```
                                                    ___  ___  ___   ___   ___(R)
                                                   /_   /  /__/  /  /__/
                                                  __/  /  /__/  /  /__/
                                                    Statistics/Data analysis
```

```
        name:  <unnamed>
         log:  H:\My Drive\Econ 640\Homework 3\Homework 3.smcl
    log type:  smcl
   opened on:  7 Nov 2025, 14:25:18
```

```
 1 .
 2 . *******************************************************************************
 3 . *Data Generating Process*
 4 . set seed 123

 5 .
 6 . *Set panel dimensions
 7 . local G = 50        // Number of clusters (states)

 8 . local T = 10        // Time periods

 9 .
10 . *Creating the Panel
11 . set obs `G'
   Number of observations (_N) was 0, now 50.

12 . gen clusters = _n

13 . expand `T'
   (450 observations created)

14 . bys clusters: gen time = _n

15 . sort clusters time

16 .
17 . *Cluster Heteroskedasticity
18 . gen sigma = runiform(0.5,2)

19 . bys clusters: replace sigma = sigma[1]
   (450 real changes made)

20 .
21 . *Generate x_it and epsilon_it
22 . gen x_it = rnormal()

23 . gen eps_it = rnormal()

24 .
25 . *Generate u_it with Heteroskedasticity
26 . gen u_it = .
   (500 missing values generated)

27 . bys clusters: replace u_it = 0 if time == 1     //u_i0 = 0
   (50 real changes made)

28 . bys clusters: replace u_it = 0.5 * u_it[_n-1] + sigma*eps_it if time > 1
   (450 real changes made)
```

```
29 .
30 . *Generate y_it
31 . gen y_it = x_it + u_it

32 .
33 . ********************************************************************************
34 .
35 . *Part A: Point Estimation*
36 .
37 . * 1. Estimation of beta
38 . reg y_it x_it   //The estimation of beta is approx. 0.9925
```

Source	SS	df	MS	Number of obs	=	500
				F(1, 498)	=	271.62
Model	464.228735	1	464.228735	Prob > F	=	0.0000
Residual	851.133252	498	1.70910291	R-squared	=	0.3529
				Adj R-squared	=	0.3516
Total	1315.36199	499	2.63599597	Root MSE	=	1.3073

y_it	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
x_it	.9924659	.060219	16.48	0.000	.8741513	1.110781
_cons	.0321421	.0585375	0.55	0.583	-.0828687	.1471529

```
39 .
40 . * 2. Estimation of beta using clusters
41 . reg y_it x_it, vce(cluster clusters)
```

Linear regression

		Number of obs	=	500
		F(1, 49)	=	327.06
		Prob > F	=	0.0000
		R-squared	=	0.3529
		Root MSE	=	1.3073

(Std. err. adjusted for **50** clusters in **clusters**)

y_it	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval]	
x_it	.9924659	.0548787	18.08	0.000	.8821831	1.102749
_cons	.0321421	.0947299	0.34	0.736	-.1582248	.222509

```
42 .
43 . * 3. Estimation of GLS and FGLS
44 . xtset clusters time
```

Panel variable: **clusters** (strongly balanced)
 Time variable: **time, 1** to **10**
        Delta: **1 unit**

```
45 . xtgls y_it x_it, p(h) c(a)
```

Cross-sectional time-series FGLS regression

Coefficients: **generalized least squares**
Panels: **heteroskedastic**
Correlation: **common AR(1) coefficient for all panels** (0.3980)

Estimated covariances	=	50	Number of obs	=	500
Estimated autocorrelations	=	1	Number of groups	=	50
Estimated coefficients	=	2	Time periods	=	10
			Wald chi2(**1**)	=	605.45
			Prob > chi2	=	0.0000

y_it	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
x_it	.9629843	.0391364	24.61	0.000	.8862784	1.03969
_cons	-.0672985	.0636043	-1.06	0.290	-.1919607	.0573637

```
46 .
47 . /*
   > The estimation of beta-hat is the same when estimating it by OLS and OLS
   > clusters and it is very close to the true beta. However, the SE is smaller when
   > estimating by OLS clusters. On the other hand, when estimating beta-hat by GLS,
   > the estimation further away from the true beta than the other two methods. But,
   > the SE is considerably smaller than the SEs of the other two methods
   > */
48 .
49 . *Part B: Monte Carlo*
50 . capture program drop montecarlo

51 . program define montecarlo, rclass //recreating the DGP in a program
    1.          clear
    2.          args regression
    3.          set obs 50
    4.          gen clusters = _n
    5.          expand 10
    6.          bys clusters: gen time = _n
    7.          sort clusters time
    8.          gen sigma = runiform(0.5,2)
    9.          bys clusters: replace sigma = sigma[1]
   10.          gen x_it = rnormal()
   11.          gen eps_it = rnormal()
   12.          gen u_it = .
   13.          bys clusters: replace u_it = 0 if time == 1
   14.          bys clusters: replace u_it = 0.5 * u_it[_n-1] + sigma*eps_it if time > 1
   15.          gen y_it = x_it + u_it
   16.          xtset clusters time
   17.          `regression'
   18.          return scalar b_x = _b[x_it]
   19.          return scalar se_x = _se[x_it]
   20. end

52 .
53 . * 1. OLS
54 . set seed 123

55 . simulate b_x = r(b_x), reps(1000): montecarlo "reg y_it x_it"

        Command: montecarlo "reg y_it x_it"
           b_x: r(b_x)

   Simulations (1,000): .........10.........20.........30.........40.........50.........60.........70.........80.........90
   > ........120.........130.........140.........150.........160.........170.........180.........190.........200.........21
   > .........240.........250.........260.........270.........280.........290.........300.........310.........320.........3
   > 0.........360.........370.........380.........390.........400.........410.........420.........430.........440.......
   > 70.........480.........490.........500.........510.........520.........530.........540.........550.........560.......
   > 590.........600.........610.........620.........630.........640.........650.........660.........670.........680......
   > .710.........720.........730.........740.........750.........760.........770.........780.........790.........800.....
   > ..830.........840.........850.........860.........870.........880.........890.........900.........910.........920....
   > ...950.........960.........970.........980.........990.........1,000 done
```

```
56 .
57 . hist b_x, title("Estimation of β OLS") xtitle("β OLS") ///
   >          xlabel(0.8(0.2)1.2) ylabel(0(2)8)
   (bin=29, start=.80443794, width=.01333467)

58 . graph save "Estimation of β OLS.gph", replace
   file Estimation of β OLS.gph saved

59 .
60 . * 2. Robust OLS
61 . set seed 123

62 . simulate b_x = r(b_x) se_x = r(se_x), reps(1000): ///
   >          montecarlo "reg y_it x_it, vce(cluster clusters)"

        Command: montecarlo "reg y_it x_it, vce(cluster clusters)"
            b_x: r(b_x)
            se_x: r(se_x)

   Simulations (1,000): .........10.........20.........30.........40.........50.........60.........70.........80.........90
   > ........120.........130.........140.........150.........160.........170.........180.........190.........200.........21
   > .........240.........250.........260.........270.........280.........290.........300.........310.........320.........3
   > 0.........360.........370.........380.........390.........400.........410.........420.........430.........440.........
   > 70.........480.........490.........500.........510.........520.........530.........540.........550.........560.......
   > 590.........600.........610.........620.........630.........640.........650.........660.........670.........680......
   > .710.........720.........730.........740.........750.........760.........770.........780.........790.........800.....
   > ..830.........840.........850.........860.........870.........880.........890.........900.........910.........920....
   > ...950.........960.........970.........980.........990.........1,000 done

63 .
64 . hist b_x, title("Estimation of β Cluster OLS") xtitle("β COLS") ///
   >          xlabel(0.8(0.2)1.2) ylabel(0(2)8)
   (bin=29, start=.80443794, width=.01333467)

65 . graph save "Estimation of β COLS.gph", replace
   file Estimation of β COLS.gph saved

66 .
67 . hist se_x, title("Distribution of clustered SEs for β") ///
   >     xtitle("SE(β)") xlabel(0(0.01)0.1)
   (bin=29, start=.03761144, width=.00198253)

68 . graph save "Clustered SEs β.gph", replace
   file Clustered SEs β.gph saved

69 .
70 . * 3. GLS/FGLS
71 . set seed 123

72 . simulate b_x = r(b_x), reps(1000): montecarlo "xtgls y_it x_it, p(h) c(a)"

        Command: montecarlo "xtgls y_it x_it, p(h) c(a)"
            b_x: r(b_x)

   Simulations (1,000): .........10.........20.........30.........40.........50.........60.........70.........80.........90
   > ........120.........130.........140.........150.........160.........170.........180.........190.........200.........21
   > .........240.........250.........260.........270.........280.........290.........300.........310.........320.........3
   > 0.........360.........370.........380.........390.........400.........410.........420.........430.........440.........
   > 70.........480.........490.........500.........510.........520.........530.........540.........550.........560.......
   > 590.........600.........610.........620.........630.........640.........650.........660.........670.........680......
   > .710.........720.........730.........740.........750.........760.........770.........780.........790.........800.....
   > ..830.........840.........850.........860.........870.........880.........890.........900.........910.........920....
   > ...950.........960.........970.........980.........990.........1,000 done
```

```
73 .
74 . hist b_x, title("Estimation of GLS") xtitle("β GLS") ///
   >         xlabel(0.8(0.1)1.2) ylabel(0(2)10)
   (bin=29, start=.87584674, width=.00906006)

75 . graph save "Estimation of β GLS.gph", replace
   file Estimation of β GLS.gph saved

76 .
77 . ********************************************************************************
78 .
79 . log close
           name:  <unnamed>
            log:  H:\My Drive\Econ 640\Homework 3\Homework 3.smcl
       log type:  smcl
      closed on:   7 Nov 2025, 14:27:26
```