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

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Exercise 11.3

Upload packages

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

Upload database

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

(i) In Example 11.4, it may be that the expected value of the return at time t, given past returns, is a quadratic function of returnt21. To check this possibility, use the data in NYSE.RAW to estimate

$$return_t = \beta_0 + \beta_1 return_{t-1} + \beta_2 return_{t-1}^2 + u_t$$

report the results in standard form.

```
retsq<-return_1*return_1

summary(lm1<-lm(return~return_1+retsq))
```

```
##
## Call:
## lm(formula = return ~ return_1 + retsq)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -15.1867  -1.3051   0.1005   1.3229   8.1718
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.225549   0.087234   2.586  0.00993 **
## return_1     0.048572   0.038722   1.254  0.21013
## retsq       -0.009735   0.007030  -1.385  0.16654
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.109 on 686 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.006259,	Adjusted R-squared:  0.003362
## F-statistic:  2.16 on 2 and 686 DF,  p-value: 0.1161
```

The estimated equation is expressed as follows

$$\widehat{return}_t = 0.22 + 0.04 return_{t-1} - 0.009 return_{t-1}^2$$

ii. State and test the null hypothesis that $\mathbb{E}(return_t \mid return_{t-1})$ does not depend on return_{t-1}. (Hint: There are two restrictions to test here.) What do you conclude?

The null hypothesus is that $H_0 : \beta_1 = \beta_2 = 0$

```
linearHypothesis(lm1, c("return_1=0","retsq=0"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## return_1 = 0
## retsq = 0
##
## Model 1: restricted model
## Model 2: return ~ return_1 + retsq
##
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    688 3070.4
## 2    686 3051.2  2    19.217 2.1603 0.1161
```

Based in the p-value of F-Test isn’t possible to reject the null hypothesis that `return` depends on its lagged value. Thus, we cannot corroborate the hypothesis of efficient markets.

(iii) Drop $return_{t-1}^2$ from the model, but add the interaction term $return_{t-1} \cdot returnt - 2$. Now test the efficient markets hypothesis.

```
return_2<-diff(return_1)

ret_int<-return_1*return_2
```

```
## Warning in return_1 * return_2: comprimento do objeto maior não é múltiplo do
## comprimento do objeto menor
```

```
summary(lm2<-lm(return~return_1+ret_int))
```

```
##
## Call:
## lm(formula = return ~ return_1 + ret_int)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.8733  -1.3010   0.1089   1.3613   8.5413
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.066237   0.086813   0.763 0.445740
## return_1     0.082195   0.038386   2.141 0.032607 *
## ret_int     -0.025696   0.007551  -3.403 0.000705 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.096 on 685 degrees of freedom
##   (3 observations deleted due to missingness)
## Multiple R-squared:  0.02008,    Adjusted R-squared:  0.01722
## F-statistic: 7.019 on 2 and 685 DF,  p-value: 0.0009608
```

```
linearHypothesis(lm2,c("return_1=0","ret_int=0"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## return_1 = 0
## ret_int = 0
##
## Model 1: restricted model
## Model 2: return ~ return_1 + ret_int
##
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1    687 3070.3
## 2    685 3008.7  2    61.655 7.0187 0.0009608 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Now, in this case, its possible to reject the null hypothesis, and we can corroborate the efficient market hypothesis.