2005

Q. Define Autocorrelation. What are the sources of autocorrelation? (1+3) = 4

Correlation is defined as the measurement of degree of association between two variables. Autocorrelation is defined as the measurement of degree of association between the two values of a same variable. Auto correlation is special type of correlation. It is basically a time series problem. As, it is a time series problem. it is also known as serial correlation i.e. the correlation between two series of a same variable.

Here the two series of disturbance term are correlated. The actual meaning of autocorrelation is,

u_1	u_2
u_2	u_3
u_3	⋮
⋮	
u_{n-1}	u_{n-2}
u_n	u_{n-1}

$$E(u_t, u_{t\pm s}) \neq 0 \quad \forall\, t,\ s \neq 0$$

$$\Rightarrow \quad Cov(u_t, u_{t\pm s}) \neq 0.$$

It means that u_t and $u_{t\pm s}$ are pairwise autocorrelated i.e. co-variance between u_t and $u_{t\pm s}$ is not equal to zero. This violates the classical assumption of applying OLS method.

Though autocorrelation is a time series problem but it does not confirm that it is not appear in cross section data. It also comes up in the presence of ~~cor~~ cross section data. When we speak of autocorrelation in case of cross section data we measure the degree of association between two disturbance terms of two economic agents.

$$E(u_{it}, u_{jt}) \neq 0.$$

$$\Rightarrow \quad Cov(u_{it}, u_{jt}) \neq 0.$$

At the same point of time the two disturbance term of the two economic agent is correlated. It is the autocorrelation at the same point of time. This type of autocorrelation is known as contemporeneous auto correlation.

Sources of Autocorrelation

The presence of autocorrelation is very common in emperical research work. Autocorrelation comes up —

(1) Due to mis-specification of a model. The specified model is

$$Y_t = \beta_0 + \beta_1 X_t + u_t$$

But the actual model is,

$$Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_t^2 + u_t$$

we are neglecting a term X_t^2 in the specified model. Then,

$$Cov(u_t, \beta_2 X_t^2 + u_t) = \sigma_u^2$$

$$\text{ie.} \quad Cov(u_t, \beta_2 X_t^2 + u_t) \neq 0.$$

That means in the specified model autocorrelation is present

Scanned with CamScanner

The specified u_t and the actual u_t (i.e. $\beta_2 X_t^2 + u_t$) is correlated, it is not equal to zero. Then we can not estimate the model.

(2) Omission of relevant variables may lead to misspecification.

we specify the model.

$$D_t = \beta_0 + \beta_1 P_t + u_t$$

But the actual model is,

$$D_t = \beta_0 + \beta_1 P_t + \beta_2 Y_t + u_t$$

$$\therefore \quad cov\,(u_t, \beta_2 Y_t + u_t) \neq 0$$

Thus, the omission of certain variables may lead to the appearance of autocorrelation.

(3) Due to some measurement error autocorrelation may comes up. In generally we can write the consumption function as.

$$C_t = \alpha + \beta Y_t + u_t$$

C_t = consumption in period t

Y_t = disposable income in period t

But the actual model is,

$$C_t = \alpha + \beta\,(Y_t + V_t) + u_t$$

$$= \alpha + \beta Y_t + \beta V_t + u_t$$

V_t = measurement error. Y_t = income in period t

$$cov\,(u_t, \beta V_t + u_t) \neq 0.$$

$$\Rightarrow \beta\, cov\,(u_t, V_t) + \sigma_u^2 \neq 0$$

If we introduce proxy variable then measurement error comes up.

(4) In case of cob-web model

$$q_t^d = f\,(p_t, u_t) = a_0 + a_1 p_t + u_{1t} \rightarrow \text{demand function}$$

$$q_t^s = f\,(p_{t-1}, u_t) = b_0 + b_1 p_{t-1} + u_{2t} \rightarrow \text{Supply function}$$

$$q_t^d = q_t^s$$

$$\Rightarrow a_0 + a_1 p_t + u_{1t} = b_0 + b_1 p_{t-1} + u_{2t}$$

$$\Rightarrow p_t = \frac{b_0 - a_0}{a_1} + \frac{b_1}{a_1} p_{t-1} + \frac{u_{2t} - u_{1t}}{a_1}$$

$$\Rightarrow p_t = \frac{b_0 - a_0}{a_1} + \frac{b_1}{a_1} p_{t-1} + V_t$$

$$\Rightarrow p_t = \alpha_0 + \alpha_1 p_{t-1} + V_t$$

$$p_{t-1} = \alpha_0 + \alpha_1 p_{t-2} + V_{t-1}.$$

In P_{t-1} we can find a error V_{t-1}. Therefore,

$$cov(V_t, V_{t-1}) \neq 0$$

Thus, if we use cob-web model then there is no guaranty that autocorrelation is not come up.

(5) Due to averaging technique

Auto correlation may come up due to averaging technique.

1971
1972
⋮
1999
2000

Then we fit a trend equation.

$$\ln Y_t = \alpha + \beta t$$

x_1, x_2, x_3, ⋮, x_{20} — $\overline{x}_1$, $\overline{x}_2$, $\overline{x}_3$

Here. $\overline{x}_1$, $\overline{x}_2$, $\overline{x}_3$ are also interlinked or correlated. Therefore in case of moving average method autocorrelation also comes up.

When we use averaging technique, moving average technique, interpolation technique, extrapolation technique then the different values of a same variable is correlated i.e. autocorrelation appears.

Consequences of applying OLS technique when the disturbance term is autocorrelated

There will be atleast three consequences of applying OLSE where the disturbance term is autocorrelated.

(1) OLS estimators of the parameters of the model are linear and unbiased but sample variances are unduely large when there is AC and small when there is no AC. So, by applying OLS technique when there is AC we have lost minimum variance property.

(2) By the usual application of OLS formula for the sampling variance of the regression coefficient underestimate the sampling variance of the regression coefficient by applying OLS when there is autocorrelation.

(3) Because of underestimation of sampling variance the test statistic 't' will be overestimated and we get a wrong inference analysis. We obtain an inefficient prediction about the significance of the parameters.