**ONE COMMON MISS-USED OF F-test (ANOVA) IN REGRESSION: Testing Symultaneous Effect of Independent Variables**

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In regression analysis of the following model (without loss of generality, let’s have three independent variables):

$$Y=β\_{0}+β\_{1}X\_{1}+β\_{2}X\_{2}+β\_{3}X\_{3}+ε……………………(1)$$

one might want to test whether the three independent variables have an impact simultaneously on the dependent variable Y. It is common to have this tested (mistakenly) by using the ***F-test*** from the ANOVA of the regression, or equivalently by looking at corresponding *p-value*. It is mistaken because the hypothesis corresponding to such F-test is:

H0: $β\_{1}=β\_{2}=β\_{3}=0$ against

H1: At least one of the betas is not equal to zero

So for example if we reject H0, it only means that one or more of the $β\_{i}$ is not equal to zero and to know which one that is not equal to zero, can be tested partially using ***t-test****.*

How then we can test hypothesis to find out the effect of all independent variables simultaneously? We approach this by introducing a new variable into equation (1), that is, multiplication of all independent variables as follows:

$$Y=β\_{0}+β\_{1}X\_{1}+β\_{2}X\_{2}+β\_{3}X\_{3}+β\_{4}X\_{1}X\_{2}X\_{3}+ε……………………(2)$$

Now, to test such hypothesis then is equivalent to testing

H0: $β\_{3}=0$ against

H1: $β\_{3}\ne 0$

If from the data there enough evidence to reject H0 then it can be concluded that the three independent variables interact (*hence the term to test the “interaction” of the independent variables)* or simultaneously has an impact on the dependent variable Y. Researchers might want to test the impact of interaction of pairs of the independent variables. In such case, we would have to introduce three more independent variables into equation (2) as follows:

$$Y=β\_{0}+β\_{1}X\_{1}+β\_{2}X\_{2}+β\_{3}X\_{3}+β\_{4}X\_{1}X\_{2}+β\_{5}X\_{1}X\_{3}+β\_{6}X\_{2}X\_{3}+β\_{7}X\_{1}X\_{2}X\_{3}+ε…(3)$$

And testing the impact of the interaction would be testing the corresponding betas, i.e., $β\_{i}$, *i =4,5,6,7.*