PRINCETON
UNIVERSITY

# **Predicted probabilities and marginal effects after (ordered) logit/probit using `margins` in Stata**

(v2.0)

*Oscar Torres-Reyna*
*otorres@princeton.edu*

# Predicted probabilities after logit/probit:
# estimating the probability that the outcome variable = 1

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins, atmeans post
```

```
. margins, atmeans

Adjusted predictions                              Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
at           : x1               =     .6480006  (mean)
               x2               =     .1338694  (mean)
               x3               =      .761851  (mean)
               1.opinion        =     .2857143  (mean)
               2.opinion        =     .2142857  (mean)
               3.opinion        =     .2714286  (mean)
               4.opinion        =     .2285714  (mean)
```

Variables at mean values

```
─────────────────────────────────────────────────────────────────────────
                         Delta-method
                Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
─────────────────────────────────────────────────────────────────────────
       _cons   .8575618   .0512873   16.72   0.000     .7570405    .9580832
─────────────────────────────────────────────────────────────────────────
```

The probability of y_bin = 1 is 85% given that all predictors are set to their mean values.

Type `help margins` for more details. Available since Stata 11+

# Predicted probabilities after logit/probit:
## estimating the probability that the outcome variable = 1, setting a predictor to specific value

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins, at(x2=3) atmeans post
```

```
. margins, at(x2=3) atmeans

Adjusted predictions                              Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
at           : x1              =    .6480006  (mean)
               x2              =           3
               x3              =     .761851  (mean)
               1.opinion       =    .2857143  (mean)
               2.opinion       =    .2142857  (mean)
               3.opinion       =    .2714286  (mean)
               4.opinion       =    .2285714  (mean)
```

Variables at mean values

```
------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   .9346922   .0732788    12.76   0.000     .7910683    1.078316
------------------------------------------------------------------------------
```

`.`

The probability of y_bin = 1 is 93% given that x2 = 3 and the rest of predictors are set to their mean values.

Type `help margins` for more details. Available since Stata 11+

# Predicted probabilities after logit/probit:
# estimating the probability that the outcome variable = 1,
# setting predictors to specific value

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins, at(x2=3 x3=5) atmeans post
```

```
. margins, at(x2=3 x3=5) atmeans

Adjusted predictions                              Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
at           : x1              =    .6480006 (mean)
               x2              =           3
               x3              =           5
               1.opinion       =    .2857143 (mean)
               2.opinion       =    .2142857 (mean)
               3.opinion       =    .2714286 (mean)
               4.opinion       =    .2285714 (mean)
```

Variables at mean values

|        | Margin | Delta-method Std. Err. | z | P>\|z\| | [95% Conf. Interval] |
|--------|--------|------------------------|-------|-------|----------------------|
| _cons  | .9872112 | .0357288 | 27.63 | 0.000 | .917184    1.057238 |

The probability of y_bin = 1 is 99% given that x2 = 3, x3 = 5 and the rest of predictors are set to their mean values.

Type `help margins` for more details. Available since Stata 11+

# Predicted probabilities after logit/probit:
# estimating the probability that the outcome variable = 1,
# setting predictors to specific value

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins, at(x2=3 x3=5 opinion=(1 2)) atmeans post
```

```
. margins, at(x2=3 x3=5 opinion=1 opinion=2) atmeans

Adjusted predictions                              Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()

1._at        : x1              =    .6480006  (mean)
               x2              =           3
               x3              =           5
               opinion         =           1

2._at        : x1              =    .6480006  (mean)
               x2              =           3
               x3              =           5
               opinion         =           2

─────────────┬────────────────────────────────────────────────────────────────
             │            Delta-method
             │    Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
─────────────┼────────────────────────────────────────────────────────────────
         _at │
          1  │  .9891283   .0305393    32.39   0.000     .9292724    1.048984
          2  │  .9304941   .1915434     4.86   0.000     .5550758    1.305912
─────────────┴────────────────────────────────────────────────────────────────
```

1. The probability of y_bin = 1 is 98% given that x2 = 3, x3 = 5, the opinion is "strongly agree" and the rest of predictors are set to their mean values.
2. The probability of y_bin = 1 is 93% given that x2 = 3, x3 = 5, the opinion is "agree" and the rest of predictors are set to their mean values.

OTR        Type `help margins` for more details. Available since Stata 11+

# Predicted probabilities after logit/probit: categorical variables as predictors

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins opinion, atmeans post
```

Categorical variable

```
. margins opinion, atmeans

Adjusted predictions                         Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
at           : x1              =     .6480006 (mean)
               x2              =     .1338694 (mean)
               x3              =      .761851 (mean)
               1.opinion       =     .2857143 (mean)
               2.opinion       =     .2142857 (mean)
               3.opinion       =     .2714286 (mean)
               4.opinion       =     .2285714 (mean)
```
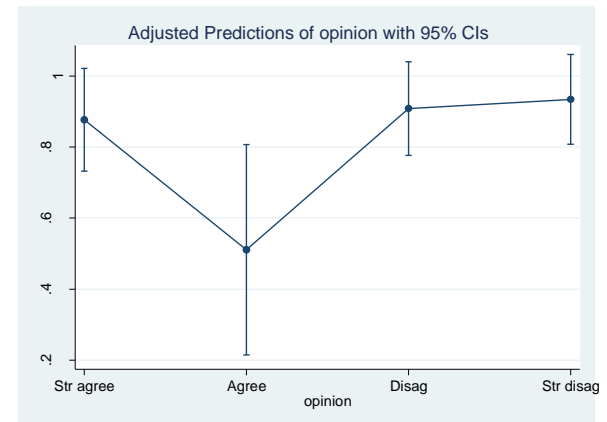
Variables at mean values

```
                          Delta-method
                 Margin    Std. Err.      z    P>|z|     [95% Conf. Interval]

      opinion
   Str agree    .8764826   .0739471    11.85   0.000     .731549    1.021416
       Agree    .5107928   .1509988     3.38   0.001    .2148405    .8067451
       Disag     .907761   .0673524    13.48   0.000    .7757527    1.039769
   Str disag     .933931   .0644709    14.49   0.000    .8075704    1.060292
```

After `margins`, type **marginsplot** to produce the graph below



Adjusted Predictions of opinion with 95% CIs

**Source**: http://www.stata.com/stata12/margins-plots/

Holding all variables at their mean values. The probability of y_bin = 1 is:

- 87% among those who "strongly agree",
- 51% among those who "agree",
- 91% among those who "disagree" and
- 93% among those who "strongly disagree"

*OTR*

Type `help margins` or `help marginsplot` for more details

# Predicted probabilities after logit/probit: categorical variables as predictors

**use** *http://dss.princeton.edu/training/Panel101.dta*

**quietly logit y_bin x1 x2 x3 i.opinion i.country**

**margins opinion#country, post**

```
. margins opinion#country,

Predictive margins                              Number of obs   =        70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
```

|  | Margin | Delta-method Std. Err. | z | P>\|z\| | [95% Conf. Interval] |  |
|---|---|---|---|---|---|---|
| **opinion# country** |  |  |  |  |  |  |
| Str agree#A | .8722717 | .1676835 | 5.20 | 0.000 | .5436181 | 1.200925 |
| Str agree#B | .2206027 | .0739956 | 2.98 | 0.003 | .0755741 | .3656314 |
| Str agree#C | .8860908 | .0855355 | 10.36 | 0.000 | .7184442 | 1.053737 |
| Str agree#D | .3920647 | .0347693 | 11.28 | 0.000 | .3239182 | .4602113 |
| Str agree#E | .4157172 | .0210781 | 19.72 | 0.000 | .3744049 | .4570296 |
| Str agree#F | .8212669 | .2431515 | 3.38 | 0.001 | .3446987 | 1.297835 |
| Str agree#G | .9779035 | .0330825 | 29.56 | 0.000 | .9130629 | 1.042744 |
| Agree#A | .6922923 | .1568031 | 4.42 | 0.000 | .3849638 | .9996208 |
| Agree#B | .0950865 | .07074 | 1.34 | 0.179 | -.0435612 | .2337343 |
| Agree#C | .7094636 | .1163811 | 6.10 | 0.000 | .4813608 | .9375665 |
| Agree#D | .307147 | .0782601 | 3.92 | 0.000 | .1537601 | .460534 |
| Agree#E | .3715877 | .0632413 | 5.88 | 0.000 | .2476371 | .4955382 |
| Agree#F | .6391978 | .1394519 | 4.58 | 0.000 | .3658771 | .9125185 |
| Agree#G | .890433 | .1141899 | 7.80 | 0.000 | .666625 | 1.114241 |
| Disag#A | .8748461 | .1403006 | 6.24 | 0.000 | .5998621 | 1.14983 |
| Disag#B | .222955 | .0875026 | 2.55 | 0.011 | .0514531 | .3944569 |
| Disag#C | .8885042 | .1006077 | 8.83 | 0.000 | .6913168 | 1.085692 |
| Disag#D | .3929169 | .0339031 | 11.59 | 0.000 | .3264681 | .4593657 |
| Disag#E | .4161 | .0224011 | 18.58 | 0.000 | .3721947 | .4600053 |
| Disag#F | .8242678 | .2382172 | 3.46 | 0.001 | .3573707 | 1.291165 |
| Disag#G | .9786051 | .0349299 | 28.02 | 0.000 | .9101439 | 1.047066 |
| Str disag#A | .951193 | .1069996 | 8.89 | 0.000 | .7414776 | 1.160908 |
| Str disag#B | .3106484 | .0851639 | 3.65 | 0.000 | .1437303 | .4775665 |
| Str disag#C | .9582401 | .0615373 | 15.57 | 0.000 | .8376292 | 1.078851 |
| Str disag#D | .4160411 | .0212865 | 19.54 | 0.000 | .3743203 | .457762 |
| Str disag#E | .4251606 | .0078968 | 53.84 | 0.000 | .4096831 | .4406381 |
| Str disag#F | .9216348 | .1814934 | 5.08 | 0.000 | .5659143 | 1.277355 |
| Str disag#G | .9944189 | .0104861 | 94.83 | 0.000 | .9738664 | 1.014971 |

After `margins`, type **marginsplot** to produce the graph below



**Source**: http://www.stata.com/stata12/margins-plots/
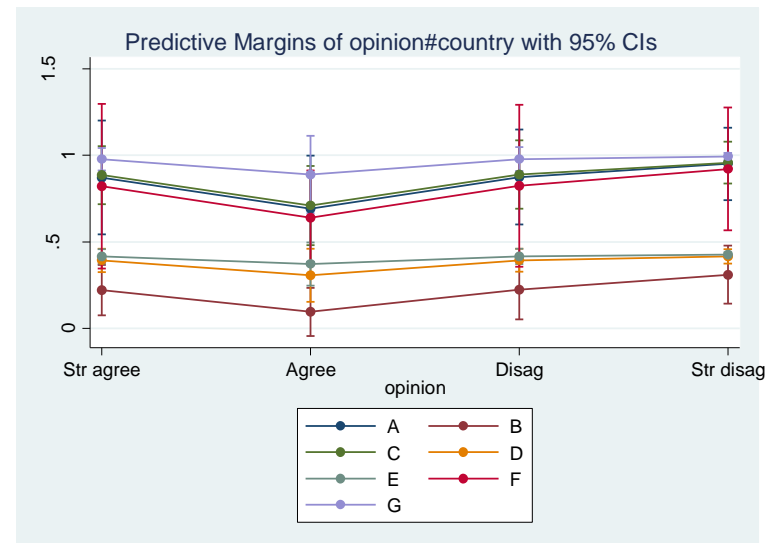
The probability of y_bin = 1 is:

- 87% among those who "strongly agree" in country A
- 22% among those who "strongly agree", in country B
- 89% among those who "strongly agree", in country C

Type `help margins` or `help marginsplot` for more details

# Marginal effects after logit/probit:

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins, dydx(*) atmeans post
```

Categorical variable

**Marginal effects** show the change in probability when the predictor or independent variable increases by one unit. For continuous variables this represents the instantaneous change given that the 'unit' may be very small. For binary variables, the change is from 0 to 1, so one 'unit' as it is usually thought.

```
. margins, dydx(*) atmeans

Conditional marginal effects                        Number of obs   =        70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
dy/dx w.r.t. : x1 x2 x3 2.opinion 3.opinion 4.opinion
at           : x1              =      .6480006 (mean)
               x2              =      .1338694 (mean)
               x3              =       .761851 (mean)
               1.opinion       =      .2857143 (mean)
               2.opinion       =      .2142857 (mean)
               3.opinion       =      .2714286 (mean)
               4.opinion       =      .2285714 (mean)
```

The change in probability for one instant change in *x1* is 13 percentage points (pp), in *x2* is 3 pp and in *x3* is 4 pp.
None of the effects here are significant (see column P>|z|, for significance at 95% values should be < 0.05)

|  | dy/dx | Delta-method Std. Err. | z | P>|z| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| x1 | .1384634 | .1093955 | 1.27 | 0.206 | -.0759478 | .3528746 |
| x2 | .036904 | .0421082 | 0.88 | 0.381 | -.0456266 | .1194346 |
| x3 | .04857 | .0548416 | 0.89 | 0.376 | -.0589176 | .1560577 |
| opinion |  |  |  |  |  |  |
| Agree | -.3656898 | .1670551 | -2.19 | 0.029 | -.6931118 | -.0382678 |
| Disag | .0312784 | .0945857 | 0.33 | 0.741 | -.1541062 | .2166629 |
| Str disag | .0574484 | .098205 | 0.58 | 0.559 | -.1350299 | .2499268 |

Note: dy/dx for factor levels is the discrete change from the base level.

1. The change in probability when opinion goes from 'strongly agree' to 'agree' decreases 36 percentage points or -0.36, and is significant.
2. The change in probability when opinion goes from 'strongly agree' to 'disagree' increases by 3 percentage points or 0.03.
3. The change in probability when opinion goes from 'strongly agree' to 'strongly disagree' increases by 5 percentage points or 0.05.

Type `help margins` for more details

# Predicted probabilities after logit/probit: publishing results in a word document using `outreg2`

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins opinion, atmeans post
outreg2 using test.doc, word replace ctitle(Predicted prob.) addnote(NOTE: All predictors at
their mean value)
```

Notice the `post` option

```
. margins opinion, atmeans vsquish post

Adjusted predictions                          Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
at           : x1              =      .6480006 (mean)
               x2              =      .1338694 (mean)
               x3              =       .761851 (mean)
               1.opinion       =      .2857143 (mean)
               2.opinion       =      .2142857 (mean)
               3.opinion       =      .2714286 (mean)
               4.opinion       =      .2285714 (mean)

                          Delta-method
                 Margin    Std. Err.      z     P>|z|     [95% Conf. Interval]

       opinion
     Str agree   .8764826   .0739471    11.85   0.000     .731549    1.021416
         Agree   .5107928   .1509988     3.38   0.001    .2148405    .8067451
         Disag    .907761   .0673524    13.48   0.000    .7757527    1.039769
     Str disag   .933931   .0644709    14.49   0.000    .8075704    1.060292

. outreg2 using test.doc, word replace ctitle(Predicted prob.) addnote(NOTE: All
>  predictors at their mean value)
test.doc
dir : seeout
```

Windows users click here to open the file `test.doc` in Word.
Otherwise follow the Mac instructions.

| VARIABLES | (1) Predicted prob. |
|---|---|
| 1bn.opinion | 0.876*** |
|  | (0.0739) |
| 2.opinion | 0.511*** |
|  | (0.151) |
| 3.opinion | 0.908*** |
|  | (0.0674) |
| 4.opinion | 0.934*** |
|  | (0.0645) |
| Observations | 70 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
NOTE: All predictors at their mean value

Mac users click here to go to the directory where `test.doc` is saved, open it with Word

# Marginal effects after logit/probit: publishing results in a word document using `outreg2`

```
use http://dss.princeton.edu/training/Panel101.dta
quietly logit y_bin x1 x2 x3 i.opinion
margins, dydx(*) post          ←  Notice the post option
outreg2 using test.doc, word replace ctitle(Marginal effects)
```

```
. margins, dydx(*) post

Average marginal effects                        Number of obs   =         70
Model VCE    : OIM

Expression   : Pr(y_bin), predict()
dy/dx w.r.t. : x1 x2 x3 2.opinion 3.opinion 4.opinion
```

|  | Delta-method | | | | | |
|---|---|---|---|---|---|---|
|  | dy/dx | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
| x1 | .1411603 | .1137246 | 1.24 | 0.215 | -.0817359 | .3640564 |
| x2 | .0376228 | .0440405 | 0.85 | 0.393 | -.048695 | .1239406 |
| x3 | .049516 | .058822 | 0.84 | 0.400 | -.065773 | .1648051 |
| opinion |  |  |  |  |  |  |
| Agree | -.3564299 | .1565868 | -2.28 | 0.023 | -.6633343 | -.0495255 |
| Disag | .0338245 | .1022902 | 0.33 | 0.741 | -.1666607 | .2343096 |
| Str disag | .0628003 | .1062941 | 0.59 | 0.555 | -.1455323 | .2711329 |

```
Note: dy/dx for factor levels is the discrete change from the base level.

. outreg2 using test.doc, word replace ctitle(Marginal effects)
test.doc
dir : seeout
```

Windows users click here to open the file `test.doc` in Word. Otherwise follow the Mac instructions.

Mac users click here to go to the directory where `test.doc` is saved, open it with Word

| VARIABLES | (1) Marginal effects |
|---|---|
| x1 | 0.141 |
|  | (0.114) |
| x2 | 0.0376 |
|  | (0.0440) |
| x3 | 0.0495 |
|  | (0.0588) |
| 2.opinion | -0.356** |
|  | (0.157) |
| 3.opinion | 0.0338 |
|  | (0.102) |
| 4.opinion | 0.0628 |
|  | (0.106) |
| Observations | 70 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Predicted probabilities after ordinal logit/probit

```
use http://dss.princeton.edu/training/Panel101.dta
ologit opinion x1 x2 x3
margins, predict(outcome(1)) atmeans post
margins, predict(outcome(2)) atmeans post
margins, predict(outcome(3)) atmeans post
margins, predict(outcome(4)) atmeans post
```

In ordinal logit/probit the outcome (dependent) variable has categories in meaningful order. In this example, the variable `opinion` has four categories: 1 "Strongly agree" 2 "Agree" 3 "Disagree" and 4 "Strongly disagree"

```
. margins, predict(outcome(1)) atmeans

Adjusted predictions                          Number of obs    =         70
Model VCE    : OIM

Expression   : Pr(opinion==1), predict(outcome(1))
at           : x1             =     .6480006 (mean)
               x2             =     .1338694 (mean)
               x3             =      .761851 (mean)

                    Delta-method
           Margin    Std. Err.      z     P>|z|     [95% Conf. Interval]

   _cons  .2800935   .0541271     5.17    0.000     .1740064    .3861805
```

The probability of opinion = 1 given that the rest of the variables are at their mean values is 28%

```
. margins, predict(outcome(2)) atmeans

Adjusted predictions                          Number of obs    =         70
Model VCE    : OIM

Expression   : Pr(opinion==2), predict(outcome(2))
at           : x1             =     .6480006 (mean)
               x2             =     .1338694 (mean)
               x3             =      .761851 (mean)

                    Delta-method
           Margin    Std. Err.      z     P>|z|     [95% Conf. Interval]

   _cons   .219505   .0502736     4.37    0.000     .1209706    .3180394
```

```
. margins, predict(outcome(3)) atmeans

Adjusted predictions                          Number of obs    =         70
Model VCE    : OIM

Expression   : Pr(opinion==3), predict(outcome(3))
at           : x1             =     .6480006 (mean)
               x2             =     .1338694 (mean)
               x3             =      .761851 (mean)

                    Delta-method
           Margin    Std. Err.      z     P>|z|     [95% Conf. Interval]

   _cons  .2788256   .0546476     5.10    0.000     .1717183    .3859328
```

```
. margins, predict(outcome(4)) atmeans

Adjusted predictions                          Number of obs    =         70
Model VCE    : OIM

Expression   : Pr(opinion==4), predict(outcome(4))
at           : x1             =     .6480006 (mean)
               x2             =     .1338694 (mean)
               x3             =      .761851 (mean)

                    Delta-method
           Margin    Std. Err.      z     P>|z|     [95% Conf. Interval]

   _cons   .221576   .0501011     4.42    0.000     .1233796    .3197723
```

The probability of opinion = 4 given that the rest of the variables are at their mean values is 22%

# Predicted probabilities after ordinal logit/probit: setting predictors to specific value

```
use http://dss.princeton.edu/training/Panel101.dta
ologit opinion x1 x2 x3
margins, predict(outcome(1)) at(x3=5) atmeans post
margins, predict(outcome(2)) at(x3=5) atmeans post
margins, predict(outcome(3)) at(x3=5) atmeans post
margins, predict(outcome(4)) at(x3=5) atmeans post
```

In ordinal logit/probit the outcome (dependent) variable has categories in meaningful order. In this example, the variable `opinion` has four categories: 1 "Strongly agree" 2 "Agree" 3 "Disagree" and 4 "Strongly disagree"

. margins, predict(outcome(1)) at(x3=5) atmeans

```
Adjusted predictions                          Number of obs   =         70
Model VCE     : OIM

Expression    : Pr(opinion==1), predict(outcome(1))
at            : x1              =     .6480006 (mean)
                x2              =     .1338694 (mean)
                x3              =            5
```

|       | Margin | Delta-method Std. Err. | z | P>\|z\| | [95% Conf. Interval] |
|-------|--------|------------------------|---|---------|----------------------|
| _cons | .2092897 | .1191718 | 1.76 | 0.079 | -.0242826    .4428621 |

. margins, predict(outcome(2)) at(x3=5) atmeans

```
Adjusted predictions                          Number of obs   =         70
Model VCE     : OIM

Expression    : Pr(opinion==2), predict(outcome(2))
at            : x1              =     .6480006 (mean)
                x2              =     .1338694 (mean)
                x3              =            5
```

|       | Margin | Delta-method Std. Err. | z | P>\|z\| | [95% Conf. Interval] |
|-------|--------|------------------------|---|---------|----------------------|
| _cons | .1951933 | .0665121 | 2.93 | 0.003 | .0648321    .3255545 |

The probability of opinion = 1, x3=5 and the rest of the variables are at their mean values is 21%

. margins, predict(outcome(3)) at(x3=5) atmeans

```
Adjusted predictions                          Number of obs   =         70
Model VCE     : OIM

Expression    : Pr(opinion==3), predict(outcome(3))
at            : x1              =     .6480006 (mean)
                x2              =     .1338694 (mean)
                x3              =            5
```

|       | Margin | Delta-method Std. Err. | z | P>\|z\| | [95% Conf. Interval] |
|-------|--------|------------------------|---|---------|----------------------|
| _cons | .3005314 | .063336 | 4.75 | 0.000 | .1763952    .4246676 |

. margins, predict(outcome(4)) at(x3=5) atmeans

```
Adjusted predictions                          Number of obs   =         70
Model VCE     : OIM

Expression    : Pr(opinion==4), predict(outcome(4))
at            : x1              =     .6480006 (mean)
                x2              =     .1338694 (mean)
                x3              =            5
```

|       | Margin | Delta-method Std. Err. | z | P>\|z\| | [95% Conf. Interval] |
|-------|--------|------------------------|---|---------|----------------------|
| _cons | .2949855 | .1450564 | 2.03 | 0.042 | .0106803    .5792908 |

The probability of opinion = 4, x3=5 and the rest of the variables are at their mean values is 29%

# Odds ratio: publishing regression output (`outreg2`)

In the case of logit models with odds ratios, you need to use the option `eform`, see below

```
use "H:\public_html\Stata\Panel101.dta", clear
logit y_bin x1
outreg2 using mymod.doc, replace ctitle(Logit coeff)
```

```
. outreg2 using mymod.doc, replace ctitle(Logit coeff)
mymod.doc
dir : seeout
```

```
logit y_bin x1, or
outreg2 using mymod.doc, append ctitle(Odds ratio) eform
```

```
. outreg2 using mymod.doc, append ctitle(Odds ratio) eform
mymod.doc
dir : seeout
```

Windows users click here to open the file `mymod.doc` in Word (you can replace this name for your own) . Otherwise follow the Mac instructions.

Mac users click here to go to the directory where `mymod.doc` is saved, open it with Word (you can replace this name for your own)

For more details/options type
`help outreg2`

|  |  | (1) | (2) |
|---|---|---|---|
| EQUATION | VARIABLES | Logit coeff | Odds ratio |
| y_bin | x1 | 0.493 | 1.637 |
|  |  | (0.645) | (1.055) |
|  | Constant | 1.082** | 2.952** |
|  |  | (0.482) | (1.422) |
| Observations |  | 70 | 70 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1