Module 15: Advanced interactions

(The attached PDF file has better formatting.)

Practice problems for Interactions, dummy variables, F tests

(This posting covers Modules 14 and 15.)

*Question 15.1: Hypothesis testing

We use regression analysis to compare personal auto claim frequency in urban, suburban, and rural areas.

Claim frequency = $\alpha + \beta_1 D_1 + \beta_2 D_2 + \epsilon$, where

- D_1 = 1 for urban and 0 otherwise
- D_2 = 1 for sub-urban and 0 otherwise

How do we show that territory (urban vs sub-urban vs rural) is significant?

A. The *t*-values for both β_1 and β_2 are greater than their critical values.
B. The *t*-value for either β_1 or β_2 is greater than its critical value.
C. The *t*-values for both β_1 and β_2 are less than their critical values.
D. The *F*-value for β_1 plus β_2 is greater than its critical value.
E. The *F*-value for β_1 plus β_2 is less than its critical value.

Answer 15.1: D

By "β_1 plus β_2" we mean the F test examining the combination of these two coefficients. Fox uses qualitative explanatory variables in many examples, just as actuaries use age, sex, and other attributes of the insured.

*Question 15.2: Parameters

We regress personal auto claim frequency on (i) annual driving and (ii) urban, suburban, and rural areas.

Claim frequency = $\alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 DD + \epsilon$, where

- D_1 = 1 for urban and 0 otherwise
- D_2 = 1 for sub-urban and 0 otherwise
- DD = annual driving distance in kilometers

What is the predicted difference in claim frequency for urban vs sub-urban insureds driving 30,000 kilometers a years?

A. $\beta_1 + \beta_2 + \beta_3 \times 30{,}000$
B. $\beta_1 - \beta_2 + \beta_3 \times 30{,}000$
C. $\beta_1 + \beta_2$
D. $\beta_1 - \beta_2$
E. $\beta_1 D_1 + \beta_2 D_2$

Answer 15.2: D

*Question 15.3: Principle of marginality

An actuary regresses personal auto claim frequency on (i) amount of driving, (ii) income of driver, and (iii) territory. Driving and income are quantitative explanatory variables, and territory is a qualitative factor with three levels: urban, sub-urban, and rural.

Which of the following correctly reflects the principle of marginality?

A. The income by territory interaction is marginal to the income effect.
B. The amount of driving effect is marginal to the amount of driving by territory interaction.
C. We do not test the income by territory interaction until we test the income effect.
D. If we can rule out a main effect on theoretical grounds, we test the interaction effect.
E. None of A, B, C, or D is true.

Answer 15.3: B

(P135)

Fox emphasizes the principle of marginality. Some other textbooks do not discuss this topic. It is useful for actuarial analyses, which looks at the interactions of policyholder attributes.