AUTOCORRELATION AND ITS DETECTION

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AUTOCORRELATION

- In linear regression Analysis for time dependent phenomenon it is assumed that the error term doesn't depend upon its past (previous) value/s.
- If this assumption is not fulfilled then autocorrelation is said to be present.
- In presence of autocorrelation although the estimate remain unbiased and linear but will not have minimum variance.

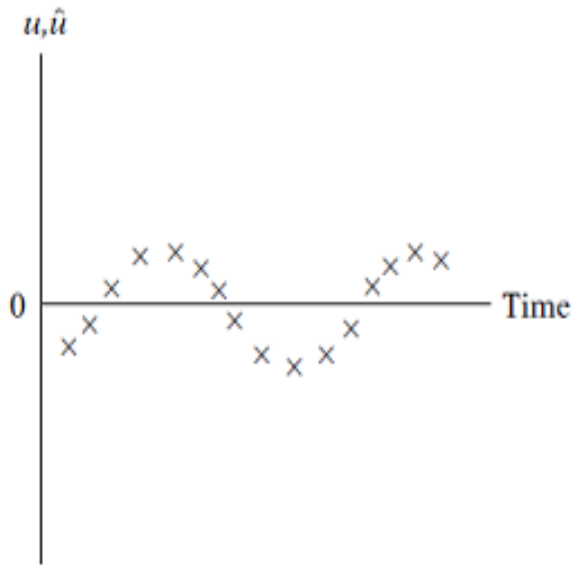
DETECTION OF AUTOCORRELATION

- There are several method for the detection of autocorrelation among which commonly used methods are:

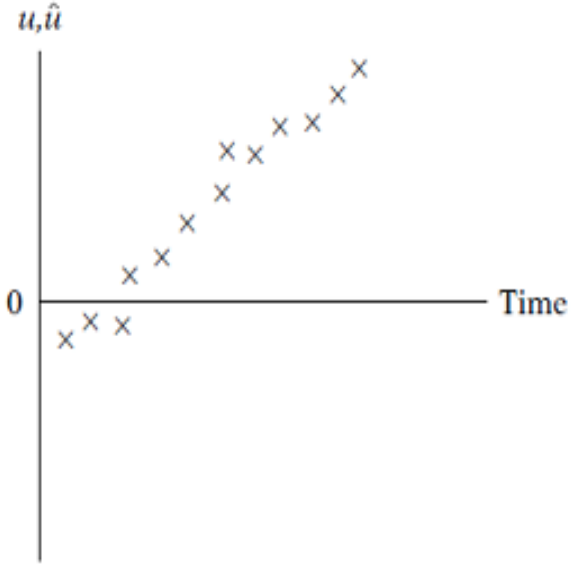
1. Graphical Method
2. Run Test
3. Durbin–Watson test

GRAPHICAL METHOD

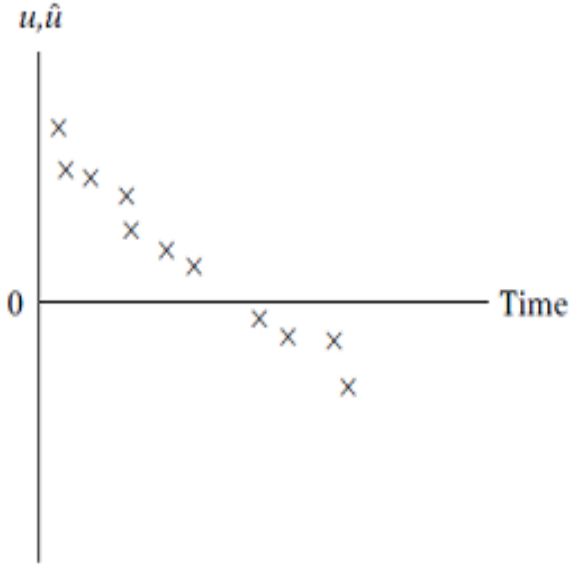
- In this method the residuals are plotted against the time.
- This plot is called as Time Sequence Plot.
- If time sequence plot doesn't exhibit any pattern then autocorrelation is said to be absent (fig. e).
- If it exhibit some pattern then autocorrelation is said to be present (Figure a, b, c & d)


$u,\hat{u}$
0
Time

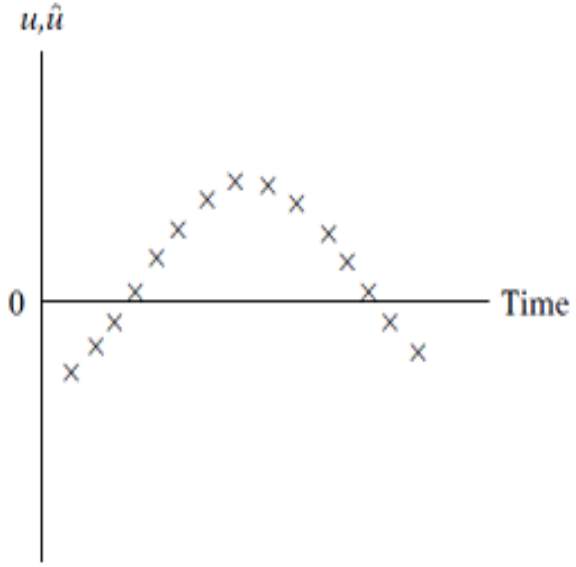
(a)


$u,\hat{u}$
0
Time

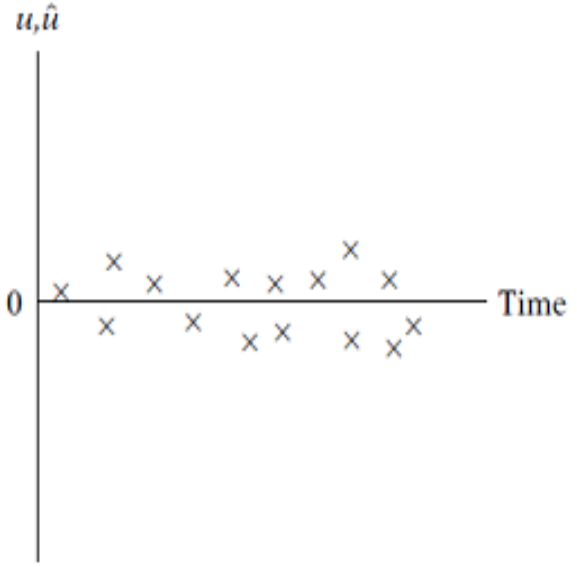
(b)


$u,\hat{u}$
0
Time

(c)


$u,\hat{u}$
0
Time

(d)


$u,\hat{u}$
0
Time

(e)

RUN TEST

- This method is similar to the run test for randomness.
- In this method first the regression model is fitted using OLS method and the residual are obtained.
- The residuals are arranged according to time.
- The no. of runs (R) formed by + and – signs are counted. If it exceeds the tabulated value then autocorrelation is said to be absent.
- If N_1 & N_2 are no. of + & – signs respectively then for large sample the test can be approximated by Wald's test using:

$$E(R) = \frac{2N_1N_2}{N_1+N_2} + 1, V(R) = \frac{2N_1N_2(2N_1N_2 - N_1 - N_2)}{(N_1+N_2)^2(N_1+N_2-1)}$$

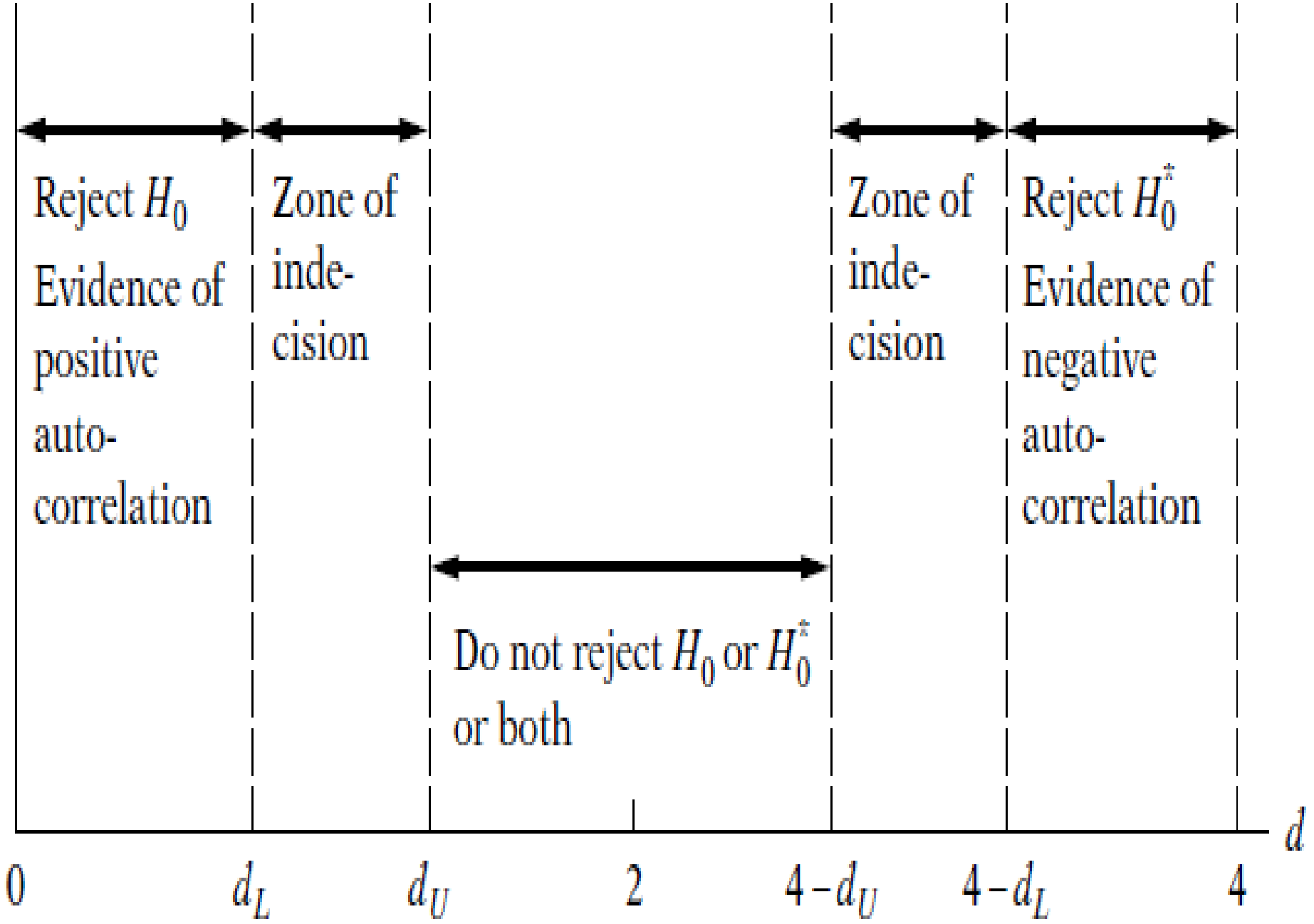
DURBIN–WATSON TEST

- This test was developed by Statisticians Durbin and Watson.
- It is most frequently used test for the detection of autocorrelation. It is also called as Durbin–Watson d test.
- It is used to test the null hypothesis that there is no autocorrelation.
- The Durbin–Watson d statistic is given by:

$$d = \frac{\sum_{t=2}^{n}(r_t - r_{t-1})^2}{\sum_{t=1}^{n} r_t^2}$$

DURBIN–WATSON TEST

- The value of d statistic lies between 0 and 4. A value near 0 shows the presence of positive autocorrelation, value near 4 shows presence of negative autocorrelation whereas value near two shows absence of autocorrelation.
- However it is difficult to decide how much near to 0, 2 or 4. Therefore a criteria was suggested by Durbin and Watson. They construct a table for upper bound (d_U) and lower bound (d_L) for the d statistic. This table is for 6 to 200 observations and maximum 20 explanatory variables. The decision criteria is explained in figure on next slide.


Reject H_0
Evidence of positive auto-correlation
Zone of inde-cision
Do not reject H_0 or H_0^* or both
Zone of inde-cision
Reject H_0^*
Evidence of negative auto-correlation
d
0
d_L
d_U
2
$4-d_U$
$4-d_L$
4

DURBIN–WATSON TEST

- The Durbin – Watson test is used under following assumptions only:

1. The Regression model includes intercept term.
2. The explanatory variables must be non stochastic (non random or fixed).
3. The error term must be normally distributed.
4. The regression term doesn’t include any lagged (past) value of dependent variable.
5. There must be no missing observation.
6. It can be used only for first order autocorrelation

REFRENCES

1. Gujrati DN, Basic Econometrics, 4th edition (2004) , The McGraw-Hill Companies.
2. Draper NR & Smith H, Applied Regression Analysis, 3rd edition (1998), John Wiley & Sons Inc.
3. Johnston J & Dinardo J, Econometric Methods, 4th edition (1997), McGraw-Hill Companies.