

## Exercise 4

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1. Open the file `simulations.xlsx`. Use the sheets “AR(1)” (with  $\phi_1$  set to 1) to simulate a random walk with drift, and the sheet “Linear Trend” to simulate a trend-stationary process. Play with the parameters and describe your observations.
2.
  - (a) The file `tbill.wf1` contains monthly data for the 3-month T-Bill rate. Plot them, study the correlogram, and conduct a unit root test.
  - (b) Model the first difference of the T-Bill rate as an ARMA process, hence modelling the T-Bill rate as an ARIMA process.
  - (c) Forecast the T-Bill rate for 2022M11 and 2022M12 based on the model you found in the previous question.
3.
  - (a) The file `ibm_capm.wf` contains data for the S&P500, IBM stock, and the 3-month T-Bill rate. Use it to estimate the CAPM  $\beta$  of IBM, by regressing the excess returns of IBM on the excess returns of the market.
  - (b) Use the Durbin-Watson test to test for first-order autocorrelation in the residuals.
  - (c) Use the Breusch-Pagan test to test for autocorrelation up to order 5 in the residuals.
  - (d) Re-estimate the regression using HAC standard errors.
4.
  - (a) Show that for both

$$\begin{aligned} Y_{1,t} &= \delta t + U_{1,t} \quad \text{and} \\ Y_{2,t} &= \delta + Y_{2,t-1} + U_{2,t}. \end{aligned}$$

we have  $\mathbb{E}[\Delta Y_{i,t}] = 0$ .

- (b) Derive the ADF regression for an AR(2) process.