Example 1 (1)

In an economy system, the central government collects the tax revenue from its population with a progressive tax system. The first ฿100,000 of family income will be exempted from tax. The next ฿400,000 of family income will be taxed at 10 percent rate. The family income beyond ฿500,000 will be taxed at 40 percent rate The household expenditure for each income level can be expressed as a function of before-tax income as follows:

Example 1 (2)

For INC <=100,000

$$EX_i = \beta_1 + \beta_2 INC_i + \varepsilon_i$$

For 100,000<INC <=500,000

$$EX_i = \beta_1 + \beta_2 x100000 + \beta_3 0.9(INC_i - 100000) + \varepsilon_i$$

For INC >500,000

$$EX_i = \beta_1 + \beta_2 100000 + \beta_3 0.9(400,000) + \beta_4 0.6(INC_i - 500000) + \varepsilon_i$$

Example 1 (3)

where i = observation index of household

EX_i = expenditure of household i

INC_i = household i's before-tax income

ε_i = independently and identically distributed error terms

$Var(\varepsilon_i) = \sigma^2$

Note that β_2, β_3 and β_4 are the marginal propensity to consume for each income bracket.

Example 1 (4)

```
=========================================================
Dependent Variable: EX
Method: Least Squares
Date: 08/03/02   Time: 13:29
Sample: 1 200
Included observations: 200
=========================================================
     Variable      CoefficientStd. Errort-Statistic  Prob.
=========================================================
         C          573.2755   32009.20   0.017910   0.9857
        INC         0.525873   0.047981   10.95995   0.0000
  D1*(INC-100000)   0.146444   0.035913   4.077698   0.0001
  D2*(INC-500000)  -0.125072   0.016844  -7.425236   0.0000
=========================================================
R-squared           0.980046    Mean dependent var 1307445.
Adjusted R-squared  0.979741    S.D. dependent var 849270.3
S.E. of regression  120881.3    Akaike info criteri26.26280
Sum squared resid   2.86E+12    Schwarz criterion  26.32877
Log likelihood     -2622.280    F-statistic        3208.867
Durbin-Watson stat  2.088838    Prob(F-statistic)  0.000000
=========================================================
```

Example 1 (5)

Printout 1.1 is based on the data from the socio-economic survey on 200 families.

Note that

$D1_i$ = 1 if before-tax income exceeds ฿100,000

0 otherwise

$D2_i$ = 1 if before-tax income exceeds ฿500,000

0 otherwise

Question: What is the BLUE of $(\beta_1, \beta_2, \beta_3, \beta_4)$? Also give the corresponding estimate for σ^2.

Example 2 (1)

It has been argued that the amount of Foreign Direct Investment from US before and after the financial liberalization can be described with the following model.

Unrestricted Model

$$\ln(USFDI_t) = \beta_1 + \beta_2 \, LIB_t IDIFF_t + \beta_3 \, (1-LIB_t) IDIFF_t + \varepsilon_t$$

Example 2 (2)

where t = quarter

$USFDI_t$ = direct investment from US in quarter t

$IDIFF_t$ = Thailand-US interest rate differential in quarter t

LIB_t = 1 for quarter t after financial liberalization

0 otherwise

ε_t = independent and identical error terms.

$Var(\varepsilon_t) = \sigma^2 > 0$ for all t

Example 2 (3)

Questions

1) estimate parameters β_1, β_2 and β_3

2) test the hypothesis that the effect of IDIFF on USFDI is the same before and after the financial liberalization.

Example 2 (4)

Equation: EQ01 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:19
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.21497	5.755404	3.338596	0.0012
LIB*IDIFF	20.13824	1.638177	12.29308	0.0000
(1-LIB)*IDIFF	30.01966	1.680465	17.86390	0.0000

R-squared	0.938611	Mean dependent var	107.7710
Adjusted R-squared	0.937441	S.D. dependent var	17.89190
S.E. of regression	4.475073	Akaike info criterion	5.862307
Sum squared resid	2102.760	Schwarz criterion	5.936811
Log likelihood	-313.5646	F-statistic	802.6971
Durbin-Watson stat	2.135384	Prob(F-statistic)	0.000000

Example 2 (5)

$$H_0 : \beta_2 = \beta_3$$

$$H_1 : \beta_2 \neq \beta_3$$

Equation: EQ01 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Wald Test:
Equation: EQ01

Null Hypothesis: C(2)=C(3)

F-statistic	1529.414	Probability	0.000000
Chi-square	1529.414	Probability	0.000000

Example 2 (6)

Equation: EQ02 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:34
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	58.51648	22.25257	2.629650	0.0098
IDIFF	14.21837	6.405113	2.219846	0.0286

R-squared	0.044423	Mean dependent var	107.7710
Adjusted R-squared	0.035408	S.D. dependent var	17.89190
S.E. of regression	17.57228	Akaike info criterion	8.588868
Sum squared resid	32731.23	Schwarz criterion	8.638537
Log likelihood	-461.7989	F-statistic	4.927718
Durbin-Watson stat	0.235521	Prob(F-statistic)	0.028559

Example 2 (7)

<u>Restricted Model</u>

$$\ln(USFDI_t) = \beta_1 + \beta_2 \; IDIFF_t + \varepsilon_t$$

The same model applies to both before and after financial liberalization

$$F_{cal} = \frac{(32731.23 - 2120.76)/1}{2120.76/(108-3)}$$

$$= 1515.5413$$

==> reject H_0

Example 3 (1)

Based on data in Example 2

<u>Unrestricted Model</u>

$$\ln(USFDI_t) = \beta_1 LIB_t + \beta_2(1-LIB_t) + \beta_3 LIB_t IDIFF_t + \beta_4 (1-LIB_t) IDIFF_t + \varepsilon_t$$

$$H_0 : \beta_1 = \beta_2, \beta_3 = \beta_4$$

$$H_1 : \beta_1 \neq \beta_2, \beta_3 \neq \beta_4$$

Example 3 (2)

Equation: EQ03 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:37
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIB	23.69065	8.480797	2.793446	0.0062
1-LIB	15.36110	7.869648	1.951943	0.0536
LIB*IDIFF	18.87231	2.405786	7.844550	0.0000
(1-LIB)*IDIFF	31.13926	2.292445	13.58342	0.0000

R-squared	0.938915	Mean dependent var	107.7710
Adjusted R-squared	0.937153	S.D. dependent var	17.89190
S.E. of regression	4.485373	Akaike info criterion	5.875854
Sum squared resid	2092.332	Schwarz criterion	5.975192
Log likelihood	-313.2961	Durbin-Watson stat	2.100222

Example 3 (3)

Equation: EQ03 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Wald Test:
Equation: EQ03

Null Hypothesis: C(1)=C(2)
C(3)=C(4)

F-statistic	761.4581	Probability	0.000000
Chi-square	1522.916	Probability	0.000000

Example 3 (4)

Do 2-run F-test

$$F_{cal} = \frac{(32731.23 - 2092.332)/2}{2092.332/(108-4)}$$

$$= 761.458$$

same as F_{cal} as single-run F-test

==> reject H_0

Example 3 (5)

Chow Breakpoint test

Equation: EQ02 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Chow Breakpoint Test: 1998:01

F-statistic	761.4581	Probability	0.000000
Log likelihood ratio	297.0055	Probability	0.000000

Example 4 (1)

Based on data of Example 2 but different intercept

<u>Unrestricted Model</u>

$$\ln(USFDI)_t = \beta_1 LIB_t + \beta_2(1\text{-}LIB_t) + \beta_3\, IDIFF_t + \varepsilon_t$$

$$H_0 : \beta_1 = \beta_2$$

$$H_1 : \beta_1 \neq \beta_2$$

Example 4 (2)

Equation: EQ04 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:40
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIB	1.092674	6.212078	0.175895	0.8607
1-LIB	35.34685	6.044902	5.847383	0.0000
IDIFF	25.30154	1.756580	14.40386	0.0000

R-squared	0.930912	Mean dependent var	107.7710
Adjusted R-squared	0.929596	S.D. dependent var	17.89190
S.E. of regression	4.747406	Akaike info criterion	5.980458
Sum squared resid	2366.476	Schwarz criterion	6.054962
Log likelihood	-319.9448	Durbin-Watson stat	2.257681

Example 4 (3)

Equation: EQ04 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Wald Test:
Equation: EQ04

Null Hypothesis: C(1)=C(2)

F-statistic	1347.278	Probability	0.000000
Chi-square	1347.278	Probability	0.000000

Example 4 (4)

Do 2-run F-test

$$F_{cal} = \frac{(32731.23 - 2366.476)/1}{2366.476/(108-3)}$$

$$= 1347.277$$

same as F_{cal} as single-run F-test
==> reject H_0

Example 5 (1)

Example 2 in Incremental setting

<u>Unrestricted Model</u>

$$\ln(USFDI)_t = \beta_1 + \beta_2\, IDIFF_t + \delta\, LIB_t{*}IDIFF_t + \varepsilon_t$$

$$H_0 : \delta = 0$$

$$H_1 : \delta \neq 0$$

t-stat ==>reject H_0

Example 5 (2)

Equation: EQ05 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:56
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.21497	5.755404	3.338596	0.0012
IDIFF	30.01966	1.680465	17.86390	0.0000
LIB*IDIFF	-9.881420	0.252672	-39.10772	0.0000

R-squared	0.938611	Mean dependent var	107.7710
Adjusted R-squared	0.937441	S.D. dependent var	17.89190
S.E. of regression	4.475073	Akaike info criterion	5.862307
Sum squared resid	2102.760	Schwarz criterion	5.936811
Log likelihood	-313.5646	F-statistic	802.6971
Durbin-Watson stat	2.135384	Prob(F-statistic)	0.000000

Example 6 (1)

Example 3 in Incremental setting
==> same SSR

<u>Unrestricted Model</u>

$$\ln(USFDI)_t = \beta_1 + \delta_1\, LIB_t + \beta_2\, IDIFF_t + \delta_2\, LIB_t{*}IDIFF_t + \varepsilon_t$$

$$H_0 : \delta_1 = 0, \delta_2 = 0$$

$$H_1 : \delta_1 \neq 0, \delta_2 \neq 0$$

==>reject H_0

Example 6 (2)

Equation: EQ06 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:58
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.36110	7.869648	1.951943	0.0536
LIB	8.329547	11.56958	0.719952	0.4732
IDIFF	31.13926	2.292445	13.58342	0.0000
LIB*IDIFF	-12.26695	3.323118	-3.691397	0.0004

R-squared	0.938915	Mean dependent var	107.7710
Adjusted R-squared	0.937153	S.D. dependent var	17.89190
S.E. of regression	4.485373	Akaike info criterion	5.875854
Sum squared resid	2092.332	Schwarz criterion	5.975192
Log likelihood	-313.2961	F-statistic	532.8494

Example 6 (3)

Equation: EQ06 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Wald Test:
Equation: EQ06

Null Hypothesis: C(2)=0
C(4)=0

F-statistic	761.4581	Probability	0.000000
Chi-square	1522.916	Probability	0.000000

Example 6 (4)

Do 2-run F-test

$$F_{cal} = \frac{(32731.23 - 2092.332)/2}{2092.332/(108-4)}$$

$$= 761.458$$

same as F_{cal} as single-run F-test
==> reject H_0

Example 7 (1)

Example 4 in Incremental setting
==> same SSR
<u>Model U</u>

$$\ln(USFDI)_t = \beta_1 + \delta_1 \, LIB_t + \beta_2 \, IDIFF_t + \varepsilon_t$$

$$H_0 : \delta_1 = 0$$

$$H_1 : \delta_1 \neq 0$$

t-stat==>reject H_0

Example 7 (2)

Equation: EQ07 Workfile: DUMMY2

View | Procs | Objects | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: USFDI
Method: Least Squares
Date: 08/29/02 Time: 01:59
Sample: 1993:01 2001:12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	35.34685	6.044902	5.847383	0.0000
LIB	-34.25418	0.933222	-36.70528	0.0000
IDIFF	25.30154	1.756580	14.40386	0.0000

R-squared	0.930912	Mean dependent var	107.7710
Adjusted R-squared	0.929596	S.D. dependent var	17.89190
S.E. of regression	4.747406	Akaike info criterion	5.980458
Sum squared resid	2366.476	Schwarz criterion	6.054962
Log likelihood	-319.9448	F-statistic	707.3954
Durbin-Watson stat	2.257681	Prob(F-statistic)	0.000000