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## **Assignment 5: Multiple Linear Regression Refresher**

**(60 points + 9 bonus points)**

**Due: by 11:59 pm, Sunday, April 4<sup>th</sup>, 2021**

*\* No assignments will be accepted late without written documentation of an unavoidable or unforeseeable event.*

### **Why this assignment?**

This assignment is intended to achieve the goal of our Module 10 learning objective, “conduct a multiple linear regression analysis to investigate and evaluate the relationship between two variables while holding other conditions constant.” This skill is also needed to do the assignment in the following module (*Module 11: Pay Discrimination*).

### **Instruction**

Watch the video *Multiple Linear Regression Refresher* in Module 10 and answer the questions (Questions 1 to 3) on pages 4 to 7 of this document. For this assignment, you’ll need to analyze the attached data (*Dataset for Assignment 5*) using the Microsoft Excel software.

### **Important Note**

1. In writing your answers, **NEVER copy-and-paste any part of the textbook or any other sources**. Write the answers in your own words. If more than seven consecutive words are identical to a writing from another source (including the textbook, your past works, and any other sources), it will be considered as plagiarism, and you will receive a failing grade “F” in this course. You will also be referred to Students Affairs.
2. I change the numbers on the dataset every semester. So, **do not copy-and-paste the answers from the assignments that were given out in this course in the past**. In the case of your answers being the same as the answers in the past, it will be regarded as plagiarism and behavior that violates the ‘4. Ethics’ category of the professional etiquette outlined on page 5 of our syllabus. In this case, you will receive a failing grade “F” in this course and be referred to Students Affairs.
3. In Excel, ‘E’ is often used to indicate a very small decimal number. For example, 2.37E-20 is not 2.37. 2.37E-20 is 0.000000000000000000237. How to interpret ‘E’ was explained in the video *Simple Linear Regression Refresher* in Module 6 (in a yellow box from runtime 23:14 to 23:42).

### **Grading Rubric**

There is no rubric for this assignment. If you answer a question right, you’ll receive a full credit assigned for that question. If you do not answer a question right, you’ll receive 0 points for that question. The answers for the ‘Example Question’ will be provided on pages 2 and 3 of this document. How you phrase your answers for Questions 1 to 3 should be similar. The cases that will be graded as wrong answers are also shown in the ‘Example Question.’ Please read this carefully before you start your assignment.

### Example Question

For this question, use the data on the sheet *Example Question* in the attached Excel file (*Dataset for Assignment 5*).

A researcher wanted to examine the relationship between job security perception and job satisfaction, holding stress level constant.

As in the datasheet, the researcher has collected data from 99 participants. Columns B, C, and D represent job security perception, stress level, and job satisfaction of the participants, respectively.

**Example Question 1.** Conduct a simple linear regression analysis with *job security perception* as the independent variable (X) and *job satisfaction* as the dependent variable (Y). What is the estimated linear regression equation?

**Answer:**  $\text{Job satisfaction} = 0.55 * \text{Job security perception} + 1.30$

**Example Question 2.** Explain the relationship between *job satisfaction* and *job security perception* based on the simple linear regression equation that you have estimated in Example Question 1. Also, report the p-value for the coefficient of interest.

**Answer:**

**The p-value for the coefficient of job security perception in the equation is smaller than 0.05 ( $9.46 * 10^{-10}$ ). So, we can expect the job satisfaction level to increase by 0.55 points as the job security perception level increases by one point.**

*\* Cases that will be graded as wrong answers.*

- *The p-value is not reported.*
- *The relationship is explained but not specifically in numbers. (e.g., "There is a positive relationship between job satisfaction and job security perception.", "Job satisfaction level increases as job security perception increases.")*
- *The relationship is explained but not in an easy-to-understand English format. (e.g., when the independent variable is gender, using a phrase like "one unit increase in gender (or female)")*

**Example Question 3.** Now, conduct a multiple linear regression with *job security perception* and *stress level* as the independent variables (Xs) and *job satisfaction* as the dependent variable (Y). What is the estimated linear regression equation?

**Answer:**  $\text{Job satisfaction} = 0.01 * \text{Job security perception} - 0.82 * \text{Stress level} + 5.40$

**Example Question 4.** Explain the relationship between *job satisfaction* and *job security perception* based on the multiple linear regression equation that you have estimated in Example Question 3. Also, report the p-value for the coefficient of interest.

**Answer:**

The p-value for the coefficient of job security perception in the equation is larger than 0.05 (0.92). So, there is no significant relationship between job satisfaction and job security perception holding stress level constant. (You can also say something like “When the stress level is the same, we can expect that there is no relationship between job satisfaction and job security perception.”)

*\* Cases that will be graded as wrong answers.*

*- All the cases presented in Example Question 2.*

*- And the following: The relationship is explained, but the phrase “holding stress level constant” (or some other variations of this phrase) is not stated.*

**Example Question 5.** Based on the results of simple linear regression and multiple linear regression, what is your speculation of the relationship among the three variables in the model (i.e., job satisfaction, job security perception, and stress level)? You do not need to draw a figure for this.

**Possible Answer:**

There is a significant positive relationship between job satisfaction and job security perception, but this relationship disappears when the stress level is held constant. And although not reported in other steps in this question, the relationship between job satisfaction and stress level is significantly negative. And when you run a simple linear regression with job security perception as the independent variable (X) and stress level as the dependent variable (Y), the relationship is significantly negative. So, I would speculate the overall relationship to be that job security perception negatively affects stress level, and in turn, the stress level negatively affects job satisfaction.

**Question 1 (Total of 20 points + 3 bonus points)**

For this question, use the data on the sheet *Question 1* in the attached Excel file (*Dataset for Assignment 5*).

Jake, the owner of the Jake Automotive, wanted to examine the relationship between the number of cars that his sales associates sold and their happiness level of work-life balance holding average work hours constant.

As in the datasheet, Jake has collected data from 49 sales associates. Columns B, C, and D represent an average number of car sold per month, average work hours per week, and happiness level with the work-life balance of the sales associates, respectively.

**Question 1-1.** Conduct a simple linear regression analysis with a *number of cars sold per month* as the independent variable (X) and *happiness level with work-life balance* as the dependent variable (Y). What is the estimated linear regression equation? **(4 points)**

**Question 1-2.** Explain the relationship between a *number of cars sold per month* and *happiness level with work-life balance* based on the simple linear regression equation that you have estimated in Question 1-1. Also, report the p-value for the coefficient of interest. **(6 points)**

**Question 1-3.** Now, conduct a multiple linear regression with a *number of cars sold per month* and *average work hours per week* as the independent variables (Xs) and *happiness level with work-life balance* as the dependent variable (Y). What is the estimated linear regression equation? **(4 points)**

**Question 1-4.** Explain the relationship between a *number of cars sold per month* and *happiness level with work-life balance* based on the multiple linear regression equation that you have estimated in Question 1-3. Also, report the p-value for the coefficient of interest. **(6 points)**

**Bonus Question 1.** Based on the results of simple linear regression and multiple linear regression, what is your speculation of the relationship among the three variables in the model (i.e., an average number of car sold per month, average work hours per week, and happiness level with work-life balance)? You do not need to draw a figure for this. And if Jake wants to increase the happiness level with the work-life balance of his sales associates, what should he do? The suggestion should be based on the results of the analyses that you have done. **(3 bonus points)**

**Question 2 (Total of 20 points + 3 bonus points)**

For this question, use the data on the sheet *Question 2* in the attached Excel file (*Dataset for Assignment 5*).

A researcher wanted to examine the relationship between job satisfaction and years of education holding gender constant.

As in the datasheet, the researcher has collected data from 100 individuals. Columns B, C, and D represent years of education, gender (male = 0, female = 1), and job-satisfaction level of the participants, respectively.

**Question 2-1.** Conduct a simple linear regression analysis with *years of education* as the independent variable (X) and *job satisfaction* as the dependent variable (Y). What is the estimated linear regression equation? **(4 points)**

**Question 2-2.** Explain the relationship between *years of education* and *job satisfaction* based on the simple linear regression equation that you have estimated in Question 2-1. Also, report the p-value for the coefficient of interest. **(6 points)**

**Question 2-3.** Now, conduct a multiple linear regression with *years of education* and *gender* as the independent variables (Xs) and *job satisfaction* as the dependent variable (Y). What is the estimated linear regression equation? **(4 points)**

**Question 2-4.** Explain the relationship between *years of education* and *job satisfaction* based on the multiple linear regression equation that you have estimated in Question 2-3. Also, report the p-value for the coefficient of interest. **(6 points)**

**Bonus Question 2.** Based on the results of simple linear regression and multiple linear regression, what is your speculation of the relationship among the three variables in the model (i.e., years of education, gender, and job-satisfaction)? You do not need to draw a figure for this. **(3 bonus points)**

**Question 3 (Total of 20 points + 3 bonus points)**

For this question, use the data on the sheet *Question 3* in the attached Excel file (*Dataset for Assignment 5*).

A researcher wanted to examine the relationship between gender and pay holding job performance and shift type constant.

As in the datasheet, the researcher has collected data from 70 individuals. Columns B, C, D, and E represent gender (male = 0, female = 1), job performance, shift type (day shift = 0, night shift = 1), and annual pay of the participants, respectively.

**Question 3-1.** Conduct a simple linear regression analysis with *gender* as the independent variable (X) and *annual pay* as the dependent variable (Y). What is the estimated linear regression equation? **(2 points)**

**Question 3-2.** Explain the relationship between *gender* and *annual pay* based on the simple linear regression equation that you have estimated in Question 3-1. Also, report the p-value for the coefficient of interest. **(4 points)**

**Question 3-3.** Now, conduct a multiple linear regression with *gender* and *job performance* as the independent variables (Xs) and *annual pay* as the dependent variable (Y). What is the estimated linear regression equation? **(3 points)**

**Question 3-4.** Explain the relationship between *gender* and *annual pay* based on the multiple linear regression equation that you have estimated in Question 3-3. Also, report the p-value for the coefficient of interest. **(4 points)**

**Question 3-5.** Now, conduct a multiple linear regression with *gender*, *job performance*, and *shift type* as the independent variables (Xs) and *annual pay* as the dependent variable (Y). What is the estimated linear regression equation? **(3 points)**

**Question 3-6.** Explain the relationship between *gender* and *annual pay* based on the multiple linear regression equation that you have estimated in Q3-5. Also, report the p-value for the coefficient of interest. **(4 points)**

**Bonus Question 3.** Based on the results of simple linear regression and multiple linear regressions, what is your speculation of the relationship among the four variables in the model (i.e., gender, job performance, shift type, and annual pay)? You do not need to draw a figure for this. **(3 bonus points)**





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