Assignment 5

1. In the study of interest rate structure, the continuous time model can be specified as:

$$r_{t+\Delta t} - r_t = (\alpha + \beta r_t)\Delta t + \varepsilon_{t+\Delta t} \tag{1}$$

where: $E[\varepsilon_{t+\Delta t}] = 0$ and $E[\varepsilon^2_{t+\Delta t}] = \sigma^2 r_t^{2\gamma} \Delta t$

Then, the model can be transformed to be discrete time model by setting $\Delta t = 1$. The discrete time model can be stated as:

$$r_{t+1} - r_t = \Delta r_t = \alpha + \beta r_t + \varepsilon_{t+1} \tag{2}$$

where: $E[\varepsilon_{t+1}] = 0$ and $E[\varepsilon^2_{t+1}] = \sigma^2 r_t^{2\gamma}$

The above model consists of four parameters including $\alpha, \beta, \sigma^2, \gamma$. The model can be estimate using GMM. Four moment condition equations can be stated as:

Zero mean condition: $E(\varepsilon_{t+1}) = 0$

Orthogonality condition: $E(\varepsilon_{t+1} r_t) = 0$

Variance condition: $E(\varepsilon^2_{t+1} - \sigma^2 r_t^{2\gamma}) = 0$

Zero covariance condition: $E\left(\left(\varepsilon^2_{t+1} - \sigma^2 r_t^{2\gamma}\right) r_t\right) = 0$

The above model can be claimed as unrestricted model for other eight interest rate structure models which can be indicated as follows:

Model	α	β	σ^2	γ
(1) Unrestricted				
(2) Merton		0		0
(3) Vasicek				0
(4) CIR SR				0.5
(5) Dothan	0	0		1
(6) GBM	0			1
(7) Brennan & Schwartz				1
(8) CIR VR	0	0		1.5
(9) CEV	0			

From the given data set (`assign5-1.dta`):

a. Estimate the interest rate structure models applying all 9 models using GMM. Also perform Overidentification Test. (Hint: command for generating $\Delta r_t = r_{t+1} - r_t$ is `gen dr=f.r-r`)

b. Determine the most appropriated model using Wald Test.

2. From the model:

$$y_i = \alpha + \beta x_i + u_i \quad (3)$$

where: y_i is dependent variable

x_i is explanatory variable

u_i is stochastic error term

$E(u_i) = 0$ but $E(x_i u_i) \neq 0$.

From the given data set (`assign5-2.dta`):

a. Estimate model (3) using OLS.
b. Based on z_1, z_2, z_3, z_4, determine the best set of instrumental variables, then, estimate model (3) using GMM.
c. Determine whether OLS estimated results in (a) or GMM estimated results in (b) is more appropriate using the Hansen's J chi2 statistic test.

```
-------------------------------------------------------------------------------
-------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\assignment 5.log
  log type:  text
 opened on:  25 Feb 2021, 09:51:42

. use "C:\Users\User\Desktop\EE 426 stata\assign5-1.dta", clear

. tsset time
        time variable:  time, 1 to 1335
                delta:  1 unit

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

. 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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  8.321e-06  (backed up)
Iteration 2:   GMM criterion Q(b) =  6.043e-06  (not concave)
Iteration 3:   GMM criterion Q(b) =  1.604e-06
Iteration 4:   GMM criterion Q(b) =  1.662e-09
Iteration 5:   GMM criterion Q(b) =  1.344e-13

Step 2
Iteration 0:   GMM criterion Q(b) =  3.899e-10
Iteration 1:   GMM criterion Q(b) =  4.098e-18

note: model is exactly identified

GMM estimation

Number of parameters =   4
Number of moments    =   4
Initial weight matrix: Identity                  Number of obs   =      1,334
GMM weight matrix:     Robust

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

a.)

unrestricted model.

```
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0023725   .0011574    -2.05   0.040    -.0046409   -.0001041
       /beta |   .0004291   .0002873     1.49   0.135     -.000134    .0009922
     /sigma2 |   .0005043    .000324     1.56   0.120    -.0001307    .0011393
      /gamma |   .0985177   .1823933     0.54   0.589    -.2589666     .456002
------------------------------------------------------------------------------
Instruments for equation 1: _cons
Instruments for equation 2: _cons
Instruments for equation 3: _cons
Instruments for equation 4: _cons

. 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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  4.045e-08
Iteration 2:   GMM criterion Q(b) =  4.044e-08

Step 2
Iteration 0:   GMM criterion Q(b) =  .00798141
Iteration 1:   GMM criterion Q(b) =  .00552368
Iteration 2:   GMM criterion Q(b) =  .00552368

GMM estimation

Number of parameters =   2
Number of moments    =   4
Initial weight matrix: Identity                  Number of obs   =      1,334
GMM weight matrix:     Robust

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0008137   .0006821    -1.19   0.233    -.0021507    .0005232
     /sigma2 |   .0004277   .0002902     1.47   0.141    -.0001412    .0009965
------------------------------------------------------------------------------
Instruments for equation 1: _cons
Instruments for equation 2: _cons
Instruments for equation 3: _cons
Instruments for equation 4: _cons
```

```
. 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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  4.045e-08
Iteration 2:   GMM criterion Q(b) =  4.044e-08

Step 2
Iteration 0:   GMM criterion Q(b) =  .00798141
Iteration 1:   GMM criterion Q(b) =  .00552368
Iteration 2:   GMM criterion Q(b) =  .00552368

GMM estimation

Number of parameters =   2
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,334
GMM weight matrix:     Robust
```

merton

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
/alpha	-.0008137	.0006821	-1.19	0.233	-.0021507	.0005232
/sigma2	.0004277	.0002902	1.47	0.141	-.0001412	.0009965

```
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) = 7.36859 (p = 0.0251)
```

H_0 is rejected at .05 level, merton is not appropriated model (not satisfy moment conditions)

```
. 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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  3.336e-10
Iteration 2:   GMM criterion Q(b) =  3.273e-10

Step 2
Iteration 0:   GMM criterion Q(b) =  .00063051
Iteration 1:   GMM criterion Q(b) =  .00020488
Iteration 2:   GMM criterion Q(b) =  .00020488

GMM estimation

Number of parameters =   3
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,334
GMM weight matrix:     Robust
```

Vasicek

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
/alpha	-.0026994	.0009734	-2.77	0.006	-.0046072	-.0007915
/beta	.0005368	.0001999	2.69	0.007	.000145	.0009286
/sigma2	.0005887	.0002977	1.98	0.048	5.20e-06	.0011722

```
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) = .273315 (p = 0.6011)
```

$p > \alpha = 0.05$

H_0 is not rejected,

Vasicek is appropriated

```
. est store vasicek

. gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r)
((dr-{alpha}-{beta}*r)^2-{sigma2}*r) (((dr-{alpha}-{beta}*r)^2-{sigma2}*r)*r)
winiti
> al(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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  3.349e-09
Iteration 2:   GMM criterion Q(b) =  3.343e-09

Step 2
Iteration 0:   GMM criterion Q(b) =  .00651703
Iteration 1:   GMM criterion Q(b) =  .00164197
Iteration 2:   GMM criterion Q(b) =  .00164196

GMM estimation

Number of parameters =   3
Number of moments    =   4
Initial weight matrix: Identity                  Number of obs   =      1,334
GMM weight matrix:     Robust
```

CIR_SR

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
/alpha	-.0010252	.0007112	-1.44	0.149	-.0024191	.0003686
/beta	.0002288	.0002532	0.90	0.366	-.0002675	.000725
/sigma2	.0000917	.0000646	1.42	0.156	-.000035	.0002183

```
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) = 2.19038 (p = 0.1389)
```

H_0 is not rejected/ appropriated.

```
. est store CIR_SR

. gmm (dr) ((dr)*r) ((dr)^2-{sigma2}*r^2) (((dr)^2-{sigma2}*r^2)*r)
winitial(identity)
note: no parameters in equation 1
note: no parameters in equation 2
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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  5.688e-06
```

```
Iteration 2:   GMM criterion Q(b) =  5.688e-06

Step 2
Iteration 0:   GMM criterion Q(b) =  .00932249
Iteration 1:   GMM criterion Q(b) =  .00344401
Iteration 2:   GMM criterion Q(b) =  .00344401

GMM estimation

Number of parameters =   1
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,334
GMM weight matrix:     Robust
```

Dothan

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
/sigma2	.0000162	7.20e-06	2.25	0.025	2.08e-06	.0000303

```
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(3) = 4.59432 (p = 0.2040)
```

FTR H_0, appropriated.

```
. est store dothan

. gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^2)
(((dr-{beta}*r)^2-{sigma2}*r^2)*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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  8.547e-08
Iteration 2:   GMM criterion Q(b) =  8.547e-08

Step 2
Iteration 0:   GMM criterion Q(b) =   .0082543
Iteration 1:   GMM criterion Q(b) =  .00342544
Iteration 2:   GMM criterion Q(b) =  .00342542
```

```
GMM estimation

Number of parameters =   2
Number of moments    =   4
Initial weight matrix: Identity                  Number of obs   =      1,334
GMM weight matrix:     Robust
```

GMM

```
------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       /beta |   .0000248   .0001265     0.20   0.844     -.000223    .0002727
     /sigma2 |   .0000154   8.33e-06     1.84   0.065    -9.60e-07    .0000317
------------------------------------------------------------------------------
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) = 4.56951 (p = 0.1018)
```

$p > \alpha = 0.05$ fail to reject H_0, appropriate.

```
. est store GBM

. gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r)
((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2))
(((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2))*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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  1.062e-08
Iteration 2:   GMM criterion Q(b) =  1.061e-08

Step 2
Iteration 0:   GMM criterion Q(b) =   .0202404
Iteration 1:   GMM criterion Q(b) =  .00259237
Iteration 2:   GMM criterion Q(b) =  .00259234

GMM estimation

Number of parameters =   3
Number of moments    =   4
```

```
Initial weight matrix: Identity                   Number of obs   =      1,334
GMM weight matrix:     Robust
```

Brennan & Shwartz

```
------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0008979   .0008413    -1.07   0.286    -.0025469     .000751
       /beta |   .0002882   .0002774     1.04   0.299    -.0002555    .0008319
     /sigma2 |   8.91e-06   .0000103     0.87   0.387    -.0000113    .0000291
------------------------------------------------------------------------------
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) = 3.45819 (p = 0.0629)
```

$p > \alpha = 0.05$ H_0 is not rejected, appropriated.

```
. est store brennan

. gmm (dr) ((dr)*r) ((dr)^2-{sigma2}*r^(2*1.5)) (((dr)^2-{sigma2}*r^(2*1.5))*r)
winitial(identity)
note: no parameters in equation 1
note: no parameters in equation 2
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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  5.694e-06
Iteration 2:   GMM criterion Q(b) =  5.694e-06

Step 2
Iteration 0:   GMM criterion Q(b) =  .01561186
Iteration 1:   GMM criterion Q(b) =   .0038055
Iteration 2:   GMM criterion Q(b) =   .0038055

GMM estimation

Number of parameters =   1
Number of moments    =   4
Initial weight matrix: Identity                   Number of obs   =      1,334
GMM weight matrix:     Robust
```

CIR_VR

```
------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /sigma2 |   2.70e-06   1.26e-06     2.15   0.032     2.35e-07    5.16e-06
------------------------------------------------------------------------------
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(3) = 5.07654 (p = 0.1663)
```

H_0 is not rejected, appropriated.

```
. est store CIR_VR

. gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma}))
(((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma}))*r) winitial(ident
> ity)
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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  8.627e-06  (backed up)
Iteration 2:   GMM criterion Q(b) =  6.127e-06  (not concave)
Iteration 3:   GMM criterion Q(b) =  5.400e-06  (backed up)
Iteration 4:   GMM criterion Q(b) =  5.310e-06

Step 2
Iteration 0:   GMM criterion Q(b) =  .01236133
Iteration 1:   GMM criterion Q(b) =  .01075751
Iteration 2:   GMM criterion Q(b) =  .00760436
Iteration 3:   GMM criterion Q(b) =  .00678694
Iteration 4:   GMM criterion Q(b) =  .00326882
Iteration 5:   GMM criterion Q(b) =  .00316225
Iteration 6:   GMM criterion Q(b) =  .00313882
Iteration 7:   GMM criterion Q(b) =   .0031388

GMM estimation

Number of parameters =   3
Number of moments    =   4
```

```
Initial weight matrix: Identity                   Number of obs   =      1,334
GMM weight matrix:     Robust
```

CEV

```
------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       /beta |  -.0000453   .0001702    -0.27   0.790    -.0003789    .0002883
     /sigma2 |   .0000881   .0001436     0.61   0.539    -.0001933    .0003696
      /gamma |   .5717551   .3668112     1.56   0.119    -.1471817    1.290692
------------------------------------------------------------------------------
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) = 4.18715 (p = 0.0407)
```

H_0 is rejected at .05 level, not appropriated.

```
. est store CEV

. est table unrestricted merton vasicek CIR_SR dothan GBM brennan CIR_VR CEV,
star(0.1 0.05 0.01)

----------------------------------------------------------------------------------------
-----------------------------------------
    Variable | unrestricted       merton          vasicek         CIR_SR
dothan            GBM           brennan
-------------+--------------------------------------------------------------------------
-----------------------------------------
alpha        |
       _cons | -.00237253**    -.00081372      -.00269937***   -.00102525
                            -.00089794
-------------+--------------------------------------------------------------------------
-----------------------------------------
beta         |
       _cons |  .00042912                       .00053681***    .00022877
             .00002483        .0002882
-------------+--------------------------------------------------------------------------
-----------------------------------------
sigma2       |
       _cons |  .00050427       .00042766       .00058872**     .00009168
.00001618**     .00001536*      8.909e-06
-------------+--------------------------------------------------------------------------
-----------------------------------------
gamma        |
       _cons |  .09851773
```

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

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


---------------------------------------------
    Variable |    CIR_VR            CEV
-------------+-------------------------------
alpha        |
       _cons |
-------------+-------------------------------
beta         |
       _cons |                 -.00004534
-------------+-------------------------------
sigma2       |
       _cons |  2.698e-06**     .00008815
-------------+-------------------------------
gamma        |
       _cons |                  .57175507
---------------------------------------------
           legend: * p<.1; ** p<.05; *** p<.01

. 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) =  .00001173
Iteration 1:   GMM criterion Q(b) =  8.321e-06  (backed up)
Iteration 2:   GMM criterion Q(b) =  6.043e-06  (not concave)
Iteration 3:   GMM criterion Q(b) =  1.604e-06
Iteration 4:   GMM criterion Q(b) =  1.662e-09
Iteration 5:   GMM criterion Q(b) =  1.344e-13

Step 2
Iteration 0:   GMM criterion Q(b) =  3.899e-10
Iteration 1:   GMM criterion Q(b) =  4.098e-18

note: model is exactly identified

GMM estimation
```

```
Number of parameters =   4
Number of moments    =   4
Initial weight matrix: Identity                  Number of obs   =      1,334
GMM weight matrix:     Robust

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      /alpha |  -.0023725   .0011574    -2.05   0.040    -.0046409   -.0001041
       /beta |   .0004291   .0002873     1.49   0.135     -.000134    .0009922
     /sigma2 |   .0005043    .000324     1.56   0.120    -.0001307    .0011393
      /gamma |   .0985177   .1823933     0.54   0.589    -.2589666     .456002
------------------------------------------------------------------------------
Instruments for equation 1: _cons
Instruments for equation 2: _cons
Instruments for equation 3: _cons
Instruments for equation 4: _cons
```

b.)

```
. *test unrestricted vs Merton

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

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

           chi2(  2) =    7.92
         Prob > chi2 =    0.0191

. *test unrestricted vs vasicek

. test (_b[/gamma]=0)

 ( 1)  [gamma]_cons = 0

           chi2(  1) =    0.29
         Prob > chi2 =    0.5891

. *test unrestricted vs CIR SR

. test (_b[/gamma]=0.5)

 ( 1)  [gamma]_cons = .5

           chi2(  1) =    4.85
         Prob > chi2 =    0.0277

. *test unrestricted vs dothan
```

H_0 is rejected

H_0 is not rejected

H_0 is rejected

```
. test (_b[/alpha]=0) (_b[/beta]=0) (_b[/gamma]=1)

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

           chi2(  3) =   34.04
         Prob > chi2 =    0.0000

. *test unrestricted vs GBM

. test (_b[/alpha]=0) (_b[/gamma]=1)

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

           chi2(  2) =   27.48
         Prob > chi2 =    0.0000

. *test unrestricted vs brennan

. test (_b[/gamma]=1)

 ( 1)  [gamma]_cons = 1

           chi2(  1) =   24.43
         Prob > chi2 =    0.0000

. *test unrestricted vs CIR VR

. test (_b[/alpha]=0) (_b[/beta]=0) (_b[/gamma]=1.5)

 ( 1)  [alpha]_cons = 0
 ( 2)  [beta]_cons = 0
 ( 3)  [gamma]_cons = 1.5

           chi2(  3) =   95.71
         Prob > chi2 =    0.0000

. *test unrestricted vs CEV

. test (_b[/alpha]=0)

 ( 1)  [alpha]_cons = 0

           chi2(  1) =    4.20
         Prob > chi2 =    0.0404

. save "C:\Users\User\Desktop\EE 426 stata\assign5-1.dta", replace
file C:\Users\User\Desktop\EE 426 stata\assign5-1.dta saved
```

H_0 is rejected

H_0 is rejected

H_0 is rejected

H_0 is rejected

H_0 is rejected

∴ From Wald test,

only Vasicek model is failed to reject H_0.

Vasicek is the most appropriate model in this case.

(2)

```
. use "C:\Users\User\Desktop\EE 426 stata\assign5-2.dta", clear

. drop u

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

. reg y x
```

a.)

```
      Source |       SS           df       MS      Number of obs   =       500
-------------+----------------------------------   F(1, 498)       =    449.66
       Model |  132481.702         1  132481.702   Prob > F        =    0.0000
    Residual |  146722.774       498  294.624043   R-squared       =    0.4745
-------------+----------------------------------   Adj R-squared   =    0.4734
       Total |  279204.475       499  559.528007   Root MSE        =    17.165

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   5.431333   .2561312    21.21   0.000     4.928102    5.934564
       _cons |  -33.31333   2.673868   -12.46   0.000    -38.56678   -28.05988
------------------------------------------------------------------------------

. predict u, resid

. corr
(obs=500)

             |        t        y        x       z1       z2       z3       z4
 u
-------------+------------------------------------------------------------------
---
           t |   1.0000
           y |   0.0681   1.0000
           x |   0.0517   0.6888   1.0000
          z1 |   0.0661   0.2002   0.7215   1.0000
          z2 |   0.0062   0.1203   0.2352   0.1937   1.0000
          z3 |   0.0387   0.9214   0.5487   0.0918   0.0933   1.0000
          z4 |   0.0143   0.1887   0.6954   0.4738   0.1607   0.0828   1.0000
           u |   0.0447   0.7249  -0.0000  -0.4095  -0.0575   0.7496  -0.4006
1.0000


. ivregress gmm y (x=z1 z2 z3 z4)

Instrumental variables (GMM) regression          Number of obs   =        500
                                                 Wald chi2(1)    =     415.07
                                                 Prob > chi2     =     0.0000
```

```
                                                R-squared       =     0.4710
GMM weight matrix: Robust                       Root MSE        =     17.187

------------------------------------------------------------------------------
             |               Robust
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   5.262505   .2583042    20.37   0.000     4.756238    5.768772
       _cons |  -30.33032   2.737777   -11.08   0.000    -35.69627   -24.96438
------------------------------------------------------------------------------
Instrumented:  x
Instruments:   z1 z2 z3 z4

. estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(3) = 163.488 (p = 0.0000)

. save "C:\Users\User\Desktop\EE 426 stata\assign5-2.dta", replace
file C:\Users\User\Desktop\EE 426 stata\assign5-2.dta saved

. log close
      name:  <unnamed>
       log:  C:\Users\User\Desktop\EE 426 stata\assignment 5.log
  log type:  text
 closed on:  25 Feb 2021, 09:54:42
-------------------------------------------------------------------------------
-----------------------------------------------------
```

H_0 is rejected at .05 level, GMM is not appropriated.

b.) Since, all of IV is correlated w/ u the good IV is not available in this case,

c.) OLS is more appropriate since, $E(x\,u) = 0$ making, the result to be unbiased,