Γεννητικότητα και φοροαπαλλαγές
(10.4, 11.6, 11.8, 18.5)

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + u_t$$

$$\Delta\Pi\Pi_t = \begin{cases} 1 \text{ για } t \in [41,45] \\ 0 \text{ διαφορετικά} \end{cases}$$

$$Χάπι_t = \begin{cases} 1 \text{ για } t \geq 63 \\ 0 \text{ για } t < 63 \end{cases}$$

$y_t = Γεννητικότητα$
$x_{1t} = Φόρο\text{-}απαλλαγές$
$x_{2t} = 2^{ος}\ Παγκόσμιος\ Πόλεμος$
$x_{3t} = Χάπι$

Dependent Variable: FERTILITY_RATE
Method: Least Squares
Sample: 1913-1984 (71)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	98.68	3.21	30.76	0.00
TAX_EXEMPTION	0.08	0.03	2.78	0.01
WORLD_WAR2	-24.24	7.46	-3.25	0.00
PILL	-31.59	4.08	-7.74	0.00

R-squared	0.47	Mean dependent var	95.63
Adjusted R-squared	0.45	S.D. dependent var	19.80
S.E. of regression	14.69	Akaike info criterion	8.27
Sum squared resid	14664.27	Schwarz criterion	8.39
Log likelihood	-293.56	Hannan-Quinn criter.	8.32
F-statistic	20.38	Durbin-Watson stat	0.18
Prob(F-statistic)	0.00		

Command Window:
LS FERTILITY_RATE C TAX_EXEMPTION WORLD_WAR2 PILL

Dependent Variable: FERTILITY_RATE
Method: Least Squares
Sample (adjusted): 1915-1984 (70)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	95.87	3.28	29.21	0.00
TAX_EXEMPTION	0.073	0.13	0.58	0.56
TAX_EXEMPTION_1	-0.0058	0.16	-0.04	0.97
TAX_EXEMPTION_2	0.034	0.13	0.27	0.79
WORLD_WAR2	-22.13	10.73	-2.06	0.04
PILL	-31.30	3.98	-7.86	0.00

R-squared	0.50	Mean dependent var	94.77
Adjusted R-squared	0.46	S.D. dependent var	19.41
S.E. of regression	14.27	Akaike info criterion	8.24
Sum squared resid	13032.64	Schwarz criterion	8.43
Log likelihood	-282.26	Hannan-Quinn criter.	8.31
F-statistic	12.73	Durbin-Watson stat	0.19
Prob(F-statistic)	0.00		

Command Window:

LS FERTILITY_RATE C TAX_EXEMPTION TAX_EXEMPTION_1 TAX_EXEMPTION_2 WORLD_WAR2 PILL

- H_0: $\beta_1 = \beta_2 = \beta_3 = 0$: F-test: p =0.012

  $\beta_1, \beta_2, \beta_3$ μοιάζουν ασήμαντες

?

- $\widehat{\beta_1} + \widehat{\beta_2} + \widehat{\beta_3} \cong 0.101$

Redundant Variables Test

Redundant Variables:

TAX_EXEMPTION TAX_EXEMPTION_1 TAX_EXEMPTION_2

	Value	df	Probability
F-statistic	3.97	(3, 64)	0.012
Likelihood ratio	11.95	3.00	0.008

Command Window:

```
LS FERTILITY_RATE C TAX_EXEMPTION TAX_EXEMPTION_1 TAX_EXEMPTION_2 WORLD_WAR2 PILL
testdrop TAX_EXEMPTION TAX_EXEMPTION_1 TAX_EXEMPTION_2
```

Για να εκτιμήσουμε την τυπική απόκλιση του μακροπρόθεσμου αποτελέσματος ($\beta_1 + \beta_2 + \beta_3$) παλινδρομούμε:

$$y_t = \beta_0 + (\beta_1+\beta_2+\beta_3)x_{1t} + \beta_2 (x_{1t-1} - x_{1t}) + \beta_3 (x_{1t-2} - x_{1t}) + \beta_4 x_{2t} + \beta_5 x_{3t}+u_t$$

$$\hat{\sigma}_{\hat{\beta}_1+\hat{\beta}_2+\hat{\beta}_3} = .03 \Rightarrow t_{\hat{\beta}_1+\hat{\beta}_2+\hat{\beta}_3} = 3.37 \Rightarrow$$

Μακροπρόθεσμο αποτέλεσμα σημαντικό

Dependent Variable: FERTILITY_RATE
Method: Least Squares
Sample (adjusted): 1916-1984 (69)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	95.87	3.28	29.21	0.00
TAX_EXEMPTION	0.10	0.03	3.38	0.00
TAX_EXEMPTION_1-TAX_EXEMPTION	-0.01	0.16	-0.04	0.97
TAX_EXEMPTION_2-TAX_EXEMPTION	0.03	0.13	0.27	0.79
WORLD_WAR2	-22.13	10.73	-2.06	0.04
PILL	-31.30	3.98	-7.86	0.00

R-squared	0.50	Mean dependent var	94.77
Adjusted R-squared	0.46	S.D. dependent var	19.41
S.E. of regression	14.27	Akaike info criterion	8.24
Sum squared resid	13032.64	Schwarz criterion	8.43
Log likelihood	-282.26	Hannan-Quinn criter.	8.31
F-statistic	12.73	Durbin-Watson stat	0.19
Prob(F-statistic)	0.00		

Command Window:

```
LS FERTILITY_RATE C TAX_EXEMPTION (TAX_EXEMPTION_1-TAX_EXEMPTION) (TAX_EXEMPTION_2-TAX_EXEMPTION)
WORLD_WAR2 PILL
```

Η αυτοσυσχέτιση ως ένδειξη έλλειψης στασιμότητας

Dependent Variable: FERTILITY_RATE
Method: Least Squares
Sample (adjusted): 1914-1984

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	1.30	2.55	0.51	0.61
FERTILITY_RATE_1	0.98	0.03	37.60	0.00

R-squared	0.95	Mean dependent var	95.22
Adjusted R-squared	0.95	S.D. dependent var	19.64
S.E. of regression	4.27	Akaike info criterion	5.77
Sum squared resid	1256.22	Schwarz criterion	5.83
Log likelihood	-202.74	Hannan-Quinn criter.	5.79
F-statistic	1413.53	Durbin-Watson stat	1.40
Prob(F-statistic)	0.00		

Command Window:
LS FERTILITY_RATE C FERTILITY_RATE_1

Dependent Variable: TAX_EXEMPTION
Method: Least Squares
Sample (adjusted): 1914-1984

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	6.43	3.81	1.69	0.10
TAX_EXEMPTION_1	0.95	0.03	29.93	0.00

R-squared	0.93	Mean dependent var	101.82
Adjusted R-squared	0.93	S.D. dependent var	65.23
S.E. of regression	17.57	Akaike info criterion	8.60
Sum squared resid	21303.12	Schwarz criterion	8.66
Log likelihood	-303.23	Hannan-Quinn criter.	8.62
F-statistic	895.85	Durbin-Watson stat	1.51
Prob(F-statistic)	0.00		

Command Window:
LS TAX_EXEMPTION C TAX_EXEMPTION_1

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_{1t} + u_t$$

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_{1t} + \beta_2 \Delta x_{1t-1} + \beta_3 \Delta x_{1t-2} + u_t$$

Dependent Variable: D(FERTILITY_RATE)

Method: Least Squares

Sample (adjusted):1914-1984 (71)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	-0.78	0.50	-1.56	0.12
D(TAX_EXEMPTION)	-0.04	0.03	-1.50	0.14

R-squared	0.03	Mean dependent var	-0.84
Adjusted R-squared	0.02	S.D. dependent var	4.26
S.E. of regression	4.22	Akaike info criterion	5.75
Sum squared resid	1229.26	Schwarz criterion	5.81
Log likelihood	-201.97	Hannan-Quinn criter.	5.77
F-statistic	2.26	Durbin-Watson stat	1.36
Prob(F-statistic)	0.14		

Command Window:

LS D(FERTILITY_RATE) C D(TAX_EXEMPTION)

Dependent Variable: D(FERTILITY_RATE)
Method: Least Squares
Sample (adjusted): 1916-1984 (69)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	-0.96	0.47	-2.06	0.04
D(TAX_EXEMPTION)	-0.04	0.03	-1.35	0.18
D(TAX_EXEMPTION_1)	-0.01	0.03	-0.51	0.61
D(TAX_EXEMPTION_2)	0.11	0.03	4.09	0.00

R-squared	0.23	Mean dependent var	-0.86
Adjusted R-squared	0.20	S.D. dependent var	4.31
S.E. of regression	3.86	Akaike info criterion	5.60
Sum squared resid	968.20	Schwarz criterion	5.72
Log likelihood	-189.03	Hannan-Quinn criter.	5.65
F-statistic	6.56	Durbin-Watson stat	1.41
Prob(F-statistic)	0.00		

Command Window:

```
LS D(FERTILITY_RATE) C D(TAX_EXEMPTION) D(TAX_EXEMPTION_1) D(TAX_EXEMPTION_2)
```

Dependent Variable: D(FERTILITY_RATE)
Method: Least Squares
Sample (adjusted): 1916-1984

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
C	-0.70	0.45	-1.55	0.13
D(TAX_EXEMPTION)	-0.05	0.03	-1.77	0.08
D(TAX_EXEMPTION_1)	0.00	0.03	0.08	0.94
D(TAX_EXEMPTION_2)	0.11	0.03	4.11	0.00
D(FERTILITY_RATE_1)	0.30	0.11	2.84	0.01

R-squared	0.32	Mean dependent var	-0.86
Adjusted R-squared	0.28	S.D. dependent var	4.31
S.E. of regression	3.67	Akaike info criterion	5.51
Sum squared resid	860.17	Schwarz criterion	5.67
Log likelihood	-184.95	Hannan-Quinn criter.	5.57
F-statistic	7.46	Durbin-Watson stat	1.94
Prob(F-statistic)	0.00		

Command Window:

```
LS D(FERTILITY_RATE) C D(TAX_EXEMPTION) D(TAX_EXEMPTION_1) D(TAX_EXEMPTION_2) D(FERTILITY_RATE_1)
```

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_{1t} + \beta_2 \Delta x_{1t-1} + \beta_3 \Delta x_{1t-2} + \beta_4 \Delta y_{t-1} + u_t$$

t-stat (H0: β4=0) = 2.84 =>

προβλέψεις
μικρής αυτοσυσχέτισης,
συμπεράσματα είναι παρόμοια

δυναμικά ελλιπές=>

με β4 καλύτερο για
δεδομένου

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 t + u_t$$

Dependent Variable: FERTILITY_RATE
Method: Least Squares
Sample: 1913:01-1984:01

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
C	109.02	3.43	31.83	0.00
TAX_EXEMPTION	0.19	0.03	5.39	0.00
@TREND	-0.91	0.11	-8.31	0.00

R-squared	0.50	Mean dependent var	95.63
Adjusted R-squared	0.49	S.D. dependent var	19.80
S.E. of regression	14.20	Akaike info criterion	8.19
Sum squared resid	13918.81	Schwarz criterion	8.28
Log likelihood	-291.68	Hannan-Quinn criter.	8.22
F-statistic	34.53	Durbin-Watson stat	0.17
Prob(F-statistic)	0.00		

Command Window:
LS FERTILITY_RATE C TAX_EXEMPTION @TREND

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_{1t} + u_t$$

Dependent Variable: D(FERTILITY_RATE)
Method: Least Squares
Sample (adjusted): 2 72

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	-0.78	0.50	-1.56	0.12
D(TAX_EXEMPTION)	-0.04	0.03	-1.50	0.14

R-squared	0.03	Mean dependent var	-0.84
Adjusted R-squared	0.02	S.D. dependent var	4.26
S.E. of regression	4.22	Akaike info criterion	5.75
Sum squared resid	1229.26	Schwarz criterion	5.81
Log likelihood	-201.97	Hannan-Quinn criter.	5.77
F-statistic	2.26	Durbin-Watson stat	1.36
Prob(F-statistic)	0.14		

Command Window:
LS D(FERTILITY_RATE) C D(TAX_EXEMPTION)

Γιατί τόσο διαφορετικά αποτελέσματα;

ADF (1 υστέρηση και τάση) Γεννητικότητα *y(t)* => I(1)

ADF (1 υστέρηση και τάση) Απαλλαγές *x1(t)* => I(1)

Μήπως υπάρχει σχέση συνολοκλήρωσης;

ADF: *y(t)*

Null Hypothesis: UHAT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.42	0.37
Test critical values:	1% level	-4.09	
	5% level	-3.48	
	10% level	-3.17	

```
Command Window:
LS FERTILITY_RATE C TAX_EXEMPTION @TREND
series uhat=resid
uroot(adf,const,lag=1) uhat
```

Στα κατάλοιπα από την πρώτη παλινδρόμηση

ADF με 1 υστέρηση => tstat = -2.42

(Κριτική Τιμή –3.50 σε Επίπεδο Σημαντικότητας 5%)

Δεν μπορούμε να απορρίψουμε έλλειψη συνολοκλήρωσης

Εξήγηση προηγούμενων αποτελεσμάτων;

Σχέση επιπέδου: φαινομενική συσχέτιση

Σχέση διαφορών: χρειάζεται περισσότερες υστερήσεις