

Tutorial 10

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Part A

Autocorrelation vs Partial Autocorrelation

Consider a time series

$$y_t = \phi_0 + \phi_1 y_{t-1} + u_t$$

y_t is directly affected by y_{t-1} , the effect is measured by ϕ_1 .
However, y_t is indirectly affected by y_{t-2} and we can see that if we lag both sides of the equation.

$$y_{t-1} = \phi_0 + \phi_1 y_{t-2} + u_{t-1}$$

Autocorrelation vs Partial Autocorrelation

The partial autocorrelation at lag 1 will measure the direct effect of y_{t-1} on y_t .

- ▶ We are keeping y_{t-2} constant and not allowing for flow on effects, like a partial derivative

The autocorrelation at lag 1 will include the indirect effect that y_{t-2} has on y_t through y_{t-1}

- ▶ We are not keeping y_{t-2} constant but allowing for flow on effects

Part B

Question 1a

Download the SeattleElectric2005-6.xlsx file from Moodle and open it up in EViews

1. Create a dummy variable for Saturday and a variable for Sunday
2. Use these to create a dummy variable for the weekend

Question 1b

We're trying to predict aveload, the average electricity load on a particular day based on a few variables. Conduct some exploratory data analysis to determine what factors could be relevant in predicting average electricity usage. Feel free to use whatever software (e.g. Excel, R, Stata, Python, SAS, SPSS etc.) and techniques you feel comfortable with (e.g. Scatterplots, Bar charts, Pivot Tables)

Question 1c: Consequences of Serial Correlation

Estimate a regression of aveload on a constant, avetemp, wknd and pubhol.

Part of the electricity load that remains unexplained by the model could potentially be correlated over time. What consequences would this have for the OLS estimator?

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Question 1d: Identifying Serial Correlation

We think that the errors may follow an autoregressive process of order 7 (AR(7)). Let's check the correlogram of the residuals first. Next we'll conduct a Breusch-Godfrey test of the errors.

Our model is

$$aveload_i = \beta_0 + \beta_1 avetemp_i + \beta_2 wknd_i + \beta_3 pubhol_i + u_t$$

If the errors are AR(7), then:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \dots + \rho_7 u_{t-7} + e_t$$

And e_t are “true errors”, they are i.i.d. (independently and identically distributed) with mean 0 and variance σ^2

Question 1d: Breusch-Godfrey Test

The hypotheses are

$$H_0 : \rho_1 = \rho_2 = \dots = \rho_7 = 0$$

H_1 : At least one of the above is not zero

1. Estimate our main model via OLS
2. Obtain the residuals $\hat{u}_t, t = 1, 2, \dots, n$
3. Run an auxiliary (supporting) regression of the residuals on the explanatory variables and the lags of the residuals
4. The test statistic is $n \times R_{\hat{u}}^2$, what is its distribution under the null hypothesis?

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Question 1d,e: Identifying lag order of the errors

Now we want to include past residuals as explanatory variables in our estimated model. How many lags should we use? Have a look at the PACF of the correlogram and the statistical significance of the lagged residuals in our auxiliary equation.

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Question 1e: Including residuals in our estimated model through FGLS

Having decided on incorporating one lag in our residuals, we now want to estimate

$$aveload = \beta_0 + \beta_1 avetemp + \beta_2 wknd + \beta_3 pubhol + \rho_1 u_{t-1} + e_t$$

This can't be done by OLS because the model is no longer linear in parameters, instead we'll do this using FGLS instead.

Question 1e: Hypothesis testing

With our model free of serial correlation, we now want to test if the sensitivity of electricity load to temperature is different for weekends vs weekdays. Let's estimate:

$$\begin{aligned} aveload = & \beta_0 + \beta_1 avetemp + \beta_2 wknd + \beta_3 pubhol \\ & + \delta_1 wknd * avetemp + \rho_1 u_{t-1} + e_t \end{aligned}$$

And test $H_0 : \delta_1 = 0$ vs $H_1 : \delta_1 \neq 0$

Question 1f: Hypothesis testing

Using the regression model with AR errors, test whether or not having separate dummies for Sat and Sun would improve the model.