Assignment 9
MN Logit & Ordered Logit Models
Guideline Solution

The model

In the study of problems of the business, the most serious problem was the price-war. The analysis is trying to estimate the model that determines factors that have impact on the degree of seriousness of the problem.

$$Prob(y_i=j|X) = f(x_1, x_2, x_3, x_4)$$

where: y_i is categorical data = 0 for no problem, = 1 for less serious, …, and = 5 for very serious, and $i=1$ or 2.
x_1 is dummy variable = 0 for nonfamily firm and =1 for family firm.
x_2 is dummy variable = 0 for no brand and =1 for have own-brand name.
x_3 is dummy variable = 0 for low technology and =1 for high technology firm.
x_4 is log of the size of the firm.

Requirements: From data file – `Assign09.dta`:

1 Estimate the model using multinomial logit of y_i. Perform IIA test. Interpret your estimated result (overall test, individual test, pseudo R^2, counted R^2).

```
. mlogit y x1 x2 x3 x4, base(0) nolog

Multinomial logistic regression                   Number of obs     =        152
                                                  LR chi2(20)       =      50.72
                                                  Prob > chi2       =     0.0002
Log likelihood = -203.28337                       Pseudo R2         =     0.1109

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
          x1 |  -.1220175   1.086872    -0.11   0.911    -2.252248    2.008213
          x2 |  -2.016388   1.349482    -1.49   0.135    -4.661323    .6285484
          x3 |   1.253423    1.23587     1.01   0.310    -1.168837    3.675683
          x4 |   1.307279   .5491571     2.38   0.017     .2309504    2.383607
       _cons |  -18.06503   8.062973    -2.24   0.025    -33.86817   -2.261896
-------------+----------------------------------------------------------------
2            |
          x1 |   .9699943    .991428     0.98   0.328    -.9731688    2.913157
          x2 |  -1.631037    1.27855    -1.28   0.202    -4.136949    .8748753
          x3 |  -1.034421   .9547311    -1.08   0.279    -2.905659     .836818
          x4 |   .2042703   .3925818     0.52   0.603    -.5651758    .9737165
       _cons |  -.9022321    5.40243    -0.17   0.867     -11.4908    9.686336
-------------+----------------------------------------------------------------
3            |
          x1 |  -.4040394    .938099    -0.43   0.667     -2.24268    1.434601
          x2 |  -.9533924   1.222189    -0.78   0.435    -3.348838    1.442053
          x3 |  -.1658373   .8733107    -0.19   0.849    -1.877495     1.54582
          x4 |   .2174653   .3490812     0.62   0.533    -.4667212    .9016518
       _cons |  -1.061943   4.802704    -0.22   0.825    -10.47507    8.351185
-------------+----------------------------------------------------------------
4            |
          x1 |   1.677905   .9300468     1.80   0.071    -.1449532    3.500763
          x2 |  -2.104352   1.212395    -1.74   0.083    -4.480602    .2718986
          x3 |  -1.209535   .8915675    -1.36   0.175    -2.956975    .5379055
          x4 |   .1831672   .3654684     0.50   0.616    -.5331376     .899472
       _cons |  -.0171095   5.005591    -0.00   0.997    -9.827887    9.793669
-------------+----------------------------------------------------------------
5            |
          x1 |   1.832363   .8632903     2.12   0.034     .1403452    3.524381
          x2 |  -2.368735   1.168139    -2.03   0.043    -4.658246    -.079224
          x3 |   .0976971   .8455682     0.12   0.908    -1.559586     1.75498
          x4 |   .4905651   .3468626     1.41   0.157     -.189273    1.170403
       _cons |  -4.204706   4.763082    -0.88   0.377    -13.54017    5.130762
```

```
------------------------------------------------------------------------------

. est store my

. fitstat, saving(my1)

Measures of Fit for mlogit of y

Log-Lik Intercept Only:       -228.644   Log-Lik Full Model:           -203.283
D(122):                        406.567   LR(20):                         50.721
                                         Prob > LR:                       0.000
McFadden's R2:                   0.111   McFadden's Adj R2:              -0.020
ML (Cox-Snell) R2:               0.284   Cragg-Uhler(Nagelkerke) R2:      0.298
Count R2:                        0.500   Adj Count R2:                    0.062
AIC:                             3.070   AIC*n:                         466.567
BIC:                          -206.347   BIC':                           49.757
BIC used by Stata:             532.164   AIC used by Stata:             456.567

(Indices saved in matrix fs_my1)

. mlogit y x1 x2 x3 x4 if y!=5, base(0) nolog

Multinomial logistic regression                   Number of obs   =         81
                                                  LR chi2(16)     =      26.01
                                                  Prob > chi2     =     0.0539
Log likelihood = -110.60839                       Pseudo R2       =     0.1052

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
          x1 |  -.1485919    1.09501    -0.14   0.892    -2.294771    1.997588
          x2 |   -2.34891   1.426225    -1.65   0.100     -5.14426    .4464398
          x3 |   1.214949   1.241148     0.98   0.328    -1.217656    3.647554
          x4 |   1.440948   .5937873     2.43   0.015     .2771465     2.60475
       _cons |  -19.70723   8.610109    -2.29   0.022    -36.58274   -2.831728
-------------+----------------------------------------------------------------
2            |
          x1 |   .8102007   .9767255     0.83   0.407    -1.104146    2.724548
          x2 |  -1.804572   1.322361    -1.36   0.172    -4.396351    .7872074
          x3 |  -1.056176   .9618536    -1.10   0.272    -2.941375    .8290223
          x4 |   .2541214   .4086664     0.62   0.534     -.54685     1.055093
       _cons |  -1.386087   5.561535    -0.25   0.803     -12.2865    9.514321
-------------+----------------------------------------------------------------
3            |
          x1 |  -.4484998   .9236975    -0.49   0.627    -2.258914    1.361914
          x2 |  -1.067195   1.250358    -0.85   0.393    -3.517852    1.383461
          x3 |  -.2305792   .8714357    -0.26   0.791    -1.938562    1.477403
          x4 |   .2442322   .3624086     0.67   0.500    -.4660757      .95454
       _cons |  -1.284649   4.928861    -0.26   0.794    -10.94504    8.375741
-------------+----------------------------------------------------------------
4            |
          x1 |   1.478476   .9219773     1.60   0.109    -.3285659    3.285519
          x2 |  -2.278957   1.262343    -1.81   0.071    -4.753103    .1951893
          x3 |   -1.24603   .9042926    -1.38   0.168    -3.018411    .5263504
          x4 |   .2456624   .3840924     0.64   0.522    -.5071447    .9984696
       _cons |  -.6496392   5.194425    -0.13   0.900    -10.83052    9.531246
------------------------------------------------------------------------------

. est store myno5
```

IIA Test

```
. hausman my myno5, alleqs constant

Note: the rank of the differenced variance matrix (19) does not equal the number of
coefficients being tested (20); be sure this is what you expect, or there may be problems
computing the test. Examine the output of your estimators for anything unexpected and possibly
consider scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       my         myno5        Difference          S.E.
-------------+----------------------------------------------------------------
1            |
          x1 |   -.1220175    -.1485919        .0265744               .
          x2 |   -2.016388     -2.34891        .3325224               .
          x3 |    1.253423     1.214949        .0384741               .
          x4 |    1.307279     1.440948       -.1336696               .
       _cons |   -18.06503    -19.70723          1.6422               .
-------------+----------------------------------------------------------------
2            |
          x1 |    .9699943     .8102007        .1597936         .170108
          x2 |   -1.631037    -1.804572        .1735351               .
```

```
          x3 |   -1.034421    -1.056176        .0217556                .
          x4 |    .2042703     .2541214       -.0498511                .
       _cons |   -.9022321    -1.386087        .4838551                .
-------------+----------------------------------------------------------------
3            |
          x1 |   -.4040394    -.4484998        .0444605        .1637462
          x2 |   -.9533924    -1.067195         .113803                .
          x3 |   -.1658373    -.2305792        .0647419        .0571963
          x4 |    .2174653     .2442322       -.0267669                .
       _cons |   -1.061943    -1.284649        .2227059                .
-------------+----------------------------------------------------------------
4            |
          x1 |    1.677905     1.478476        .1994286         .122249
          x2 |   -2.104352    -2.278957         .174605                .
          x3 |   -1.209535     -1.24603        .0364958                .
          x4 |    .1831672     .2456624       -.0624952                .
       _cons |   -.0171095    -.6496392        .6325297                .
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from mlogit
           B = inconsistent under Ha, efficient under Ho; obtained from mlogit

    Test:  Ho:  difference in coefficients not systematic

                 chi2(19) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.92
                Prob>chi2 =      1.0000
                (V_b-V_B is not positive definite)
```

According to IIA (Hausman) test of y with p-value of 1.0, which is greater than 0.05, IIA hypothesis is not rejected. Thus, IIA is satisfied in Model y.

2 Estimate the model using order logit of y_i. Interpret your estimated result (overall test, individual test, pseudo R^2, counted R^2).

```
. ologit y x1 x2 x3 x4, nolog

Ordered logistic regression                       Number of obs   =        152
                                                  LR chi2(4)      =      24.81
                                                  Prob > chi2     =     0.0001
Log likelihood = -216.23748                       Pseudo R2       =     0.0543

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |    1.26067   .3475145     3.63   0.000     .5795538    1.941786
          x2 |  -.8530234   .3508641    -2.43   0.015    -1.540705   -.1653424
          x3 |   .2068371   .3398536     0.61   0.543    -.4592637    .8729379
          x4 |   .1261028   .1511501     0.83   0.404    -.1701459    .4223515
-------------+----------------------------------------------------------------
       /cut1 |  -.8807685   2.139511                     -5.074134    3.312597
       /cut2 |  -.0328063   2.126237                     -4.200155    4.134542
       /cut3 |   .6557008   2.118367                     -3.496223    4.807624
       /cut4 |    1.48964   2.117389                     -2.660365    5.639646
       /cut5 |   2.283969   2.124223                     -1.879432    6.447371
------------------------------------------------------------------------------

. est store oy

. fitstat, saving(oy)

Measures of Fit for ologit of y

Log-Lik Intercept Only:       -228.644   Log-Lik Full Model:           -216.237
D(143):                        432.475   LR(4):                          24.812
                                         Prob > LR:                       0.000
McFadden's R2:                   0.054   McFadden's Adj R2:               0.015
ML (Cox-Snell) R2:               0.151   Cragg-Uhler(Nagelkerke) R2:      0.158
McKelvey & Zavoina's R2:         0.157
Variance of y*:                  3.904   Variance of error:               3.290
Count R2:                        0.480   Adj Count R2:                    0.025
AIC:                             2.964   AIC*n:                         450.475
BIC:                          -285.940   BIC':                           -4.717
BIC used by Stata:             477.690   AIC used by Stata:             450.475

(Indices saved in matrix fs_oy)

. fitstat, using(my) force

Measures of Fit for ologit of y
```

```
Warning: Current model estimated by ologit, but saved model estimated by mlogit

                              Current            Saved         Difference
Model:                         ologit            mlogit
N:                                152               152                 0
Log-Lik Intercept Only       -228.644          -228.644             0.000
Log-Lik Full Model           -216.237          -203.283           -12.954
D                             432.475(143)      406.567(122)       25.908(21)
LR                             24.812(4)         50.721(20)        25.908(16)
Prob > LR                       0.000             0.000             0.055
McFadden's R2                   0.054             0.111            -0.057
McFadden's Adj R2               0.015            -0.020             0.035
ML (Cox-Snell) R2               0.151             0.284            -0.133
Cragg-Uhler(Nagelkerke) R2      0.158             0.298            -0.140
McKelvey & Zavoina's R2         0.157                .x                 .
Variance of y*                  3.904                .x                 .
Variance of error               3.290                .x                 .
Count R2                        0.480             0.500            -0.020
Adj Count R2                    0.025             0.062            -0.037
AIC                             2.964             3.070            -0.106
AIC*n                         450.475           466.567           -16.092
BIC                          -285.940          -206.347           -79.593
BIC'                           -4.717            49.757           -54.474
BIC used by Stata             477.690           532.164           -54.474
AIC used by Stata             450.475           456.567            -6.092

Difference of   54.474 in BIC' provides very strong support for current model.

Note: p-value for difference in LR is only valid if models are nested.
```

3 Compare the two models. Which model is more appropriated in this case? Why?

According to the comparison of BIC′ between the two models (mlogit vs ologit), ordered logit model is more appropriated model for y.

```
. g y_15=(y>0)

. g y_25=(y>1)

. g y_35=(y>2)

. g y_45=(y>3)

. g y_55=(y>4)

. qui logit y_15 x1 x2 x3 x4, nolog

. est store m15

. qui logit y_25 x1 x2 x3 x4, nolog

. est store m25

. qui logit y_35 x1 x2 x3 x4, nolog

. est store m35

. qui logit y_45 x1 x2 x3 x4, nolog

. est store m45

. qui logit y_55 x1 x2 x3 x4, nolog

. est store m55

. suest m15 m25 m35 m45 m55

Simultaneous results for m15, m25, m35, m45, m55

                                                Number of obs      =       152

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
m15_y_15     |
          x1 |   1.097122   .9033857     1.21   0.225    -.6734812    2.867725
          x2 |   -1.82336   1.135405    -1.61   0.108    -4.048713    .4019928
          x3 |  -.3069072    .803698    -0.38   0.703    -1.882126    1.268312
          x4 |   .3527502   .3544918     1.00   0.320    -.3420409    1.047541
       _cons |  -1.099312   4.856106    -0.23   0.821     -10.6171    8.418481
-------------+----------------------------------------------------------------
```

```
m25_y_25     |
          x1 |   1.264527   .5825003     2.17   0.030     .1228478    2.406207
          x2 |  -.7792338    .604258    -1.29   0.197    -1.963558    .4050901
          x3 |  -.8053988   .6052151    -1.33   0.183    -1.991599     .380801
          x4 |  -.2074297   .3082284    -0.67   0.501    -.8115462    .3966868
       _cons |   5.389609   4.422033     1.22   0.223    -3.277416    14.05663
-------------+----------------------------------------------------------------
m35_y_35     |
          x1 |    .864886   .4721274     1.83   0.067    -.0604667    1.790239
          x2 |  -.6170464   .4658079    -1.32   0.185    -1.530013    .2959203
          x3 |  -.0281734   .4629933    -0.06   0.951    -.9356237    .8792769
          x4 |  -.0449685   .2176813    -0.21   0.836    -.4716161    .3816791
       _cons |   1.899683   3.086536     0.62   0.538    -4.149816    7.949182
-------------+----------------------------------------------------------------
m45_y_45     |
          x1 |   1.679889   .4359289     3.85   0.000     .8254838    2.534294
          x2 |  -1.051402   .4339843    -2.42   0.015    -1.901996   -.2008088
          x3 |  -.1154448   .4385046    -0.26   0.792     -.974898    .7440085
          x4 |   .0623465   .1817055     0.34   0.732    -.2937897    .4184826
       _cons |  -.4960081   2.567482    -0.19   0.847     -5.52818    4.536164
-------------+----------------------------------------------------------------
m55_y_55     |
          x1 |   1.213482   .3980963     3.05   0.002     .4332271    1.993736
          x2 |  -.8226954   .3994092    -2.06   0.039    -1.605523   -.0398677
          x3 |    .672316   .4147506     1.62   0.105    -.1405801    1.485212
          x4 |   .2113165   .1907187     1.11   0.268    -.1624853    .5851183
       _cons |  -3.847181   2.713683    -1.42   0.156    -9.165902    1.471539
------------------------------------------------------------------------------

. test [m15_y_15]x1=[m25_y_25]x1=[m35_y_35]x1=[m45_y_45]x1=[m55_y_55]x1

 ( 1)  [m15_y_15]x1 - [m25_y_25]x1 = 0
 ( 2)  [m15_y_15]x1 - [m35_y_35]x1 = 0
 ( 3)  [m15_y_15]x1 - [m45_y_45]x1 = 0
 ( 4)  [m15_y_15]x1 - [m55_y_55]x1 = 0

           chi2(  4) =    6.95
         Prob > chi2 =    0.1384

. test [m15_y_15]x2=[m25_y_25]x2=[m35_y_35]x2=[m45_y_45]x2=[m55_y_55]x2

 ( 1)  [m15_y_15]x2 - [m25_y_25]x2 = 0
 ( 2)  [m15_y_15]x2 - [m35_y_35]x2 = 0
 ( 3)  [m15_y_15]x2 - [m45_y_45]x2 = 0
 ( 4)  [m15_y_15]x2 - [m55_y_55]x2 = 0

           chi2(  4) =    3.24
         Prob > chi2 =    0.5186

. test [m15_y_15]x3=[m25_y_25]x3=[m35_y_35]x3=[m45_y_45]x3=[m55_y_55]x3

 ( 1)  [m15_y_15]x3 - [m25_y_25]x3 = 0
 ( 2)  [m15_y_15]x3 - [m35_y_35]x3 = 0
 ( 3)  [m15_y_15]x3 - [m45_y_45]x3 = 0
 ( 4)  [m15_y_15]x3 - [m55_y_55]x3 = 0

           chi2(  4) =    8.55
         Prob > chi2 =    0.0734

. test [m15_y_15]x4=[m25_y_25]x4=[m35_y_35]x4=[m45_y_45]x4=[m55_y_55]x4

 ( 1)  [m15_y_15]x4 - [m25_y_25]x4 = 0
 ( 2)  [m15_y_15]x4 - [m35_y_35]x4 = 0
 ( 3)  [m15_y_15]x4 - [m45_y_45]x4 = 0
 ( 4)  [m15_y_15]x4 - [m55_y_55]x4 = 0

           chi2(  4) =    7.47
         Prob > chi2 =    0.1130
```

According to all the tests, ordered logit model is appropriated.

```
. gologit2 y x1 x2 x3 x4, pl sto(ologit) link(l)

Generalized Ordered Logit Estimates               Number of obs   =        152
                                                  LR chi2(4)      =      24.81
                                                  Prob > chi2     =     0.0001
Log likelihood = -216.23748                       Pseudo R2       =     0.0543

 ( 1)  [0]x1 - [1]x1 = 0
 ( 2)  [0]x2 - [1]x2 = 0
 ( 3)  [0]x3 - [1]x3 = 0
 ( 4)  [0]x4 - [1]x4 = 0
 ( 5)  [1]x1 - [2]x1 = 0
 ( 6)  [1]x2 - [2]x2 = 0
 ( 7)  [1]x3 - [2]x3 = 0
 ( 8)  [1]x4 - [2]x4 = 0
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 ( 9)  [2]x1 - [3]x1 = 0
 (10)  [2]x2 - [3]x2 = 0
 (11)  [2]x3 - [3]x3 = 0
 (12)  [2]x4 - [3]x4 = 0
 (13)  [3]x1 - [4]x1 = 0
 (14)  [3]x2 - [4]x2 = 0
 (15)  [3]x3 - [4]x3 = 0
 (16)  [3]x4 - [4]x4 = 0
------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |
          x1 |    1.26067   .3475146     3.63   0.000     .5795538    1.941786
          x2 |  -.8530235   .3508642    -2.43   0.015    -1.540705   -.1653424
          x3 |   .2068371   .3398536     0.61   0.543    -.4592638     .872938
          x4 |   .1261029   .1511501     0.83   0.404    -.1701459    .4223516
       _cons |   .8807684   2.139512     0.41   0.681    -3.312597    5.074134
-------------+----------------------------------------------------------------
1            |
          x1 |    1.26067   .3475146     3.63   0.000     .5795538    1.941786
          x2 |  -.8530235   .3508642    -2.43   0.015    -1.540705   -.1653424
          x3 |   .2068371   .3398536     0.61   0.543    -.4592638     .872938
          x4 |   .1261029   .1511501     0.83   0.404    -.1701459    .4223516
       _cons |    .032806   2.126238     0.02   0.988    -4.134543    4.200155
-------------+----------------------------------------------------------------
2            |
          x1 |    1.26067   .3475146     3.63   0.000     .5795538    1.941786
          x2 |  -.8530235   .3508642    -2.43   0.015    -1.540705   -.1653424
          x3 |   .2068371   .3398536     0.61   0.543    -.4592638     .872938
          x4 |   .1261029   .1511501     0.83   0.404    -.1701459    .4223516
       _cons |  -.6557013   2.118368    -0.31   0.757    -4.807626    3.496223
-------------+----------------------------------------------------------------
3            |
          x1 |    1.26067   .3475146     3.63   0.000     .5795538    1.941786
          x2 |  -.8530235   .3508642    -2.43   0.015    -1.540705   -.1653424
          x3 |   .2068371   .3398536     0.61   0.543    -.4592638     .872938
          x4 |   .1261029   .1511501     0.83   0.404    -.1701459    .4223516
       _cons |  -1.489641   2.117389    -0.70   0.482    -5.639647    2.660365
-------------+----------------------------------------------------------------
4            |
          x1 |    1.26067   .3475146     3.63   0.000     .5795538    1.941786
          x2 |  -.8530235   .3508642    -2.43   0.015    -1.540705   -.1653424
          x3 |   .2068371   .3398536     0.61   0.543    -.4592638     .872938
          x4 |   .1261029   .1511501     0.83   0.404    -.1701459    .4223516
       _cons |   -2.28397   2.124224    -1.08   0.282    -6.447372    1.879432
------------------------------------------------------------------------------

. gologit2 y x1 x2 x3 x4, npl sto(gologit) link(l)

Generalized Ordered Logit Estimates               Number of obs   =        152
                                                  LR chi2(20)     =      62.94
                                                  Prob > chi2     =     0.0000
Log likelihood = -197.17364                       Pseudo R2       =     0.1376

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |
          x1 |   .8894721   .8518267     1.04   0.296    -.7800776    2.559022
          x2 |  -1.776235   1.146953    -1.55   0.121    -4.024221    .4717503
          x3 |   .1843202   .9665914     0.19   0.849    -1.710164    2.078805
          x4 |   1.379697   .6615566     2.09   0.037       .08307    2.676324
       _cons |  -16.39183   9.550861    -1.72   0.086    -35.11118    2.327512
-------------+----------------------------------------------------------------
1            |
          x1 |   .6730729   .5597329     1.20   0.229    -.4239835    1.770129
          x2 |   .0265208   .6553099     0.04   0.968    -1.257863    1.310905
          x3 |  -.8956345   .6073762    -1.47   0.140     -2.08607     .294801
          x4 |   -.594607   .3011119    -1.97   0.048    -1.184775   -.0044386
       _cons |   10.80396   4.390112     2.46   0.014     2.199497    19.40842
-------------+----------------------------------------------------------------
2            |
          x1 |   .5781009   .4873534     1.19   0.236    -.3770942    1.533296
          x2 |   .0853443   .5334526     0.16   0.873    -.9602035    1.130892
          x3 |  -.1559428   .4486182    -0.35   0.728    -1.035218    .7233327
          x4 |  -.3337043   .2252469    -1.48   0.138    -.7751801    .1077715
       _cons |   5.748211   3.228175     1.78   0.075    -.5788958    12.07532
-------------+----------------------------------------------------------------
3            |
          x1 |    1.83456   .4332694     4.23   0.000     .9853678    2.683752
          x2 |  -1.079388    .434023    -2.49   0.013    -1.930057   -.2287181
          x3 |  -.1056892   .4021623    -0.26   0.793    -.8939128    .6825344
          x4 |  -.0528439   .2018831    -0.26   0.794    -.4485275    .3428396
       _cons |   1.086122    2.83546     0.38   0.702    -4.471278    6.643521
-------------+----------------------------------------------------------------
4            |
          x1 |   1.227296   .4227161     2.90   0.004     .3987872    2.055804
```

```
          x2 |  -.9826126   .4014263    -2.45   0.014    -1.769394   -.1958316
          x3 |   .6629394    .410843     1.61   0.107    -.1422981    1.468177
          x4 |   .2049157    .193693     1.06   0.290    -.1747155     .584547
       _cons |   -3.64077   2.708043    -1.34   0.179    -8.948437    1.666896
------------------------------------------------------------------------------

WARNING! 86 in-sample cases have an outcome with a predicted probability that is
less than 0. See the gologit2 help section on Warning Messages for more information.

. lrtest ologit gologit, stats

Likelihood-ratio test                                 LR chi2(16) =     38.13
(Assumption: ologit nested in gologit)                Prob > chi2 =    0.0015

Akaike's information criterion and Bayesian information criterion

-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
      ologit |    152   -228.6436   -216.2375      9      450.475    477.6899
     gologit |    152   -228.6436   -197.1736     25     444.3473    519.9443
-----------------------------------------------------------------------------
               Note:  N=Obs used in calculating BIC; see [R] BIC note
```

4 Compute marginal effect at mean and median of both model.

MLogit y

```
. est restore my
(results my1 are active now)

. mfx, predict(outcome(0))

Marginal effects after mlogit
      y  = Pr(y1==0) (predict, outcome(0))
         =  .04444813
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|  -.0555962      .04366   -1.27   0.203  -.141164  .029971   .605263
      x2*|   .0718253      .03283    2.19   0.029   .007483  .136168   .664474
      x3*|   .0123912      .02934    0.42   0.673  -.045115  .069898   .690789
      x4 |  -.0173643      .01412   -1.23   0.219  -.045038  .010309   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(1))

Marginal effects after mlogit
      y  = Pr(y1==1) (predict, outcome(1))
         =  .04923437
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   -.069836      .04594   -1.52   0.128  -.159875  .020203   .605263
      x2*|  -.0012996      .03458   -0.04   0.970  -.069075  .066476   .664474
      x3*|    .060368      .03025    2.00   0.046   .001084  .119652   .690789
      x4 |    .045129      .01732    2.61   0.009   .011175  .079083   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(2))

Marginal effects after mlogit
      y  = Pr(y1==2) (predict, outcome(2))
         =    .100003
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|  -.0167033      .05375   -0.31   0.756  -.122057  .088651   .605263
      x2*|    .032593      .05181    0.63   0.529  -.068945   .13413   .664474
      x3*|  -.0817691      .06699   -1.22   0.222  -.213075  .049536   .690789
      x4 |  -.0186399      .02375   -0.78   0.433  -.065196  .027916   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(3))

Marginal effects after mlogit
      y  = Pr(y1==3) (predict, outcome(3))
         =  .12812718
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
```

```
---------+--------------------------------------------------------------------
     x1*|  -.2362191      .07561   -3.12   0.002  -.384418 -.088021   .605263
     x2*|   .1123575      .05146    2.18   0.029   .011506  .213209   .664474
     x3*|    .016927      .05587    0.30   0.762  -.092584  .126438   .690789
     x4 |  -.0221914      .02513   -0.88   0.377  -.071442  .027059   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(4))

Marginal effects after mlogit
      y  = Pr(y1==4) (predict, outcome(4))
         =  .17789762
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     x1*|   .0821963      .06403    1.28   0.199  -.043293  .207686   .605263
     x2*|  -.0200933      .07209   -0.28   0.780  -.161396   .12121   .664474
     x3*|   -.188838      .08661   -2.18   0.029  -.358587 -.019089   .690789
     x4 |  -.0369131        .031   -1.19   0.234  -.097679  .023853   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(5))

Marginal effects after mlogit
      y  = Pr(y1==5) (predict, outcome(5))
         =  .50028971
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     x1*|   .2961583      .09037    3.28   0.001   .119039  .473278   .605263
     x2*|  -.1953829      .09455   -2.07   0.039  -.380699 -.010067   .664474
     x3*|    .180921      .09818    1.84   0.065  -.011515  .373357   .690789
     x4 |   .0499797      .04513    1.11   0.268  -.038476  .138436   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(0))

Marginal effects after mlogit
      y  = Pr(y1==0) (predict, outcome(0))
         =  .05043387
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     x1*|   -.078538      .07484   -1.05   0.294  -.225213  .068137         1
     x2*|   .0445449      .02783    1.60   0.109  -.009995  .099085         1
     x3*|   .0138733      .03127    0.44   0.657  -.047406  .075153         1
     x4 |  -.0211929      .01936   -1.09   0.274  -.059143  .016757   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(1))

Marginal effects after mlogit
      y  = Pr(y1==1) (predict, outcome(1))
         =  .05129069
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     x1*|  -.0968939      .08108   -1.20   0.232    -.2558  .062012         1
     x2*|   .0063067       .0345    0.18   0.855  -.061303  .073916         1
     x3*|   .0406744      .02325    1.75   0.080  -.004904  .086253         1
     x4 |   .0454983      .02388    1.91   0.057    -.0013  .092297   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(2))

Marginal effects after mlogit
      y  = Pr(y1==2) (predict, outcome(2))
         =   .0727229
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     x1*|   .0022242      .04242    0.05   0.958  -.080913  .085361         1
     x2*|   .0293384      .03423    0.86   0.391  -.037749  .096426         1
     x3*|  -.0755991      .06901   -1.10   0.273  -.210864  .059666         1
     x4 |  -.0157039      .01906   -0.82   0.410  -.053056  .021648   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(3))

Marginal effects after mlogit
      y  = Pr(y1==3) (predict, outcome(3))
```

```
         =  .08917325
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|  -.2523966      .10206   -2.47   0.013  -.452435 -.052358         1
      x2*|   .0621585       .0323    1.92   0.054  -.001157  .125474         1
      x3*|   .0128691      .04031    0.32   0.750  -.066141  .091879         1
      x4 |  -.0180795      .01977   -0.91   0.361  -.056835  .020676   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(4))

Marginal effects after mlogit
      y  = Pr(y1==4) (predict, outcome(4))
         =  .13770069
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   .0719343      .04297    1.67   0.094  -.012289  .156158         1
      x2*|    .005827      .05875    0.10   0.921  -.109323  .120977         1
      x3*|  -.1968959      .09662   -2.04   0.042  -.386277 -.007515         1
      x4 |  -.0326412      .02707   -1.21   0.228  -.085705  .020422   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(5))

Marginal effects after mlogit
      y  = Pr(y1==5) (predict, outcome(5))
         =  .59867861
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|     .35367      .08715    4.06   0.000   .182852  .524488         1
      x2*|  -.1481755       .0831   -1.78   0.075  -.311047  .014696         1
      x3*|   .2050782      .10182    2.01   0.044   .005511  .404645         1
      x4 |   .0421192      .04542    0.93   0.354  -.046902   .13114   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

Ordered Logit *y*

```
. est restore oy
(results my1 are active now)

. mfx, predict(outcome(0))

Marginal effects after ologit
      y  = Pr(y1==0) (predict, outcome(0))
         =  .04630137
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|  -.0656373      .02731   -2.40   0.016  -.119168 -.012107   .605263
      x2*|   .0339077      .01594    2.13   0.033   .002667  .065149   .664474
      x3*|   -.009478      .01637   -0.58   0.563  -.041565  .022609   .690789
      x4 |  -.0055684      .00686   -0.81   0.417  -.019019  .007882   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(1))

Marginal effects after ologit
      y  = Pr(y1==1) (predict, outcome(1))
         =  .05551405
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|  -.0654647      .02615   -2.50   0.012  -.116721 -.014209   .605263
      x2*|   .0367976      .01719    2.14   0.032   .003098  .070498   .664474
      x3*|  -.0100532      .01711   -0.59   0.557   -.04358  .023473   .690789
      x4 |  -.0059636      .00733   -0.81   0.416  -.020335  .008408   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(2))

Marginal effects after ologit
      y  = Pr(y1==2) (predict, outcome(2))
         =  .08230048
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   -.074399      .02658   -2.80   0.005   -.12649 -.022308   .605263
      x2*|   .0468304      .02084    2.25   0.025   .005978  .087683   .664474
```

```
      x3*|  -.0123204      .02063   -0.60   0.550  -.052755  .028114   .690789
      x4 |  -.0074108      .00901   -0.82   0.411  -.025061   .01024   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(3))

Marginal effects after ologit
      y  = Pr(y1==3) (predict, outcome(3))
         =  .15780009
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|    -.081489      .02712   -3.00   0.003  -.134653 -.028325   .605263
      x2*|    .0636957       .0289    2.20   0.027   .007062   .12033   .664474
      x3*|   -.0152256      .02481   -0.61   0.539  -.063843  .033391   .690789
      x4 |   -.0094315      .01151   -0.82   0.413  -.031991  .013128   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(4))

Marginal effects after ologit
      y  = Pr(y1==4) (predict, outcome(4))
         =  .19291787
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   -.0130666      .01689   -0.77   0.439  -.046179  .020046   .605263
      x2*|    .0288494      .01952    1.48   0.140  -.009417  .067116   .664474
      x3*|   -.0041753      .00664   -0.63   0.529   -.01719   .00884   .690789
      x4 |   -.0029984      .00416   -0.72   0.471  -.011148  .005151   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, predict(outcome(5))

Marginal effects after ologit
      y  = Pr(y1==5) (predict, outcome(5))
         =  .46516613
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|    .3000567      .07652    3.92   0.000   .150075  .450038   .605263
      x2*|   -.2100808      .08384   -2.51   0.012  -.374401 -.045761   .664474
      x3*|    .0512526      .08382    0.61   0.541   -.11304  .215545   .690789
      x4 |    .0313727      .03762    0.83   0.404  -.042356  .105101   14.3161
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(0))

Marginal effects after ologit
      y  = Pr(y1==0) (predict, outcome(0))
         =  .03472896
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   -.0778999      .03595   -2.17   0.030  -.148356 -.007444         1
      x2*|    .0196292      .00998    1.97   0.049   .000078   .03918         1
      x3*|    -.007642      .01346   -0.57   0.570  -.034017  .018733         1
      x4 |   -.0042273      .00534   -0.79   0.429  -.014698  .006243   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(1))

Marginal effects after ologit
      y  = Pr(y1==1) (predict, outcome(1))
         =  .04276651
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|     -.07321      .03094   -2.37   0.018  -.133848 -.012572         1
      x2*|    .0233066      .01151    2.02   0.043    .00074  .045874         1
      x3*|   -.0084977      .01471   -0.58   0.563   -.03732  .020324         1
      x4 |   -.0047878        .006   -0.80   0.425  -.016548  .006972   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(2))

Marginal effects after ologit
      y  = Pr(y1==2) (predict, outcome(2))
         =  .06577775
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
```

```
---------+--------------------------------------------------------------------
      x1*|  -.0766714      .02748   -2.79   0.005  -.130529 -.022814         1
      x2*|   .0338157      .01543    2.19   0.028   .003571  .064061         1
      x3*|  -.0111662      .01895   -0.59   0.556  -.048302  .025969         1
      x4 |  -.0064635      .00794   -0.81   0.415  -.022018  .009091   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(3))

Marginal effects after ologit
      y  = Pr(y1==3) (predict, outcome(3))
         =  .13472231
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|  -.0701913      .02547   -2.76   0.006  -.120107 -.020275         1
      x2*|   .0602974      .02582    2.33   0.020   .009683  .110912         1
      x3*|  -.0160454      .02633   -0.61   0.542  -.067643  .035552         1
      x4 |   -.009832      .01194   -0.82   0.410  -.033229  .013565   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(4))

Marginal effects after ologit
      y  = Pr(y1==4) (predict, outcome(4))
         =  .18206544
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   .0076661      .02615    0.29   0.769   -.04358  .058912         1
      x2*|   .0566425       .0273    2.07   0.038   .003135   .11015         1
      x3*|  -.0082706      .01297   -0.64   0.524   -.03369  .017149         1
      x4 |   -.006014      .00759   -0.79   0.428  -.020899  .008871   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx, at(median) predict(outcome(5))

Marginal effects after ologit
      y  = Pr(y1==5) (predict, outcome(5))
         =  .53993903
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1*|   .2903064      .07144    4.06   0.000   .150293   .43032         1
      x2*|  -.1936914      .07514   -2.58   0.010  -.340954 -.046429         1
      x3*|   .0516219      .08479    0.61   0.543  -.114554  .217798         1
      x4 |   .0313246      .03758    0.83   0.405  -.042332  .104981   14.5087
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```