Assignment 11
Truncated Regression & Tobit Models
Guideline Solution

The model

According to the following model,

$$y_{ki} = \beta_{k0} + \beta_{k1} x_i + u_{ki} \qquad (1)$$

where: y_{ki} is Dependent variable, k=1, 2, 3.

x_i is Independent variable

u_i is Stochastic disturbance term

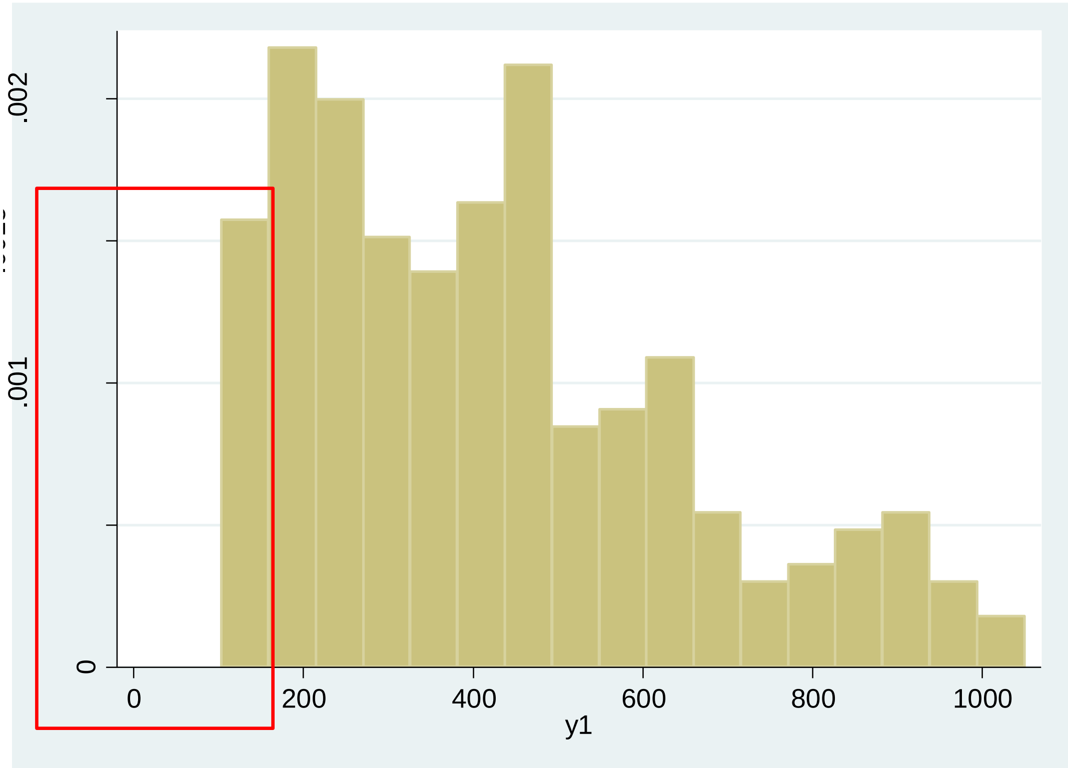
Requirements: `(assign11.dta)`

1 Plot histogram of y_{1i}, y_{2i}, y_{3i}, compute descriptive statistics of these three variables, then determine limitation of these three dependent variables.

```
. sum y1 y2 y3

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
          y1 |       297    423.1683    227.8976   103.4663   1049.314
          y2 |       400    317.5914    266.3419          0   1049.314
          y3 |       400     10446.1    23186.57  -866.3348   99508.07

. histogram y1
(bin=17, start=103.46626, width=55.638129)
```



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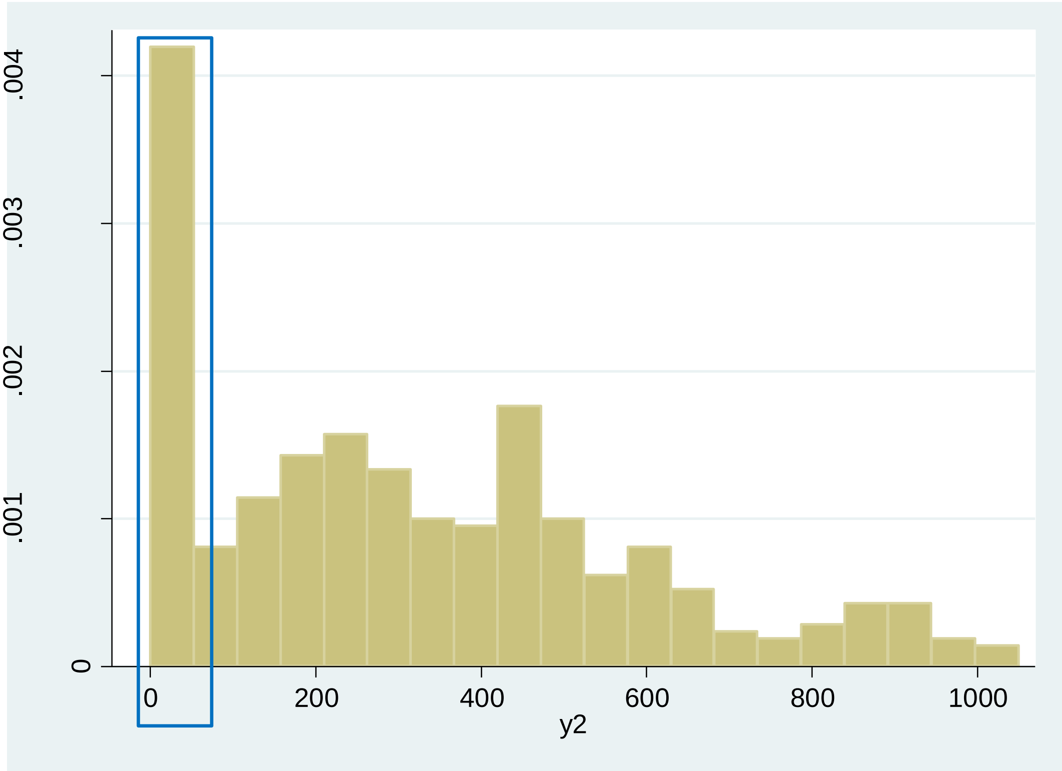
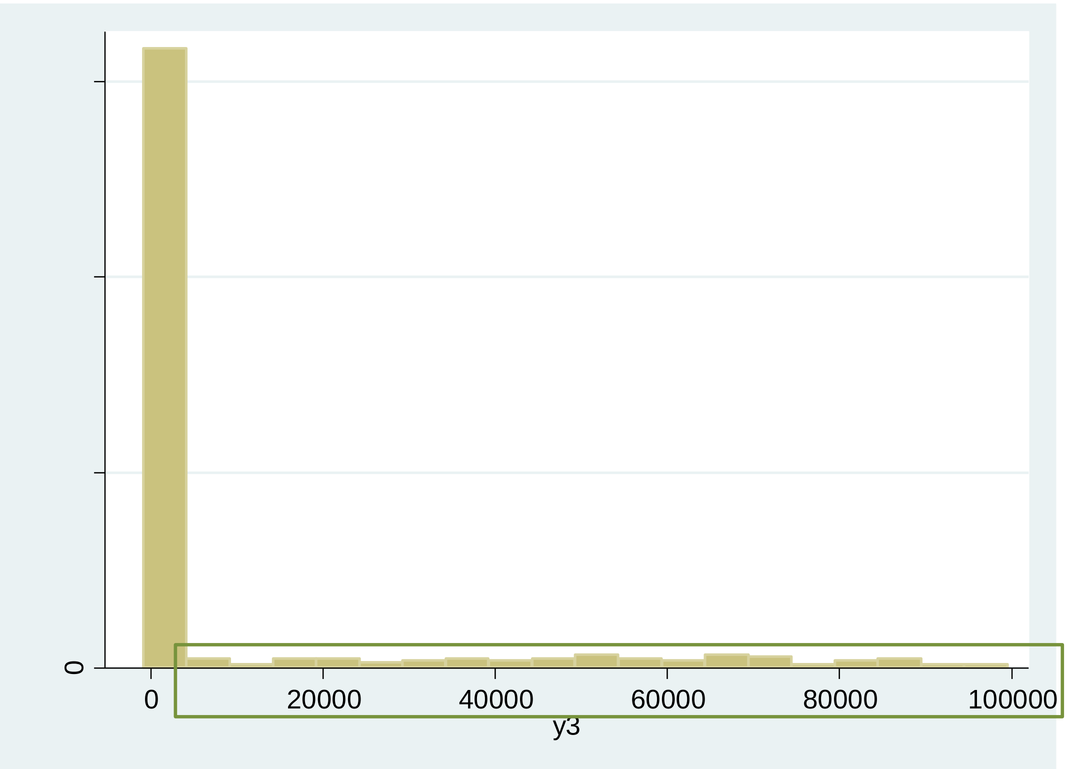
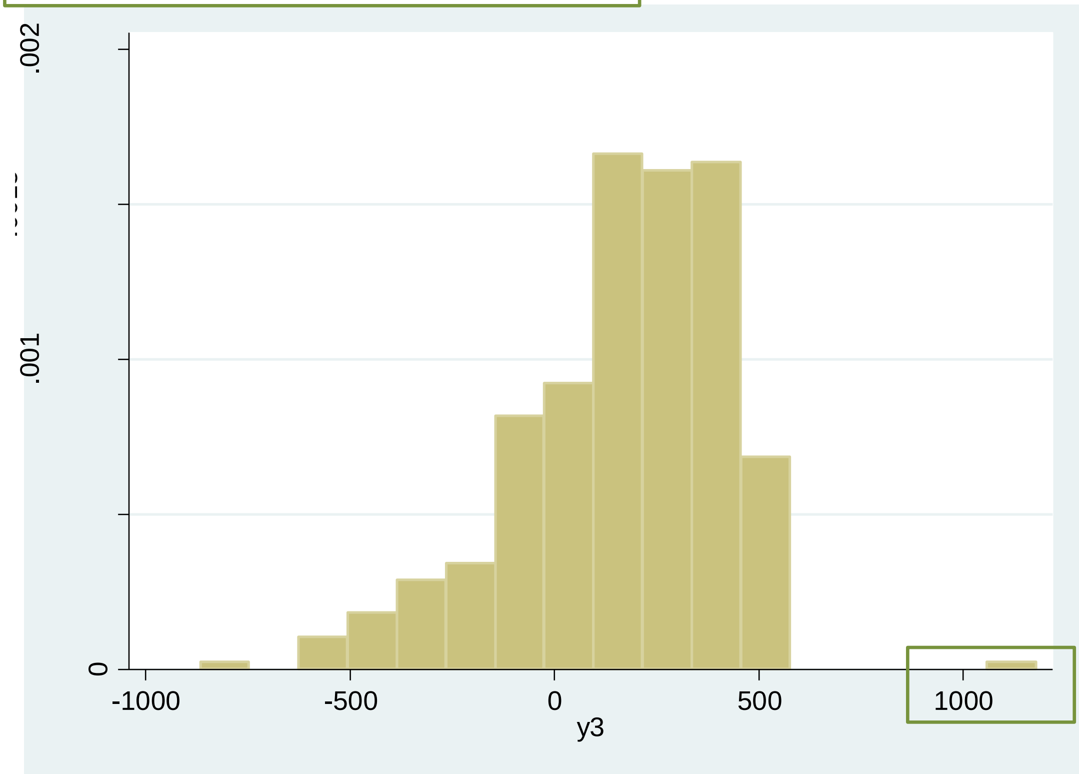
```
. histogram y2
(bin=20, start=0, width=52.465723)
```




```
. histogram y3
(bin=20, start=-866.33484, width=5018.7203)
```



```
. histogram y3 if y3<2000
(bin=17, start=-866.33484, width=120.20064)
```



- ***According to descriptive statistics (mean, sd., min., & max.) and histogram, it might be concluded that y_1 has truncated problem at around 103, y_2 has censored problem at 0, y_3 has outlier problem.***

2 Estimate the model (1) for y_{1i}, y_{2i}, y_{3i} using OLS, using truncated regression model, Tobit model, determine the most appropriated models for each y_{ki}.

(1) <u>Estimated Results of Linear Regression Model of y_1 using OLS</u>

```
. reg y1 x

      Source |       SS           df       MS      Number of obs   =       297
-------------+----------------------------------   F(1, 295)       =     30.30
       Model |  1431905.59         1  1431905.59   Prob > F        =    0.0000
    Residual |  13941534.7       295  47259.4396   R-squared       =    0.0931
-------------+----------------------------------   Adj R-squared   =    0.0901
       Total |  15373440.3       296  51937.2982   Root MSE        =    217.39

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   123.1693   22.37637     5.50   0.000     79.13176    167.2069
       _cons |   69.01677   65.56422     1.05   0.293    -60.01611    198.0496
------------------------------------------------------------------------------

. est store m_y1

. sum y1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y1 |        297    423.1683    227.8976   103.4663   1049.314

. scalar miny1=round(r(min))

. scalar list miny1
     miny1 =        103
```

Estimated Results of Truncated Regression Model

```
. truncreg y1 x, ll(miny1) nolog
(note: 0 obs. truncated)

Truncated regression
Limit:   lower =        103                     Number of obs     =        297
         upper =       +inf                     Wald chi2(1)      =      23.38
Log likelihood = -1973.9423                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   249.6062   51.61679     4.84   0.000     148.4392    350.7733
       _cons |  -456.6913   178.5338    -2.56   0.011    -806.6112   -106.7714
-------------+----------------------------------------------------------------
      /sigma |   306.4488   26.46552    11.58   0.000     254.5774    358.3203
------------------------------------------------------------------------------

. predict truncated, e(103,.)

. est store m_y1t
```

Marginal Effects

```
. mfx compute, predict(e(103,.)) at(mean)

Marginal effects after truncreg
      y  = E(y1|y1>103) (predict, e(103,.))
         =  414.59149
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
       x |   122.4108      21.825    5.61   0.000   79.6352  165.186   2.87532
------------------------------------------------------------------------------

. mfx compute, predict(e(103,.)) at(median)

Marginal effects after truncreg
      y  = E(y1|y1>103) (predict, e(103,.))
         =  412.26932
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
       x |   121.3584      21.453    5.66   0.000   79.3107  163.406   2.85627
------------------------------------------------------------------------------

. mfx compute, predict(e(103,.)) at(0)

Marginal effects after truncreg
      y  = E(y1|y1>103) (predict, e(103,.))
         =  223.73689
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
       x |   31.25194     2.26987   13.77   0.000   26.8031  35.7008         0
------------------------------------------------------------------------------
```

Test Appropriateness of Truncated Regression Model

```
. lrtest m_y1 m_y1t, force

Likelihood-ratio test                                 LR chi2(1)  =     89.69
(Assumption: m_y1 nested in m_y1t)                    Prob > chi2 =    0.0000
```

- ***According to significant LR-test between linear regression model and Truncated regression model, it can be concluded that Truncated regression model is a more appropriated model in this case.***

(2) Estimated Results of Linear Regression Model of y_2 using OLS

```
. reg y2 x

      Source |       SS           df       MS      Number of obs   =       400
-------------+----------------------------------   F(1, 398)       =     76.58
       Model |  4567087.34         1  4567087.34   Prob > F        =    0.0000
    Residual |  23737174.2       398  59641.1413   R-squared       =    0.1614
-------------+----------------------------------   Adj R-squared   =    0.1592
       Total |  28304261.6       399  70937.9989   Root MSE        =    244.22
------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   179.8325   20.55046     8.75   0.000     139.4315    220.2335
       _cons |  -179.3679   58.08821    -3.09   0.002     -293.566   -65.1698
------------------------------------------------------------------------------

. est store m_y2
```

Estimated Results of Tobit Regression Model setting lower limit at 0

```
. tobit y2 x, ll(0)

Tobit regression                                  Number of obs     =       400
                                                  LR chi2(1)        =     73.17
                                                  Prob > chi2       =    0.0000
Log likelihood = -2389.3077                       Pseudo R2         =    0.0151

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   219.1562   24.86468     8.81   0.000     170.2741    268.0383
       _cons |  -318.6265   70.93087    -4.49   0.000    -458.0714   -179.1816
-------------+----------------------------------------------------------------
      /sigma |   284.9073   11.56717                      262.1671    307.6475
------------------------------------------------------------------------------
          72  left-censored observations at y2 <= 0
         328     uncensored observations
           0 right-censored observations

. est store m_y2c
```

Marginal Effects

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

Marginal effects after tobit
      y  = E(y2*|y2>0) (predict, ystar(0,.))
         =  310.40874
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
       x |   184.7744      20.984    8.81   0.000   143.647  225.902   2.76346
------------------------------------------------------------------------------

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

Marginal effects after tobit
      y  = E(y2*|y2>0) (predict, ystar(0,.))
         =  308.36848
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
       x |   184.3248      20.885    8.83   0.000    143.39  225.259    2.7524
------------------------------------------------------------------------------

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

Marginal effects after tobit
      y  = E(y2*|y2>0) (predict, ystar(0,.))
         =  18.851247
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
       x |   28.86472     8.50363    3.39   0.001   12.1979  45.5315         0
------------------------------------------------------------------------------
```

Test Appropriateness of Tobit Regression Model

```
. lrtest m_y2 m_y2c, force

Likelihood-ratio test                                 LR chi2(1)  =    752.97
(Assumption: m_y2 nested in m_y2c)                    Prob > chi2 =    0.0000
```

- ***According to significant LR-test between linear regression model and Tobit regression model, it can be concluded that Tobit regression model is a more appropriated model in this case.***

(3) Estimated Results of Linear Regression Model of y_3 using OLS

```
. reg y3 x

      Source |       SS           df       MS      Number of obs   =       400
-------------+----------------------------------   F(1, 398)       =     26.43
       Model |  1.3359e+10         1  1.3359e+10   Prob > F        =    0.0000
    Residual |  2.0115e+11       398   505402183   R-squared       =    0.0623
-------------+----------------------------------   Adj R-squared   =    0.0599
       Total |  2.1451e+11       399   537616802   Root MSE        =     22481

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   9726.042   1891.765     5.14   0.000     6006.941    13445.14
       _cons |  -16431.39   5347.288    -3.07   0.002    -26943.85   -5918.932
------------------------------------------------------------------------------

. predict y3_hat
(option xb assumed; fitted values)

. est store m_y3

. sum y3

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y3 |        400     10446.1    23186.57  -866.3348   99508.07
```

Estimated Results of Linear Regression Model setting constraint only y_3<=500

```
. reg y3 x if y3<=500

      Source |       SS           df       MS      Number of obs   =       314
-------------+----------------------------------   F(1, 312)       =     30.33
       Model |  1748440.94         1  1748440.94   Prob > F        =    0.0000
    Residual |  17984963.6       312  57644.1141   R-squared       =    0.0886
-------------+----------------------------------   Adj R-squared   =    0.0857
       Total |  19733404.5       313  63046.0209   Root MSE        =    240.09

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   130.1676   23.63496     5.51   0.000     83.66353    176.6717
       _cons |  -188.1423   64.52556    -2.92   0.004    -315.1025   -61.18199
------------------------------------------------------------------------------

. predict y3_hat_o
(option xb assumed; fitted values)

. est store m_y3o
```

Estimated Results of Tobit Regression Model setting upper limit at 500

```
. tobit y3 x, ul(500) nolog

Tobit regression                                Number of obs     =        400
                                                LR chi2(1)        =      67.20
                                                Prob > chi2       =     0.0000
Log likelihood = -2305.4404                     Pseudo R2         =     0.0144

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

```
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   216.5213   25.84755     8.38   0.000     165.7069    267.3357
       _cons |  -325.0374   72.09175    -4.51   0.000    -466.7645   -183.3102
-------------+----------------------------------------------------------------
      /sigma |   292.3574   12.15972                      268.4523    316.2625
------------------------------------------------------------------------------
               0  left-censored observations
             314     uncensored observations
              86 right-censored observations at y3 >= 500

. est store m_y3o_t

. lrtest m_y3 m_y3o_t, force

Likelihood-ratio test                                 LR chi2(1)  =   4538.61
(Assumption: m_y3 nested in m_y3o_t)                  Prob > chi2 =    0.0000
```

- ***According to significant LR-test between linear regression model and Tobit regression model, it can be concluded that Tobit regression model is a more appropriated model in this case.***

```
. est table m_y1 m_y1t m_y2 m_y2c m_y3 m_y3o m_y3o_t, star(.1 .05 .01) stat(N
N_cens rss ll rmse F chi2 r2 r2_a)
```

Variable	m_y1	m_y1t	m_y2	m_y2c	m_y3	m_y3o	m_y3o_t
_							
x	123.16931***		179.83253***		9726.0419***	130.1676***	
_cons	69.01677		-179.36788***		-16431.393***	-188.14225***	
eq1							
x		249.60624***					
_cons		-456.6913**					
sigma							
_cons		306.44885***		284.90726***			292.3574***
model							
x				219.1562***			216.52134***
_cons				-318.6265***			-325.03736***
Statistics							
N	297	297	400	400	400	314	400
N_cens							
rss	13941535		23737174		2.012e+11	17984964	
ll	-2018.7874	-1973.9423	-2765.7931	-2389.3077	-4574.7459	-2165.5843	-2305.4404
rmse	217.39236		244.21536		22481.152	240.09189	
F	30.298827		76.576122		26.432484	30.331647	
chi2		23.384541		73.173596			67.204135
r2	.09314152		.16135688		.06227724	.08860311	
r2_a	.09006742		.15924974		.05992115	.08568196	

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