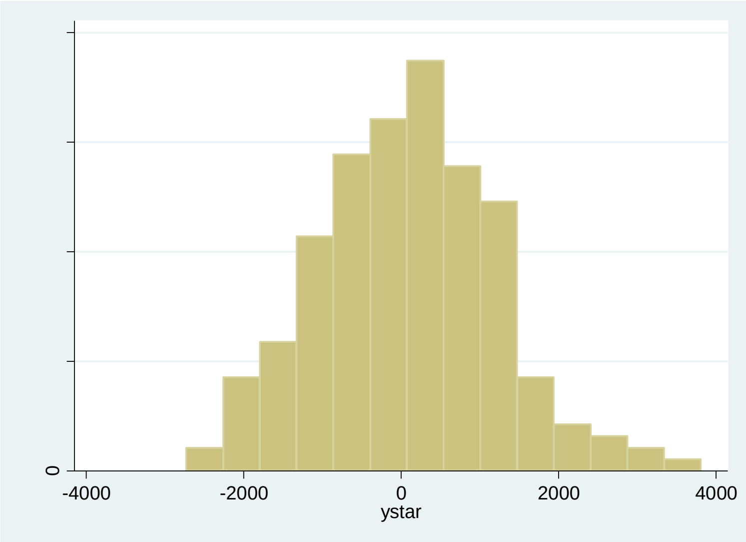
Truncated & Censored Data

<u>Simulated Data</u>
STATA command

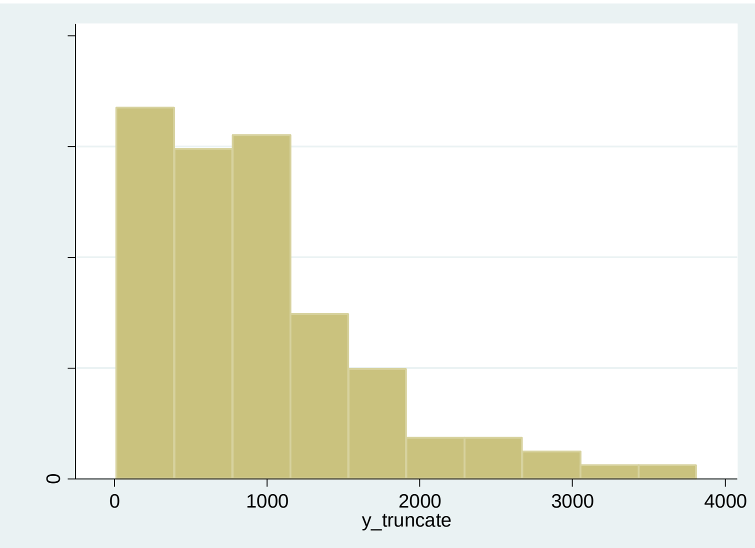
```
*Generate Truncated Data (Sample Selection Biased #3)
set obs 200
g e=rnormal(0,1000)
g lnw=rnormal(2.75,0.6)
g ystar=-2500+1000*lnw+e
g y_truncate=ystar if ystar>0

*Generate Truncated Data (Sample Selection Biased #4)
g e2=rnormal(0,1)
g iq=abs(int(rnormal(100,15)))
g i=-10+0.1*iq+0.5*lnw+e2
g p=normal(i)
g shat=(p>0.5)
g e3=3500*shat+e
g ystar2=-6000+1000*lnw+e3
g y_heckit=ystar2 if ystar2>0

*Generate Censored Data
g y_censor=ystar
replace y_censor=0 if ystar<=0

*Generate Outlier Case
g y_out=ystar
g out=runiform(0,100000)
replace y_out=out if ystar>2000
```

```
*Generate Truncated Data (Sample Selection Biased #3)

. set obs 200
number of observations (_N) was 0, now 200

. g e=rnormal(0,1000)

. g lnw=rnormal(2.75,0.6)

. g ystar=-2500+1000*lnw+e

. g y_truncate=ystar if ystar>0
(94 missing values generated)

*Generate Truncated Data (Sample Selection Biased #4)

. g e2=rnormal(0,1)

. g iq=abs(int(rnormal(100,15)))

. g ihat=-10+0.1*iq+0.5*lnw+e2

. g phat=normal(ihat)

. g shat=(phat>0.5)

. g e3=3500*shat+e

. g ystar2=-6000+1000*lnw+e3

. g y_heckit=ystar2 if ystar2>0
(117 missing values generated)

*Generate Censored Data

. g y_censor=ystar

. replace y_censor=0 if ystar<=0
(94 real changes made)
```

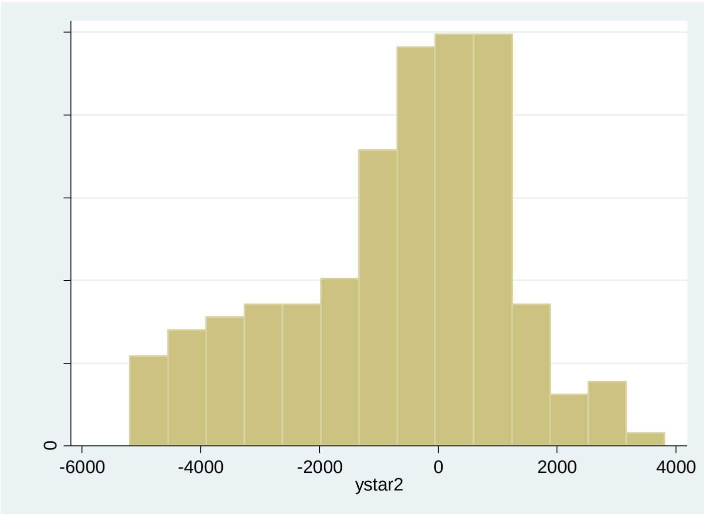
```
*Generate Outlier Case

. g y_out=ystar

. g out=runiform(0,100000)

. replace y_out=out if ystar>2000
(10 real changes made)

. sum ystar y_truncate ystar2 y_heckit y_censor y_out lnw iq

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       ystar |        200    95.06321    1124.415  -2728.715   3812.745
  y_truncate |        106    932.4709    736.4561   14.26584   3812.745
      ystar2 |        200   -692.4368     1892.71  -5192.655   3812.745
    y_heckit |         83    994.3141    772.8268   30.09209   3812.745
    y_censor |        200    494.2096    709.8276          0   3812.745
       y_out |        200    1909.285    10506.08  -2728.715   76160.63
         lnw |        200    2.748838    .5637259   1.384946   4.473701
          iq |        200     100.155    15.39957         52        139

. histogram ystar
(bin=14, start=-2728.7151, width=467.24712)
```



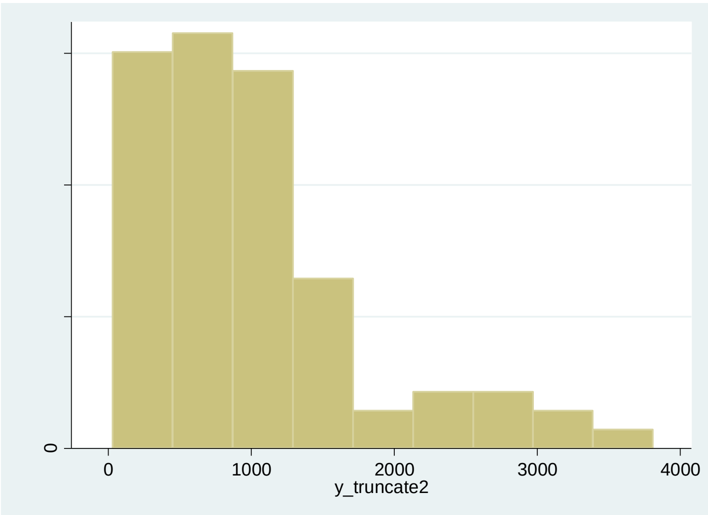

```
. histogram y_truncate
(bin=10, start=14.265841, width=379.84788)
```



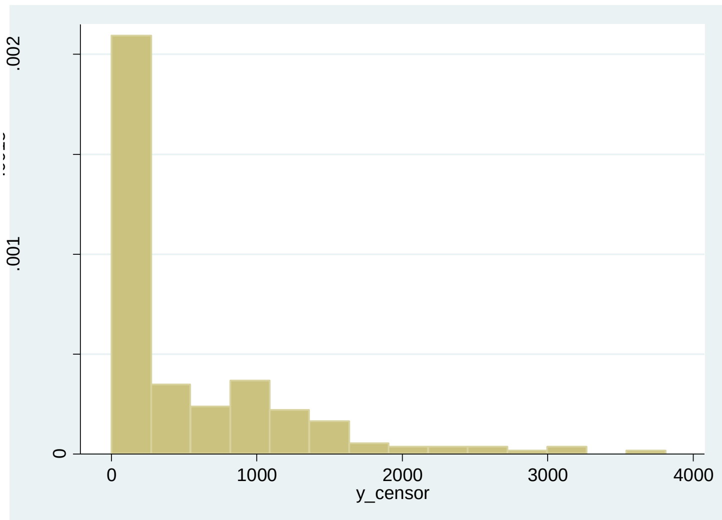
```
. histogram ystar2
(bin=14, start=-5192.6553, width=643.24285)
```



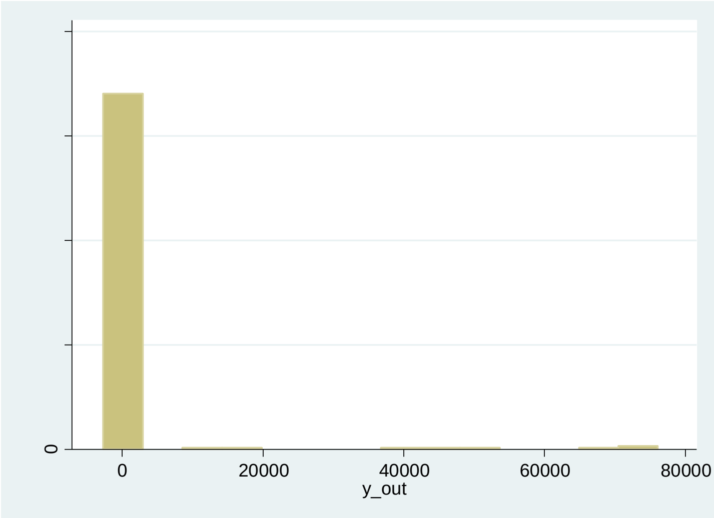

```
. histogram y_heckit
(bin=9, start=30.092091, width=420.29473)
```



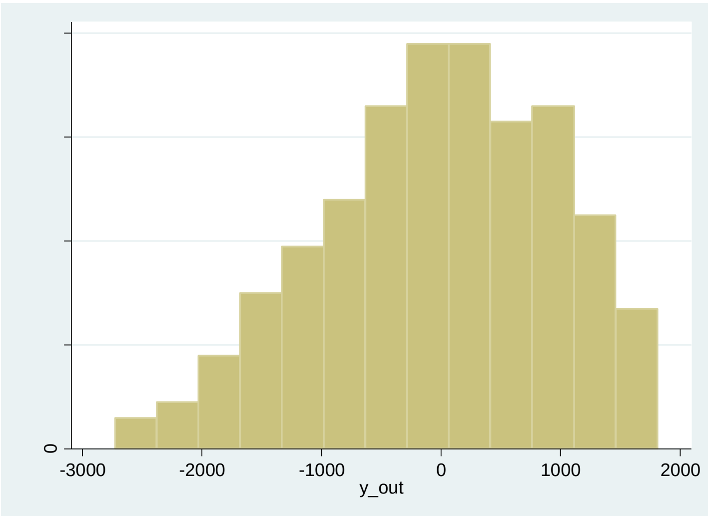

```
. histogram y_censor
(bin=14, start=0, width=272.3389)
```



```
. histogram y_out
(bin=14, start=-2728.7151, width=5634.9534)
```




```
. histogram y_out if y_out<=2000
(bin=13, start=-2728.7151, width=349.18581)
```




```
. reg ystar lnw

      Source |       SS           df       MS      Number of obs   =       200
-------------+----------------------------------   F(1, 198)       =     77.36
       Model |  70682512.1         1  70682512.1   Prob > F        =    0.0000
    Residual |   180914930       198  913711.765   R-squared       =    0.2809
-------------+----------------------------------   Adj R-squared   =    0.2773
       Total |   251597442       199  1264308.75   Root MSE        =    955.88

------------------------------------------------------------------------------
       ystar |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   1057.211   120.2016     8.80   0.000      820.171     1294.25
       _cons |  -2811.037   337.2571    -8.33   0.000    -3476.114    -2145.96
------------------------------------------------------------------------------

. predict uncensored
(option xb assumed; fitted values)

. est store m_ystar
```

Truncated Regression Model

Truncated Data #3 (Truncate both Y and X)

```
. reg y_truncate lnw

      Source |       SS           df       MS      Number of obs   =       106
-------------+----------------------------------   F(1, 104)       =     19.60
       Model |  9031908.27         1  9031908.27   Prob > F        =    0.0000
    Residual |  47916691.2       104  460737.416   R-squared       =    0.1586
-------------+----------------------------------   Adj R-squared   =    0.1505
       Total |  56948599.5       105  542367.614   Root MSE        =    678.78

------------------------------------------------------------------------------
  y_truncate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   526.5597   118.9281     4.43   0.000     290.7207    762.3986
       _cons |  -627.6924    358.491    -1.75   0.083    -1338.594    83.20879
------------------------------------------------------------------------------

. predict y_that
(option xb assumed; fitted values)

. est store m_ythat

. truncreg y_truncate lnw, ll(0) nolog
(note: 0 obs. truncated)

Truncated regression
Limit:   lower =          0                     Number of obs     =       106
         upper =       +inf                     Wald chi2(1)      =     11.33
Log likelihood = -818.34658                     Prob > chi2       =    0.0008

------------------------------------------------------------------------------
  y_truncate |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   1196.569   355.4781     3.37   0.001      499.845    1893.294
       _cons |  -3411.608   1356.581    -2.51   0.012    -6070.457   -752.7591
-------------+----------------------------------------------------------------
      /sigma |   1043.268   173.2952     6.02   0.000     703.6157    1382.921
------------------------------------------------------------------------------

. predict truncated, e(0,.)

. est store m_ytrunc
```

Test Appropriateness of Truncated Regression Model

```
. lrtest m_ythat m_ytrunc, force

Likelihood-ratio test                                 LR chi2(1)  =     44.40
(Assumption: m_ythat nested in m_ytrunc)              Prob > chi2 =    0.0000
```

Marginal Effects

```
. mfx compute, predict(e(0,.)) at(mean)

Marginal effects after truncreg
      y  = E(y_truncate|y_truncate>0) (predict, e(0,.))
         =  882.92127
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     lnw |   469.3786      102.92    4.56   0.000   267.655  671.103   2.96294
------------------------------------------------------------------------------

. mfx compute, predict(e(0,.)) at(median)
```

```
Marginal effects after truncreg
      y  = E(y_truncate|y_truncate>0) (predict, e(0,.))
         =  871.71836
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     lnw |   461.7475      99.761    4.63   0.000    266.22  657.275   2.93887
------------------------------------------------------------------------------

. mfx compute, predict(e(0,.)) at(0)

Marginal effects after truncreg
      y  = E(y_truncate|y_truncate>0) (predict, e(0,.))
         =  276.59986
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     lnw |   75.03293      10.673    7.03   0.000   54.1142  95.9516         0
------------------------------------------------------------------------------
```

Heckit Model

Censored Data #4 (Truncate only Y not X)

```
. reg y_heckit lnw

      Source |       SS           df       MS      Number of obs   =        83
-------------+----------------------------------   F(1, 81)        =     19.52
       Model |  9511473.82         1  9511473.82   Prob > F        =    0.0000
    Residual |  39463947.3        81  487209.226   R-squared       =    0.1942
-------------+----------------------------------   Adj R-squared   =    0.1843
       Total |  48975421.1        82  597261.233   Root MSE        =       698

------------------------------------------------------------------------------
    y_heckit |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |    610.591   138.1924     4.42   0.000     335.6314    885.5506
       _cons |  -864.1064   427.5293    -2.02   0.047    -1714.756   -13.45715
------------------------------------------------------------------------------

. g s=(y_heckit!=.)

. heckman y_heckit lnw, select(s=iq lnw) twostep

Heckman selection model -- two-step estimates   Number of obs      =       200
(regression model with sample selection)        Censored obs       =       117
                                                Uncensored obs     =        83

                                                Wald chi2(1)       =     12.78
                                                Prob > chi2        =    0.0004

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   y_heckit  |
         lnw |   1050.129   293.8055     3.57   0.000     474.2813    1625.978
       _cons |  -2683.291   1137.001    -2.36   0.018    -4911.772   -454.8098
-------------+----------------------------------------------------------------
s            |
          iq |   .0261638     .00682     3.84   0.000     .0127969    .0395307
         lnw |   1.261181   .2148837     5.87   0.000     .8400171    1.682346
       _cons |  -6.338834   .9643107    -6.57   0.000    -8.228848    -4.44882
-------------+----------------------------------------------------------------
mills        |
      lambda |   666.5792   371.6204     1.79   0.073    -61.78329    1394.942
-------------+----------------------------------------------------------------
         rho |    0.79511
       sigma |  838.34915
------------------------------------------------------------------------------

. est store m_ytrunc2
```

Manually Two-step Heckman

*First Step estimate Probit model and predict index value (ihat)

```
. probit s iq lnw, nolog

Probit regression                                 Number of obs     =        200
                                                  LR chi2(2)        =      59.40
                                                  Prob > chi2       =     0.0000
Log likelihood = -106.02769                       Pseudo R2         =     0.2188

------------------------------------------------------------------------------
           s |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          iq |   .0261638     .00682     3.84   0.000     .0127969    .0395307
         lnw |   1.261181   .2148837     5.87   0.000     .8400171    1.682346
       _cons |  -6.338834   .9643107    -6.57   0.000    -8.228848    -4.44882
------------------------------------------------------------------------------
. predict ihat, xb

. g lambda=normalden(ihat)/normal(ihat)
```

*Second Step estimate Linear model using lambda as another independent variable

```
. reg y_heckit lnw lambda

      Source |       SS           df       MS      Number of obs   =        83
-------------+----------------------------------   F(2, 80)        =     11.81
       Model |  11165797.9         2  5582898.93   Prob > F        =    0.0000
    Residual |  37809623.2        80   472620.29   R-squared       =    0.2280
-------------+----------------------------------   Adj R-squared   =    0.2087
       Total |  48975421.1        82  597261.233   Root MSE        =    687.47

------------------------------------------------------------------------------
    y_heckit |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   1050.129   271.5115     3.87   0.000     509.8043    1590.454
      lambda |   666.5792   356.2851     1.87   0.065    -42.45072    1375.609
       _cons |  -2683.291    1059.61    -2.53   0.013    -4791.981   -574.6004
------------------------------------------------------------------------------

. heckman y_heckit lnw, select(s=iq lnw) twostep

Heckman selection model -- two-step estimates   Number of obs     =        200
(regression model with sample selection)        Censored obs      =        117
                                                Uncensored obs    =         83

                                                Wald chi2(1)      =      12.78
                                                Prob > chi2       =     0.0004

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  y_heckit   |
         lnw |   1050.129   293.8055     3.57   0.000     474.2813    1625.978
       _cons |  -2683.291   1137.001    -2.36   0.018    -4911.772   -454.8098
-------------+----------------------------------------------------------------
s            |
          iq |   .0261638     .00682     3.84   0.000     .0127969    .0395307
         lnw |   1.261181   .2148837     5.87   0.000     .8400171    1.682346
       _cons |  -6.338834   .9643107    -6.57   0.000    -8.228848    -4.44882
-------------+----------------------------------------------------------------
mills        |
      lambda |   666.5792   371.6204     1.79   0.073    -61.78329    1394.942
-------------+----------------------------------------------------------------
         rho |    0.79511
       sigma |  838.34915
------------------------------------------------------------------------------
```

Tobit Model

Censored Data #3 (Both variables can be observed but y is censored)

```
. reg y_censor lnw

      Source |       SS           df       MS      Number of obs   =       200
-------------+----------------------------------   F(1, 198)       =     59.65
       Model |  23213531.4         1  23213531.4   Prob > F        =    0.0000
    Residual |  77053652.3       198   389159.86   R-squared       =    0.2315
-------------+----------------------------------   Adj R-squared   =    0.2276
       Total |   100267184       199  503855.194   Root MSE        =    623.83

------------------------------------------------------------------------------
    y_censor |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   605.8653   78.44577     7.72   0.000     451.1689    760.5618
       _cons |  -1171.216   220.1003    -5.32   0.000    -1605.258   -737.1745
------------------------------------------------------------------------------

. predict y_chat
(option xb assumed; fitted values)

. est store m_ychat

. tobit y_censor lnw, ll(0)

Tobit regression                                Number of obs     =        200
                                                LR chi2(1)        =      54.42
                                                Prob > chi2       =     0.0000
Log likelihood = -938.40494                     Pseudo R2         =     0.0282

------------------------------------------------------------------------------
    y_censor |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   1064.249   144.4785     7.37   0.000     779.3438    1349.154
       _cons |  -2840.529   425.9706    -6.67   0.000    -3680.525   -2000.534
-------------+----------------------------------------------------------------
      /sigma |   971.0231   72.23195                      828.5849    1113.461
------------------------------------------------------------------------------
            94  left-censored observations at y_censor <= 0
           106     uncensored observations
             0 right-censored observations

. predict censored, ystar(0,.)

. est store m_ycensor

. lrtest m_ychat m_ycensor, force

Likelihood-ratio test                                 LR chi2(1)  =   1263.10
(Assumption: m_ychat nested in m_ycensor)             Prob > chi2 =    0.0000

. mfx compute, predict(ystar(0,.)) at(mean)

Marginal effects after tobit
      y  = E(y_censor*|y_censor>0) (predict, ystar(0,.))
         =  431.32202
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     lnw |   569.2075      77.128    7.38   0.000   418.039  720.376   2.74884
------------------------------------------------------------------------------

. mfx compute, predict(ystar(0,.)) at(median)

Marginal effects after tobit
      y  = E(y_censor*|y_censor>0) (predict, ystar(0,.))
```

```
         =  430.76061
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     lnw |   568.7501       77.02    7.38   0.000   417.793  719.707   2.74785
------------------------------------------------------------------------------

. mfx compute, predict(ystar(0,.)) at(0)

Marginal effects after tobit
      y  = E(y_censor*|y_censor>0) (predict, ystar(0,.))
         =  .48195414
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     lnw |   1.831199     2.30802    0.79   0.428  -2.69244  6.35484         0
------------------------------------------------------------------------------

. reg y_out lnw

      Source |       SS           df       MS      Number of obs   =       200
-------------+----------------------------------   F(1, 198)       =     15.29
       Model |  1.5746e+09         1  1.5746e+09   Prob > F        =    0.0001
    Residual |  2.0391e+10       198   102982831   R-squared       =    0.0717
-------------+----------------------------------   Adj R-squared   =    0.0670
       Total |  2.1965e+10       199   110377668   Root MSE        =     10148

------------------------------------------------------------------------------
       y_out |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   4989.815   1276.109     3.91   0.000     2473.305    7506.326
       _cons |  -11806.91   3580.461    -3.30   0.001    -18867.64   -4746.177
------------------------------------------------------------------------------

. predict y_ohat
(option xb assumed; fitted values)

. est store m_yout

. reg y_out lnw if y_out<=2000

      Source |       SS           df       MS      Number of obs   =       191
-------------+----------------------------------   F(1, 189)       =     44.50
       Model |  34734753.2         1  34734753.2   Prob > F        =    0.0000
    Residual |   147535536       189  780611.304   R-squared       =    0.1906
-------------+----------------------------------   Adj R-squared   =    0.1863
       Total |   182270290       190  959317.314   Root MSE        =    883.52

------------------------------------------------------------------------------
       y_out |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   821.3192   123.1253     6.67   0.000     578.4429    1064.196
       _cons |  -2254.793   339.3867    -6.64   0.000    -2924.266   -1585.321
------------------------------------------------------------------------------

. predict y_ohat2000
(option xb assumed; fitted values)

. est store m_yout2000

. tobit y_out lnw, ul(2000)

Tobit regression                                Number of obs     =        200
                                                LR chi2(1)        =      60.50
                                                Prob > chi2       =     0.0000
Log likelihood = -1587.9905                     Pseudo R2         =     0.0187
```

```
------------------------------------------------------------------------------
       y_out |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnw |   1001.682   121.2511     8.26   0.000     762.5804    1240.784
       _cons |  -2670.814   338.5213    -7.89   0.000    -3338.363   -2003.264
-------------+----------------------------------------------------------------
      /sigma |   937.6824   48.43803                      842.1647      1033.2
------------------------------------------------------------------------------
           0  left-censored observations
         191     uncensored observations
           9 right-censored observations at y_out >= 2000

. predict y_outcensor
(option xb assumed; fitted values)

. est store m_youtcensor

. est table m_ystar m_ythat m_ytrunc m_ythat2 m_ytrunc2 m_ychat m_ycensor m_yout
m_yout2000 m_youtcensor, star(.1 .05 .01) stat(N N_cens rss ll rmse F chi2 r2
r2_a)
```

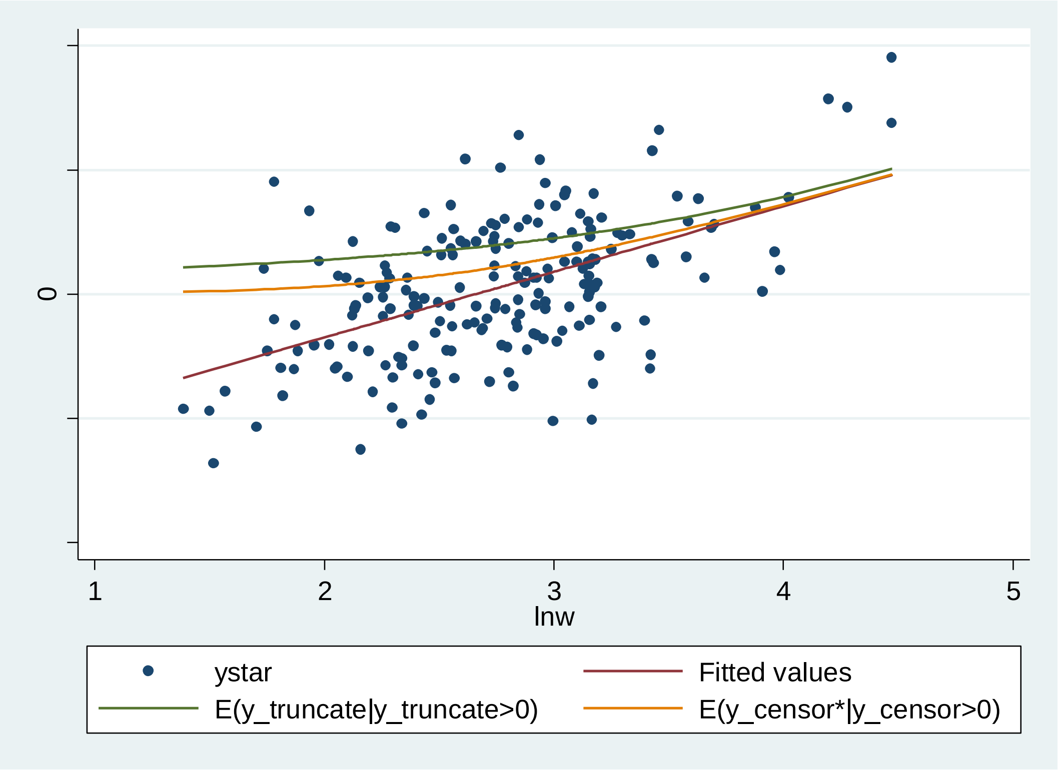
Variable	m_ystar	m_ythat	m_ytrunc	m_ythat2	m_yheckit	m_ychat	m_ycensor	m_yout	m_yout2000	m_youtcensor
_										
lnw	1057.2106***	526.55967***		610.591***		605.86535***		4989.8154***	821.31922***	
_cons	-2811.0372***	-627.69241*		-864.1064**		-1171.216***		-11806.909***	-2254.7934***	
eq1										
lnw			1196.5693***							
_cons			-3411.6083**							
sigma										
_cons			1043.2681***				971.02312***			937.68243***
y_heckit										
lnw					1050.1294***					
_cons					-2683.291**					
s										
iq					.02616383***					
lnw					1.2611814***					
_cons					-6.338834***					
mills										
lambda					666.57923*					
model										
lnw							1064.249***			1001.6824***
_cons							-2840.5292***			-2670.8136***
Statistics										
N	200	106	106	83	200	200	200	200	191	200
N_cens					117					
rss	1.809e+08	47916691		39463947		77053652		2.039e+10	1.475e+08	
ll	-1655.3097	-840.54886	-818.34658	-660.26228		-1569.9572	-938.40494	-2127.79	-1565.74	-1587.9905
rmse	955.88272	678.77641		698.00374		623.82679		10148.046	883.5221	
F	77.357559	19.603158		19.52236		59.650374		15.289494	44.496862	
chi2			11.330525		12.775146		54.415606			60.498833
r2	.28093494	.15859755		.19420913		.23151674		.07168423	.19056728	
r2_a	.2773033	.15050714		.18426109		.22763551		.06699577	.18628457	

legend: * p<.1; ** p<.05; *** p<.01

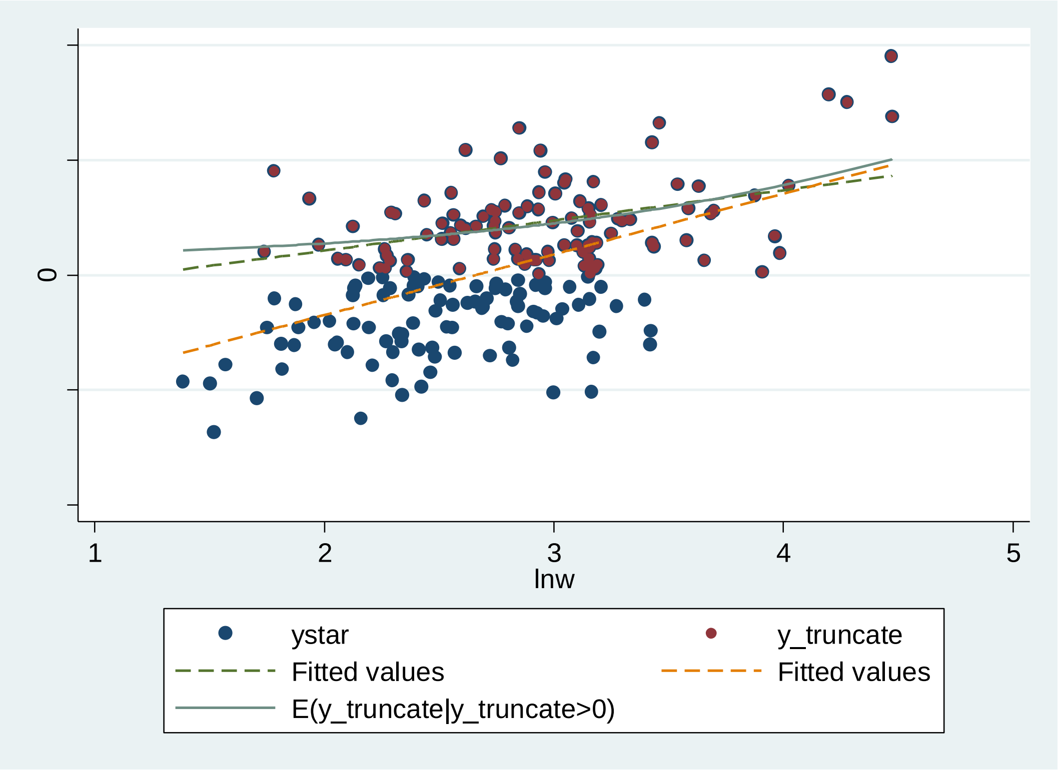
Variable	m_ystar	m_ythat	m_y trunc	m_ythat2	m_y Heckit	m_ychat	m_y censor	m_yout	m_yout 2000	m_yout censor
lnw	1057.21 ***	526.56 ***	1196.57 ***	610.59 ***	1050.13 ***	605.87 ***	1064.25 ***	4989.82 ***	821.32 ***	1001.68 ***
Constant	-2811.04 ***	-627.69 *	-3411.61 **	-864.11 **	-2683.29 **	-1171.22 ***	-2840.53 ***	-11806.91 ***	-2254.79 ***	-2670.81 ***
lambda					666.58 *					
s-(Selection)										
iq					0.03 ***					
lnw					1.26 ***					
Constant					-6.34 ***					
sigma			1043.27 ***				971.02 ***			937.68 ***
RMSE	955.88	678.78		698.00		623.83		10148.05	883.52	
Observations	200	106	106	83	200	200	200	200	191	200
Censored Obs.					117					
RSS	1.8E+08	4.8E+07		3.9E+07		7.7E+07		2.0E+10	1.5E+08	
Loglikelihood	-1655.31	-840.55	-818.35	-660.26		-1569.96	-938.40	-2127.79	-1565.74	-1587.99
F-test	77.36 ***	19.60 ***		19.52 ***		59.65 ***		15.29 ***	44.50 ***	
Chi-square Test			11.33 ***		12.78 ***		54.42 ***			60.50 ***
R-square	0.2809	0.1586		0.1942		0.2315		0.0717	0.1906	
Adj. R-square	0.2773	0.1505		0.1843		0.2276		0.0670	0.1863	
Pseudo R^2							0.0282			0.0187

Note: * significant at 0.1, ** significant at 0.05, and *** significant at 0.01

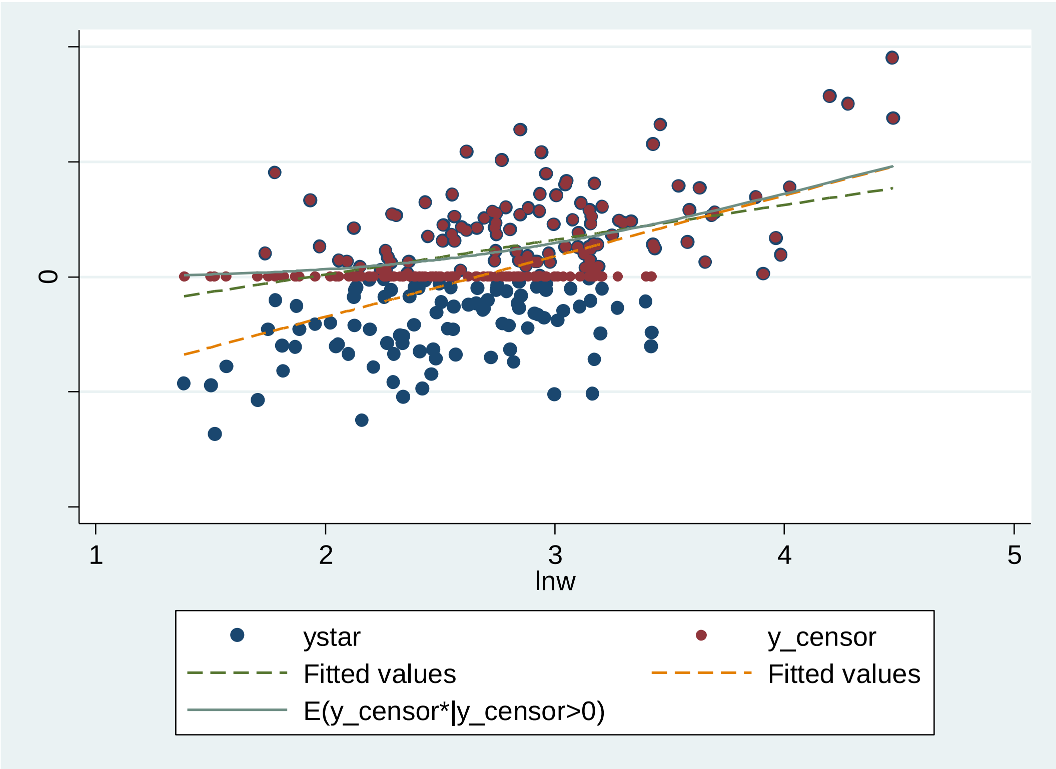
```
. graph twoway (scatter ystar lnw, ms(o)) (line uncensored lnw, sort) (line
truncated lnw, sort) (line censored lnw, sort)
```




```
. graph twoway (scatter ystar lnw) (scatter y_truncate lnw, ms(o)) (line y_that
lnw, sort lpattern(dash)) (line uncensored lnw, sort lpattern(dash)) (line
truncated lnw, sort)
```



```
. graph twoway (scatter ystar lnw) (scatter y_censor lnw, ms(o)) (line y_chat
lnw, sort lpattern(dash)) (line uncensored lnw, sort lpattern(dash)) (line
censored lnw, sort)
```



Truncated Regression Model

The model:

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \varepsilon_i$$

where

y_i	=	wife's hours of work
x_{1i}	=	number of children younger than 6
x_{2i}	=	number of children between 6 and 18
x_{3i}	=	wife's age
x_{4i}	=	wife's educational attainment
ε_i	=	Error term

```
. regress y x1 x2 x3 x4

      Source |       SS       df       MS              Number of obs =     250
-------------+------------------------------           F(  4,   245) =    5.27
       Model |  16526046.1     4  4131511.52           Prob > F      =  0.0004
    Residual |   192218058   245    784563.5           R-squared     =  0.0792
-------------+------------------------------           Adj R-squared =  0.0641
       Total |   208744104   249  838329.733           Root MSE      =  885.76

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -462.1233   124.6768    -3.71   0.000    -707.6985   -216.5481
          x2 |    -91.141   45.85001    -1.99   0.048    -181.4515   -.8305151
          x3 |   -13.1577   8.334958    -1.58   0.116    -29.57502    3.259612
          x4 |   53.26156   26.09369     2.04   0.042     1.864986    104.6581
       _cons |   940.0593   530.7197     1.77   0.078     -105.296    1985.415
------------------------------------------------------------------------------

. regress y x1 x2 x3 x4 if y>0

      Source |       SS       df       MS              Number of obs =     150
-------------+------------------------------           F(  4,   145) =    2.80
       Model |  7326995.15     4  1831748.79           Prob > F      =  0.0281
    Residual |  94793104.2   145  653745.546           R-squared     =  0.0717
-------------+------------------------------           Adj R-squared =  0.0461
       Total |   102120099   149  685369.794           Root MSE      =  808.55

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -421.4822   167.9734    -2.51   0.013    -753.4748   -89.48953
          x2 |  -104.4571   54.18616    -1.93   0.056    -211.5538    2.639668
          x3 |  -4.784917   9.690502    -0.49   0.622     -23.9378    14.36797
          x4 |   9.353195   31.23793     0.30   0.765    -52.38731     71.0937
       _cons |   1629.817   615.1301     2.65   0.009     414.0371    2845.597
------------------------------------------------------------------------------

. truncreg y x1 x2 x3 x4, ll(0) nolog
(note: 100 obs. truncated)

Truncated regression
Limit:   lower =          0                             Number of obs =    150
         upper =       +inf                             Wald chi2(4)  =  10.05
Log likelihood = -1200.9157                             Prob > chi2   = 0.0395
------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -803.0042   321.3614    -2.50   0.012    -1432.861   -173.1474
          x2 |   -172.875   88.72898    -1.95   0.051    -346.7806    1.030578
          x3 |  -8.821122   14.36848    -0.61   0.539    -36.98283    19.34059
          x4 |   16.52873   46.50375     0.36   0.722    -74.61695    107.6744
       _cons |    1586.26    912.355     1.74   0.082    -201.9233    3374.442
-------------+----------------------------------------------------------------
      /sigma |   983.7262   94.44303    10.42   0.000     798.6213    1168.831
------------------------------------------------------------------------------
```

Marginal Effect on Truncated Expected Value

```
. mfx compute, predict(e(0,.))

Marginal effects after truncreg
      y  = E(y|y>0) (predict, e(0,.))
         =  1310.0294
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |  -521.9979       199.4   -2.62   0.009  -912.818 -131.178   .173333
      x2 |  -112.3785      56.487   -1.99   0.047  -223.091 -1.66638   1.31333
      x3 |  -5.734226     9.31985   -0.62   0.538  -24.0008  12.5323   42.7867
      x4 |    10.7446       30.21    0.36   0.722  -48.4655  69.9547     12.64
------------------------------------------------------------------------------
```

Marginal Effect on Censored Expected Value

```
. mfx compute, predict(ystar(0,.))

Marginal effects after truncreg
      y  = E(y*|y>0) (predict, ystar(0,.))
         =  1123.2815
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |   -688.534      266.12   -2.59   0.010  -1210.11 -166.957   .173333
      x2 |  -148.2313      74.802   -1.98   0.048  -294.841 -1.62154   1.31333
      x3 |   -7.56365      12.299   -0.61   0.539  -31.6686  16.5413   42.7867
      x4 |   14.17252      39.853    0.36   0.722  -63.9373  92.2823     12.64
------------------------------------------------------------------------------
```

Tobit Model: Factors Determining Research and Development Expenditures of the Firm in Thai Electronic Industry

Tobit (Censored regression) Model

Metakunnavat (1999) studied factors determined research and development (R&D) expenditures of the firm in Thai electronic industry. The study applied Tobit model since the data set was censored distributed. The model is as follows:

$$Z_i = \alpha + \beta_1 MS_i + \beta_2 PCM_i + \beta_4 EXI_i + \beta_5 TOR_i + \beta_6 TOA_i + \beta_7 GOV_i + u_i \qquad \text{if } Z_{ik} > 0$$
$$Z_i = 0 \qquad \textit{Otherwise}$$

where:

Z_i	=	Research and development expenditures of firm i
MS_i	=	Market share of firm i
PCM_i	=	Profit contribution margin of firm i
CR_i	=	Concentration ratio of the industry
EXI_i	=	Export concentration of the industry
TOR_i	=	Dummy Variable = 1 if technology change within or more than 1 year = 0 otherwise
TOA_i	=	Dummy Variable = 1 if technology transfers from mother company = 0 otherwise
GOV_i	=	Dummy Variable = 1 if the industry receives government incentive for R&D = 0 otherwise
u_i	=	Error term

α and β_k are coefficients, where β_1, β_2, β_3, β_7 can be positive or negative, β_4 should be positive, β_5 and β_6 should be negative.

Since the data is censored distributed, the model should be estimated by using Maximum Likelihood Estimation (MLE) method. The log-likelihood function is as follows:

$$\ln L = \sum_0 \ln\left[\frac{1}{\sqrt{(2\pi\sigma^2)}}\right] - \sum_1 \frac{1}{2\sigma^2}\left(Z_i = \alpha + \beta_1 MS_i + \beta_2 PCM_i + \beta_4 EXI_i + \beta_5 TOR_i + \beta_6 TOA_i + \beta_7 GOV_i + u_i\right)^2$$

where $\sum_0$ is sum of observation N_0 for $Z_i = 0$

$\sum_1$ is sum of observation N_1 for $Z_i > 0$

Estimate Tobit Model

```
. reg z ms pcm exi tor toa gov

      Source |       SS       df       MS              Number of obs =      39
-------------+------------------------------           F(  6,    32) =   32.63
       Model |  216.685223     6  36.1142038           Prob > F      =  0.0000
    Residual |  35.4154445    32  1.10673264           R-squared     =  0.8595
-------------+------------------------------           Adj R-squared =  0.8332
       Total |  252.100667    38  6.63422808           Root MSE      =   1.052

------------------------------------------------------------------------------
           z |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ms |  -.0640993   .0351223    -1.83   0.077    -.1356411    .0074426
         pcm |   .0309549   .0168661     1.84   0.076    -.0034001      .06531
         exi |  -.0400559   .0277357    -1.44   0.158    -.0965517    .0164399
         tor |  -.2361991   .7166092    -0.33   0.744    -1.695884    1.223486
         toa |  -.3944311   .8892493    -0.44   0.660    -2.205773     1.41691
         gov |   4.507958   .5964943     7.56   0.000     3.292939    5.722977
       _cons |   2.127431    .639876     3.32   0.002     .8240464    3.430816
------------------------------------------------------------------------------

. reg z ms pcm exi tor toa gov if z>0

      Source |       SS       df       MS              Number of obs =      32
-------------+------------------------------           F(  6,    25) =   28.21
       Model |  175.885314     6   29.314219           Prob > F      =  0.0000
    Residual |  25.9772868    25  1.03909147           R-squared     =  0.8713
-------------+------------------------------           Adj R-squared =  0.8404
       Total |  201.862601    31   6.5116968           Root MSE      =  1.0194

------------------------------------------------------------------------------
           z |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ms |  -.1203294    .039932    -3.01   0.006    -.2025708    -.038088
         pcm |  -3.27e-06   .0195447    -0.00   1.000    -.0402564    .0402498
         exi |   -.004589   .0555295    -0.08   0.935    -.1189541     .109776
         tor |  -.7234769   .7208991    -1.00   0.325    -2.208196    .7612425
         toa |  -.0729069   .8929615    -0.08   0.936    -1.911996    1.766182
         gov |   4.227732   .5889693     7.18   0.000     3.014727    5.440737
       _cons |   3.710537   .8150497     4.55   0.000      2.03191    5.389163
------------------------------------------------------------------------------

. tobit z ms pcm exi tor toa gov, ll

Tobit regression                                  Number of obs   =         39
                                                  LR chi2(6)      =      72.99
                                                  Prob > chi2     =     0.0000
Log likelihood =  -50.51938                       Pseudo R2       =     0.4194

------------------------------------------------------------------------------
           z |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ms |  -.0477107   .0371136    -1.29   0.208    -.1232189    .0277974
         pcm |   .0348347   .0176433     1.97   0.057    -.0010609    .0707303
         exi |  -.0868502    .037064    -2.34   0.025    -.1622576   -.0114429
         tor |  -.0636297   .7400413    -0.09   0.932    -1.569255    1.441996
         toa |  -.3227235   .9279608    -0.35   0.730    -2.210674    1.565227
         gov |   4.603485   .6137318     7.50   0.000     3.354838    5.852132
       _cons |   1.857899   .6802613     2.73   0.010     .4738968    3.241901
-------------+----------------------------------------------------------------
      /sigma |   1.078782   .1373532                      .7993348    1.358229
------------------------------------------------------------------------------
  Obs. summary:          7  left-censored observations at z<=0
                        32     uncensored observations
                         0 right-censored observations
```

Marginal Effect on Censored Expected Value

```
. mfx compute, predict(ystar(0,.))

Marginal effects after tobit
      y  = E(z*|z>0) (predict, ystar(0,.))
         =  2.1685388
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      ms |  -.0466297      .03637   -1.28   0.200  -.117921  .024661   8.87769
     pcm |   .0340454      .01723    1.98   0.048   .000284  .067807    25.741
     exi |  -.0848824      .03577   -2.37   0.018  -.154982 -.014783   7.34615
    tor*|  -.0621636      .72276   -0.09   0.931  -1.47874  1.35441   .384615
    toa*|  -.3142121      .89959   -0.35   0.727  -2.07738  1.44895   .307692
    gov*|   4.568452      .60762    7.52   0.000   3.37755  5.75936   .128205
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

Marginal Effect on Truncated Expected Value

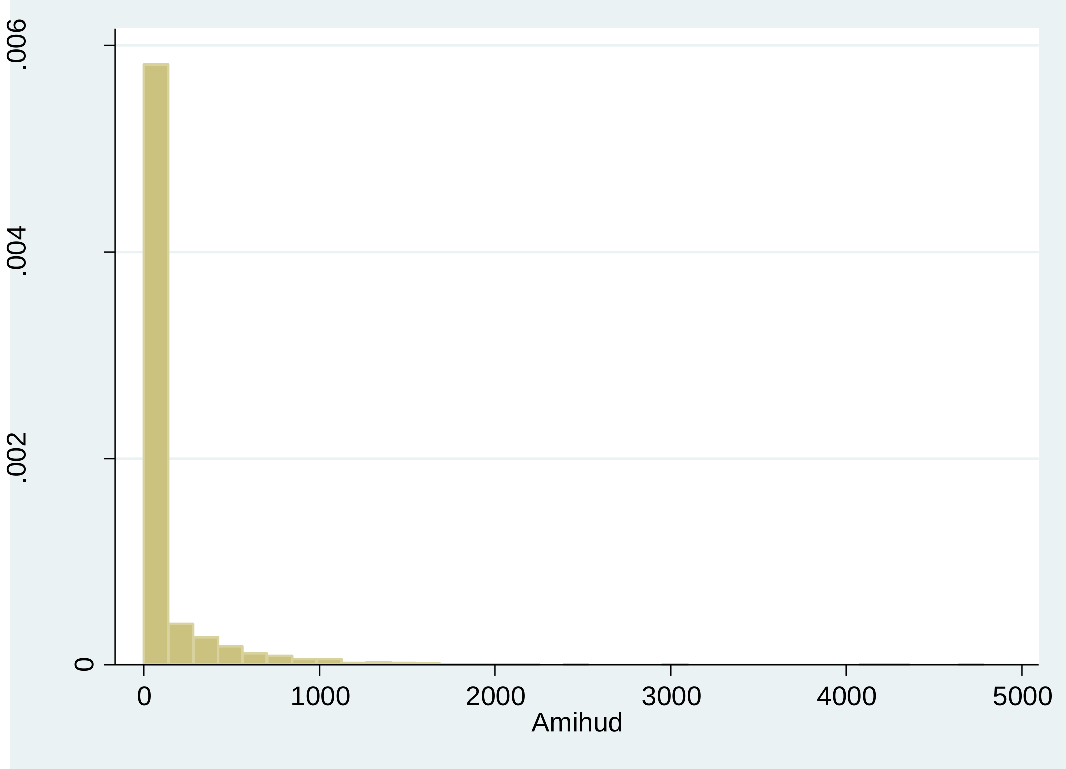
```
. mfx compute, predict(e(0,.))

Marginal effects after tobit
      y  = E(z|z>0) (predict, e(0,.))
         =  2.2188111
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      ms |  -.0423084      .03336   -1.27   0.205  -.107687  .023071   8.87769
     pcm |   .0308903       .0157    1.97   0.049   .000118  .061662    25.741
     exi |  -.0770161      .03163   -2.44   0.015  -.139005 -.015027   7.34615
    tor*|  -.0563431      .65456   -0.09   0.931  -1.33925  1.22656   .384615
    toa*|  -.2824412       .8012   -0.35   0.724  -1.85277  1.28789   .307692
    gov*|   4.442333      .59864    7.42   0.000   3.26902  5.61564   .128205
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

Tobit Model using Panel Data

The model:

```
. reg illiq cg3 cg4 cg5 priceinverse volatility age lnta lntv

      Source |       SS           df       MS      Number of obs   =     2,977
-------------+----------------------------------   F(8, 2968)      =     97.15
       Model |  56363870.5         8  7045483.82   Prob > F        =    0.0000
    Residual |   215247984     2,968  72522.9055   R-squared       =    0.2075
-------------+----------------------------------   Adj R-squared   =    0.2054
       Total |   271611854     2,976  91267.4241   Root MSE        =     269.3

------------------------------------------------------------------------------
       illiq |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         cg3 |   24.80985   13.18405     1.88   0.060    -1.040957    50.66066
         cg4 |  -7.020101    13.5703    -0.52   0.605    -33.62825    19.58805
         cg5 |  -.3996451   19.35628    -0.02   0.984    -38.35273    37.55344
priceinverse |   17.58497   4.064562     4.33   0.000      9.61532    25.55461
  volatility |   49.96149   12.54445     3.98   0.000     25.36479    74.55819
         age |  -.7652942   .6221881    -1.23   0.219    -1.985258    .4546697
        lnta |   2.136847   3.549215     0.60   0.547    -4.822325    9.096019
        lntv |  -30.41288   1.190944   -25.54   0.000    -32.74804   -28.07772
       _cons |   410.1833   51.51606     7.96   0.000     309.1725    511.1941
------------------------------------------------------------------------------

. xtreg illiq cg3 cg4 cg5 priceinverse volatility age lnta lntv

Random-effects GLS regression                   Number of obs     =      2,977
Group variable: id                              Number of groups  =        364

R-sq:                                           Obs per group:
     within  = 0.2147                                         min =          1
     between = 0.1891                                         avg =        8.2
     overall = 0.2075                                         max =         11

                                                Wald chi2(8)      =     777.19
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       illiq |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         cg3 |   24.80985   13.18405     1.88   0.060    -1.030415    50.65012
         cg4 |  -7.020101    13.5703    -0.52   0.605     -33.6174     19.5772
         cg5 |  -.3996451   19.35628    -0.02   0.984    -38.33726    37.53797
priceinverse |   17.58497   4.064562     4.33   0.000      9.61857    25.55136
  volatility |   49.96149   12.54445     3.98   0.000     25.37482    74.54816
         age |  -.7652942   .6221881    -1.23   0.219     -1.98476    .4541722
        lnta |   2.136847   3.549215     0.60   0.547    -4.819487    9.093181
        lntv |  -30.41288   1.190944   -25.54   0.000    -32.74708   -28.07867
       _cons |   410.1833   51.51606     7.96   0.000     309.2137    511.1529
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  263.35265
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. histogram illiq
(bin=34, start=0, width=140.68379)
```




```
. reg illiq cg3 cg4 cg5 priceinverse volatility age lnta lntv if illiq<=10

      Source |       SS           df       MS      Number of obs   =     1,955
-------------+----------------------------------   F(8, 1946)      =    119.48
       Model |  4107.06559         8  513.383199   Prob > F        =    0.0000
    Residual |   8361.3469     1,946  4.29668392   R-squared       =    0.3294
-------------+----------------------------------   Adj R-squared   =    0.3266
       Total |  12468.4125     1,954  6.38096852   Root MSE        =    2.0728

------------------------------------------------------------------------------
       illiq |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         cg3 |   .1123272   .1307872     0.86   0.391    -.1441704    .3688249
         cg4 |   .0250911   .1295811     0.19   0.846    -.2290412    .2792234
         cg5 |  -.2842084   .1745142    -1.63   0.104    -.6264628    .0580461
priceinverse |   .0490283   .0361919     1.35   0.176    -.0219506    .1200072
  volatility |   .4704564   .3073261     1.53   0.126    -.1322667    1.073179
         age |  -.0057336   .0061178    -0.94   0.349    -.0177317    .0062646
        lnta |  -.0873353   .0322229    -2.71   0.007    -.1505304   -.0241403
        lntv |  -.3887633   .0141307   -27.51   0.000    -.4164762   -.3610503
       _cons |   8.613544   .4742816    18.16   0.000     7.683391    9.543697
------------------------------------------------------------------------------

. est store m_ols

. xtreg illiq cg3 cg4 cg5 priceinverse volatility age lnta lntv if illiq<=10

Random-effects GLS regression                   Number of obs     =      1,955
Group variable: id                              Number of groups  =        363

R-sq:                                           Obs per group:
     within  = 0.2137                                         min =          1
     between = 0.3917                                         avg =        5.4
     overall = 0.3265                                         max =         11
```

```
                                                Wald chi2(8)      =     675.63
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       illiq |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         cg3 |   .1798028    .138313     1.30   0.194    -.0912858    .4508913
         cg4 |   .0675304   .1518841     0.44   0.657    -.2301568    .3652177
         cg5 |  -.3543256    .206638    -1.71   0.086    -.7593285    .0506774
priceinverse |   .0458346   .0449247     1.02   0.308    -.0422162    .1338855
  volatility |   .4216365   .2782431     1.52   0.130    -.1237101     .966983
         age |  -.0055548   .0101237    -0.55   0.583    -.0253969    .0142873
        lnta |  -.1492212   .0498566    -2.99   0.003    -.2469383   -.0515042
        lntv |  -.3708759   .0156255   -23.74   0.000    -.4015014   -.3402505
       _cons |   9.305451    .753601    12.35   0.000      7.82842    10.78248
-------------+----------------------------------------------------------------
     sigma_u |   1.237113
     sigma_e |  1.7903483
         rho |  .32316608   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store m_re

. tobit illiq cg3 cg4 cg5 priceinverse volatility age lnta lntv, ul(10)

Tobit regression                                Number of obs     =      2,977
                                                LR chi2(8)        =    2533.12
                                                Prob > chi2       =     0.0000
Log likelihood =  -6029.448                     Pseudo R2         =     0.1736

------------------------------------------------------------------------------
       illiq |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         cg3 |   .2172985   .2003655     1.08   0.278    -.1755708    .6101678
         cg4 |  -.3826641    .202276    -1.89   0.059    -.7792795    .0139513
         cg5 |  -1.071681   .2817109    -3.80   0.000    -1.624049   -.5193121
priceinverse |   .4909429   .0600655     8.17   0.000     .3731686    .6087172
  volatility |   1.280187    .409213     3.13   0.002     .4778173    2.082557
         age |  -.0608728   .0093941    -6.48   0.000    -.0792925   -.0424532
        lnta |   .1099787   .0518977     2.12   0.034     .0082196    .2117379
        lntv |  -1.026462   .0198271   -51.77   0.000    -1.065339   -.9875858
       _cons |   16.63525   .7591861    21.91   0.000     15.14666    18.12383
-------------+----------------------------------------------------------------
      /sigma |   3.728514   .0639989                      3.603027    3.854001
------------------------------------------------------------------------------
              0  left-censored observations
          1,955     uncensored observations
          1,022 right-censored observations at illiq >= 10

. est store m_tobit

. xttobit illiq cg3 cg4 cg5 priceinverse volatility age lnta lntv, ul(10) tobit

Fitting comparison model:

Fitting constant-only model:

Iteration 0:   log likelihood = -7610.0147
...
Iteration 4:   log likelihood = -7296.0086

Fitting full model:

Iteration 0:   log likelihood = -6428.0774
...
Iteration 4:   log likelihood =  -6029.448
```

```
Obtaining starting values for full model:

Iteration 0:   log likelihood = -20869.134
...
Iteration 3:   log likelihood = -20868.303

Fitting full model:

Iteration 0:   log likelihood = -13142.023  (not concave)
...
Iteration 24:  log likelihood =  -5963.092

Random-effects tobit regression                 Number of obs     =      2,977
Group variable: id                              Number of groups  =        364

Random effects u_i ~ Gaussian                   Obs per group:
                                                              min =          1
                                                              avg =        8.2
                                                              max =         11

Integration method: mvaghermite                 Integration pts.  =         12

                                                Wald chi2(8)      =    2733.60
Log likelihood  =  -5963.092                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       illiq |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         cg3 |   .2228948   .2097675     1.06   0.288    -.1882418    .6340315
         cg4 |  -.4571934   .2307403    -1.98   0.048     -.909436   -.0049508
         cg5 |  -1.323098   .3258371    -4.06   0.000    -1.961727   -.6844687
priceinverse |   .4500789   .0707748     6.36   0.000     .3113629     .588795
  volatility |   .9726182   .3663227     2.66   0.008      .254639    1.690597
         age |  -.0727522    .015117    -4.81   0.000    -.1023811   -.0431234
        lnta |     .07527   .0776228     0.97   0.332     -.076868     .227408
        lntv |  -1.110499   .0219535   -50.58   0.000    -1.153527   -1.067471
       _cons |   18.19677   1.177496    15.45   0.000     15.88892    20.50462
-------------+----------------------------------------------------------------
    /sigma_u |   1.787151   .1292638    13.83   0.000     1.533799    2.040503
    /sigma_e |   3.371697   .0621459    54.25   0.000     3.249893    3.493501
-------------+----------------------------------------------------------------
         rho |    .219328   .0264152                      .1711513     .274485
------------------------------------------------------------------------------
LR test of sigma_u=0: chibar2(01) = 132.71             Prob >= chibar2 = 0.000

             0  left-censored observations
         1,955     uncensored observations
         1,022 right-censored observations

. est store m_tobitRE
```

```
. est table m_ols m_re m_tobit m_tobitRE, star(.1 .05 .01) stat(N rss ll rmse F chi2
r2)

------------------------------------------------------------------------------
    Variable |     m_ols            m_re            m_tobit        m_tobitRE    
-------------+----------------------------------------------------------------
_            |
         cg3 |  .11232723       .17980277                                      
         cg4 |  .02509113       .06753045                                      
         cg5 | -.28420835      -.35432556*                                     
priceinverse |  .04902826       .04583464                                      
  volatility |  .47045635       .42163649                                      
         age | -.00573357      -.00555479                                      
        lnta | -.08733535***   -.14922121***                                   
        lntv | -.38876328***   -.37087594***                                   
       _cons |  8.6135439***    9.3054512***                                   
-------------+----------------------------------------------------------------
model        |
         cg3 |                                  .21729851                      
         cg4 |                                 -.38266409*                     
         cg5 |                                 -1.0716805***                   
priceinverse |                                   .4909429***                   
  volatility |                                  1.2801871***                   
         age |                                 -.06087281***                   
        lnta |                                  .10997874**                    
        lntv |                                 -1.0264622***                   
       _cons |                                  16.635248***                   
-------------+----------------------------------------------------------------
sigma        |
       _cons |                                  3.7285138***                   
-------------+----------------------------------------------------------------
illiq        |
         cg3 |                                                   .2228948      
         cg4 |                                                 -.45719339**    
         cg5 |                                                 -1.3230978***   
priceinverse |                                                  .45007892***   
  volatility |                                                  .97261821***   
         age |                                                 -.07275223***   
        lnta |                                                  .07527003      
        lntv |                                                 -1.1104994***   
       _cons |                                                  18.196771***   
-------------+----------------------------------------------------------------
sigma_u      |
       _cons |                                                   1.787151***   
-------------+----------------------------------------------------------------
sigma_e      |
       _cons |                                                  3.3716973***   
-------------+----------------------------------------------------------------
Statistics   |
           N |       1955            1955            2977            2977      
         rss |  8361.3469                                                      
          ll | -4194.5565                       -6029.448       -5963.092      
        rmse |  2.0728444       1.7955137                                      
           F |  119.48359                                                      
        chi2 |                  675.63485       2533.1212       2733.6048      
          r2 |  .32939764                                                      
------------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01
```

Variable	m_ols	m_re	m_tobit	m_tobitRE
cg3	0.1123	0.1798	0.2173	0.2229
cg4	0.0251	0.0675	-0.3827 *	-0.4572 **
cg5	-0.2842	-0.3543 *	-1.0717 ***	-1.3231 ***
priceinverse	0.0490	0.0458	0.4909 ***	0.4501 ***
volatility	0.4705	0.4216	1.2802 ***	0.9726 ***
age	-0.0057	-0.0056	-0.0609 ***	-0.0728 ***
lnta	-0.0873 ***	-0.1492 ***	0.1100 **	0.0753
lntv	-0.3888 ***	-0.3709 ***	-1.0265 ***	-1.1105 ***
Constant	8.6135 ***	9.3055 ***	16.6352 ***	18.1968 ***
sigma_u				1.7872 ***
sigma_e			3.7285 ***	3.3717 ***
N	1955	1955	2977	2977
RSS	8361.35			
Log-likelihood	-4194.6		-6029.4	-5963.09
RMSE	2.07284	1.79551		
F-test	119.484 ***			
Chi-square Test		675.635 ***	2533.12 ***	2733.605 ***
Chi2 Comparison				132.712 ***
R-square	0.3294			
Overall R2		0.32654		
Pseudo R2			0.1736	