Pongpanot 6204641267 Seat No. 11

1) a)

```
mlogit y x1 x2 x3 x4, rrr 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 |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
          x1 |   .2599617   .1658795    -2.11   0.035     .0744329    .9079339
          x2 |   .3818281   .2992225    -1.23   0.219     .0821897    1.773857
          x3 |   .6644484   .4190852    -0.65   0.517     .1930127    2.287371
          x4 |   2.033882   .5337481     2.71   0.007     1.216036    3.401771
       _cons |   .0001886   .0007014    -2.31   0.021     1.29e-07    .2763357
-------------+----------------------------------------------------------------
2            |
          x1 |   .3193839   .2197084    -1.66   0.097     .0829393    1.229889
          x2 |   .1662242   .1344288    -2.22   0.026     .0340652    .8111065
          x3 |   2.072154   1.376082     1.10   0.273     .5638369    7.615361
          x4 |   6.282728    1.95573     5.90   0.000     3.413347    11.56421
       _cons |   3.72e-12   1.72e-11    -5.70   0.000     4.40e-16    3.15e-08

est store my

fitstat

Measures of Fit for mlogit of y

Log-Lik Intercept Only:     -150.239     Log-Lik Full Model:          -104.807
D(155):                      209.614     LR(8):                         90.864
                                         Prob > LR:                      0.000
McFadden's R2:                 0.302     McFadden's Adj R2:              0.203
Maximum Likelihood R2:         0.414     Cragg & Uhler's R2:             0.499
Count R2:                      0.259     Adj Count R2:                   0.031
AIC:                           1.409     AIC*n:                        239.614
BIC:                        -586.435     BIC':                         -49.777
```

Variable x1 increases  the probability that alternative 4 is chosen instead of the baseline alternative if RRR > 1
Variable x1 increases  the probability that alternative 2 is chosen instead of the baseline alternative if RRR > 1
Variable x1 increases  the probability that alternative 3is chosen instead of the baseline alternative if RRR > 1

```
mlogit y x1 x2 x3 x4 if y!=2, rrr 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 |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
          x1 |   .3234342   .1977792    -1.85   0.065     .0975614    1.072244
          x2 |   .5219172   .3930008    -0.86   0.388      .119303    2.283241
          x3 |   .8017844   .5258649    -0.34   0.736     .2217081     2.89957
          x4 |   1.886394   .4854053     2.47   0.014     1.139205    3.123653
       _cons |    .000378   .0014383    -2.07   0.038     2.18e-07    .6552516
------------------------------------------------------------------------------
```

```
est store myno2

hausman my myno2, alleqs constant

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       my         myno2        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)
```

According to IIA (Hausman) test of y with p-value of 0.9239, which is greater than 0.05, IIA hypothesis is not rejected. Thus, IIA is satisfied in Model y

Independence of Irrelevant Alternatives (IIA) is the important assumption of Multinomial Logit Model It implies that the decision between two alternatives is independent from the existence of more alternatives

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 y12=y>1

. qui probit y01 x*, nolog

. est store m01

. qui probit y12 x*, nolog

. est store m12

. suest m01 m12

Simultaneous results for m01, m12

                                                Number of obs     =        170

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
m01_y01      |
          x1 |  -.6851706   .3512494    -1.95   0.051    -1.373607    .0032655
          x2 |  -.6845366   .3809002    -1.80   0.072    -1.431087    .0620141
          x3 |   .1281714   .3167247     0.40   0.686    -.4925977    .7489404
          x4 |   .6859726   .1150367     5.96   0.000     .4605049    .9114403
       _cons |  -8.921267   1.648028    -5.41   0.000    -12.15134   -5.691193
-------------+----------------------------------------------------------------
m12_y12      |
          x1 |  -.0894519    .279171    -0.32   0.749    -.6366171    .4577133
          x2 |  -.5374584   .2915773    -1.84   0.065    -1.108939    .0340227
          x3 |   .6475463   .2623226     2.47   0.014     .1334035    1.161689
          x4 |   .7409548   .1229369     6.03   0.000     .5000028    .9819068
       _cons |  -11.72697   1.949461    -6.02   0.000    -15.54784   -7.906094
------------------------------------------------------------------------------
test [m01_y01]x1=[m12_y12]x1

 ( 1)  [m01_y01]x1 - [m12_y12]x1 = 0

           chi2(  1) =    2.38
         Prob > chi2 =    0.1226
```

P-value > 0.05. Accept the null hypothesis implying that it is Ordered probit model is appropriated

```
test [m01_y01]x2=[m12_y12]x2

 ( 1)  [m01_y01]x2 - [m12_y12]x2 = 0

           chi2(  1) =    0.12
         Prob > chi2 =    0.7251
```

P-value > 0.05. Accept the null hypothesis implying that it is Ordered probit model is appropriated

```
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
```

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```
mvprobit (y1 x1 x2 x3 x4) (y2 x1 x2 x3 x4) (y3 x1 x2 x3 x4)

Iteration 0:   log likelihood = -1058.0443
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Iteration 1:   log likelihood = -949.01698
Iteration 2:   log likelihood = -935.93086
Iteration 3:   log likelihood = -934.31518
Iteration 4:   log likelihood = -934.30894
Iteration 5:   log likelihood = -934.30894

Multivariate probit (SML, # 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 |  -.7005574   .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    -.2693829    .9122902
-------------+----------------------------------------------------------------
y3           |
          x1 |  -.5286327   .3907745    -1.35   0.176    -1.294537    .2372713
          x2 |   .6349395    .387475     1.64   0.101    -.1244975    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   .0748361    -8.33   0.000    -.7697613   -.4764093
-------------+----------------------------------------------------------------
    /atrho31 |  -.4021503   .0739359    -5.44   0.000    -.5470621   -.2572386
-------------+----------------------------------------------------------------
    /atrho32 |  -.3327245   .0712366    -4.67   0.000    -.4723456   -.1931033
-------------+----------------------------------------------------------------
       rho21 |  -.5532726    .051928   -10.65   0.000    -.6467906   -.4433634
-------------+----------------------------------------------------------------
       rho31 |  -.3817873   .0631589    -6.04   0.000     -.498315   -.2517109
-------------+----------------------------------------------------------------
       rho32 |  -.3209667   .0638978    -5.02   0.000    -.4400926   -.1907384
------------------------------------------------------------------------------
Likelihood ratio test of  rho21 = rho31 = rho32 = 0:
             chi2(3) =  247.471   Prob > chi2 = 0.0000
```

c).

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Since p-value of LR test of rhoij=0 is less than 0.05, the hypothesis can be rejected. It implies that there are correlation among the disturbance terms of these three models. MV probit is appropriated and three separate probit models are not appropriated.

d)

```
mvprobit (y1 x1 x2 x3 x4) (y2 x1 x2 x3 x4) (y3 x1 x2 x3 x4)

Iteration 0:   log likelihood = -1058.0443
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Iteration 1:   log likelihood = -949.01698
Iteration 2:   log likelihood = -935.93086
Iteration 3:   log likelihood = -934.31518
Iteration 4:   log likelihood = -934.30894
Iteration 5:   log likelihood = -934.30894

Multivariate probit (SML, # 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 |  -.7005574   .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    -.2693829    .9122902
-------------+----------------------------------------------------------------
y3           |
          x1 |  -.5286327   .3907745    -1.35   0.176    -1.294537    .2372713
          x2 |   .6349395    .387475     1.64   0.101    -.1244975    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   .0748361    -8.33   0.000    -.7697613   -.4764093
-------------+----------------------------------------------------------------
    /atrho31 |  -.4021503   .0739359    -5.44   0.000    -.5470621   -.2572386
-------------+----------------------------------------------------------------
    /atrho32 |  -.3327245   .0712366    -4.67   0.000    -.4723456   -.1931033
-------------+----------------------------------------------------------------
       rho21 |  -.5532726    .051928   -10.65   0.000    -.6467906   -.4433634
-------------+----------------------------------------------------------------
       rho31 |  -.3817873   .0631589    -6.04   0.000     -.498315   -.2517109
-------------+----------------------------------------------------------------
       rho32 |  -.3209667   .0638978    -5.02   0.000    -.4400926   -.1907384
------------------------------------------------------------------------------
Likelihood ratio test of  rho21 = rho31 = rho32 = 0:
             chi2(3) =  247.471   Prob > chi2 = 0.0000
```

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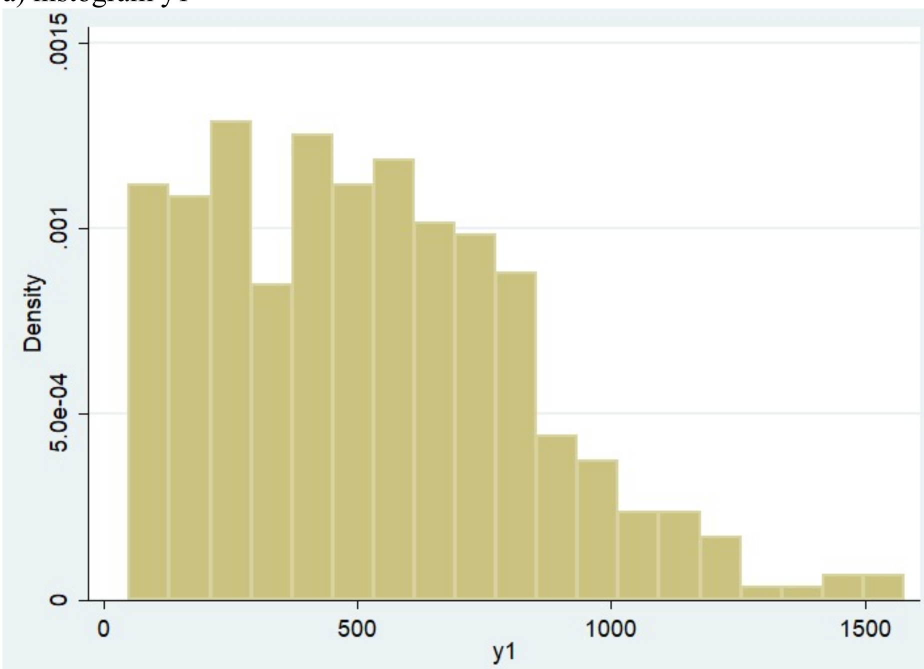
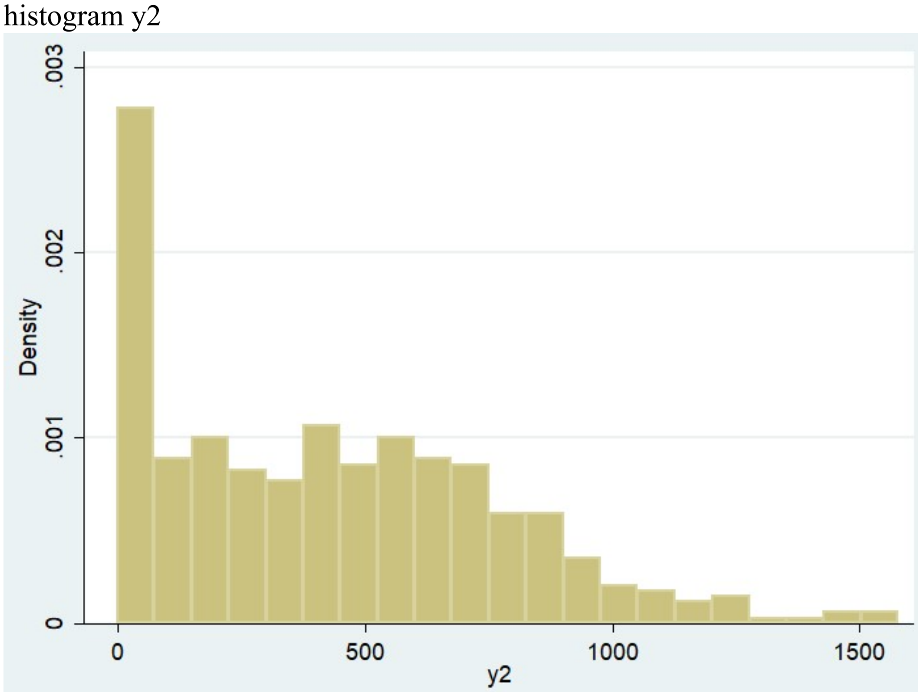
d)
Since p-value of LR test of rhoij=0 is less than 0.05, the hypothesis can be rejected. It implies that there are correlation among the disturbance terms of these three models. MV probit is appropriated and three separate probit models are not appropriated.

2) –

a) histogram y1




histogram y2




histogram y3

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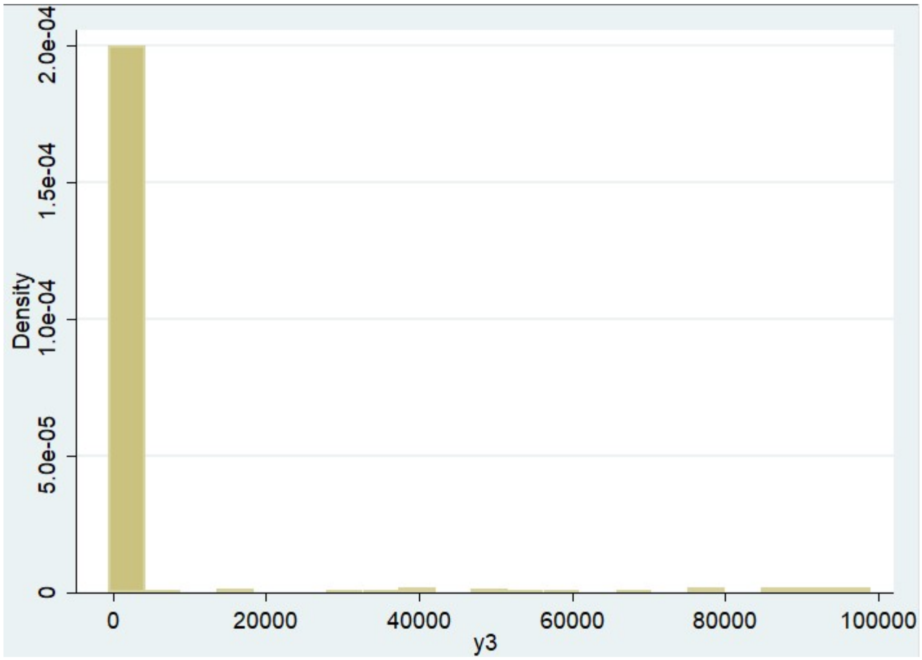
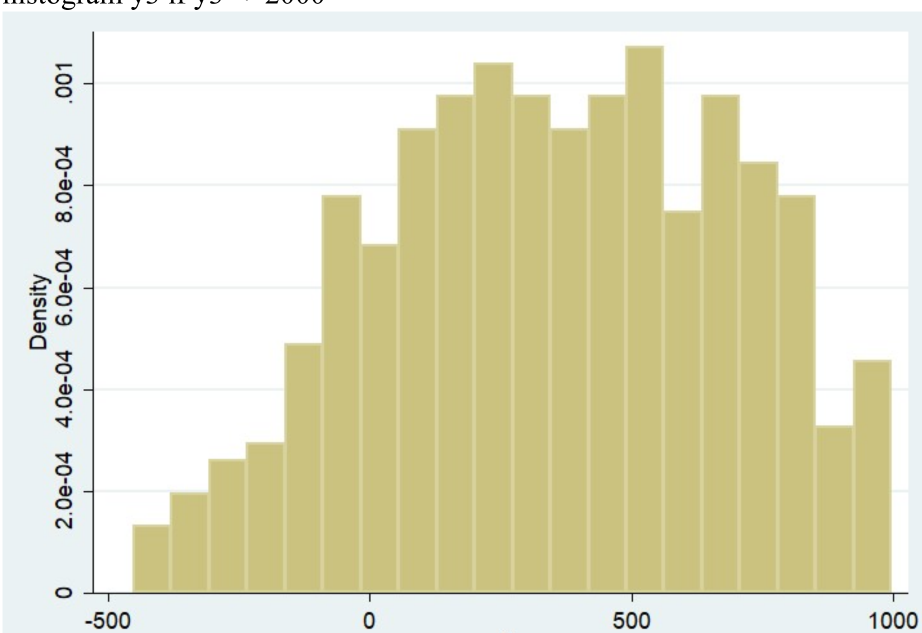



histogram y3 if y3 <=2000




```
sum y1 y2 y3 x

    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
           x |        450    3.008544    1.036395   .2858976   6.098752
```

On the y1, Some of obs are gone y1 (367 obs) which is implying that it is truncate sample. Sample is selected based only on value of y

On the y2 , many 0 is too huge which imply that it is censor sample

On Y3, it shows that is range between Min and Max is too large causing it to be outliner.

b)

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```
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 m_y1

sum y1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          y1 |        367    524.2029    308.2434   50.21759    1578.51
. scalar miny1=round(r(min))
. scalar list miny1
     miny1 =         50
truncreg y1 x, ll(miny1) 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 m_y1t

. lrtest m_y1 m_y1t, force

Likelihood-ratio test                                 LR chi2(1)  =     76.33
(Assumption: m_y1 nested in m_y1t)                    Prob > chi2 =    0.0000
```

P-value is less than 0.05 so reject the null hypothesis. 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.

In this case, some of data is truncated where Variable x and y can’t be observed. If we ignore it, it will lead to bias since it is not normally distribution 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 m_y

. 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 m_y2c
lrtest m_y m_y2c, force

Likelihood-ratio test                                 LR chi2(1)  =    734.73
(Assumption: m_y nested in m_y2c)                     Prob > chi2 =    0.0000
```

P-value is less than 0.05 so reject the null hypothesis. 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.

In this case, some of data is censored based only on value of y. If we ignore it, it will lead to bias since it is not normally distribution .

d)

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

. predict y3_hat
(option xb assumed; fitted values)

.  est store m_y3

. sum y3

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

.  reg y3 x if y3<=2000

      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
------------------------------------------------------------------------------

. predict y3_hat_o
(option xb assumed; fitted values)

.  est store m_y3o

. tobit y3 x, ul(2000) nolog

Tobit regression                                Number of obs     =        450
                                                LR chi2(1)        =     196.29
                                                Prob > chi2       =     0.0000
Log likelihood = -3207.5141                     Pseudo R2         =     0.0297

------------------------------------------------------------------------------
          y3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   299.4023   19.17712    15.61   0.000     261.7142    337.0903
       _cons |  -444.6084   60.82021    -7.31   0.000     -564.136   -325.0808
-------------+----------------------------------------------------------------
      /sigma |    417.685   14.63844                      388.9166    446.4534
```

```
------------------------------------------------------------------------------
            0  left-censored observations
          425     uncensored observations
           25 right-censored observations at y3 >= 2000

.  est store m_y3o_t

.  lrtest m_y3 m_y3o_t, force

Likelihood-ratio test                                 LR chi2(1)  =   3521.34
(Assumption: m_y3 nested in m_y3o_t)                  Prob > chi2 =    0.0000
```

P-value is less than 0.05 so reject the null hypothesis. 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.

In this case, some of data is censored based only on value of y. If we ignore it, it will lead to bias since it is not normally distribution.

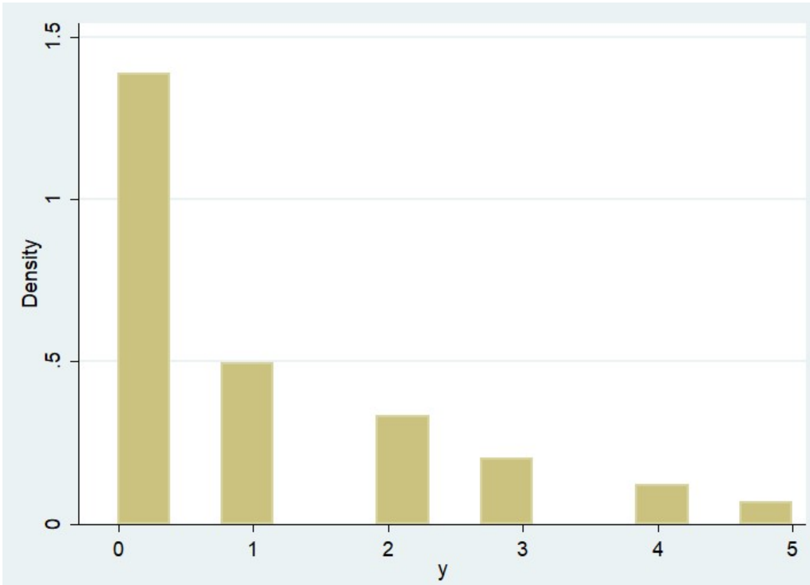
```
3) -
a)
reg y x1 x2 x3 x4

      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 linear

. histogram y
```




a) Continued

According to Histogram, it looks like that the distribution of dependent variable follows Poisson distribution. It shows that the model is Poisson model

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
```

According to GOF test, null hypothesis of the test was rejected, thus, Poisson regression model is inappropriated.

```
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 poisson

```
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 results, interpretation can be made concerning: sign and meaning of the estimated coefficient – correct sign (positive mfx sign and irr>1 for x1, x2, x3 and negative mfx sign and irr<1 for x4 Overall test LR-Chi-squared-test – significant, Pseudo R-squared 0.0587 - not quite fit the data, Individual test z-test – all significant.

c)

```
nbreg y x1 x2 x3 x4, nolog

Negative binomial regression                    Number of obs     =        195
```

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```
                                                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
```

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

```
nbreg y x1 x2 x3 x4, ir 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 |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   1.114903   .0588123     2.06   0.039     1.005392    1.236343
          x2 |   1.167644   .0613025     2.95   0.003     1.053468    1.294194
          x3 |   1.215694   .0865752     2.74   0.006      1.05732    1.397792
          x4 |   .9723842   .0490474    -0.56   0.579     .8808521    1.073428
       _cons |   .8393668   .1036519    -1.42   0.156     .6589286    1.069215
-------------+----------------------------------------------------------------
    /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 nb

.  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 results, interpretation can be made concerning: sign and meaning of the estimated coefficient – correct sign (positive mfx sign and irr>1 for x1, x2, x3 and negative mfx sign and irr<1 for x4 Overall test LR-Chi-squared-test – significant, Pseudo R-squared 0.0342 - not quite fit the data, Individual test z-test – all significant.

```
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
est store zip
```

- According to Vuong test, null hypothesis of the test was rejected, thus, Zero Inflated Poisson regression model is more appropriated than Poisson regression model.

```
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 results, interpretation can be made concerning: sign and meaning of the estimated coefficient – correct sign (positive mfx sign for x1, x2, x3 and negative mfx sign for x4), Overall test LR-Chi-squared-test – significant, Individual test z-test –significant except x3.

est table linear poisson nb zip, star(.1 .05 .01) stat(N ll chi2 chi2_c vuong)

| Variable | linear | poisson | nb | zip |
|---|---|---|---|---|
| _ | | | | |
| x1 | .07938862* | | | |
| x2 | .13905091*** | | | |
| x3 | .1906963*** | | | |
| x4 | -.02407411 | | | |
| _cons | .92932537*** | | | |
| y | | | | |
| x1 | | .0806329** | .10876739** | .09108141** |
| x2 | | .1401445*** | .15498784*** | .12283434*** |
| x3 | | .20349954*** | .19531545*** | .14362543** |
| x4 | | -.02439041 | -.02800431 | |
| _cons | | -.15802244* | -.17510753 | .32438125*** |
| lnalpha | | | | |
| _cons | | | -.16534997 | |
| inflate | | | | |
| x4 | | | | .02180894 |
| _cons | | | | -.52301075** |
| Statistics | | | | |
| N | 195 | 195 | 195 | 195 |
| ll | -323.93584 | -274.62075 | -259.61412 | -258.07613 |
| chi2 | | 34.227955 | 18.368828 | 14.280926 |
| chi2_c | | | 30.013259 | |
| vuong | | | | 2.5787063 |

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

. According to GOF test, null hypothesis of the test was rejected, thus, Poisson regression model is more appropriated than linear regression model.

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

According to Vuong test, null hypothesis of the test was rejected, thus, Zero Inflated Poisson regression model is more appropriated than Poisson regression model.

Also, Histogram illustrates zero inflated distribution of dependent variable, therefore, Zero Inflated Poisson regression model should be applied in this case.

4) -

a)

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

reject the null hypothesis hence, there is no Unit Root

```
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
```

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

reject the null hypothesis hence, there is no Unit Root

a) Continued

X and Y are both stationary, the oder of integration is (0), It does not need any order. The test is to determine unit root problem the series is stationary or nonstationary. The process is to set the null hypothesis that Gamma = 0 and reject the null hypothesis ,hence, there is no Unit Root and if accept the null hypothesis ,continue with test hypothesis where trend=0 if reject there is Unit root And repeat with intercept term =0 and if yes ,without intercept and trend, still reject Gamma hypothesis there is no Unit Root Problem if not there is still Unit Root

b)

```
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.
. est store arima101
. qui arima y, arima(1,0,2) nolog
. est store arima102
. qui arima y, arima(1,0,3) nolog
. est store arima103
. qui arima y, arima(1,0,4) nolog
. est store arima104
. qui arima y, arima(2,0,1) nolog
. est store arima201
. qui arima y, arima(2,0,2) nolog
. est store arima202
. qui arima y, arima(2,0,3) nolog
. est store arima203
. qui arima y, arima(2,0,4) nolog
. est store arima204
. qui arima y, arima(3,0,1) nolog
. est store arima301
. qui arima y, arima(3,0,2) nolog
. est store arima302
```

```
. qui arima y, arima(3,0,3) nolog
. est store arima303
. qui arima y, arima(3,0,4) nolog
. est store arima304
. qui arima y, arima(4,0,1) nolog
. est store arima401
. qui arima y, arima(4,0,2) nolog
. est store arima402
. qui arima y, arima(4,0,3) nolog
. est store arima403
. qui arima y, arima(4,0,4) nolog
. est store arima404

est table arima10*, star(0.1 0.05 0.01) stat(N ll chi2 aic bic)

------------------------------------------------------------------------------
    Variable |   arima101        arima102        arima103        arima104     
-------------+----------------------------------------------------------------
y            |
       _cons |  1.3160732***    1.3164623***    1.3169246***    1.3196561***  
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.85671231***    -.8407698***   -.85479005***    .79555112***  
             |
          ma |
         L1. |  .81381586***    .81081395***    .82385933***   -.83063072***  
         L2. |                  .01776181       .02900763       .08192832     
         L3. |                                  .01703608      -.04696028     
         L4. |                                                  .03883734     
-------------+----------------------------------------------------------------
sigma        |
       _cons |  6.7070643***    6.7062145***    6.7052679***    6.7033168***  
-------------+----------------------------------------------------------------
Statistics   |
           N |        500             500             500             500     
          ll | -1661.0562      -1660.9819      -1660.9152      -1660.7819     
        chi2 |  52.431996       48.538035       51.947118       20.004068     
         aic |  3330.1124       3331.9639       3333.8305       3335.5639     
         bic |  3346.9709       3353.0369       3359.1181       3365.0661     
------------------------------------------------------------------------------
                                          legend: * p<.1; ** p<.05; *** p<.01

. est table arima20*, star(0.1 0.05 0.01) stat(N ll chi2 aic bic)

------------------------------------------------------------------------------
    Variable |   arima201        arima202        arima203        arima204     
-------------+----------------------------------------------------------------
y            |
       _cons |  1.3165966***    1.3193097***    1.3192028***    1.3190979***  
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.81679808***    .02485091      -.00880392      -.01799803     
         L2. |  .01965322       .72638325***    .72631603***    .68941508**   
             |
          ma |
         L1. |  .78741991***   -.04728285      -.02454975      -.01490702     
         L2. |                 -.65937106**    -.66072222**    -.63706121**   
```

```
         L3. |                                    .01970127       .01889581    
         L4. |                                                    .02331994    
-------------+----------------------------------------------------------------
sigma        |
       _cons |  6.706091***    6.6966012***     6.695548***    6.6939821***  
-------------+----------------------------------------------------------------
Statistics   |
           N |        500             500             500             500    
          ll | -1660.9785      -1660.2724      -1660.1961      -1660.0893    
        chi2 |  46.275204        20.50189        21.61323       20.409942    
         aic |   3331.957       3332.5449       3334.3921       3336.1786    
         bic |  3353.0301       3357.8325       3363.8944       3369.8955    
------------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

. est table arima30*, star(0.1 0.05 0.01) stat(N ll chi2 aic bic)

------------------------------------------------------------------------------
    Variable |  arima301        arima302        arima303        arima304     
-------------+----------------------------------------------------------------
y            |
       _cons |  1.3170214***    1.3192207***    1.3311023***    1.3312982***  
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.84311244***   -.03418916       1.0641965***    1.0672402***  
         L2. |  .03190832       .72699651***     .6530733**      .64680736*   
         L3. |  .01910909       .02024337      -.83386019***   -.83047128***  
             |
          ma |
         L1. |  .81339159***    .00153606      -1.1231676       -1.123462***  
         L2. |                 -.66194403**    -.55645796      -.55183321    
         L3. |                                  .80656679       .79853444***  
         L4. |                                                  .00399858    
-------------+----------------------------------------------------------------
sigma        |
       _cons |  6.7050253***    6.6954461***    6.6128034       6.6127984    
-------------+----------------------------------------------------------------
Statistics   |
           N |        500             500             500             500    
          ll | -1660.9029      -1660.2011      -1656.0279      -1656.0246    
        chi2 |  52.888952       22.065233       44673.068       44570.467    
         aic |  3333.8057       3334.4022       3326.0559       3328.0491    
         bic |  3359.0934       3363.9044       3355.5581        3361.766    
------------------------------------------------------------------------------
                                           legend: * p<.1; ** p<.05; *** p<.01

. est table arima40*, star(0.1 0.05 0.01) stat(N ll chi2 aic bic)

------------------------------------------------------------------------------
    Variable |  arima401        arima402        arima403        arima404     
-------------+----------------------------------------------------------------
y            |
       _cons |  1.3175059***    1.3190967***                    1.3187605***  
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. | -.78144222**    -.0441011                          .090027    
         L2. |  .03235516       .65860818*                      -.22996396    
```

```
         L3. |  .04475517       .02006821                                    -.05809939   
         L4. |  .04099103       .02440356                                     .70709274***
             |
          ma |
         L1. |  .75091484**     .01110505                                    -.12463059   
         L2. |                 -.6062543                                      .31438256   
         L3. |                                                                .05252582   
         L4. |                                                               -.66037916** 
-------------+----------------------------------------------------------------------------
sigma        |
       _cons |  6.7000467***     6.694033***                                  6.6579737***
-------------+----------------------------------------------------------------------------
_            |
    __000001 |
         L1. |                                 -.06660543                                 
         L2. |                                    .045068                                 
         L3. |                                  .13149793                                 
         L4. |                                  .05926447                                 
             |
    __000002 |
         L1. |                                  .04013471                                 
         L2. |                                  .01365599                                 
         L3. |                                 -.14130775                                 
-------------+----------------------------------------------------------------------------
Statistics   |
           N |        500             500             466             500   
          ll | -1660.5409      -1660.0958      -1551.5332      -1657.6826   
        chi2 |  37.986475       19.683851                        1491.758   
         aic |  3335.0818       3336.1916       3117.0664       3335.3652   
         bic |  3364.5841       3369.9085       3146.0757       3377.5113   
------------------------------------------------------------------------------------------
                                                    legend: * p<.1; ** p<.05; *** p<.01
```

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

Make dynamic forecast for period time = 501 to 505

```
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
```

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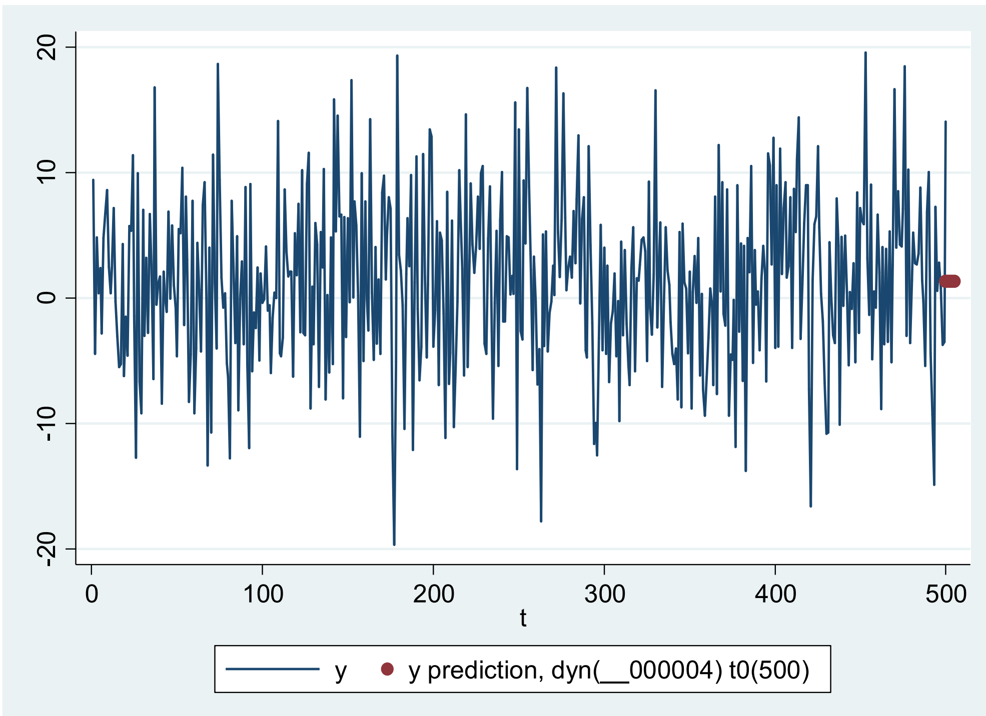
```
------------------------------------------------------------------------------
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

.   set obs 505
number of observations (_N) was 500, now 505

. replace t=_n
(5 real changes made)

. predict yhat, y dynamic(.) t0(500)
```




```
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. The reason is that OLS is a restricted model.

d)

qui arch y x, arch(1) garch(1) nolog

. est store garch11

. qui arch y x, arch(1) garch(1/2) nolog

. est store garch21

. qui arch y x, arch(1/2) garch(1) nolog

. est store garch12

. qui arch y x, arch(1/2) garch(1/2) nolog

. est store garch22

. est table garch*, star(0.1 0.05 0.01) stat(N ll chi2 aic bic)

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

According BICThe most appropriated order for yt is GARCH(1,0,1)

arch y x, arch(1)  garch(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
```

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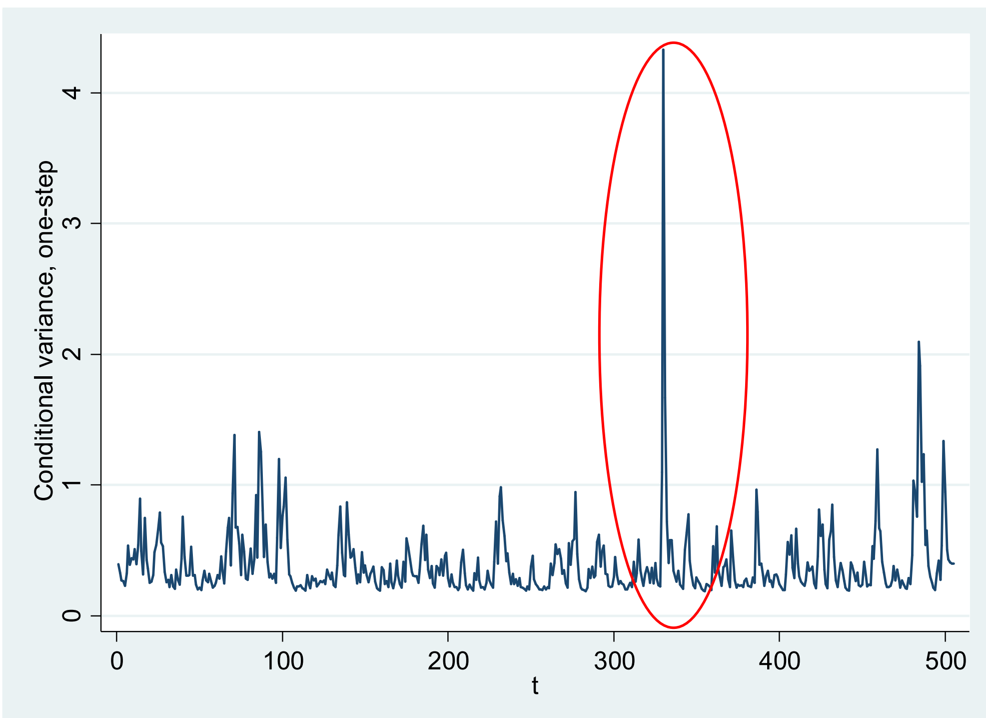
```
------------------------------------------------------------------------------
             |                 OPG
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
         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




e)

```
        arch y x, arch(1) nolog

ARCH family regression

Sample: 1 - 500                                 Number of obs     =        500
Distribution: Gaussian                          Wald chi2(1)      =   66213.67
Log likelihood = -449.2639                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |                 OPG
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
           x |    .697721   .0027115   257.32   0.000     .6924066    .7030354
```

```
       _cons |   .5145876   .0246724    20.86   0.000     .4662306    .5629445
-------------+----------------------------------------------------------------
ARCH         |
        arch |
         L1. |   .3824911   .0787597     4.86   0.000     .2281249    .5368573
             |
       _cons |   .2418237   .0222347    10.88   0.000     .1982444    .2854029
------------------------------------------------------------------------------

. est store arch1

. arch y x, arch(1) garch(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
------------------------------------------------------------------------------

. est store garch11

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

ARCH family regression

Sample: 1 - 500                                   Number of obs   =        500
Distribution: Gaussian                            Wald chi2(1)    =   66927.82
Log likelihood = -447.5247                        Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |                 OPG
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
           x |   .6979922    .002698   258.70   0.000     .6927041    .7032802
       _cons |   .5119584   .0250226    20.46   0.000      .462915    .5610018
-------------+----------------------------------------------------------------
ARCH         |
      egarch |
         L1. |   .3694437   .1220793     3.03   0.002     .1301726    .6087148
             |
```

```
        arch |
         L1. |   .6732196   .0925378     7.28   0.000     .4918488    .8545903
             |
       garch |
         L1. |  -.0060374   .0101859    -0.59   0.553    -.0260015    .0139267
             |
       _cons |  -.9151576   .1550718    -5.90   0.000    -1.219093   -.6112225
------------------------------------------------------------------------------

. est store egarch111

. est table arch1 garch11 egarch111, star(0.1 0.05 0.01) stat(N ll chi2 aic
bic)

--------------------------------------------------------------
    Variable |     arch1          garch11        egarch111
-------------+------------------------------------------------
y            |
           x |  .69772101***    .69785097***    .69799216***
       _cons |  .51458758***    .51851398***    .51195842***
-------------+------------------------------------------------
ARCH         |
        arch |
         L1. |  .38249114***    .36250292***    .67321956***
             |
       garch |
         L1. |                   .3251895***    -.0060374
             |
      egarch |
         L1. |                                   .3694437***
             |
       _cons |  .24182366***    .12545535***   -.91515762***
-------------+------------------------------------------------
Statistics   |
           N |        500             500             500
          ll | -449.26385      -443.95805      -447.52473
        chi2 |  66213.674       72868.369       66927.823
         aic |   906.5277        897.9161       907.04945
         bic |  923.38613       918.98914        932.3371
--------------------------------------------------------------
                           legend: * p<.1; ** p<.05; *** p<.01

the most appropriated model is Garch(1,1) because it has lowest Bic
Arch will only have epsilon(t) while Garch will have summation of error term-
square.On the other hand, Egarch will have summation of ln(error term -square)
```

5)

a)

```
varsoc y x

   Selection-order criteria
   Sample:  5 - 500                                Number of obs      =       496
  +---------------------------------------------------------------------------+
  |lag |    LL      LR      df    p      FPE       AIC       HQIC      SBIC    |
  |----+----------------------------------------------------------------------|
  |  0 | -1365.17                      .849628    5.5128    5.51946   5.52976  |
  |  1 | -1318.07    94.2*   4  0.000   .71409*  5.33901*  5.35898*  5.38989* |
  |  2 | -1317.22  1.7068    4  0.789  .723209    5.3517   5.38499   5.43651  |
  |  3 | -1315.98  2.4783    4  0.649  .731307   5.36283   5.40944   5.48156  |
```

```
  |  4 | -1313.81  4.3465    4  0.361  .736717   5.37019   5.43012   5.52285  |
  +---------------------------------------------------------------------------+
   Endogenous:  y x
    Exogenous:  _cons
```

According to SBIC, the most appropriated lag order is 1

```
var y x, lag(1)

Vector autoregression

Sample:  2 - 500                                Number of obs     =        499
Log likelihood =  -1328.195                     AIC               =   5.347476
FPE            =   .7201626                     HQIC              =   5.367353
Det(Sigma_ml)  =   .7030505                     SBIC              =   5.398128

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
y                     3     .994349   0.0148   7.487749   0.0237
x                     3     .995147   0.0887   48.59594   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y            |
           y |
         L1. |   .1368742   .0501021     2.73   0.006     .0386758    .2350726
             |
           x |
         L1. |   .0538789   .0481082     1.12   0.263    -.0404114    .1481691
             |
       _cons |   .3380393   .0544338     6.21   0.000     .2313511    .4447276
-------------+----------------------------------------------------------------
x            |
           y |
         L1. |    .342059   .0501424     6.82   0.000     .2437818    .4403362
             |
           x |
         L1. |    .212658   .0481468     4.42   0.000      .118292    .3070239
             |
       _cons |   .1205365   .0544775     2.21   0.027     .0137627    .2273104
------------------------------------------------------------------------------

. varstable, graph

   Eigenvalue stability condition
  +----------------------------------------+
  |        Eigenvalue        |   Modulus   |
  |--------------------------+-------------|
  |   .3157113               |   .315711   |
  |   .0338209               |   .033821   |
  +----------------------------------------+
   All the eigenvalues lie inside the unit circle.
   VAR satisfies stability condition.
```

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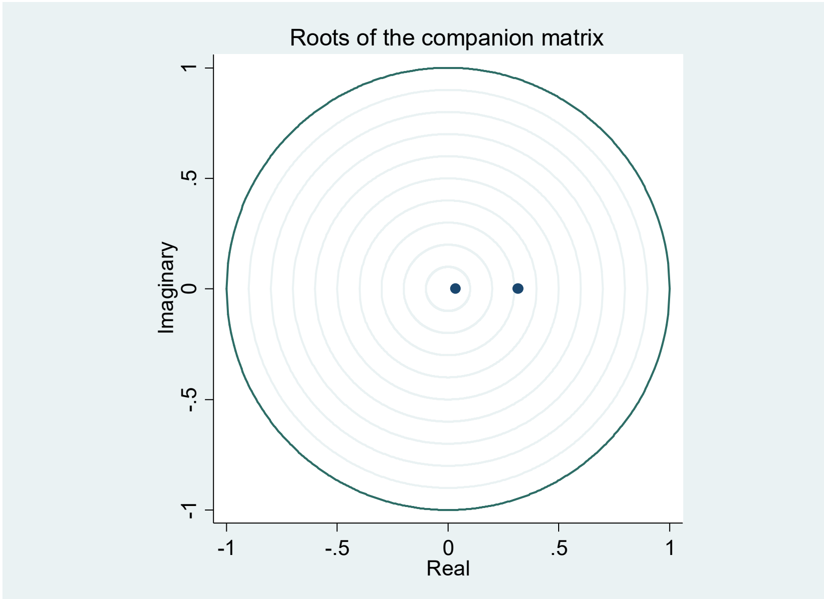


```
vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  |                 y                  x |  1.2543     1    0.263    |
  |                 y                ALL |  1.2543     1    0.263    |
  |--------------------------------------+---------------------------|
  |                 x                  y |  46.536     1    0.000    |
  |                 x                ALL |  46.536     1    0.000    |
  +------------------------------------------------------------------+
```

According to stability test, the system is stable since all the eigenvalues lie inside the unit circle.
According to Granger exogeneity, both x is endogenous variable since the tests are significant while y seems not to be endogenous.
If the stability is unsatisfied, It leads to divergence and unstationary.
c)

```
irf create order1, order(y x) step(5) set(xy)
(file xy.irf created)
(file xy.irf now active)
(file xy.irf updated)

.  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 | .136874 | .038676 | .235073 | .342059 | .243782 | .440336 |
| 2 | .037164 | -.011403 | .085732 | .119561 | .068148 | .170974 |
| 3 | .011529 | -.008353 | .03141 | .038138 | .013188 | .063088 |
| 4 | .003633 | -.003911 | .011176 | .012054 | .000586 | .023522 |
| 5 | .001147 | -.001632 | .003925 | .003806 | -.001076 | .008688 |

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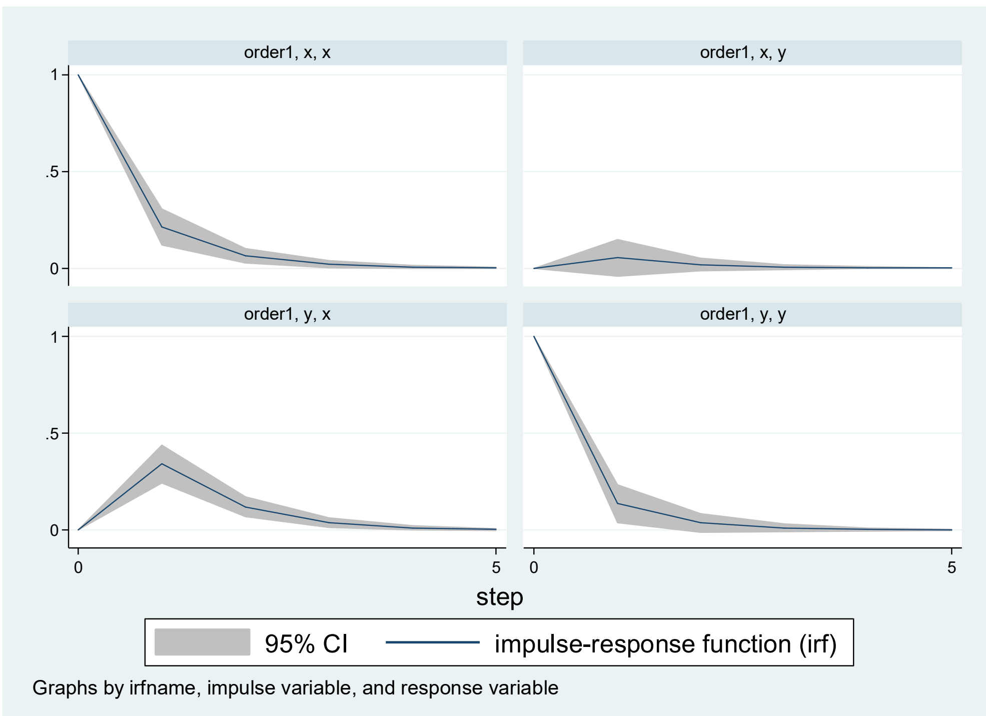
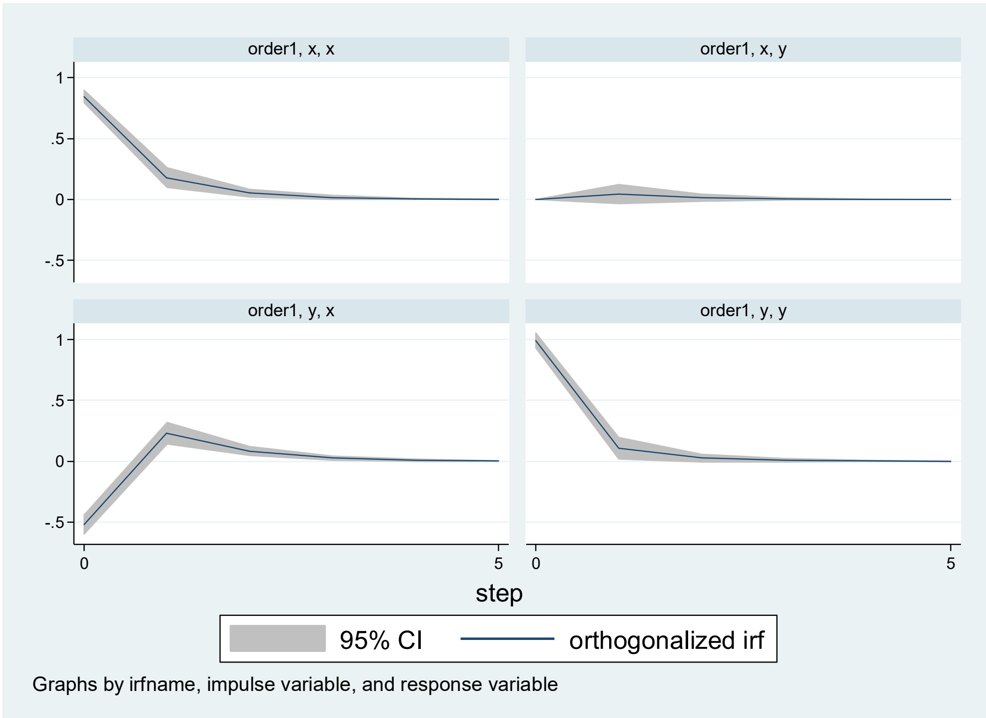
| step | (3) irf | (3) Lower | (3) Upper | (4) irf | (4) Lower | (4) Upper |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | .053879 | -.040411 | .148169 | .212658 | .118292 | .307024 |
| 2 | .018832 | -.014523 | .052188 | .063653 | .025715 | .101591 |
| 3 | .006007 | -.006328 | .018342 | .019978 | .001911 | .038045 |
| 4 | .001899 | -.002639 | .006437 | .006303 | -.001523 | .014129 |
| 5 | .000599 | -.001043 | .002242 | .00199 | -.001173 | .005153 |

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

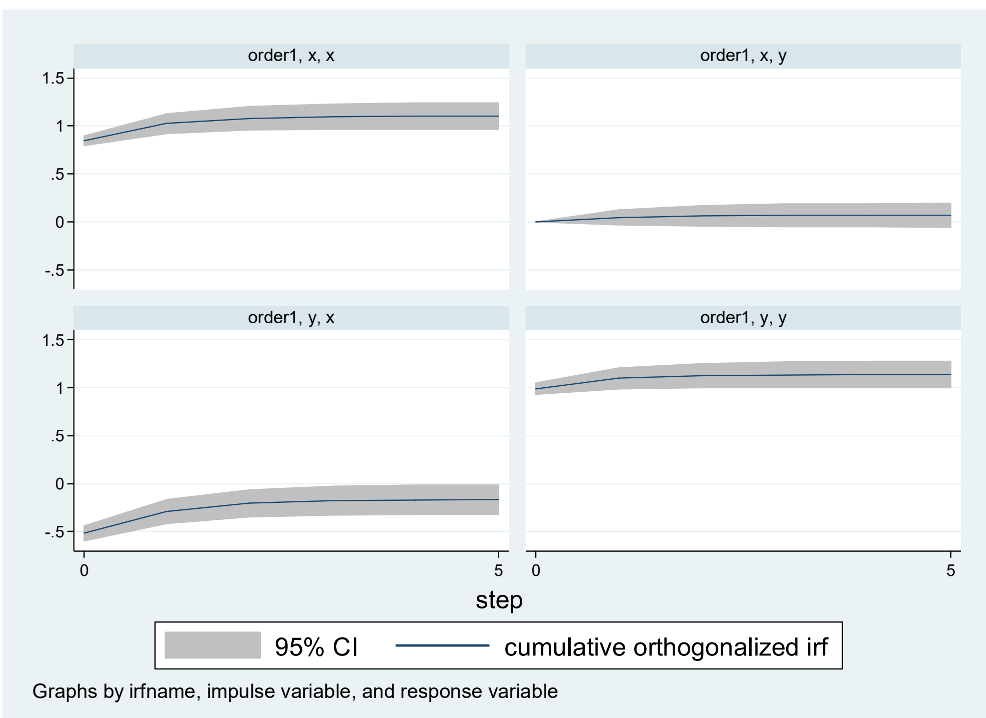
```
irf graph irf, impulse(y x) response(y x)
```



```
c) continued
irf graph oirf, impulse(y x) response(y x)
```




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




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

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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 | .273273 | .206608 | .339938 |
| 2 | .997916 | .990626 | 1.00521 | .300591 | .235783 | .3654 |
| 3 | .997664 | .989501 | 1.00583 | .304523 | .240271 | .368775 |
| 4 | .997638 | .989374 | 1.0059 | .304927 | .24074 | .369115 |
| 5 | .997635 | .98936 | 1.00591 | .304968 | .240787 | .369148 |

| step | (3) fevd | (3) Lower | (3) Upper | (4) fevd | (4) Lower | (4) Upper |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | .726727 | .660062 | .793392 |
| 2 | .002084 | -.005206 | .009374 | .699409 | .6346 | .764217 |
| 3 | .002336 | -.005826 | .010499 | .695477 | .631225 | .759729 |
| 4 | .002362 | -.005902 | .010626 | .695073 | .630885 | .75926 |
| 5 | .002365 | -.005911 | .01064 | .695032 | .630852 | .759213 |

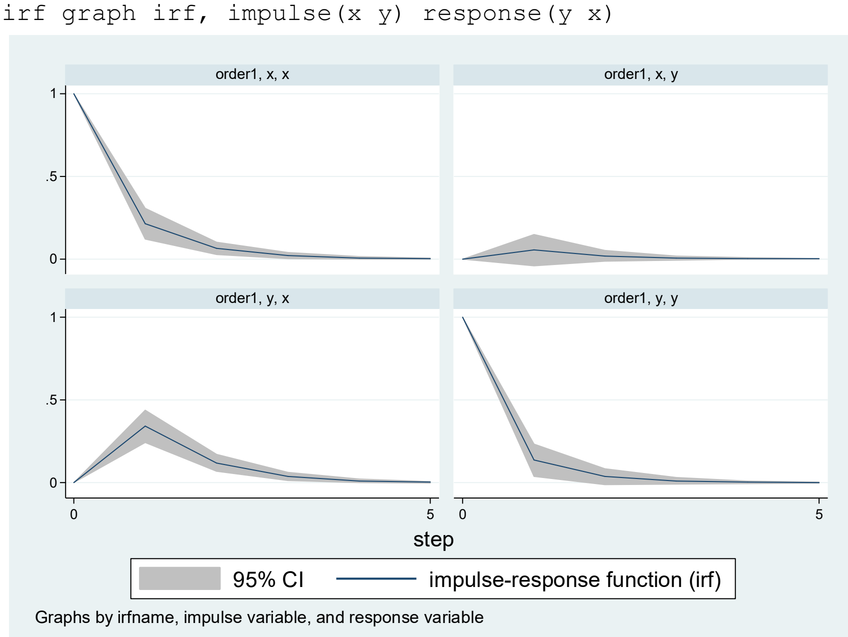
```
95% lower and upper bounds reported
(1) irfname = order1, impulse = y, and response = y
(2) irfname = order1, impulse = y, and response = x
(3) irfname = order1, impulse = x, and response = y
(4) irfname = order1, impulse = x, and response = x
```

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

e)

irf create order1, order(x y) step(5) set(xy2)

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



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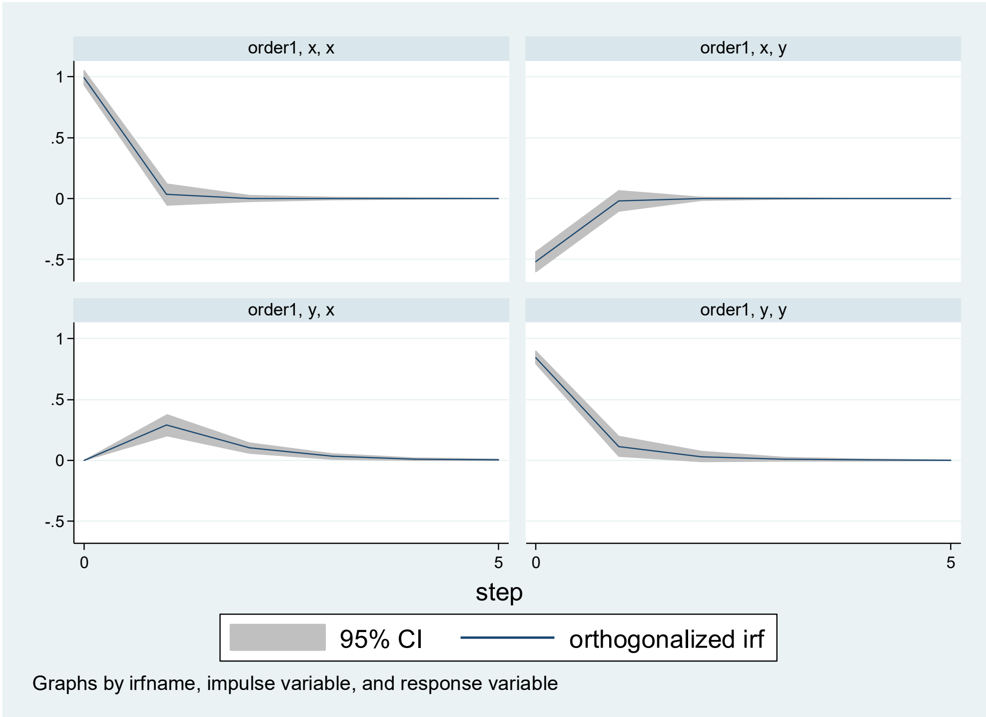
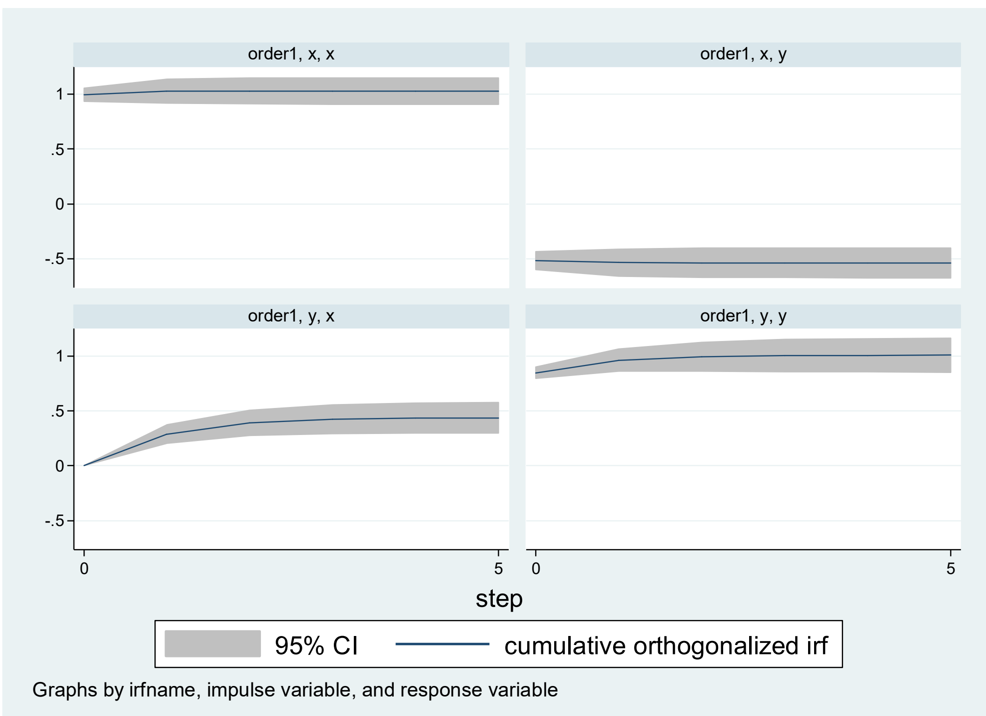
```
irf graph oirf, impulse(x y) response(y x)
```




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



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

Results from order1

| step | (1) fevd | (1) Lower | (1) Upper | (2) fevd | (2) Lower | (2) Upper |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | .273273 | .206608 | .339938 | .726727 | .660062 | .793392 |
| 2 | .269826 | .203301 | .336352 | .730174 | .663648 | .796699 |
| 3 | .26956 | .203015 | .336104 | .73044 | .663896 | .796985 |
| 4 | .269534 | .202986 | .336082 | .730466 | .663918 | .797014 |
| 5 | .269531 | .202983 | .33608 | .730469 | .66392 | .797017 |

95% lower and upper bounds reported

(1) irfname = order1, impulse = x, and response = y

(2) irfname = order1, impulse = y, and response = y

```
irf table fevd, impulse(x y) response(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 | 0 | 0 | 0 |
| 2 | .921832 | .8785 | .965165 | .078168 | .034835 | .1215 |
| 3 | .913112 | .865451 | .960773 | .086888 | .039227 | .134549 |
| 4 | .912234 | .864064 | .960404 | .087766 | .039596 | .135936 |
| 5 | .912147 | .86392 | .960374 | .087853 | .039626 | .13608 |

95% lower and upper bounds reported

(1) irfname = order1, impulse = x, and response = x

(2) irfname = order1, impulse = y, and response = x

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

The result changes as the order changes. The reason is that it changes theoretical framework and lead to the different values.