

Chapter 11 - Further Issues in Using OLS with Time Series Data

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Exercise 11.5

Upload packages

```
library(wooldridge)
library(lmreg)
library(car)
```

Upload database

```
data<-wooldridge::fertil3
attach(data)
```

(i) Add a linear time trend to equation (11.27). Is a time trend necessary in the first difference equation?

The equation (11.27) is expressed as follows

$$\widehat{\Delta gfr} = 0.964 - 0.36\Delta pe - 0.014\Delta pe_{t-1} + 0.110\Delta pe_{t-2}$$

```
summary(lm1<-lm(cgfr~pe+pe_1+pe_2+t))
```

```
##
## Call:
## lm(formula = cgfr ~ pe + pe_1 + pe_2 + t)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.1259 -2.9995 -0.1086  1.9640 11.2359
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.215875   1.082531  -1.123   0.265
## pe           -0.032662   0.029226  -1.118   0.268
## pe_1          0.052035   0.044858   1.160   0.250
## pe_2          0.008732   0.029943   0.292   0.771
## t            -0.066038   0.034770  -1.899   0.062 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.121 on 65 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.1253, Adjusted R-squared:  0.07147
## F-statistic: 2.328 on 4 and 65 DF, p-value: 0.06541
```

The purpose of estimate with variables in differences is remove trend or seasonality or both. However, in specific scenarios is necessary to include a time trend. In this specific item, the inclusion of a time trend do not contribute for a better performance of the model. The F-Statistic shows that the variables are not jointly significant.

(ii) Drop the time trend and add the variables `ww2` and `pill` to (11.27) (do not difference these dummy variables). Are these variables jointly significant at the 5% level?

```
summary(lm2<-lm(cgfr~pe+pe_1+pe_2+ww2+pill))
```

```
##
## Call:
## lm(formula = cgfr ~ pe + pe_1 + pe_2 + ww2 + pill)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -9.4493 -2.6713  0.1375  1.9225 10.3140
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.78483    0.90066  -1.982   0.0518 .
## pe          -0.08257    0.03445  -2.397   0.0195 *
## pe_1         0.04764    0.04272   1.115   0.2689
## pe_2         0.04947    0.03465   1.428   0.1582
## ww2          6.11892    2.94515   2.078   0.0418 *
## pill        -2.69307    1.09265  -2.465   0.0164 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.916 on 64 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.2223, Adjusted R-squared:  0.1615
## F-statistic: 3.658 on 5 and 64 DF,  p-value: 0.005662
```

Now, the F-Statistic of the estimated model shows jointly significance of variables.

```
linearHypothesis(lm2, c("ww2=0", "pill=0"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## ww2 = 0
## pill = 0
##
## Model 1: restricted model
## Model 2: cgfr ~ pe + pe_1 + pe_2 + ww2 + pill
##
##      Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1         66 1165.1
## 2         64  981.5  2    183.63 5.9871 0.004135 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Yes, it's possible to reject the null hypothesis that these two variables jointly don't influence the dependent variable.

(iii) Add the linear time trend, `ww2`, and `pill` all to equation (11.27). What happens to the magnitude and statistical significance of the time trend as compared with that in part (i)? What about the coefficient on `pill` as compared with that in part (ii)?

```
summary(lm3<-lm(cgfr~pe+pe_1+pe_2+ww2+pill+t))
```

```
##
## Call:
## lm(formula = cgfr ~ pe + pe_1 + pe_2 + ww2 + pill + t)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -9.2250 -2.3653  0.0927  2.0153 11.0641
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.53225     1.21254  -2.088   0.0408 *
## pe          -0.08908     0.03520  -2.530   0.0139 *
## pe_1         0.04957     0.04282   1.158   0.2514
## pe_2         0.04439     0.03512   1.264   0.2110
## ww2          6.35271     2.95949   2.147   0.0357 *
## pill        -4.36724     2.11985  -2.060   0.0435 *
## t            0.05986     0.06492   0.922   0.3600
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.921 on 63 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.2326, Adjusted R-squared:  0.1595
## F-statistic: 3.183 on 6 and 63 DF,  p-value: 0.008599
```

The coefficient associated to the trend variable is still not significant. However, the overall significance of the model becomes significant, as $p\text{-value} < 0.05$.

The coefficient associated to the `pill` variable changes from -2.69 to -4.36 with statistical significance of 5% in both cases.