ECOM20001: Econometrics 1

Tutorial 9: Joint Hypothesis Testing with Multiple Linear Regression

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A. Getting Started

Please create a Tutorial9 folder on your computer, and then go to the LMS site for ECOM 20001 and download the following files into the Tutorial9 folder:

- tute9.R
- tute9_smoke.csv

The first file is the R code for tutorial 9. The second file is a micro dataset[1] with the following 13 variables:

- id: baby identifier
- birthweight: baby's birthweight in grams
- smoker: equals one if mother is a smoker, 0 otherwise
- alcohol: equals one if mother drank alcohol during pregnancy, 0 otherwise
- drinks: number of drinks per week during pregnancy
- nprevisit: total number of prenatal visits
- tripre1: equals one if 1st prenatal care in 1st trimester, 0 otherwise
- tripre2: equals one if 1st prenatal care in 2nd trimester, 0 otherwise
- tripre3: equals one if 1st prenatal care in 3rd trimester, 0 otherwise
- tripre0: equals one if no prenatal visits, 0 otherwise
- unmarried: equals one if mother is unmarried
- educ: years of educational attainment of mother
- age: age of mother
- gambles: equals one if mother is a problem gambler, 0 otherwise

In total, the dataset contains this information for n=3000 babies and their mothers.

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[1] Recall from Tutorial 7 that this dataset is from Almond, D and K. Chay (2005): "The Costs of Low Birth Weight," *Quarterly Journal of Economics*, 120(3): 1031-1083.

B. Go to the Code

With the R file downloaded into your Tutorial9 folder, you are ready to proceed with the tutorial. Please go to the tute9.R file to continue with the tutorial.

C. Questions

Having worked through the tute9.R code and graphs, please answer the following:

Start by re-running the main regression of birthweight on the following set of regressors:

- smoker, alcohol, drinks, nprevisit, tripre1, tripre2, tripre3, unmarried, educ, age

Throughout, use heteroskedasticity-robust standard errors in conducting the various hypothesis tests below, unless otherwise stated in the question.

Testing Joint Hypotheses About Regression Coefficients

1. Compute the overall regression F-statistic and corresponding p-value for the test of the null that all of the regression coefficients jointly equal 0 against the alternative that at least one coefficient does not equal 0.
   - Compute this F-statistic and p-value using two different commands in R: waldtest(), and linearHypothesis(). The tute9.R code provides details on these R commands.
   - Compare your results to the overall regression F-statistic that is reported using the summary() command in R, which assumes homoskedasticity.
2. Using the regression from question 1, run the following joint hypothesis tests, reporting the F-statistic, degrees of freedom, and p-value for each. Also provide a plain language interpretation for each test result.
   - Test the joint null that the coefficients on smoker and alcohol both equal 0 against the alternative that at least one of the equalities does not hold.
   - Test the joint null that the coefficient on smoker equals -200 and that the coefficient on alcohol equals -50 against the alternative that at least one of the equalities does not hold.

- Test the joint null that the coefficients on tripre1, tripre2 and tripre3 all equal 0 against the alternative that at least one of the equalities does not hold.
- Test the joint null that the coefficients on tripre1, and tripre2 equals 0 against the alternative that at least one of the equalities does not hold. Compare your results to the joint null you just tested that the coefficients on tripre1, tripre2 and tripre3 all equal 0, and provide intuition for the difference in p-values of the respective tests.
- Test the joint null that the coefficient on tripre1 equals 200, the coefficient on tripre2 equals 300, and the coefficient on tripre3 equals 400 against the alternative that at least one of the equalities does not hold.

3. Compute, by hand, the homoskedasticity-only F-statistic and corresponding p-value for the joint null that the coefficients on tripre1, tripre2 and tripre3 all equal 0 against the alternative that at least one of the equalities does not hold.

Testing Joint Restrictions Involving Multiple Regression Coefficients

4. Using the regression from question 1, run the following joint hypothesis tests involving multiple regression coefficients, reporting the F-statistic, degrees of freedom, and p-value for each. Also provide a plain language interpretation for each test result.
   - Test the joint null that the coefficient on smoker equals the coefficient on alcohol against the alternative that the equality does not hold.
   - Test the joint null that the coefficient on smoker is twice the coefficient of alcohol against the alternative that the equality does not hold.
   - Test the joint null that the sum of the coefficients on smoker and alcohol equals -200 against the alternative that the equality does not hold.
   - Test the joint null that the sum of the coefficients on alcohol and unmarried equals the coefficient on smoker against the alternative that the equality does not hold
   - Test the joint null that the coefficient on tripre1 equals the coefficient on tripre2 and that the coefficient on tripre2 equals the coefficient on tripre3 against the null that at least one of the equalities does not hold.
   - Test the joint null that the coefficient on tripre2 equals 2 times the coefficient on tripre1 and that the coefficient on tripre3 equals 2 times the coefficient on tripre2 against the null that at least one of the equalities does not hold.

5. Create a new, transformed regression based on the regression from question 1 that allows you to conduct a single hypothesis test of an individual regression coefficient using a t-statistic that yields the identical p-value to the joint test of the null that the sum of the coefficients on alcohol and unmarried equals the coefficient on smoker against the alternative that the equality does not hold.