BACHELOR OF ECONOMICS
THAMMASAT UNIVERSITY

Answer Sheet Cover Page
Final Examination Semester 2/2020

(Readable handwriting and printed version are acceptable)

Student Name 6104640021

Student ID Thamchanok Pianmuean

Course ID EE426 Course Title Econometric 2.

Lecturer Assoc. Prof. Dr. Tatre Jantarakolica

Exam date May 28 Time 9.00 - 15.00

Total pages 30.

***Students are responsible for checking the number of pages before submitting the answer sheets. Incomplete submissions caused by carelessness will not be accepted as an excuse for resubmission**

Student Signature Thamchanok

Date 28 May.

FACULTY OF ECONOMICS THAMMASAT UNIVERSITY
2 PRACHAN ROAD, PHRANAKORN BANGKOK 10200 THAILAND

WWW.BE.ECON.TU.AC.TH
B.E. INTERNATIONAL PROGRAM

FAX: +66 (0) 2224 0150
PHONE: +66 (0) 2613 2437 TO 8
E-MAIL: BE@ECON.TU.AC.TH

THAMCHANOK PIANMUEAN
6104640021

1.)

a.)

```
. mlogit y x1 x2 x3 x4, base(0) nolog

Multinomial logistic regression                 Number of obs     =        170
                                                LR chi2(8)        =      90.86
                                                Prob > chi2       =     0.0000
Log likelihood =  -104.8068                     Pseudo R2         =     0.3024

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
          x1 |  -1.347221   .6380919    -2.11   0.035    -2.597858   -.0965837
          x2 |  -.9627847   .7836576    -1.23   0.219    -2.498725     .573156
          x3 |   -.408798   .6307265    -0.65   0.517    -1.644999    .8274031
          x4 |   .7099461   .2624283     2.71   0.007      .195596    1.224296
       _cons |  -8.576009    3.71939    -2.31   0.021    -15.86588   -1.286139
-------------+----------------------------------------------------------------
2            |
          x1 |  -1.141361   .6879132    -1.66   0.097    -2.489647    .2069238
          x2 |  -1.794418     .80872    -2.22   0.026     -3.37948    -.209356
          x3 |   .7285886    .664083     1.10   0.273    -.5729902    2.030167
          x4 |   1.837804   .3112868     5.90   0.000     1.227693    2.447915
       _cons |   -26.3164    4.61453    -5.70   0.000    -35.36071   -17.27209
------------------------------------------------------------------------------

. est store m1

. mlogit y x1 x2 x3 x4 if y!=2, base(0) nolog

Multinomial logistic regression                 Number of obs     =         61
                                                LR chi2(4)        =      10.66
                                                Prob > chi2       =     0.0307
Log likelihood = -33.945638                     Pseudo R2         =     0.1357

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
          x1 |   -1.12876   .6114976    -1.85   0.065    -2.327273    .0697537
          x2 |  -.6502463   .7529945    -0.86   0.388    -2.126088    .8255959
          x3 |  -.2209155   .6558682    -0.34   0.736    -1.506394    1.064563
          x4 |   .6346669   .2573192     2.47   0.014     .1303306    1.139003
       _cons |  -7.880673    3.80514    -2.07   0.038    -15.33861    -.422736
------------------------------------------------------------------------------

. est store m3
. hausman m1 m3, alleqs constant

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       m1           m3         Difference          S.E.
-------------+----------------------------------------------------------------
          x1 |   -1.347221     -1.12876       -.2184611        .1822961
          x2 |   -.9627847    -.6502463       -.3125384        .2170679
          x3 |    -.408798    -.2209155       -.1878825               .
          x4 |    .7099461     .6346669        .0752791        .0515311
       _cons |   -8.576009    -7.880673       -.6953359               .
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from mlogit
           B = inconsistent under Ha, efficient under Ho; obtained from mlogit
```

```
    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        1.40
                Prob>chi2 =      0.9239
                (V_b-V_B is not positive definite)
```

-Null hypothesis is rejected, IIA is not violated. Multinomial Logit is appropriated in this case.
-IIA is importance because if IIA doesn't hold, comparison between base case and other cases will not give a solution.
-Multinomial logit is inappropriate because it is an ordered data.

b.)

```
. oprobit y x1 x2 x3 x4, nolog

Ordered probit regression                         Number of obs     =        170
                                                  LR chi2(4)        =      82.32
                                                  Prob > chi2       =     0.0000
Log likelihood = -109.07948                       Pseudo R2         =     0.2740

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.2521765   .2334709    -1.08   0.280    -.7097711    .2054182
          x2 |  -.5121066   .2373109    -2.16   0.031    -.9772274   -.0469858
          x3 |   .5218909    .221538     2.36   0.018     .0876843    .9560974
          x4 |   .6962484   .0932722     7.46   0.000     .5134383    .8790585
-------------+----------------------------------------------------------------
       /cut1 |   9.656838   1.425278                      6.863345    12.45033
       /cut2 |   10.84958    1.47619                      7.956298    13.74286
------------------------------------------------------------------------------

. tab y

          y |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |         21       12.35       12.35
          1 |         40       23.53       35.88
          2 |        109       64.12      100.00
------------+-----------------------------------
      Total |        170      100.00

. g y01=y>0

. g y1=y>1

. drop y1

. g y12=y>1

. tab y y01

           |          y01
         y |         0          1 |     Total
-----------+----------------------+----------
         0 |        21          0 |        21
         1 |         0         40 |        40
         2 |         0        109 |       109
-----------+----------------------+----------
     Total |        21        149 |       170


. tab y y12

           |          y12
         y |         0          1 |     Total
-----------+----------------------+----------
         0 |        21          0 |        21
```

```
        1 |        40          0 |        40
        2 |         0        109 |       109
-----------+----------------------+----------
     Total |        61        109 |       170


. probit y01 x1 x2, nolog

Probit regression                               Number of obs     =        170
                                                LR chi2(2)        =       1.22
                                                Prob > chi2       =     0.5441
Log likelihood = -62.954181                     Pseudo R2         =     0.0096

------------------------------------------------------------------------------
         y01 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.0418363    .271849    -0.15   0.878    -.5746505    .4909779
          x2 |  -.2958165   .2766328    -1.07   0.285    -.8380068    .2463738
       _cons |    1.38165   .2601436     5.31   0.000     .8717783    1.891522
------------------------------------------------------------------------------

. est store probit01

. probit y12 x1 x2, nolog

Probit regression                               Number of obs     =        170
                                                LR chi2(2)        =       9.42
                                                Prob > chi2       =     0.0090
Log likelihood = -106.25363                     Pseudo R2         =     0.0425

------------------------------------------------------------------------------
         y12 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .5566823   .2142879     2.60   0.009     .1366857    .9766789
          x2 |  -.3878755   .2156422    -1.80   0.072    -.8105263    .0347754
       _cons |   .3975119   .1915046     2.08   0.038     .0221698    .7728541
------------------------------------------------------------------------------

. est store probit12

. suest probit01 probit12

Simultaneous results for probit01, probit12

                                                Number of obs     =        170

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
probit01_y01 |
          x1 |  -.0418363    .289243    -0.14   0.885    -.6087422    .5250696
          x2 |  -.2958165   .2781781    -1.06   0.288    -.8410356    .2494026
       _cons |    1.38165   .2495808     5.54   0.000     .8924809     1.87082
-------------+----------------------------------------------------------------
probit12_y12 |
          x1 |   .5566823   .2297184     2.42   0.015     .1064425    1.006922
          x2 |  -.3878755   .2198123    -1.76   0.078    -.8186997    .0429488
       _cons |   .3975119   .1930813     2.06   0.040     .0190795    .7759444
------------------------------------------------------------------------------

. test [probit01_y01]x1 - [probit12_y12]x1 = 0

 ( 1)  [probit01_y01]x1 - [probit12_y12]x1 = 0

           chi2(  1) =    5.12
         Prob > chi2 =    0.0236

. test [probit01_y01]x2 - [probit12_y12]x2 = 0
```

```
 ( 1)  [probit01_y01]x2 - [probit12_y12]x2 = 0

           chi2(  1) =    0.14
         Prob > chi2 =    0.7102
```

-According to all the tests, ordered logit model is inappropriated, not the same betahat.

c.)

```
. probit y1 x*, nolog

Probit regression                               Number of obs     =        550
                                                LR chi2(4)        =      25.09
                                                Prob > chi2       =     0.0000
Log likelihood = -366.03158                     Pseudo R2         =     0.0331

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   1.188599   .3999831     2.97   0.003      .404647    1.972552
          x2 |  -.6426085   .3842609    -1.67   0.094    -1.395746     .110529
          x3 |   .6270111   .1774683     3.53   0.000     .2791796    .9748426
          x4 |   .1931299   .1937898     1.00   0.319    -.1866911     .572951
       _cons |  -.7679513   .3042386    -2.52   0.012    -1.364248   -.1716547
------------------------------------------------------------------------------

. probit y2 x*, nolog

Probit regression                               Number of obs     =        550
                                                LR chi2(4)        =      10.90
                                                Prob > chi2       =     0.0277
Log likelihood = -363.87855                     Pseudo R2         =     0.0148

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.4235012   .3884698    -1.09   0.276    -1.184888    .3378857
          x2 |  -.7384116   .3799839    -1.94   0.052    -1.483166    .0063431
          x3 |  -.2458996     .17666    -1.39   0.164    -.5921468    .1003475
          x4 |   .5397564   .1996099     2.70   0.007     .1485281    .9309847
       _cons |    .296472   .3036155     0.98   0.329    -.2986034    .8915473
------------------------------------------------------------------------------

. probit y3 x*, nolog

Probit regression                               Number of obs     =        550
                                                LR chi2(4)        =      10.52
                                                Prob > chi2       =     0.0325
Log likelihood = -328.13418                     Pseudo R2         =     0.0158

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.6290106   .4029907    -1.56   0.119    -1.418858    .1608366
          x2 |   .8205646   .3951429     2.08   0.038     .0460987    1.595031
          x3 |  -.3849673   .1978462    -1.95   0.052    -.7727386    .0028041
          x4 |  -.2225176   .1935093    -1.15   0.250    -.6017889    .1567537
       _cons |   -.482039   .3192918    -1.51   0.131    -1.107839    .1437615
------------------------------------------------------------------------------
```

-We shouldn't use these three separate probit models because the correlation among disturbance terms are not zero.

d.)

```
. mvprobit (y1 x*) (y2 x*) (y3 x*), nolog

Multivariate probit (MSL, # draws = 5)            Number of obs   =        550
                                                  Wald chi2(12)   =      34.94
```

```
Log likelihood = -934.30894                       Prob > chi2     =     0.0005

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y1           |
          x1 |   1.063387   .3921018     2.71   0.007      .294882    1.831893
          x2 |  -.5473706   .3795919    -1.44   0.149    -1.291357    .1966158
          x3 |   .6165159   .1787051     3.45   0.001     .2662604    .9667714
          x4 |   .1801909    .192658     0.94   0.350    -.1974119    .5577937
       _cons |  -.7005573   .3065515    -2.29   0.022    -1.301387   -.0997274
-------------+----------------------------------------------------------------
y2           |
          x1 |  -.4897698   .3831145    -1.28   0.201     -1.24066    .2611208
          x2 |   -.636445   .3778582    -1.68   0.092    -1.377033    .1041434
          x3 |  -.2634882    .178032    -1.48   0.139    -.6124246    .0854481
          x4 |   .5059698   .1986647     2.55   0.011     .1165941    .8953454
       _cons |   .3214536   .3014528     1.07   0.286     -.269383    .9122902
-------------+----------------------------------------------------------------
y3           |
          x1 |  -.5286327   .3907745    -1.35   0.176    -1.294537    .2372713
          x2 |   .6349395    .387475     1.64   0.101    -.1244976    1.394377
          x3 |  -.2770804   .1869191    -1.48   0.138    -.6434351    .0892743
          x4 |  -.1793495   .1961704    -0.91   0.361    -.5638365    .2051374
       _cons |  -.4569501   .3206043    -1.43   0.154    -1.085323    .1714229
-------------+----------------------------------------------------------------
    /atrho21 |  -.6230853    .074836    -8.33   0.000    -.7697612   -.4764094
-------------+----------------------------------------------------------------
    /atrho31 |  -.4021504   .0739358    -5.44   0.000    -.5470619   -.2572388
-------------+----------------------------------------------------------------
    /atrho32 |  -.3327244   .0712365    -4.67   0.000    -.4723455   -.1931034
-------------+----------------------------------------------------------------
       rho21 |  -.5532725   .0519279   -10.65   0.000    -.6467906   -.4433634
-------------+----------------------------------------------------------------
       rho31 |  -.3817874   .0631588    -6.04   0.000    -.4983149   -.2517111
-------------+----------------------------------------------------------------
       rho32 |  -.3209667   .0638978    -5.02   0.000    -.4400925   -.1907385
------------------------------------------------------------------------------
Likelihood ratio test of  rho21 = rho31 = rho32 = 0:
             chi2(3) =  247.471   Prob > chi2 = 0.0000
```

-mvprobit is appropriated, because the null hypothesis is rejected at 0.05 level. Since correlation among the disturbance terms are existed, mvprobit would be more appropriated.

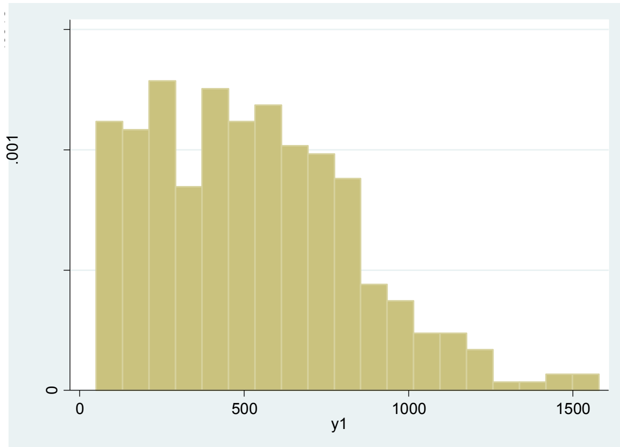
-MV Probit model has limitation of dependent variables, discrete dependent variable, and limitation of the distribution, limitation of dependent variables. Probit models have binary choices.

2.)

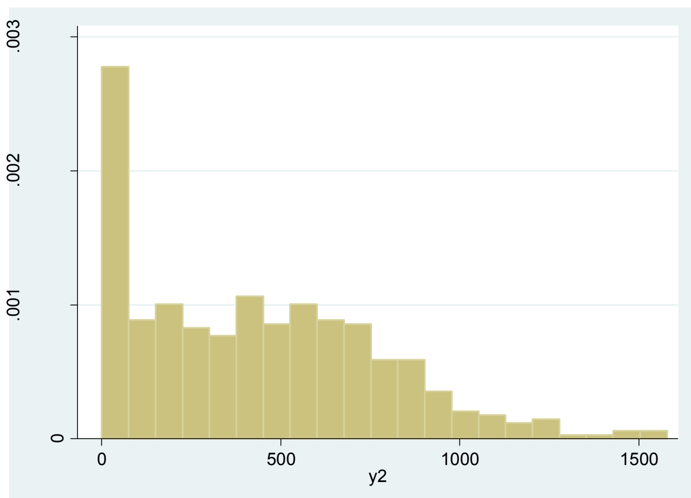
a.)

```
. sum y1 y2 y3

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y1 |        367    524.2029    308.2434   50.21759    1578.51
          y2 |        450     428.525    343.5781          0    1578.51
          y3 |        450    3815.157    15783.46  -450.6205   98951.63

. histogram y1
(bin=19, start=50.217594, width=80.436449)
```

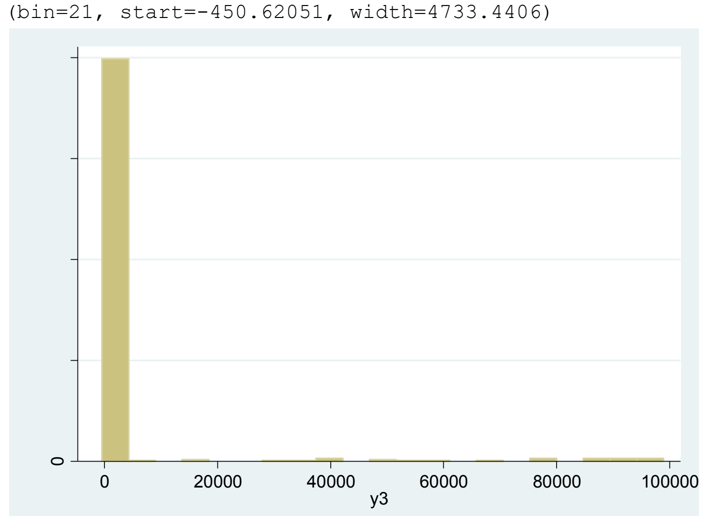
THAMCHANOK PIANMUEAN
6104640021



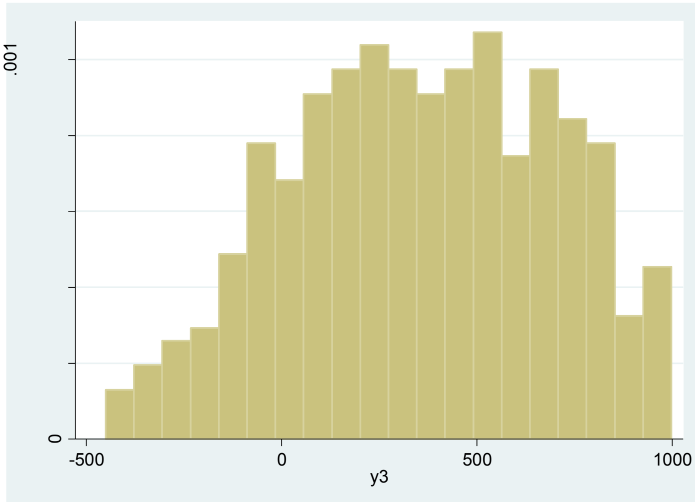

```
. histogram y2
(bin=21, start=0, width=75.167149)
```




```
. histogram y3
(bin=21, start=-450.62051, width=4733.4406)
```




```
. histogram y3 if y3<2000
(bin=20, start=-450.62051, width=72.440572)
```



-According to data summarize and histogram, it might be concluded that y1 has truncated problem at approximately 50, y2 has censored problem at 0, y3 has outlier problem.

b.)

```
. reg y1 x

      Source |       SS           df       MS      Number of obs   =       367
-------------+----------------------------------   F(1, 365)       =    149.88
       Model |  10122896.2         1  10122896.2   Prob > F        =    0.0000
    Residual |    24652219       365  67540.3262   R-squared       =    0.2911
-------------+----------------------------------   Adj R-squared   =    0.2892
       Total |  34775115.2       366   95013.976   Root MSE        =    259.89

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   173.8049   14.19682    12.24   0.000      145.887    201.7227
       _cons |  -35.64063   47.69921    -0.75   0.455    -129.4404    58.15913
------------------------------------------------------------------------------

. est store olsy1

. sum y1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y1 |        367    524.2029    308.2434   50.21759    1578.51

. scalar miny=round(r(min))

. scalar lsit miny
varlist not allowed
r(101);

. scalar list miny
      miny =         50

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

Truncated regression
Limit:   lower =         50                     Number of obs     =        367
         upper =       +inf                     Wald chi2(1)      =     110.04
Log likelihood = -2522.1932                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
           x |    248.761   23.71448    10.49   0.000     202.2815    295.2405
       _cons |  -365.4996   91.34527    -4.00   0.000     -544.533   -186.4661
-------------+----------------------------------------------------------------
      /sigma |   311.7764   17.43206    17.89   0.000     277.6102    345.9426
------------------------------------------------------------------------------

. predict truncated, e(50,.)

. est store ty1

. lrtest olsy1 ty1, force

Likelihood-ratio test                                 LR chi2(1)  =     76.33
(Assumption: olsy1 nested in ty1)                     Prob > chi2 =    0.0000
```

-According to significant LR-test between linear regression model and truncated model, it can be concluded that truncated regression model is more appropriated since null hypothesis of LR test is rejected. The major problem caused by sample is based only on value of y which will make OLS estimator biased.

c.)

```
. reg y2 x

      Source |       SS           df       MS      Number of obs   =       450
-------------+----------------------------------   F(1, 448)       =    277.79
       Model |    20286305         1    20286305   Prob > F        =    0.0000
    Residual |  32716310.8       448  73027.4794   R-squared       =    0.3827
-------------+----------------------------------   Adj R-squared   =    0.3814
       Total |  53002615.7       449  118045.915   Root MSE        =    270.24

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   205.0939   12.30536    16.67   0.000     180.9105    229.2773
       _cons |  -188.5091   39.15169    -4.81   0.000    -265.4529   -111.5653
------------------------------------------------------------------------------

. est store olsy2

. sum y2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y2 |        450     428.525    343.5781          0    1578.51

. tobit y2 x, ll(0)

Tobit regression                                Number of obs     =        450
                                                LR chi2(1)        =     226.65
                                                Prob > chi2       =     0.0000
Log likelihood = -2789.8363                     Pseudo R2         =     0.0390

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   242.0191   14.66612    16.50   0.000     213.1964    270.8419
       _cons |  -330.3892   47.49046    -6.96   0.000    -423.7204    -237.058
-------------+----------------------------------------------------------------
      /sigma |   302.3027   11.19031                      280.3108    324.2946
------------------------------------------------------------------------------
           67  left-censored observations at y2 <= 0
          383     uncensored observations
            0 right-censored observations
```

```
. est store tby2

. lrtest olsy2 tby2, force

Likelihood-ratio test                                 LR chi2(1)  =    734.73
(Assumption: olsy2 nested in tby2)                    Prob > chi2 =    0.0000
```

-According to significant LR-test between OLS and tobit model, it can be concluded that tobit regression modeil is more appropriated since null hypothesis of LR-test is rejected. The major problem caused by sample is censored based only on value of y which will make OLS estimator be bias.

d.)

```
. reg y3 x if y3<1000

      Source |       SS           df       MS      Number of obs   =       425
-------------+----------------------------------   F(1, 423)       =    210.21
       Model |  15612930.7         1  15612930.7   Prob > F        =    0.0000
    Residual |  31416934.1       423  74271.7118   R-squared       =    0.3320
-------------+----------------------------------   Adj R-squared   =    0.3304
       Total |  47029864.8       424  110919.492   Root MSE        =    272.53

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   195.0079   13.44998    14.50   0.000     168.5708    221.4451
       _cons |  -212.5701   41.48733    -5.12   0.000    -294.1171   -131.0231
------------------------------------------------------------------------------

. reg y3 x

      Source |       SS           df       MS      Number of obs   =       450
-------------+----------------------------------   F(1, 448)       =     41.34
       Model |  9.4500e+09         1  9.4500e+09   Prob > F        =    0.0000
    Residual |  1.0240e+11       448   228579849   R-squared       =    0.0845
-------------+----------------------------------   Adj R-squared   =    0.0824
       Total |  1.1185e+11       449   249117556   Root MSE        =     15119

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   4426.571   688.4466     6.43   0.000     3073.585    5779.557
       _cons |  -9502.377   2190.414    -4.34   0.000    -13807.14   -5197.613
------------------------------------------------------------------------------

. est store olsy3

. sum y3

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y3 |        450    3815.157    15783.46  -450.6205   98951.63

. tobit y3 x, ul(1000) nolog

Tobit regression                                Number of obs     =        450
                                                LR chi2(1)        =     226.53
                                                Prob > chi2       =     0.0000
Log likelihood =  -3038.746                     Pseudo R2         =     0.0359

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   227.9317   13.50702    16.88   0.000     201.3868    254.4765
       _cons |  -283.3561   42.60586    -6.65   0.000    -367.0878   -199.6244
-------------+----------------------------------------------------------------
```

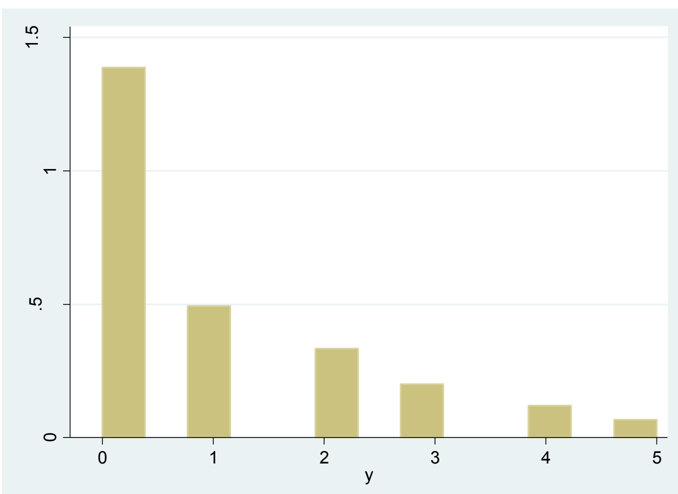
```
      /sigma |   289.9756   10.05253                      270.2197    309.7314
------------------------------------------------------------------------------
             0  left-censored observations
           425     uncensored observations
            25 right-censored observations at y3 >= 1000

. est store tby3

. lrtest olsy3 tby3, force

Likelihood-ratio test                                 LR chi2(1)  =   3858.88
(Assumption: olsy3 nested in tby3)                    Prob > chi2 =    0.0000
```

-According to significant LR-test between linear regression and tobit model, it can be concluded that tobit regression model is more appropriated since the null hypothesis of LR-test is rejected. The major problem caused by sample exist an outlier which will make OLS estimator to be biased

3.)

a.)

```
. histogram y

(bin=13, start=0, width=.38461538)
```



-According to histogram, it exist that the distribution of dependent variable follows Possion distribution, which mean the value is non-negative and also discrete, hence, Poission regression model should be applied.

```
. reg y x1 x2 x3 x4

      Source |       SS           df       MS      Number of obs   =       195
-------------+----------------------------------   F(4, 190)       =      5.01
       Model |  33.4104504         4  8.35261259   Prob > F        =    0.0007
    Residual |  316.569037       190  1.66615283   R-squared       =    0.0955
-------------+----------------------------------   Adj R-squared   =    0.0764
       Total |  349.979487       194  1.80401798   Root MSE        =    1.2908

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0793886   .0446285     1.78   0.077    -.0086424    .1674196
          x2 |   .1390509   .0477181     2.91   0.004     .0449255    .2331763
          x3 |   .1906963    .068193     2.80   0.006     .0561837    .3252089
          x4 |  -.0240741   .0483414    -0.50   0.619    -.1194289    .0712806
       _cons |   .9293254   .1099856     8.45   0.000     .7123757    1.146275
```

```
------------------------------------------------------------------------------
. est store olsy
```

b.)

```
. poisson y x1 x2 x3 x4, nolog

Poisson regression                              Number of obs     =        195
                                                LR chi2(4)        =      34.23
                                                Prob > chi2       =     0.0000
Log likelihood = -274.62075                     Pseudo R2         =     0.0587

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0806329   .0343856     2.34   0.019     .0132383    .1480275
          x2 |   .1401445   .0367381     3.81   0.000     .0681392    .2121498
          x3 |   .2034995   .0551258     3.69   0.000     .0954549    .3115441
          x4 |  -.0243904   .0374602    -0.65   0.515     -.097811    .0490301
       _cons |  -.1580224   .0935666    -1.69   0.091    -.3414097    .0253648
------------------------------------------------------------------------------

. estat gof

         Deviance goodness-of-fit =  318.2264
         Prob > chi2(190)         =    0.0000

         Pearson goodness-of-fit  =  332.2892
         Prob > chi2(190)         =    0.0000

. poisson y x1 x2 x3 x4, ir nolog

Poisson regression                              Number of obs     =        195
                                                LR chi2(4)        =      34.23
                                                Prob > chi2       =     0.0000
Log likelihood = -274.62075                     Pseudo R2         =     0.0587

------------------------------------------------------------------------------
           y |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   1.083973   .0372731     2.34   0.019     1.013326    1.159545
          x2 |    1.15044    .042265     3.81   0.000     1.070514    1.236333
          x3 |   1.225685   .0675669     3.69   0.000     1.100159    1.365532
          x4 |   .9759046   .0365575    -0.65   0.515     .9068203    1.050252
       _cons |   .8538306   .0798901    -1.69   0.091     .7107677    1.025689
------------------------------------------------------------------------------

. est store psy

. mfx

Marginal effects after poisson
      y  = Predicted number of events (predict)
         =  .90429488
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |   .0729159      .03071    2.37   0.018   .012716  .133116  -.281682
      x2 |    .126732       .0322    3.94   0.000   .063621  .189843   .871385
      x3 |   .1840236      .04814    3.82   0.000    .08968  .278367  -.300421
      x4 |  -.0220561      .03384   -0.65   0.515  -.088378  .044266  -.785193
------------------------------------------------------------------------------
```

-According to the above estimated result, interpretation can be made concerning sign and meaning of the estimated coefficient – positive mfx sign and irr>1 for x1, x2, and x3, and negative mfx sign and irr<1 for x4. Overall test LR-Chi-square-test, significant, Pseudo R-squared 0.0633, not quite fit the data. Individual z-test, all significant except x4.

c.)

```
. nbreg y x1 x2 x3 x4, nolog

Negative binomial regression                    Number of obs     =        195
                                                LR chi2(4)        =      18.37
Dispersion     = mean                           Prob > chi2       =     0.0010
Log likelihood = -259.61412                     Pseudo R2         =     0.0342

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .1087674   .0527511     2.06   0.039     .0053772    .2121576
          x2 |   .1549878    .052501     2.95   0.003     .0520877    .2578879
          x3 |   .1953154   .0712146     2.74   0.006     .0557373    .3348936
          x4 |  -.0280043   .0504403    -0.56   0.579    -.1268655    .0708569
       _cons |  -.1751075   .1234882    -1.42   0.156      -.41714     .066925
-------------+----------------------------------------------------------------
    /lnalpha |    -.16535   .2903142                     -.7343554    .4036555
-------------+----------------------------------------------------------------
       alpha |    .847597   .2460695                      .4798146    1.497288
------------------------------------------------------------------------------
Likelihood-ratio test of alpha=0:  chibar2(01) =   30.01 Prob>=chibar2 = 0.000

. est store nby

. mfx

Marginal effects after nbreg
      y  = Predicted number of events (predict)
         =  .89818493
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |   .0976932      .04724    2.07   0.039   .005103  .190283  -.281682
      x2 |   .1392077      .04697    2.96   0.003   .047148  .231268   .871385
      x3 |   .1754294      .06369    2.75   0.006   .050608  .300251  -.300421
      x4 |   -.025153       .0453   -0.56   0.579  -.113947  .063641  -.785193
------------------------------------------------------------------------------
```

-According to the above estimated result, interpretation can be made concerning sign and meaning of the estimated coefficient, positive mfx sign and irr>1 for x1, x2, and x3, and negative mfx sign and irr<1 for x4. For overall test, LR-Chi-squared-test is significant. Pseudo R-squared 0.0384, not quie fit the data. Individual z-tests are all significant except x4.

d.)

```
. zip y x1 x2 x3, inflate(x4) vuong nolog

Zero-inflated Poisson regression                Number of obs     =        195
                                                Nonzero obs       =         91
                                                Zero obs          =        104

Inflation model = logit                         LR chi2(3)        =      14.28
Log likelihood  = -258.0761                     Prob > chi2       =     0.0025

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
          x1 |   .0910814   .0438491     2.08   0.038     .0051388     .177024
          x2 |   .1228343   .0405771     3.03   0.002     .0433047    .2023639
          x3 |   .1436254   .0562275     2.55   0.011     .0334216    .2538293
       _cons |   .3243813   .1173574     2.76   0.006     .0943649    .5543976
-------------+----------------------------------------------------------------
inflate      |
          x4 |   .0218089   .1008201     0.22   0.829    -.1757948    .2194126
       _cons |  -.5230108    .259533    -2.02   0.044    -1.031686   -.0143354
------------------------------------------------------------------------------
```

```
Vuong test of zip vs. standard Poisson:            z =     2.58  Pr>z = 0.0050

. mfx

Marginal effects after zip
      y  = Predicted number of events (predict)
         =  .90801003
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |   .0827028      .03951    2.09   0.036   .005255   .16015  -.281682
      x2 |   .1115348      .03615    3.09   0.002   .040688  .182381   .871385
      x3 |   .1304133      .05005    2.61   0.009    .03232  .228507  -.300421
      x4 |  -.0072905      .03379   -0.22   0.829  -.073524  .058943  -.785193
------------------------------------------------------------------------------
```

-According to the above estimated result =, interpretation can be made concerning the sign and meaning of the estimated coefficient. Positive mfx sign and irr>1 for x1, x2, and x3, and negative mfx sign and irr<1 for x4. Overall test LR-Chi-Squared-test is significant. Individual z-test are all significant except x4.'

-According to GOF-test, we reject the null hypothesis of the test, Poisson regression model is more appropriated than linear regression model

-According to LR-test of alpha, null hypothesis is rejected, the distribution of dependent variable follows Negative Binomial regression model is more appropriated than Poisson regression model.

-According to Vuong test, H null is rejected, zero inflated model is more appropriated than Poisson regression model

-Histogram illustrate zero inflated distribution of dependent variable, therefore, zero inflated regression model should be applied in this case.

4.)

a.)

```
. tsset t
        time variable:  t, 1 to 500
                delta:  1 unit

. dfuller y, trend lag(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =       498

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -15.034            -3.980            -3.420            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.y          |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           y |
         L1. |  -.9728018   .0647089   -15.03   0.000     -1.09994   -.8456632
         LD. |  -.0592117   .0449927    -1.32   0.189    -.1476124    .0291891
      _trend |   .0012784   .0021013     0.61   0.543    -.0028501    .0054069
       _cons |   .9566398   .6100881     1.57   0.118    -.2420477    2.155327
------------------------------------------------------------------------------

. dfuller x, trend lag(1) regress
```

```
Augmented Dickey-Fuller test for unit root         Number of obs   =       498

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)           -15.189            -3.980            -3.420            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.x          |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |
         L1. |  -.9848987   .0648429   -15.19   0.000    -1.112301   -.8574967
         LD. |  -.0505535   .0449977    -1.12   0.262     -.138964     .037857
      _trend |   .0021181   .0030005     0.71   0.481    -.0037772    .0080135
       _cons |   .5922071   .8669077     0.68   0.495    -1.111074    2.295488
------------------------------------------------------------------------------
```

-y and x are stationary or I(0)

- The Unit root test is testing of the variable be stationary or nonstationary. If the data is stationary, OLS can still be used. But if the data is nonstationary, then the OLS estimator will be biased. Stationary is important to time-series due to the fact than most of the time-series data is high frequency and nonstationary which will lead OLS estimator to be biased.

b.)

```
. *For y
. *specify order p d q
. forvalue d = 0(1)0 {
  2. forvalue p = 1(1)4 {
  3. forvalue q = 1(1)4 {
  4.  display  "estimate arima`p'`d'`q'"
  5.  capture: qui arima y, arima(`q',`d',`p') nolog
  6.  if _rc~=0 {
  7.  display "flatlog when pdq =" `p'`d'`q'
  8.  continue
  9.  }
 10.  estimates store arima`p'`d'`q'
 11.  display "arima`p'`d'`q' already estimated"
 12.  }
 13.  }
 14. estimates table arima1`d'1 arima1`d'2 arima1`d'3 arima1`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 15. estimates table arima2`d'1 arima2`d'2 arima2`d'3 arima2`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 16. estimates table arima3`d'1 arima3`d'2 arima3`d'3 arima3`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 17. estimates table arima4`d'1 arima4`d'2 arima4`d'3 arima4`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 18. }
estimate arima101
arima101 already estimated
estimate arima102
arima102 already estimated
estimate arima103
arima103 already estimated
estimate arima104
arima104 already estimated
estimate arima201
arima201 already estimated
estimate arima202
arima202 already estimated
estimate arima203
```

```
arima203 already estimated
estimate arima204
arima204 already estimated
estimate arima301
arima301 already estimated
estimate arima302
arima302 already estimated
estimate arima303
arima303 already estimated
estimate arima304
flatlog when pdq =304
estimate arima401
arima401 already estimated
estimate arima402
arima402 already estimated
estimate arima403
arima403 already estimated
estimate arima404
arima404 already estimated

------------------------------------------------------------------------------
    Variable |   arima101        arima102        arima103        arima104
-------------+----------------------------------------------------------------
y            |
       _cons |  1.3160732***    1.3165966***    1.3170214***    1.3175059***
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.85671231***   -.81679808***   -.84311244***   -.78144222**
         L2. |                  .01965322       .03190832       .03235516
         L3. |                                  .01910909       .04475517
         L4. |                                                  .04099103
             |
          ma |
         L1. |  .81381586***    .78741991***    .81339159***    .75091484**
-------------+----------------------------------------------------------------
sigma        |
       _cons |  6.7070643***     6.706091***    6.7050253***    6.7000467***
-------------+----------------------------------------------------------------
Statistics   |
         aic |  3330.1124        3331.957       3333.8057       3335.0818
         bic |  3346.9709       3353.0301       3359.0934       3364.5841
          ll | -1661.0562      -1660.9785      -1660.9029      -1660.5409
------------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

------------------------------------------------------------------------------
    Variable |   arima201        arima202        arima203        arima204
-------------+----------------------------------------------------------------
y            |
       _cons |  1.3164623***    1.3193097***    1.3192207***    1.3190967***
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |  -.8407698***    .02485091      -.03418916      -.0441011
         L2. |                  .72638325***    .72699651***    .65860818*
         L3. |                                  .02024337       .02006821
         L4. |                                                  .02440356
             |
          ma |
         L1. |  .81081395***   -.04728285       .00153606       .01110505
         L2. |  .01776181      -.65937106**    -.66194403**    -.6062543
-------------+----------------------------------------------------------------
sigma        |
       _cons |  6.7062145***    6.6966012***    6.6954461***     6.694033***
-------------+----------------------------------------------------------------
Statistics   |
         aic |  3331.9639       3332.5449       3334.4022       3336.1916
         bic |  3353.0369       3357.8325       3363.9044       3369.9085
```

```
          ll | -1660.9819      -1660.2724      -1660.2011      -1660.0958   
-----------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

-----------------------------------------------------------------------------
    Variable |   arima301        arima302        arima303        arima304    
-------------+---------------------------------------------------------------
y            |
       _cons |  1.3169246***    1.3192028***    1.3310897***                 
-------------+---------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.85479005***   -.00880392       1.0641766***   -1.1197775*** 
         L2. |                  .72631603***     .65311363**     .60359466   
         L3. |                                 -.83388151***    .84850518*** 
         L4. |                                                  .05544077    
             |
          ma |
         L1. |  .82385933***   -.02454975      -1.1231441***    1.0897361*** 
         L2. |  .02900763      -.66072222**    -.55650296      -.59325463    
         L3. |  .01703608       .01970127       .80658953***    -.7687395*** 
-------------+---------------------------------------------------------------
sigma        |
       _cons |  6.7052679***     6.695548***    6.6127568       9.5277271*** 
-------------+---------------------------------------------------------------
x            |
       _cons |                                                  1.1486373**  
-------------+---------------------------------------------------------------
Statistics   |
         aic |  3333.8305       3334.3921       3326.0559        3691.346    
         bic |  3359.1181       3363.8944       3355.5581       3729.2774    
          ll | -1660.9152      -1660.1961      -1656.0279       -1836.673    
-----------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

-----------------------------------------------------------------------------
    Variable |   arima401        arima402        arima403        arima404    
-------------+---------------------------------------------------------------
y            |
       _cons |  1.3197063***    1.3190979***    1.3312903***    1.3187605*** 
-------------+---------------------------------------------------------------
ARMA         |
          ar |
         L1. |  .79554291***   -.01799803       1.0672528***      .090027    
         L2. |                  .68941508**     .64678484*     -.22996396    
         L3. |                                 -.83046045***   -.05809939    
         L4. |                                                  .70709274*** 
             |
          ma |
         L1. | -.83063231***   -.01490702       -1.123474      -.12463059    
         L2. |  .08194831      -.63706121**    -.55181303       .31438256    
         L3. | -.04699497       .01889581       .79852779       .05252582    
         L4. |  .03885793       .02331994       .00399586      -.66037916**  
-------------+---------------------------------------------------------------
sigma        |
       _cons |  6.7032944***    6.6939821***    6.6127831       6.6579737*** 
-------------+---------------------------------------------------------------
Statistics   |
         aic |  3335.5639       3336.1786       3328.0491       3335.3652    
         bic |  3365.0661       3369.8955        3361.766       3377.5113    
          ll | -1660.7819      -1660.0893      -1656.0246      -1657.6826    
-----------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01
. *For x
. *specify order p d q
. forvalue d = 0(1)0 {
  2. forvalue p = 1(1)4 {
  3. forvalue q = 1(1)4 {
  4.  display  "estimate arima`p'`d'`q'"
```

```
  5.  capture: qui arima x, arima(`q',`d',`p') nolog
  6.  if _rc~=0 {
  7.  display "flatlog when pdq =" `p'`d'`q'
  8.  continue
  9.  }
 10.  estimates store arima`p'`d'`q'
 11.  display "arima`p'`d'`q' already estimated"
 12.  }
 13.  }
 14. estimates table arima1`d'1 arima1`d'2 arima1`d'3 arima1`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 15. estimates table arima2`d'1 arima2`d'2 arima2`d'3 arima2`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 16. estimates table arima3`d'1 arima3`d'2 arima3`d'3 arima3`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 17. estimates table arima4`d'1 arima4`d'2 arima4`d'3 arima4`d'4, star(0.1 0.05 0.01) stat( aic
bic ll)
 18. }
estimate arima101
arima101 already estimated
estimate arima102
arima102 already estimated
estimate arima103
arima103 already estimated
estimate arima104
arima104 already estimated
estimate arima201
arima201 already estimated
estimate arima202
arima202 already estimated
estimate arima203
arima203 already estimated
estimate arima204
arima204 already estimated
estimate arima301
arima301 already estimated
estimate arima302
arima302 already estimated
estimate arima303
arima303 already estimated
estimate arima304
arima304 already estimated
estimate arima401
arima401 already estimated
estimate arima402
arima402 already estimated
estimate arima403
arima403 already estimated
estimate arima404
arima404 already estimated

------------------------------------------------------------------------------
    Variable |   arima101        arima102        arima103        arima104     
-------------+----------------------------------------------------------------
x            |
       _cons |  1.1429574***    1.1438648***    1.1435826***     1.144789**   
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.87226788***   -.84813314***   -.85922478***   -.79064859***  
         L2. |                  .01339278       .02025562       .02132992     
         L3. |                                  .00996172       .04351126     
         L4. |                                                  .05104355     
             |
          ma |
         L1. |  .83034368***    .81593968***    .82688807***    .75769917***  
-------------+----------------------------------------------------------------
sigma        |
       _cons |  9.5703726***    9.5696168***    9.5694102***    9.5583281***  
```

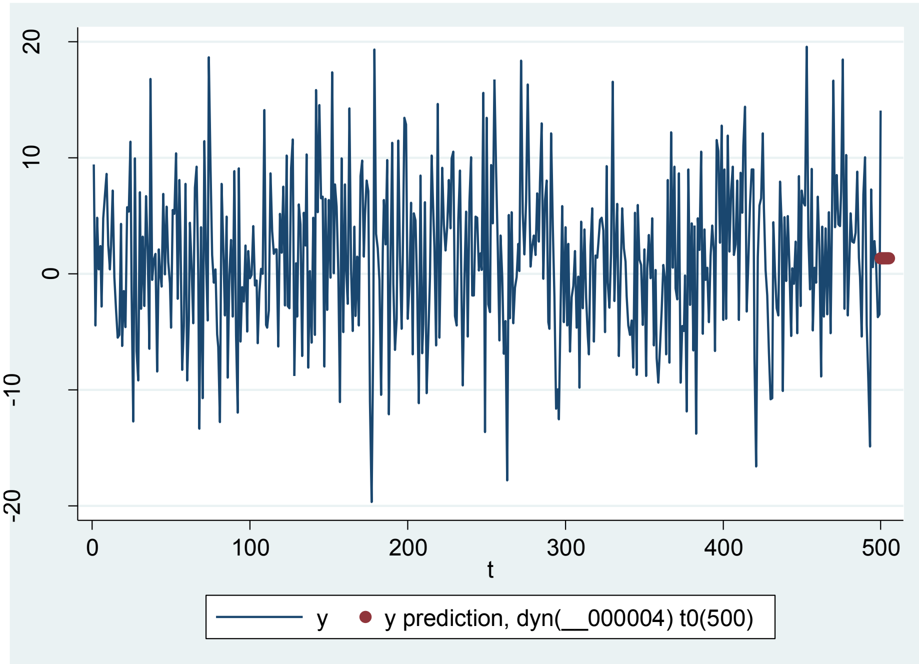
```
-------------+------------------------------------------------------------
Statistics   |
         aic |  3685.6274       3687.5528       3689.5106       3690.3884
         bic |  3702.4858       3708.6258       3714.7982       3719.8907
          ll | -1838.8137      -1838.7764      -1838.7553      -1838.1942
--------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

--------------------------------------------------------------------------
    Variable |   arima201        arima202        arima203        arima204
-------------+------------------------------------------------------------
x            |
       _cons |  1.1434802***    1.1477731**     1.1481455**     1.1476833**
-------------+------------------------------------------------------------
ARMA         |
          ar |
         L1. |  -.8637267***    .01984067      -.03979143      -.06877967
         L2. |                  .75797154***    .75496418***    .65528076*
         L3. |                                  .02222992       .02359464
         L4. |                                                  .03474976
             |
          ma |
         L1. |   .8313275***   -.0428149        .0045602        .03306671
         L2. |  .01248218      -.69472386***   -.69347266***   -.61275455*
-------------+------------------------------------------------------------
sigma        |
       _cons |  9.5696138***    9.5569958***     9.555084***    9.5512798***
-------------+------------------------------------------------------------
Statistics   |
         aic |  3687.5544       3688.2364       3690.0573       3691.6355
         bic |  3708.6274        3713.524       3719.5595       3725.3523
          ll | -1838.7772      -1838.1182      -1838.0286      -1837.8177
--------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

--------------------------------------------------------------------------
    Variable |   arima301        arima302        arima303        arima304
-------------+------------------------------------------------------------
x            |
       _cons |  1.1437579***    1.1481262**     1.1692449**     1.1486373**
-------------+------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.86931937***   -.01360873       1.0436082***   -1.1197775***
         L2. |                   .7537429***    .68694475**     .60359466
         L3. |                                 -.84827425***    .84850518***
         L4. |                                                  .05544077
             |
          ma |
         L1. |  .83624098***   -.02269915      -1.1034825***    1.0897361***
         L2. |  .01801232       -.6916531***   -.59313834*     -.59325463
         L3. |  .00837349        .0222733       .82577707***    -.7687395***
-------------+------------------------------------------------------------
sigma        |
       _cons |  9.5692441***    9.5549359***    9.4344997       9.5277271***
-------------+------------------------------------------------------------
Statistics   |
         aic |  3689.5218       3690.0407       3681.4935        3691.346
         bic |  3714.8095       3719.5429       3710.9958       3729.2774
          ll | -1838.7609      -1838.0203      -1833.7468       -1836.673
--------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

--------------------------------------------------------------------------
    Variable |   arima401        arima402        arima403        arima404
-------------+------------------------------------------------------------
x            |
       _cons |  1.1445228**     1.1477398**     1.1486154**      1.149491**
-------------+------------------------------------------------------------
```

```
ARMA         |
          ar |
         L1. | -.83159841***    -.0360773      -1.0556571***   -.43620697*
         L2. |                  .70081296**      .6665806      -.19060125
         L3. |                                  .79635047***    .36572357
         L4. |                                                  .69806251***
             |
          ma |
         L1. |  .79792245***    .00106843       1.0251578***    .41330159
         L2. |  .01579383      -.65762305**    -.65682261       .23343208
         L3. |  .04217276       .02139641      -.71845214***   -.3600084
         L4. |  .05092146       .03206129       .05455814      -.61928398**
-------------+----------------------------------------------------------------
sigma        |
       _cons |  9.5581147***    9.5512942***    9.5276194***    9.5426163***
-------------+----------------------------------------------------------------
Statistics   |
         aic |  3690.3703       3691.6363       3691.3316       3694.7701
         bic |  3719.8725       3725.3532        3729.263       3736.9162
          ll | -1838.1851      -1837.8181      -1836.6658      -1837.3851
------------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01
```

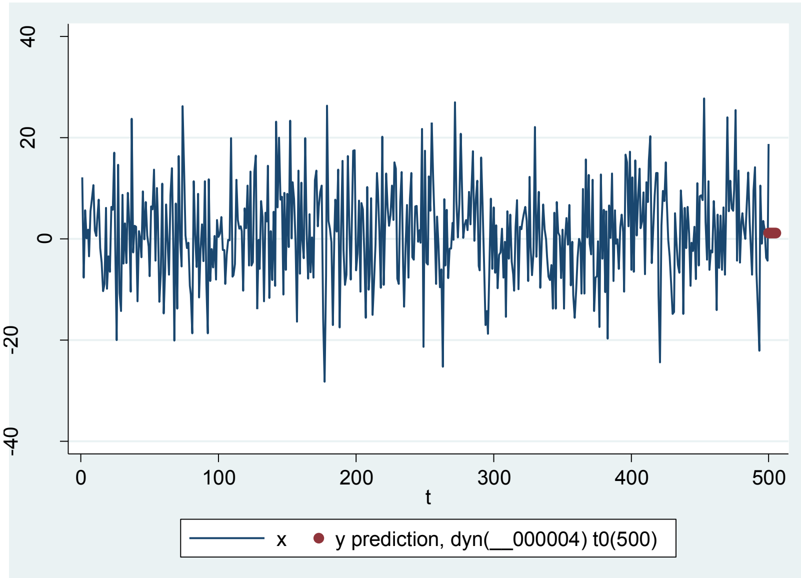
-The most appropriated order for y is ARIMA(1,0,1)

-The most appropriated order for x is ARIMA(1,0,1)

```
. arima y, arima(1,0,1) nolog

ARIMA regression

Sample:  1 - 500                                Number of obs     =        500
                                                Wald chi2(2)      =      52.43
Log likelihood = -1661.056                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |                 OPG
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
       _cons |   1.316073   .2953446     4.46   0.000     .7372084    1.894938
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |  -.8567123   .1648398    -5.20   0.000    -1.179792   -.5336322
             |
          ma |
         L1. |   .8138159   .1863522     4.37   0.000     .4485723    1.179059
-------------+----------------------------------------------------------------
      /sigma |   6.707064   .2139816    31.34   0.000     6.287668    7.126461
------------------------------------------------------------------------------
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.
. set obs 505
number of observations (_N) was 500, now 505

. replace t=_n
(5 real changes made)

. predict yhat, y dynamic(.) t0(500)
Note: beginning dynamic predictions in period         3.
(499 missing values generated)

. twoway (line y t, sort) (scatter yhat t, sort)
```




```
. arima x, arima(1,0,1) nolog

ARIMA regression

Sample:  1 - 500                                Number of obs     =        500
                                                Wald chi2(2)      =      66.85
Log likelihood = -1838.814                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |                 OPG
           x |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
x            |
       _cons |   1.142957    .422537     2.70   0.007     .3148001    1.971115
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |  -.8722679   .1450005    -6.02   0.000    -1.156464    -.588072
             |
          ma |
         L1. |   .8303437   .1653247     5.02   0.000     .5063132    1.154374
-------------+----------------------------------------------------------------
      /sigma |   9.570373   .3051603    31.36   0.000     8.972269    10.16848
------------------------------------------------------------------------------
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict yhat2, y dynamic(.) t0(500)
Note: beginning dynamic predictions in period         3.
(499 missing values generated)

. twoway (line x t, sort) (scatter yhat2 t, sort)
```



c.)

```
. reg y x

      Source |       SS           df       MS      Number of obs   =       500
-------------+----------------------------------   F(1, 498)       =  56889.89
       Model |  22448.3939         1  22448.3939   Prob > F        =    0.0000
    Residual |  196.507666       498  .394593706   R-squared       =    0.9913
-------------+----------------------------------   Adj R-squared   =    0.9913
       Total |  22644.9015       499  45.3805642   Root MSE        =    .62817

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   .6976152   .0029248   238.52   0.000     .6918687    .7033617
       _cons |   .5187858   .0282915    18.34   0.000     .4632004    .5743713
------------------------------------------------------------------------------

. estat archlm
LM test for autoregressive conditional heteroskedasticity (ARCH)
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |         38.784               1                   0.0000
---------------------------------------------------------------------------
         H0: no ARCH effects      vs.  H1: ARCH(p) disturbance
```

-There exist significant ARCH effects since p-value of the ARCHLM-test is less than 0.05. Rejct the null hypothesis that all of alpha are equal to zero.

-This test is classified as LM test because, it computed bases on Restricted Model.

d.)

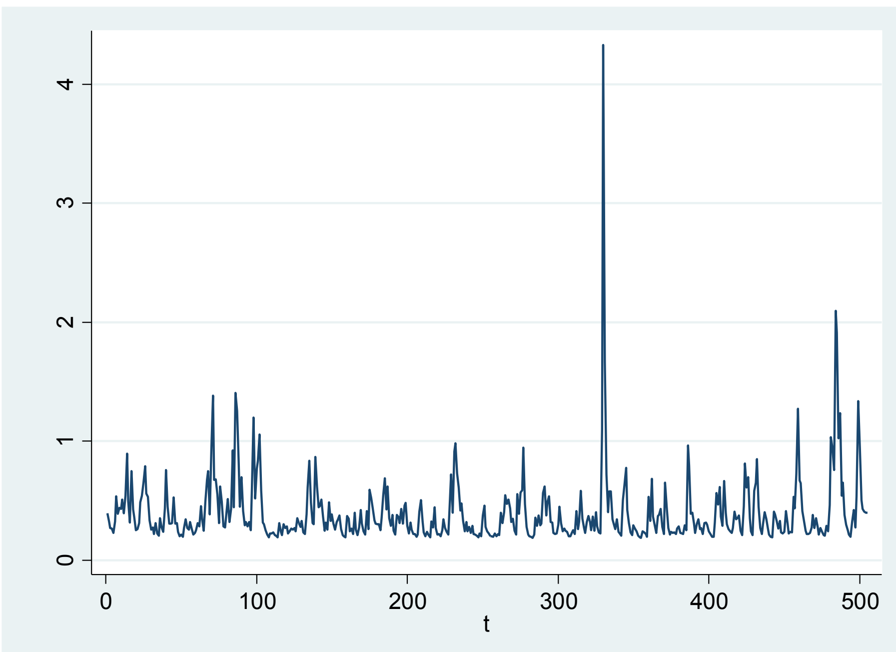
```
. *GARCH
. forvalue p=1(1)2 {
  2. forvalue q=1(1)2 {
  3. display "estimate garch`p'`q'"
  4. qui arch y x, garch(1/`p') arch(1/`q') nolog
  5. qui est store garch`p'`q'
```

```
  6. }
  7. est table garch*, star(0.1 0.05 0.01) stat(N ll chi2 aic bic)
  8. }
estimate garch11
estimate garch12

----------------------------------------------
    Variable |    garch11         garch12     
-------------+--------------------------------
y            |
           x |  .69785097***    .69783972***  
       _cons |  .51851398***    .51850887***  
-------------+--------------------------------
ARCH         |
        arch |
         L1. |  .36250292***    .36097359***  
         L2. |                  .00984107     
             |
       garch |
         L1. |   .3251895***    .30886518     
             |
       _cons |  .12545535***     .1286695*    
-------------+--------------------------------
Statistics   |
           N |        500             500     
          ll | -443.95805      -443.95432     
        chi2 |  72868.369       72933.849     
         aic |   897.9161       899.90864     
         bic |  918.98914       925.19629     
----------------------------------------------
           legend: * p<.1; ** p<.05; *** p<.01
estimate garch21
estimate garch22

------------------------------------------------------------------------------
    Variable |    garch11         garch12         garch21         garch22     
-------------+----------------------------------------------------------------
y            |
           x |  .69785097***    .69783972***    .69783869***    .69779147***  
       _cons |  .51851398***    .51850887***    .51850973***    .51882531***  
-------------+----------------------------------------------------------------
ARCH         |
        arch |
         L1. |  .36250292***    .36097359***    .36074245***    .36521493***  
         L2. |                  .00984107                       .27444452     
             |
       garch |
         L1. |   .3251895***    .30886518       .33749919*     -.35594504     
         L2. |                                 -.00992983       .16076458     
             |
       _cons |  .12545535***     .1286695*       .125209***    .22454219**   
-------------+----------------------------------------------------------------
Statistics   |
           N |        500             500             500             500     
          ll | -443.95805      -443.95432      -443.95377      -443.79435     
        chi2 |  72868.369       72933.849       72940.007        73674.66     
         aic |   897.9161       899.90864       899.90755       901.58871     
         bic |  918.98914       925.19629        925.1952       931.09096     
------------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

. arch y x, garch(1/1) arch(1/1) nolog

ARCH family regression

Sample: 1 - 500                                 Number of obs   =        500
Distribution: Gaussian                          Wald chi2(1)    =   72868.37
Log likelihood =  -443.958                      Prob > chi2     =     0.0000
```

```
------------------------------------------------------------------------------
             |                 OPG
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
           x |    .697851   .0025852   269.94   0.000     .6927841    .7029179
       _cons |    .518514   .0239007    21.69   0.000     .4716695    .5653585
-------------+----------------------------------------------------------------
ARCH         |
        arch |
         L1. |   .3625029   .0743235     4.88   0.000     .2168315    .5081743
             |
       garch |
         L1. |   .3251895   .1186414     2.74   0.006     .0926567    .5577223
             |
       _cons |   .1254554   .0357542     3.51   0.000     .0553784    .1955323
------------------------------------------------------------------------------
```

-According to BIC, the most appropriated lags order in this case is GARCH(1,1)

```
. predict sigmahat, v

. line sigmahat t
```



e.)

Among three models, the most appropriated in this case is GARCH, because it is the generalized of ARCH and we have p and q. GARCH is extended from ARCH and EGARCH is an asymmetric GARCH model, we react to shock asymmetrically, good for fluctuation period.

5.)

a.)

```
. tsset t
        time variable:  t, 1 to 500
                delta:  1 unit
```

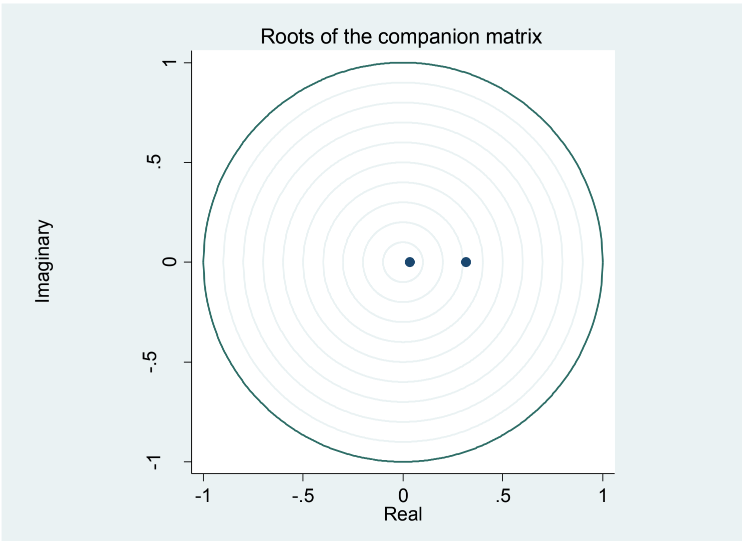
```
. varsoc y x, maxlag(5)

   Selection-order criteria
   Sample:  6 - 500                                Number of obs      =       495
  +---------------------------------------------------------------------------+
  |lag |    LL      LR      df    p      FPE       AIC      HQIC      SBIC    |
  |----+----------------------------------------------------------------------|
  |  0 | -1363.76                      .854259   5.51823    5.5249   5.53522  |
  |  1 | -1316.78  93.956*   4  0.000  .718084*  5.34458*  5.36459*  5.39555* |
  |  2 | -1316.03  1.5085    4  0.825  .727564    5.3577   5.39104   5.44264  |
  |  3 |  -1315.1  1.8666    4  0.760  .736636   5.37009   5.41677   5.48901  |
  |  4 | -1313.08  4.0355    4  0.401  .742563    5.3781   5.43812   5.53099  |
  |  5 | -1311.42  3.3226    4  0.505  .749618   5.38755   5.46091   5.57442  |
  +---------------------------------------------------------------------------+
   Endogenous:  y x

    Exogenous:  _cons
```

-According to SBIC, the most appropriated lag order is 1.

b.)

```
. var y x, lag(1/1)

Vector autoregression

Sample:  2 - 500                                   Number of obs     =        499
Log likelihood =  -1329.966                        AIC               =   5.354573
FPE            =   .7252923                        HQIC              =   5.374451
Det(Sigma_ml)  =   .7080582                        SBIC              =   5.405226

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
y                    3      .994217   0.0148   7.510069   0.0234
x                    3       .99826   0.0877   47.99154   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
           y |
         L1. |   .1370087   .0500719     2.74   0.006     .0388696    .2351478
             |
           x |
         L1. |   .0538854   .0479496     1.12   0.261    -.0400941    .1478649
             |
       _cons |   .3367878   .0544732     6.18   0.000     .2300223    .4435534
-------------+----------------------------------------------------------------
x            |
           y |
         L1. |   .3405712   .0502755     6.77   0.000      .242033    .4391095
             |
           x |
         L1. |   .2120147   .0481446     4.40   0.000      .117653    .3063764
             |
       _cons |   .1231797   .0546947     2.25   0.024     .0159799    .2303794
------------------------------------------------------------------------------


. varstable, graph

   Eigenvalue stability condition
  +----------------------------------------+
  |        Eigenvalue        |   Modulus   |
  |--------------------------+-------------|
  |   .3150759               |   .315076   |
  |   .0339475               |   .033948   |
```

```
+---------------------------------------+
 All the eigenvalues lie inside the unit circle.
 VAR satisfies stability condition.
```




```
. vargranger
```

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
y	x	1.2629	1	0.261
y	ALL	1.2629	1	0.261
x	y	45.888	1	0.000
x	ALL	45.888	1	0.000

-According to stability test, the system is stable since all the eigenvalue lie inside the unit circle.
-According to Granger exogeneity, x is endogenous since the test is significant, while y is not endogenous.
-If the stability assumption is unsatisfied, the IRF won't get back to the equilibrium.

c.)

```
. irf table irf, impulse(y x) response(y x)
```

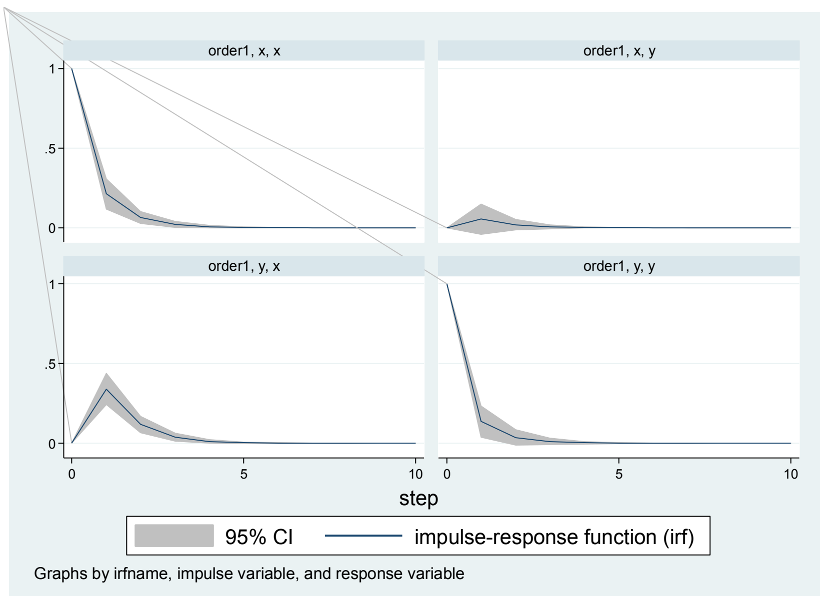
Results from order1

step	(1) irf	(1) Lower	(1) Upper	(2) irf	(2) Lower	(2) Upper
0	1	1	1	0	0	0
1	.137009	.03887	.235148	.340571	.242033	.439109
2	.037123	-.011219	.085465	.118867	.067548	.170187
3	.011491	-.008261	.031244	.037845	.013023	.062667
4	.003614	-.003868	.011095	.011937	.000566	.023308
5	.001138	-.001613	.003889	.003762	-.001066	.008589
6	.000359	-.000633	.001351	.001185	-.000745	.003115
7	.000113	-.000239	.000465	.000373	-.000366	.001113
8	.000036	-.000088	.000159	.000118	-.000157	.000392
9	.000011	-.000032	.000054	.000037	-.000063	.000137
10	3.5e-06	-.000011	.000018	.000012	-.000024	.000047

step	(3) irf	(3) Lower	(3) Upper	(4) irf	(4) Lower	(4) Upper
0	0	0	0	1	1	1
1	.053885	-.040094	.147865	.212015	.117653	.306376
2	.018807	-.014393	.052008	.063302	.02548	.101124
3	.005988	-.006268	.018244	.019826	.001882	.03777
4	.001889	-.002612	.006389	.006243	-.001509	.013994
5	.000595	-.00103	.002221	.001967	-.001159	.005092
6	.000188	-.000391	.000766	.00062	-.000584	.001823
7	.000059	-.000144	.000262	.000195	-.000254	.000644
8	.000019	-.000052	.000089	.000062	-.000102	.000225
9	5.9e-06	-.000018	.00003	.000019	-.000039	.000078
10	1.8e-06	-6.5e-06	.00001	6.1e-06	-.000015	.000027

95% lower and upper bounds reported
(1) irfname = order1, impulse = y, and response = y
(2) irfname = order1, impulse = y, and response = x
(3) irfname = order1, impulse = x, and response = y
(4) irfname = order1, impulse = x, and response = x

```
. irf graph irf, impulse(y x) response(y x)
```




```
. irf table oirf, impulse(y x) response(y x)
```

Results from order1

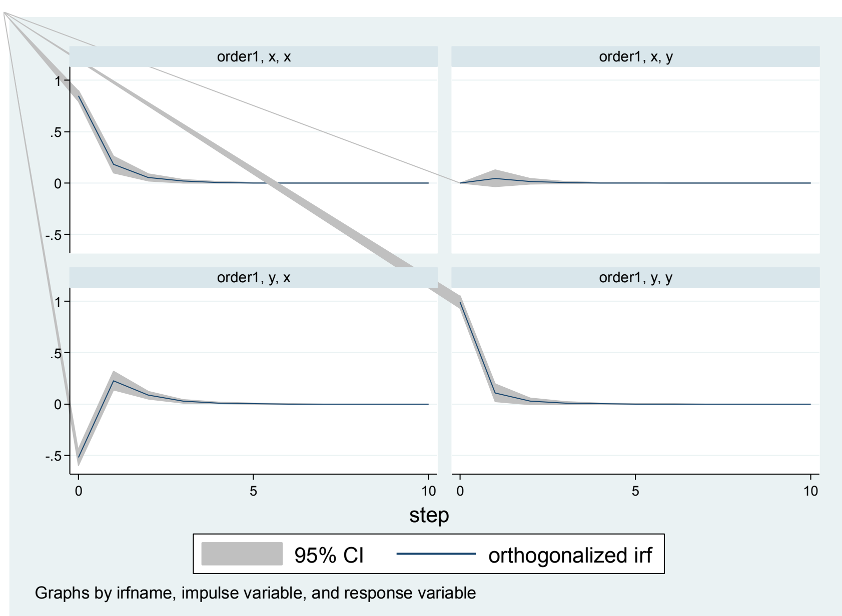
step	(1) oirf	(1) Lower	(1) Upper	(2) oirf	(2) Lower	(2) Upper
0	.991224	.929727	1.05272	-.519501	-.600659	-.438343
1	.107813	.02099	.194635	.227441	.138072	.316809
2	.027027	-.005211	.059265	.084939	.045912	.123965
3	.00828	-.005161	.021721	.027213	.009891	.044535
4	.002601	-.002531	.007732	.008589	.000924	.016255

5	.000819	-.001077	.002715	.002707	-.000547	.005961
6	.000258	-.000429	.000945	.000853	-.000457	.002162
7	.000081	-.000163	.000326	.000269	-.000236	.000774
8	.000026	-.000061	.000112	.000085	-.000104	.000274
9	8.1e-06	-.000022	.000038	.000027	-.000042	.000096
10	2.5e-06	-7.8e-06	.000013	8.4e-06	-.000016	.000033

step	(3) oirf	(3) Lower	(3) Upper	(4) oirf	(4) Lower	(4) Upper
0	0	0	0	.848912	.796244	.90158
1	.045744	-.034087	.125575	.179982	.099103	.260861
2	.015966	-.012236	.044168	.053738	.021458	.086018
3	.005083	-.005326	.015492	.016831	.001562	.032099
4	.001603	-.002219	.005425	.0053	-.001289	.011888
5	.000505	-.000875	.001886	.00167	-.000986	.004325
6	.000159	-.000332	.00065	.000526	-.000496	.001548
7	.00005	-.000122	.000223	.000166	-.000215	.000547
8	.000016	-.000044	.000076	.000052	-.000087	.000191
9	5.0e-06	-.000016	.000026	.000016	-.000033	.000066
10	1.6e-06	-5.5e-06	8.6e-06	5.2e-06	-.000012	.000023

95% lower and upper bounds reported
(1) irfname = order1, impulse = y, and response = y
(2) irfname = order1, impulse = y, and response = x
(3) irfname = order1, impulse = x, and response = y
(4) irfname = order1, impulse = x, and response = x

```
. irf graph oirf, impulse(y x) response(y x)
```



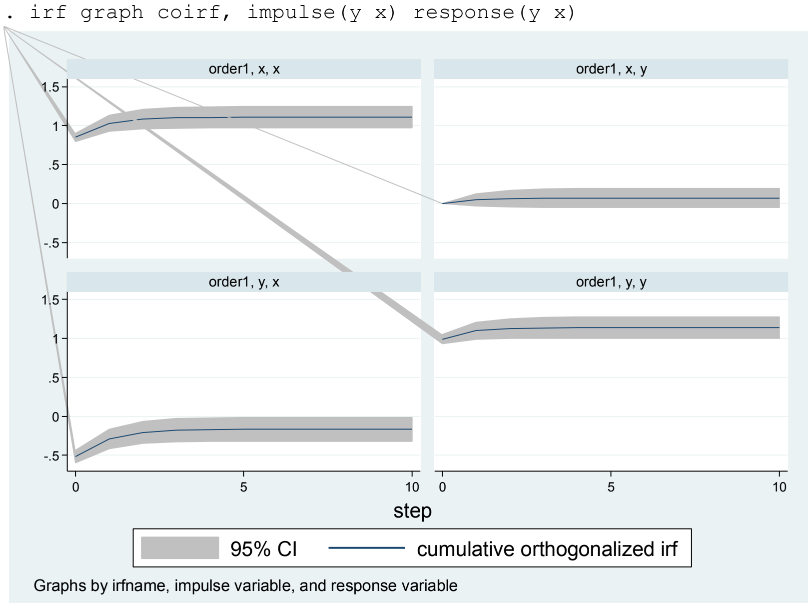

```
. irf table coirf, impulse(y x) response(y x)
```

Results from order1

step	(1) coirf	(1) Lower	(1) Upper	(2) coirf	(2) Lower	(2) Upper
0	.991224	.929727	1.05272	-.519501	-.600659	-.438343
1	1.09904	.988843	1.20923	-.29206	-.418616	-.165505
2	1.12606	.997777	1.25435	-.207122	-.349063	-.065181
3	1.13434	.9985	1.27019	-.179909	-.329085	-.030733
4	1.13694	.99817	1.27572	-.171319	-.323504	-.019135
5	1.13776	.997917	1.27761	-.168613	-.321961	-.015264
6	1.13802	.997794	1.27825	-.16776	-.321537	-.013982
7	1.1381	.997743	1.27846	-.167491	-.321422	-.01356
8	1.13813	.997723	1.27853	-.167406	-.321391	-.013421
9	1.13814	.997715	1.27856	-.16738	-.321383	-.013376
10	1.13814	.997712	1.27857	-.167371	-.321381	-.013361

step	(3) coirf	(3) Lower	(3) Upper	(4) coirf	(4) Lower	(4) Upper
0	0	0	0	.848912	.796244	.90158
1	.045744	-.034087	.125575	1.02889	.926465	1.13132
2	.06171	-.045933	.169352	1.08263	.958289	1.20697
3	.066793	-.051017	.184603	1.09946	.965973	1.23295
4	.068396	-.053116	.189909	1.10476	.967587	1.24194
5	.068901	-.053937	.19174	1.10643	.967855	1.24501
6	.069061	-.054246	.192368	1.10696	.967868	1.24605
7	.069111	-.05436	.192581	1.10712	.967851	1.2464
8	.069127	-.0544	.192653	1.10718	.967839	1.24651
9	.069132	-.054415	.192678	1.10719	.967833	1.24655
10	.069133	-.05442	.192686	1.1072	.967831	1.24656

```
95% lower and upper bounds reported
(1) irfname = order1, impulse = y, and response = y
(2) irfname = order1, impulse = y, and response = x
(3) irfname = order1, impulse = x, and response = y
(4) irfname = order1, impulse = x, and response = x

. irf graph coirf, impulse(y x) response(y x)
```



-According to IRF analysis, y has more impact on x.

d.)

```
. irf table fevd, impulse(y x) response(y x)
```

Results from order1

step	(1) fevd	(1) Lower	(1) Upper	(2) fevd	(2) Lower	(2) Upper
0	0	0	0	0	0	0
1	1	1	1	.272461	.20582	.339101
2	.9979	.990577	1.00522	.299268	.234485	.364052
3	.997646	.98945	1.00584	.303132	.238893	.367371
4	.99762	.989324	1.00592	.303528	.239353	.367704
5	.997618	.989309	1.00593	.303568	.239398	.367737
6	.997618	.989308	1.00593	.303572	.239403	.367741
7	.997618	.989308	1.00593	.303572	.239403	.367741
8	.997618	.989308	1.00593	.303572	.239403	.367741
9	.997618	.989308	1.00593	.303572	.239403	.367741
10	.997618	.989308	1.00593	.303572	.239403	.367741

step	(3) fevd	(3) Lower	(3) Upper	(4) fevd	(4) Lower	(4) Upper
0	0	0	0	0	0	0
1	0	0	0	.727539	.660899	.79418
2	.0021	-.005222	.009423	.700732	.635948	.765515
3	.002354	-.005842	.01055	.696868	.632629	.761107
4	.00238	-.005917	.010676	.696472	.632296	.760647
5	.002382	-.005926	.010691	.696432	.632263	.760602
6	.002382	-.005927	.010692	.696428	.632259	.760597
7	.002382	-.005927	.010692	.696428	.632259	.760597
8	.002382	-.005927	.010692	.696428	.632259	.760597
9	.002382	-.005927	.010692	.696428	.632259	.760597
10	.002382	-.005927	.010692	.696428	.632259	.760597

```
95% lower and upper bounds reported
(1) irfname = order1, impulse = y, and response = y
(2) irfname = order1, impulse = y, and response = x
(3) irfname = order1, impulse = x, and response = y
(4) irfname = order1, impulse = x, and response = x
```

-According to forecast error variance decomposition, y has more impact on x.

e.)

Yes, because if we change the order, the matrix that we begin with will be different.