y Insignificant
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ıum Variance Unbiased
timators
ple Hypotheses Test
ple Restrictions
ality Assumption
Hypothesis
rator Degrees of Freedom

One-Sided Alternative
One-Tailed Test
Overall Significance of the Regression
p-Value
Practical Significance
R-squared Form of the F Statistic
Rejection Rule

Restricted Model
Significance Level
Statistically Insignificant
Statistically Significant
t Ratio
t Statistic
Two-Sided Alternative
Two-Tailed Test
Unrestricted Model

PROBLEMS

Which of the following can cause the usual OLS t statistics to be invalid (that is, not to have t distributions under H_0)?

(i) Heteroskedasticity.

(ii) A sample correlation coefficient of .95 between two independent variables that are in the model.

(iii) Omitting an important explanatory variable.

Consider an equation to explain salaries of CEOs in terms of annual firm sales, return on equity (*roe*, in percentage form), and return on the firm's stock (*ros*, in percentage form):

$$\log(salary) = \beta_0 + \beta_1 \log(sales) + \beta_2 roe + \beta_3 ros + u.$$

(i) In terms of the model parameters, state the null hypothesis that, after controlling for *sales* and *roe*, *ros* has no effect on CEO salary. State the alternative that better stock market performance increases a CEO's salary.

(ii) Using the data in CEOSAL1.RAW, the following equation was obtained by OLS:

$$\widehat{\log(salary)} = \underset{(.32)}{4.32} + \underset{(.035)}{.280} \log(sales) + \underset{(.0041)}{.0174}\, roe + \underset{(.00054)}{.00024}\, ros$$
$$n = 209,\ R^2 = .283.$$

By what percentage is *salary* predicted to increase if *ros* increases by 50 points? Does *ros* have a practically large effect on *salary*?

(iii) Test the null hypothesis that *ros* has no effect on *salary* against the alternative that *ros* has a positive effect. Carry out the test at the 10% significance level.

(iv) Would you include *ros* in a final model explaining CEO compensation in terms of firm performance? Explain.

The variable *rdintens* is expenditures on research and development (R&D) as a percentage of sales. Sales are measured in millions of dollars. The variable *profmarg* is profits as a percentage of sales.

Using the data in RDCHEM.RAW for 32 firms in the chemical industry, the following equation is estimated:

$$\widehat{rdintens} = \underset{(1.369)}{.472} + \underset{(.216)}{.321} \log(sales) + \underset{(.046)}{.050}\, profmarg$$
$$n = 32,\ R^2 = .099.$$

(i) Interpret the coefficient on log(*sales*). In particular, if *sales* increases by 10%, what is the estimated percentage point change in *rdintens*? Is this an economically large effect?

(ii) Test the hypothesis that R&D intensity does not change with *sales* against the alternative that it does increase with sales. Do the test at the 5% and 10% levels.

(iii) Interpret the coefficient on *profmarg*. Is it economically large?

(iv) Does *profmarg* have a statistically significant effect on *rdintens*?

4.4 Are rent rates influenced by the student population in a college town? Let *rent* be the average monthly rent paid on rental units in a college town in the United States. Let *pop* denote the total city population, *avginc* the average city income, and *pctstu* the student population as a percentage of the total population. One model to test for a relationship is

$$\log(rent) = \beta_0 + \beta_1 \log(pop) + \beta_2 \log(avginc) + \beta_3 pctstu + u.$$

(i) State the null hypothesis that size of the student body relative to the population has no ceteris paribus effect on monthly rents. State the alternative that there is an effect.

(ii) What signs do you expect for β_1 and β_2?

(iii) The equation estimated using 1990 data from RENTAL.RAW for 64 college towns is

$$\widehat{\log(rent)} = \underset{(.844)}{.043} + \underset{(.039)}{.066} \log(pop) + \underset{(.081)}{.507} \log(avginc) + \underset{(.0017)}{.0056}\ pctstu$$

$$n = 64,\ R^2 = .458.$$

What is wrong with the statement: "A 10% increase in population is associated with about a 6.6% increase in rent"?

(iv) Test the hypothesis stated in part (i) at the 1% level.

4.5 Consider the estimated equation from Example 4.3, which can be used to study the effects of skipping class on college GPA:

$$\widehat{colGPA} = \underset{(.33)}{1.39} + \underset{(.094)}{.412}\ hsGPA + \underset{(.011)}{.015}\ ACT - \underset{(.026)}{.083}\ skipped$$

$$n = 141,\ R^2 = .234.$$

(i) Using the standard normal approximation, find the 95% confidence interval for β_{hsGPA}.

(ii) Can you reject the hypothesis H_0: $\beta_{hsGPA} = .4$ against the two-sided alternative at the 5% level?

(iii) Can you reject the hypothesis H_0: $\beta_{hsGPA} = 1$ against the two-sided alternative at the 5% level?

4.6 In Section 4.5, we used as an example testing the rationality of assessments of housing prices. There, we used a log-log model in *price* and *assess* [see equation (4.47)]. Here, we use a level-level formulation.

(i) In the simple regression model

$$price = \beta_0 + \beta_1 assess + u,$$

the assessment is rational if $\beta_1 = 1$ and $\beta_0 = 0$. The estimated equation is

$$\widehat{price} = \underset{(16.27)}{-14.47} + \underset{(.049)}{.976}\ assess$$

$$n = 88,\ \text{SSR} = 165{,}644.51,\ R^2 = .820.$$