RMSEA <= 0.050 0.001 0.000
## P-value H_0: RMSEA >= 0.080 0.959 0.970
##
## Robust RMSEA 0.112
## 90 Percent confidence interval - lower 0.084
## 90 Percent confidence interval - upper 0.140
## P-value H_0: Robust RMSEA <= 0.050 0.000
## P-value H_0: Robust RMSEA >= 0.080 0.969
##
## Standardized Root Mean Square Residual:
##
## SRMR 0.067 0.067
##
## Parameter Estimates:
##
## Standard errors Sandwich
## Information bread Observed
## Observed information based on Hessian
##
## Latent Variables:

```

```

##               Estimate   Std.Err   z-value   P(>|z|)   Std.lv   Std.all
##   i =~
##   riesgo12           1.000           3.479       0.744
##   riesgo13           1.000           3.479       0.784
##   riesgo14           1.000           3.479       0.782
##   riesgo15           1.000           3.479       0.773
##   riesgo16           1.000           3.479       0.755
##   riesgo17           1.000           3.479       0.674
##   riesgo18           1.000           3.479       0.599
##   s =~
##   riesgo12           0.000           0.000       0.000
##   riesgo13           3.000           0.628       0.142
##   riesgo14           6.000           1.255       0.282
##   riesgo15           9.000           1.883       0.419
##   riesgo16          12.000           2.511       0.545
##   riesgo17          15.000           3.139       0.608
##   riesgo18          18.000           3.766       0.648
##   q =~
##   riesgo12           0.000           0.000       0.000
##   riesgo13           9.000           0.022       0.005
##   riesgo14          36.000           0.088       0.020
##   riesgo15          81.000           0.197       0.044
##   riesgo16         144.000           0.350       0.076
##   riesgo17         625.000           1.520       0.295
##   riesgo18        324.000           0.788       0.136
##
## Covariances:
##               Estimate   Std.Err   z-value   P(>|z|)   Std.lv   Std.all
##   i ~~
##   s          -0.201     0.143    -1.405     0.160    -0.276    -0.276
##   q          -0.002     0.003    -0.644     0.520    -0.193    -0.193
##   s ~~
##   q           0.000     0.000     0.428     0.669     0.383     0.383
##
## Intercepts:
##               Estimate   Std.Err   z-value   P(>|z|)   Std.lv   Std.all
##   i          16.163     0.298    54.227     0.000     4.646     4.646
##   s           0.324     0.029    11.076     0.000     1.550     1.550
##   q           0.001     0.001     1.927     0.054     0.520     0.520
##
## Variances:

```

##		Estimate	Std.Err	z-value	P(> z )	Std.lv	Std.all
##	.riesgo12	9.745	1.245	7.830	0.000	9.745	0.446
##	.riesgo13	8.391	0.899	9.338	0.000	8.391	0.427
##	.riesgo14	8.529	0.881	9.684	0.000	8.529	0.431
##	.riesgo15	8.135	0.943	8.623	0.000	8.135	0.402
##	.riesgo16	7.315	0.899	8.139	0.000	7.315	0.345
##	.riesgo17	6.757	4.586	1.473	0.141	6.757	0.254
##	.riesgo18	12.882	1.945	6.623	0.000	12.882	0.381
##	i	12.101	2.240	5.402	0.000	1.000	1.000
##	s	0.044	0.016	2.697	0.007	1.000	1.000
##	q	0.000	0.000	0.231	0.818	1.000	1.000

Volvamos a nuestro ejemplo

*Modelo condicional con covariable cambia en el tiempo: efecto sobre parámetros de cambio*

```
modelo3<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
            1*riesgo16 + 1*riesgo17 + 1*riesgo18
            s=~ 0*riesgo12 + 1*riesgo13+ 2*riesgo14 + 3*riesgo15 +
            4*riesgo16 + 5*riesgo17 + 6*riesgo18
            q=~ 0*riesgo12 + 1*riesgo13+ 4*riesgo14 + 9*riesgo15 +
            16*riesgo16 + 25*riesgo17 + 36*riesgo18

            i ~ actitud12
            s ~ actitud12
            q ~ actitud12
            "

fit3<- growth(modelo3, data = base,
               missing="fiml", se="robust", estimator="mlr")
summary(fit3, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 81 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters      19
##
##      Number of observations          200
##      Number of missing patterns      1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      25.901      26.607
##      Degrees of freedom      23         23
##      P-value (Chi-square)      0.306      0.273
##      Scaling correction factor      0.973
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      766.764      798.582
##      Degrees of freedom      28         28
##      P-value      0.000      0.000
##      Scaling correction factor      0.960
##
```

```

## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                0.996      0.995
##   Tucker-Lewis Index (TLI)                  0.995      0.994
##
##   Robust Comparative Fit Index (CFI)                0.995
##   Robust Tucker-Lewis Index (TLI)                0.994
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)                -3797.666   -3797.666
##   Scaling correction factor                      0.929
##   for the MLR correction
##   Loglikelihood unrestricted model (H1)          -3784.716   -3784.716
##   Scaling correction factor                      0.954
##   for the MLR correction
##
##   Akaike (AIC)                                7633.332   7633.332
##   Bayesian (BIC)                              7696.000   7696.000
##   Sample-size adjusted Bayesian (SABIC)          7635.806   7635.806
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                0.025      0.028
##   90 Percent confidence interval - lower          0.000      0.000
##   90 Percent confidence interval - upper          0.065      0.067
##   P-value H_0: RMSEA <= 0.050                  0.813      0.784
##   P-value H_0: RMSEA >= 0.080                  0.008      0.010
##
##   Robust RMSEA                                0.028
##   90 Percent confidence interval - lower          0.000
##   90 Percent confidence interval - upper          0.066
##   P-value H_0: Robust RMSEA <= 0.050            0.791
##   P-value H_0: Robust RMSEA >= 0.080            0.008
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                0.031      0.031
##
## Parameter Estimates:
##
##   Standard errors                        Sandwich

```

```

## Information bread Observed
## Observed information based on Hessian
##
## Latent Variables:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## i =~
## riesgo12 1.000 3.606 0.799
## riesgo13 1.000 3.606 0.802
## riesgo14 1.000 3.606 0.801
## riesgo15 1.000 3.606 0.784
## riesgo16 1.000 3.606 0.768
## riesgo17 1.000 3.606 0.706
## riesgo18 1.000 3.606 0.662
## s =~
## riesgo12 0.000 0.000 0.000
## riesgo13 1.000 1.330 0.296
## riesgo14 2.000 2.660 0.591
## riesgo15 3.000 3.990 0.868
## riesgo16 4.000 5.320 1.133
## riesgo17 5.000 6.650 1.302
## riesgo18 6.000 7.980 1.464
## q =~
## riesgo12 0.000 0.000 0.000
## riesgo13 1.000 0.173 0.038
## riesgo14 4.000 0.691 0.153
## riesgo15 9.000 1.555 0.338
## riesgo16 16.000 2.765 0.589
## riesgo17 25.000 4.320 0.846
## riesgo18 36.000 6.220 1.141
##
## Regressions:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## i ~
## actitud12 -0.351 0.505 -0.695 0.487 -0.097 -0.059
## s ~
## actitud12 -0.176 0.253 -0.696 0.486 -0.132 -0.080
## q ~
## actitud12 -0.057 0.038 -1.508 0.131 -0.333 -0.200
##
## Covariances:
## Estimate Std.Err z-value P(>|z|) Std.lv Std.all
## .i ~~

```



```

##      .s      -1.460    0.896   -1.630    0.103   -0.306   -0.306
##      .q      0.051    0.122    0.416    0.678    0.083    0.083
##      .s ~~
##      .q     -0.192    0.088   -2.171    0.030   -0.855   -0.855
##
## Intercepts:
##      Estimate Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      .i      18.158   2.004    9.063    0.000    5.035    5.035
##      .s       0.924   1.042    0.887    0.375    0.694    0.694
##      .q       0.375   0.156    2.402    0.016    2.168    2.168
##
## Variances:
##      Estimate Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      .riesgo12   7.380   1.504    4.905    0.000    7.380    0.362
##      .riesgo13   8.543   0.884    9.661    0.000    8.543    0.423
##      .riesgo14   8.016   0.900    8.909    0.000    8.016    0.395
##      .riesgo15   7.555   0.893    8.459    0.000    7.555    0.357
##      .riesgo16   6.827   0.865    7.894    0.000    6.827    0.310
##      .riesgo17   8.703   1.199    7.260    0.000    8.703    0.334
##      .riesgo18   8.689   1.877    4.630    0.000    8.689    0.292
##      .i      12.958   2.322    5.582    0.000    0.997    0.997
##      .s       1.758   0.630    2.790    0.005    0.994    0.994
##      .q       0.029   0.014    1.997    0.046    0.960    0.960

```

*Modelo condicional con covariable cambia en el tiempo: efecto sobre los tiempos*

```

modelo4<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
              1*riesgo16 + 1*riesgo17 + 1*riesgo18
s=~ 0*riesgo12 + 1*riesgo13+ 2*riesgo14 + 3*riesgo15 +
      4*riesgo16 + 5*riesgo17 + 6*riesgo18
q=~ 0*riesgo12 + 1*riesgo13+ 4*riesgo14 + 9*riesgo15 +
      16*riesgo16 + 25*riesgo17 + 36*riesgo18

riesgo12~ a*age12
riesgo13~ a*age13
riesgo14~ a*age14
riesgo15~ a*age15
riesgo16~ a*age16
riesgo17~ a*age17
riesgo18~ a*age18
"
fit4<- growth(modelo4, data = base,
              missing="fiml", se="robust", estimator="mlr")
summary(fit4, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 72 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters      23
##      Number of equality constraints     6
##
##      Number of observations          200
##      Number of missing patterns       1
##
## Model Test User Model:
##
##              Standard      Scaled
##      Test Statistic      72.628    74.523
##      Degrees of freedom        67        67
##      P-value (Chi-square)      0.298    0.247
##      Scaling correction factor      0.975
##      Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##      Test statistic      785.500    805.174
##      Degrees of freedom      70        70

```

```

##      P-value                                0.000          0.000
##      Scaling correction factor                0.976
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)              0.992          0.990
##      Tucker-Lewis Index (TLI)                0.992          0.989
##
##      Robust Comparative Fit Index (CFI)        0.989
##      Robust Tucker-Lewis Index (TLI)          0.989
##
## Loglikelihood and Information Criteria:
##
##      Loglikelihood user model (H0)            -3811.661    -3811.661
##      Scaling correction factor                  0.703
##      for the MLR correction
##      Loglikelihood unrestricted model (H1)     -3775.347    -3775.347
##      Scaling correction factor                  0.970
##      for the MLR correction
##
##      Akaike (AIC)                            7657.323    7657.323
##      Bayesian (BIC)                          7713.394    7713.394
##      Sample-size adjusted Bayesian (SABIC)    7659.536    7659.536
##
## Root Mean Square Error of Approximation:
##
##      RMSEA                                    0.020          0.024
##      90 Percent confidence interval - lower    0.000          0.000
##      90 Percent confidence interval - upper    0.048          0.050
##      P-value H_0: RMSEA <= 0.050             0.966          0.952
##      P-value H_0: RMSEA >= 0.080             0.000          0.000
##
##      Robust RMSEA                              0.024
##      90 Percent confidence interval - lower    0.000
##      90 Percent confidence interval - upper    0.049
##      P-value H_0: Robust RMSEA <= 0.050       0.956
##      P-value H_0: Robust RMSEA >= 0.080       0.000
##
## Standardized Root Mean Square Residual:
##
##      SRMR                                      0.039          0.039
##

```

```

## Parameter Estimates:
##
## Standard errors                      Sandwich
## Information bread                    Observed
## Observed information based on        Hessian
##
## Latent Variables:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
## i =~
##   riesgo12      1.000                3.629    0.803
##   riesgo13      1.000                3.629    0.809
##   riesgo14      1.000                3.629    0.804
##   riesgo15      1.000                3.629    0.788
##   riesgo16      1.000                3.629    0.775
##   riesgo17      1.000                3.629    0.712
##   riesgo18      1.000                3.629    0.665
## s =~
##   riesgo12      0.000                0.000    0.000
##   riesgo13      1.000                1.379    0.307
##   riesgo14      2.000                2.759    0.611
##   riesgo15      3.000                4.138    0.899
##   riesgo16      4.000                5.518    1.179
##   riesgo17      5.000                6.897    1.354
##   riesgo18      6.000                8.276    1.516
## q =~
##   riesgo12      0.000                0.000    0.000
##   riesgo13      1.000                0.180    0.040
##   riesgo14      4.000                0.719    0.159
##   riesgo15      9.000                1.617    0.351
##   riesgo16     16.000                2.875    0.614
##   riesgo17     25.000                4.492    0.882
##   riesgo18     36.000                6.468    1.185
##
## Regressions:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
## riesgo12 ~
##   age12      (a)    1.480    0.548    2.701    0.007    1.480    0.056
## riesgo13 ~
##   age13      (a)    1.480    0.548    2.701    0.007    1.480    0.056
## riesgo14 ~
##   age14      (a)    1.480    0.548    2.701    0.007    1.480    0.060
## riesgo15 ~

```

```

##      age15      (a)      1.480      0.548      2.701      0.007      1.480      0.059
##      riesgo16 ~
##      age16      (a)      1.480      0.548      2.701      0.007      1.480      0.056
##      riesgo17 ~
##      age17      (a)      1.480      0.548      2.701      0.007      1.480      0.049
##      riesgo18 ~
##      age18      (a)      1.480      0.548      2.701      0.007      1.480      0.041
##
## Covariances:
##              Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i ~~
##      s      -1.597      0.898     -1.778     0.075     -0.319     -0.319
##      q         0.080      0.122      0.658     0.511      0.123      0.123
##      s ~~
##      q      -0.206      0.092     -2.237     0.025     -0.833     -0.833
##
## Intercepts:
##              Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      i      -1.001      6.639     -0.151     0.880     -0.276     -0.276
##      s      -1.250      0.561     -2.229     0.026     -0.906     -0.906
##      q         0.148      0.025      5.862     0.000      0.822      0.822
##
## Variances:
##              Estimate Std.Err z-value P(>|z|) Std.lv Std.all
##      .riesgo12       7.185      1.473      4.879     0.000      7.185      0.352
##      .riesgo13       8.422      0.880      9.572     0.000      8.422      0.418
##      .riesgo14       8.039      0.923      8.713     0.000      8.039      0.395
##      .riesgo15       7.512      0.884      8.497     0.000      7.512      0.354
##      .riesgo16       6.596      0.854      7.725     0.000      6.596      0.301
##      .riesgo17       8.539      1.186      7.200     0.000      8.539      0.329
##      .riesgo18       8.802      1.994      4.415     0.000      8.802      0.295
##      i      13.167      2.323      5.667     0.000      1.000      1.000
##      s       1.903      0.647      2.941     0.003      1.000      1.000
##      q       0.032      0.015      2.104     0.035      1.000      1.000

```

## Modelo sin restricciones

```

modelo4<- "i=~ 1*riesgo12 + 1*riesgo13+ 1*riesgo14 + 1*riesgo15 +
            1*riesgo16 + 1*riesgo17 + 1*riesgo18
s=~ 0*riesgo12 + 1*riesgo13+ 2*riesgo14 + 3*riesgo15 +
4*riesgo16 + 5*riesgo17 + 6*riesgo18
q=~ 0*riesgo12 + 1*riesgo13+ 4*riesgo14 + 9*riesgo15 +
16*riesgo16 + 25*riesgo17 + 36*riesgo18

riesgo12~ age12
riesgo13~ age13
riesgo14~ age14
riesgo15~ age15
riesgo16~ age16
riesgo17~ age17
riesgo18~ age18
"
fit4<- growth(modelo4, data = base,
               missing="fiml", se="robust", estimator="mlr")
summary(fit4, fit.measures= T, standardized=T)

## lavaan 0.6-19 ended normally after 105 iterations
##
##      Estimator                      ML
##      Optimization method          NLMINB
##      Number of model parameters    23
##
##      Number of observations        200
##      Number of missing patterns    1
##
## Model Test User Model:
##
##      Test Statistic                Standard      Scaled
##      Degrees of freedom            70.003        72.612
##      P-value (Chi-square)          61            61
##      Scaling correction factor      0.201        0.147
##      Yuan-Bentler correction (Mplus variant) 0.964
##
## Model Test Baseline Model:
##
##      Test statistic                785.500      805.174
##      Degrees of freedom            70            70
##      P-value                      0.000        0.000

```

```

##      Scaling correction factor                                0.976
##
## User Model versus Baseline Model:
##
##      Comparative Fit Index (CFI)                            0.987      0.984
##      Tucker-Lewis Index (TLI)                              0.986      0.982
##
##      Robust Comparative Fit Index (CFI)                     0.984
##      Robust Tucker-Lewis Index (TLI)                        0.981
##
## Loglikelihood and Information Criteria:
##
##      Loglikelihood user model (H0)                          -3810.349  -3810.349
##      Scaling correction factor                                0.985
##      for the MLR correction
##      Loglikelihood unrestricted model (H1)                   -3775.347  -3775.347
##      Scaling correction factor                                0.970
##      for the MLR correction
##
##      Akaike (AIC)                                            7666.698  7666.698
##      Bayesian (BIC)                                          7742.559  7742.559
##      Sample-size adjusted Bayesian (SABIC)                  7669.693  7669.693
##
## Root Mean Square Error of Approximation:
##
##      RMSEA                                                    0.027      0.031
##      90 Percent confidence interval - lower                  0.000      0.000
##      90 Percent confidence interval - upper                  0.053      0.056
##      P-value H_0: RMSEA <= 0.050                            0.925      0.888
##      P-value H_0: RMSEA >= 0.080                            0.000      0.000
##
##      Robust RMSEA                                            0.031
##      90 Percent confidence interval - lower                  0.000
##      90 Percent confidence interval - upper                  0.054
##      P-value H_0: Robust RMSEA <= 0.050                     0.901
##      P-value H_0: Robust RMSEA >= 0.080                     0.000
##
## Standardized Root Mean Square Residual:
##
##      SRMR                                                    0.039      0.039
##
## Parameter Estimates:

```

```

##
## Standard errors                      Sandwich
## Information bread                    Observed
## Observed information based on        Hessian
##
## Latent Variables:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      i =~
##      riesgo12      1.000                3.627    0.803
##      riesgo13      1.000                3.627    0.808
##      riesgo14      1.000                3.627    0.804
##      riesgo15      1.000                3.627    0.788
##      riesgo16      1.000                3.627    0.776
##      riesgo17      1.000                3.627    0.712
##      riesgo18      1.000                3.627    0.664
##      s =~
##      riesgo12      0.000                0.000    0.000
##      riesgo13      1.000                1.379    0.307
##      riesgo14      2.000                2.757    0.611
##      riesgo15      3.000                4.136    0.899
##      riesgo16      4.000                5.515    1.180
##      riesgo17      5.000                6.894    1.353
##      riesgo18      6.000                8.272    1.514
##      q =~
##      riesgo12      0.000                0.000    0.000
##      riesgo13      1.000                0.180    0.040
##      riesgo14      4.000                0.720    0.160
##      riesgo15      9.000                1.621    0.352
##      riesgo16     16.000                2.882    0.617
##      riesgo17     25.000                4.503    0.884
##      riesgo18     36.000                6.484    1.187
##
## Regressions:
##      Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##      riesgo12 ~
##      age12      1.139    1.433    0.795    0.427    1.139    0.043
##      riesgo13 ~
##      age13      1.216    0.873    1.394    0.163    1.216    0.046
##      riesgo14 ~
##      age14      1.304    0.812    1.606    0.108    1.304    0.053
##      riesgo15 ~
##      age15      1.412    0.771    1.832    0.067    1.412    0.056

```



```

##   riesgo16 ~
##   age16           1.494    0.698    2.140    0.032    1.494    0.057
##   riesgo17 ~
##   age17           1.624    0.890    1.823    0.068    1.624    0.054
##   riesgo18 ~
##   age18           1.745    1.491    1.171    0.242    1.745    0.049
##
## Covariances:
##           Estimate Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   i ~~
##   s      -1.582    0.894   -1.769    0.077   -0.316   -0.316
##   q       0.078    0.122    0.644    0.520    0.120    0.120
##   s ~~
##   q      -0.207    0.092   -2.254    0.024   -0.832   -0.832
##
## Intercepts:
##           Estimate Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   i          3.059   17.201    0.178    0.859    0.843    0.843
##   s         -1.692   13.780   -0.123    0.902   -1.227   -1.227
##   q         -0.022    2.462   -0.009    0.993   -0.124   -0.124
##
## Variances:
##           Estimate Std.Err  z-value  P(>|z|)  Std.lv  Std.all
##   .riesgo12      7.182    1.476    4.865    0.000    7.182    0.353
##   .riesgo13      8.452    0.887    9.525    0.000    8.452    0.419
##   .riesgo14      8.018    0.915    8.761    0.000    8.018    0.394
##   .riesgo15      7.461    0.895    8.339    0.000    7.461    0.352
##   .riesgo16      6.520    0.845    7.720    0.000    6.520    0.298
##   .riesgo17      8.526    1.187    7.185    0.000    8.526    0.328
##   .riesgo18      8.805    2.006    4.390    0.000    8.805    0.295
##   i          13.152    2.321    5.667    0.000    1.000    1.000
##   s           1.901    0.643    2.954    0.003    1.000    1.000
##   q           0.032    0.015    2.126    0.034    1.000    1.000

```