Examples of Estimates for Nonnormal Data

I provide a number of examples below. The standard ML (without robust estimation) examples are used just for comparison. I would not recommend using this estimation unless you can be certain your data are multivariate normal. And given sufficient sample size, the ML chi-square and sample size will be the same as the MLM values if variables are multivariate normal. Also, the MLM estimation is *much* more commonly used than bootstrap approach, but I provide the bootstrap approach as a possible alternative, if desired. If missing data are present, use estimator = MLR (see the subsequent handout "Examples of Yuan-Bentler Corrections for Nonnormal and Missing Data).

Mplus Example with Satorra-Bentler Scaled χ^2 and Robust Standard Errors

```
(excerpts from output)
INPUT INSTRUCTIONS
    title:  CFA of three negative exchanges factors;
    data:  file=c:\jason\mplus\semclass\nonnorm1.dat;
                format=12f1.0;
                listwise=on;
    variable:  names = neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;
    usevariables=neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;
    analysis:  type=general; estimator=mlm;
!MLM is used to request Satorra & Bentler (1988; 1994)
! robust standard errors and scaled chi-square;
!if missing data are present, use estimator=mlr
! for robust estimates (Yuan & Bentler, 2006)
    model: hostile by neg6-neg35;
           badadv by neg11-neg14;
           demands by neg16-neg20;
    output: stdyx;
INPUT READING TERMINATED NORMALLY
SUMMARY OF ANALYSIS
Number of groups                                         1
Number of observations                                 194
Number of dependent variables                           12
Number of independent variables                          0
Number of continuous latent variables                    3

Estimator                                              MLM
Information matrix                                EXPECTED
Maximum number of iterations                          1000
Convergence criterion                            0.500D-04
Maximum number of steepest descent iterations           20
THE MODEL ESTIMATION TERMINATED NORMALLY
MODEL FIT INFORMATION
Number of Free Parameters                       39
Loglikelihood
          H0 Value                      -2102.720
          H1 Value                      -2036.636
Information Criteria
          Akaike (AIC)                   4283.440
          Bayesian (BIC)                 4410.886
          Sample-Size Adjusted BIC       4287.342
            (n* = (n + 2) / 24)
Chi-Square Test of Model Fit
          Value                             90.344*
          Degrees of Freedom                   51
          P-Value                          0.0006
          Scaling Correction Factor         1.463
            for MLM
*   The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used
    for chi-square difference testing in the regular way.  MLM, MLR and WLSM
    chi-square difference testing is described on the Mplus website.  MLMV, WLSMV,
    and ULSMV difference testing is done using the DIFFTEST option.
RMSEA (Root Mean Square Error Of Approximation)
          Estimate                         0.063
          90 Percent C.I.                  0.041  0.084
          Probability RMSEA <= .05         0.151
CFI/TLI
          CFI                              0.951
```

MLM estimator requests the Satorra-Bentler Corrections to chi-square and SEs when there are no missing values

This is the Satorra-Bentler Scaled chi-square which adjusts chi-square for nonnormality

Degree to which chi-square was adjusted:
$scf = \chi^2_{ML} / \chi^2_{SB}$

```
          TLI                                0.937
Chi-Square Test of Model Fit for the Baseline Model
          Value                            870.347
          Degrees of Freedom                    66
          P-Value                           0.0000
SRMR (Standardized Root Mean Square Residual)
          Value                              0.051



MODEL RESULTS
                                                    Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
 HOSTILE  BY
    NEG6               1.000      0.000    999.000    999.000
    NEG26              1.406      0.165      8.531      0.000
    NEG30              1.252      0.149      8.423      0.000
    NEG35              1.172      0.121      9.681      0.000
 BADADV   BY
    NEG11              1.000      0.000    999.000    999.000
    NEG12              1.036      0.155      6.668      0.000
    NEG13              1.369      0.155      8.856      0.000
    NEG14              1.490      0.151      9.857      0.000
 DEMANDS  BY
    NEG16              1.000      0.000    999.000    999.000
    NEG17              1.037      0.103     10.080      0.000
    NEG19              0.966      0.177      5.446      0.000
    NEG20              0.934      0.151      6.186      0.000
 BADADV   WITH
    HOSTILE            0.174      0.042      4.118      0.000
 DEMANDS  WITH
    HOSTILE            0.215      0.068      3.157      0.002
    BADADV             0.200      0.045      4.464      0.000
```

Mplus: Same Model <u>without</u> Robust Statistics (to illustrate bias in chi-square and standard errors due to violations of multivariate normality assumption)

(excerpts from output)

```
INPUT INSTRUCTIONS
    title:  CFA of three negative exchanges factors;
    data:  file=c:\jason\mplus\semclass\nonnorm1.dat;
                format=12f1.0;
             listwise=on;
    variable:  names = neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;
    usevariables=neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;
    analysis:  type=general; estimator=ml;
    model=nomeanstructure; information=expected;  (statements used to request standard ML)
    model: hostile by neg6-neg35;
           badadv by neg11-neg14;
           demands by neg16-neg20;
    output: standardized;
Estimator                                                ML
MODEL FIT INFORMATION
Chi-Square Test of Model Fit
          Value                            132.168
          Degrees of Freedom                    51
          P-Value                           0.0000
RMSEA (Root Mean Square Error Of Approximation)
          Estimate                           0.091
          90 Percent C.I.                    0.072  0.110
          Probability RMSEA <= .05           0.000
CFI/TLI
          CFI                                0.934
          TLI                                0.914
Chi-Square Test of Model Fit for the Baseline Model
          Value                           1287.035
          Degrees of Freedom                    66
          P-Value                           0.0000
SRMR (Standardized Root Mean Square Residual)
          Value                              0.055
```

Wow, it is a lot worse! Note that the regular ML chi-square is $\chi^2_{ML} = scf \cdot \chi^2_{SB}$

Alternative fit indices also show poorer fit with ML

Notice standard errors tend to be too small (inflating significance) compared with the robust obtain with

```
MODEL RESULTS
                                                    Two-Tailed
                  Estimate       S.E.  Est./S.E.    P-Value
 HOSTILE  BY
    NEG6             1.000      0.000   999.000    999.000
    NEG26            1.406      0.139    10.089      0.000
    NEG30            1.252      0.132     9.512      0.000
    NEG35            1.172      0.134     8.714      0.000
 BADADV   BY
    NEG11            1.000      0.000   999.000    999.000
    NEG12            1.036      0.103    10.040      0.000
    NEG13            1.369      0.128    10.683      0.000
    NEG14            1.490      0.137    10.902      0.000
 DEMANDS  BY
    NEG16            1.000      0.000   999.000    999.000
    NEG17            1.037      0.105     9.854      0.000
    NEG19            0.966      0.134     7.231      0.000
    NEG20            0.934      0.112     8.340      0.000
 BADADV   WITH
    HOSTILE          0.174      0.030     5.850      0.000
 DEMANDS  WITH
    HOSTILE          0.215      0.036     6.002      0.000
    BADADV           0.200      0.033     5.993      0.000
```

Mplus Bootstrap Approach

```
    title:  CFA of three negative exchanges factors;
    data:  file=c:\jason\mplus\semclass\nonnorm1.dat;
                format=12f1.0;
                listwise=on;
    variable:  names = neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;
    usevariables=neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;
    analysis:  type=general; estimator=ml;
      bootstrap=1000(residual);
!residual option gives Bollen-Stine bootstrap corrected chi-square p-value;
    model: hostile by neg6-neg35;
           badadv by neg11-neg14;
           demands by neg16-neg20;
    output: stdyx cinterval(bcbootstrap);
!bcbootstrap option gives bias-corrected bootstrap estimates
! for nonsymmetric sampling distribution;
```

(excerpts)

```
**********************************
Chi-Square Test of Model Fit
          Value                            132.168
          Degrees of Freedom                   51
          P-Value                          0.0000
          Bootstrap P-Value                0.0170
***********************************
CONFIDENCE INTERVALS OF MODEL RESULTS
                 Lower .5%  Lower 2.5%    Lower 5%    Estimate    Upper 5%  Upper 2.5%   Upper .5%
 HOSTILE  BY
    NEG6             1.000       1.000       1.000       1.000       1.000       1.000       1.000
    NEG26            1.004       1.088       1.145       1.406       1.702       1.785       1.946
    NEG30            0.872       0.981       1.025       1.252       1.503       1.562       1.647
    NEG35            0.723       0.827       0.901       1.172       1.536       1.652       1.794
 BADADV   BY
    NEG11            1.000       1.000       1.000       1.000       1.000       1.000       1.000
    NEG12            0.636       0.773       0.806       1.036       1.252       1.297       1.367
    NEG13            1.065       1.123       1.174       1.369       1.646       1.709       1.805
    NEG14            1.096       1.221       1.260       1.490       1.855       1.921       2.024
 DEMANDS  BY
    NEG16            1.000       1.000       1.000       1.000       1.000       1.000       1.000
    NEG17            0.729       0.812       0.843       1.037       1.264       1.311       1.466
    NEG19            0.642       0.722       0.764       0.966       1.211       1.277       1.415
    NEG20            0.647       0.697       0.729       0.934       1.210       1.273       1.431
 BADADV   WITH
    HOSTILE          0.097       0.116       0.125       0.174       0.237       0.251       0.278
 DEMANDS  WITH
    HOSTILE          0.124       0.145       0.157       0.215       0.288       0.301       0.333
    BADADV           0.121       0.137       0.146       0.200       0.269       0.284       0.313
```

```
Intercepts
    NEG6              0.450       0.490       0.509       0.588       0.683       0.699       0.727
    NEG26             0.436       0.472       0.488       0.567       0.667       0.684       0.716
    NEG30             0.520       0.548       0.560       0.639       0.734       0.753       0.781
    NEG35             0.340       0.366       0.387       0.469       0.555       0.574       0.598
    NEG11             0.333       0.358       0.368       0.454       0.533       0.549       0.579
    NEG12             0.318       0.348       0.364       0.438       0.522       0.535       0.556
    NEG13             0.702       0.734       0.757       0.851       0.949       0.976       1.025
    NEG14             0.650       0.691       0.706       0.804       0.913       0.932       0.971
    NEG16             0.353       0.394       0.414       0.500       0.597       0.611       0.654
    NEG17             0.258       0.289       0.306       0.381       0.468       0.480       0.509
    NEG19             0.832       0.874       0.895       1.000       1.103       1.124       1.169
    NEG20             0.524       0.549       0.564       0.649       0.748       0.774       0.804
 Variances
    HOSTILE           0.115       0.140       0.158       0.231       0.315       0.339       0.375
    BADADV            0.125       0.157       0.167       0.245       0.334       0.348       0.385
    DEMANDS           0.132       0.176       0.195       0.290       0.402       0.425       0.455
```

lavaan
MLM (robust) estimates

Note: The scaled chi-square and standard errors differ from the Mplus values

```
> model = '
+         hostile =~ neg6 + neg26 + neg30 + neg35
+        badadv =~ neg11 + neg12 + neg13 + neg14
+        demands =~ neg16 + neg17 + neg19 + neg20
+ '
>
> #Below, MLM is used to request Satorra & Bentler (1988; 1994)
> #robust standard errors and scaled chi-square
> #Note: results similar to Mplus but adjusted chi-square and robust SEs differ
> fit = sem(model, data = nonnorm1, estimator="mlm")
> summary(fit,fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
lavaan 0.6-5 ended normally after 47 iterations

  Estimator                                         ML
  Optimization method                           NLMINB
  Number of free parameters                         27

  Number of observations                           194

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               132.168      80.888
  Degrees of freedom                            51           51
  P-value (Chi-square)                           0.000        0.005
  Scaling correction factor                                   1.634
    for the Satorra-Bentler correction

Model Test Baseline Model:

  Test statistic                              1287.035     586.734
  Degrees of freedom                            66           66
  P-value                                        0.000        0.000
  Scaling correction factor                                   2.194

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.934        0.943
  Tucker-Lewis Index (TLI)                       0.914        0.926

  Robust Comparative Fit Index (CFI)                          0.957
  Robust Tucker-Lewis Index (TLI)                             0.945

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)              -2102.720    -2102.720
  Loglikelihood unrestricted model (H1)      -2036.636    -2036.636

  Akaike (AIC)                                4259.440     4259.440
  Bayesian (BIC)                              4347.672     4347.672
  Sample-size adjusted Bayesian (BIC)         4262.141     4262.141

Root Mean Square Error of Approximation:

  RMSEA                                          0.091        0.055
  90 Percent confidence interval - lower         0.072        0.036
  90 Percent confidence interval - upper         0.110        0.072
  P-value RMSEA <= 0.05                          0.000        0.308

  Robust RMSEA                                                0.070
```

Robust chi-square differs considerably from Mplus value

Corrected index that uses robust null model chi-square value

```
  90 Percent confidence interval - lower                  0.039
  90 Percent confidence interval - upper                  0.098

Standardized Root Mean Square Residual:

  SRMR                                            0.055       0.055

Parameter Estimates:

  Information                                 Expected
  Information saturated (h1) model          Structured
  Standard errors                           Robust.sem


Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  hostile =~
    neg6              1.000                               0.480    0.659
    neg26             1.406    0.165    8.540    0.000    0.675    0.875
    neg30             1.252    0.150    8.340    0.000    0.601    0.803
    neg35             1.172    0.117   10.017    0.000    0.563    0.720
  badadv =~
    neg11             1.000                               0.495    0.726
    neg12             1.036    0.166    6.227    0.000    0.512    0.761
    neg13             1.369    0.160    8.536    0.000    0.677    0.813
    neg14             1.490    0.152    9.820    0.000    0.737    0.831
  demands =~
    neg16             1.000                               0.538    0.701
    neg17             1.037    0.100   10.346    0.000    0.558    0.812
    neg19             0.966    0.173    5.585    0.000    0.520    0.573
    neg20             0.934    0.148    6.299    0.000    0.503    0.667

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  hostile ~~
    badadv            0.174    0.042    4.161    0.000    0.734    0.734
    demands           0.215    0.068    3.168    0.002    0.831    0.831
  badadv ~~
    demands           0.200    0.045    4.482    0.000    0.753    0.753

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .neg6              0.300    0.039    7.734    0.000    0.300    0.566
   .neg26             0.140    0.034    4.175    0.000    0.140    0.235
   .neg30             0.199    0.031    6.423    0.000    0.199    0.355
   .neg35             0.293    0.078    3.769    0.000    0.293    0.481
   .neg11             0.220    0.033    6.582    0.000    0.220    0.473
   .neg12             0.190    0.041    4.632    0.000    0.190    0.420
   .neg13             0.236    0.036    6.544    0.000    0.236    0.340
   .neg14             0.243    0.044    5.473    0.000    0.243    0.309
   .neg16             0.300    0.056    5.344    0.000    0.300    0.509
   .neg17             0.161    0.033    4.856    0.000    0.161    0.341
   .neg19             0.554    0.080    6.885    0.000    0.554    0.672
   .neg20             0.315    0.046    6.904    0.000    0.315    0.555
    hostile           0.231    0.072    3.193    0.001    1.000    1.000
    badadv            0.245    0.056    4.391    0.000    1.000    1.000
    demands           0.290    0.084    3.461    0.001    1.000    1.000

R-Square:
                   Estimate
    neg6              0.434
    neg26             0.765
    neg30             0.645
    neg35             0.519
    neg11             0.527
    neg12             0.580
    neg13             0.660
    neg14             0.691
    neg16             0.491
    neg17             0.659
    neg19             0.328
    neg20             0.445
```

Matches the uncorrected value in Mplus

Robust SEs also differ a little from Mplus values

Bootstrap

The following code can be used for obtaining bootstrap standard errors and Bollen-Stine bootstrap chi-square. Bias corrected was used because that was the Mplus approach.

```
> #use bootstrap to find the Bollen-Stine chi-square and test (follows example in lavaan documentation)
> fit = sem(model, data = nonnorm1, estimator="ml")
> summary(fit,fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
```

Regular output omitted from the first run to obtain original ML chi-square

```
> T.orig <- fitMeasures(fit, "chisq")
> bootfit <- sem(model, data=nonnorm1, se="none")
> T.boot <- bootstrapLavaan(bootfit, R=1000, type="bollen.stine", FUN=fitMeasures, fit.measures="chisq")
> summary(T.boot,fit.measures=TRUE)
     chisq
 Min.   : 30.18
 1st Qu.: 61.13
 Median : 73.29
 Mean   : 75.85
 3rd Qu.: 87.75
 Max.   :263.32
> # compute a bootstrap based p-value
> pvalue.boot <- length(which(T.boot > T.orig))/length(T.boot)
> print(pvalue.boot, digits = 3)
[1] 0.008
> #Below, bias-corrected bootstrap standard errors and Bollen-Stine bootstrap chi-square are obtained
> nBoots <- 1000
> SEM.model <- sem(model, data = nonnorm1, se = "boot", test = "Bollen.Stine", bootstrap = nBoots)
> parameterEstimates(SEM.model, boot.ci.type = "bca.simple", standardized = TRUE)
       lhs op     rhs   est    se     z pvalue ci.lower ci.upper std.lv std.all std.nox
1  hostile =~    neg6 1.000 0.000    NA     NA    1.000    1.000  0.480   0.659   0.659
2  hostile =~   neg26 1.406 0.194 7.263  0.000    1.124    1.795  0.675   0.875   0.875
3  hostile =~   neg30 1.252 0.166 7.527  0.000    1.020    1.668  0.601   0.803   0.803
4  hostile =~   neg35 1.172 0.143 8.169  0.000    0.941    1.500  0.563   0.720   0.720
5   badadv =~   neg11 1.000 0.000    NA     NA    1.000    1.000  0.495   0.726   0.726
6   badadv =~   neg12 1.036 0.162 6.388  0.000    0.765    1.362  0.512   0.761   0.761
7   badadv =~   neg13 1.369 0.176 7.758  0.000    1.092    1.797  0.677   0.813   0.813
8   badadv =~   neg14 1.490 0.163 9.140  0.000    1.219    1.874  0.737   0.831   0.831
9  demands =~   neg16 1.000 0.000    NA     NA    1.000    1.000  0.538   0.701   0.701
10 demands =~   neg17 1.037 0.112 9.253  0.000    0.835    1.280  0.558   0.812   0.812
11 demands =~   neg19 0.966 0.171 5.644  0.000    0.695    1.377  0.520   0.573   0.573
12 demands =~   neg20 0.934 0.144 6.488  0.000    0.680    1.247  0.503   0.667   0.667
13    neg6 ~~    neg6 0.300 0.039 7.696  0.000    0.232    0.390  0.300   0.566   0.566
14   neg26 ~~   neg26 0.140 0.034 4.178  0.000    0.086    0.236  0.140   0.235   0.235
15   neg30 ~~   neg30 0.199 0.031 6.364  0.000    0.138    0.261  0.199   0.355   0.355
16   neg35 ~~   neg35 0.293 0.080 3.684  0.000    0.162    0.488  0.293   0.481   0.481
17   neg11 ~~   neg11 0.220 0.035 6.198  0.000    0.164    0.313  0.220   0.473   0.473
18   neg12 ~~   neg12 0.190 0.032 5.874  0.000    0.140    0.267  0.190   0.420   0.420
19   neg13 ~~   neg13 0.236 0.034 6.880  0.000    0.179    0.316  0.236   0.340   0.340
20   neg14 ~~   neg14 0.243 0.047 5.179  0.000    0.155    0.347  0.243   0.309   0.309
21   neg16 ~~   neg16 0.300 0.059 5.119  0.000    0.196    0.429  0.300   0.509   0.509
22   neg17 ~~   neg17 0.161 0.035 4.677  0.000    0.104    0.247  0.161   0.341   0.341
23   neg19 ~~   neg19 0.554 0.079 7.001  0.000    0.425    0.730  0.554   0.672   0.672
24   neg20 ~~   neg20 0.315 0.042 7.449  0.000    0.241    0.407  0.315   0.555   0.555
25 hostile ~~ hostile 0.231 0.075 3.077  0.002    0.122    0.434  1.000   1.000   1.000
26  badadv ~~  badadv 0.245 0.055 4.486  0.000    0.151    0.363  1.000   1.000   1.000
27 demands ~~ demands 0.290 0.081 3.560  0.000    0.157    0.480  1.000   1.000   1.000
28 hostile ~~  badadv 0.174 0.040 4.309  0.000    0.112    0.285  0.734   0.734   0.734
29 hostile ~~ demands 0.215 0.066 3.233  0.001    0.116    0.382  0.831   0.831   0.831
30  badadv ~~ demands 0.200 0.040 4.962  0.000    0.130    0.286  0.753   0.753   0.753
```

Bootstrap p-value differs from Mplus (although some variation expected because of different bootstrap samples)

Summary statement used with the bootstrapped model

```
> summary(SEM.model,fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
```

[Excerpt from output]

```
  Test statistic                               132.168
  Degrees of freedom                            51
  P-value (Bollen-Stine bootstrap)               0.014
```

Lawrence DeCarlo's SPSS Macro for Computing Mardia's Coefficient for Multivariate Normality

These analyses are just to illustrate the degree of nonnormality but not needed to justify using scaled chi-square and robust standard errors. Mardia's multivariate tests are using macro found here: http://www.columbia.edu/~ld208/

Syntax

```
INCLUDE file='C:\jason\spsswin\semclass\mardia.sps'.
mardia vars=neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20 /.
execute.
```

Output

```
Mardia's multivariate skew (small sample adjustment: Mardia 1974 Sankya)
        b1p    Chi(b1p)    p-value    adj-Chi    p-value
    47.8734  1547.9076      .0000  1575.5735      .0000
Mardia's multivariate kurtosis
        b2p     N(b2p)    p-value
   254.2928    32.7851      .0000
```

Note: A significant result indicates the data diverge from a multivariate normal distribution, but this test is likely to be significant when sample size is large. Significant results do not necessarily mean that the model chi-square or the standard errors will be substantially biased, and researchers need to try to gauge the magnitude of the departure from normality. N(b2p) is the normalized estimate of the multivariate kurtosis measure. Bentler and Wu (2002) suggest that a normalized estimate greater than 3 will lead to chi-square and standard error biases.

Univariate Statistics using SPSS

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
neg6 Act angry or hostile	194	.59	.731	1.222	.175	1.821	.347
neg26 Behave insensitively toward you	194	.57	.774	1.332	.175	1.649	.347
neg30 Do thoughtless things	194	.64	.751	1.075	.175	1.248	.347
neg35 Make you feel inferior	194	.47	.783	1.969	.175	4.360	.347
neg11 Give you bad advice	194	.45	.683	1.401	.175	1.364	.347
neg12 interfere or meddle with problems	194	.44	.674	1.355	.175	.927	.347
neg13 Question your decisions	194	.85	.835	.719	.175	.122	.347
neg14 Give unwanted advice	194	.80	.889	1.021	.175	.785	.347
neg16 Not give help	194	.50	.770	1.822	.175	4.016	.347
neg17 Take advantage of you	194	.38	.690	2.111	.175	5.228	.347
neg19 Make demands or favors	194	1.00	.911	.749	.175	.250	.347
neg20 Ask for more help than you can give	194	.65	.756	.755	.175	.602	.347

R

The Mardia's Kurtosis in the output is the normalized estimate

```
library(MVN)
mvn(data = nonnorm1, mvnTest = "mardia")

$multivariateNormality
             Test         Statistic               p value Result
1 Mardia Skewness 1547.90761621155 1.94256712173418e-145     NO
2 Mardia Kurtosis 32.7850589952044                     0     NO
3             MVN              <NA>                  <NA>     NO

$univariateNormality
               Test  Variable Statistic   p value Normality
1  Anderson-Darling   neg6      20.7842  <0.001      NO
2  Anderson-Darling   neg26     22.8027  <0.001      NO
3  Anderson-Darling   neg30     19.1099  <0.001      NO
4  Anderson-Darling   neg35     28.5928  <0.001      NO
5  Anderson-Darling   neg11     28.1852  <0.001      NO
6  Anderson-Darling   neg12     29.8331  <0.001      NO
7  Anderson-Darling   neg13     14.0723  <0.001      NO
8  Anderson-Darling   neg14     15.0322  <0.001      NO
9  Anderson-Darling   neg16     25.7165  <0.001      NO
10 Anderson-Darling   neg17     33.2410  <0.001      NO
11 Anderson-Darling   neg19     11.7243  <0.001      NO
12 Anderson-Darling   neg20     20.0916  <0.001      NO

$Descriptives
        n      Mean   Std.Dev Median Min Max 25th 75th      Skew    Kurtosis
neg6  194 0.5876289 0.7305698      0   0   4    0    1 1.2034907  1.69479511
neg26 194 0.5670103 0.7740241      0   0   4    0    1 1.3110536  1.52928814
neg30 194 0.6391753 0.7506207      0   0   4    0    1 1.0582250  1.14181881
neg35 194 0.4690722 0.7829611      0   0   4    0    1 1.9382725  4.14309494
neg11 194 0.4536082 0.6831900      0   0   3    0    1 1.3789754  1.25402554
neg12 194 0.4381443 0.6743169      0   0   3    0    1 1.3336697  0.83280800
neg13 194 0.8505155 0.8353118      1   0   4    0    1 0.7078709  0.05675242
neg14 194 0.8041237 0.8890721      1   0   4    0    1 1.0056332  0.69611188
neg16 194 0.5000000 0.7702365      0   0   4    0    1 1.7935898  3.81195229
neg17 194 0.3814433 0.6895715      0   0   4    0    1 2.0784461  4.98007637
neg19 194 1.0000000 0.9105029      1   0   4    0    2 0.7375272  0.18008537
neg20 194 0.6494845 0.7555150      0   0   3    0    1 0.7434406 -0.64164953

> #what's printed by mvn under Mardia's Kurtosis is the normalized estimate
```