Solutions for Session 9

26/12/2023

```
. do solution.do

. global basedir http://personalpages.manchester.ac.uk/staff/mark.lunt

. global datadir $basedir/stats/9_counts/data

. use "$datadir/ships.dta", clear

. label list
type:
           1 A
           2 B
           3 C
           4 D
           5 E
built:
           1 1960-1964
           2 1965-1969
           3 1970-1974
           4 1975-1979
sailed:
           1 1960-1974
           2 1975-1979

. fvset base 5 type

. fvset base 4 built
```

```
. poisson damage i.type, exposure(months) irr

Iteration 0:   log likelihood = -95.935753
Iteration 1:   log likelihood = -94.378778
Iteration 2:   log likelihood = -94.377885
Iteration 3:   log likelihood = -94.377885

Poisson regression                                Number of obs   =         34
                                                  LR chi2(4)      =      55.44
                                                  Prob > chi2     =     0.0000
Log likelihood = -94.377885                       Pseudo R2       =     0.2270

------------------------------------------------------------------------------
      damage |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        type |
          A  |   .7097099   .1665318    -1.46   0.144     .4480726    1.124122
          B  |   .2932898   .0550281    -6.54   0.000     .2030447    .4236453
          C  |   .3106935   .1051703    -3.45   0.001     .1600292    .6032055
          D  |   .6133762    .184088    -1.63   0.103     .3406137    1.104566
             |
       _cons |   .0062366   .0011025   -28.72   0.000     .0044104     .008819
  ln(months) |          1  (exposure)
------------------------------------------------------------------------------
```

1.2 Yes: the LR chi2 is 55.4 on 4 d.f., p = 0.0000

```
. poisson damage i.built, exposure(months) irr

Iteration 0:   log likelihood = -170.08778
Iteration 1:   log likelihood = -86.166648
Iteration 2:   log likelihood = -85.546883
Iteration 3:   log likelihood =  -85.54581
Iteration 4:   log likelihood =  -85.54581

Poisson regression                                Number of obs   =         34
                                                  LR chi2(3)      =      73.10
                                                  Prob > chi2     =     0.0000
Log likelihood =  -85.54581                       Pseudo R2       =     0.2994

------------------------------------------------------------------------------
      damage |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       built |
  1960-1964  |   .3798695   .0786405    -4.68   0.000     .2531739    .5699673
  1965-1969  |   .8552308   .1624719    -0.82   0.410      .589355    1.241051
  1970-1974  |   1.263278   .2431475     1.21   0.225     .8662943    1.842183
             |
       _cons |   .0028623   .0004838   -34.65   0.000     .0020551    .0039865
  ln(months) |          1  (exposure)
------------------------------------------------------------------------------
```

1.3 Yes: the LR chi2 is 73.10 on 3 d.f., p = 0.0000

```
. poisson damage i.sailed, exposure(months) irr
Iteration 0:   log likelihood = -105.73595
Iteration 1:   log likelihood = -105.31593
Iteration 2:   log likelihood = -105.31569
Iteration 3:   log likelihood = -105.31569
Poisson regression                              Number of obs   =         34
                                                LR chi2(1)      =      33.56
                                                Prob > chi2     =     0.0000
Log likelihood = -105.31569                     Pseudo R2       =     0.1374
```

damage	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
sailed						
1975-1979	1.859067	.2019681	5.71	0.000	1.502522	2.300219
_cons	.0015634	.0001326	-76.17	0.000	.0013239	.0018461
ln(months)	1	(exposure)				

1.4 Yes: the LR chi2 is 33.56 on 1 d.f., p = 0.0000

```
. poisson damage i.type i.built i.sailed, exposure(months) irr
Iteration 0:   log likelihood = -120.33891
Iteration 1:   log likelihood = -68.554441
Iteration 2:   log likelihood = -68.280965
Iteration 3:   log likelihood = -68.280771
Iteration 4:   log likelihood = -68.280771
Poisson regression                              Number of obs   =         34
                                                LR chi2(8)      =     107.63
                                                Prob > chi2     =     0.0000
Log likelihood = -68.280771                     Pseudo R2       =     0.4408
```

damage	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
type						
A	.7221088	.1703306	-1.38	0.168	.4548013	1.146525
B	.4194027	.0832148	-4.38	0.000	.2842772	.6187574
C	.3631348	.1232671	-2.98	0.003	.1866918	.7063347
D	.669288	.2055492	-1.31	0.191	.3666023	1.221887
built						
1960-1964	.635447	.1481675	-1.94	0.052	.4023502	1.003586
1965-1969	1.275979	.2663647	1.17	0.243	.847525	1.921032
1970-1974	1.440514	.2873331	1.83	0.067	.9743881	2.129624
sailed						
1975-1979	1.468831	.1737218	3.25	0.001	1.164926	1.852019
_cons	.0035997	.0009804	-20.66	0.000	.0021108	.0061391
ln(months)	1	(exposure)				

```
. testparm i.type

 ( 1)  [damage]1.type = 0
 ( 2)  [damage]2.type = 0
 ( 3)  [damage]3.type = 0
 ( 4)  [damage]4.type = 0

           chi2(  4) =   26.07
         Prob > chi2 =    0.0000
```

1.5 Yes: chi2 = 26.07 on 4 d.f., p = 0.0000

```
. predict pred_n
(option n assumed; predicted number of events)
```

```
. list type built sailed damage pred_n
```

	type	built	sailed	damage	pred_n
1.	A	1960-1964	1960-1974	0	.2097761
2.	A	1960-1964	1975-1979	0	.1528497
3.	A	1965-1969	1960-1974	3	3.631873
4.	A	1965-1969	1975-1979	4	5.334609
5.	A	1970-1974	1960-1974	6	5.66164
6.	A	1970-1974	1975-1979	18	18.44148
7.	A	1975-1979	1975-1979	11	8.567768
8.	B	1960-1964	1960-1974	39	43.05792
9.	B	1960-1964	1975-1979	29	24.20331
10.	B	1965-1969	1960-1974	58	55.11221
11.	B	1965-1969	1975-1979	53	57.63788
12.	B	1970-1974	1960-1974	12	15.36278
13.	B	1970-1974	1975-1979	44	41.8436
14.	B	1975-1979	1975-1979	18	15.7823
15.	C	1960-1964	1960-1974	1	.9793352
16.	C	1960-1964	1975-1979	1	.6734859
17.	C	1965-1969	1960-1974	0	1.302665
18.	C	1965-1969	1975-1979	1	1.656153
19.	C	1970-1974	1960-1974	6	1.474407
20.	C	1970-1974	1975-1979	2	5.387863
21.	C	1975-1979	1975-1979	1	.5260908
22.	D	1960-1964	1960-1974	0	.3842699
23.	D	1960-1964	1975-1979	0	.2361151
24.	D	1965-1969	1960-1974	0	.885359
25.	D	1965-1969	1975-1979	0	.8669619
26.	D	1970-1974	1960-1974	2	1.211229
27.	D	1970-1974	1975-1979	11	6.157999
28.	D	1975-1979	1975-1979	4	7.258066
29.	E	1960-1964	1960-1974	0	.1029348
30.	E	1965-1969	1960-1974	7	3.624023
31.	E	1965-1969	1975-1979	7	2.94827
32.	E	1970-1974	1960-1974	5	5.999584
33.	E	1970-1974	1975-1979	12	16.45942
34.	E	1975-1979	1975-1979	1	2.865771

```
. gen diff = abs(damage - pred_n)

. sort diff
```

```
. list type built sailed damage pred_n diff
```

	type	built	sailed	damage	pred_n	diff
1.	C	1960-1964	1960-1974	1	.9793352	.0206648
2.	E	1960-1964	1960-1974	0	.1029348	.1029348
3.	A	1960-1964	1975-1979	0	.1528497	.1528497
4.	A	1960-1964	1960-1974	0	.2097761	.2097761
5.	D	1960-1964	1975-1979	0	.2361151	.2361151
6.	C	1960-1964	1975-1979	1	.6734859	.3265141
7.	A	1970-1974	1960-1974	6	5.66164	.3383603
8.	D	1960-1964	1960-1974	0	.3842699	.3842699
9.	A	1970-1974	1975-1979	18	18.44148	.4414845
10.	C	1975-1979	1975-1979	1	.5260908	.4739092
11.	A	1965-1969	1960-1974	3	3.631873	.6318731
12.	C	1965-1969	1975-1979	1	1.656153	.6561527
13.	D	1970-1974	1960-1974	2	1.211229	.788771
14.	D	1965-1969	1975-1979	0	.8669619	.8669619
15.	D	1965-1969	1960-1974	0	.885359	.885359
16.	E	1970-1974	1960-1974	5	5.999584	.9995842
17.	C	1965-1969	1960-1974	0	1.302665	1.302665
18.	A	1965-1969	1975-1979	4	5.334609	1.334609
19.	E	1975-1979	1975-1979	1	2.865771	1.865771
20.	B	1970-1974	1975-1979	44	41.8436	2.156399
21.	B	1975-1979	1975-1979	18	15.7823	2.217696
22.	A	1975-1979	1975-1979	11	8.567768	2.432232
23.	B	1965-1969	1960-1974	58	55.11221	2.887794
24.	D	1975-1979	1975-1979	4	7.258066	3.258066
25.	B	1970-1974	1960-1974	12	15.36278	3.362776
26.	E	1965-1969	1960-1974	7	3.624023	3.375977
27.	C	1970-1974	1975-1979	2	5.387863	3.387863
28.	E	1965-1969	1975-1979	7	2.94827	4.05173
29.	B	1960-1964	1960-1974	39	43.05792	4.057922
30.	E	1970-1974	1975-1979	12	16.45942	4.459417
31.	C	1970-1974	1960-1974	6	1.474407	4.525593
32.	B	1965-1969	1975-1979	53	57.63788	4.637882
33.	B	1960-1964	1975-1979	29	24.20331	4.79669
34.	D	1970-1974	1975-1979	11	6.157999	4.842001

1.6 Type D , built 1970-1974, operated 1975-1979: 11 events observed, 6.18 expected

```
. estat gof

         Deviance goodness-of-fit =  38.69497
         Prob > chi2(25)          =    0.0395

         Pearson goodness-of-fit  =  42.27525
         Prob > chi2(25)          =    0.0168
```

1.7 No, the test is significant, so the observed values are significantly different from the expected valu

```
. poisson damage i.type##i.built i.sailed, exposure(months) irr
Iteration 0:   log likelihood =   -238.642
Iteration 1:   log likelihood = -94.000802
Iteration 2:   log likelihood = -57.602995
Iteration 3:   log likelihood = -56.466838
Iteration 4:   log likelihood = -56.261433
Iteration 5:   log likelihood = -56.231311
Iteration 6:   log likelihood = -56.227601
Iteration 7:   log likelihood = -56.226886
Iteration 8:   log likelihood = -56.226731
Iteration 9:   log likelihood = -56.226694
Iteration 10:  log likelihood = -56.226685
Iteration 11:  log likelihood = -56.226684
Poisson regression                              Number of obs   =         34
                                                LR chi2(19)     =     131.74
                                                Prob > chi2     =     0.0000
Log likelihood = -56.226684                     Pseudo R2       =     0.5395

------------------------------------------------------------------------------
      damage |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        type |
          A  |   2.656963   2.775147     0.94   0.349     .3430218    20.58018
          B  |   1.370922   1.408507     0.31   0.759     .1830098    10.26954
          C  |   1.978102   2.797503     0.48   0.630     .1237226    31.62631
          D  |   1.057118   1.181905     0.05   0.960     .1181525    9.458111
             |
       built |
  1960-1964  |   2.94e-07    .002281    -0.00   0.998            0           .
  1965-1969  |   7.792271   8.081959     1.98   0.048     1.020512    59.49907
  1970-1974  |   3.125501   3.217682     1.11   0.268     .4155408    23.50854
             |
  type#built |
A#1960-1964  |    .156876   1486.908    -0.00   1.000            0           .
A#1965-1969  |   .0995945   .1137962    -2.02   0.044     .0106086    .9350052
A#1970-1974  |   .3575119   .3902353    -0.94   0.346     .0420899     3.03671
B#1960-1964  |    1916926   1.49e+10     0.00   0.999            0           .
B#1965-1969  |   .1413811   .1506935    -1.84   0.066     .0175034    1.141983
B#1970-1974  |     .39561     .42096    -0.87   0.383     .0491498    3.184288
C#1960-1964  |    1376759   1.07e+10     0.00   0.999            0           .
C#1965-1969  |    .029125   .0510446    -2.02   0.044     .0009385    .9038252
C#1970-1974  |   .2827134   .4177967    -0.85   0.393      .015611    5.119891
D#1960-1964  |   .2176931   2056.971    -0.00   1.000            0           .
D#1965-1969  |   5.64e-09   .0000309    -0.00   0.997            0           .
D#1970-1974  |   1.475427   1.736943     0.33   0.741     .1468394    14.82493
             |
      sailed |
  1975-1979  |    1.46968    .174355     3.25   0.001     1.164772    1.854406
       _cons |   .0012553   .0012642    -6.63   0.000     .0001744    .0090354
 ln(months)  |          1  (exposure)
------------------------------------------------------------------------------
```

```
. testparm i.type#i.built
 ( 1)  [damage]1.type#1.built = 0
 ( 2)  [damage]1.type#2.built = 0
 ( 3)  [damage]1.type#3.built = 0
 ( 4)  [damage]2.type#1.built = 0
 ( 5)  [damage]2.type#2.built = 0
 ( 6)  [damage]2.type#3.built = 0
 ( 7)  [damage]3.type#1.built = 0
 ( 8)  [damage]3.type#2.built = 0
 ( 9)  [damage]3.type#3.built = 0
 (10)  [damage]4.type#1.built = 0
 (11)  [damage]4.type#2.built = 0
 (12)  [damage]4.type#3.built = 0
           chi2( 12) =   16.65
         Prob > chi2 =    0.1631
```

1.8 No, this term is not significant

```
. estat gof
         Deviance goodness-of-fit =  14.58679
         Prob > chi2(14)          =    0.4070
         Pearson goodness-of-fit  =  17.36812
         Prob > chi2(14)          =    0.2371
```

1.9 The fit of the model is now adequate

```
. use $datadir/nbreg, clear

. poisson deaths i.cohort, exposure(exposure) irr
Iteration 0:   log likelihood = -2160.0542
Iteration 1:   log likelihood =  -2159.516
Iteration 2:   log likelihood = -2159.5158
Iteration 3:   log likelihood = -2159.5158
Poisson regression                                Number of obs   =         21
                                                  LR chi2(2)      =      49.16
                                                  Prob > chi2     =     0.0000
Log likelihood = -2159.5158                       Pseudo R2       =     0.0113
```

deaths	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
cohort						
2	.7393079	.0423859	-5.27	0.000	.6607305	.82723
3	1.077037	.0635156	1.26	0.208	.959474	1.209005
_cons	.0202523	.0008331	-94.80	0.000	.0186836	.0219527
ln(exposure)	1	(exposure)				

2.1 Yes, the rate is lower in cohort 2 than in cohort 1. Cohorts 3 and 1 are not significantly different

```
. estat gof

         Deviance goodness-of-fit =  4190.689
         Prob > chi2(18)          =    0.0000

         Pearson goodness-of-fit  =  15387.67
         Prob > chi2(18)          =    0.0000
```

2.2 The Poisson model was not appropriate

```
. nbreg deaths i.cohort, exposure(exposure) irr

Fitting Poisson model:

Iteration 0:   log likelihood = -2160.0542
Iteration 1:   log likelihood =  -2159.516
Iteration 2:   log likelihood = -2159.5158
Iteration 3:   log likelihood = -2159.5158

Fitting constant-only model:

Iteration 0:   log likelihood = -187.06699
Iteration 1:   log likelihood = -151.29069
Iteration 2:   log likelihood = -131.82867
Iteration 3:   log likelihood = -131.58459
Iteration 4:   log likelihood = -131.58186
Iteration 5:   log likelihood = -131.58186

Fitting full model:

Iteration 0:   log likelihood = -131.58186
Iteration 1:   log likelihood = -131.38447
Iteration 2:   log likelihood =  -131.3799
Iteration 3:   log likelihood =  -131.3799

Negative binomial regression                      Number of obs   =         21
                                                  LR chi2(2)      =       0.40
Dispersion     = mean                             Prob > chi2     =     0.8171
Log likelihood = -131.3799                        Pseudo R2       =     0.0015
```

deaths	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
cohort						
2	.7651995	.5537904	-0.37	0.712	.1852434	3.160869
3	.6329298	.4580292	-0.63	0.527	.1532395	2.614209
_cons	.1240922	.0635173	-4.08	0.000	.0455042	.3384052
ln(exposure)	1	(exposure)				
/lnalpha	.5939963	.2583615			.087617	1.100376
alpha	1.811212	.4679475			1.09157	3.005294

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 4056.27 Prob>=chibar2 = 0.000
```

2.3 No, there are no longer any significant differences between the cohorts
2.4 alpha = 1.81, with a 95\% confidence interval (1.09, 3.00)

```
. nbreg deaths i.cohort, exposure(exposure) irr dispersion(constant)

Fitting Poisson model:

Iteration 0:   log likelihood = -2160.0542
Iteration 1:   log likelihood =  -2159.516
Iteration 2:   log likelihood = -2159.5158
Iteration 3:   log likelihood = -2159.5158

Fitting constant-only model:

Iteration 0:   log likelihood = -844.20224
Iteration 1:   log likelihood =  -142.6386
Iteration 2:   log likelihood = -140.47973
Iteration 3:   log likelihood = -140.24986
Iteration 4:   log likelihood = -140.24929
Iteration 5:   log likelihood = -140.24929

Fitting full model:

Iteration 0:   log likelihood = -140.24929
Iteration 1:   log likelihood = -139.68449
Iteration 2:   log likelihood = -139.66915
Iteration 3:   log likelihood = -139.66914

Negative binomial regression                    Number of obs   =         21
                                                LR chi2(2)      =       1.16
Dispersion     = constant                       Prob > chi2     =     0.5598
Log likelihood = -139.66914                     Pseudo R2       =     0.0041

------------------------------------------------------------------------------
      deaths |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      cohort |
          2  |    .727568   .3181285    -0.73   0.467     .3088065    1.714197
          3  |    1.14667   .5068641     0.31   0.757      .482148     2.72707
             |
       _cons |   .0199577   .0072107   -10.83   0.000     .0098303    .0405182
ln(exposure) |          1  (exposure)
-------------+----------------------------------------------------------------
    /lndelta |   4.741895   .3590761                      4.038118    5.445671
-------------+----------------------------------------------------------------
       delta |   114.6512   41.16851                      56.71952    231.7527
------------------------------------------------------------------------------
Likelihood-ratio test of delta=0:  chibar2(01) = 4039.69 Prob>=chibar2 = 0.000
```

2.5 Yes: delta = 115, with a 95\% confidence interval of (57, 232)
2.6 Both negative binomial models suggest that there is no effect of cohort

```
. nbreg deaths i.age_gp, exposure(exposure) irr

Fitting Poisson model:

Iteration 0:   log likelihood = -100.90574
Iteration 1:   log likelihood = -100.49825
Iteration 2:   log likelihood = -100.49818
Iteration 3:   log likelihood = -100.49818

Fitting constant-only model:

Iteration 0:   log likelihood = -187.06699
Iteration 1:   log likelihood = -151.29069
Iteration 2:   log likelihood = -131.82867
Iteration 3:   log likelihood = -131.58459
Iteration 4:   log likelihood = -131.58186
Iteration 5:   log likelihood = -131.58186

Fitting full model:

Iteration 0:   log likelihood = -123.82035  (not concave)
Iteration 1:   log likelihood = -113.11495  (not concave)
Iteration 2:   log likelihood = -97.696131
Iteration 3:   log likelihood = -90.854654
Iteration 4:   log likelihood = -87.400074
Iteration 5:   log likelihood = -87.305951
Iteration 6:   log likelihood = -87.305423
Iteration 7:   log likelihood = -87.305423

Negative binomial regression                      Number of obs   =         21
                                                  LR chi2(6)      =      88.55
Dispersion     = mean                             Prob > chi2     =     0.0000
Log likelihood = -87.305423                       Pseudo R2       =     0.3365

------------------------------------------------------------------------------
      deaths |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      age_gp |
 1 - 3 months |    .137994   .0235195   -11.62   0.000     .0988059    .1927249
 3 - 6 months |   .1156055   .0192971   -12.93   0.000     .0833478    .1603477
6 - 12 months |   .0834847   .0135297   -15.32   0.000     .0607659    .1146976
  1 - 2 years |   .0496582   .0079758   -18.69   0.000     .0362473    .0680307
  2 - 5 years |    .016348    .002647   -25.41   0.000     .0119026    .0224535
 5 - 10 years |   .0045406   .0008438   -29.03   0.000     .0031545    .0065359
             |
       _cons |   .4921381   .0539926    -6.46   0.000     .3969186    .6102004
ln(exposure) |          1  (exposure)
-------------+----------------------------------------------------------------
    /lnalpha |  -3.491011    .448881                     -4.370802    -2.61122
-------------+----------------------------------------------------------------
       alpha |   .0304701   .0136774                      .0126411    .0734449
------------------------------------------------------------------------------
Likelihood-ratio test of alpha=0:  chibar2(01) =   26.39 Prob>=chibar2 = 0.000
```

2.7 Yes: LR chi2 = 88.55 on 6 d.f, p = 0.0000
2.8 No, alpha is significantly greater than 0

```
. nbreg deaths i.age_gp i.cohort, exposure(exposure) irr  ltol(0.000001)
Fitting Poisson model:
Iteration 0:   log likelihood = -67.793759
Iteration 1:   log likelihood = -67.262771
Iteration 2:   log likelihood = -67.262633
Iteration 3:   log likelihood = -67.262633
Fitting constant-only model:
Iteration 0:   log likelihood = -187.06699
Iteration 1:   log likelihood = -151.29069
Iteration 2:   log likelihood = -131.82867
Iteration 3:   log likelihood = -131.58459
Iteration 4:   log likelihood = -131.58186
Iteration 5:   log likelihood = -131.58186
Fitting full model:
Iteration 0:   log likelihood = -123.74065  (not concave)
Iteration 1:   log likelihood = -113.18062  (not concave)
Iteration 2:   log likelihood = -96.869841  (not concave)
Iteration 3:   log likelihood = -84.938628  (not concave)
Iteration 4:   log likelihood = -80.708453  (not concave)
Iteration 5:   log likelihood = -73.085268
Iteration 6:   log likelihood = -69.240226
Iteration 7:   log likelihood = -67.500711
Iteration 8:   log likelihood =  -67.31847
Iteration 9:   log likelihood = -67.275755
Iteration 10:  log likelihood = -67.265449
Iteration 11:  log likelihood = -67.263232
Iteration 12:  log likelihood = -67.262768
Iteration 13:  log likelihood = -67.262664
Iteration 14:  log likelihood = -67.262642
Negative binomial regression                      Number of obs   =         21
                                                  LR chi2(8)      =     128.64
Dispersion     = mean                             Prob > chi2     =     0.0000
Log likelihood = -67.262642                       Pseudo R2       =     0.4888

------------------------------------------------------------------------------
      deaths |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      age_gp |
 1 - 3 months    .1390834   .0127534   -21.51   0.000     .1162047    .1664667
 3 - 6 months    .1149395   .0097869   -25.41   0.000     .0972727     .135815
6 - 12 months    .0827704   .0062533   -32.98   0.000     .0713783    .0959807
  1 - 2 years    .0490928   .0035692   -41.46   0.000     .0425729    .0566113
  2 - 5 years    .0163198   .0012375   -54.27   0.000      .014066    .0189346
 5 - 10 years    .0043573   .0005001   -47.36   0.000     .0034796    .0054564
             |
      cohort |
          2  |   .7230909   .0414584    -5.65   0.000     .6462332    .8090895
          3  |   .6197831    .036769    -8.06   0.000     .5517492    .6962059
             |
       _cons |   .6386021    .034829    -8.22   0.000     .5738604    .7106477
ln(exposure) |          1  (exposure)
-------------+----------------------------------------------------------------
    /lnalpha |  -18.13518   327.9527                     -660.9106    624.6402
-------------+----------------------------------------------------------------
       alpha |   1.33e-08   4.36e-06                      9.3e-288    1.9e+271
------------------------------------------------------------------------------
Likelihood-ratio test of alpha=0:  chibar2(01) = 0.0e+00 Prob>=chibar2 = 0.500
```

```
. testparm i.age_gp
 ( 1)  [deaths]1.age_gp = 0
 ( 2)  [deaths]2.age_gp = 0
 ( 3)  [deaths]3.age_gp = 0
 ( 4)  [deaths]4.age_gp = 0
 ( 5)  [deaths]5.age_gp = 0
 ( 6)  [deaths]6.age_gp = 0
           chi2(  6) = 4726.39
         Prob > chi2 =    0.0000

. testparm i.cohort
 ( 1)  [deaths]2.cohort = 0
 ( 2)  [deaths]3.cohort = 0
           chi2(  2) =   68.60
         Prob > chi2 =    0.0000
```

2.9 Yes, both age and cohort are significant predictors in this model
2.10 No, alpha is no longer significantly greater than 0 (according to the likelihood ratio test)

```
. xi: poisson deaths i.age_mos i.cohort, exposure(exposure) irr
i.age_mos         _Iage_mos_1-7       (_Iage_mos_1 for age_mos==.5 omitted)
i.cohort          _Icohort_1-3        (naturally coded; _Icohort_1 omitted)
Iteration 0:   log likelihood = -67.793759
Iteration 1:   log likelihood = -67.262771
Iteration 2:   log likelihood = -67.262633
Iteration 3:   log likelihood = -67.262633
Poisson regression                                Number of obs   =         21
                                                  LR chi2(8)      =    4233.67
                                                  Prob > chi2     =     0.0000
Log likelihood = -67.262633                       Pseudo R2       =     0.9692
```

deaths	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_Iage_mos_2	.1390849	.0127536	-21.51	0.000	.1162058	.1664685
_Iage_mos_3	.1149404	.009787	-25.41	0.000	.0972733	.1358162
_Iage_mos_4	.0827705	.0062534	-32.98	0.000	.0713783	.0959809
_Iage_mos_5	.0490927	.0035692	-41.46	0.000	.0425727	.0566112
_Iage_mos_6	.0163198	.0012375	-54.27	0.000	.014066	.0189347
_Iage_mos_7	.0043574	.0005001	-47.36	0.000	.0034796	.0054565
_Icohort_2	.723064	.041457	-5.66	0.000	.6462089	.8090597
_Icohort_3	.6197651	.036768	-8.06	0.000	.551733	.6961859
_cons	.6386067	.0348292	-8.22	0.000	.5738646	.7106529
ln(exposure)	1	(exposure)				

```
. estat gof
         Deviance goodness-of-fit =  6.182492
         Prob > chi2(12)          =    0.9066
         Pearson goodness-of-fit  =  6.177684
         Prob > chi2(12)          =    0.9069
```

2.11 Yes, the parameter estimates and standard errors are identical
2.12 Yes, the goodness of fit test is no longer significant

```
. use $datadir/ships, clear

. poisson damage i.type i.built i.sailed, exposure(months) irr
Iteration 0:   log likelihood = -120.33891
Iteration 1:   log likelihood = -68.554441
Iteration 2:   log likelihood = -68.280965
Iteration 3:   log likelihood = -68.280771
Iteration 4:   log likelihood = -68.280771
Poisson regression                                Number of obs   =         34
                                                  LR chi2(8)      =     107.63
                                                  Prob > chi2     =     0.0000
Log likelihood = -68.280771                       Pseudo R2       =     0.4408
```

damage	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
type						
B	.5808026	.1031447	-3.06	0.002	.4100754	.8226088
C	.502881	.1654716	-2.09	0.037	.2638638	.9584087
D	.926852	.2693234	-0.26	0.794	.5244081	1.638141
E	1.384833	.3266535	1.38	0.168	.8722007	2.198762
built						
1965-1969	2.008002	.3004803	4.66	0.000	1.497577	2.692398
1970-1974	2.26693	.384865	4.82	0.000	1.625274	3.161912
1975-1979	1.573695	.3669393	1.94	0.052	.9964273	2.485397
sailed						
1975-1979	1.468831	.1737218	3.25	0.001	1.164926	1.852019
_cons	.0016518	.0003592	-29.46	0.000	.0010786	.0025295
ln(months)	1	(exposure)				

3.1 _Itype_4 and _Itype_5. _Ibuilt_4 is quite borderline

```
. predict pred_n
(option n assumed; predicted number of events)

. constraint define 1 4.type = 0
```

```
. xi: poisson damage i.type i.built i.sailed, exposure(months) irr const(1)
i.type           _Itype_1-5          (naturally coded; _Itype_1 omitted)
i.built          _Ibuilt_1-4         (naturally coded; _Ibuilt_1 omitted)
i.sailed         _Isailed_1-2        (naturally coded; _Isailed_1 omitted)
(note: constraint number 1 caused error r(111))
Iteration 0:   log likelihood = -120.33891
Iteration 1:   log likelihood = -68.554441
Iteration 2:   log likelihood = -68.280965
Iteration 3:   log likelihood = -68.280771
Iteration 4:   log likelihood = -68.280771
Poisson regression                                Number of obs   =         34
                                                  Wald chi2(8)    =     107.70
Log likelihood = -68.280771                       Prob > chi2     =     0.0000
```

damage	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_Itype_2	.5808026	.1031447	-3.06	0.002	.4100754	.8226088
_Itype_3	.502881	.1654716	-2.09	0.037	.2638638	.9584087
_Itype_4	.926852	.2693234	-0.26	0.794	.5244081	1.638141
_Itype_5	1.384833	.3266535	1.38	0.168	.8722007	2.198762
_Ibuilt_2	2.008002	.3004803	4.66	0.000	1.497577	2.692398
_Ibuilt_3	2.26693	.384865	4.82	0.000	1.625274	3.161912
_Ibuilt_4	1.573695	.3669393	1.94	0.052	.9964273	2.485397
_Isailed_2	1.468831	.1737218	3.25	0.001	1.164926	1.852019
_cons	.0016518	.0003592	-29.46	0.000	.0010786	.0025295
ln(months)	1	(exposure)				

3.4 The line for _Itype_4 now has only an entry of 1 for the IRR. The other entries in the table are blank
o longer make sense: the coeficient was forced to be 0, so it does not have a standard error
The other coefficients have all changed very slightly

```
. estat gof
         Deviance goodness-of-fit =  38.69497
         Prob > chi2(25)          =    0.0395
         Pearson goodness-of-fit  =  42.27525
         Prob > chi2(25)          =    0.0168
```

3.5 The lack of fit in the constrained model is very similar to that in the unconstrained model
There was a bug in stata 8.0 which did not adjust the degrees of freedom
in estat gof when constraints were applied. Therefore your results will have
differed from these.

```
. constraint define 2 5.type = 0
```

```
. xi: poisson damage i.type i.built i.sailed, exposure(months) irr const(1 2)
i.type           _Itype_1-5          (naturally coded; _Itype_1 omitted)
i.built          _Ibuilt_1-4         (naturally coded; _Ibuilt_1 omitted)
i.sailed         _Isailed_1-2        (naturally coded; _Isailed_1 omitted)
(note: constraint number 1 caused error r(111))
(note: constraint number 2 caused error r(111))

Iteration 0:   log likelihood = -120.33891
Iteration 1:   log likelihood = -68.554441
Iteration 2:   log likelihood = -68.280965
Iteration 3:   log likelihood = -68.280771
Iteration 4:   log likelihood = -68.280771

Poisson regression                                Number of obs   =         34
                                                  Wald chi2(8)    =     107.70
Log likelihood = -68.280771                       Prob > chi2     =     0.0000
```

damage	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_Itype_2	.5808026	.1031447	-3.06	0.002	.4100754	.8226088
_Itype_3	.502881	.1654716	-2.09	0.037	.2638638	.9584087
_Itype_4	.926852	.2693234	-0.26	0.794	.5244081	1.638141
_Itype_5	1.384833	.3266535	1.38	0.168	.8722007	2.198762
_Ibuilt_2	2.008002	.3004803	4.66	0.000	1.497577	2.692398
_Ibuilt_3	2.26693	.384865	4.82	0.000	1.625274	3.161912
_Ibuilt_4	1.573695	.3669393	1.94	0.052	.9964273	2.485397
_Isailed_2	1.468831	.1737218	3.25	0.001	1.164926	1.852019
_cons	.0016518	.0003592	-29.46	0.000	.0010786	.0025295
ln(months)	1	(exposure)				

```
. estat gof

         Deviance goodness-of-fit =  38.69497
         Prob > chi2(25)          =    0.0395

         Pearson goodness-of-fit  =  42.27525
         Prob > chi2(25)          =    0.0168
```

3.8 the lack of fit has got slightly greater

```
. constraint define 3 2.built = 3.built
```

```
. xi: poisson damage i.type i.built i.sailed, exposure(months) irr const(1 2 3)
i.type            _Itype_1-5          (naturally coded; _Itype_1 omitted)
i.built           _Ibuilt_1-4         (naturally coded; _Ibuilt_1 omitted)
i.sailed          _Isailed_1-2        (naturally coded; _Isailed_1 omitted)
(note: constraint number 1 caused error r(111))
(note: constraint number 2 caused error r(111))
(note: constraint number 3 caused error r(111))
Iteration 0:   log likelihood = -120.33891
Iteration 1:   log likelihood = -68.554441
Iteration 2:   log likelihood = -68.280965
Iteration 3:   log likelihood = -68.280771
Iteration 4:   log likelihood = -68.280771
Poisson regression                                Number of obs   =         34
                                                  Wald chi2(8)    =     107.70
Log likelihood = -68.280771                       Prob > chi2     =     0.0000
```

damage	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_Itype_2	.5808026	.1031447	-3.06	0.002	.4100754	.8226088
_Itype_3	.502881	.1654716	-2.09	0.037	.2638638	.9584087
_Itype_4	.926852	.2693234	-0.26	0.794	.5244081	1.638141
_Itype_5	1.384833	.3266535	1.38	0.168	.8722007	2.198762
_Ibuilt_2	2.008002	.3004803	4.66	0.000	1.497577	2.692398
_Ibuilt_3	2.26693	.384865	4.82	0.000	1.625274	3.161912
_Ibuilt_4	1.573695	.3669393	1.94	0.052	.9964273	2.485397
_Isailed_2	1.468831	.1737218	3.25	0.001	1.164926	1.852019
_cons	.0016518	.0003592	-29.46	0.000	.0010786	.0025295
ln(months)	1	(exposure)				

3.9 These lines do have standard errors, confidence intervals etc since they were not constrained to take

3.10 They were not constrained to take a specific value

```
. estat gof
         Deviance goodness-of-fit =  38.69497
         Prob > chi2(25)          =    0.0395
         Pearson goodness-of-fit  =  42.27525
         Prob > chi2(25)          =    0.0168
```

3.11 The fit of the model has deteriorated slightly

```
. predict pred_cn
(option n assumed; predicted number of events)
```

```
. corr damage pred_n pred_cn
(obs=34)
```

	damage	pred_n	pred_cn
damage	1.0000		
pred_n	0.9865	1.0000	
pred_cn	0.9865	1.0000	1.0000

3.13 The constraints have had little effect on the fit of the model: the correlation between observed and
has dropped from 0.9865 to 0.9848

```
. list type built sailed pred_n pred_cn
```

	type	built	sailed	pred_n	pred_cn
1.	A	1960-1964	1960-1974	.2097761	.2097761
2.	A	1960-1964	1975-1979	.1528497	.1528497
3.	A	1965-1969	1960-1974	3.631873	3.631873
4.	A	1965-1969	1975-1979	5.334609	5.334609
5.	A	1970-1974	1960-1974	5.66164	5.66164
6.	A	1970-1974	1975-1979	18.44148	18.44148
7.	A	1975-1979	1975-1979	8.567768	8.567768
8.	B	1960-1964	1960-1974	43.05792	43.05792
9.	B	1960-1964	1975-1979	24.20331	24.20331
10.	B	1965-1969	1960-1974	55.11221	55.11221
11.	B	1965-1969	1975-1979	57.63788	57.63788
12.	B	1970-1974	1960-1974	15.36278	15.36278
13.	B	1970-1974	1975-1979	41.8436	41.8436
14.	B	1975-1979	1975-1979	15.7823	15.7823
15.	C	1960-1964	1960-1974	.9793352	.9793352
16.	C	1960-1964	1975-1979	.6734859	.6734859
17.	C	1965-1969	1960-1974	1.302665	1.302665
18.	C	1965-1969	1975-1979	1.656153	1.656153
19.	C	1970-1974	1960-1974	1.474407	1.474407
20.	C	1970-1974	1975-1979	5.387863	5.387863
21.	C	1975-1979	1975-1979	.5260908	.5260908
22.	D	1960-1964	1960-1974	.3842699	.3842699
23.	D	1960-1964	1975-1979	.2361151	.2361151
24.	D	1965-1969	1960-1974	.885359	.885359
25.	D	1965-1969	1975-1979	.8669619	.8669619
26.	D	1970-1974	1960-1974	1.211229	1.211229
27.	D	1970-1974	1975-1979	6.157999	6.157999
28.	D	1975-1979	1975-1979	7.258066	7.258066
29.	E	1960-1964	1960-1974	.1029348	.1029348
30.	E	1965-1969	1960-1974	3.624023	3.624023
31.	E	1965-1969	1975-1979	2.94827	2.94827
32.	E	1970-1974	1960-1974	5.999584	5.999584
33.	E	1970-1974	1975-1979	16.45942	16.45942
34.	E	1975-1979	1975-1979	2.865771	2.865771

```
. list type built sailed  damage pred_n pred_cn
```

	type	built	sailed	damage	pred_n	pred_cn
1.	A	1960-1964	1960-1974	0	.2097761	.2097761
2.	A	1960-1964	1975-1979	0	.1528497	.1528497
3.	A	1965-1969	1960-1974	3	3.631873	3.631873
4.	A	1965-1969	1975-1979	4	5.334609	5.334609
5.	A	1970-1974	1960-1974	6	5.66164	5.66164
6.	A	1970-1974	1975-1979	18	18.44148	18.44148
7.	A	1975-1979	1975-1979	11	8.567768	8.567768
8.	B	1960-1964	1960-1974	39	43.05792	43.05792
9.	B	1960-1964	1975-1979	29	24.20331	24.20331
10.	B	1965-1969	1960-1974	58	55.11221	55.11221
11.	B	1965-1969	1975-1979	53	57.63788	57.63788
12.	B	1970-1974	1960-1974	12	15.36278	15.36278
13.	B	1970-1974	1975-1979	44	41.8436	41.8436
14.	B	1975-1979	1975-1979	18	15.7823	15.7823
15.	C	1960-1964	1960-1974	1	.9793352	.9793352
16.	C	1960-1964	1975-1979	1	.6734859	.6734859
17.	C	1965-1969	1960-1974	0	1.302665	1.302665
18.	C	1965-1969	1975-1979	1	1.656153	1.656153
19.	C	1970-1974	1960-1974	6	1.474407	1.474407
20.	C	1970-1974	1975-1979	2	5.387863	5.387863
21.	C	1975-1979	1975-1979	1	.5260908	.5260908
22.	D	1960-1964	1960-1974	0	.3842699	.3842699
23.	D	1960-1964	1975-1979	0	.2361151	.2361151
24.	D	1965-1969	1960-1974	0	.885359	.885359
25.	D	1965-1969	1975-1979	0	.8669619	.8669619
26.	D	1970-1974	1960-1974	2	1.211229	1.211229
27.	D	1970-1974	1975-1979	11	6.157999	6.157999
28.	D	1975-1979	1975-1979	4	7.258066	7.258066
29.	E	1960-1964	1960-1974	0	.1029348	.1029348
30.	E	1965-1969	1960-1974	7	3.624023	3.624023
31.	E	1965-1969	1975-1979	7	2.94827	2.94827
32.	E	1970-1974	1960-1974	5	5.999584	5.999584
33.	E	1970-1974	1975-1979	12	16.45942	16.45942
34.	E	1975-1979	1975-1979	1	2.865771	2.865771

3.14 There have only been very slight changes in the predicted values

```
. clear

. use $datadir/alligators
```

```
. label list
lake:
           1 Hancock
           2 Oklawaha
           3 Trafford
           4 George
gender:
           0 Male
           1 Female
size:
           0 <= 2.3m
           1 > 2.3m
food:
           1 Fish
           2 Invertebrate
           3 Reptile
           4 Bird
           5 Other
```

```
. mlogit food i.lake, rrr

Iteration 0:   log likelihood = -302.18146
Iteration 1:   log likelihood = -281.77642
Iteration 2:   log likelihood = -280.60116
Iteration 3:   log likelihood = -280.58389
Iteration 4:   log likelihood = -280.58384
Iteration 5:   log likelihood = -280.58384

Multinomial logistic regression                   Number of obs   =        219
                                                  LR chi2(12)     =      43.20
                                                  Prob > chi2     =     0.0000
Log likelihood = -280.58384                       Pseudo R2       =     0.0715

------------------------------------------------------------------------------
        food |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Fish         |  (base outcome)
-------------+----------------------------------------------------------------
Invertebrate |
        lake |
   Oklawaha  |   7.916667   4.953585     3.31   0.001     2.322373    26.98688
   Trafford  |   10.38462   6.696362     3.63   0.000      2.93431    36.75148
     George  |   4.545455   2.741012     2.51   0.012     1.394066    14.82078
             |
       _cons |   .1333333   .0709721    -3.79   0.000     .0469734    .3784647
-------------+----------------------------------------------------------------
Reptile      |
        lake |
   Oklawaha  |   3.888889   2.923346     1.81   0.071     .8911737    16.97027
   Trafford  |   6.153846   4.640301     2.41   0.016      1.40378    26.97704
     George  |   .3030303    .358162    -1.01   0.312     .0298828    3.072916
             |
       _cons |         .1    .060553    -3.80   0.000     .0305191    .3276635
-------------+----------------------------------------------------------------
Bird         |
        lake |
   Oklawaha  |   .3333333   .3784308    -0.97   0.333     .0360177    3.084902
   Trafford  |   1.846154   1.381851     0.82   0.413     .4257368    8.005613
     George  |   .5454545    .421439    -0.78   0.433     .1199742    2.479872
             |
       _cons |   .1666667   .0805076    -3.71   0.000     .0646665    .4295544
-------------+----------------------------------------------------------------
Other        |
        lake |
   Oklawaha  |   .3846154   .2717316    -1.35   0.176     .0963055    1.536039
   Trafford  |   1.775148   .9512863     1.07   0.284     .6209878    5.074416
     George  |   .4195804    .232565    -1.57   0.117     .1415831    1.243423
             |
       _cons |   .4333333   .1438878    -2.52   0.012     .2260381    .8307351
------------------------------------------------------------------------------
```

4.2 Yes: LR chi2 = 43.20 on 12 d.f., p = 0.0000
4.3 7.9, 10.4 and 4.5 respectively

```
. constraint define 1 [Invertebrate]2.lake = [Invertebrate]3.lake
```

```
. mlogit food i.lake, rrr const(1)

Iteration 0:   log likelihood = -302.18146
Iteration 1:   log likelihood = -281.88258
Iteration 2:   log likelihood = -280.75289
Iteration 3:   log likelihood = -280.73734
Iteration 4:   log likelihood =  -280.7373
Iteration 5:   log likelihood =  -280.7373

Multinomial logistic regression                 Number of obs   =        219
                                                Wald chi2(11)   =      31.76
Log likelihood =  -280.7373                     Prob > chi2     =     0.0008

 ( 1)  [Invertebrate]2.lake - [Invertebrate]3.lake = 0

------------------------------------------------------------------------------
        food |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Fish         |  (base outcome)
-------------+----------------------------------------------------------------
Invertebrate |
        lake |
   Oklawaha  |   8.951613   5.239703     3.74   0.000      2.84225    28.19294
   Trafford  |   8.951613   5.239703     3.74   0.000      2.84225    28.19294
     George  |   4.545455   2.741012     2.51   0.012     1.394066    14.82078
             |
       _cons |   .1333333   .0709721    -3.79   0.000     .0469734    .3784647
-------------+----------------------------------------------------------------
Reptile      |
        lake |
   Oklawaha  |   4.149956   3.089149     1.91   0.056     .9647734    17.85097
   Trafford  |    5.66077   4.165484     2.36   0.018      1.33819    23.94601
     George  |   .3030303    .358162    -1.01   0.312     .0298828    3.072916
             |
       _cons |         .1    .060553    -3.80   0.000     .0305191    .3276635
-------------+----------------------------------------------------------------
Bird         |
        lake |
   Oklawaha  |   .3557105   .4021123    -0.91   0.361     .0388023    3.260887
   Trafford  |   1.698231   1.239992     0.73   0.468     .4059548    7.104212
     George  |   .5454545    .421439    -0.78   0.433     .1199742    2.479872
             |
       _cons |   .1666667   .0805076    -3.71   0.000     .0646665    .4295544
-------------+----------------------------------------------------------------
Other        |
        lake |
   Oklawaha  |   .4104352   .2867674    -1.27   0.202     .1043561    1.614252
   Trafford  |   1.632914    .832733     0.96   0.336     .6010055    4.436581
     George  |   .4195804    .232565    -1.57   0.117     .1415831    1.243423
             |
       _cons |   .4333333   .1438878    -2.52   0.012     .2260381    .8307351
------------------------------------------------------------------------------

. constraint define 2 [Invertebrate]4.lake = [Invertebrate]3.lake
```

```
. mlogit food i.lake, rrr const(1 2)

Iteration 0:   log likelihood = -302.18146
Iteration 1:   log likelihood =  -283.6911
Iteration 2:   log likelihood = -282.42615
Iteration 3:   log likelihood = -282.41052
Iteration 4:   log likelihood = -282.41048
Iteration 5:   log likelihood = -282.41048

Multinomial logistic regression                 Number of obs   =        219
                                                Wald chi2(10)   =      28.61
Log likelihood = -282.41048                     Prob > chi2     =     0.0014

 ( 1)  [Invertebrate]2.lake - [Invertebrate]3.lake = 0
 ( 2)  - [Invertebrate]3.lake + [Invertebrate]4.lake = 0

------------------------------------------------------------------------------
        food |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Fish         |  (base outcome)
-------------+----------------------------------------------------------------
Invertebrate |
        lake |
   Oklawaha  |   6.679688   3.757894     3.38   0.001     2.217597    20.12008
   Trafford  |   6.679688   3.757894     3.38   0.001     2.217597    20.12008
     George  |   6.679688   3.757894     3.38   0.001     2.217597    20.12008
             |
       _cons |   .1333333   .0709721    -3.79   0.000     .0469734    .3784647
-------------+----------------------------------------------------------------
Reptile      |
        lake |
   Oklawaha  |   3.576858   2.637945     1.73   0.084     .8428254    15.17979
   Trafford  |   4.879032   3.556293     2.17   0.030     1.169227    20.35957
     George  |   .3567217   .4210064    -0.87   0.382     .0352966    3.605171
             |
       _cons |         .1    .060553    -3.80   0.000     .0305191    .3276635
-------------+----------------------------------------------------------------
Bird         |
        lake |
   Oklawaha  |   .3065878   .3451968    -1.05   0.294     .0337412    2.785796
   Trafford  |    1.46371   1.058488     0.53   0.598     .3547358    6.039554
     George  |   .6420991   .4944142    -0.58   0.565     .1419644    2.904187
             |
       _cons |   .1666667   .0805076    -3.71   0.000     .0646665    .4295544
-------------+----------------------------------------------------------------
Other        |
        lake |
   Oklawaha  |   .3537552   .2445719    -1.50   0.133     .0912467    1.371478
   Trafford  |   1.407413   .7035306     0.68   0.494     .5283567    3.749005
     George  |   .4939224   .2719497    -1.28   0.200     .1678781    1.453193
             |
       _cons |   .4333333   .1438878    -2.52   0.012     .2260381    .8307351
------------------------------------------------------------------------------
```

4.5 The common odds ratio (6.68) lies between the three previous estimates
end of do-file