

1 Estimate the model using multinomial logit of yi. Perform IIA test. Interpret your estimated result (overall test, individual test, pseudo R², counted R²).

mlogit y x1 x2 x3 x4, 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						
	x1	-1.832363	.8632903	-2.12	0.034	-3.524381 - .1403452
	x2	2.368735	1.168139	2.03	0.043	.079224 4.658246
	x3	-.0976971	.8455682	-0.12	0.908	-1.75498 1.559586
	x4	-.4905651	.3468626	-1.41	0.157	-1.170403 .189273
	_cons	4.204706	4.763082	0.88	0.377	-5.130762 13.54017
1						
	x1	-1.954381	.814615	-2.40	0.016	-3.550997 -.3577647
	x2	.3523473	.782471	0.45	0.652	-1.181268 1.885962
	x3	1.155726	1.030763	1.12	0.262	-.864533 3.175985
	x4	.8167134	.4673336	1.75	0.081	-.0992436 1.732671
	_cons	-13.86033	7.056818	-1.96	0.050	-27.69144 -.0292169
2						
	x1	-.8623688	.6749745	-1.28	0.201	-2.185294 .4605568
	x2	.7376981	.6909685	1.07	0.286	-.6165753 2.091972
	x3	-1.132118	.6624929	-1.71	0.087	-2.43058 .1663445
	x4	-.2862948	.2878698	-0.99	0.320	-.8505092 .2779195
	_cons	3.302474	4.043716	0.82	0.414	-4.623064 11.22801
3						
	x1	-2.236402	.6199683	-3.61	0.000	-3.451518 -1.021287
	x2	1.415342	.6376614	2.22	0.026	.1655491 2.665136

	x3		-.2635344	.6026228	-0.44	0.662	-1.444653	.9175846
	x4		-.2730998	.2507716	-1.09	0.276	-.7646032	.2184035
	_cons		3.142763	3.534705	0.89	0.374	-3.785131	10.07066
-----+-----								
4								
	x1		-.1544581	.5644404	-0.27	0.784	-1.260741	.9518248
	x2		.2643829	.5265539	0.50	0.616	-.7676439	1.29641
	x3		-1.307232	.5372575	-2.43	0.015	-2.360237	-.2542264
	x4		-.3073979	.2338932	-1.31	0.189	-.7658201	.1510242
	_cons		4.187597	3.285728	1.27	0.202	-2.252312	10.62751
-----+-----								
5			(base outcome)					

. est store mlogit

. fitstat

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

- Overall test > all independent variables in the model can be used to explain probability of having different levels of seriousness of the price-war problem. (reject H0)
- Individual test > almost independent variables are insignificant.
- Pseudo R-square is quite low. (Pseudo R2 = 0.1109) as well as counted R square Count R2 = 0.500), the model should be improved.

```
. mlogtest, iia
```

Problem determining number of categories.

**** Hausman tests of IIA assumption

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

You used the old syntax of hausman. Click here to learn about the new syntax.

(storing estimation results as HAUSMAN)

Omitted	chi2	df	P>chi2	evidence
0	1.121	20	1.000	for Ho
1	-1.168	20	1.000	for Ho
2	0.603	19	1.000	for Ho
3	1.946	19	1.000	for Ho
4	1.739	19	1.000	for Ho
5	38.423	20	0.008	against Ho

**** Small-Hsiao tests of IIA assumption

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

equation 5 not found

r(303);

```
. mlogit y x1 x2 x3 x4 if y!=5, 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      |
      x1 | -1.478476  .9219773  -1.60  0.109  -3.285519  .3285659
      x2 |  2.278957  1.262343   1.81  0.071  -1.1951893  4.753103
      x3 |   1.24603  .9042926   1.38  0.168  -1.5263504  3.018411
      x4 |  -.2456624  .3840924  -0.64  0.522  -1.9984696  .5071447
      _cons | .6496392  5.194425   0.13  0.900  -9.531246  10.83052
-----+-----

```

```

1      |
      x1 | -1.627068  .9097198  -1.79  0.074  -3.410086  .1559497
      x2 |  -.069953  .9655357  -0.07  0.942  -1.962368  1.822462
      x3 |   2.46098  1.083477   2.27  0.023  .3374045  4.584555
      x4 |   1.195286  .5375378   2.22  0.026  .141731  2.248841
      _cons | -19.05759  7.947682  -2.40  0.016  -34.63476  -3.480423
-----+-----

```

```

2      |
      x1 | -.6682758  .7251691  -0.92  0.357  -2.089581  .7530297
      x2 |   .474385  .8025042   0.59  0.554  -1.098494  2.047264
      x3 |   .1898543  .7435874   0.26  0.798  -1.26755  1.647259
      x4 |   .008459  .3195421   0.03  0.979  -.617832  .6347499
      _cons | -.7364481  4.457569  -0.17  0.869  -9.473122  8.000226
-----+-----

```

```

3      |
      x1 | -1.926976  .7013588  -2.75  0.006  -3.301614  -.5523383
      x2 |   1.211761  .7669472   1.58  0.114  -.2914274  2.71495
      x3 |   1.015451  .6931046   1.47  0.143  -.3430088  2.373911
      x4 |  -.0014303  .2925217  -0.00  0.996  -.5747623  .5719017
      _cons | -.6350097  4.062346  -0.16  0.876  -8.597062  7.327042
-----+-----

```

```

4      | (base outcome)
-----+-----

```

```
. est store m2
```

```
. hausman m2 mlogit, alleqs constant
```

---- Coefficients ----					
	(b)	(B)	(b-B)	sqrt (diag (V_b-V_B))	
	m2	mlogit	Difference	S.E.	
-----+-----					
0					
	x1	-1.478476	-1.832363	.3538867	.323685
	x2	2.278957	2.368735	-.0897779	.4784974
	x3	1.24603	-.0976971	1.343728	.3205611
	x4	-.2456624	-.4905651	.2449027	.1649645
	_cons	.6496392	4.204706	-3.555067	2.072463
-----+-----					
1					
	x1	-1.627068	-1.954381	.3273123	.40496
	x2	-.069953	.3523473	-.4223003	.5656839
	x3	2.46098	1.155726	1.305253	.3338389
	x4	1.195286	.8167134	.3785723	.2656054
	_cons	-19.05759	-13.86033	-5.197267	3.656087
-----+-----					
2					
	x1	-.6682758	-.8623688	.1940931	.2651033
	x2	.474385	.7376981	-.2633131	.4081365
	x3	.1898543	-1.132118	1.321972	.3376765
	x4	.008459	-.2862948	.2947538	.1387016
	_cons	-.7364481	3.302474	-4.038922	1.875707
-----+-----					
3					
	x1	-1.926976	-2.236402	.3094262	.3279383
	x2	1.211761	1.415342	-.203581	.4261408
	x3	1.015451	-.2635344	1.278986	.3424029
	x4	-.0014303	-.2730998	.2716696	.1506073
	_cons	-.6350097	3.142763	-3.777773	2.002128
-----+-----					

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(20) = (b-B)' [(V_b-V_B)^(-1)] (b-B)
          =          38.42
Prob>chi2 =          0.0079

(V_b-V_B is not positive definite)

```

Since the p-value of Hausman test is less than 0.05, H0 is rejected. This implies that IIA assumption is not held, multinomial logit model has problem.

2 Estimate the model using order logit of yi. Interpret your estimated result (overall test, individual test, pseudo R², counted R²).

```
. 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 |   -0.8530234 .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 |   -0.8807685  2.139511             -5.074134   3.312597
      /cut2 |   -0.0328063  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 ologit
```

```
. fitstat
```

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

- Overall test > all independent variables in the model can be used to explain probability of having different levels of seriousness of the price-war problem. (reject H0)
- Individual test > x3 x4 are insignificant while x1 x2 are significant.
- Pseudo R-square is quite low. (Pseudo R2 = 0.0543)
- Count R2 = 0.480

3 From (a) and (b), compare the two models. Perform order logit test. Which model is more appropriated in this case? Why?

mLogit > BIC': 49.757

oLogit > BIC': -4.717

According to BIC', it can be interpreted that oLogit 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% Con
> f. 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
too few ')' or ']'
r(132);

```

```

. 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 test, Ho cannot be rejected. Therefore, order logit model is more appropriated.

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

```
. margins, dydx(*) predict(outcome(0))
```

Average marginal effects

Number of obs =

152

