Paper 10 Time Series Models 2019-2020

Supervision Questions

Supervision 1. Univariate Time Series Models. ARMA models, non-linear models and trends.

(1) Explain the procedure you would use to fit an ARMA model to a time series of data on the growth rate of UK GDP.

(2) Show the autocorrelation function for an $MA(1)$ with parameter θ is the same as for an $MA(1)$ with parameter $\frac{1}{\theta}$

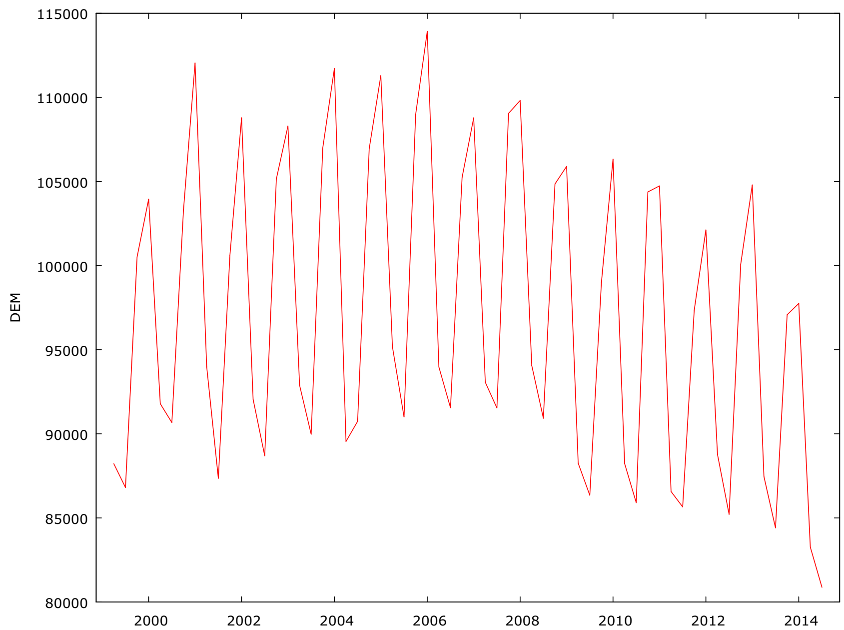
(3) Suppose z_{1t} is an AR1 with parameter λ_1 and z_{2t} an independent AR1 with parameter λ_2. If $y_t = z_{1t} + z_{2t}$ show that y_t is an ARMA(2,1).

(4) An econometrician estimates the following ARMA model for the log of UK GDP over the period $1970Q1 - 2001Q4$ (standard errors in parentheses)

$$\begin{aligned} \Delta y_t &= \underset{(0.002)}{0.002} + \underset{(0.376)}{0.633}\Delta y_{t-1} + \varepsilon_t - \underset{(0.371)}{0.568}\varepsilon_{t-1} \\ R^2 &= 0.006 \\ DW &= 2.07 \end{aligned}$$

where $y_t = ln(UKGDP_t)$ and $\Delta y_t = y_t - y_{t-1}$. Explain how you could use such a model to obtain estimates of a trend (non-stationary) and cycle (stationary) decomposition for UK GDP.

(5) (Exam 2015) Figure 1 shows quarterly UK electricity demand (measured in Gigawatt hours) from 1998Q1 to 2014Q3 (from DECC Energy Trends).



An econometrician wishes to produce a forecasting model for UK electricity demand (dem_t).

To produce a forecast model they first estimate the following where Δ is the first difference operator ($\Delta = 1 - L$) and 'time' a time trend

$$\widehat{\Delta\text{dem}}_t = \underset{(12862.)}{29632.5} - \underset{(21.862)}{53.9941}\,\text{time} - \underset{(0.12928)}{0.285923}\,\text{dem}_{t-1} + \underset{(0.073133)}{0.113146}\,\Delta\text{dem}_{t-1} - \underset{(0.071540)}{0.820524}\,\Delta\text{dem}_{t-2}$$

$$T = 64 \quad \bar{R}^2 = 0.9334$$

(standarderrorsinparentheses)

(i) Does this provide evidence that demand is an $I(1)$ variable?

They decide demand is best modelled as an $I(1)$ variable and then estimate the following model

Model I

$$\widehat{\Delta_4\text{dem}}_t = \underset{(864.62)}{1422.98} - \underset{(21.766)}{45.1086}\,\text{time} + \underset{(0.12232)}{0.341583}\,\Delta_4\text{dem}_{t-1}$$

$$T = 62 \quad \bar{R}^2 = 0.2228 \quad DW = 1.99$$

(standarderrorsinparentheses)

where $\Delta_4 = 1 - L^4$ gives fourth differences.
(ii) Explain why 4th difference model might be used for this data?
(iii) What can be deduced from the Durbin Watson statistic?
(iv) What might the presence of the time trend in Model I indicate?

Examination of the correlogram of the residuals from Model I shows the autocorrelations are (approximately) $\rho_0 = 1, \rho_1 = 0, \rho_2 = 0, \rho_3 = 0, \rho_4 = -0.5$ and zero thereafter.

(v) What does this pattern of residuals suggest? How does this relate to your answers to (c) and (d)?

An alternative strategy estimates the following model (where Q1,Q2,Q3 and Q4 are seasonal dummies)

Model II

$$\widehat{\text{dem}}_t = \underset{(12320.)}{65315.5}\,\text{Q1} + \underset{(12835.)}{47050.3}\,\text{Q2} + \underset{(10763.)}{51069.5}\,\text{Q3} + \underset{(10464.)}{66884.2}\,\text{Q4}$$

$$+ \underset{(0.12483)}{0.383250}\,\text{dem}_{t-1} + \underset{(89.901)}{288.831}\,\text{time} - \underset{(1.3345)}{4.94084}\,\text{time}^2$$

$$T = 62 \quad \bar{R}^2 = 0.9545$$

(standarderrorsinparentheses)

(vi) To what extent does Model II help explain the earlier results?
(vii) What problems might arise in using Model II as a forecasting model?