# Asymptotic Properties

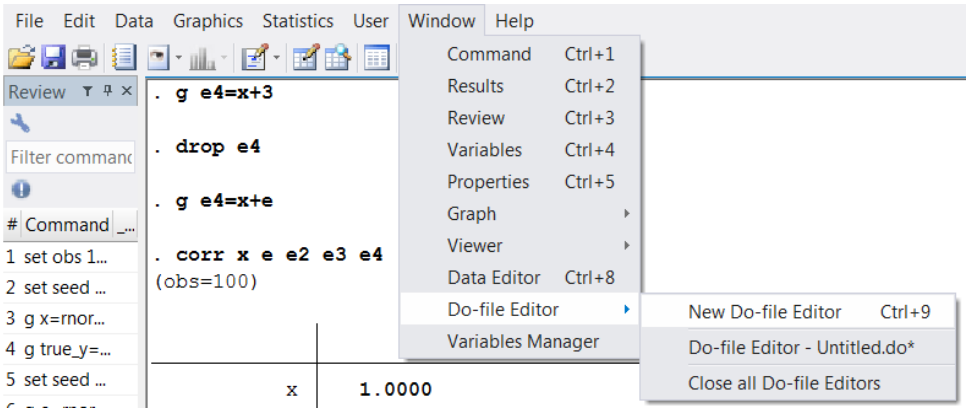
## Exogeneity Condition – Endogeneity Bias

## Monte Carlo Simulation

```
. set obs 100
obs was 0, now 100
. set seed 54321
. g x=rnormal(0,1)
. g true_y=1+2*x
. set seed 98765
. g e=rnormal(0,1)
. g e2=0.01*x+e
. g e3=0.1*x+e
. g e4=x+e
. corr x e e2 e3 e4
(obs=100)
             |        x        e       e2       e3       e4
-------------+---------------------------------------------
           x |   1.0000
           e |   0.0796   1.0000
          e2 |   0.0896   1.0000   1.0000
          e3 |   0.1776   0.9951   0.9961   1.0000
          e4 |   0.7355   0.7340   0.7407   0.7974   1.0000

. save truth
file truth.dta saved
```

To create Do-file, go to Window, choose Do-file Editor, then, select New Do-file Ctrl+8.




Then, type in the command program in Do-file Editor. After finish, go to Tools, then, choose Run.

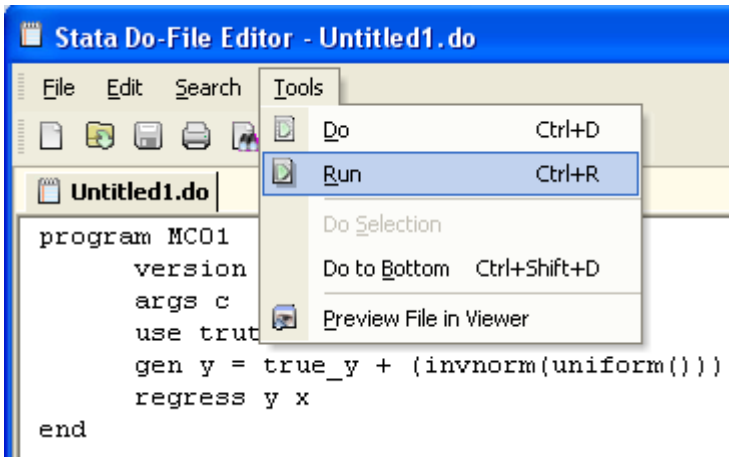
```
program MC01
      use truth, clear
      gen y = true_y + rnormal(0,1)
      regress y x
end
```

```
program MC02
      use truth, clear
      gen y = true_y + (0.01*x+rnormal(0,1))
      regress y x
```

```
end
```

```
program MC03
      use truth, clear
      gen y = true_y + (0.1*x+rnormal(0,1))
      regress y x
end
```

```
program MC04
      use truth, clear
      gen y = true_y + (x+rnormal(0,1))
      regress y x
end
```




```
. run "L:\Econometrics\Manual STATA\Do-Files\MC01.do"

. simulate _b _se, reps(10): MC01

      command:  MC01

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                   Number of obs    =      10

------------------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _b_x |   2.003454   .0185034      1.961596    2.045312
     _b_cons |   .9973035   .0178505      .9569228    1.037684
------------------------------------------------------------------------------

. run "L:\Econometrics\Manual STATA\Do-Files\MC02.do"
. simulate _b _se, reps(10): MC02

      command:  MC02

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                   Number of obs    =      10

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

```
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+------------------------------------------------
         _b_x |   2.057198   .0457031       1.95381    2.160586
      _b_cons |    .993492   .0322138      .9206194    1.066365
------------------------------------------------------------------------------

. run "L:\Econometrics\Manual STATA\Do-Files\MC03.do"

. simulate _b _se, reps(10): MC03

      command:  MC03

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                     Number of obs    =      10

------------------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+------------------------------------------------
         _b_x |   2.121299   .0245532      2.065756    2.176842
      _b_cons |   1.032642   .0303892      .9638965    1.101387
------------------------------------------------------------------------------

. run "L:\Econometrics\Manual STATA\Do-Files\MC04.do"
. simulate _b _se, reps(10): MC04

      command:  MC04

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                     Number of obs    =      10

------------------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+------------------------------------------------
         _b_x |   2.954651   .0384074      2.867767    3.041535
      _b_cons |   .9386876   .0224924      .8878062    .9895689
------------------------------------------------------------------------------
```

```
. simulate _b _se, reps(10): MC01

      command:  MC01

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                     Number of obs    =      10

------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------------
        _b_x |   1.916494   .0244379      1.861211    1.971776
     _b_cons |   1.038201   .0278255      .9752557    1.101147
------------------------------------------------------------------

. simulate _b _se, reps(10000): MC01

      command:  MC01

Simulations (10000)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..................................................    50
..................................................   100

.................................................. 10000

. mean _b_x _b_cons

Mean estimation                     Number of obs    =   10000

------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------------
        _b_x |   1.999439    .000977      1.997524    2.001354
     _b_cons |   1.000931   .0010088      .9989539    1.002909
------------------------------------------------------------------
```

**Orthogonality Condition**

n=10

```
. set obs 10
obs was 0, now 10

. set seed 54321

. g x=rnormal(0,1)

. g true_y1=1+2*x

. save truth1
file truth1.dta saved
```

---

```
program MC05
      use truth1, clear
      g n=10
      g y=true_y1 + (1/n)*x*rnormal(0,1)
      reg y x
end
```

---

```
. run "C:\DOCUME~1\Home\LOCALS~1\Temp\STD04000000.tmp"

. simulate _b _se, reps(10): MC05
```

```
      command:  MC05

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                     Number of obs    =      10

------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------------
        _b_x |   1.995817    .011397      1.970035    2.021599
     _b_cons |   .9877481   .0119996      .9606033    1.014893
------------------------------------------------------------------

. drop _all
```

n=100

```
. set obs 100
obs was 0, now 100

. set seed 54321

. g x=rnormal(0,1)

. g true_y2=1+2*x

. save truth2
file truth2.dta saved
```

---

```
program MC06
      use truth2, clear
      g n=100
      g y=true_y2 + (1/n)*x*rnormal(0,1)
      reg y x
end
```

---

```
. run "C:\DOCUME~1\Home\LOCALS~1\Temp\STD04000000.tmp"

. simulate _b _se, reps(10): MC06

      command:  MC06

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                     Number of obs    =      10

------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------------
        _b_x |   1.999682    .000406      1.998764    2.000601
     _b_cons |   1.000079   .0002488      .9995166    1.000642
------------------------------------------------------------------
```

n=1000

```
. drop _all

. set obs 1000
obs was 0, now 1000

. set seed 54321
```

```
. g x=rnormal(0,1)

. g true_y3=1+2*x

. save truth3
file truth3.dta saved
```

```
program MC07
      use truth3, clear
      g n=1000
      g y=true_y3 + (1/n)*x*rnormal(0.1)
      reg y x
end
```

```
. run "L:\TU\ECON\EC625\Manual STATA\Do-Files\MC07.do"

. simulate _b _se, reps(10): MC07

      command:  MC07

Simulations (10)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..........

. mean _b_x _b_cons

Mean estimation                   Number of obs    =      10

------------------------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _b_x |   1.999984   .0000187      1.999941    2.000026
     _b_cons |    .999992   .0000134      .9999616    1.000022
------------------------------------------------------------------------------
```

# Nonlinear Least Squares

Constant Elasticity

$$\log(q) = \beta_1 + \beta_2 \log(d) + \varepsilon$$

**OLS**

```
. regress logq1 logd1

      Source |       SS       df       MS              Number of obs =      12
-------------+------------------------------           F(  1,    10) =   64.26
       Model |  .850306125     1  .850306125           Prob > F      =  0.0000
    Residual |  .132328268    10  .013232827           R-squared     =  0.8653
-------------+------------------------------           Adj R-squared =  0.8519
       Total |  .982634394    11  .089330399           Root MSE      =  .11503

------------------------------------------------------------------------------
       logq1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       logd1 |   4.664693   .5819179     8.02   0.000     3.368099    5.961287
       _cons |   5.841739   .0430716   135.63   0.000      5.74577    5.937709
------------------------------------------------------------------------------

. sca rss1=e(rss)

. sca list rss1
      rss1 =  .13232827

. sca df1=e(df_r)

. sca list df1
       df1 =         10
```

Varying Elasticity

$$\log(q) = \beta_1 + \frac{\beta_2}{\beta_3}(d^{\beta_3} - 1) + \varepsilon$$

**NLS**

```
. nl (logq1 = {b1}+({b2}/{b3})*(d1^{b3}-1)), init(b1 1 b2 1 b3 1)
(obs = 12)

Iteration 0:  residual SS =  1.029138
.
Iteration 6:  residual SS =  .0870486

      Source |       SS       df       MS
-------------+------------------------------         Number of obs =        12
       Model |  .895585822     2  .447792911         R-squared     =    0.9114
    Residual |  .087048572     9  .009672064         Adj R-squared =    0.8917
-------------+------------------------------         Root MSE      =  .0983466
       Total |  .982634394    11  .089330399         Res. dev.     = -25.05982

------------------------------------------------------------------------------
       logq1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         /b1 |   5.807118   .0401499   144.64   0.000     5.716292    5.897943
         /b2 |   10.29833   3.295601     3.12   0.012      2.84316    17.75349
         /b3 |  -13.43075   6.676098    -2.01   0.075    -28.53313    1.671633
------------------------------------------------------------------------------
  Parameter b1 taken as constant term in model & ANOVA table

. sca rss2=e(rss)

. sca list rss2
      rss2 =  .08704857

. sca df2=e(df_r)

. sca list df2
       df2 =          9
```

Overall Test

Linear Restriction Test

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

```
. test (_b[/b2]=0) (_b[/b3]=0)

 ( 1)  [b2]_cons = 0
 ( 2)  [b3]_cons = 0

       F(  2,     9) =    9.11
            Prob > F =    0.0069
```

Nonlinear Restriction Test

$$H_0: \quad \frac{\beta_2}{\beta_3} = 0 \ \& \ \beta_3 = 0$$

```
. testnl (_b[/b2]/_b[/b3]=0) (_b[/b3]=0)

  (1)  _b[/b2]/_b[/b3] = 0
  (2)  _b[/b3] = 0

               chi2(2) =      183.23
          Prob > chi2 =        0.0000
```

Test Constant Elasticity

```
. sca F_con_e=((rss1-rss2)/(df1-df2))/(rss2/df2)

. sca list F_con_e
   F_con_e =  4.6814929

. sca p_value=Fden((df1-df2),df2,F_con_e)

. sca list p_value
   p_value =  .02209142
```