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> ##########################
> #Replication of Stapleton's (2008) ECLS-K demonstration of SEM with complex samples
> #Available from http://dx.doi.org/10.1080/10705510801922316
> #R code written by Christopher Moore http://umn.edu/~moor0554
> ##########################
>
> #descriptives
> library(psych)
> describe(data.ecls[,c(7, 17, 31, 44, 54)])[c(2,3,4,8,9)]
            n   mean     sd   min     max
C1CPTW0  15757 224.86 104.63  2.17 1018.25
C1RSCALE 15757  22.60   8.63 10.08   69.66
C1MSCALE 15757  20.03   7.35  6.90   59.81
C1GSCALE 15757  22.56   7.39  7.30   47.78
P1NUMPLA 15757   2.18   1.39  1.00   20.00
>
> #Create a function to produce a weighted covariance matrix for variables in Stapleton's mod
el.
> func.vcov.wt <- function(data) cov.wt(data[,c(17, 31, 44, 54)], wt=data[,i])$cov
>
> #Assign the model's weighted covariance matrix to an object.
> i <- 7 #the full sample weight is located in column 7
> (vcov.ecls <- func.vcov.wt(data.ecls))
          C1RSCALE   C1MSCALE   C1GSCALE   P1NUMPLA
C1RSCALE 71.0024006 45.4260726 33.1635963 -0.8076403
C1MSCALE 45.4260726 52.3786774 33.4288340 -0.7476734
C1GSCALE 33.1635963 33.4288340 53.9441643 -0.7371464
P1NUMPLA -0.8076403 -0.7476734 -0.7371464  2.0121129
>
> #Specify the RAM.
> library(sem)
> model.ecls <- specify.model()
1: FCOGACH -> C1RSCALE, NA, 1
2: FCOGACH -> C1MSCALE, lambda21, NA
3: FCOGACH -> C1GSCALE, lambda31, NA
4: P1NUMPLA -> FCOGACH, gamma11, NA
5: P1NUMPLA <-> P1NUMPLA, NA, 1
6: FCOGACH <-> FCOGACH, zeta11, NA
7: C1RSCALE <-> C1RSCALE, epsilon11, NA
8: C1MSCALE <-> C1MSCALE, epsilon22, NA
9: C1GSCALE <-> C1GSCALE, epsilon33, NA
10:
Read 9 records
> #Fit the structural equation model.
> summary(sem.ecls <- sem(model.ecls, vcov.ecls, N=nrow(data.ecls)))

 Model Chisquare =  4939.5   Df =  3 Pr(>Chisq) = 0
 Chisquare (null model) =  21056   Df =  6
 Goodness-of-fit index =  0.8544
 Adjusted goodness-of-fit index =  0.51464
 RMSEA index =  0.32317   90% CI: (NA, 0.33077)
 Bentler-Bonnett NFI =  0.7654
 Tucker-Lewis NNFI =  0.53096
 Bentler CFI =  0.76548
 SRMR =  0.16044
 BIC =  4910.5

 Normalized Residuals
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 -7.740  -6.240   0.125   3.200   0.237  89.800

 Parameter Estimates
          Estimate Std Error z value  Pr(>|z|)
lambda21   1.00649 0.010063  100.0184 0        C1MSCALE <--- FCOGACH
lambda31   0.73594 0.008376   87.8628 0        C1GSCALE <--- FCOGACH
gamma11   -0.38643 0.039722   -9.7283 0        FCOGACH <--- P1NUMPLA
zeta11    44.82657 0.816570   54.8962 0        FCOGACH <--> FCOGACH
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epsilon11 25.87528 0.454192   56.9699 0        C1RSCALE <--> C1RSCALE
epsilon22  6.66421 0.360857   18.4677 0        C1MSCALE <--> C1MSCALE
epsilon33 29.50331 0.382520   77.1288 0        C1GSCALE <--> C1GSCALE

 Iterations =  44
>
> #Plot path diagram with results.
> path.diagram(sem.ecls, out.file="Path_Diagram_Stapleton's_Data.txt", edge.labels="both", ig
nore.double=F, rank.direction="TB", node.font=c("Garamond", 12), edge.font=c("Garamond", 10))
>
> #Attempt to replicate Stapleton's jacknife standard errors.
> matrix.jk <- matrix(ncol=7, nrow=90) #an empty matrix
> for(i in 57:146) {matrix.jk[i-56,] <- sem(model.ecls, func.vcov.wt(data.ecls), N=nrow(data.
ecls))$coef} #90 different sets of parameter estimates, varying according to replicate weight
s
> head(matrix.jk) #peek at matrix
         [,1]      [,2]       [,3]     [,4]     [,5]     [,6]     [,7]
[1,] 1.006908 0.7344982 -0.3846373 44.76861 26.07951 6.530417 29.48383
[2,] 1.007349 0.7373901 -0.3868790 44.93374 25.93106 6.688790 29.50017
[3,] 1.007143 0.7360928 -0.3765962 44.75326 25.87076 6.663657 29.44377
[4,] 1.005499 0.7364139 -0.3863027 45.00384 25.89516 6.798260 29.37207
[5,] 1.006469 0.7347785 -0.3874263 44.83537 25.91797 6.672554 29.51726
[6,] 1.005891 0.7352345 -0.3869698 44.81324 25.96737 6.641025 29.55304
> dim(matrix.jk) #dimensions
[1] 90  7
> matrix.orig <- matrix(rep(sem.ecls$coef, 90), byrow=T, ncol=7)
> head(matrix.orig) #peek at matrix of original parameter estimates based on full sample weig
hts (C1CPTW0)
         [,1]      [,2]       [,3]     [,4]     [,5]     [,6]     [,7]
[1,] 1.006485 0.7359393 -0.3864299 44.82657 25.87528 6.664206 29.50331
[2,] 1.006485 0.7359393 -0.3864299 44.82657 25.87528 6.664206 29.50331
[3,] 1.006485 0.7359393 -0.3864299 44.82657 25.87528 6.664206 29.50331
[4,] 1.006485 0.7359393 -0.3864299 44.82657 25.87528 6.664206 29.50331
[5,] 1.006485 0.7359393 -0.3864299 44.82657 25.87528 6.664206 29.50331
[6,] 1.006485 0.7359393 -0.3864299 44.82657 25.87528 6.664206 29.50331
> E <- matrix.jk - matrix.orig
> head(E) #peek at matrix of differences
              [,1]          [,2]          [,3]         [,4]         [,5]         [,6]
[1,]  4.230782e-04 -0.0014411128  0.0017926674 -0.057963725  0.204228590 -0.133788946
[2,]  8.640002e-04  0.0014507987 -0.0004490399  0.107165538  0.055779008  0.024584506
[3,]  6.577310e-04  0.0001535416  0.0098337046 -0.073308246 -0.004518564 -0.000548724
[4,] -9.864199e-04  0.0004746164  0.0001272171  0.177267761  0.019881144  0.134053761
[5,] -1.604131e-05 -0.0011607434 -0.0009963572  0.008799869  0.042696347  0.008348255
[6,] -5.938980e-04 -0.0007047620 -0.0005398411 -0.013333597  0.092093652 -0.023181298
             [,7]
[1,] -0.019472961
[2,] -0.003131565
[3,] -0.059535121
[4,] -0.131233302
[5,]  0.013954664
[6,]  0.049735854
> se.jk.R <- sqrt(diag(t(E) %*% E)) #square root of sum of squared differences
> se.jk.Stapleton <- c(0.012, 0.012, 0.05, 1.426, 0.933, 0.5, 0.548)
> se.naive <- summary(sem.ecls)$coef[,2]
> round(data.frame(cbind(se.naive, se.jk.Stapleton, se.jk.R), row.names=names(sem.ecls$coef))
, 3)
          se.naive se.jk.Stapleton se.jk.R
lambda21     0.010           0.012   0.012
lambda31     0.008           0.012   0.012
gamma11      0.040           0.050   0.049
zeta11       0.817           1.426   1.426
epsilon11    0.454           0.933   0.933
epsilon22    0.361           0.500   0.499
epsilon33    0.383           0.548   0.548
>
> #Calculate relative standard errors.
> se.results <- summary(sem.ecls)$coeff[,1:2]
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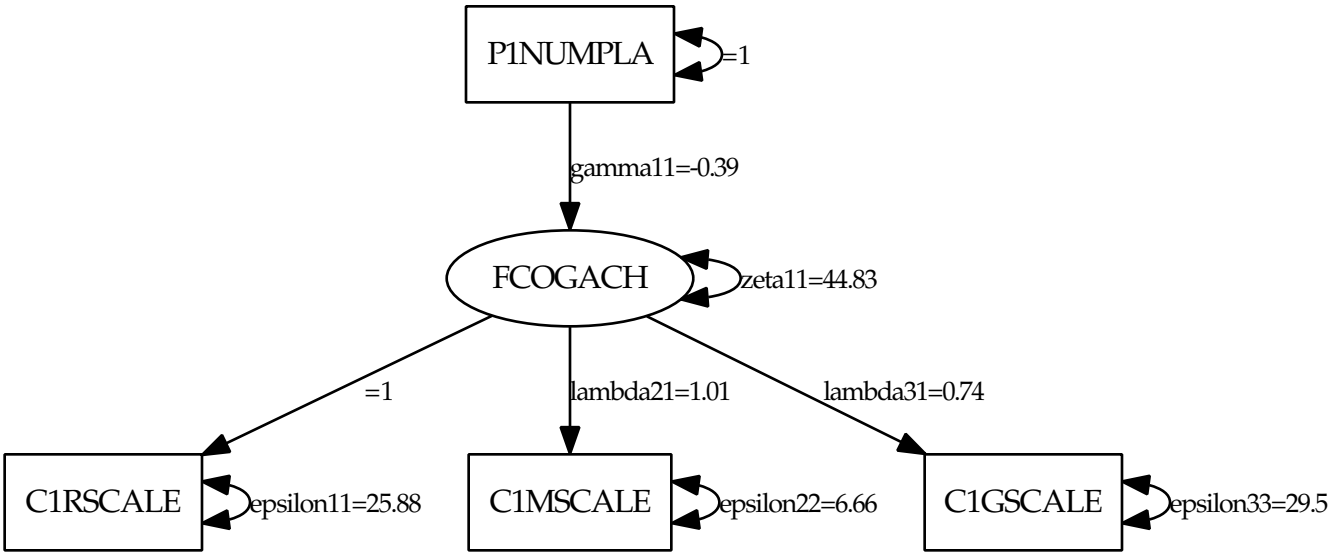
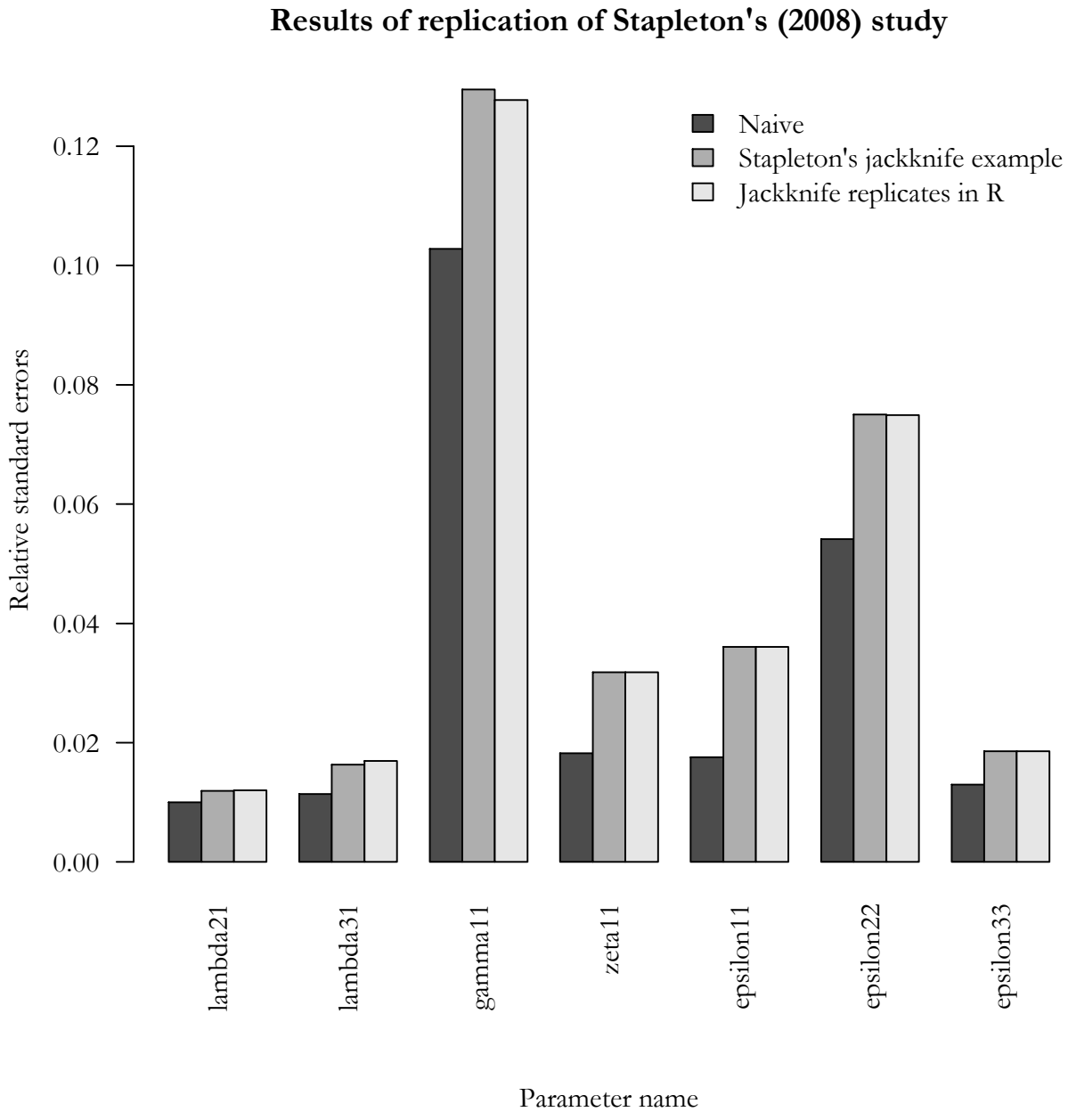
> se.results[,3] <- abs(se.naive/sem.ecls$coef)
> se.results[,4] <- abs(se.jk.Stapleton/c(1.006, 0.736, -0.386, 44.824, 25.873, 6.664, 29.501
))
> se.results[,5] <- abs(se.jk.R/sem.ecls$coef)
> names(se.results)[3:5] <- c("rse.naive", "rse.jk.Stapleton", "rse.jk.R")
> se.results
           Estimate   Std Error  rse.naive rse.jk.Stapleton   rse.jk.R
lambda21   1.0064850 0.010062998 0.00999816       0.01192843 0.01203158
lambda31   0.7359393 0.008376002 0.01138138       0.01630435 0.01695758
gamma11   -0.3864299 0.039722444 0.10279339       0.12953368 0.12772825
zeta11    44.8265695 0.816569837 0.01821620       0.03181331 0.03181656
epsilon11 25.8752782 0.454192094 0.01755313       0.03606076 0.03605652
epsilon22  6.6642059 0.360856979 0.05414853       0.07503001 0.07492249
epsilon33 29.5033064 0.382520086 0.01296533       0.01857564 0.01856546
>
> #Plot relative standard errors.
> par(las=2, mar=c(7,4,4,2)+0.1)
> barplot(t(as.matrix(se.results[3:5])), beside=T, legend=c("Naive", "Stapleton's jackknife e
xample", "Jackknife replicates in R"), args.legend=list(x="topright", bty="n"), ylab="Relativ
e standard errors")
> par(oldpar)
> title(main="Results of replication of Stapleton's (2008) study", sub="Parameter name")
>
>
```


P1NUMPLA
=1
gamma11=-0.39
FCOGACH
zeta11=44.83
=1
lambda21=1.01
lambda31=0.74
C1RSCALE
epsilon11=25.88
C1MSCALE
epsilon22=6.66
C1GSCALE
epsilon33=29.5


Results of replication of Stapleton's (2008) study
Naive
Stapleton's jackknife example
Jackknife replicates in R
Relative standard errors
0.00
0.02
0.04
0.06
0.08
0.10
0.12
lambda21
lambda31
gamma11
zeta11
epsilon11
epsilon22
epsilon33
Parameter name