Chapter 17

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Chapter Outline
1. Bivariate Regression
2. Multivariate Regression

17.1 Bivariate Regression

17.1.1 Hypothesis Testing

1. Suppose regression of y on x with a sample of size 35 yields a slope coefficient of 7 with a standard error of 4.
(a) Perform a two-sided test of statistical significance of x at 5 percent. Use the critical value approach.
(b) Perform a two-sided test of statistical significance of x at 5 percent. Use the p value approach.
(c) Perform a one-sided test of positive statistical significance of x at 5 percent. Use the critical value approach.
(d) Perform a one-sided test of positive statistical significance of x at 5 percent. Use the p value approach.
(e) Perform a two-sided test at 10 percent of whether or not the slope coefficient equals 1.

17.1.2 Coefficient estimate, standard error and t statistic

2.**(a)** Suppose regression of y on x with a sample of size 35 yields a slope coefficient of 10 and a t statistic of 4. Calculate the standard error of the slope coefficient.
(b) Suppose regression of y on x with a sample of size 35 yields a slope coefficient of 10 and a p value of 0.0575. Calculate the t statistic. This is harder and will require

use of TINV.

17.1.3 R-Squared

3. Suppose regression of y on x with a sample of size 37 yields $R^2 = 0.4$.
(a) What is the correlation coefficient between y and x? Do we know the sign of the correlation coefficient?
(b) What fraction of the variance of y is explained by regression on x?
(c) If the sample variance of y is 100 what is the total sum of squares of y?
(d) Given $R^2 = 0.40$ and using the answer to part (c), calculate the error sums of squares R^2 in the regression of y on x.

17.1.4 Inflation and Money Supply Growth

An implication of the quantity theory of money is that the growth in the quantity of money is the primary determinant of the inflation rate. Let INFL denote the inflation rate, based on the GDP deflator, expressed in percentage terms and GM2 denote the percentage growth in money supply measured using M2, the sum of currency, demand deposits, traveler's checks, other checkable deposits, overnight repurchase agreements, Eurodollars, money market deposit accounts, money market mutual fund shares, and savings and small time deposits.
Using annual data from 1960 to 1998, INFL has sample mean of 4.19 and sample variance of 6.19, while GM2 has sample mean of 7.12 and sample variance of 9.32. The following gives results of regression of INFL on GM2, with $R^2 = 0.13$.

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	2.093872521	0.965631851	2.168396	0.036631
GM2	0.294905384	0.124894803	2.36123	0.023592

Figure 17.1: Regression of percentage inflation rate on percentage growth in M2.

1. Explain how to calculate GM2, the percentage change in M2, given data on M2.
2. Which is more volatile, inflation or money supply growth?
3. Is GM2 statistically significant in the regression at 5 percent?
4. According to the regression results, a one percentage point increase in the growth rate of M2 is associated with amount of change in the inflation rate?
5. Is an increase in M2 of one percentage point associated with a one percentage point increase in the inflation rate? Perform an appropriate statistical significance test at significance level 5 percent.
6. Are INFL and GM2 highly correlated?

7. There is a great debate about whether money supply growth leads to inflation or whether inflation leads to money supply growth? Which of these two theories, if any, does the regression here support?

17.1.5 Okun's Law

According to Okun's Law there is a negative relationship between unemployment and real GDP, with a decrease in unemployment of one percentage point being associated with additional growth in real GDP of two percent. Regression of the percentage change in real GDP on change in unemployment rate using annual U.S. data from 1960 to 1998 yields the regression results in the figure.

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.031753228	0.001977186	16.0598	2.9154E-18
CHANGE IN UNEM	-1.950919378	0.212418975	-9.1843	4.4262E-11

Figure 17.2: Okun's Law. Regression of percentage change in real GDP on change in unemployment rate.

1. Explain how to calculate the percentage change in real GDP given data on real GDP.
2. Is the change in unemployment statistically significant at 5 percent?
3. Is the coefficient of the change in unemployment statistically significantly different from the hypothesized value of -2? perform an appropriate test at significance level 5 percent.
4. Suppose a recession leads to an increase in the unemployment rate from 5 percent to 7 percent in the course of a year. What is the predicted reduction in the growth rate of real GDP?

17.2 Multivariate Regression

17.2.1 Hypothesis Testing

1. Suppose regression of y on $x2$and $x3$ with a sample of size 40 yields $x2$ with coefficient of 20 and t ratio of 2.5 and $x3$ with coefficient of 40 and t ratio of 1.5.
(a) Perform a two-sided test of statistical significance of $x2$ and $x3$ at 5 percent. Use the critical value approach.
(b) Perform a two-sided test of statistical significance of $x2$ and $x3$ at 5 percent. Use the p value approach.

(c) Perform a two-sided test at 10 percent of whether or not the coefficient of $x3$ equals 20. Note that to do this you will first need to calculate the standard error of $x3$, which is possible given the information above.

17.2.2 F-test, R-squared and Adjusted R-squared

2. Suppose in a sample of size 35 that regression of y on $x2$ yields $R^2 = 0.40$, while regression of y on $x2$ and $x3$ yields $R^2 = 0.41$.
(a) Perform an F test of whether or not $x2$ is statistically significant at 5 percent in regression of y on $x2$.
(b) Perform an F test of whether or not $x2$ and $x3$ are jointly statistically significant at 5 percent in regression of y on $x2$ and $x3$.
(c) Which of the two regression models is preferred on the basis of $\bar{R}^2$, the adjusted R^2.

17.2.3 Republican Voting

Spot-on, a political consulting firm, believes that the vote for the Republican presidential candidate in a region is positively associated with growth in the region and negatively related with the amount of money people in the region are willing to spend in government services. Using data from each of the 50 states, Spot-on obtains the following output for 50 states. [ARE 106 Fall 90 Final].

$$VOTEREPUB = \underset{(20.63)}{58.5814} + \underset{(3.22)}{0.27829} \times POPCH - \underset{(-2.24)}{0.0014034} \times SCHOOL \qquad R^2 = 0.258.$$

Here VOTEREPUB is the percentage of voters in the state voting for the Republican presidential candidate in the 1988 election, POPCH is the percentage change in the state's population from 1980-1988, and SCHOOL is school expenditures per pupil in 1988 (in dollars). Spot-on believe that POPCH is a good measure of state growth, and SCHOOL is a good measure of voters' willingness to provide of government services.
1. Are the coefficients of the two regressor variables statistically significant? Do a two-tailed test at 5 percent.
2. Does the estimated least squares regression support the theory of Spot-on? Explain you answer.
3. Are the two regressors jointly significant at 5 percent? Perform an appropriate F test.
4. With the growth of super-nations, such as the European Community, political strategists look to the day when Canada becomes the fifty-first state of the U.S. The population of Canada grew by 10 percent between 1980 and 1988, and 1988

Canadian school expenditures were $4,000 per pupil (in U.S. dollars.) Would a majority of Canadians have voted for the Republican U.S. presidential candidate in 1988? Explain your answer.

5. An ambitious staff member points out to the founder of Spot-on that a far superior model to the above would be one that additionally includes the variable INCOME, which equals personal income per capita in 1987 (in dollars). Do you expect INCOME to be positively or negatively related to VOTEREP? Explain your answer (in less than 15 words).

6. Upon running a least squares regression with the same regressors as above, plus INCOME as a regressor, the ambitious staff member excitedly reports to the boss that the model with INCOME also included is indeed superior, since the R^2 has increased, to 0.270. Explain how the ambitious staff member has just humiliated himself in front of the boss.

7. Compare the two models (with and without INCOME) in a way that overcomes this objection. Which model do you prefer? Why?