EC 320: Introduction to Econometrics
Lecture Notes

David M. Hall
University of Oregon

Fall 2025

1 Session Overview

- Date:
- Topic:
  - Chapters (Dougherty):
- Goals/Objectives:
  1. One
  2. Two
  3. Three

1.1 Before Class:

2 During Class:

2.1 Welcome

- Explain goals and plan for the day here.

2.1.1 Warm Up:

Example 2.1. Match the proper transformation for OLS:

Theortical Function	**Transformation**
$Y = \beta_0 + \beta_1 X_1 + \varepsilon$	Logarithmic
$Y = \beta_0 + \beta_1 X_1^3 + \beta_2 log(X_2) + \varepsilon$	None
$Y = \beta_0 X^{\beta_1}$	Semi-Log
$Y = \beta_0 e^{\beta_1 X}$	Variable Transformation

2.2 Content Section #1:

Time:

2.2.1 Models with Quadratic and Interaction Terms

Prior to logarithmic transformation, we dealt with simple linear models where the theoretical model was written s.t.

$$Y = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k + \varepsilon \tag{1}$$

and we noted that sometimes you will have a case where just your *variables* need transformation. One of those cases was our variable exponentiated s.t.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_1^2 + \varepsilon \tag{2}$$

Note here that X_1 enters linearly as well as through a second power. We can also note that we can simply estimate these models via OLS. It is the interpretation of the models that we need to work on.

For the quadratic model, you'll want to estimate what the effect of a one-unit shock in X_1 would be. You have already seen that to get that effect, you would simply differentiate Y w.r.t. X_1 s.t.:

$$\frac{dY}{dX_1} = \beta_1 + 2\beta_2 X_1$$

You'll notice two things here:

1. This equation depends on *two* coefficients.
2. This equation depends on a variable itself.

So when interpreting an effect of X_1, the effect will vary based on where the current value is. This is fairly common in economics; a common theme you have come across is "marginal returns". The marginal return to producing another product depends entirely on what you have *already* produced. If your goal was to estimate the marginal cost/product/return of producing more bananas in America, you would use an equation such as this to better understand when production becomes profit-maximizing.

A common example might also be a wage regression with age as a variable. We might think that an older person would make a higher wage as they gain more experience (pretend we do not observe experience). Experience increases their marginal product of labor, and therefore their wage. Yet, as you age even further, your marginal product of labor might decrease due to other features of aging.

If age were to enter linearly into your equation, you might overestimate the impact of age, particularly for older people who are physically deteriorating.

2.2.2 Interaction Variables

Sometimes, an outcome depends on not just a single variable but on multiple variables. Or, estimating the effect of a single variable without consideration of others' interaction with it may be invalid.

For example, consider our exam score regression. We can separately estimate the effect of hours of sleep and hours of study on exam scores, but think about how these variables *interact*. If one is studying for an exam on 3 hours of sleep, are they going to retain the information well?

An interaction variable can assist in estimating the effect of one variable, say study hours in this instance, conditional on other relevant factors such as sleep.

The theoretical model may look something like this (single interaction):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 X_2 + \varepsilon \tag{3}$$

Similarly here, we can note that if we want to get the effect of X_2 on Y then we need to consider X_3:

$$\frac{dY}{dX_2} = \beta_2 + \beta_3 X_1 \tag{4}$$

We can also see this by simply rewriting the equation:

$$Y = \beta_0 + (\beta_2 + \beta_3 X_1) X_2 + \beta_1 X_3 \tag{5}$$

2.3 Rest of Class: Work on Interpretation

2.4 Summary Activity (5 Q's of Reflection):

3 Be Able To

- Write out a be able to - separate but related to the goals of this lecture.

4 Key Words

- Fill in Here