Assignment 5

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

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

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:

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

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:

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

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`):

ivregress GMM

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.

```
1 . log using "C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\As5.smcl"
-------------------------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\As5.smcl
  log type:  smcl
 opened on:  24 Feb 2021, 16:27:23

2 . use "C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\Data\assign5-1.dta"

3 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{alp
  > 2}*r^(2*{gamma}))*r) winitial(identity) from(alpha -0.1 beta 0.01 sigma2 0.01 gamma 0.1) nolog
  could not evaluate equation 1
  r(498);

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

5 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{alp
  > 2}*r^(2*{gamma}))*r) winitial(identity) from(alpha -0.1 beta 0.01 sigma2 0.01 gamma 0.1) nolog
  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

  Final GMM criterion Q(b) =  2.51e-21

  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
```

	Coef.	Robust 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**

```
6 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(0) = 3.3e-18 (p =     .)

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

7 . est store Unrestricted

8 . gmm (dr-{alpha}) ((dr-{alpha})*r) ((dr-{alpha})^2-{sigma2}) (((dr-{alpha})^2-{sigma2})*r) winitial(identity) fr
> 2 0.0001 gamma 0.5) nolog
invalid parameter beta in from()
r(480);

9 . gmm (dr-{alpha}) ((dr-{alpha})*r) ((dr-{alpha})^2-{sigma2}) (((dr-{alpha})^2-{sigma2})*r) winitial(identity) fr
> .0001) nolog
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

Final GMM criterion Q(b) =  .0055237

GMM estimation

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

	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**

```
10 . estat overid

     Test of overidentifying restriction:

     Hansen's J chi2(2) = 7.36859 (p = 0.0251)

11 . est store Merton

12 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}) (((dr-{alpha}-{beta}*r)^
   > l(identity) from(alpha -0.1 beta 0.01 sigma2 0.01) nolog
   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

   Final GMM criterion Q(b) =  .0002049

   GMM estimation

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

	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

13 . estat overid

     Test of overidentifying restriction:

     Hansen's J chi2(1) = .273315 (p = 0.6011)

14 . est store Vasicek

15 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r) (((dr-{alpha}-{beta}*r
   > itial(identity) from(alpha -0.1 beta 0.01 sigma2 0.01)nolog
   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

   Final GMM criterion Q(b) =   .001642

   GMM estimation

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

	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**

```
16 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = 2.19038 (p = 0.1389)

17 . est store CIR_SR

18 . gmm (dr)(dr*r)(dr^2-{sigma2}*r^2)((dr^2-{sigma2}*r^2)*r) winitial(identity) (from sigma2 0.01)nolog
note: no parameters in equation 1
note: no parameters in equation 2
( from sigma2 0.01 ) not allowed with interactive version
r(198);

19 . gmm (dr)(dr*r)(dr^2-{sigma2}*r^2)((dr^2-{sigma2}*r^2)*r) winitial(identity) from(sigma2 0.01)nolog
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

Final GMM criterion Q(b) =   .003444

GMM estimation

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

	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**

```
20 . estat overid

     Test of overidentifying restriction:

     Hansen's J chi2(3) = 4.59432 (p = 0.2040)

21 . est store Dothan

22 . gmm (dr-{beta}*r)((dr-{beta}*r)*r)((dr-{beta}*r)^2-{sigma2}*r^2)(((dr-{beta}*r)^2-{sigma2}*r^2)*r) winitial(ide
   > sigma2 0.01)nolog
   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

   Final GMM criterion Q(b) =  .0034254

   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]
   -------------+----------------------------------------------------------------
          /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

23 . estat overid

     Test of overidentifying restriction:

     Hansen's J chi2(2) = 4.56951 (p = 0.1018)

24 . est store GBM

25 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r^2) (((dr-{alpha}-{beta}
   >  winitial(identity) from(alpha -0.1 beta 0.01 sigma2 0.01)nolog
   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

   Final GMM criterion Q(b) =  .0025923

   GMM estimation

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

	Coef.	Robust 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**

```
26 . estat overid
```

Test of overidentifying restriction:

Hansen's J chi2(**1**) = **3.45819** (p = **0.0629**)

```
27 . est store B&S
```
& invalid name
r(7);

```
28 . est store B_S

29 . gmm (dr)(dr*r)(dr^2-{sigma2}*r^3) ((dr^2-{sigma2}*r^3)*r) winitial(identity) from(sigma2 0.01)nolog
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

Final 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
```

	Coef.	Robust 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**

```
30 . estat overid

     Test of overidentifying restriction:

     Hansen's J chi2(3) = 5.07654 (p = 0.1663)

31 . est store CIR_VR

32 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
   > entity) from(beta 0.01 sigma2 0.01 gamma 0.1)nolog
   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
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   r(430);

33 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
   > entity) from(beta 0.01 sigma2 0.01 gamma 0.1) nolog
   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
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   r(430);

34 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
   > entity) from(beta 0.01 sigma2 0.01 gamma 0.1)nolog
   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
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   r(430);

35 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
   > entity) from(beta 0.01 sigma2 0.01 gamma 0.1) from(beta 0.01 sigma2 0.01 gamma 0.1) nolog
   from(beta 0.01 sigma2 0.01 gamma 0.1) not allowed with interactive version
   r(198);

36 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
   > entity) from(beta 0.01 sigma2 0.01 gamma 0.1) nolog
   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
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   could not calculate numerical derivatives -- flat or discontinuous region encountered
   r(430);
```

* CEV model cannot be run, so it do it seperately in STATA 14

```
37 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
> entity)nolog
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
could not calculate numerical derivatives -- discontinuous region with missing values encountered
could not calculate numerical derivatives -- discontinuous region with missing values encountered
r(430);

38 .
39 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-{sigma2}*r^(2*{g
> entity)nolog
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
could not calculate numerical derivatives -- discontinuous region with missing values encountered
could not calculate numerical derivatives -- discontinuous region with missing values encountered
r(430);

40 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{alp
> 2}*r^(2*{gamma}))*r) winitial(identity) from(alpha -0.1 beta 0.01 sigma2 0.01 gamma 0.1) nolog
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

Final GMM criterion Q(b) =  2.51e-21

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
```

	Coef.	Robust 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
```

```
41 . #test merton
Unknown #command

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

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

           chi2(  2) =    7.92
         Prob > chi2 =    0.0191

43 . *test vasice

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

 ( 1)  [gamma]_cons = 0

           chi2(  1) =    0.29
         Prob > chi2 =    0.5891

45 . *test cir_sr

46 . test (_b[/gamma]=0.5)

 ( 1)  [gamma]_cons = .5

           chi2(  1) =    4.85
         Prob > chi2 =    0.0277

47 . *test dothan

48 . 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

49 . *test gbm

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

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

           chi2(  2) =   27.48
         Prob > chi2 =    0.0000

51 . *test b_s
```

b. Among all models, Vasicek model has the largest p-value. ∴ This suggest that this is the most appropriate model.

```
52 . test (_b[/gamma]=1)

    ( 1)  [gamma]_cons = 1

              chi2(  1) =   24.43
            Prob > chi2 =    0.0000

53 . *test cir_vr

54 . 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

55 . *test cev

56 . test (_b[/alpha]=0)

    ( 1)  [alpha]_cons = 0

              chi2(  1) =    4.20
            Prob > chi2 =    0.0404

57 . log close
          name:  <unnamed>
           log:  C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\As5.smcl
      log type:  smcl
     closed on:  24 Feb 2021, 21:29:54
-------------------------------------------------------------------------------

58 .
```

Notes:
1. Unicode is supported; see help unicode_advice.
2. Maximum number of variables is set to 5000; see help set_maxvar.

Checking for updates...
(contacting http://www.stata.com)
bad serial number
unable to check for update; verify Internet settings are correct.

```
1 . log using "C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\AS5 stata 14 CEV.smcl"
```

---

name: **<unnamed>**
log: **C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\AS5 stata 14 CEV.smcl**
log type: **smcl**
opened on: **24 Feb 2021, 21:13:23**

```
2 . use "C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\Data\assign5-1.dta", clear

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

4 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2*{gam
> sigma2}*r^(2*{gamma}))*r) winitial(identity)nolog
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
numerical derivatives are approximate
flat or discontinuous region encountered

Final GMM criterion Q(b) = 4.10e-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
```

	Coef.	Robust 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**

```
5 . estat overid
```

Test of overidentifying restriction:

Hansen's J chi2(**0**) = **5.5e-15** (p = .)

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

```
6 . est store Unrestricted

7 . gmm (dr-{beta}*r) ((dr-{beta}*r)*r) ((dr-{beta}*r)^2-{sigma2}*r^(2*{gamma})) (((dr-{beta}*r)^2-
> al(identity)nolog
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
numerical derivatives are approximate
flat or discontinuous region encountered
```

Final 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**

	Coef.	Robust 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**

```
 8 . estat overid

     Test of overidentifying restriction:

     Hansen's J chi2(1) = 4.18715 (p = 0.0407)

 9 . est store CEV
```

I did it in STATA 14

```
10 . test (_b[/alpha]=0)
equation alpha not found
r(111);

11 . gmm (dr-{alpha}-{beta}*r) ((dr-{alpha}-{beta}*r)*r) ((dr-{alpha}-{beta}*r)^2-{sigma2}*r^(2*{gam
> sigma2}*r^(2*{gamma}))*r) winitial(identity)nolog
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
numerical derivatives are approximate
flat or discontinuous region encountered

Final GMM criterion Q(b) =  4.10e-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
```

	Coef.	Robust 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

12 . test (_b[/alpha]=0)

 ( 1)  [alpha]_cons = 0

           chi2(  1) =    4.20
         Prob > chi2 =    0.0404

13 . log close
      name:  <unnamed>
       log:  C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\AS5 stata 14 CEV.smcl
  log type:  smcl
 closed on:  24 Feb 2021, 21:21:08

14 .
```

```
                                                      ___  ____  ____  ____  ____(R)
                                                     /__    /   ____/   /   ____/
                                                    ___/   /   /___/   /   /___/
                                                      Statistics/Data Analysis
```

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   16.0   Copyright 1985-2019 StataCorp LLC
  Statistics/Data Analysis             StataCorp
                                       4905 Lakeway Drive
     MP - Parallel Edition             College Station, Texas 77845 USA
                                       800-STATA-PC        http://www.stata.com
                                       979-696-4600        stata@stata.com
                                       979-696-4601 (fax)

20-student 2-core Stata lab perpetual license:
       Serial number:  501606222284
         Licensed to:  Faculty of economics
                       Thammasat University

Notes:
      1.  Unicode is supported; see help unicode advice.
      2.  More than 2 billion observations are allowed; see help obs advice.
      3.  Maximum number of variables is set to 5000; see help set_maxvar.
      4.  New update available; type -update all-
```

```
1 . log using "C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\As5 2.smcl"
-------------------------------------------------------------------------------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\As5 2.smcl
  log type:  smcl
 opened on:  24 Feb 2021, 21:31:44

2 . use "C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\Data\assign5-2.dta"

1. 3 . reg y x

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

4 . est u, resid
the subcommand unhold has been moved from estimates to _estimates
r(198);
```

```
5 . est u
the subcommand unhold has been moved from estimates to _estimates
r(198);

6 . predict uhat, resid

7 . corr x uhat z1 z2 z3 z4
(obs=500)
```

	x	uhat	z1	z2	z3	z4
x	1.0000					
uhat	-0.0000	1.0000				
z1	0.7215	-0.4095	1.0000			
z2	0.2352	-0.0575	0.1937	1.0000		
z3	0.5487	0.7496	0.0918	0.0933	1.0000	
z4	0.6954	-0.4006	0.4738	0.1607	0.0828	1.0000

2. From here, z_1 & z_4 are most correlated with x. ∴ They are the most appropriate instrumental variables.

```
8 . ivregress gmm y (x = z1 z2)

Instrumental variables (GMM) regression          Number of obs    =        500
                                                 Wald chi2(1)     =      36.13
                                                 Prob > chi2      =     0.0000
                                                 R-squared        =     0.3136
GMM weight matrix: Robust                        Root MSE         =     19.577
```

y	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
x	2.269419	.3775527	6.01	0.000	1.529429	3.009409
_cons	-1.848121	3.763999	-0.49	0.623	-9.225423	5.529182

```
Instrumented:  x
Instruments:   z1 z2

9 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = 2.55533 (p = 0.1099)

10 . ivregress gmm y (x = z1 z3)

Instrumental variables (GMM) regression          Number of obs    =        500
                                                 Wald chi2(1)     =     412.16
                                                 Prob > chi2      =     0.0000
                                                 R-squared        =     0.4692
GMM weight matrix: Robust                        Root MSE         =     17.217
```

y	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
x	5.902412	.2907357	20.30	0.000	5.332581	6.472244
_cons	-37.03774	3.094795	-11.97	0.000	-43.10343	-30.97206

```
Instrumented:  x
Instruments:   z1 z3
```

```
11 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = 159.838 (p = 0.0000)

12 . ivregress gmm y (x = z1 z4)

Instrumental variables (GMM) regression          Number of obs   =        500
                                                 Wald chi2(1)    =      40.88
                                                 Prob > chi2     =     0.0000
                                                 R-squared       =     0.3031
GMM weight matrix: Robust                        Root MSE        =     19.727

------------------------------------------------------------------------------
             |               Robust
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   2.167043   .3389432     6.39   0.000     1.502726    2.831359
       _cons |  -.6716121   3.395567    -0.20   0.843    -7.326801    5.983577
------------------------------------------------------------------------------
Instrumented:  x
Instruments:   z1 z4

13 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = .012951 (p = 0.9094)

14 . ivregress gmm y (x = z2 z3)

Instrumental variables (GMM) regression          Number of obs   =        500
                                                 Wald chi2(1)    =     336.01
                                                 Prob > chi2     =     0.0000
                                                 R-squared       =          .
GMM weight matrix: Robust                        Root MSE        =     26.192

------------------------------------------------------------------------------
             |               Robust
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |   12.04153   .6569059    18.33   0.000     10.75402    13.32904
       _cons |  -99.72932   6.694597   -14.90   0.000    -112.8505   -86.60815
------------------------------------------------------------------------------
Instrumented:  x
Instruments:   z2 z3

15 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = 24.2483 (p = 0.0000)
```

3. P-value is highest ∴ This model assure that z_1 & z_4 is the most appropriate model.

```
16 . ivregress gmm y (x = z2 z4)

Instrumental variables (GMM) regression         Number of obs   =        500
                                                Wald chi2(1)    =      33.24
                                                Prob > chi2     =     0.0000
                                                R-squared       =     0.3176
GMM weight matrix: Robust                       Root MSE        =     19.521

------------------------------------------------------------------------------
             |               Robust
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |    2.308142   .4003308     5.77   0.000     1.523508    3.092776
       _cons |   -2.231979   3.988067    -0.56   0.576    -10.04845    5.584488
------------------------------------------------------------------------------
Instrumented:  x
Instruments:   z2 z4

17 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = 2.47701 (p = 0.1155)

18 . ivregress gmm y (x = z3 z4)

Instrumental variables (GMM) regression         Number of obs   =        500
                                                Wald chi2(1)    =     457.33
                                                Prob > chi2     =     0.0000
                                                R-squared       =     0.4615
GMM weight matrix: Robust                       Root MSE        =     17.341

------------------------------------------------------------------------------
             |               Robust
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           x |    6.237532   .2916741    21.39   0.000     5.665861    6.809202
       _cons |   -40.18052   3.069851   -13.09   0.000    -46.19731   -34.16372
------------------------------------------------------------------------------
Instrumented:  x
Instruments:   z3 z4

19 . estat overid

  Test of overidentifying restriction:

  Hansen's J chi2(1) = 148.756 (p = 0.0000)

20 . log close
      name:  <unnamed>
       log:  C:\Users\Jilllin\OneDrive\Desktop\Thammasat\EE426\As5 2.smcl
  log type:  smcl
 closed on:  24 Feb 2021, 21:54:59
-------------------------------------------------------------------------------

21 .
```