Solution to Exercise 1

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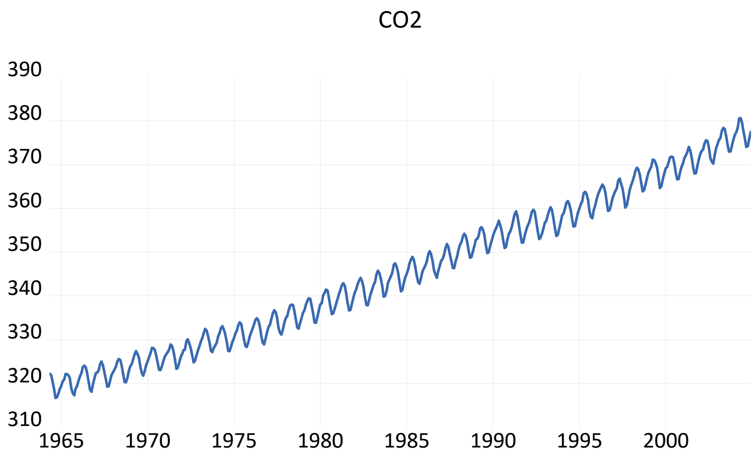
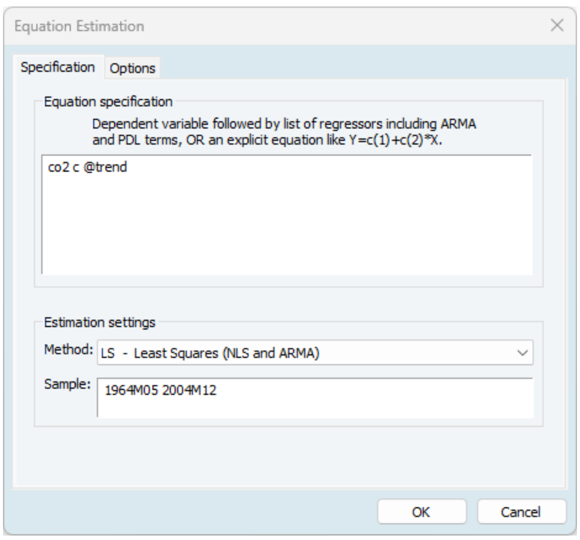
1. (a) Double-clicking the `co2` series followed by `View→Graph` results in the graph below.



(b) Click on `Quick→Estimate Equation` and enter the dependent variable, followed by the independent variables, as follows: `co2 c time`. Here, `c` stands for a constant (intercept) and `time` is the variable `time` from the dataset (take a look at it). Alternatively to `time`, you can also write `@trend`. This is an EViews function that generates the trend automatically (in fact, it's how I created the `time` variable, by writing `genr time = @trend` in the command window up top).



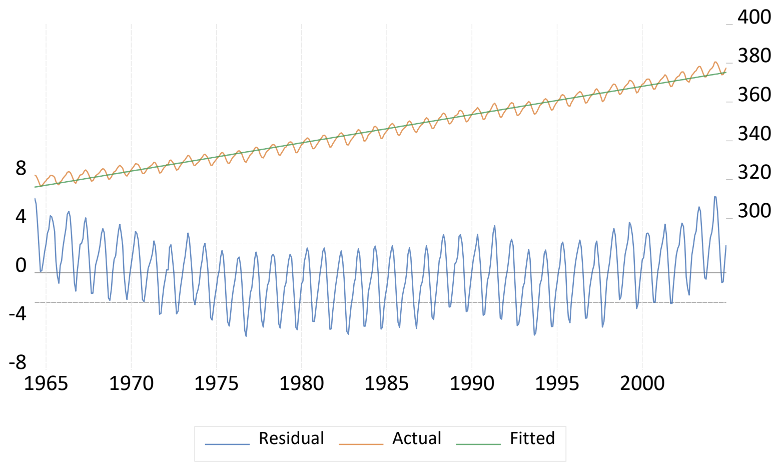
The result is

Dependent Variable: CO2
Method: Least Squares
Date: 10/26/22 Time: 16:19
Sample: 1964M05 2004M12
Included observations: 488

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	316.1023	0.221460	1427.355	0.0000
@TREND	0.121425	0.000787	154.2429	0.0000

R-squared	0.979981	Mean dependent var	345.6694
Adjusted R-squared	0.979940	S.D. dependent var	17.29716
S.E. of regression	2.449868	Akaike info criterion	4.634035
Sum squared resid	2916.901	Schwarz criterion	4.651209
Log likelihood	-1128.705	Hannan-Quinn criter.	4.640781
F-statistic	23790.89	Durbin-Watson stat	0.252267
Prob(F-statistic)	0.000000		

(c) Inside the window with the regression output, go to `View→Actual-Fitted-Residual→Actual-Fitted-Residual Plot`. This results in the follow graph.



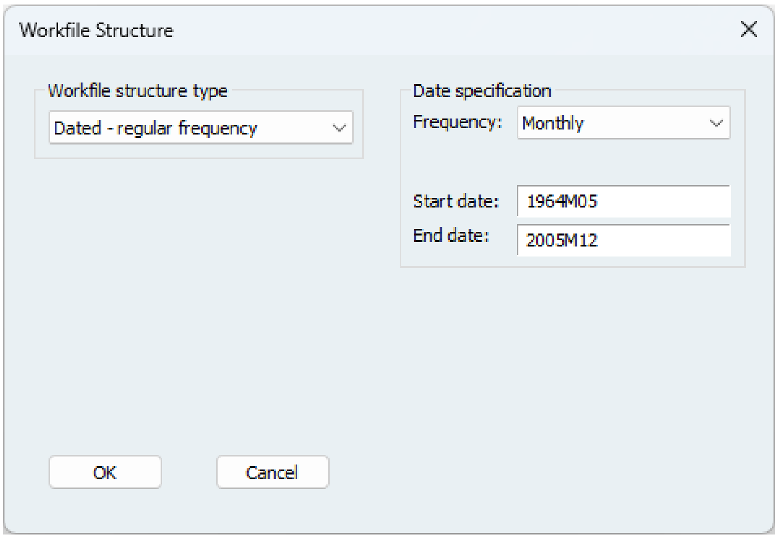
(d) 2005M1 corresponds to $t = 488$. Plugging this into the fitted regression

$$\widehat{Y}_t = 316.1 + 0.121 \cdot t,$$

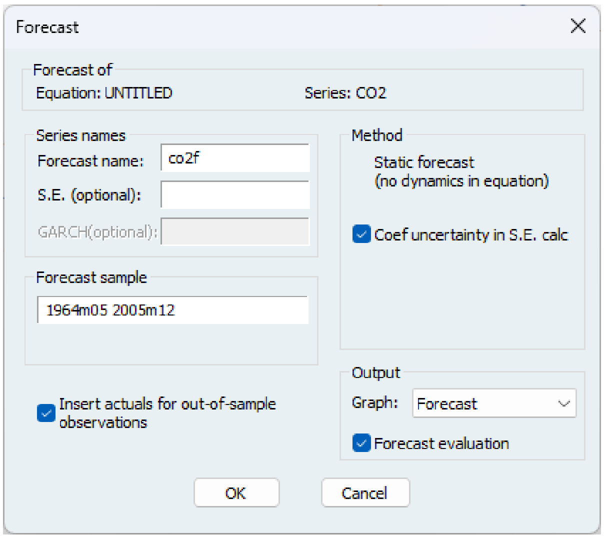
one obtains

$$\widehat{Y_{488}} = 316.1 + 0.121 \cdot 488 = 375.148.$$

Alternatively, inside the workfile pane on the left, go to `Proc→Structure / Resize Current Page...`, and resize the file so that it includes 2005:



Then, inside the window with the estimation output, click on `Proc`→`Forecasts...`, and extend the forecast sample to 2005M12.



Finally, open the `co2f` series and find the value corresponding to 2005M1; it's 375.358. The difference is due to the fact that EViews uses the unrounded estimates.

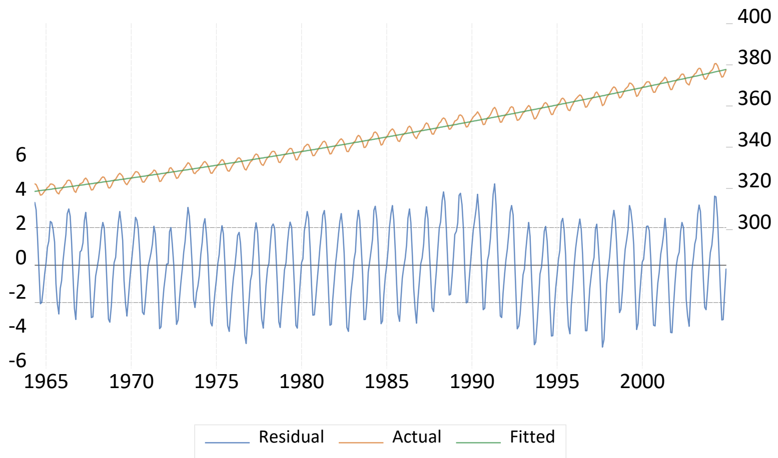
(e) Estimating `co2 c @trend @trend^2` yields

Dependent Variable: CO2
Method: Least Squares
Date: 10/26/22 Time: 18:01
Sample: 1964M05 2004M12
Included observations: 488

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	318.5814	0.295145	1079.407	0.0000
@TREND	0.090819	0.002800	32.44047	0.0000
@TREND^2	6.28E-05	5.57E-06	11.29240	0.0000

R-squared	0.984149	Mean dependent var	345.6694
Adjusted R-squared	0.984083	S.D. dependent var	17.29716
S.E. of regression	2.182234	Akaike info criterion	4.404704
Sum squared resid	2309.640	Schwarz criterion	4.430464
Log likelihood	-1071.748	Hannan-Quinn criter.	4.414822
F-statistic	15055.89	Durbin-Watson stat	0.318438
Prob(F-statistic)	0.000000		

and



Eyeballing, the resulting fit looks better; also, there is less structure in the residuals. The forecast is

$$\widehat{Y_{488}} = 318.58 + 0.09 \cdot 488 + 0.0000628 \cdot 488^2 \approx 377.868.$$

(f) First, we have to take logs of the dependent variable: in the command window up top, write `genr logco2 log(co2)` (`genr` stands for generating a new series; `log` is the natural logarithm). This creates a new series `logco2`. Next, regress this new variable on a constant and the time trend using `logco2 c @trend`. This yields

Dependent Variable: LOGCO2
Method: Least Squares
Date: 10/26/22 Time: 18:12
Sample (adjusted): 1964M05 2004M12
Included observations: 488 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.758822	0.000603	9548.688	0.0000
@TREND	0.000351	2.14E-06	163.6211	0.0000

R-squared	0.982170	Mean dependent var	5.844238
Adjusted R-squared	0.982134	S.D. dependent var	0.049914
S.E. of regression	0.006672	Akaike info criterion	-7.177792
Sum squared resid	0.021633	Schwarz criterion	-7.160619
Log likelihood	1753.381	Hannan-Quinn criter.	-7.171046
F-statistic	26771.88	Durbin-Watson stat	0.284591
Prob(F-statistic)	0.000000		

The estimated parameters of our exponential trend

$$F_t = \beta_0 \cdot \beta_1^t$$

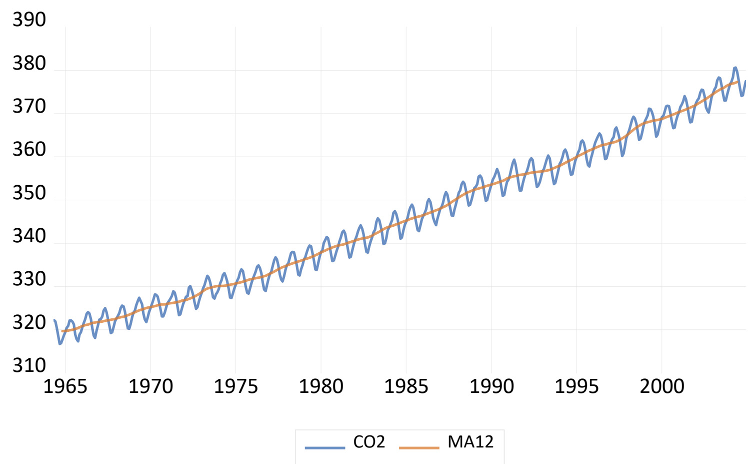
are $\widehat{\beta_0} = \exp(5.758822251222528) = 316.97$ and $\widehat{\beta_1} = \exp(0.0003507827256490508) = 1.0003508442571039$, implying that atmospheric CO2 increases by 0.035% a month, or $1.035^{12} - 1 = 0.42\%$ a year. The forecast for 2005M1 is

$$\widehat{Y_{488}} = 316.97 \cdot 1.0003508442571039^{488} = 376.15.$$

2. (a) We obtain

$$(322.23 + 321.89 + 320.44)/3 = 321.52.$$

(b) Enter `genr ma12 = @movavc(co2, 12)` in the command window (`@movavc` stands for a centered moving average). For the plot, select both series with the mouse (press `CTRL` while clicking to select both), then right-click and select `Open`→`As Group`, and plot as usual. This results in the following plot.



3. (a) Rather than constructing the dummies manually, we can have EViews construct them automatically for us, by entering the equation as `co2 @trend @expand(@month)` (for quarterly data, we would use `co2 @trend @expand(@quarter)`, etc.). This results in the following output:

Dependent Variable: CO2
Method: Least Squares
Date: 10/27/22 Time: 17:10
Sample: 1964M05 2004M12
Included observations: 488

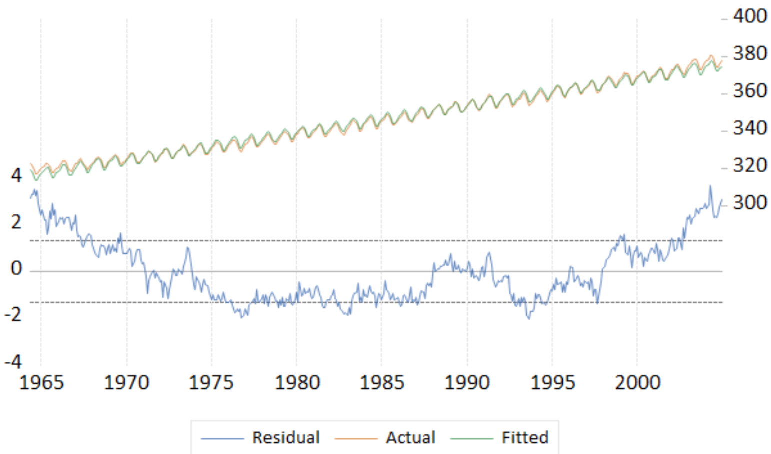
Variable	Coefficient	Std. Error	t-Statistic	Prob.
@TREND	0.121542	0.000422	287.8086	0.0000
@MONTH=1	316.0377	0.231547	1364.898	0.0000
@MONTH=2	316.7015	0.231733	1366.663	0.0000
@MONTH=3	317.4439	0.231921	1368.760	0.0000
@MONTH=4	318.6116	0.232109	1372.683	0.0000
@MONTH=5	319.1081	0.228887	1394.176	0.0000
@MONTH=6	318.4388	0.229074	1390.114	0.0000
@MONTH=7	316.8955	0.229262	1382.243	0.0000
@MONTH=8	314.7891	0.229450	1371.927	0.0000
@MONTH=9	312.9317	0.229640	1362.708	0.0000
@MONTH=10	312.7980	0.229829	1361.001	0.0000
@MONTH=11	314.0347	0.230020	1365.251	0.0000
@MONTH=12	315.2056	0.230211	1369.204	0.0000

R-squared	0.994371	Mean dependent var	345.6694
Adjusted R-squared	0.994228	S.D. dependent var	17.29716
S.E. of regression	1.314072	Akaike info criterion	3.410416
Sum squared resid	820.2228	Schwarz criterion	3.522044
Log likelihood	-819.1416	Hannan-Quinn criter.	3.454264
Durbin-Watson stat	0.052427		

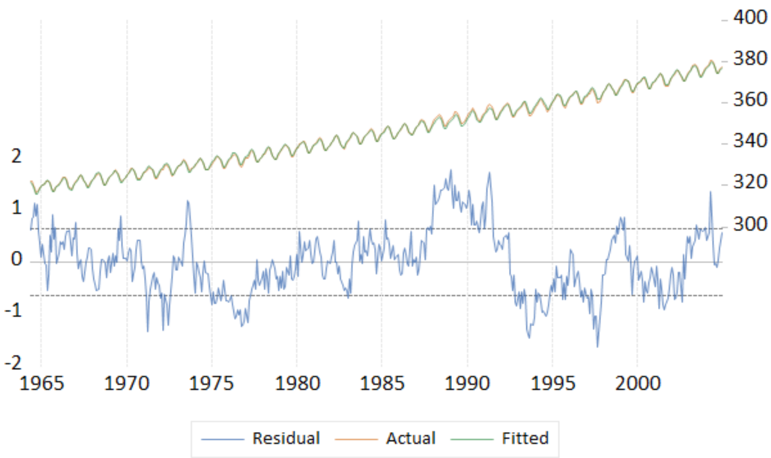
The forecast for 2004M12 is

$$\widehat{Y}_{487} = 0.121542 \cdot 487 + 315.2056 = 374.397,$$

which can also be obtained via `Proc`→`Forecasts...`. The actual-fitted-residual plot is given below.



As we had discovered earlier, there is still structure left in the residuals; a quadratic trend is a better fit. Including a quadratic term (not asked) yields the following:



(b) Now we use the specification `co2 c @trend @expand(@month, @droplast)`. This yields the following output.

Dependent Variable: CO2
Method: Least Squares
Date: 10/27/22 Time: 17:23
Sample: 1964M05 2004M12
Included observations: 488

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	315.2056	0.230211	1369.204	0.0000
@TREND	0.121542	0.000422	287.8086	0.0000
@MONTH=1	0.832127	0.292046	2.849301	0.0046
@MONTH=2	1.495834	0.292043	5.121964	0.0000
@MONTH=3	2.238292	0.292041	7.664308	0.0000
@MONTH=4	3.405999	0.292039	11.66281	0.0000
@MONTH=5	3.902504	0.290245	13.44555	0.0000
@MONTH=6	3.233157	0.290241	11.13956	0.0000
@MONTH=7	1.689907	0.290238	5.822495	0.0000
@MONTH=8	-0.416513	0.290235	-1.435091	0.1519
@MONTH=9	-2.273909	0.290233	-7.834781	0.0000
@MONTH=10	-2.407647	0.290231	-8.295619	0.0000
@MONTH=11	-1.170897	0.290230	-4.034372	0.0001

R-squared	0.994371	Mean dependent var	345.6694
Adjusted R-squared	0.994228	S.D. dependent var	17.29716
S.E. of regression	1.314072	Akaike info criterion	3.410416
Sum squared resid	820.2228	Schwarz criterion	3.522044
Log likelihood	-819.1416	Hannan-Quinn criter.	3.454264
F-statistic	6992.094	Durbin-Watson stat	0.052427
Prob(F-statistic)	0.000000		

Notice how December is now the base case with an average of 315.2, and all other months are measured in relation to it. The forecast for 2004M12 is

$$\widehat{Y}_{487} = 315.2056 + 0.121542 \cdot 487 = 374.397,$$

the same as before.