Multinomial Logit & Ordered Probit Models

Multinomial Logit Model

Dependent variable has more than two choices.

$$p_{ij} = \frac{e^{x_i'\beta_j}}{\sum_{h=1}^{3} e^{x_i'\beta_h}} = \frac{e^{x_i'\beta_j}}{1+\sum_{h=2}^{3} e^{x_i'\beta_h}}$$

Ordered Probit Model

In case that choices are ordered, ordered probit model can be applied.

$$y_i^* = x_i'\beta + \varepsilon_i, \quad E(\varepsilon_i) = 0$$

$$y_i = 1 \quad if \; -\infty < y_i^* \le c_1,$$
$$y_i = 2 \quad if \; c_1 < y_i^* \le c_2,$$
$$y_i = 3 \quad if \; c_2 < y_i^* \le \infty$$

where: c_i = Threshold value and $i=1,2$

Data

Dependent Variables--Financing Choices (y)

1 = Internal Finance
2 = Long- term debt and bond
3 = Share issues

Independent Variables (x_k):

x_1 = Liquidity
x_2 = Profitability
x_3 = Log of firm size
x_4 = Interest Payments
x_6 = Depreciation
x_7 = Deviation from target capital structure

Multinomial Logit Model

```
. mlogit y x1 x2 x3 x4 x5 x6 x7

Iteration 0:   log likelihood =  -229.0604
...
Iteration 6:   log likelihood = -166.15829

Multinomial logistic regression                 Number of obs   =        345
                                                LR chi2(14)     =     125.80
                                                Prob > chi2     =     0.0000
Log likelihood = -166.15829                     Pseudo R2       =     0.2746

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
2            |
          x1 |  -10.99413   1.565082    -7.02   0.000    -14.06163   -7.926625
          x2 |   1.959274   1.713848     1.14   0.253    -1.399806    5.318353
          x3 |      .00002   .0000276     0.73   0.468     -.000034     .000074
          x4 |   -.444847   .2259241    -1.97   0.049    -.8876502   -.0020438
          x5 |   20.26386   9.895417     2.05   0.041      .869197    39.65852
          x6 |   3.01e-06   .0003993     0.01   0.994    -.0007795    .0007855
          x7 |   .1615299   .1213036     1.33   0.183    -.0762209    .3992806
       _cons |   .8172448   .3323678     2.46   0.014     .1658159    1.468674
-------------+----------------------------------------------------------------
3            |
          x1 |  -5.229735   2.489153    -2.10   0.036    -10.10839   -.3510836
          x2 |   13.82778   4.370697     3.16   0.002     5.261368    22.39418
          x3 |   .0000185   .0000537     0.34   0.731    -.0000867    .0001237
          x4 |  -1.504211   .7736294    -1.94   0.052    -3.020497    .0120745
          x5 |   13.04574   37.47837     0.35   0.728    -60.41051    86.50199
          x6 |   -.000379    .000864    -0.44   0.661    -.0020723    .0013144
          x7 |   .3027194   .2599409     1.16   0.244    -.2067554    .8121942
       _cons |  -2.047637   .8040618    -2.55   0.011    -3.623569   -.4717048
------------------------------------------------------------------------------
(y==1 is the base outcome)


. fitstat

Measures of Fit for mlogit of y

Log-Lik Intercept Only:       -229.060   Log-Lik Full Model:           -166.158
D(329):                        332.317   LR(14):                        125.804
                                         Prob > LR:                       0.000
McFadden's R2:                   0.275   McFadden's Adj R2:               0.205
ML (Cox-Snell) R2:               0.306   Cragg-Uhler(Nagelkerke) R2:      0.416
Count R2:                        0.835   Adj Count R2:                    0.352
AIC:                             1.056   AIC*n:                         364.317
BIC:                         -1590.210   BIC':                          -43.995
BIC used by Stata:             425.813   AIC used by Stata:             364.317


. mfx compute, predict(outcome(1))

Marginal effects after mlogit
      y  = Pr(y==1) (predict, outcome(1))
         =  .87484547
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |   1.140146      .13885    8.21   0.000   .868009  1.41228    .27949
      x2 |  -.3454925      .18583   -1.86   0.063  -.709721  .018736  -.046302
      x3 |  -2.17e-06      .00000   -0.72   0.474  -8.1e-06  3.8e-06   5637.03
      x4 |   .0603969      .02498    2.42   0.016   .011439  .109355    .15155
      x5 |  -2.139055     1.10189   -1.94   0.052  -4.29872  .020609    .01289
      x6 |   3.89e-06      .00004    0.09   0.928  -.000081  .000089   295.209
      x7 |  -.0192441      .01317   -1.46   0.144  -.045059  .006571  -.073405
------------------------------------------------------------------------------
```

```
. mfx compute, predict(outcome(2))

Marginal effects after mlogit
      y  = Pr(y==2) (predict, outcome(2))
         =  .11254078
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |  -1.090619      .13546   -8.05   0.000  -1.35611 -.825124    .27949
      x2 |   .1760538      .17103    1.03   0.303  -.159166  .511274  -.046302
      x3 |   1.97e-06      .00000    0.71   0.478  -3.5e-06  7.4e-06   5637.03
      x4 |  -.0422939      .02289   -1.85   0.065  -.087148   .00256    .15155
      x5 |   2.005341      .98426    2.04   0.042   .076221  3.93446    .01289
      x6 |   8.38e-07      .00004    0.02   0.983  -.000077  .000078   295.209
      x7 |   .0157031       .0123    1.28   0.202  -.008405  .039811  -.073405
------------------------------------------------------------------------------

. mfx compute, predict(outcome(3))

Marginal effects after mlogit
      y  = Pr(y==3) (predict, outcome(3))
         =  .01261375
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |  -.0495276      .03451   -1.44   0.151  -.117158  .018103    .27949
      x2 |   .1694387      .07835    2.16   0.031   .015876  .323001  -.046302
      x3 |   2.02e-07      .00000    0.30   0.762  -1.1e-06  1.5e-06   5637.03
      x4 |  -.0181029      .01053   -1.72   0.086  -.038739  .002534    .15155
      x5 |   .1337143        .489    0.27   0.785  -.824706  1.09213    .01289
      x6 |  -4.72e-06      .00001   -0.44   0.661  -.000026  .000016   295.209
      x7 |    .003541      .00352    1.00   0.315  -.003365  .010447  -.073405
------------------------------------------------------------------------------
```

Ordered Probit

```
. oprobit y x1 x2 x3 x4 x5 x6 x7

Iteration 0:   log likelihood =  -229.0604
...
Iteration 4:   log likelihood =  -185.5201

Ordered probit regression                         Number of obs   =        345
                                                  LR chi2(7)      =      87.08
                                                  Prob > chi2     =     0.0000
Log likelihood =  -185.5201                       Pseudo R2       =     0.1901

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   -4.03138   .5938243    -6.79   0.000    -5.195255   -2.867506
          x2 |   1.687187   .8529887     1.98   0.048     .0153596    3.359014
          x3 |   5.56e-06   .0000117     0.47   0.636    -.0000175    .0000286
          x4 |  -.3061237   .1149779    -2.66   0.008    -.5314762   -.0807712
          x5 |   8.843271   4.609554     1.92   0.055    -.1912879    17.87783
          x6 |  -.0000151   .0001689    -0.09   0.929    -.0003462     .000316
          x7 |   .0720901   .0593954     1.21   0.225    -.0443228    .1885029
-------------+----------------------------------------------------------------
       /cut1 |  -.2196101   .1640562                     -.5411544    .1019342
       /cut2 |    1.23118   .1943152                       .850329    1.612031
------------------------------------------------------------------------------
Note: 1 observation completely determined.  Standard errors questionable.

. fitstat

Measures of Fit for oprobit of y

Log-Lik Intercept Only:       -229.060   Log-Lik Full Model:           -185.520
D(336):                        371.040   LR(7):                          87.081
                                         Prob > LR:                       0.000
McFadden's R2:                   0.190   McFadden's Adj R2:               0.151
ML (Cox-Snell) R2:               0.223   Cragg-Uhler(Nagelkerke) R2:      0.304
McKelvey & Zavoina's R2:         0.471
Variance of y*:                  1.889   Variance of error:               1.000
Count R2:                        0.814   Adj Count R2:                    0.273
```

```
AIC:                             1.128   AIC*n:                          389.040
BIC:                         -1592.391   BIC':                           -46.176
BIC used by Stata:             423.632   AIC used by Stata:              389.040

. prchange

oprobit: Changes in Probabilities for y

x1
            Avg|Chg|           1           2           3
Min->Max    .3870964    .58064461  -.47449115  -.10615345
   -+1/2    .57784942   .86677413   -.4965061  -.37026803
  -+sd/2    .14522663   .21783996  -.19435603   -.0234839
MargEfct    .71768335    1.076525  -.97409793  -.10242709

x2
            Avg|Chg|           1           2           3
Min->Max    .22369273   -.3355391    .3049367    .0306024
   -+1/2    .29208588  -.43812883   .37244845   .06568038
  -+sd/2     .0465245  -.06978673   .06305777   .00672901
MargEfct    .30036012  -.45054018   .40767307   .04286711

x3
            Avg|Chg|           1           2           3
Min->Max    .2078363   -.31175447   .25083494   .06091949
   -+1/2   9.909e-07  -1.490e-06   1.341e-06   1.416e-07
  -+sd/2    .01430377  -.02145565   .01941167   .00204401
MargEfct   9.904e-07  -1.486e-06   1.344e-06   1.413e-07

x4
            Avg|Chg|           1           2           3
Min->Max    .19223931   .28835899   -.2660868  -.02227215
   -+1/2    .05445518   .08168274  -.07376806  -.00791472
  -+sd/2    .05268519   .07902777  -.07137918   -.0076486
MargEfct    .05449743   .08174615  -.07396833  -.00777782

x5
            Avg|Chg|           1           2           3
Min->Max    .57225375  -.85838063   .29884491   .55953571
   -+1/2    .66652579  -.99978869   .01879035   .98099834
  -+sd/2    .03545871  -.05318809   .04808801   .00510003
MargEfct    1.5743165  -2.3614748   2.1367898   .22468497

x6
            Avg|Chg|           1           2           3
Min->Max    .02960916   .04441375  -.04065703  -.00375671
   -+1/2    2.696e-06   4.053e-06  -3.651e-06  -3.828e-07
  -+sd/2    .00262523   .00393784  -.00356315  -.00037469
MargEfct    2.686e-06   4.029e-06  -3.646e-06  -3.834e-07

x7
            Avg|Chg|           1           2           3
Min->Max    .20690374   -.3103556   .25215909   .05819652
   -+1/2    .01283323  -.01924986   .01741643   .00183341
  -+sd/2    .02055509  -.03083265   .02789135   .00294127
MargEfct    .01283378  -.01925066   .01741904   .00183162

                  1           2           3
Pr(y|x)   .81488079   .17565194   .00946728

              x1          x2          x3          x4          x5          x6          x7
    x=     .27949   -.046302     5637.03      .15155      .01289     295.209   -.073405
sd(x)=    .203534     .154983     14443.5     .967448     .022531     977.328     1.60182


. predict one two three
(option pr assumed; predicted probabilities)

. g yhat=1 if one==max(one,two,three)
(32 missing values generated)

. replace yhat=2 if two==max(one,two,three)
(32 real changes made)

. replace yhat=3 if three==max(one,two,three)
```

```
(0 real changes made)

. tabulate y yhat
```

y	yhat 1	2	Total
1	255	2	257
2	51	26	77
3	7	4	11
Total	313	32	345

Multivariate Probit Models
Model for Financial Restructuring Strategies

Multivariate Probit Models

The model can be shown as

$$
\begin{aligned}
y_1^* &= \beta_1' x + \varepsilon_1, && y_1 = 1 \;\; if \;\; y_1^* > 0, \;\; 0 \;\; otherwise \\
y_2^* &= \beta_2' x + \varepsilon_2, && y_2 = 1 \;\; if \;\; y_2^* > 0, \;\; 0 \;\; otherwise \\
&\vdots \\
y_5^* &= \beta_5' x + \varepsilon_5, && y_5 = 1 \;\; if \;\; y_5^* > 0, \;\; 0 \;\; otherwise
\end{aligned}
$$

$$
\begin{aligned}
&E\left[\varepsilon_1 \middle| x_1, x_2, \ldots, x_6\right] = E\left[\varepsilon_2 \middle| x_1, x_2, \ldots, x_6\right] = \cdots = E\left[\varepsilon_5 \middle| x_1, x_2, \ldots, x_6\right] = 0 \\
&Var\left[\varepsilon_1 \middle| x_1, x_2, \ldots, x_6\right] = Var\left[\varepsilon_2 \middle| x_1, x_2, \ldots, x_6\right] = \cdots = Var\left[\varepsilon_5 \middle| x_1, x_2, \ldots, x_6\right] = 1 \\
&Cov\left[\varepsilon_i, \varepsilon_j \middle| x_i, x_j\right] = \rho_{ij} \qquad \forall i \neq j, i = 1,2,\ldots,5, \; j = 1,2,\ldots,5
\end{aligned}
$$

Data

y_{1it} = 1 if firm i choose asset expansion action, 0 otherwise
y_{2it} = 1 if firm i choose asset reduction action, 0 otherwise
y_{3it} = 1 if firm i choose debt restructuring, 0 otherwise
y_{4it} = 1 if firm i choose equity issues, 0 otherwise
y_{5it} = 1 if firm i choose management restructuring, 0 otherwise
x_{1it} = Firm's leverage
x_{2it} = Interest coverage ratio (debt burden)
x_{3it} = % managerial shareholding.
x_{4it} = Proportion of outside directors to total directors
x_{5it} = Country's GDP growth rate
x_{6it} = Firm's size

5 Separate Probit Models

```
. probit y1 x*, nolog

Probit regression                                 Number of obs   =       1543
                                                  LR chi2(6)      =     167.40
                                                  Prob > chi2     =     0.0000
Log likelihood = -830.24495                       Pseudo R2       =     0.0916

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.0010371   .0003794    -2.73   0.006    -.0017806   -.0002935
          x2 |  -6.67e-08   4.52e-07    -0.15   0.883    -9.53e-07    8.19e-07
          x3 |   .0016139   .0020492     0.79   0.431    -.0024026    .0056303
          x4 |   .0125037   .0027853     4.49   0.000     .0070445    .0179628
          x5 |   .0175449   .0087508     2.00   0.045     .0003937    .0346961
          x6 |    .168635   .0210309     8.02   0.000     .1274151    .2098548
       _cons |  -2.035393   .1823033   -11.16   0.000    -2.392701   -1.678086
------------------------------------------------------------------------------

. probit y2 x*, nolog

Probit regression                                 Number of obs   =       1543
                                                  LR chi2(6)      =      15.95
                                                  Prob > chi2     =     0.0140
```

```
Log likelihood = -670.63385                     Pseudo R2       =     0.0118

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   -.000246   .0002078    -1.18   0.236    -.0006532    .0001613
          x2 |   1.07e-06   1.19e-06     0.90   0.370    -1.27e-06    3.40e-06
          x3 |  -.0021927   .0022554    -0.97   0.331    -.0066132    .0022278
          x4 |   .0035001   .0030096     1.16   0.245    -.0023986    .0093987
          x5 |  -.0086695   .0084185    -1.03   0.303    -.0251694    .0078304
          x6 |  -.0630892   .0223178    -2.83   0.005    -.1068312   -.0193472
       _cons |  -.6396533   .1745235    -3.67   0.000    -.9817131   -.2975936
------------------------------------------------------------------------------

. probit y3 x*, nolog

Probit regression                               Number of obs   =       1543
                                                LR chi2(6)      =     158.20
                                                Prob > chi2     =     0.0000
Log likelihood = -973.96432                     Pseudo R2       =     0.0751

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0009642   .0001827     5.28   0.000     .0006061    .0013222
          x2 |   1.09e-07   3.44e-07     0.32   0.751    -5.65e-07    7.83e-07
          x3 |  -.0058828   .0019448    -3.02   0.002    -.0096946    -.002071
          x4 |  -.0082904   .0026507    -3.13   0.002    -.0134857    -.003095
          x5 |   .0659683   .0079619     8.29   0.000     .0503633    .0815733
          x6 |  -.1056225   .0190819    -5.54   0.000    -.1430224   -.0682227
       _cons |   .5035002   .1533072     3.28   0.001     .2030236    .8039769
------------------------------------------------------------------------------

. probit y4 x*, nolog

Probit regression                               Number of obs   =       1543
                                                LR chi2(6)      =      24.90
                                                Prob > chi2     =     0.0004
Log likelihood = -743.31718                     Pseudo R2       =     0.0165

------------------------------------------------------------------------------
          y4 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0001434   .0001504     0.95   0.340    -.0001514    .0004382
          x2 |  -6.53e-07   8.81e-07    -0.74   0.459    -2.38e-06    1.07e-06
          x3 |  -.0036262   .0021842    -1.66   0.097    -.0079072    .0006548
          x4 |  -.0092972   .0029578    -3.14   0.002    -.0150944   -.0034999
          x5 |   .0217562   .0086833     2.51   0.012     .0047373     .038775
          x6 |    .042665   .0203458     2.10   0.036      .002788     .082542
       _cons |  -.8837326   .1645487    -5.37   0.000    -1.206242   -.5612231
------------------------------------------------------------------------------

. probit y5 x*, nolog

Probit regression                               Number of obs   =       1543
                                                LR chi2(6)      =      45.68
                                                Prob > chi2     =     0.0000
Log likelihood = -1033.2938                     Pseudo R2       =     0.0216

------------------------------------------------------------------------------
          y5 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.0002979   .0001572    -1.89   0.058    -.0006061    .0000103
          x2 |   2.81e-07   3.44e-07     0.82   0.415    -3.94e-07    9.56e-07
          x3 |  -.0078703   .0019057    -4.13   0.000    -.0116054   -.0041352
          x4 |   .0026619   .0025551     1.04   0.298    -.0023461    .0076698
          x5 |  -.0217769   .0072296    -3.01   0.003    -.0359466   -.0076071
          x6 |   .0579123   .0184321     3.14   0.002     .0217862    .0940385
       _cons |  -.3985652   .1464524    -2.72   0.006    -.6856066   -.1115238
------------------------------------------------------------------------------
```

MVProbit

```
. mvprobit (y1 x*) (y2 x*) (y3 x*)(y4 x*) (y5 x*)
```

```
Iteration 0:   log likelihood = -4251.4541
...
Iteration 4:   log likelihood =  -4212.171

Multivariate probit (MSL, # draws = 5)            Number of obs   =       1543
                                                  Wald chi2(30)   =     353.46
Log likelihood =  -4212.171                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y1           |
          x1 |   -.000876   .0003613    -2.43   0.015    -.0015841    -.000168
          x2 |  -5.93e-08   4.51e-07    -0.13   0.896    -9.44e-07    8.26e-07
          x3 |   .0016751   .0020487     0.82   0.414    -.0023402    .0056904
          x4 |     .01247   .0027881     4.47   0.000     .0070055    .0179345
          x5 |   .0171524   .0087687     1.96   0.050    -.0000339    .0343386
          x6 |    .172079   .0210133     8.19   0.000     .1308937    .2132643
       _cons |  -2.070481   .1808783   -11.45   0.000    -2.424996   -1.715966
-------------+----------------------------------------------------------------
y2           |
          x1 |  -.0002315   .0002051    -1.13   0.259    -.0006336    .0001705
          x2 |   1.19e-06   1.23e-06     0.97   0.334    -1.22e-06    3.60e-06
          x3 |  -.0023022   .0022554    -1.02   0.307    -.0067226    .0021183
          x4 |    .003459   .0030047     1.15   0.250     -.00243    .0093481
          x5 |  -.0088519   .0084227    -1.05   0.293    -.0253601    .0076562
          x6 |  -.0632638   .0223573    -2.83   0.005    -.1070833   -.0194443
       _cons |  -.6366942   .1745204    -3.65   0.000    -.9787479   -.2946406
-------------+----------------------------------------------------------------
y3           |
          x1 |   .0009409   .0001781     5.28   0.000     .0005919    .0012898
          x2 |   1.25e-07   3.52e-07     0.36   0.722    -5.64e-07    8.14e-07
          x3 |  -.0060684   .0019535    -3.11   0.002    -.0098972   -.0022395
          x4 |   -.008231    .002659    -3.10   0.002    -.0134425   -.0030195
          x5 |   .0634924   .0078682     8.07   0.000     .0480709    .0789138
          x6 |  -.1051319   .0190914    -5.51   0.000    -.1425503   -.0677134
       _cons |   .5159247   .1534935     3.36   0.001      .215083    .8167665
-------------+----------------------------------------------------------------
y4           |
          x1 |   .0001815   .0001552     1.17   0.242    -.0001227    .0004857
          x2 |  -4.09e-07   6.13e-07    -0.67   0.504    -1.61e-06    7.92e-07
          x3 |  -.0039378   .0021848    -1.80   0.071      -.00822    .0003443
          x4 |  -.0090409   .0029429    -3.07   0.002    -.0148089   -.0032728
          x5 |   .0197256   .0084861     2.32   0.020     .0030932     .036358
          x6 |   .0438501   .0201694     2.17   0.030     .0043187    .0833815
       _cons |  -.8907171    .164368    -5.42   0.000    -1.212872   -.5685617
-------------+----------------------------------------------------------------
y5           |
          x1 |   -.000295    .000157    -1.88   0.060    -.0006028    .0000128
          x2 |   2.65e-07   3.40e-07     0.78   0.436    -4.02e-07    9.31e-07
          x3 |  -.0077204   .0019072    -4.05   0.000    -.0114585   -.0039823
          x4 |   .0026275   .0025524     1.03   0.303     -.002375    .0076301
          x5 |   -.021335   .0072211    -2.95   0.003     -.035488    -.007182
          x6 |   .0571631   .0184448     3.10   0.002     .0210119    .0933143
       _cons |  -.3960648   .1465514    -2.70   0.007    -.6833003   -.1088294
-------------+----------------------------------------------------------------
    /atrho21 |  -.0500533   .0510402    -0.98   0.327    -.1500902    .0499835
-------------+----------------------------------------------------------------
    /atrho31 |  -.1204213   .0426728    -2.82   0.005    -.2040586   -.0367841
-------------+----------------------------------------------------------------
    /atrho41 |   .0004555   .0471261     0.01   0.992    -.0919099    .0928209
-------------+----------------------------------------------------------------
    /atrho51 |   .0092549   .0417803     0.22   0.825    -.0726329    .0911427
-------------+----------------------------------------------------------------
    /atrho32 |   .0009379   .0447241     0.02   0.983    -.0867197    .0885955
-------------+----------------------------------------------------------------
    /atrho42 |  -.0525189   .0496414    -1.06   0.290    -.1498143    .0447766
-------------+----------------------------------------------------------------
    /atrho52 |   .1193119    .043904     2.72   0.007     .0332615    .2053622
-------------+----------------------------------------------------------------
    /atrho43 |   .3519057   .0466562     7.54   0.000     .2604613    .4433501
-------------+----------------------------------------------------------------
    /atrho53 |  -.0115279   .0392189    -0.29   0.769    -.0883954    .0653396
-------------+----------------------------------------------------------------
    /atrho54 |  -.0404692   .0422527    -0.96   0.338     -.123283    .0423446
```

```
-------------+------------------------------------------------------------------
       rho21 |  -.0500116   .0509125    -0.98   0.326    -.1489732     .049942
-------------+------------------------------------------------------------------
       rho31 |  -.1198426     .04206    -2.85   0.004    -.2012726   -.0367676
-------------+------------------------------------------------------------------
       rho41 |   .0004555   .0471261     0.01   0.992     -.091652    .0925552
-------------+------------------------------------------------------------------
       rho51 |   .0092546   .0417767     0.22   0.825    -.0725055    .0908911
-------------+------------------------------------------------------------------
       rho32 |   .0009379   .0447241     0.02   0.983    -.0865029    .0883645
-------------+------------------------------------------------------------------
       rho42 |  -.0524706   .0495048    -1.06   0.289    -.1487034    .0447467
-------------+------------------------------------------------------------------
       rho52 |   .1187489   .0432849     2.74   0.006     .0332493    .2025232
-------------+------------------------------------------------------------------
       rho43 |   .3380646   .0413239     8.18   0.000      .254727    .4164175
-------------+------------------------------------------------------------------
       rho53 |  -.0115274   .0392136    -0.29   0.769    -.0881659    .0652468
-------------+------------------------------------------------------------------
       rho54 |  -.0404471   .0421836    -0.96   0.338    -.1226622    .0423193
------------------------------------------------------------------------------
Likelihood ratio test of  rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 =
rho43 = rho53 = rho54 = 0:
             chi2(10) =  78.5662   Prob > chi2 = 0.0000
```