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## Test 1: Money Market modeling with ARMA-GARCH

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Statistics for Time Series Models  
Olivier Wintenberger (olivier.wintenberger@upmc.fr)

You have to deliver your Test by email in a pdf file accompanied with the R codes before the 17th of October, midnight. The statistical treatment of the discrete time process must be done in the software R. Commands can be described in the pdf only if necessary.

1. Upload in R the M1 Money Stock data, Weekly, Seasonally Adjusted from <https://research.stlouisfed.org> (or Data.csv where the last 2 years are missing).
2. Draw the time series ( $M1_t$ ). In view of the graph, discuss whether it is likely to be a stationary processes.
3. Consider the log ratios  $DM1_t = 100 * \log(M1_t/M1_{t-1})$  with ( $M1_t$ ) the M1 Money Stock data. Are they stationary? If necessary, treat outliers.
4. Draw the sample (partial) autocorrelation functions (acf and pacf) and discuss whether you can propose some AR or MA model to fit the data.
5. In view of the partial autocorrelation function fit an AR(p) model.
6. In view of the autocorrelation function fit an MA(q) model.
7. In the two previous models, compute the residuals. Are they likely to be uncorrelated?
8. Find the best general ARMA( $p, q$ ) model for  $p \leq 5$  and  $q \leq 5$  using a penalized maximum likelihood criterium of your choice (AIC, BIC, AICc,...). Function as `armasubsets` of the package `TSA` (in R) may be used. Compare its number of parameters with the number of parameters of the two previous AR and MA models.
9. Based on the previous steps select only one model. Explain your decision and estimate its parameters using the MLE approach. Consider the residuals of the selected model and discuss whether the assumption of white noise is likely to be satisfied. Discuss also the assumption of normality on these residuals thanks to a `qqplot`.