02417: Time Series Analysis

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Assignment 4: Multivariate Processes

In this assignment we shall return to apartment prices in 2800 Kgs. Lyngby but also from other zip codes. The data is downloaded from Realkreditrådet (`http://www.realkreditraadet.dk/Statistikker/Boligmarkedsstatistik/Data.aspx`). And to improve predictions the consumer price index (cpi) and two interest rates are included. The two interest rates are a 30 year real estate bond rate (real30yr) and the discount rate from Nationalbanken, they represent long range and short range interest rates.
You should not use the last four observations for estimating a model but save them for showing the performance of your model.
It is the intetion that you use the R-package marima for the last two questions - other software packages may have similar functionality that you can use.
Marima can be installed in R by:

```
install.packages("marima", repos = "http://www2.compute.dtu.dk/~ruju/repo")
```

Question 4.1: Presenting the data Plot the prices and the additional variables. Comment on the behaviour including considerations on stationarity. Consider transformations of the indidual series already at this point.

Question 4.2: ACF, PACF and CCF Estimate the autocorrelation function, the partial autocorrelation function and the cross correlation function of the data series and if relevant also for transformations of the data.

Comment on the structures you find.

Question 4.3: Univariate model selection Find suitable univariate ARIMA models for each of the price series.

You don't have to present diagnostic plots for all models. But do pick some examples and comment briefly on how the others behave.

Question 4.4: Multivariate model selection Select an initial model structure based on what you found above. Estimate the parameters. Validate the model. Consider tests for lower model order. Consider updating the model structure.

Argue for the choices you make. Remember that the model building process is an iterative process and you should always consider stepping back and consider your choices again.

Question 4.5: Predictions Use the model you have developed for predicting the prices for the remaining four observations and include prediction limits.

Compare with the actual data comment on the results

You are allowed to (But don't have to) assume that the consumer price index and the interest rates are known in the future.