Team Work

TEAM WORK INSTRUCTIONS

Dear group,

1. The outcome of your work should be a **report** containing a complete time series analysis of a number of variables of interest with emphasis on the performance of different forecasting methods.

2. The team is responsible for the choice of the variables but here is a list of areas worthwhile to explore:

    - Public Sector
    - Agriculture
    - Environment
    - International Trade
    - Climate
    - Private firms
    - Households
    - Financial markets
    - Fiscal policy
    - Monetary policy
    - Tourism
    - Public Health
    - ...

3. The data set should include **multiple time series** (minimum of 4 or 5 series). Ideally, the group should work with the **same variable** for **multiple keys** (for example, countries, regions, continents,...) but this is not compulsory. Moreover, the time series should have **intra-anual** frequency (quarterly, monthly, weekly, daily) and, at least, 80 observations.

4. **100% coincidence** of the selected time series between groups **is not allowed**. Moreover, you cannot select time series discussed during the lectures or included in the textbook. To avoid these situations, send the name/description, datafile, and source of the multiple time series to **nsobreira@iseg.ulisboa.pt** until **17/04 and wait for approval**. The first group that sends all this information wins the exclusive right to analyze those time series. So it is recommended that the group sends this information as soon as possible and, ideally, before 17/04.

5. The written report has a **maximum** of **40 pages**.

6. The report should be written in a standard format.

7. **An extra mark of 1 point** will be delivered for those groups who **use R Markdown** to write the report with narrative text, code and output together in a single document. Useful references: R-Ladies Sydney and Chapter 2 of R Markdown: The Definitive Guide.

8. The delivery date is until **22nd May 10:00 AM**. Send the written report to **nsobreira@iseg.ulisboa.pt** with the name Group ?? - Team Work.

9. Any case of **plagiarism** is **strictly forbidden** and will be **dealt with** in accordance with ISEG Masters' regulations.

Now it follows a list of possible sections for the work and ideas of how to approach each section:

1. **Introduction**
   - Motivate the work and why it is interesting to study the selected series.
   - Enumerate the main goals of the work.
   - Describe the dataset and provide all relevant details about the selected series: source, sample period, sample frequency,...
   - Describe the methodologies and strategies used to achieve the desired goals for this work.

2. **Time series graphics**
   - Create time plots for all or, at least, some of the series in the dataset. Moreover, use seasonal plots, seasonal subseries plots and ACF(). Based on these figures, what do you learn about the series?

- Can you spot any seasonality, cyclicity and trend?
- Do you observe any ususual observations? Do you find changing patterns on the data over time? Why might that have occurred?
- Explore the differences between the series in terms of these features.
- Does any of the series look like a white noise process?

3. **Time series decomposition**

   - Does any of the series need any kind of adjustment: calendar, population, inflation,...?
   - Check if the data needs to be transformed (logarithm, Box-Cox,...). If not, why? If yes, do so and describe the effect
   - Decompose the series using different methods. Plot and describe the results. Do the decompositions reveal features that you didn't notice previously? Check if the decomposition methods deliver very different results.

4. **The forecaster's toolbox**

   - Use intuition and graphical analysis to decide which of the simple forecasting methods enumerated in the textbook is more appropriate for each series in the data set.
   - Create training sets and test sets and use either traditional or cross validation to compare the forecasting accuracy of the different simple forecasting methods. The method that does best here coincides with the previous item?
   - Check if the residuals of the selected method looks like white noise.

5. **Exponential smoothing**

   - Consider a few series (the most representative, one or two or more, if it's relevant) and choose the most appropriate ETS model, according to the main features of the data. Justify your choice.
   - Use the ETS() function to choose an appropriate model for all series in the data set. Do they coincide with the models chosen according to the main features?

- Check the residuals of the estimated models. Do they look white-noise?
- Using the same training sets and test sets as before, check if the forecasts from the selected ETS methods perform better than the most appropriate simple forecasting methods.

6. **ARIMA**

   - For a few series (the most representative, one or two or more, if it's relevant) apply the Box-Jenkins methodology to choose your own ARIMA model:
     - Is it necessary to apply any Box-Cox transformation to the data? If yes, do it.
     - Are the time series stationary? Should the data be differenced? Should it be seasonally differenced?
     - Plot the SACF and SPACF. What can you learn from these graphs? Use this information to suggest and estimate some candidate ARIMA models.
     - Perform diagnostic testing on the residuals of the selected models and discard inadequate models.
     - Which model does best according to the information criteria?
   - Use ARIMA() to find the best model according to its automatic modelling procedure. Hint: review slide 79 of the ARIMA chapter.
   - Compare the forecasts of the automatic modelling procedure, Box-Jenkins and previous approaches (ETS, naive methods). Which one performs best?

7. **Other forecasting methods** try other forecasting methods not necessarily covered in class, *e.g*:

   - Dynamic regression models with the elements you find relevant such as specific predictor variables, deterministic trends, seasonal dummy variables, other dummy variables or Fourier terms (chapter 10);
   - Prophet model (section 12.2);
   - Neural Network Autoregression (section 12.4).