KSE

Kyiv
School of
Economics

Special types of regressions

Ass. Prof. Andriy Stavytskyy

Agenda

- Dummy Variables
- Trend extraction
- Trend Extraction in EViews
- Smoothing methods
- Smoothing methods in EViews

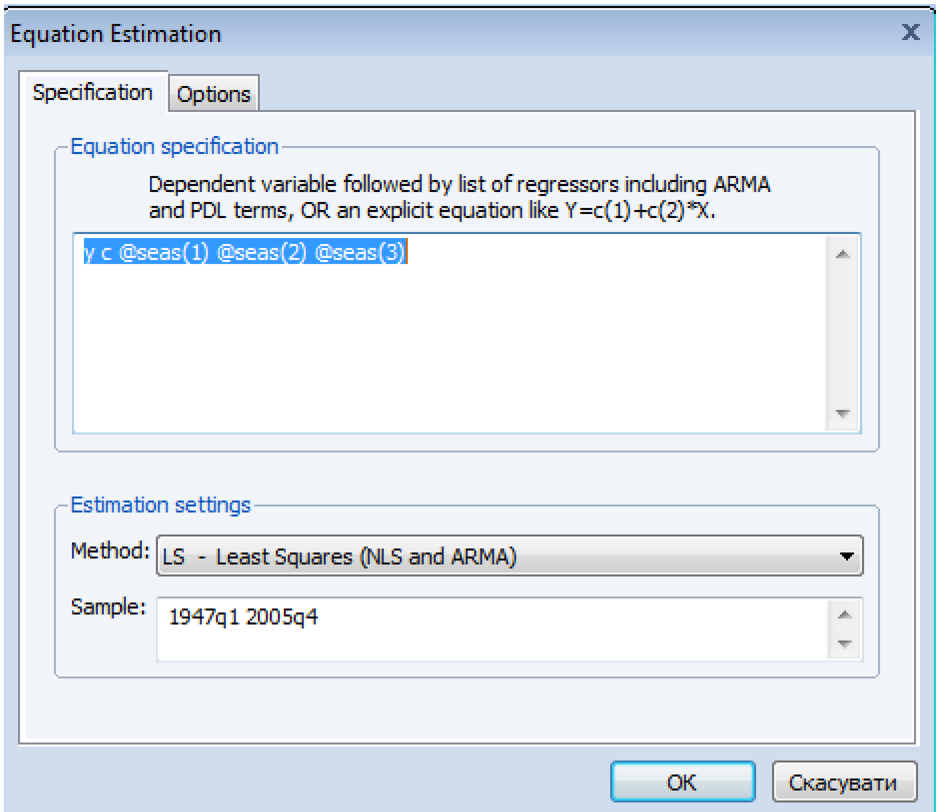
Dummy Variables

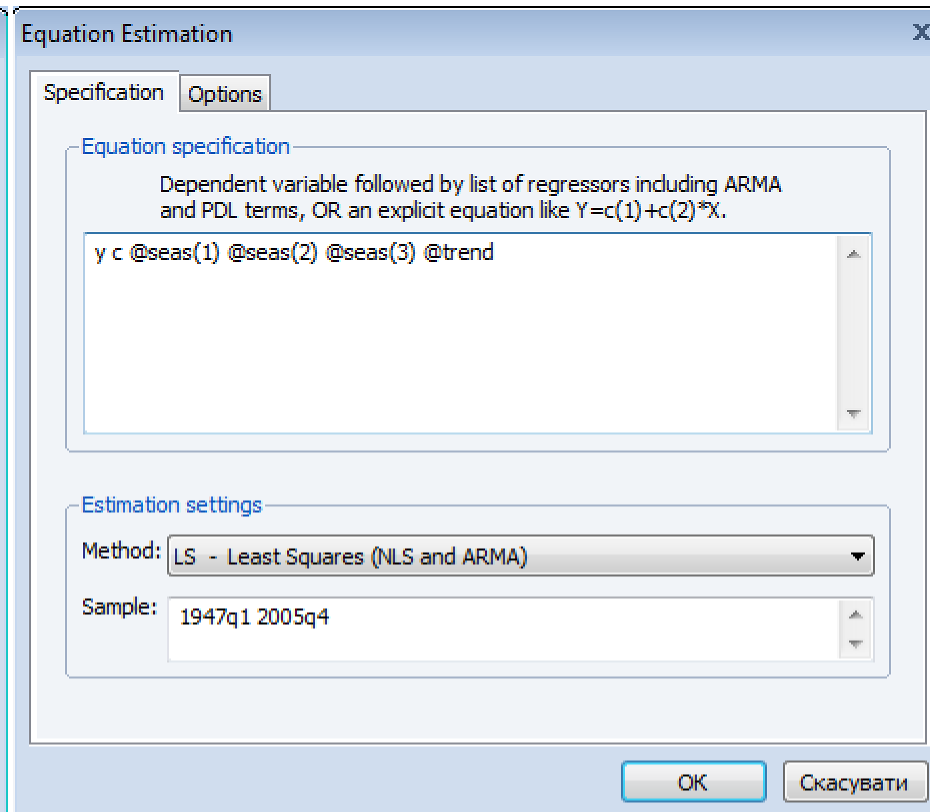
Special functions

- @trend
- @seas(i)

$$y_t = \beta_0 + \beta_1 q_1 + \beta_2 q_2 + \beta_3 q_3 + \varepsilon_t$$

$$y_t = \beta_0 + \beta_1 q_1 + \beta_2 q_2 + \beta_3 q_3 + \beta_4 t + \varepsilon_t$$





Dummy variables

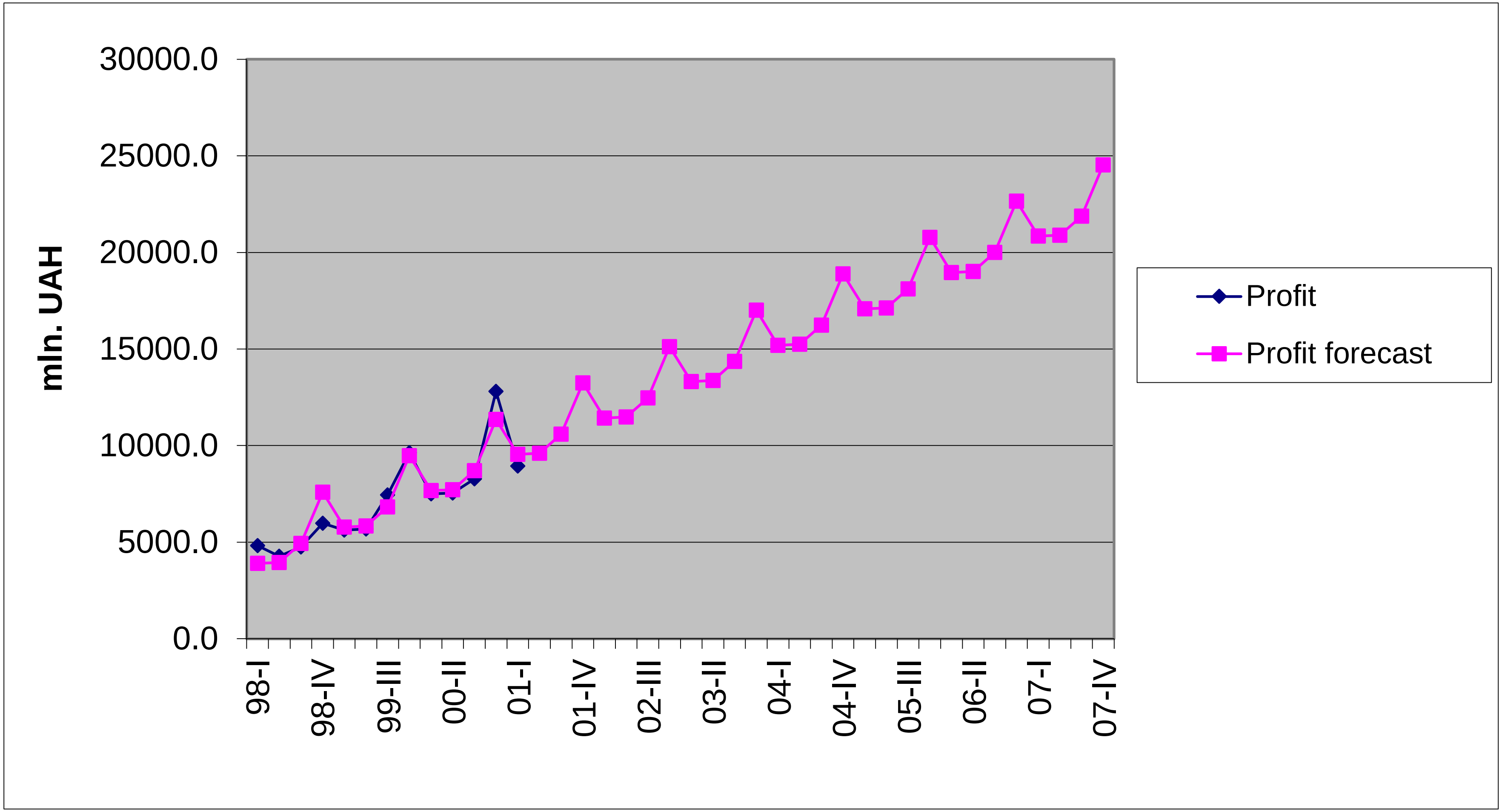
$$q_1 = (1, 0, 0, 0, 1, 0, 0, 0, 1, 0, \ldots)'$$

$$q_2 = (0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, \ldots)'$$

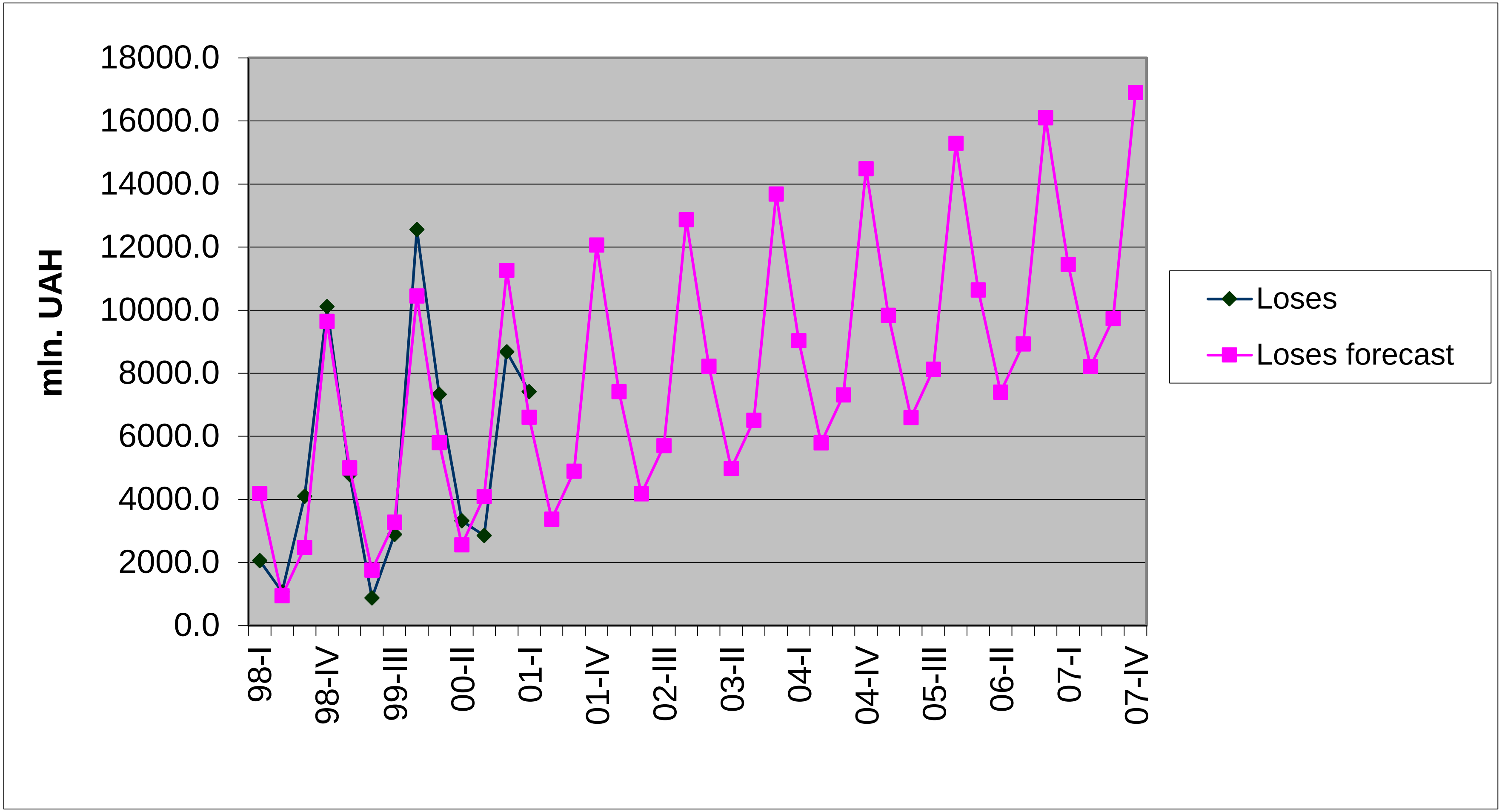
$$q_3 = (0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, \ldots)'$$

1 quarter	$y_t = \beta_0 + \beta_1 + \varepsilon_t$
2 quarter	$y_t = \beta_0 + \beta_2 + \varepsilon_t$
3 quarter	$y_t = \beta_0 + \beta_3 + \varepsilon_t$
4 quarter	$y_t = \beta_0 + \varepsilon_t$

Example – 1


30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
mln. UAH
98-I
98-IV
99-III
00-II
01-I
01-IV
02-III
03-II
04-I
04-IV
05-III
06-II
07-I
07-IV
Profit
Profit forecast

Example – 2


mln. UAH
18000.0
16000.0
14000.0
12000.0
10000.0
8000.0
6000.0
4000.0
2000.0
0.0
98-I
98-IV
99-III
00-II
01-I
01-IV
02-III
03-II
04-I
04-IV
05-III
06-II
07-I
07-IV
Loses
Loses forecast

Dummy application

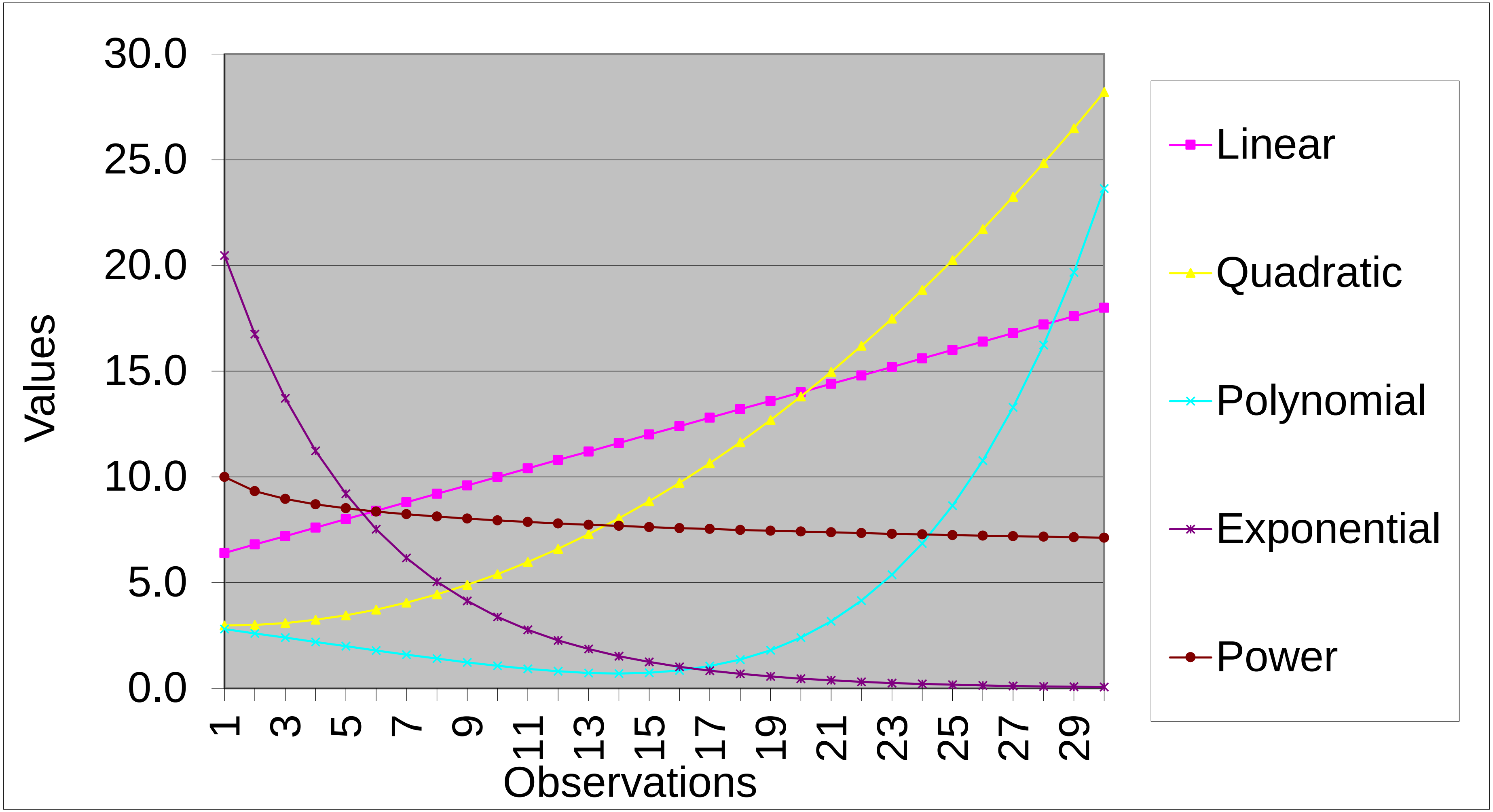
- Seasonality
- Crisis description
- Quality characteristics

Trend extraction

Trend functions

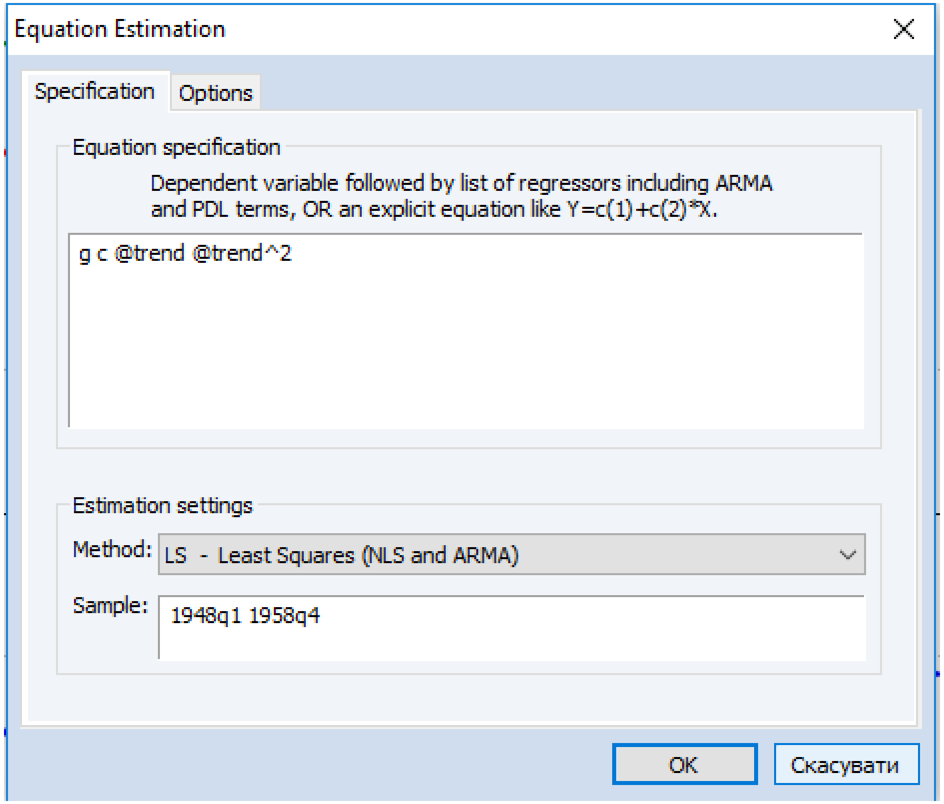
Linear	$f(t) = a_0 + a_1 t$
Quadratic	$f(t) = a_0 + a_1 t + a_2 t^2$
Polynomial	$f(t) = a_0 + a_1 t + a_2 t^2 + \ldots + a_n t^n$
Exponential	$f(t) = a_0 e^{a_1 t}$
Power	$f(t) = a_0 t^{a_1}$

Example

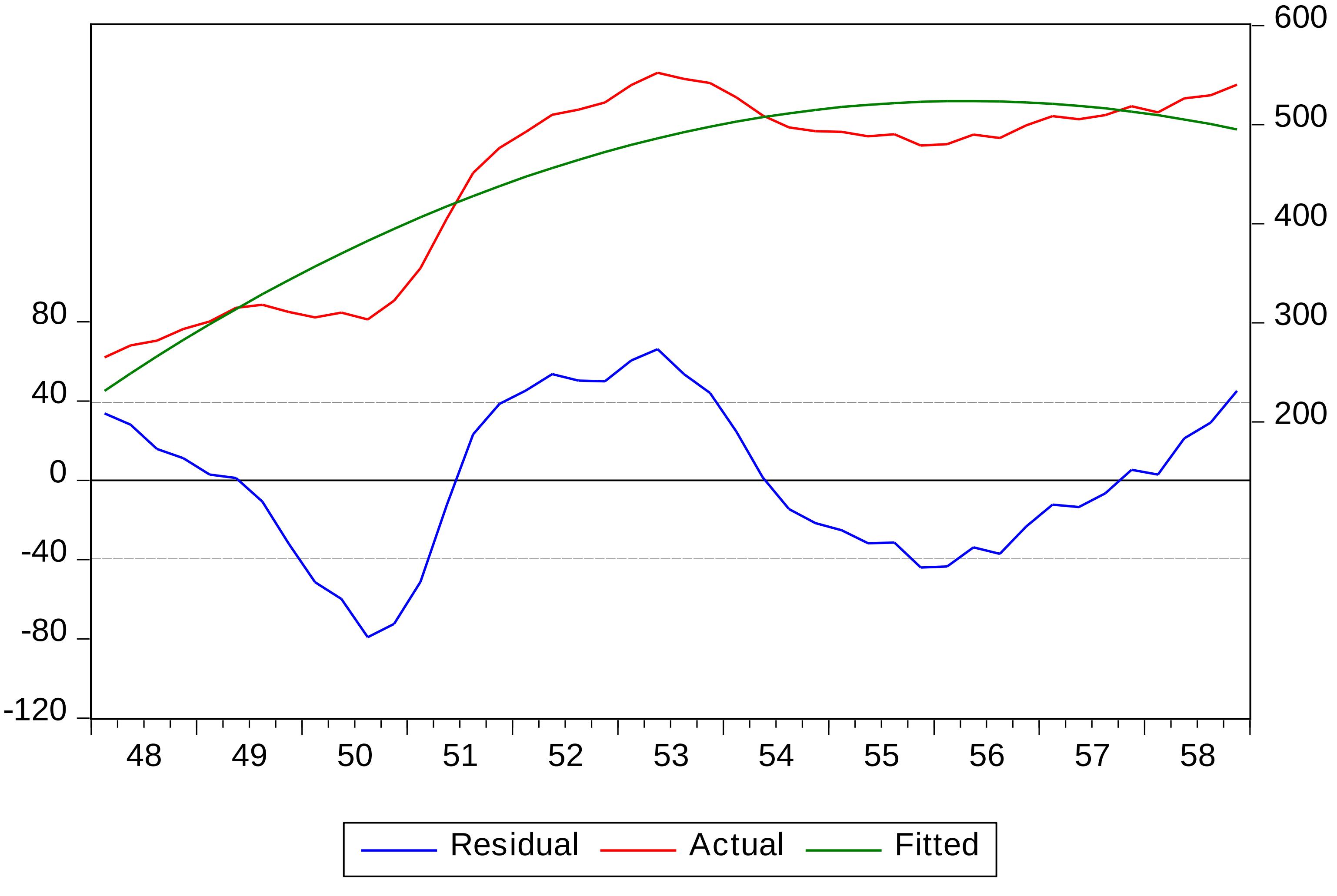

30.0
25.0
20.0
15.0
10.0
5.0
0.0
Values
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
Observations
Linear
Quadratic
Polynomial
Exponential
Power

Trend Extraction in EViews

Quadratic trend example – 1



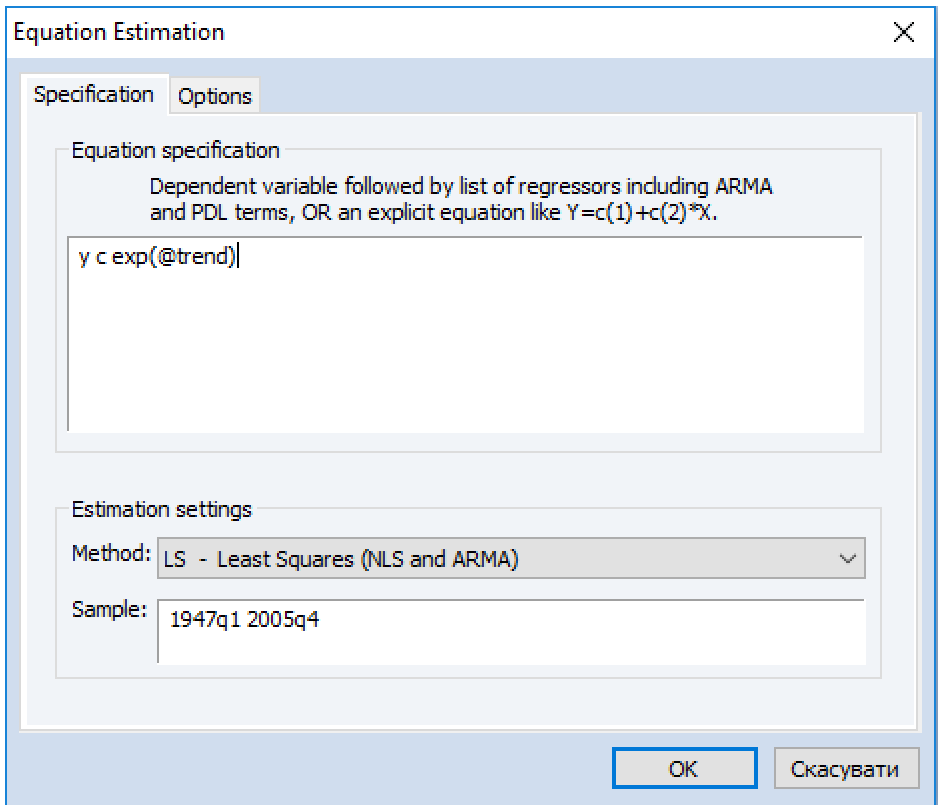
Quadratic trend example – 2



KSE

Exponential trend example

$$f(t) = a_0 + a_1 e^t$$



Smoothing Methods

Exponential smoothing

- Exponential smoothing is commonly applied to smoothen data, acting as low-pass filters to remove high frequency noise.
- New time series is build by the rule:

$$S_1 = y_1,$$

$$S_t = \alpha y_t + (1-\alpha)S_{t-1}, \quad 0 < \alpha < 1.$$

- A constant can be found by different ways.

$$\alpha = \frac{2}{T+1}.$$

Forecast

- The forecast is equal to the last value of smoothed series:

$$\hat{y}_{T+p} = S_T, \qquad p = 1, \ 2, \ \ldots.$$

Example – 1

Export of goods and services in Ukraine
6000
5500
5000
4500
4000
3500
3000
mln. USD
1--95
3--95
1--96
3--96
1--97
3--97
1--98
3--98
1--99
3-- 99
1--00
3-- 00
Quarters

Double exponential smoothing

- This method uses exponential smoothing twice with the same coefficient.

$$S_t^{/} = \alpha y_t + (1-\alpha) S_{t-1}^{/},$$

$$S_t^{//} = \alpha S_t^{/} + (1-\alpha) S_{t-1}^{//}, \quad 0 < \alpha < 1.$$

- Forecast

$$\hat{y}_{T+p} = S_T^{//}, \qquad p = 1, \quad 2, \quad \ldots .$$

Example

Export of goods and services in Ukraine
6000
5500
5000
4500
4000
3500
3000
mln. USD
1--95
3--95
1--96
3--96
1--97
3--97
1--98
3--98
1--99
3-- 99
1--00
3-- 00
quarters

Triple exponential smoothing

- Uses exponential smoothing 3 times with the same constant.

$$S_t^{/} = \alpha y_t + (1-\alpha)S_{t-1}^{/},$$

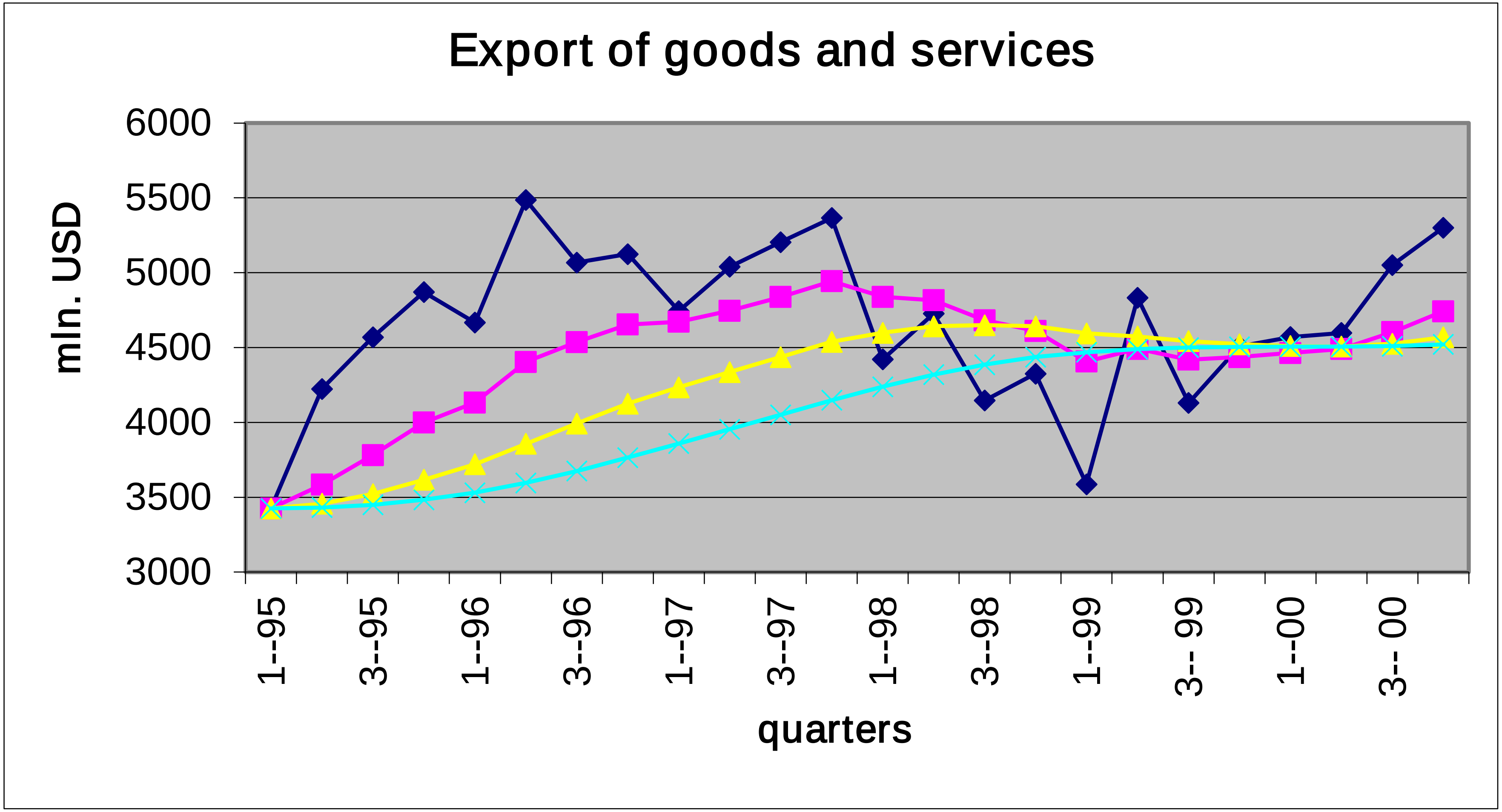
$$S_t^{//} = \alpha S_t^{/} + (1-\alpha)S_{t-1}^{//},$$

$$S_t^{///} = \alpha S_t^{//} + (1-\alpha)S_{t-1}^{///}, \quad 0 < \alpha < 1.$$

- Forecast

$$\hat{y}_{T+p} = S_T^{///}, \qquad p = 1, \quad 2, \quad \ldots.$$

Example


Export of goods and services
mln. USD
6000
5500
5000
4500
4000
3500
3000
1--95
3--95
1--96
3--96
1--97
3--97
1--98
3--98
1--99
3-- 99
1--00
3-- 00
quarters

Non-seasonal Holt-Winters smoothing

- This model extract trend as a complimentary series:

$$S_2^{/} = y_2, \quad S_2^{//} = y_2 - y_1,$$

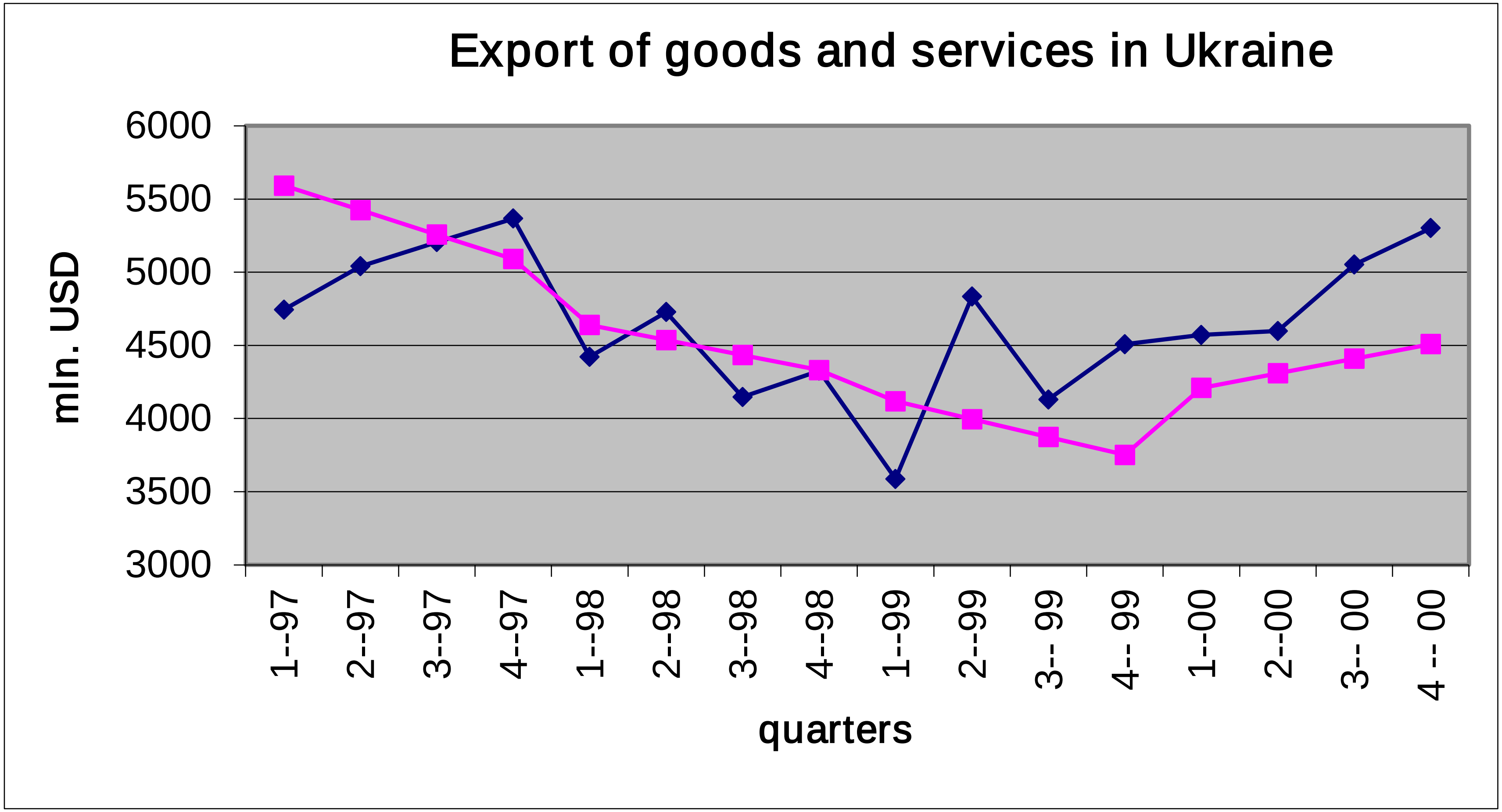
$$S_t^{/} = \alpha y_t + (1-\alpha)\left(S_{t-1}^{/} + S_{t-1}^{//}\right), \quad 0 < \alpha < 1,$$

$$S_t^{//} = \beta\left(S_t^{/} - S_{t-1}^{/}\right) + (1-\beta) S_{t-1}^{//}, \quad 0 < \beta < 1.$$

- Forecast:

$$\hat{y}_{T+p} = S_T^{/} + p S_T^{//}, \qquad p = 1, \quad 2, \quad \ldots.$$

Example



Export of goods and services in Ukraine
6000
5500
5000
4500
4000
3500
3000
mln. USD
1--97
2--97
3--97
4--97
1--98
2--98
3--98
4--98
1--99
2--99
3-- 99
4-- 99
1--00
2--00
3-- 00
4 -- 00
quarters

Multiplicative Winters smoothing

3 series are analysed:

- a_t - smoothed series,
- b_t - trend component,
- c_t - seasonality index

$$a_t = \alpha\left(\frac{y_t}{c_{t-s}}\right) + (1-\alpha)(a_{t-1} + b_{t-1}),$$

$$b_t = \beta(a_t - a_{t-1}) + (1-\beta)b_{t-1},$$

$$c_t = \gamma\left(\frac{y_t}{a_t}\right) + (1-\gamma)c_{t-s}, \qquad t = \overline{2s+1, T}.$$

S – number of season cycles

Forecast

$$\hat{y}_{T+p} = \left(a_T + p b_T\right) c_{T-s+p},$$

$$p = 1, \quad 2, \quad \ldots, \quad s,$$

$$\hat{y}_{T+p} = \left(a_T + p b_T\right) c_{T-2s+p},$$

$$p = s+1, \quad s+2, \quad \ldots, \quad 2s.$$

Hodrick-Prescott Filter

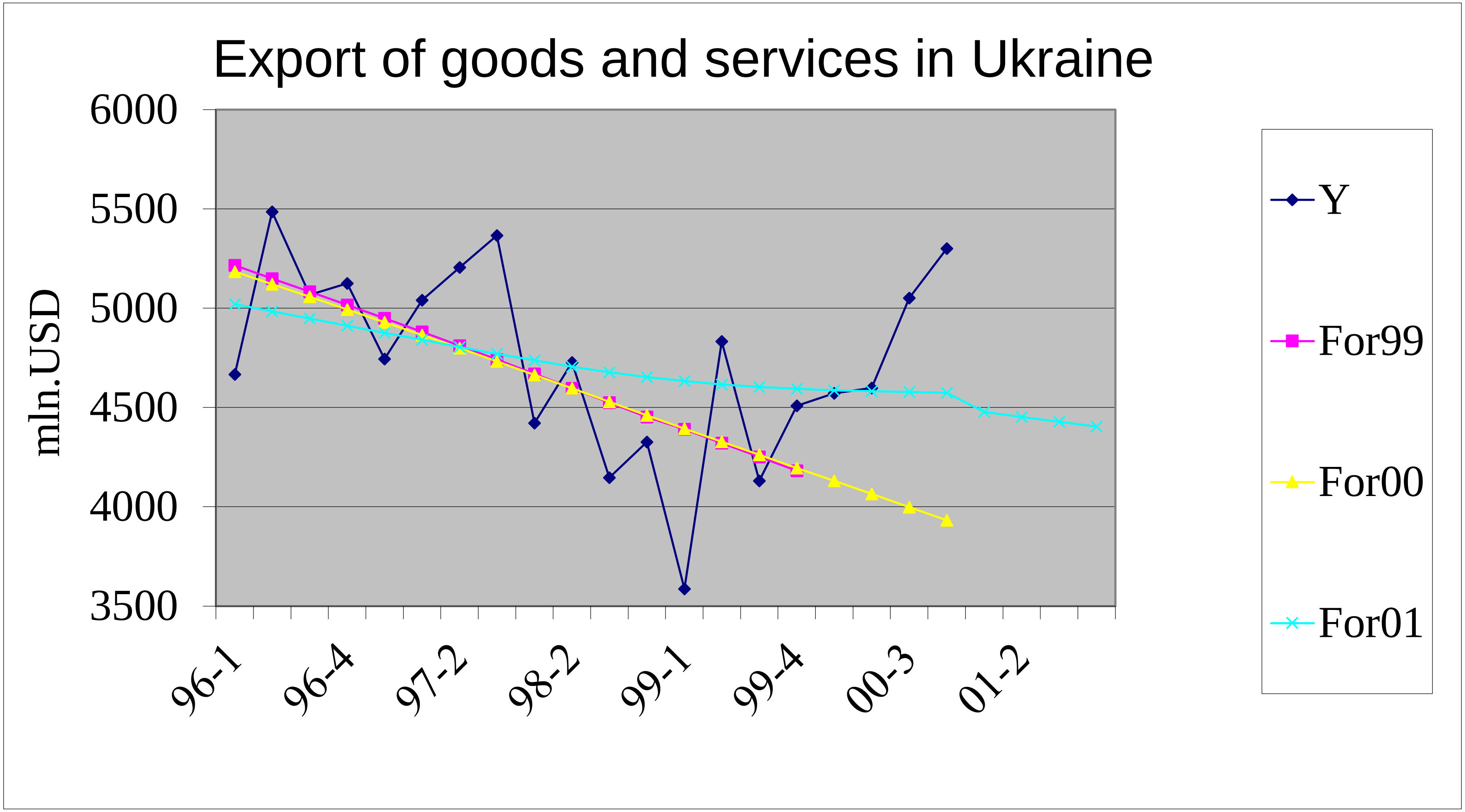
- Let $y_t = f(t) + \varepsilon_t,$

$$S = \sum_{t=1}^{T} \left(y_t - f(t) \right)^2 +$$

$$+ \lambda \sum_{t=2}^{T-2} \left(\left(f(t+1) - f(t) \right) - \left(f(t) - f(t-1) \right) \right)^2 \to \min$$

- λ=100 for annual, λ=1600 for quarterly, λ=14400 for monthly data.

Example



Export of goods and services in Ukraine
6000
5500
5000
4500
4000
3500
mln.USD
96-1
96-4
97-2
98-2
99-1
99-4
00-3
01-2
Y
For99
For00
For01

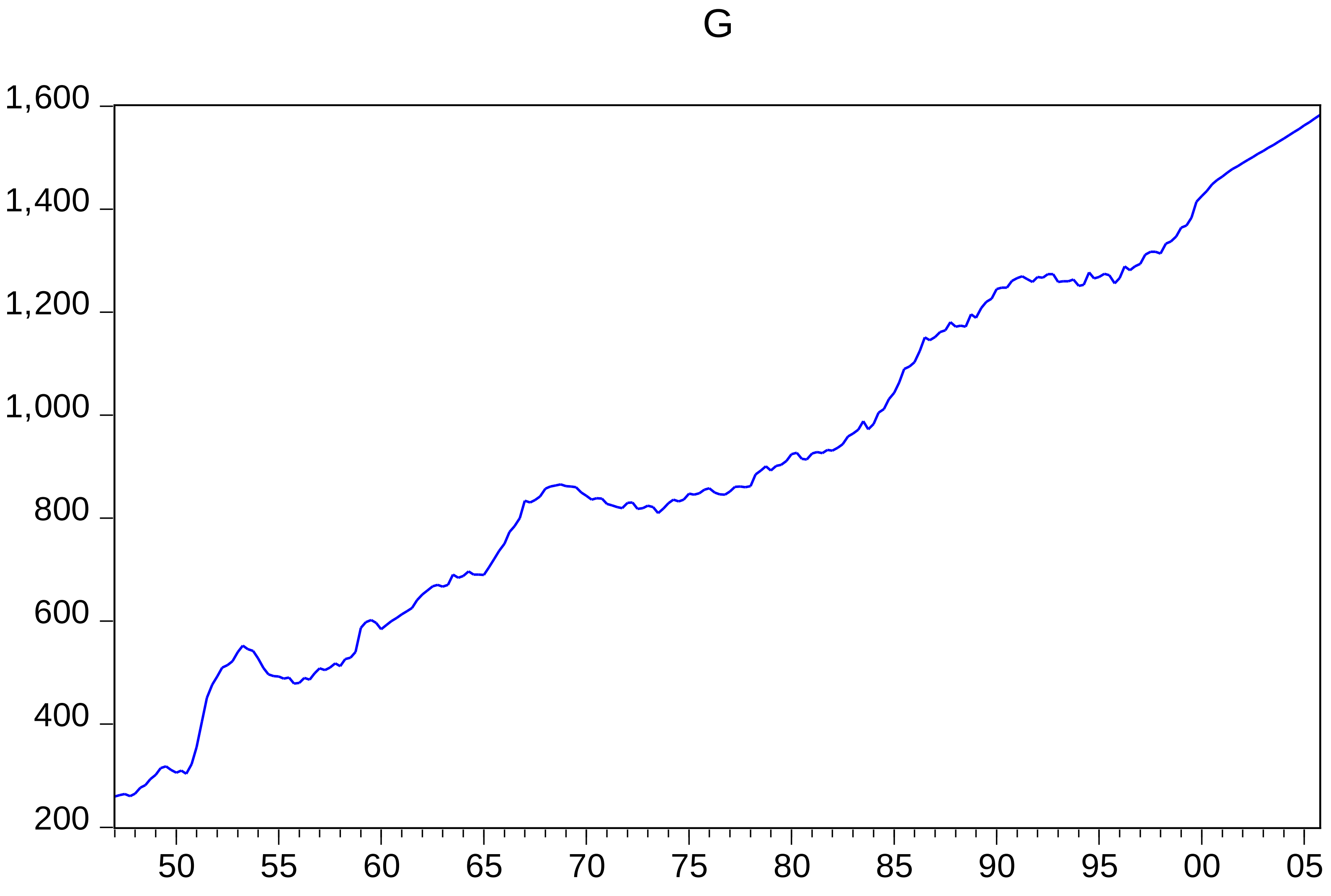
KSE

Smoothing methods in EVIEWS

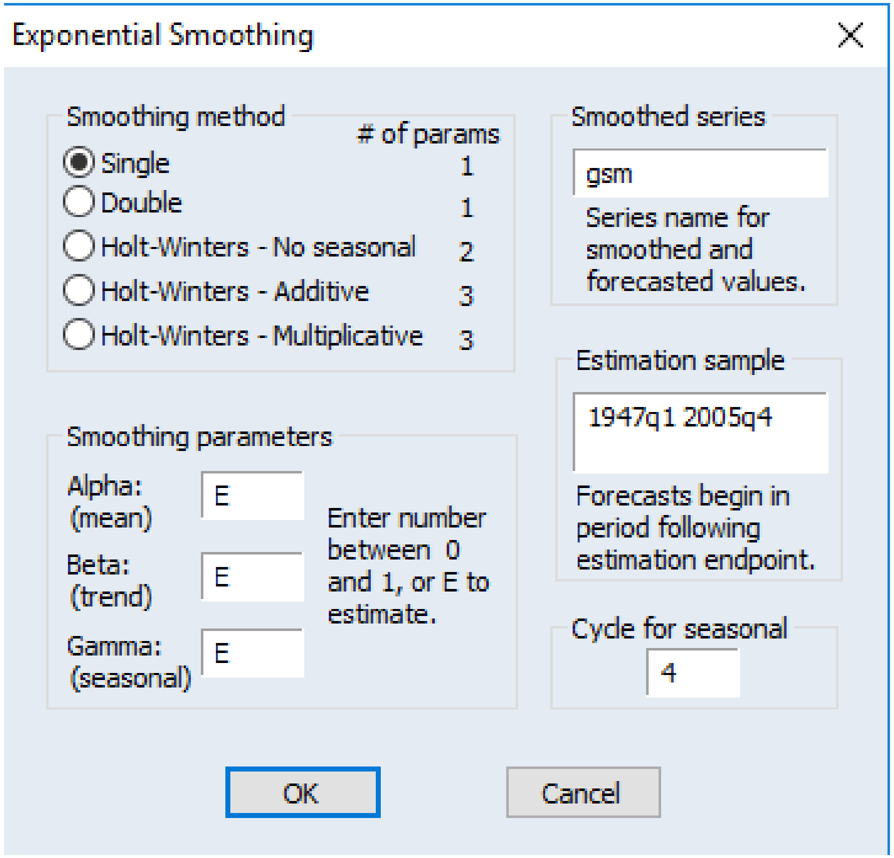
Example file

- Macromod.wf1
- Sample1: 1947q1 2005q4
- Sample2: 1947q1 1958q4

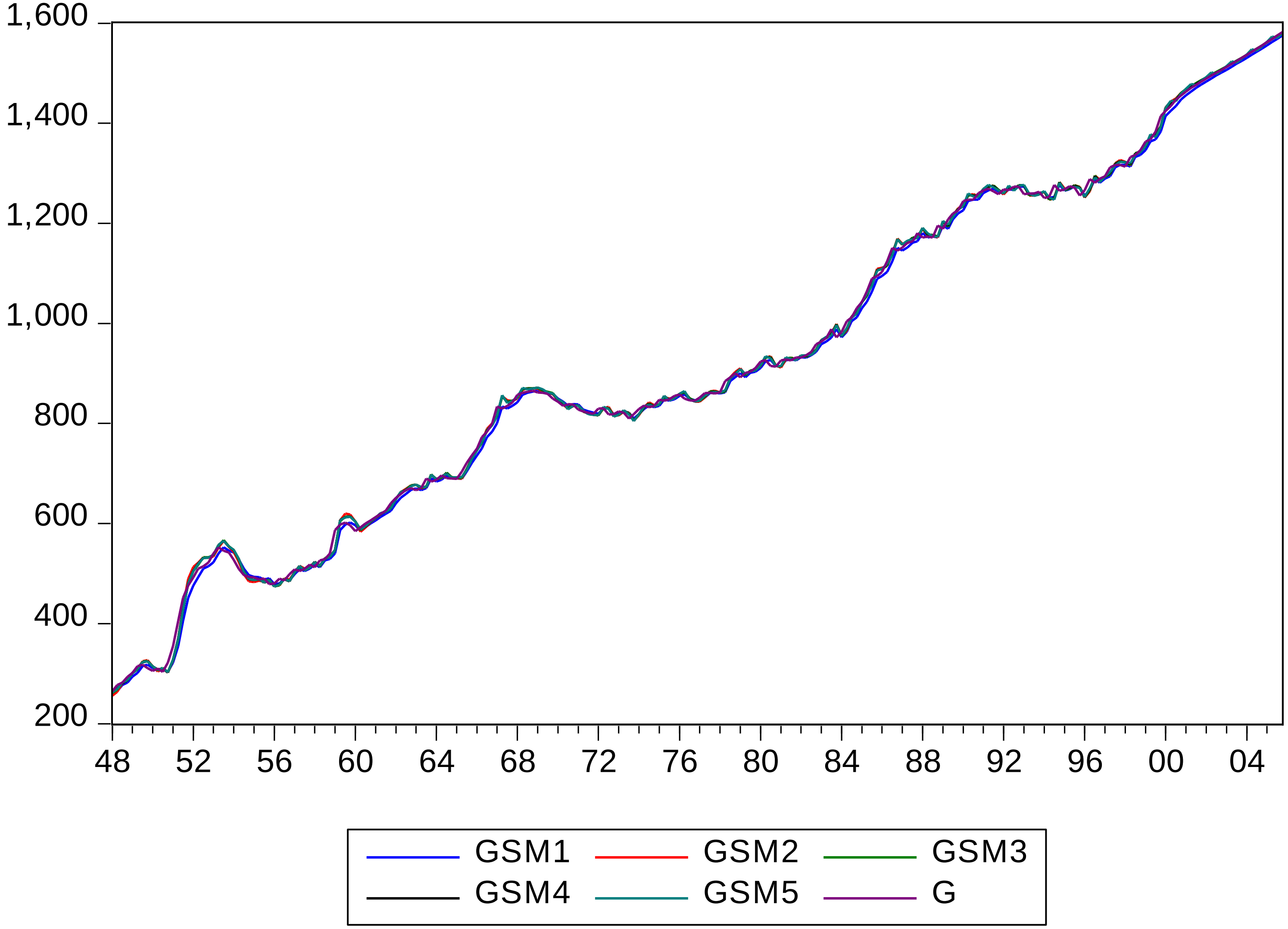
Government expenditures



Proc-Exponential smoothing- Simple Exponential smoothing

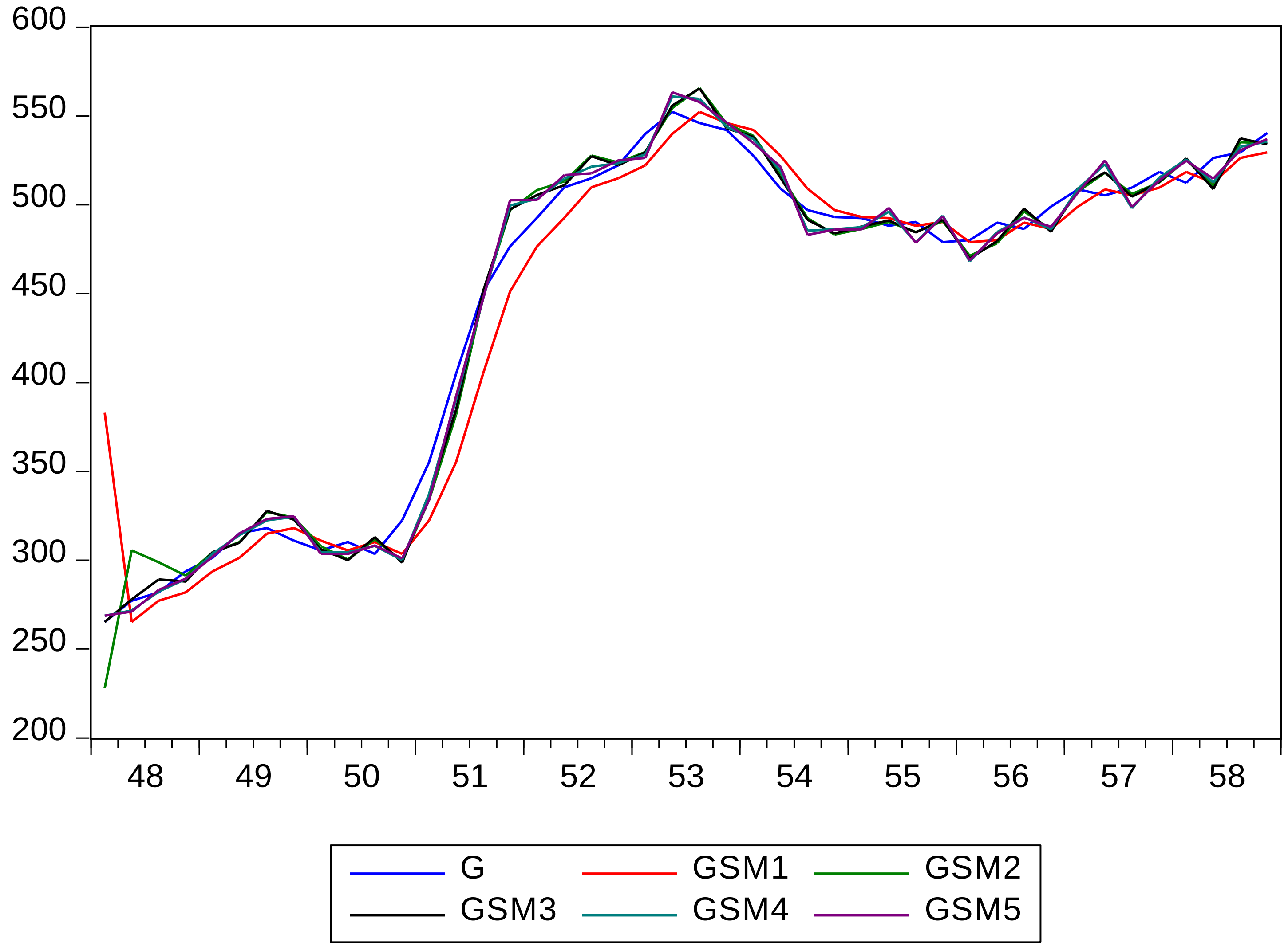


Outcome – 1



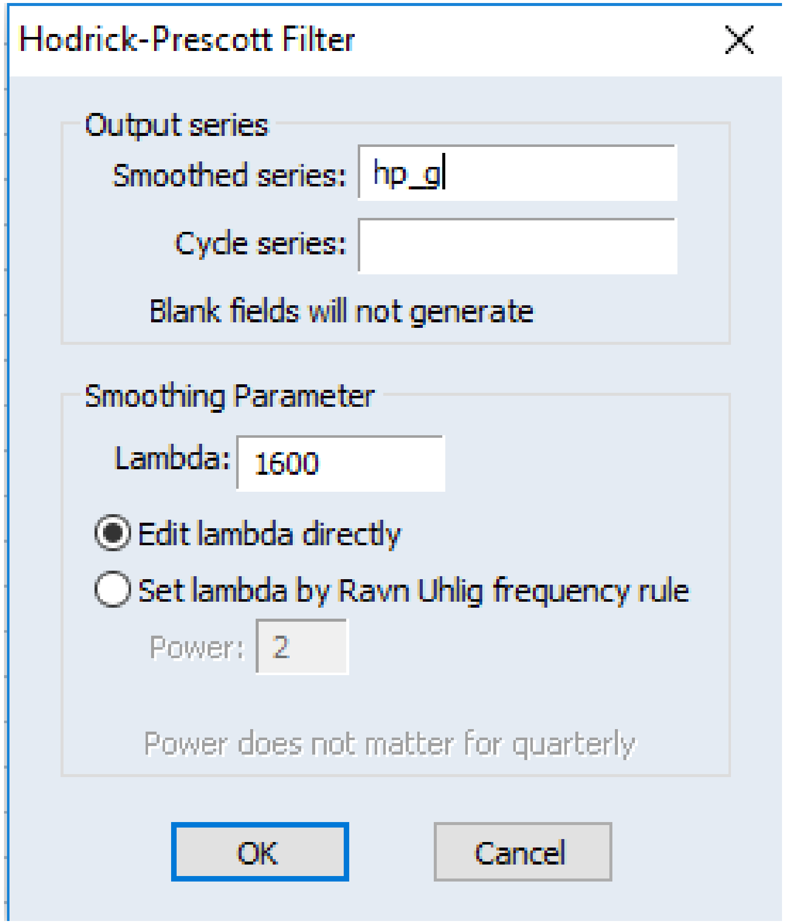
1,600
1,400
1,200
1,000
800
600
400
200
48
52
56
60
64
68
72
76
80
84
88
92
96
00
04
GSM1
GSM2
GSM3
GSM4
GSM5
G

Outcome – 2

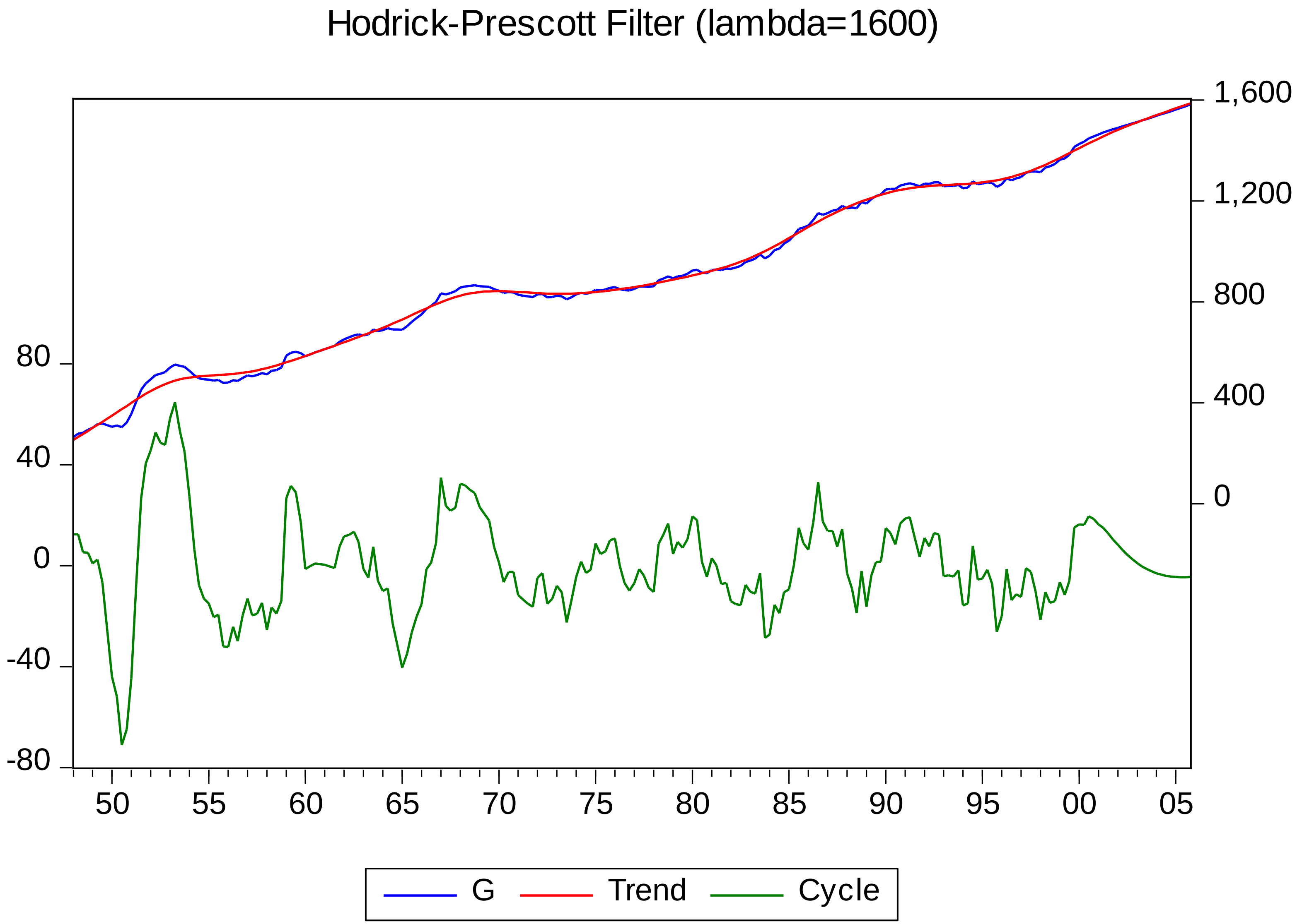


600
550
500
450
400
350
300
250
200
48
49
50
51
52
53
54
55
56
57
58
G
GSM1
GSM2
GSM3
GSM4
GSM5

Proc-Hodrick-Prescott Filter…

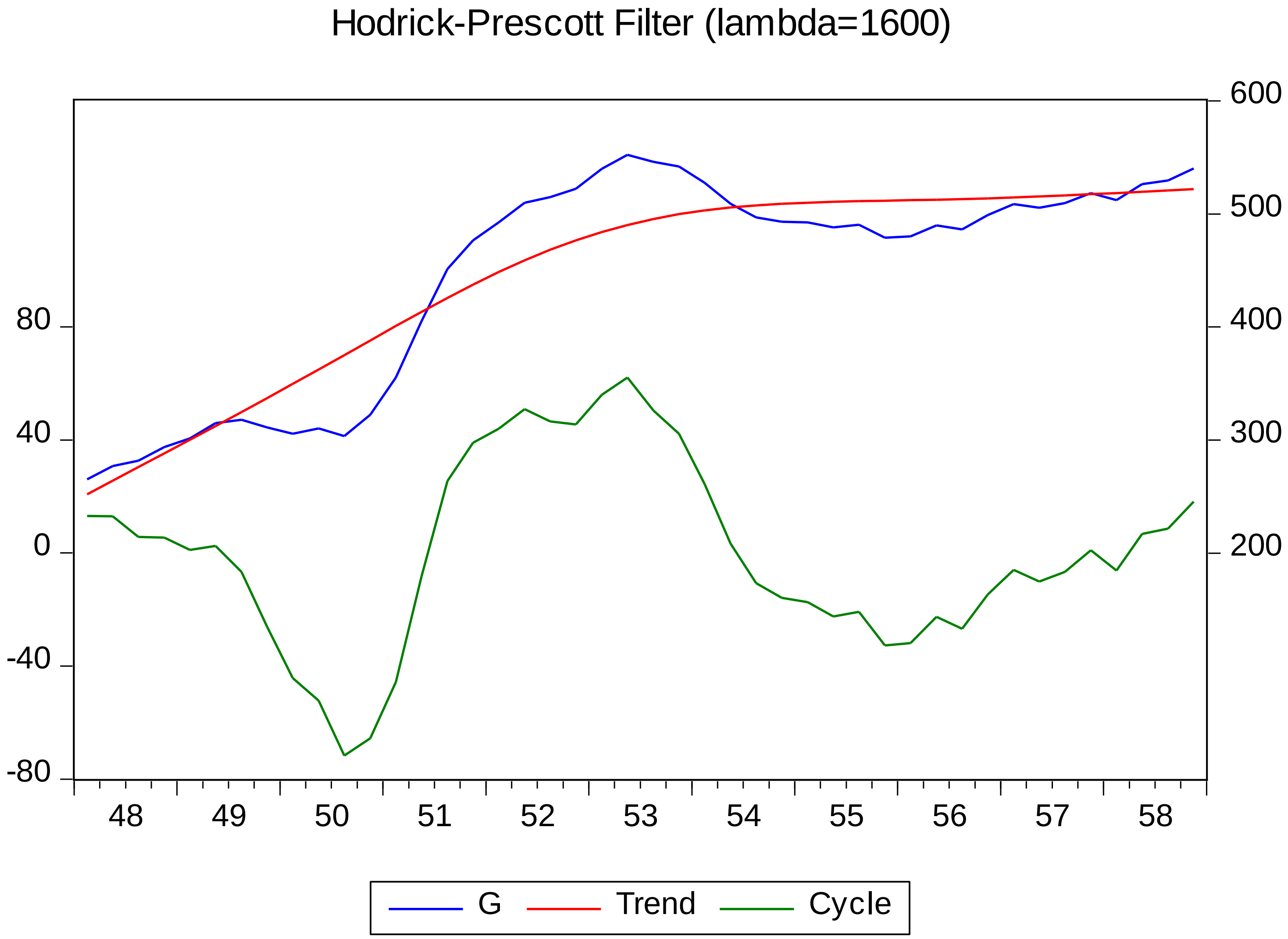


Outcome – 1



Hodrick-Prescott Filter (lambda=1600)
1,600
1,200
800
400
0
80
40
0
-40
-80
50
55
60
65
70
75
80
85
90
95
00
05
G
Trend
Cycle

Outcome – 2


Hodrick-Prescott Filter (lambda=1600)
600
500
400
300
200
80
40
0
-40
-80
48
49
50
51
52
53
54
55
56
57
58
G
Trend
Cycle

Review

Linear regression

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + ... + \beta_{k-1} x_{k-1t} + \varepsilon_t, t = \overline{1, n}$$

y_t - dependent variable;

$x_{1t}, x_{2t}, ..., x_{k-1t}$ - independent variables;

ε_t - residuals.

Dummy application

- Seasonality
- Crisis description
- Quality characteristics

Trend functions

Linear	$f(t) = a_0 + a_1 t$
Quadratic	$f(t) = a_0 + a_1 t + a_2 t^2$
Polynomial	$f(t) = a_0 + a_1 t + a_2 t^2 + \ldots + a_n t^n$
Exponential	$f(t) = a_0 e^{a_1 t}$
Power	$f(t) = a_0 t^{a_1}$

Smoothing

- Exponential smoothing
- Double exponential smoothing
- Triple exponential smoothing
- Non-seasonal Holt-Winters smoothing
- Multiplicative Winters smoothing

- Hodrick-Prescott Filter

Thank you for attention!

KSE