The REQS package for linking the SEM software EQS to R

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What is REQS?

REQS is a R package that will read statistics and estimates produced by EQS program into a R data object.

This R data object could be further analyzed with R's rich sets of procedures.

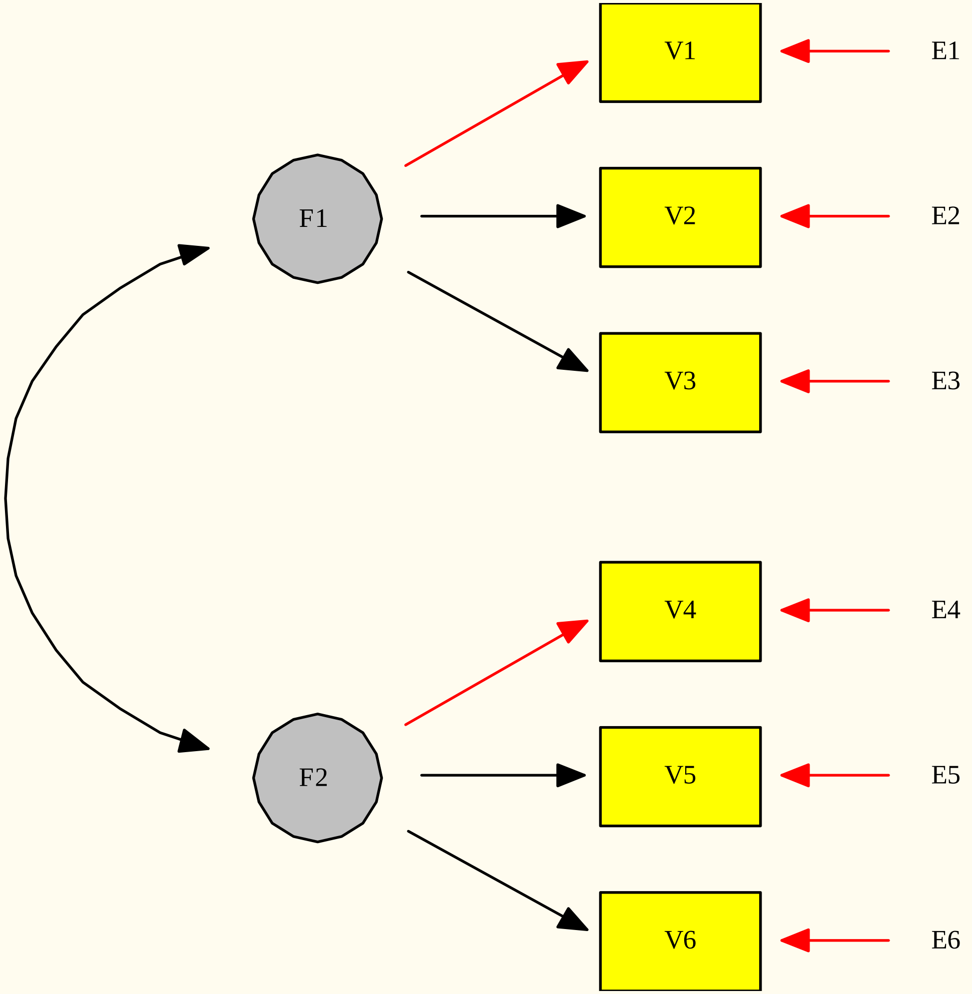
Why REQS?

- Develop new test statistics for SEM without re-program SEM in R. A rich set of statistics and estimates are readily available in EQS.
- Test new data distribution theory with R's Monte Carlo simulation capability using EQS' robust statistics
- Test new methodology that requires SEM outcomes

What is needed to use REQS

- EQS 6.1 for Windows is installed on your computer
- REQS package installed
- An EQS model with commands that output would printout certain information

First example with REQS



First example with REQS

```
/TITLE
Model built by EQS 6 for
     Windows
/SPECIFICATIONS
DATA='c:\eqs61\...\manul7.dat';
FORMAT='(1X,6F6.3)';
VARIABLES=6; CASES=50;
METHOD=ML,ROBUST;
ANALYSIS=COVARIANCE;
MATRIX=RAW;
DELETE=50;
/LABELS
V1=V1; V2=V2; V3=V3; V4=V4;
V5=V5; V6=V6;
/EQUATIONS
V1 =   1F1 + E1;
V2 =   *F1 + E2;
V3 =   *F1 + E3;
V4 =   1F2 + E4;
V5 =   *F2 + E5;
V6 =   *F2 + E6;
/VARIANCES
 F1 = *;
 F2 = *;
 E1 to E6 = *;
/COVARIANCES
F1,F2 = *;
/PRINT
FIT=ALL;
TABLE=EQUATION;
/OUTPUT
Parameters;
Standard Errors;
Listing;
DATA='MANUL7X.ETS';
/END
```

This model is MANUL7X.EQS

First example with REQS

```
#run an EQS model
call.eqs(EQSpgm
    = "C:/Program Files/EQS61/WINEQS.EXE",
        EQSmodel = "manul7x.eqs",
        serial = "45735039762xxxxxx")

#read EQS output information into R data object
out<-read.eqs("manul7x.ets")
```

First example with REQS

Available information produced by REQS

- names(out)

```
 [1] "model.info"  "pval"        "fit.indices"
     "model.desc"  "Phi"         "Gamma"
     "Beta"        "par.table"
     "sample.cov"  "sigma.hat"
[11] "inv.infmat"  "rinv.infmat" "cinv.infmat"
     "derivatives" "moment4"     "ssolution"
     "Rsquared"    "fac.means"   "var.desc"
     "indstd"
[21] "depstd"
```

First example with REQS

- `out$model.info`

```
                values
METHOD              13
CONDCODE             0
CONVRGNC             0
ITER                 7
DF                   8
CNSTRANT             0
DFDENOM             41
DFSTRMEN             0
DFGLSMEN             0
DFGLSCOV             0
DFGLSCMB             0
DFADJCHI             6
```

Note: The definitions of each statistic are printed in manul7x.cbk

First example with REQS

- `out$par.table` **!Parameter estimates**

	Parameter	SE	RSE	CSE	Gradient
(F1,F1)	0.4785696	0.22997842	0.27221813	NA	NA
(F1,F2)	0.1219112	0.07932143	0.07345954	NA	NA
(F2,F2)	0.1824982	0.12679687	0.10789365	NA	NA
(E1,E1)	0.6701202	0.18797115	0.21344979	NA	NA
(E2,E2)	0.7205869	0.16483174	0.17801464	NA	NA
(E3,E3)	0.2890225	0.28254219	0.28492610	NA	NA
(E4,E4)	0.6373262	0.14805910	0.14644224	NA	NA
(E5,E5)	0.2011031	0.23765751	0.22123471	NA	NA
(E6,E6)	0.5536707	0.13724351	0.13232039	NA	NA
(V2,F1)	0.7357411	0.24390150	0.22838400	NA	NA
(V3,F1)	1.4806968	0.46348848	0.51518950	NA	NA
(V5,F2)	1.8908805	0.83945547	0.77325226	NA	NA
(V6,F2)	1.0657280	0.43424301	0.40414574	NA	NA

Example 2: Simulation for Studying Effects on Non-normal data

Simulate contaminat normal data

```
mixcut <- 0.9               #mixture weight
c.inf <- 20                 #inflation factor

#VC matrix component 1 (3 variables)
Sigma1 <- matrix(0.36, 3, 3)
diag(Sigma1) <- 1

#VC matrix component 2
Sigma2 <- c.inf*Sigma1
```

Example 2: Simulation for Studying Effects on Non-normal data

```
for (i in 1:nrep) {

    n.comp1 <- sum(runif(n) < mixcut)          #n component 1
    n.comp2 <- n - n.comp1                     #n component 2
    X1 <- rmvnorm(n.comp1, mean = rep(0, 3), sigma = Sigma1)
    X2 <- rmvnorm(n.comp2, mean = rep(0, 3), sigma = Sigma2)
    X <- rbind(X1, X2)                         #final data matrix
    #write the R data.frame into a text data file
    write.table(X,file="1factoreqs.dat", eol="\n", sep="\t",
        quote=FALSE, row.names=FALSE, col.names=FALSE)
    #run EQS
    res <- call.eqs(EQSpgm = "C:/Program Files/EQS61/WINEQS.EXE",
    EQSmodel = "1factoreqs.eqs", serial = "927653497516xxxxxx")
    res.F1 <- read.eqs("1factoreqs.ets")
}
```

Example 2: Simulation for Studying Effects on Non-normal data

```
/TITLE
1-factor model
/SPECIFICATIONS
CAS=500; VAR=3;
ME=ML,Robust;
data='1factorreqs.dat';
matrix = raw;
/EQUATIONS
V1 = *F1+ E1;
V2 = *F1+ E2;
V3 = *F1+ E3;
/VARIANCES
F1 = 1; E1 TO E3 =*;
/CONSTRAINTS
(V1,F1) = (V2,F1) ;
(V1,F1) = (V3,F1) ;
(E1,E1) = (E2,E2) ;
(E1,E1) = (E3,E3) ;
/OUTPUT
parameter;
standard error;
codebook;
data = '1factorreqs.ets';
/END
```

EQS Model
1factoreqs.eqs

Example 2: Simulation for Studying Effects on Non-normal data

At the beginning of EQS output, right after the Univariate Statistics, there are Multivariate Kurtosis

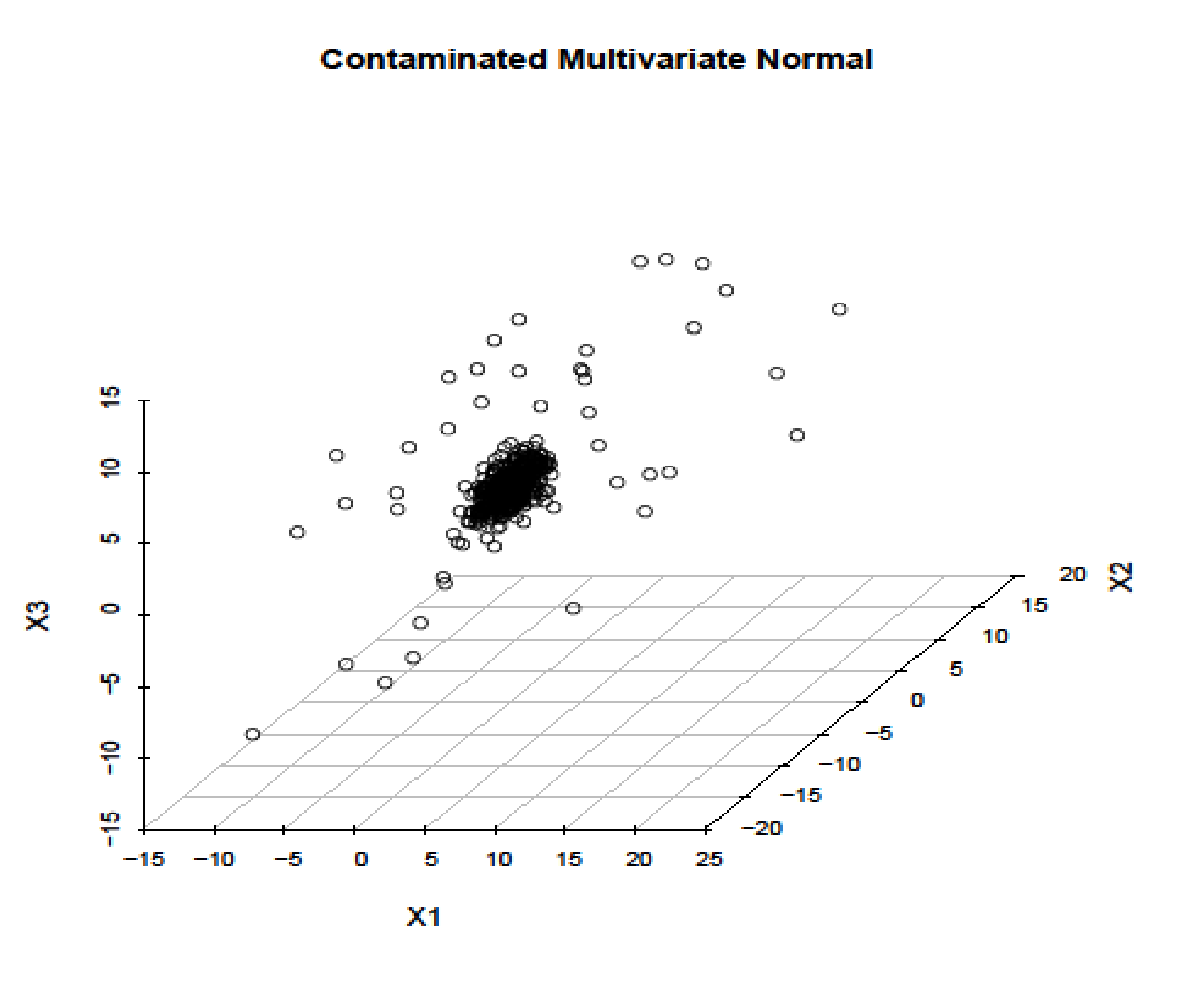
```
              MULTIVARIATE KURTOSIS
              ---------------------

MARDIA'S COEFFICIENT (G2,P) =   32.0851
NORMALIZED ESTIMATE =           18.5594
```

The large number of 18.56 in Mardia's Normalized Estimate (Mardia, 1970, 1974) provides evidence of nontrivial positive kurtosis. A more appropriate multivariate normal data has a normalized estimate of 3. In short, The data we are using in the model has violated the assumption of multivariate normal.

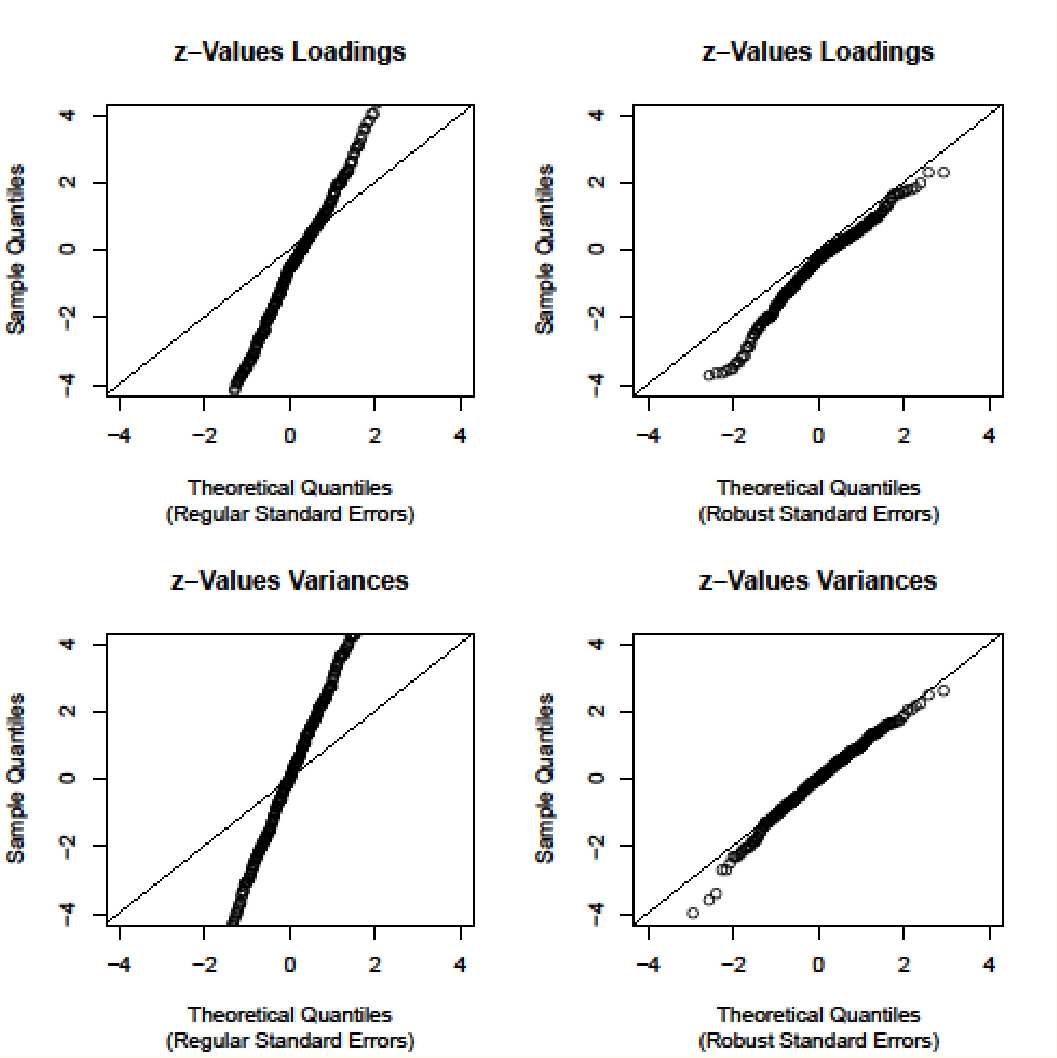
R command:

```
# Mardia's normalized kurtosis
mardia <- res.F1$model.desc["KURTOS1",]
```

Example 2: Simulation for Studying Effects on Non-normal data



Example 2: Simulation for Studying Effects on Non-normal data



Example 2: Simulation for Studying Effects on Non-normal data

Sensitivity Analysis

If (a, b) represent the least squares estimates of (α, β), then the generalized least squares estimates are also equal to

$$\begin{pmatrix} \hat{\alpha} \\ \hat{\beta} \end{pmatrix} = \begin{pmatrix} a \\ b \end{pmatrix},$$

if S represents the sample covariance matrix for the least squares estimates, then the sample covariance matrix is $Var(\hat{\alpha}, \hat{\beta}) = S + M,$

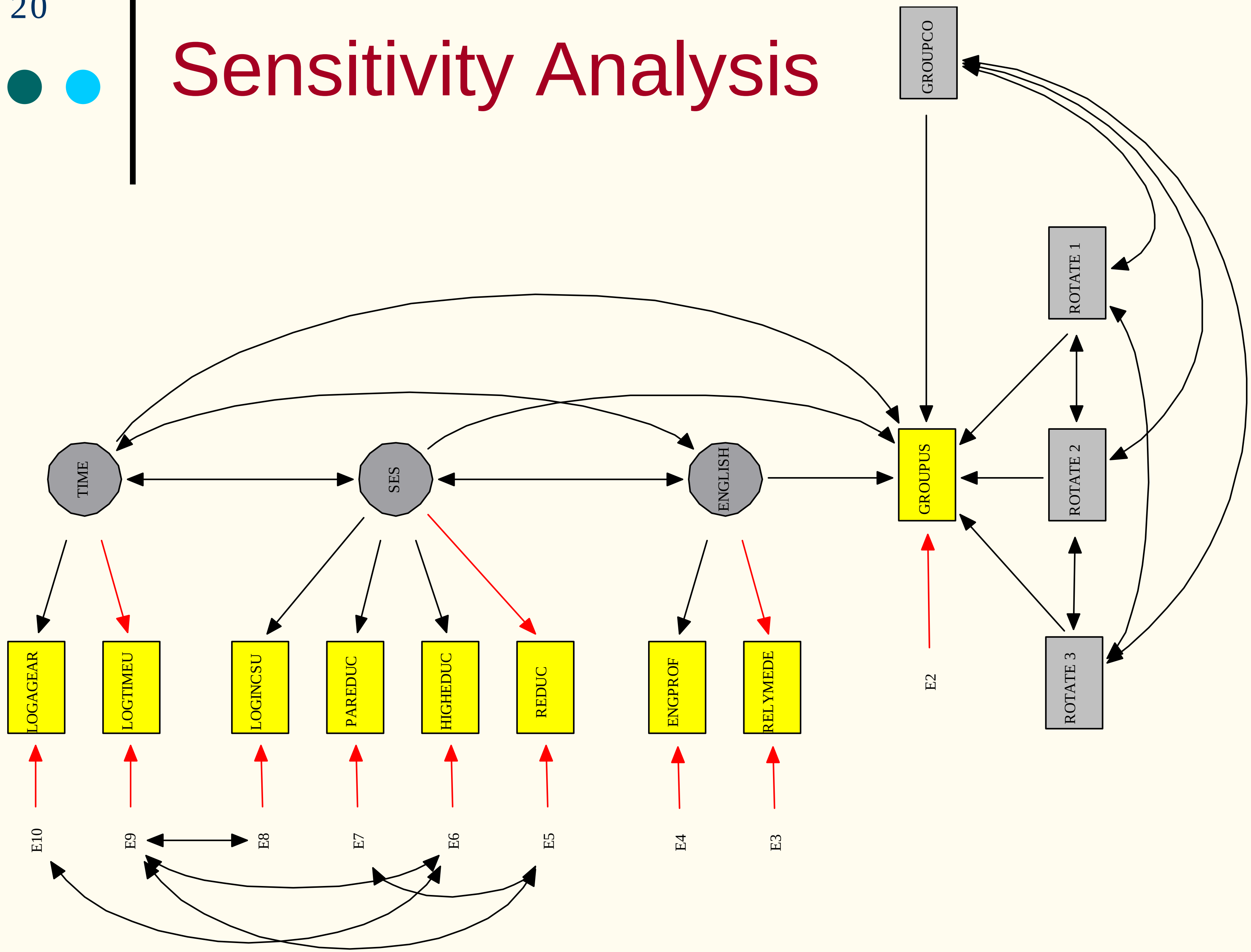
where M is the covariance matrix of (a*, B*).

Sensitivity Analysis

The nonexperimental evidence was, of course, means that the misspecification uncertainty M remained uncomfortably large. (Leamer: 1985)

Using Leamer's Extreme Bound Analysis (Leamer: 1983) our EBA uses equations of the form (1) $Y = I + M + Z + u$ where Y is either per capita GDP growth or the share of investment in GDP, I is a set of variables always included in the regression, M is the variable of interest, and Z is a subset of variables chosen from a pool of variables identified by past studies as potentially important explanatory variables of growth. (Levine and Renelt: 1992)

Sensitivity Analysis



Sensitivity Analysis

The Model

1. Variable GROUPCO (V1) and GROUPUS (V2) are variables of interests
2. Variable V3 – V10 are indicators of three factors
3. Variable V11-V13 are three rotation variables out of 21 remaining variables. There are 1330 non-duplicating combinations (i.e. 1330 model variations)

Sensitivity Analysis

```
/TITLE
Model built by EQS 6 for Windows
/SPECIFICATIONS
DATA='c:\eqs61\support\javier\R0417SUB.DAT';
VARIABLES=13; CASES=5031;
METHOD=ML; ANALYSIS=COVARIANCE; MATRIX=RAW;
/LABELS
V1=TRPOLPAR; V2=GROUPUS; V3=RELYMEDE; V4=ENGPROF; V5=REDUC;
V6=HIGHEDUC; V7=PAREDUC; V8=LOGINCSU; V9=LOGTIMEU; V10=LOGAGEAR;
V11=V11; V12=V12; V13=V13;
!V11=TRGOBACK; V12=ATTENDCH; V13=WORKPROB; V14=POLINTER; V15=NUMKIDS;
!V16=MARITAL; V17=PARBORN; V18=SEX; V19=NATUSCIT; V20=KIDSSCHO;
!V21=MILITARY; V22=BLEND; V23=DISTINCT; V24=FINANCIL; V25=UNIONM;
!V26=HOMEOWN; V27=AMERICAN; V28=TRATTPOL; V29=MEDIA; V30=KNOWLEDG;
!V31=LOGLENGT;
/EQUATIONS
V2 =   *F1 + *F2 + *F3 + *V1 + *V11 + *V12 + *V13
+ E2;
V3 =   1F1 + E3;
V4 =   *F1 + E4;
V5 =   1F2 + E5;
V6 =   *F2 + E6;
V7 =   *F2 + E7;
V8 =   *F2 + E8;
V9 =   1F3 + E9;
V10 =   *F3 + E10;
```

Sensitivity Analysis

```
/VARIANCES
 V1 = *;
 V11 = *;
 V12 = *;
 V13 = *;
 F1 = *;
 F2 = *;
 F3 = *;
 E2  to E10 = *;
/COVARIANCES
V11,V1 = *;
V12,V1 = *;
V12,V11 = *;
V13,V1 = *;
V13,V11 = *;
V13,V12 = *;
F2,F1 = *;
F1,F3 = *;
F3,F2 = *;
E7,E5 = *;
E5,E9 = *;
E6,E9 = *;
E9,E8 = *;
E6,E10 = *;
```

```
/TECH
 ITER=600;
/PRINT
EIS;
FIT=ALL;
TABLE=EQUATION;
/OUTPUIT
listing;
PARAMETER ESTIMATES;
SS;
DATA='R0417.ETS';
/END
```

Sensitivity Analysis

```
#
# Sensitivity Analysis with EQS and REQS    Eric Wu (03/15/2010)
#
library("REQS")
library("gtools")

setwd("c:/eqs61/support/javier")

#
#  read data file -- a tab delimited text data file written with EQS (missing
#  character is "*")
#  a pre-prepared EQS model file "rotate.eqs"  with input data file as "rotate.dat"
#
r0417_data<-read.delim("r0417.dat", header = TRUE, sep = "\t")

xx1 <- combinations(21, 3, 11:31)

x <- as.matrix(xx1)
loop <- nrow(x)
vnames<-colnames(r0417_data)
```

Sensitivity Analysis

All possible combinations of remaining variables

```
> xx1
      [,1] [,2] [,3]
 [1,]   11   12   13
 [2,]   11   12   14
 [3,]   11   12   15
 [4,]   11   12   16
 [5,]   11   12   17
 [6,]   11   12   18
 [7,]   11   12   19
 [8,]   11   12   20
 [9,]   11   12   21
[10,]   11   12   22
[11,]   11   12   23
[12,]   11   12   24
[13,]   11   12   25
[14,]   11   12   26
[15,]   11   12   27
[16,]   11   12   28
[17,]   11   12   29
[18,]   11   12   30
```

Sensitivity Analysis

```
fit.mat <- matrix(NA, loop, 22)             #initialize matrix for final results

################################################## BEGINNING OF THE LOOP
for(i in 1:loop) {                          #loop with all runs
i1 <- x[i,1]
i2 <- x[i,2]
i3 <- x[i,3]
r0417_data1<-r0417_data[1:10]               #variables always in the model
r0417_data2<-r0417_data[i1]                 #replacement variable 1
r0417_data3<-r0417_data[i2]                 #replacement variable 2
r0417_data4<-r0417_data[i3]                 #replacement variable 3
r0417<-cbind(r0417_data1,r0417_data2,r0417_data3,r0417_data4)    #combined new data file

###################################################################
# write the new combined variables into a new text data file
# this data file will be read by EQS in each run
write.table(r0417,file="R0417SUB.DAT", eol="\n", sep="\t", quote=FALSE, row.names=FALSE,
    col.names=FALSE)    #write the R data.frame into a text data file

###################################################################
# run EQS and put the outcome of the EQS into R object "rotate"
rotate <- run.eqs(EQSpgm = "'C:/Program Files/EQS61/WINEQS.EXE'", EQSmodel =
    "r0417.eqs", serial = " 457350397624xxxxxx ")
```

Sensitivity Analysis

```
# Acquire outcome of a run.
ccode <- rotate$model.info["CONDCODE",]                    # condition codes:  0 means
      complete run
cfi <- rotate$fit.indices["CFI",]
rmsea <- rotate$fit.indices["RMSEA",]
mardia1 <- rotate$model.desc["KURTOS1",]
mardia2 <- rotate$model.desc["KURTOS2",]
sv2v1  <- rotate$ssolution[31]                             # standardized solution
sv2v11 <- rotate$ssolution[32]
sv2v12 <- rotate$ssolution[33]
sv2v13 <- rotate$ssolution[34]
sv2f1  <- rotate$ssolution[35]
sv2f2  <- rotate$ssolution[36]
sv2f3  <- rotate$ssolution[37]
v2v1 <- rotate$Gamma[1,1]
v2v11 <- rotate$Gamma[1,2]
v2v12 <- rotate$Gamma[1,3]
v2v13 <- rotate$Gamma[1,4]
v2f1 <- rotate$Gamma[1,5]
v2f2 <- rotate$Gamma[1,6]
v2f3 <- rotate$Gamma[1,7]
```

Sensitivity Analysis

```
fit.mat[i, ] <- c(ccode, cfi, rmsea, mardia1, mardia2, sv2v1, sv2v11, sv2v12, sv2v13,
      sv2f1, sv2f2, sv2f3, v2v1, v2v11, v2v12, v2v13, v2f1, v2f2, v2f3, vnames[i1],
      vnames[i2], vnames[i3])       # index "i" is the index of the "for" loop
}
############################################################   END OF THE LOOP

#################################################################################
#### create variable names for the new data file.  The data file is tab delimited
##########text file with variable names at the frist line

cname<-cbind("CCODE","CFI","RMSEA","MARDIA1","MARDIA2","sv2v1",
      "sv2v11", "sv2v12", "sv2v13", "sv2f1", "sv2f2", "sv2f3", "v2v1", "v2v11", "v2v12",
      "v2v13", "v2f1", "v2f2", "v2f3", "NAME1", "NAME2", "NAME3")

write.table(fit.mat,file="FINAL0417.DAT", eol="\n", quote=FALSE,
      row.names=FALSE, col.names=cname)
```

Sensitivity Analysis

EQS 6.1 for Windows - [final0417.ess]

File Edit View Data Analysis Data Plot Build_EQS Window Help

	CCODE	CFI	RMSEA	MARDIA1	MARDIA2	sv2v1	sv2v11	sv2v12	sv2v13	sv2f1	sv2f2	sv2f3	v2v1	v2v
1	0.0000	0.8877	NA	22.3070	40.0600	0.0338	-0.0001	0.1390	0.1014	0.4158	-0.0021	-0.1499	0.0361	-(
2	0.0000	0.8519	NA	22.8370	41.0110	0.0290	0.0041	0.1425	0.1209	0.3908	-0.0055	-0.1409	0.0309	(
3	0.0000	0.8186	NA	26.8950	48.2990	0.0429	0.0052	0.1409	0.0215	0.4297	0.0018	-0.1521	0.0461	(
4	0.0000	0.8831	NA	22.9400	41.1960	0.0426	0.0020	0.1410	0.0318	0.4264	0.0053	-0.1545	0.0458	(
5	0.0000	0.9008	NA	23.8050	42.7490	0.0423	0.0028	0.1437	-0.0000	0.4231	0.0029	-0.1501	0.0454	(
6	1.0000	0.8758	NA	20.9730	37.6650	0.0400	-0.0012	0.1467	-0.0188	-10.4066	7.9791	5.1346	0.0429	-(
7	0.0000	0.7642	NA	23.1970	41.6590	0.0416	0.0058	0.1430	0.0334	0.4029	0.0118	-0.1478	0.0445	(
8	0.0000	0.8871	NA	19.9220	35.7770	0.0421	0.0025	0.1426	0.0110	0.4221	0.0054	-0.1525	0.0452	(
9	0.0000	0.8531	NA	28.7060	51.5510	0.0430	0.0060	0.1431	0.0498	0.3979	0.0117	-0.1443	0.0460	(
10	0.0000	0.8941	NA	23.9800	43.0640	0.0418	0.0036	0.1429	0.0147	0.4300	-0.0010	-0.1507	0.0449	(
11	0.0000	0.8972	NA	28.1080	50.4780	0.0428	0.0035	0.1436	0.0127	0.4231	0.0031	-0.1495	0.0459	(
12	0.0000	0.8897	NA	21.7520	39.0640	0.0421	0.0021	0.1437	0.0076	0.4230	0.0020	-0.1498	0.0452	(
13	0.0000	0.8838	NA	35.8460	64.3730	0.0400	0.0032	0.1441	0.0481	0.4129	0.0043	-0.1498	0.0428	(
14	0.0000	0.8338	NA	21.0320	37.7690	0.0425	0.0071	0.1413	0.0365	0.4081	0.0099	-0.1495	0.0455	(
15	0.0000	0.8602	NA	21.8570	39.2510	0.0391	0.0100	0.1437	0.0576	0.4145	-0.0005	-0.1515	0.0418	(
16	0.0000	0.8840	NA	22.4830	40.3760	0.0326	-0.0035	0.1436	0.0669	0.4202	-0.0082	-0.1417	0.0348	-(
17	0.0000	0.8473	NA	23.9680	43.0420	0.0369	0.0050	0.1425	0.0876	0.3959	0.0004	-0.1420	0.0393	(
18	0.0000	0.8332	NA	23.6500	42.4720	0.0388	0.0039	0.1460	0.0619	0.4042	0.0005	-0.1443	0.0414	(
19	0.0000	0.7407	NA	23.7930	42.7290	0.0430	0.0077	0.1418	0.0317	0.3992	0.0221	-0.1523	0.0460	(
20	0.0000	0.8499	NA	22.0960	39.6810	0.0254	-0.0033	0.0965	0.1095	0.3931	-0.0286	-0.1338	0.0269	-(
21	0.0000	0.8063	NA	26.1880	47.0290	0.0361	-0.0034	0.1074	0.0344	0.4312	-0.0196	-0.1477	0.0386	-(
22	0.0000	0.8727	NA	21.9580	39.4330	0.0372	-0.0062	0.1086	0.0425	0.4252	-0.0167	-0.1486	0.0397	-(
23	0.0000	0.8918	NA	23.0030	41.3090	0.0363	-0.0056	0.1084	0.0032	0.4273	-0.0252	-0.1418	0.0388	-(
24	0.0000	0.8740	NA	20.0830	36.0650	0.0364	-0.0054	0.1082	0.0014	0.4264	-0.0244	-0.1416	0.0389	-(
25	0.0000	0.7574	NA	22.3140	40.0720	0.0347	-0.0029	0.1124	0.0480	0.3881	-0.0045	-0.1398	0.0369	-(
26	0.0000	0.8773	NA	19.1390	34.3710	0.0361	-0.0071	0.1078	0.0168	0.4229	-0.0186	-0.1458	0.0385	-(
27	0.0000	0.8454	NA	27.9680	50.2250	0.0367	-0.0030	0.1085	0.0516	0.3970	-0.0119	-0.1370	0.0390	-(
28	0.0000	0.8846	NA	23.1860	41.6380	0.0356	-0.0050	0.1080	0.0183	0.4288	-0.0243	-0.1430	0.0380	-(
29	0.0000	0.8883	NA	27.3030	49.0310	0.0365	-0.0063	0.1083	0.0088	0.4240	-0.0220	-0.1423	0.0390	-(
30	0.0000	0.8806	NA	20.8700	37.4790	0.0364	-0.0063	0.1089	0.0080	0.4241	-0.0234	-0.1421	0.0388	-(
31	0.0000	0.8752	NA	35.1680	63.1550	0.0341	-0.0050	0.1093	0.0483	0.4105	-0.0183	-0.1425	0.0363	-(
32	0.0000	0.8257	NA	20.1320	36.1540	0.0364	0.0011	0.1108	0.0510	0.3966	-0.0078	-0.1422	0.0387	(
33	0.0000	0.8529	NA	20.8850	37.5060	0.0330	-0.0008	0.1096	0.0597	0.4091	-0.0219	-0.1449	0.0351	-(

For Help, press F1

Sensitivity Analysis

The output file FINAL0417.DAT is a tab delimited text file with 1330 subjects. Each subject represents one EQS run. You can read this data file using any statistical program including R for further analysis.

Conclusions

1. REQS allows researchers develop new methods or test statistics without redundant work.
2. R could enhance the traditional roles of SEM into higher level or more complex applications.

Reference

Mair, *Patrick*, Eric Wu, & Bentler, P M. (2010).
EQS Goes R: Simulations for SEM Using the Package REQS,
Structural Equation Modeling: A Multidisciplinary Journal, Volume 17, Issue 2 April 2010 , pages 333 - 349