

How to Use MULTICORR (Version 2.4)

James H. Steiger

University of British Columbia

MULTICORR is a computer program which performs a variety of complex correlational hypothesis tests, using a quadratic form asymptotic chi-square statistic. For detailed descriptions of the theory underlying the method, see Steiger (1980b). For a (relatively) non-technical review of some of the literature on correlational significance tests, see Steiger (1980a).

MULTICORR is designed to provide fast, accurate, and relatively inexpensive tests of correlational pattern hypotheses. It is not intended to be a replacement for larger, more general programs for testing covariance structures. However, for the task at hand, the typical user will probably find that this program is very easy to use. Perhaps more importantly, the chi-square statistic it provides is somewhat more accurate at small samples than the statistic printed by covariance structure programs.

Correlational Pattern Hypotheses

A *correlational pattern hypothesis* is a null hypothesis that constrains elements of a correlation matrix to be equal to each other, or to specified numerical values, or both. For example, suppose, in a 3×3 correlation matrix, we hypothesize that $\rho_{21} = \rho_{31}$, and that $\rho_{32} = .60$. We can write such a hypothesis vectorially in the notation:

$$H_0: \begin{bmatrix} \rho_{21} \\ \rho_{31} \\ \rho_{32} \end{bmatrix} = \begin{bmatrix} \rho_1 \\ \rho_1 \\ .60 \end{bmatrix}$$

MULTICORR allows a significance test to be performed on such a hypothesis. In order to use MULTICORR, the following steps should be executed.

1. Write the correlational hypothesis in vectorial format. You must state all hypotheses in terms of the *lower triangular* constrained elements of the correlation matrix, i.e.,

those *below*, and *not including* the diagonal, which are hypothesized to be equal to each other, or to a specified numerical value.

2. Construct a data file, with lines in the following structure:

1. **TITLE CARD** (up to 80 alphanumeric characters describing the computation).

2. **PARAMETER CARD** (Format 4I5)

Columns 1-5	Dimension of the correlation matrix.
Columns 6-10	Number of sample observations on which the correlations are based
Columns 11-15	Number of constrained parameters, i.e., number of elements in the left hypothesis vector.
Columns 16-20	Output parameter - Leave blank unless detailed technical output is desired. For detailed output, set to 09876

3. **FORMAT CARD FOR CORRELATION MATRIX**

Print the input format for a line of the correlation matrix, using the standard FORTRAN symbolism, *including parentheses*.

4. **INPUT CORRELATION MATRIX**

Type the input correlation matrix (either the entire matrix, or lower triangular form, *including the 1's on the diagonal*).

5. **HYPOTHESIS MATRIX** (Format 3I5, F10.0)

The hypothesis matrix is constructed directly from the null hypothesis in vectorial form. Each row of the null hypothesis has a corresponding row in the hypothesis matrix. The first two elements (cols 1-5, 6-10) of each row are integers equal to the subscripts of the correlation coefficient on the left side of the hypothesis vector. The third element (cols 11-15) is an integer which is 0 if the correlation is numerically specified by the null hypothesis. If the correlation is not numerically specified, then the third coefficient is set equal to the subscript of the value on the right side of the hypothesis vector. (**CAUTION: When specifying H_0 , these subscripts should be numbered successively, beginning at 1.**)

The fourth element (cols 16-25) of each row is simply left blank, *unless* the correlation coefficient is numerically specified by the null hypothesis. If the coefficient is numerically specified, the value, including decimal point, is punched in columns 16-25.

For example:

$$H_0: \begin{bmatrix} \rho_{21} \\ \rho_{31} \\ \rho_{32} \end{bmatrix} = \begin{bmatrix} \rho_1 \\ \rho_1 \\ .60 \end{bmatrix}$$

For the above hypothesis, the hypothesis matrix would be (# stands for blank spaces in what follows):

```
#####2#####1#####1
#####3#####1#####1
#####3#####2#####0.60
```

Notice that the .60, since it used decimal override, could have been positioned anywhere in the ten space field reserved for specified numerical values. However, we have found that the format above is particularly easy for users to read and apply.

Note also that you **must use decimal override (i.e., include a decimal point) in specifying numerical values for correlations.**

Some Numerical Examples

1. Identity Hypothesis

This tests, simultaneously, whether all the correlations among a set of variables are zero (See Steiger, 1980a, p. 249). In this case, suppose a 3×3 correlation matrix, based on $N = 100$, has the following values:

```

1.00
0.22  1.00
0.06  0.08  1.00

```

The full input and output from MULTICORR are given in Appendix A1.

2. Circumplex Hypothesis

A circumplex hypothesis specifies that a correlation matrix has a particular form in which correlations on diagonal strips take on equivalent values. For example, the 6×6 correlation matrix circumplex form is

```

1.00
ρ1  1.00
ρ2  ρ1  1.00
ρ3  ρ2  ρ1  1.00
ρ2  ρ3  ρ2  ρ1  1.00
ρ1  ρ2  ρ3  ρ2  ρ1  1.00

```

The sample input and output are shown in appendix A2, for some classic data given by Guttman (1954), based on a sample of 709 subjects. Here we request standard output, and the program returns GLS estimates, the chi-square goodness-of-fit statistic, and its associated probability level.

References

- Guttman, L.B. (1954). A new approach to factor analysis: the radex. In P.F. Lazarsfeld (Ed.), *Mathematical thinking in the social sciences*. New York: Columbia University Press.
- Steiger, J.H. (1980a). Tests for comparing elements of a correlation matrix. *Psychological Bulletin*, 87, 245-251.
- Steiger, J.H. (1980b). Testing pattern hypotheses on correlation matrices: Alternative statistics and some empirical results. *Multivariate Behavioral Research*, 15, 335-352.

Appendix A1

Input Data Deck:

```

TEST DATA SET #1 -- 3X3 IDENTITY
      3 100      3 9876
(3F7.2)
1.00
0.22  1.00
0.06  0.08  1.00
      2   1   0.0
      3   1   0.0
      3   2   0.0

```

Program Output:

```

*****
*   PROGRAM MULTICORR - VERSION 2.4 - MAY 1987   *
*
*                   BY                           *
*
*                   JAMES H. STEIGER            *
*
*                   UNIVERSITY OF BRITISH COLUMBIA *
*
*                   DEPT OF PSYCHOLOGY          *
*****

TEST DATA SET #1 -- 3X3 IDENTITY

NUMBER OF VARIABLES =      3      N= 100
NUMBER OF CONSTRAINED PARAMETERS=      3

FULL OUTPUT REQUESTED
0      INPUT CORRELATION MATRIX
-      1      2      3
, 1      1.0000      .2200      .0600
, 2      .2200      1.0000      .0800
, 3      .0600      .0800      1.0000
0      HYPOTHESIS MATRIX
-      1      2      3      4
, 1      2.0000      1.0000      .0000      .0000
, 2      3.0000      1.0000      .0000      .0000
, 3      3.0000      2.0000      .0000      .0000
0      MATRIX OF OLS ESTIMATES
-      1      2      3
, 1      1.0000      .0000      .0000
, 2      .0000      1.0000      .0000
, 3      .0000      .0000      1.0000
0      INVERSE OF MATRIX OF OLS ESTIMATES
-      1      2      3
, 1      1.0000      .0000      .0000
, 2      .0000      1.0000      .0000
, 3      .0000      .0000      1.0000
CONDITION NUMBER IS      .1000000E+01

```

```

0          MATRIX T
-           1           2           3
, 1        2.0000      .0000      .0000
, 2        .0000      2.0000      .0000
, 3        .0000      .0000      2.0000
0          INVERSE OF MATRIX T
-           1           2           3
, 1        .5000      .0000      .0000
, 2        .0000      .5000      .0000
, 3        .0000      .0000      .5000
CONDITION NUMBER IS      .1000000E+01
0          INVERSE VAR-COVAR MATRIX OF RAW CORRELATION VECTOR
-           1           2           3
, 1        1.0000      .0000      .0000
, 2        .0000      1.0000      .0000
, 3        .0000      .0000      1.0000
0          DIFFERENCE VECTOR OF FISHER TRANSFORMS
-           1
, 1        -.2237
, 2        -.0601
, 3        -.0802
0          INVERSE OF VAR-COVAR MTX OF FISHER TRANSFORMS
-           1           2           3
, 1        1.0000      .0000      .0000
, 2        .0000      1.0000      .0000
, 3        .0000      .0000      1.0000

CHI SQUARE =      5.8256      DF=      3.      P= .1188

END OF PROGRAM

```


Appendix A2.

Input Data Deck:

```
TEST DATA -- SAMPLE DATA SET #2 -- GUTTMAN (1954) CIRCUMPLEX
  6 709 15
(6F6.0)
1.000
0.446 1.000
0.321 0.388 1.000
0.213 0.313 0.396 1.000
0.234 0.208 0.325 0.352 1.000
0.442 0.330 0.328 0.247 0.347 1.000
  2   1   1
  3   2   1
  4   3   1
  5   4   1
  6   5   1
  3   1   2
  4   2   2
  5   3   2
  6   4   2
  4   1   3
  5   2   3
  6   3   3
  5   1   2
  6   2   2
  6   1   1
```

Program Output:

```

*****
*   PROGRAM MULTICORR - VERSION 2.4 - MAY 1987   *
*
*           BY                                     *
*
*           JAMES H. STEIGER                       *
*
*           UNIVERSITY OF BRITISH COLUMBIA        *
*
*           DEPT OF PSYCHOLOGY                     *
*****

TEST DATA -- SAMPLE DATA SET #2 -- GUTTMAN (1954) CIRCUMPLEX

NUMBER OF VARIABLES =      6      N=  709
NUMBER OF CONSTRAINED PARAMETERS=  15

STANDARD OUTPUT REQUESTED
0      INPUT CORRELATION MATRIX
-
, 1      1      2      3      4      5      6
, 1      1.0000      .4460      .3210      .2130      .2340      .4420
, 2      .4460      1.0000      .3880      .3130      .2080      .3300
, 3      .3210      .3880      1.0000      .3960      .3250      .3280
, 4      .2130      .3130      .3960      1.0000      .3520      .2470
, 5      .2340      .2080      .3250      .3520      1.0000      .3470
, 6      .4420      .3300      .3280      .2470      .3470      1.0000
0      HYPOTHESIS MATRIX
-
, 1      2.0000      1.0000      1.0000      .0000
, 2      3.0000      2.0000      1.0000      .0000
, 3      4.0000      3.0000      1.0000      .0000
, 4      5.0000      4.0000      1.0000      .0000
, 5      6.0000      5.0000      1.0000      .0000
, 6      3.0000      1.0000      2.0000      .0000
, 7      4.0000      2.0000      2.0000      .0000
, 8      5.0000      3.0000      2.0000      .0000
, 9      6.0000      4.0000      2.0000      .0000
, 10     4.0000      1.0000      3.0000      .0000
, 11     5.0000      2.0000      3.0000      .0000
, 12     6.0000      3.0000      3.0000      .0000
, 13     5.0000      1.0000      2.0000      .0000
, 14     6.0000      2.0000      2.0000      .0000
, 15     6.0000      1.0000      1.0000      .0000
0      MATRIX OF OLS ESTIMATES
-
, 1      1      2      3      4      5      6
, 1      1.0000      .3952      .2950      .2497      .2950      .3952
, 2      .3952      1.0000      .3952      .2950      .2497      .2950
, 3      .2950      .3952      1.0000      .3952      .2950      .2497
, 4      .2497      .2950      .3952      1.0000      .3952      .2950
, 5      .2950      .2497      .2950      .3952      1.0000      .3952
, 6      .3952      .2950      .2497      .2950      .3952      1.0000

```

```

0          MATRIX OF GLS ESTIMATES
-          1          2          3          4          5          6
, 1        1.0000        .3952        .2950        .2497        .2950        .3952
, 2         .3952        1.0000        .3952        .2950        .2497        .2950
, 3         .2950        .3952        1.0000        .3952        .2950        .2497
, 4         .2497        .2950        .3952        1.0000        .3952        .2950
, 5         .2950        .2497        .2950        .3952        1.0000        .3952
, 6         .3952        .2950        .2497        .2950        .3952        1.0000

CHI SQUARE = 27.3138      DF= 12.      P= .0072
END OF PROGRAM

```