1)

```
------------------------------------------------------------------------------------------
-------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q1.log
  log type:  text
 opened on:  21 Mar 2021, 09:01:09

. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q1_5.dta", clear
(1980 Census housing data)
```

Since endogenous variable (y_{1t}, y_{2t}) are effect each of them and if we use OLS to estimate will reflect in endogeneity bias, OLS estimator will biased, inconsistent, and inefficient.

a)

```
. reg y1 y2 x3

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(2, 47)        =    125.26
       Model |  54894.8643         2  27447.4321   Prob > F        =    0.0000
    Residual |  10299.2157        47  219.132249   R-squared       =    0.8420
-------------+----------------------------------   Adj R-squared   =    0.8353
       Total |    65194.08        49  1330.49143   Root MSE        =    14.803

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          y2 |   .0009205   .0001806     5.10   0.000     .0005572    .0012839
          x3 |   .0076616   .0010146     7.55   0.000     .0056206    .0097027
       _cons |   39.28822   15.54271     2.53   0.015     8.020331    70.55611
------------------------------------------------------------------------------

. reg y2 y1 x1 x2

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(3, 46)        =     32.37
       Model |  8.4448e+09         3  2.8149e+09   Prob > F        =    0.0000
    Residual |  4.0006e+09        46  86968769.4   R-squared       =    0.6786
-------------+----------------------------------   Adj R-squared   =    0.6576
       Total |  1.2445e+10        49   253988016   Root MSE        =    9325.7

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          y1 |   300.6902   46.08303     6.52   0.000     207.9299    393.4506
          x1 |    254.501    130.153     1.96   0.057    -7.483434    516.4853
          x2 |  -.0004191    .000324    -1.29   0.202    -.0010712     .000233
       _cons |  -36814.58   8831.225    -4.17   0.000    -54590.91   -19038.25
------------------------------------------------------------------------------
```

b)

```
. ivregress 2sls y1 x3 (y2= x1 x2 x3)
```

Endo genous variable : y_{1t}, y_{2t}

Exogenous variable : x_{1t}, x_{2t}, x_{3t}

```
Instrumental variables (2SLS) regression          Number of obs   =         50
                                                  Wald chi2(2)    =     242.66
                                                  Prob > chi2     =     0.0000
```

```
                                                    R-squared         =     0.8417
                                                    Root MSE          =     14.368

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          y2 |   .0009794   .0004701     2.08   0.037     .0000579    .0019009
          x3 |   .0074373   .0019323     3.85   0.000     .0036501    .0112245
       _cons |   40.81419   18.85414     2.16   0.030      3.86076    77.76762
------------------------------------------------------------------------------
Instrumented:  y2
Instruments:   x3 x1 x2

. ivregress 2sls y2 x1 x2 (y1= x1 x2 x3)

Instrumental variables (2SLS) regression            Number of obs     =         50
                                                    Wald chi2(3)      =      82.58
                                                    Prob > chi2       =     0.0000
                                                    R-squared         =     0.6759
                                                    Root MSE          =     8981.4

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          y1 |   272.4446   55.85342     4.88   0.000     162.9739    381.9153
          x1 |   302.3284   137.8725     2.19   0.028     32.10325    572.5535
          x2 |  -.0004531   .0003147    -1.44   0.150    -.0010698    .0001636
       _cons |  -33213.72   9540.729    -3.48   0.000     -51913.2   -14514.23
------------------------------------------------------------------------------
Instrumented:  y1
Instruments:   x1 x2 x3

. reg y1 x1 x2 x3

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(3, 46)        =     50.89
       Model |  50098.8491         3  16699.6164   Prob > F        =    0.0000
    Residual |  15095.2309        46  328.157192   R-squared       =    0.7685
-------------+----------------------------------   Adj R-squared   =    0.7534
       Total |    65194.08        49  1330.49143   Root MSE        =    18.115
```

y1	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
x1	$\pi_{11}=$ .4005562	.2493027	1.61	0.115	-.101264	.9023764
x2	$\pi_{12}=$ -6.37e-07	6.23e-07	-1.02	0.312	-1.89e-06	6.17e-07
x3	$\pi_{13}=$ .010164	.001145	8.88	0.000	.0078592	.0124688
_cons	$\pi_{10}=$ 11.26776	18.3155	0.62	0.541	-25.59943	48.13495

reduce form: $y_{1t} = \pi_{10} + \pi_{11} x_{1t} + \pi_{12} x_{2t} + \pi_{13} x_{3t} + w_{1t}$

$y_{2t} = \pi_{20} + \pi_{21} x_{1t} + \pi_{22} x_{2t} + \pi_{23} x_{3t} + w_{2t}$

```
. predict y1hat, xb

. reg y2 x1 x2 x3

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(3, 46)        =     17.66
       Model |  6.6614e+09         3  2.2205e+09   Prob > F        =    0.0000
    Residual |  5.7840e+09        46   125738827   R-squared       =    0.5353
-------------+----------------------------------   Adj R-squared   =    0.5049
       Total |  1.2445e+10        49   253988016   Root MSE        =     11213

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 | π21=411.4577   154.3194     2.67   0.011     100.8288    722.0867
          x2 | π22=-.0006267  .0003858    -1.62   0.111    -.0014033    .0001499
          x3 | π23=2.769135   .7087753     3.91   0.000     1.342444    4.195825
       _cons | π20=-30143.88  11337.37    -2.66   0.011    -52964.83   -7322.927
------------------------------------------------------------------------------

. predict y2hat, xb
```

Structural form $y_{1t} = 40.81 + 0.001\,\hat{y}_{2t} + 0.007\,x_{3t} + \varepsilon_{1t}$

$y_{2t} = -33213.72 + 272.445\,\hat{y}_{1t} + 302.33\,x_{1t} - 0.0005\,x_{2t} + \varepsilon_{2t}$

```
. reg y1 y2hat x3

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(2, 47)        =     77.99
       Model |  50098.1271         2  25049.0636   Prob > F        =    0.0000
    Residual |  15095.9529        47  321.190487   R-squared       =    0.7684
-------------+----------------------------------   Adj R-squared   =    0.7586
       Total |    65194.08        49  1330.49143   Root MSE        =    17.922

------------------------------------------------------------------------------
          y1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       y2hat |   .0009794   .0005864     1.67   0.102    -.0002003    .0021591
          x3 |   .0074373   .0024101     3.09   0.003     .0025887    .0122859
       _cons |   40.81419   23.51693     1.74   0.089    -6.495774    88.12415
------------------------------------------------------------------------------

. reg y2 y1hat x1 x2

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(3, 46)        =     17.66
       Model |  6.6614e+09         3  2.2205e+09   Prob > F        =    0.0000
    Residual |  5.7840e+09        46   125738836   R-squared       =    0.5353
-------------+----------------------------------   Adj R-squared   =    0.5049
       Total |  1.2445e+10        49   253988016   Root MSE        =     11213

------------------------------------------------------------------------------
          y2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
       y1hat |   272.4446     69.7337     3.91   0.000     132.0779    412.8112
          x1 |   302.3284    172.1355     1.76   0.086    -44.16246    648.8193
          x2 |  -.0004531    .0003929    -1.15   0.255    -.0012439    .0003377
       _cons |  -33213.72    11911.72    -2.79   0.008    -57190.77   -9236.669
------------------------------------------------------------------------------
```

c)

```
. reg3 (y1 y2 x3) (y2 y1 x1 x2), 3sls inst(x1 x2 x3)

Three-stage least-squares regression
----------------------------------------------------------------------
Equation             Obs   Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
y1                    50       2    14.36836    0.8417     242.66   0.0000
y2                    50       3    8980.313    0.6760      82.58   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y1           |
          y2 |   .0009794    .0004701     2.08   0.037     .0000579    .0019009
          x3 |   .0074373    .0019323     3.85   0.000     .0036501    .0112245
       _cons |   40.81419    18.85414     2.16   0.030      3.86076    77.76762
-------------+----------------------------------------------------------------
y2           |
          y1 |    272.878    55.37052     4.93   0.000     164.3538    381.4023
          x1 |   301.4264    137.0264     2.20   0.028     32.85957    569.9933
          x2 |  -.0004599     .000293    -1.57   0.117    -.0010342    .0001145
       _cons |  -33225.71    9538.573    -3.48   0.000    -51920.97   -14530.45
------------------------------------------------------------------------------
Endogenous variables:  y1 y2
Exogenous variables:   x1 x2 x3
------------------------------------------------------------------------------

. log close
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q1.log
  log type:  text
 closed on:  21 Mar 2021, 09:23:54
--------------------------------------------------------------------------------------
-------------------------------------------------------
```

c)

3SLS → OLS + IV + FGLS

2SLS → OLS + IV

OLS → OLS

Estimator of (endogeneity biased exist)

OLS → biased, inconsistent, inefficient

2SLS → biased, consistent, Asymtotic efficient

Advantage

3SLS → biased, consistent, a more Asymtotic efficient

disadvantage → 3SLS is a system equation estimation method which is a specification error exist in one equation will spread problem to other equation in system

From result below.

estimated value of $\lambda = e^{2.08}$

$\theta = 0.3095$

$\beta = 0.8205$

$\alpha = -0.9502$

$\sigma = 1.448$

2)

```
--------------------------------------------------------------------------------------
-------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q2.log
  log type:  text
 opened on:  21 Mar 2021, 09:48:32

. log using "C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q2.log"
log file already open
r(604);

. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q2_5.dta", clear
```

a)

```
. nl (lnC =
```

```
. nl (lnC={lnlamda}-({beta}/{alpha})*ln({theta}*R^(-{alpha})+(1-{theta})*W^(-{alpha}))), init(lnlamda 1 theta 0.5 beta 0.5 alpha -0.5)
(obs = 250)

Iteration 0:  residual SS =  272.8386
Iteration 1:  residual SS =  269.7382
Iteration 2:  residual SS =  269.5436
Iteration 3:  residual SS =  269.5402
Iteration 4:  residual SS =  269.5397
Iteration 5:  residual SS =  269.5397
Iteration 6:  residual SS =  269.5397
Iteration 7:  residual SS =  269.5397
Iteration 8:  residual SS =  269.5397
Iteration 9:  residual SS =  269.5397
Iteration 10:  residual SS =  269.5397
Iteration 11:  residual SS =  269.5397


      Source |      SS            df       MS
-------------+----------------------------------    Number of obs =        250
       Model |  52.987566          3  17.6625221    R-squared     =     0.1643
    Residual |  269.53966        246  1.09568968    Adj R-squared =     0.1541
-------------+----------------------------------    Root MSE      =   1.046752
       Total |  322.52723        249  1.29529007    Res. dev.     =   728.2829

------------------------------------------------------------------------------
         lnC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    /lnlamda |   2.082157   .7495103     2.78   0.006     .6058805    3.558433
       /beta |   .8204874   .1438338     5.70   0.000     .5371846     1.10379
      /alpha |  -.9501815   .5170818    -1.84   0.067    -1.968654    .0682909
      /theta |   .3094593   .2021046     1.53   0.127    -.0886169    .7075355
------------------------------------------------------------------------------
  Parameter lnlamda taken as constant term in model & ANOVA table
```

```
       Model |  52.987566          3  17.6625221    R-squared     =     0.1643
    Residual |  269.53966        246  1.09568968    Adj R-squared =     0.1541
-------------+----------------------------------    Root MSE      =   1.046752
       Total |  322.52723        249  1.29529007    Res. dev.     =   728.2829

------------------------------------------------------------------------------
         lnC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    /lnlamda |  -.2715428   1.705172    -0.16   0.874    -3.630142    3.087057
       /beta |   .8204874   .1438337     5.70   0.000     .5371847     1.10379
      /alpha |  -.9501834   .5170783    -1.84   0.067    -1.968649     .068282
      /thata |   4.724789   4.468535     1.06   0.291     -4.07668    13.52626
```

```
       /theta |   -9.543121         .         .        .            .         .
------------------------------------------------------------------------------
. test (_b[/theta]=0) (_b[/alpha]=0) (_b[/beta]=0)

 ( 1)  [theta]_cons = 0
 ( 2)  [alpha]_cons = 0
 ( 3)  [beta]_cons = 0

       F(  3,   246) =   49.35
            Prob > F =    0.0000

. sca sigma=1/(1-(_b[/theta]))

. sca list sigma
     sigma =  1.4481406
```

ANOVA table

H_0: $\theta = 0$, $\alpha = 0$, $\beta = 0$

H_a: Otherwise

$< 0.05 \rightarrow H_0$ is rejected

```
. est store lognls1
```

b)
```
. nl (lnC =
{lnlamda}-({beta}/{alpha})*ln({thata}*R^(-{alpha})+(1-{theta})*W^(-{alpha}))),
init(lnlamda 0.5 theta 0.1 beta 0.1 alpha -0.1)
(obs = 250)

Iteration 0:  residual SS =  392.0881
Iteration 1:  residual SS =  292.3054
Iteration 2:  residual SS =  290.4649
Iteration 3:  residual SS =  290.1282
Iteration 4:  residual SS =  289.5729
Iteration 5:  residual SS =  289.0515
Iteration 6:  residual SS =  288.5264
Iteration 7:  residual SS =  287.9692
Iteration 8:  residual SS =  287.9013
Iteration 9:  residual SS =  287.2156
Iteration 10:  residual SS =  286.0925
Iteration 11:  residual SS =  284.9419
Iteration 12:  residual SS =  282.4999
Iteration 13:  residual SS =  270.8794
Iteration 14:  residual SS =  269.5694
Iteration 15:  residual SS =  269.5403
Iteration 16:  residual SS =  269.5398
Iteration 17:  residual SS =  269.5397
Iteration 18:  residual SS =  269.5397
Iteration 19:  residual SS =  269.5397
Iteration 20:  residual SS =  269.5397
Iteration 21:  residual SS =  269.5397
Iteration 22:  residual SS =  269.5397
Iteration 23:  residual SS =  269.5397
```

$\therefore$ The estimated result will not be the same due to the different set of initial value will give the different in estimate result

```
Iteration 24:  residual SS =  269.5397


      Source |       SS              df       MS
-------------+----------------------------------    Number of obs =        250
       Model |  52.987566             3  17.6625221    R-squared     =     0.1643
    Residual |  269.53966           246  1.09568968    Adj R-squared =     0.1541
-------------+----------------------------------    Root MSE      =   1.046752
       Total |  322.52723           249  1.29529007    Res. dev.     =   728.2829

------------------------------------------------------------------------------
         lnC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    /lnlamda |  -1.413019   2.284255    -0.62   0.537    -5.912211    3.086172
       /beta |   .8204874   .1438337     5.70   0.000     .5371847     1.10379
      /alpha |  -.9501829   .5170793    -1.84   0.067     -1.96865    .0682845
      /thata |    17.7207   16.75958     1.06   0.291    -15.28987    50.73127
      /theta |  -38.54279          .        .       .            .           .
------------------------------------------------------------------------------
  Parameter lnlamda taken as constant term in model & ANOVA table

. est store lognls2
```

c)

```
. nl (lnC =
{lnlamda}-({beta}/{alpha})*ln({thata}*R^(-{alpha})+(1-{theta})*W^(-{alpha}))),
init(lnlamda 0.5 theta 0.1 beta 0.1 alpha -0.1)
>  eps(1e-1)
(obs = 250)

Iteration 0:  residual SS =  392.0881
Iteration 1:  residual SS =  292.3054
Iteration 2:  residual SS =  290.4649
Iteration 3:  residual SS =  290.1282
Iteration 4:  residual SS =  289.5729
Iteration 5:  residual SS =  289.0515
Iteration 6:  residual SS =  288.5264
Iteration 7:  residual SS =  287.9692
Iteration 8:  residual SS =  287.9013
Iteration 9:  residual SS =  287.2156
Iteration 10:  residual SS =  286.0925
Iteration 11:  residual SS =  284.9419
Iteration 12:  residual SS =  282.4999
Iteration 13:  residual SS =  270.8794
Iteration 14:  residual SS =  269.5694
Iteration 15:  residual SS =  269.5403


      Source |       SS              df       MS
-------------+----------------------------------    Number of obs =        250
       Model |  52.986883             3  17.6622942    R-squared     =     0.1643
```

```
    Residual |  269.54035        246  1.09569246    Adj R-squared =    0.1541
-------------+----------------------------------    Root MSE      =   1.046753
       Total |  322.52723        249  1.29529007    Res. dev.     =   728.2836

------------------------------------------------------------------------------
         lnC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    /lnlamda |   -1.37827   2.276555    -0.61   0.545    -5.862295    3.105756
       /beta |   .8210859    .143908     5.71   0.000     .5376369    1.104535
      /alpha |  -.9595803    .511271    -1.88   0.062    -1.966607    .0474467
      /thata |   17.44928   16.33312     1.07   0.286    -14.72132    49.61988
      /theta |  -38.54279          .        .       .            .           .
------------------------------------------------------------------------------
  Parameter alpha taken as constant term in model & ANOVA table

. nl (lnC =
{lnlamda}-({beta}/{alpha})*ln({thata}*R^(-{alpha})+(1-{theta})*W^(-{alpha}))),
init(lnlamda 0.5 theta 0.1 beta 0.1 alpha -0.1)
>  eps(1e-15) iter(40)
(obs = 250)

Iteration 0:  residual SS =  392.0881
Iteration 1:  residual SS =  292.3054
Iteration 2:  residual SS =  290.4649
Iteration 3:  residual SS =  290.1282
Iteration 4:  residual SS =  289.5729
Iteration 5:  residual SS =  289.0515
Iteration 6:  residual SS =  288.5264
Iteration 7:  residual SS =  287.9692
Iteration 8:  residual SS =  287.9013
Iteration 9:  residual SS =  287.2156
Iteration 10:  residual SS =  286.0925
Iteration 11:  residual SS =  284.9419
Iteration 12:  residual SS =  282.4999
Iteration 13:  residual SS =  270.8794
Iteration 14:  residual SS =  269.5694
Iteration 15:  residual SS =  269.5403
Iteration 16:  residual SS =  269.5398
Iteration 17:  residual SS =  269.5397
Iteration 18:  residual SS =  269.5397
Iteration 19:  residual SS =  269.5397
Iteration 20:  residual SS =  269.5397
Iteration 21:  residual SS =  269.5397
Iteration 22:  residual SS =  269.5397
Iteration 23:  residual SS =  269.5397
Iteration 24:  residual SS =  269.5397
Iteration 25:  residual SS =  269.5397
Iteration 26:  residual SS =  269.5397
Iteration 27:  residual SS =  269.5397
Iteration 28:  residual SS =  269.5397
```

```
Iteration 29:  residual SS =  269.5397
Iteration 30:  residual SS =  269.5397
Iteration 31:  residual SS =  269.5397
Iteration 32:  residual SS =  269.5397
Iteration 33:  residual SS =  269.5397
Iteration 34:  residual SS =  269.5397
Iteration 35:  residual SS =  269.5397
Iteration 36:  residual SS =  269.5397
Iteration 37:  residual SS =  269.5397
Iteration 38:  residual SS =  269.5397
Iteration 39:  residual SS =  269.5397


      Source |       SS              df       MS
-------------+----------------------------------    Number of obs =        250
       Model |  52.987566          3  17.6625221    R-squared     =     0.1643
    Residual |  269.53966        246  1.09568968    Adj R-squared =     0.1541
-------------+----------------------------------    Root MSE      =   1.046752
       Total |  322.52723        249  1.29529007    Res. dev.     =   728.2829

------------------------------------------------------------------------------
         lnC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    /lnlamda |  -1.413017   2.284257    -0.62   0.537    -5.912214     3.08618
       /beta |   .8204874   .1438337     5.70   0.000     .5371847     1.10379
      /alpha |  -.9501836    .517078    -1.84   0.067    -1.968648    .0682811
      /thata |   17.72068   16.75959     1.06   0.291    -15.28991    50.73128
      /theta |  -38.54279          .        .       .            .           .
------------------------------------------------------------------------------
  Parameter lnlamda taken as constant term in model & ANOVA table
convergence not achieved
r(430);


. g C = exp(lnC)

. nl (C =
{lamda}*({theta}*R^(-{alpha})+(1-{theta})*W^(-{alpha}))^(-({beta}/{alpha}))), init(
lamda 1 theta 0.5 beta 0.5 alpha -0.5)
(obs = 250)

Iteration 0:  residual SS =  1.03e+09
Iteration 1:  residual SS =  4.42e+08
Iteration 2:  residual SS =  4.41e+08
Iteration 3:  residual SS =  4.39e+08
Iteration 4:  residual SS =  4.36e+08
Iteration 5:  residual SS =  4.33e+08
Iteration 6:  residual SS =  4.32e+08
Iteration 7:  residual SS =  4.27e+08
Iteration 8:  residual SS =  4.24e+08
```

```
Iteration 9:  residual SS =  4.16e+08
Iteration 10:  residual SS =  3.71e+08
Iteration 11:  residual SS =  3.66e+08
Iteration 12:  residual SS =  3.66e+08
Iteration 13:  residual SS =  3.66e+08
Iteration 14:  residual SS =  3.66e+08
Iteration 15:  residual SS =  3.66e+08


      Source |      SS            df       MS
-------------+----------------------------------    Number of obs =        250
       Model |  6.823e+08          4   170572553    R-squared     =     0.6511
    Residual |  3.656e+08        246  1486126.57    Adj R-squared =     0.6454
-------------+----------------------------------    Root MSE      =   1219.068
       Total |  1.048e+09        250   4191509.4    Res. dev.     =   4258.358

------------------------------------------------------------------------------
           C |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /lamda |   10.92389   8.914749     1.23   0.222    -6.635086    28.48286
      /theta |   .2579155   .2150237     1.20   0.231    -.1656068    .6814378
      /alpha |  -.8748373   .4752491    -1.84   0.067    -1.810914    .0612391
       /beta |   .8567903   .1478706     5.79   0.000     .5655364    1.148044
------------------------------------------------------------------------------

. est store nls1

. nl (C =
{lamda}*({theta}*R^(-{alpha})+(1-{theta})*W^(-{alpha}))^(-({beta}/{alpha}))), init(
lamda 0.5 theta 0.1 beta 0.1 alpha -0.1)
(obs = 250)

Iteration 0:  residual SS =  1.05e+09
Iteration 1:  residual SS =  1.05e+09
Iteration 2:  residual SS =  1.05e+09
Iteration 3:  residual SS =  1.05e+09
Iteration 4:  residual SS =  1.05e+09
Iteration 5:  residual SS =  6.27e+08
Iteration 6:  residual SS =  6.24e+08
Iteration 7:  residual SS =  6.21e+08
Iteration 8:  residual SS =  6.20e+08
Iteration 9:  residual SS =  6.18e+08
Iteration 10:  residual SS =  6.14e+08
Iteration 11:  residual SS =  6.08e+08
Iteration 12:  residual SS =  6.02e+08
Iteration 13:  residual SS =  5.99e+08
Iteration 14:  residual SS =  5.90e+08
Iteration 15:  residual SS =  5.85e+08
Iteration 16:  residual SS =  5.80e+08
Iteration 17:  residual SS =  5.37e+08
```

```
Iteration 18:  residual SS =  4.41e+08
Iteration 19:  residual SS =  3.66e+08
Iteration 20:  residual SS =  3.66e+08
Iteration 21:  residual SS =  3.66e+08
Iteration 22:  residual SS =  3.66e+08
Iteration 23:  residual SS =  3.66e+08


      Source |      SS            df       MS
-------------+----------------------------------    Number of obs =        250
       Model |  6.823e+08          4   170572553    R-squared     =     0.6511
    Residual |  3.656e+08        246  1486126.57    Adj R-squared =     0.6454
-------------+----------------------------------    Root MSE      =   1219.068
       Total |  1.048e+09        250   4191509.4    Res. dev.     =   4258.358

------------------------------------------------------------------------------
           C |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /lamda |   10.92388   8.914772     1.23   0.222    -6.635133     28.4829
      /theta |   .2579155   .2150241     1.20   0.231    -.1656077    .6814386
      /alpha |  -.8748375   .4752489    -1.84   0.067    -1.810913    .0612386
       /beta |   .8567904   .1478706     5.79   0.000     .5655365    1.148044
------------------------------------------------------------------------------

. est store nls2

. est table nls1 nls2 lognls1 lognls2, star(.1 .05 .01) stat(N rss r2 r2_a)

------------------------------------------------------------------------------
    Variable |     nls1             nls2            lognls1         lognls2
-------------+----------------------------------------------------------------
lamda        |
       _cons |  10.923886       10.923885
-------------+----------------------------------------------------------------
theta        |
       _cons |  .25791551       .25791546      -9.5431207      -38.542788
-------------+----------------------------------------------------------------
alpha        |
       _cons | -.87483734*     -.87483745*     -.95018345*     -.95018292*
-------------+----------------------------------------------------------------
beta         |
       _cons |  .85679034***    .85679037***    .82048739***    .82048739***
-------------+----------------------------------------------------------------
lnlamda      |
       _cons |                                 -.27154276      -1.4130195
-------------+----------------------------------------------------------------
thata        |
       _cons |                                  4.7247891       17.720698
-------------+----------------------------------------------------------------
Statistics   |
```

```
           N |        250            250            250            250
         rss |  3.656e+08      3.656e+08      269.53966      269.53966
          r2 |  .65111648      .65111648      .16428866      .16428866
        r2_a |  .64544358      .64544358      .15409706      .15409706
------------------------------------------------------------------------------
                                     legend: * p<.1; ** p<.05; *** p<.01

. log close
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q2.log
  log type:  text
 closed on:  21 Mar 2021, 09:59:19
-------------------------------------------------------------------------------------
-------------------------------------------------------
```

b) From the above table

∴ The estimated result will not be the same due to the different set of initial value will give the different in estimate result between lognls 1 & lognls 2

c) From the abov table

(i) the different in convergence value will lead to the different estimated result

(ii) the different in Iterative time can lead to unsuccessful estimation (convergence not achived)

d) From the above table, log form can lead to estimated result that more robust

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

3)

```
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q3.log
  log type:  text
 opened on:  21 Mar 2021, 10:27:38

. clear

. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q3_5.dta", clear

. do "C:\Users\User\AppData\Local\Temp\STD00000000.tmp"

. program ml_probit
program ml_probit already defined
r(110);

end of do-file

r(110);
```

a)

```
. ml model lf ml_logit (y=x1 x2)

. ml maximize

initial:       log likelihood = -277.25887
alternative:   log likelihood = -278.63079
rescale:       log likelihood = -274.87577
Iteration 0:   log likelihood = -274.87577
Iteration 1:   log likelihood = -228.45409
Iteration 2:   log likelihood =  -227.9439
Iteration 3:   log likelihood = -227.94274
Iteration 4:   log likelihood = -227.94274

                                                Number of obs     =        400
                                                Wald chi2(2)      =      67.86
Log likelihood = -227.94274                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .4934629   .1200559     4.11   0.000     .2581577    .7287682
          x2 |  -.5955166   .0739186    -8.06   0.000    -.7403944   -.4506387
       _cons |   .3960511   .1836189     2.16   0.031     .0361646    .7559376
------------------------------------------------------------------------------

. est store nr

. ml model lf ml_logit (y=x1 x2), tech(bhhh)
```

∴ The different in algorithm will lead to an estimate result due to the different computation function

Wald test

```
. ml maximize

initial:       log likelihood = -277.25887
alternative:   log likelihood = -278.63079
rescale:       log likelihood = -274.87577
Iteration 0:   log likelihood = -274.87577
Iteration 1:   log likelihood = -228.37778
Iteration 2:   log likelihood = -227.94436
Iteration 3:   log likelihood = -227.94275
Iteration 4:   log likelihood = -227.94274

                                                Number of obs     =        400
                                                Wald chi2(2)      =      67.46
Log likelihood = -227.94274                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |                 OPG
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .4934547   .1270829     3.88   0.000     .2443768    .7425325
          x2 |  -.5955136   .0728042    -8.18   0.000    -.7382072     -.45282
       _cons |   .3960458   .1762121     2.25   0.025     .0506765    .7414152
------------------------------------------------------------------------------

. est store bhhh

. ml model lf ml_logit (y=x1 x2), tech(bfgs)

. ml maximize

initial:       log likelihood = -277.25887
alternative:   log likelihood = -278.63079
rescale:       log likelihood = -274.87577
Iteration 0:   log likelihood = -274.87577
Iteration 1:   log likelihood = -270.06677  (backed up)
Iteration 2:   log likelihood =  -255.6183  (backed up)
Iteration 3:   log likelihood = -253.92226
Iteration 4:   log likelihood =  -228.8319
Iteration 5:   log likelihood = -227.98715
Iteration 6:   log likelihood = -227.94638
Iteration 7:   log likelihood = -227.94277
Iteration 8:   log likelihood = -227.94275
Iteration 9:   log likelihood = -227.94274

                                                Number of obs     =        400
                                                Wald chi2(2)      =      67.86
Log likelihood = -227.94274                     Prob > chi2       =     0.0000

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

```
-------------+----------------------------------------------------------------
          x1 |   .4934632   .1200559     4.11   0.000     .2581579    .7287684
          x2 |  -.5955167   .0739186    -8.06   0.000    -.7403946   -.4506388
       _cons |   .3960516    .183619     2.16   0.031      .036165    .7559381
------------------------------------------------------------------------------

. est store bfgs
```

b)

```
. ml model lf ml_logit (y=)

. ml maximize

initial:       log likelihood = -277.25887
alternative:   log likelihood = -278.63079
rescale:       log likelihood = -274.87577
Iteration 0:   log likelihood = -274.87577
Iteration 1:   log likelihood = -274.83397
Iteration 2:   log likelihood = -274.83397

                                                Number of obs     =        400
                                                Wald chi2(0)      =          .
Log likelihood = -274.83397                     Prob > chi2       =          .

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |  -.2208938   .1006105    -2.20   0.028    -.4180869   -.0237008
------------------------------------------------------------------------------

. est store nocon

. est restore nr
(results nr are active now)

. lrtest nr nocon

Likelihood-ratio test                                 LR chi2(2)  =     93.78
(Assumption: nocon nested in nr)                      Prob > chi2 =    0.0000

. do "C:\Users\User\AppData\Local\Temp\STD00000000.tmp"

. program ml_probit
program ml_probit already defined
r(110);

end of do-file

r(110);
```

From a) Wald test p-value = 0.000 which less than 0.05, $H_0: \beta_1 = \beta_2 = 0$, H_0 is rejected

LR test $H_0: \beta_1 = \beta_2 = 0$
H_a: Otherwise

$0.0000 < 0.05$
$\therefore H_0$ is rejected

$\therefore$ LR-test is preferable due to more optimal power because use of 2 model for testing.

d)

```
. ml model lf ml_probit_het (y= x1 x2) (x3, noconstant)
```

```
. ml maximize

initial:       log likelihood = -277.25887
alternative:   log likelihood = -291.22568
rescale:       log likelihood = -274.84577
rescale eq:    log likelihood = -274.65472
Iteration 0:   log likelihood = -274.65472
Iteration 1:   log likelihood = -263.63393  (not concave)
Iteration 2:   log likelihood = -236.23643  (not concave)
Iteration 3:   log likelihood = -228.63176
Iteration 4:   log likelihood = -226.44344
Iteration 5:   log likelihood = -223.21726
Iteration 6:   log likelihood = -223.05974
Iteration 7:   log likelihood = -223.05935
Iteration 8:   log likelihood = -223.05935

                                                Number of obs     =        400
                                                Wald chi2(2)      =      72.97
Log likelihood = -223.05935                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
eq1          |
          x1 |    .310077   .0686179     4.52   0.000     .1755882    .4445657
          x2 |  -.3712427   .0440772    -8.42   0.000    -.4576324   -.284853
       _cons |   .2591291   .1020126     2.54   0.011      .059188    .4590702
-------------+----------------------------------------------------------------
eq2          |
          x3 |  -.4096773   .1390194    -2.95   0.003    -.6821503   -.1372044
------------------------------------------------------------------------------

. est store hetprob

. do "C:\Users\User\AppData\Local\Temp\STD00000000.tmp"

. program ml_probit
program ml_probit already defined
r(110);

end of do-file

r(110);

. ml model lf ml_probit (y=x1 x2)

. ml maximize

initial:       log likelihood = -277.25887
```

```
alternative:   log likelihood =  -291.2184
rescale:       log likelihood = -274.85635
Iteration 0:   log likelihood = -274.85635
Iteration 1:   log likelihood = -228.21969
Iteration 2:   log likelihood = -227.94988
Iteration 3:   log likelihood = -227.94971
Iteration 4:   log likelihood = -227.94971

                                                Number of obs     =        400
                                                Wald chi2(2)      =      77.68
Log likelihood = -227.94971                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .3012137   .0712688     4.23   0.000     .1615294     .440898
          x2 |  -.3561502   .0413949    -8.60   0.000    -.4372826   -.2750177
       _cons |   .2318415   .1092333     2.12   0.034     .0177483    .4459348
------------------------------------------------------------------------------

. est store probit

. lrtest hetprob probit

Likelihood-ratio test                                 LR chi2(1)  =       9.78
(Assumption: probit nested in hetprob)                Prob > chi2 =     0.0018

. log close
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q3.log
  log type:  text
 closed on:  21 Mar 2021, 10:29:42
-------------------------------------------------------------------------------------
-------------------------------------------------------
```

$H_0: \delta_1 = \delta_2 = \dots = \delta_n = \delta$

< 0.05

c) MLE is χ^2 test because $LR \xrightarrow{d} \chi^2$, therefor we can't use F test because the different of the distribution.

d) Since P-value of LR-test is less than 0.05, Ho is reject, heteroskedasticity is significant.

e) MLE assume asymtotic normalty $(n \to \infty)$ then MLE is z-test instead.

MLE use log likelihood for make comparison, the higher the better

MLE don't have R^2 due to a linear approximation

4)

```
----------------------------------------------------------------------------------
-----------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q4.log
  log type:  text
 opened on:  21 Mar 2021, 10:54:50

. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q4-1_5.dta", clear

. tsset time
        time variable:  time, 1 to 1326
                delta:  1 unit

. g dr=f.r-r
(1 missing value generated)
```

a)

```
. gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r)
((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{alpha}-{beta}*r)^2-{sigma2}*
> r^(2*{gamma}))*r) winitial(identity)
note: 1 missing value returned for equation 1 at initial values
note: 1 missing value returned for equation 2 at initial values
note: 1 missing value returned for equation 3 at initial values
note: 1 missing value returned for equation 4 at initial values

Step 1
numerical derivatives are approximate
flat or discontinuous region encountered
Iteration 0:   GMM criterion Q(b) =  .00001194
Iteration 1:   GMM criterion Q(b) =  8.809e-06  (backed up)
Iteration 2:   GMM criterion Q(b) =  6.154e-06  (not concave)
Iteration 3:   GMM criterion Q(b) =  4.182e-06  (backed up)
Iteration 4:   GMM criterion Q(b) =  3.231e-06
Iteration 5:   GMM criterion Q(b) =  7.789e-08
Iteration 6:   GMM criterion Q(b) =  3.974e-08

Step 2
Iteration 0:   GMM criterion Q(b) =  .00006118
Iteration 1:   GMM criterion Q(b) =  1.335e-09
Iteration 2:   GMM criterion Q(b) =  7.626e-17

note: model is exactly identified

GMM estimation

Number of parameters =   4
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,325
GMM weight matrix:     Robust

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

3 MOM

```
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0023874   .0011648    -2.05   0.040    -.0046703   -.0001046
       /beta |    .000431   .0002874     1.50   0.134    -.0001322    .0009942
     /sigma2 |   .0005156    .000328     1.57   0.116    -.0001272    .0011585
      /gamma |   .0933678   .1802519     0.52   0.604    -.2599195    .4466551
------------------------------------------------------------------------------
Instruments for equation 1: _cons
Instruments for equation 2: _cons
Instruments for equation 3: _cons
Instruments for equation 4: _cons

. estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(0) = 1.0e-13 (p =     .)

Note: test cannot be performed because there are no
      overidentifying restrictions.

. est store unrestricted

. gmm (dr-{alpha}) ((dr-{alpha})*r) ((dr-{alpha})^2-{sigma2})
(((dr-{alpha})^2-{sigma2})*r) winitial(identity)
note: 1 missing value returned for equation 1 at initial values
note: 1 missing value returned for equation 2 at initial values
note: 1 missing value returned for equation 3 at initial values
note: 1 missing value returned for equation 4 at initial values

Step 1
Iteration 0:   GMM criterion Q(b) =  .00001194
Iteration 1:   GMM criterion Q(b) =  4.130e-08
Iteration 2:   GMM criterion Q(b) =  4.129e-08

Step 2
Iteration 0:   GMM criterion Q(b) =  .00777293
Iteration 1:   GMM criterion Q(b) =  .00548447
Iteration 2:   GMM criterion Q(b) =  .00548447

GMM estimation

Number of parameters =   2
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,325
GMM weight matrix:     Robust

------------------------------------------------------------------------------
             |               Robust
```

```
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0008163   .0006884    -1.19   0.236    -.0021655    .0005329
     /sigma2 |   .0004387   .0002931     1.50   0.134    -.0001357    .0010131
------------------------------------------------------------------------------
Instruments for equation 1: _cons
Instruments for equation 2: _cons
Instruments for equation 3: _cons
Instruments for equation 4: _cons
```

```
estat overid

Test of overidentifying restriction:

Hansen's J chi2(2) = 7.26693 (p = 0.0264)
```

```
. est store merton

. gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r)
((dr-{alpha}-{beta}*r)^2-{sigma2}) (((dr-{alpha}-{beta}*r)^2-{sigma2})*r) winitial(i
> dentity)
note: 1 missing value returned for equation 1 at initial values
note: 1 missing value returned for equation 2 at initial values
note: 1 missing value returned for equation 3 at initial values
note: 1 missing value returned for equation 4 at initial values

Step 1
Iteration 0:   GMM criterion Q(b) =  .00001194
Iteration 1:   GMM criterion Q(b) =  3.110e-10
Iteration 2:   GMM criterion Q(b) =  3.045e-10

Step 2
Iteration 0:   GMM criterion Q(b) =  .00057424
Iteration 1:   GMM criterion Q(b) =  .00019027
Iteration 2:   GMM criterion Q(b) =  .00019027

GMM estimation

Number of parameters =   3
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,325
GMM weight matrix:     Robust

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0027025   .0009807    -2.76   0.006    -.0046247   -.0007803
       /beta |   .0005344   .0002001     2.67   0.008     .0001422    .0009266
     /sigma2 |   .0005976   .0003004     1.99   0.047     8.90e-06    .0011863
------------------------------------------------------------------------------
Instruments for equation 1: _cons
Instruments for equation 2: _cons
Instruments for equation 3: _cons
Instruments for equation 4: _cons
```

```
. estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = .252107 (p = 0.6156)
```

H_0 is not rejected, all moment condition already satisfy.

```
. est store vasicek
```

b)

```
. est restore unrestricted
(results unrestricted are active now)
```

Test coefficient of Unrestricted model that which model is suitable, using Wald - χ^2-test.

```
. test (_b[/beta]=0) (_b[/gamma]=0)

 ( 1)  [beta]_cons = 0
 ( 2)  [gamma]_cons = 0

           chi2(  2) =    7.80
         Prob > chi2 =    0.0203  <0.05
```

$\therefore H_0$ is rejected, Merton is not appropriated

```
. test (_b[/gamma]=0)

 ( 1)  [gamma]_cons = 0

           chi2(  1) =    0.27
         Prob > chi2 =    0.6045 >0.05
```

$\therefore H_0$ is not rejected, Vasicek is appropriated

$\therefore$ Vasicek is the most appropriated.

```
. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q4-2_5.dta", clear
```

c)

```
. ivregress gmm y x3 x4 (x1 x2= z1 z2 z3)

Instrumental variables (GMM) regression           Number of obs   =        500
                                                  Wald chi2(4)    =     153.30
                                                  Prob > chi2     =     0.0000
                                                  R-squared       =     0.5994
GMM weight matrix: Robust                         Root MSE        =     20.244

------------------------------------------------------------------------------
             |               Robust
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   3.276862   .9836373     3.33   0.001     1.348968    5.204756
          x2 |   1.971358   .5390094     3.66   0.000     .9149195    3.027797
          x3 |   1.026236    .309814     3.31   0.001     .4190122    1.633461
          x4 |   1.324641    .175497     7.55   0.000     .9806737    1.668609
       _cons |   3.356269   7.714633     0.44   0.664    -11.76413    18.47667
------------------------------------------------------------------------------
Instrumented:  x1 x2
Instruments:   x3 x4 z1 z2 z3

. estat overid
```

∴ H_0 is not rejected, all moment condition are satisfy

```
  Test of overidentifying restriction:

  Hansen's J chi2(1) = .005821 (p = 0.9392)
```

>0.05

```
. ivregress 2sls y x3 x4 (x1 x2= z1 z2 z3)

Instrumental variables (2SLS) regression          Number of obs   =        500
                                                  Wald chi2(4)    =     142.97
                                                  Prob > chi2     =     0.0000
                                                  R-squared       =     0.5995
                                                  Root MSE        =     20.243
```

y	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
x1	3.275548	.9668494	3.39	0.001	1.380559	5.170538
x2	1.972494	.5392279	3.66	0.000	.9156265	3.029361
x3	1.027236	.311211	3.30	0.001	.417274	1.637199
x4	1.324484	.1798322	7.37	0.000	.972019	1.676948
_cons	3.340382	8.336292	0.40	0.689	-12.99845	19.67921

```
Instrumented:  x1 x2
Instruments:   x3 x4 z1 z2 z3

. estat overid

  Tests of overidentifying restrictions:

  Sargan (score) chi2(1) =  .005008  (p = 0.9436)
  Basmann chi2(1)        =  .004948  (p = 0.9439)

. log close
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q4.log
  log type:  text
 closed on:  21 Mar 2021, 10:56:32
```

d) From using OLS with endogeneity bias will give estimator that biased, inconsistent and inefficient.

e) GMM have more moment condition than 2SLS

GMM (moment condition)

$E(U_i)=0$

$E(X_3 U_i)=0$

$E(X_4 U_i)=0$

$E(Z_1 U_i)=0$

$E(Z_2 U_i)=0$

$E(Z_3 U_i)=0$

2SLS (moment condition)

$E(U_i)=0$

$E(\hat{x}_1 U_i)=0$

$E(\hat{x}_2 U_i)=0$

$E(x_3 U_i)=0$

$E(x_4 U_1)=0$

5)

```
------------------------------------------------------------------------------------------
----------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q5.log
  log type:  text
 opened on:  21 Mar 2021, 11:24:25

. clear

. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q5_5.dta", clear
```

a)

```
. probit y x1 x2 x3
```

∴ Cannot compare due to the different in distribution.

```
Iteration 0:   log likelihood = -117.78597
Iteration 1:   log likelihood = -110.00928
Iteration 2:   log likelihood =   -109.905
Iteration 3:   log likelihood = -109.90493
Iteration 4:   log likelihood = -109.90493

Probit regression                               Number of obs     =        215
                                                LR chi2(3)        =      15.76
                                                Prob > chi2       =     0.0013
Log likelihood = -109.90493                     Pseudo R2         =     0.0669

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |     .00376   .0014412     2.61   0.009     .0009352    .0065848
          x2 |   .0102754   .0082193     1.25   0.211    -.0058341    .0263848
          x3 |   .0994396   .0427372     2.33   0.020     .0156762     .183203
       _cons |   .4106828   .1213843     3.38   0.001      .172774    .6485916
------------------------------------------------------------------------------

. fitstat

Measures of Fit for probit of y

Log-Lik Intercept Only:      -117.786   Log-Lik Full Model:            -109.905
D(211):                       219.810   LR(3):                           15.762
                                        Prob > LR:                        0.001
McFadden's R2:                  0.067   McFadden's Adj R2:                0.033
Maximum Likelihood R2:          0.071   Cragg & Uhler's R2:               0.106
McKelvey and Zavoina's R2:      0.157   Efron's R2:                       0.064
Variance of y*:                 1.186   Variance of error:                1.000
Count R2:                       0.763   Adj Count R2:                     0.000
AIC:                            1.060   AIC*n:                          227.810
BIC:                         -913.395   BIC':                             0.350

. est store probit
```

```
. logit y x1 x2 x3

Iteration 0:   log likelihood = -117.78597
Iteration 1:   log likelihood = -110.32738
Iteration 2:   log likelihood =  -109.9522
Iteration 3:   log likelihood = -109.95099
Iteration 4:   log likelihood = -109.95099

Logistic regression                             Number of obs     =        215
                                                LR chi2(3)        =      15.67
                                                Prob > chi2       =     0.0013
Log likelihood = -109.95099                     Pseudo R2         =     0.0665

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0065416   .0026044     2.51   0.012     .0014369    .0116462
          x2 |   .0196932   .0155051     1.27   0.204    -.0106962    .0500826
          x3 |   .1801955   .0802331     2.25   0.025     .0229415    .3374495
       _cons |   .6570795   .1995791     3.29   0.001     .2659116    1.048247
------------------------------------------------------------------------------
```

. . From logit distribution, overall test is significant, for counted R^2 is 0.763 means that predictable that $y=1$ is 76.3%

```
. fitstat

Measures of Fit for logit of y

Log-Lik Intercept Only:      -117.786   Log-Lik Full Model:            -109.951
D(211):                       219.902   LR(3):                           15.670
                                        Prob > LR:                        0.001
McFadden's R2:                  0.067   McFadden's Adj R2:                0.033
Maximum Likelihood R2:          0.070   Cragg & Uhler's R2:               0.106
McKelvey and Zavoina's R2:      0.151   Efron's R2:                       0.064
Variance of y*:                 3.876   Variance of error:                3.290
Count R2:                       0.763   Adj Count R2:                     0.000
AIC:                            1.060   AIC*n:                          227.902
BIC:                         -913.303   BIC':                             0.442

. est store logit
```

b)
```
. mfx, at(mean)

Marginal effects after logit
      y  = Pr(y) (predict)
      p̂  =  .78847535
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |    .001091      .00041    2.63   0.008   .000279  .001903   60.852
      x2 |   .0032845      .00253    1.30   0.195  -.00168   .008249  -1.59106
      x3 |   .0300534      .01277    2.35   0.019   .005023  .055084   1.62016
```

Interpretation of marginal effects at mean of x_{1i} is if we change x_{1t} from 60.852 to 61.852, the probability of $y=1$ will increase by 0.11%, holdin x_{2t}, x_{3t} at their mean.

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

. mfx, at(median)

Marginal effects after logit
      y  = Pr(y) (predict)
         =  .66823646
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
      x1 |   .0014502      .00062    2.32   0.020   .000226  .002674   .770154
      x2 |   .0043659      .00346    1.26   0.207  -.002419  .011151   .549624
      x3 |   .0399487      .01853    2.16   0.031   .003631  .076267   .151382
------------------------------------------------------------------------------
```

For Logit

$H_0: \beta_1 = \beta_2 = \beta_3 = 0$

c)
```
. test x1 x2 x3

 ( 1)  [y]x1 = 0
 ( 2)  [y]x2 = 0
 ( 3)  [y]x3 = 0

           chi2(  3) =   12.12
         Prob > chi2 =    0.0070
```

< 0.05

Wald test for logit distribution is rejected H_0.

LR-test

LR-test = 15.67

P-value = 0.01 < 0.05

∴ H_0 is rejected

```
. est restore probit
(results probit are active now)

. test x1 x2 x3

 ( 1)  [y]x1 = 0
 ( 2)  [y]x2 = 0
 ( 3)  [y]x3 = 0

           chi2(  3) =   13.59
         Prob > chi2 =    0.0035
```

< 0.05

For probit.

$H_0: \beta_1 = \beta_2 = \beta_3 = 0$

Wald test for probit distribution is rejected H_0

LR-test

LR-test = 15.761

P-value = 0.01 < 0.05

∴ H_0 is rejected

```
. test (x1=x2)

 ( 1)  [y]x1 - [y]x2 = 0

           chi2(  1) =    0.66
         Prob > chi2 =    0.4180
```

$H_0: \beta_1 = \beta_2$

> 0.05 → H_0 is not rejected, $\beta_1 = \beta_2$ (for probit distribution)

```
. est restore logit
(results logit are active now)

. test (x1=x2)

 ( 1)  [y]x1 - [y]x2 = 0
```

$H_0: \beta_1 = \beta_2$

```
           chi2(  1) =    0.77
         Prob > chi2 =    0.3790
```
$> 0.05 \rightarrow H_0$ is not rejected, $\beta_1 = \beta_2$ (for logit distribution)

```
. log close
      name:  &lt;unnamed&gt;
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q5.log
  log type:  text
 closed on:  21 Mar 2021, 11:25:58
------------------------------------------------------------------------------------
------------------------------------------------------
```

d) Counted R^2 is important because its tell how precise of prediction is.
If the threshold is change which will lead to the condition of prediction to be predict that $\hat{y}=1$ is harder or easier, then the precise of prediction will change accordingly or counted R^2 change

6)

```
--------------------------------------------------------------------------------------------
-------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q6.log
  log type:  text
 opened on:  21 Mar 2021, 12:06:32

. use "C:\Users\User\Desktop\EE 426 stata\midterm exam\Midterm_q6_5.dta", clear

. xtset id t
       panel variable:  id (strongly balanced)
        time variable:  t, 1 to 12
                delta:  1 unit
```

a)

```
. xtgls y x1 x2 x3, igls panels(heteroskedastic)
Iteration 1: tolerance = .00590371
Iteration 2: tolerance = .00177471
Iteration 3: tolerance = .00055434
Iteration 4: tolerance = .000177
Iteration 5: tolerance = .00005721
Iteration 6: tolerance = .00001862
Iteration 7: tolerance = 6.085e-06
Iteration 8: tolerance = 1.993e-06
Iteration 9: tolerance = 6.534e-07
Iteration 10: tolerance = 2.144e-07
Iteration 11: tolerance = 7.040e-08
```

If heteroskedasticity occur, the estimator will not be BLUE but only LUE because it is not minimum variance, t-test & f-test is invalid or not precise.

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   no autocorrelation

Estimated covariances      =       100          Number of obs     =      1,200
Estimated autocorrelations =         0          Number of groups  =        100
Estimated coefficients     =         4          Time periods      =         12
                                                Wald chi2(3)      =   33298.40
Log likelihood             = -6165.009          Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .3168738   .0100633    31.49   0.000     .2971501    .3365975
          x2 |   1.311977   .0139878    93.79   0.000     1.284562    1.339393
          x3 |  -.4630102    .011065   -41.84   0.000    -.4846972   -.4413232
       _cons |  -132.2058   6.140582   -21.53   0.000    -144.2411   -120.1705
------------------------------------------------------------------------------

. est store pannelhet
```

```
. xtgls y x1 x2 x3

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        homoskedastic
Correlation:   no autocorrelation

Estimated covariances      =         1          Number of obs     =      1,200
Estimated autocorrelations =         0          Number of groups  =        100
Estimated coefficients     =         4          Time periods      =         12
                                                Wald chi2(3)      =   29882.41
Log likelihood             =  -6211.29          Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .3183087   .0109146    29.16   0.000     .2969164    .3397011
          x2 |   1.320714   .0149495    88.34   0.000     1.291413    1.350014
          x3 |  -.4642183    .011884   -39.06   0.000    -.4875104   -.4409262
       _cons |  -136.2145   6.645908   -20.50   0.000    -149.2402   -123.1887
------------------------------------------------------------------------------

. est store panel

. local df=e(N_g)-1

. lrtest pannelhet, df(`df')
```

H_0: no heteroskedasticity

```
Likelihood-ratio test                                 LR chi2(99) =     92.56
(Assumption: panel nested in pannelhet)               Prob > chi2 =    0.6629
```

> 0.05

H_0 is not rejected, heteroskedasticity is insignificant

b)

```
. xtgls y x1 x2 x3

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        homoskedastic
Correlation:   no autocorrelation

Estimated covariances      =         1          Number of obs     =      1,200
Estimated autocorrelations =         0          Number of groups  =        100
Estimated coefficients     =         4          Time periods      =         12
                                                Wald chi2(3)      =   29882.41
Log likelihood             =  -6211.29          Prob > chi2       =     0.0000

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

```
          x1 |   .3183087   .0109146    29.16   0.000     .2969164    .3397011
          x2 |   1.320714   .0149495    88.34   0.000     1.291413    1.350014
          x3 |  -.4642183    .011884   -39.06   0.000    -.4875104   -.4409262
       _cons |  -136.2145   6.645908   -20.50   0.000    -149.2402   -123.1887
------------------------------------------------------------------------------

. xtreg y x1 x2 x3, fe

Fixed-effects (within) regression               Number of obs     =      1,200
Group variable: id                              Number of groups  =        100

R-sq:                                           Obs per group:
     within  = 0.9502                                         min =         12
     between = 0.9848                                         avg =       12.0
     overall = 0.8846                                         max =         12

                                                F(3,1097)         =    6980.72
corr(u_i, Xb)  = 0.8057                         Prob > F          =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .1014426   .0044866    22.61   0.000     .0926393    .1102459
          x2 |   .6951028   .0085422    81.37   0.000      .678342    .7118637
          x3 |  -.4953168   .0041895  -118.23   0.000    -.5035372   -.4870965
       _cons |    208.659   4.373144    47.71   0.000     200.0784    217.2397
-------------+----------------------------------------------------------------
     sigma_u |  123.46108
     sigma_e |  14.376737
         rho |  .98662139   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(99, 1097) = 96.47                   Prob > F = 0.0000
```

$H_0: \alpha_1 = \alpha_2 = \ldots = \alpha_n = \alpha$ < 0.05

H0 is rejected, Fixed effect is exist.

```
. est store fixeffect

. xtreg y x1 x2 x3, re

Random-effects GLS regression                   Number of obs     =      1,200
Group variable: id                              Number of groups  =        100

R-sq:                                           Obs per group:
     within  = 0.8956                                         min =         12
     between = 0.9953                                         avg =       12.0
     overall = 0.9543                                         max =         12

                                                Wald chi2(3)      =    8707.50
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

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

```
-------------+----------------------------------------------------------------
          x1 |   .2162513   .0090869    23.80   0.000     .1984414    .2340613
          x2 |   1.028607   .0152844    67.30   0.000     .9986503    1.058564
          x3 |  -.4779339   .0091412   -52.28   0.000    -.4958503   -.4600176
       _cons |   25.24251   8.000206     3.16   0.002     9.562392    40.92262
-------------+----------------------------------------------------------------
     sigma_u |  12.351151
     sigma_e |  14.376737
         rho |  .42464732   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est store random

. hausman fixeffect random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |   fixeffect      random       Difference          S.E.
-------------+----------------------------------------------------------------
          x1 |    .1014426     .2162513       -.1148087               .
          x2 |    .6951028     1.028607       -.3335042               .
          x3 |   -.4953168    -.4779339       -.0173829               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          = -1451.21    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

. log close
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\midterm exam\midterm q6.log
  log type:  text
 closed on:  21 Mar 2021, 12:07:47
------------------------------------------------------------------------------------
------------------------------------------------------
```

```
. hausman random fixeeffect

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     random     fixeeffect     Difference          S.E.
-------------+----------------------------------------------------------------
          x1 |    .2162513     .1014426        .1148087         .007902
          x2 |    1.028607     .6951028        .3335042        .0126745
          x3 |   -.4779339    -.4953168        .0173829        .0081246
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =     1451.21
                Prob>chi2 =      0.0000
```

b) First, test wether fixed effect is exist or not, then test that the effect is significant or not which result in fixed effect is exist and significant.

Random-effect test $H_0: E(\alpha_i x_i) = 0$

$\chi^2_3 = 1451.21$

P-value $= 0.000 < 0.05$

H_0 is rejected, fixed effect is more appropriate than random effect

c) Fixed effect estimation: $y_{it} - \bar{y}_i = \cancel{(\beta_1 - \beta_1)}^{0}\, \beta_2(x_{2it} - \bar{x}_{2i}) + \ldots + \beta_k(x_{kit} - \bar{x}_{ki}) + \cancel{(\alpha_i - \bar{\alpha})}^{0} + (\varepsilon_{it} - \bar{\varepsilon}_i)$

(computed by using mean)

First difference estimation method: $\cancel{(\beta_1 - \beta_1)}^{0}$

$$y_{it} - y_{it-1} = \beta_2(x_{2it} - x_{2it-1}) + \ldots + \beta_k(x_{kit} - x_{kit-1}) + \cancel{(\alpha_i - \alpha_i)}^{0} + (\varepsilon_{it} - \varepsilon_{it-1})$$

Random effect model: $y_{it} - \lambda \bar{y}_i = \beta_1(1-\lambda) + \beta_2(x_{2it} - \lambda \bar{x}_{2i}) + \ldots + \beta_k(x_{kit} - \lambda \bar{x}_{ki}) + (v_{it} - \lambda \bar{v}_i)$

where λ is $0 < \lambda < 1$

$\lambda = 1 \rightarrow$ Fixed effect

$\lambda = 0 \rightarrow$ POLS

d) The difference is the computation of each R^2

$$\text{Within } R^2 = \frac{\sum(\hat{y}^*_{it} - \bar{y}^*)^2}{\sum(y^*_{it} - \bar{y}^*)^2} = \frac{\sum\left((\widehat{y_{it} - \bar{y}_i}) - (\overline{y_{it} - \bar{y}_i})\right)^2}{\sum\left((y_{it} - \bar{y}_i) - (\overline{y_{it} - \bar{y}_i})\right)^2}$$

$$\text{Overall } R^2 = \frac{\sum(\hat{y}_{it} - \bar{y})^2}{\sum(y_{it} - \bar{y})^2}$$

$$\text{Between } R^2 = \frac{\sum(\hat{\bar{y}}_i - \bar{y})^2}{\sum(\bar{y}_i - \bar{y})^2}$$