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Applied Econometrics
Forecasting for Economics and Business
Module II, 2018-2019

Group Project Case

This group project will contribute 30% towards your final grade in this unit.

It is due in hardcopy, no later than 5:00pm on 18th January 2019.

Late submission will not be accepted and will attract a mark of 0.

The purpose of this project is to assess your knowledge of material in Applied Econometrics.

(Adapted from Eso, Hunter, Klibanoff, and Schmedders(2003))

Bob Johnson, Head of the Contracts Department at ODOT (Orangia [1] Department of Transportation), has been sleeping badly lately. With only 3 months until his retirement in February 2019, he not only has to subtly quash his wife's plans to travel around the US in a Winnebago (having spent his whole working life building roads, the last thing he needs is to stare at them throughout retirement!), but he desperately would like to earn the final bonus available to him at the end of this month, December 2018. Because his defined benefit pension scheme calculates his retirement proceeds based on his final year all-in compensation, his $200,000 bonus is actually worth over $2000,000 to him, a fortune for the hard-working, clean living veteran government employee of 40 years.

The Orangia Department of Transportation, specifically Bob's Contracts Department, regularly organizes auctions to find the cheapest contractors for road construction projects. As such, Bob's bonus is based on whether the aggregate price paid by the department for the projects undertaken during the calendar year falls within the department's budget. One more project with expected cost of $10 million is being auctioned off this year. Currently (excluding the final project) Bob is $9.1 million below his budget, so he knows it will be tight. The rule is simple: below budget results in a $200,000 bonus. Bob knows, of course, that this system is as inefficient as it is simple. Firstly, it provides him with an incentive to puff up his budget and no incentive to exceed expectations if within budget. Secondly, his reward depends on many

[1] Orangia is the name of a fictional state.

inputs out of his control such as bidder aggressiveness (Bob is glad, however, that there isn't a fickle stock-price to tie his compensation to). Finally, he is evaluated purely on the basis of upfront cost, neglecting such factors as quality and cost of perpetual maintenance. However, for the last time, Bob is determined to play by the rules and give his very best.

The department has made Bob's life easier by hiring you, a consultant, to analyse past ODOT auction data (see the file odot.xls). Your role is to determine the likely winning bid for the single auction remaining this year as well as the likelihood of Bob coming in below budget. Your expertise will also be used to analyse other upcoming auctions, and assist in determining whether an auction has been rigged as the department has had problems with this before. You are expected to carry out a sophisticated statistical analysis of the dataset in support of your recommendations.

The Planning and Costing of a Road Construction Project. When the repair, widening, resurfacing, or new construction of a state road ("road construction," for short) becomes necessary, ODOT first outlines a project plan. Based on the project plan, ODOT engineers determine detailed cost estimates for the overall project (from the estimated costs of building structures, like bridges, through material costs, to traffic control costs, etc). The result is a cost range for each component of the project as well as a range for the overall cost of the project. Point estimates for each of these costs are then prepared for advertising the project. While ranges vary for each component of the project, experience has shown that the overall project cost estimate range is always plus/minus fifteen percent of the midpoint of the range. ODOT's protocol has always been to quote the midpoint of the range as the overall cost estimate, although it has never disclosed this methodology, and only claims that its advertised cost is its "best estimate."

The Peculiar Geology of Orangia. Orangia is known by road constructors (as well as third grade geography students) to consist of only two types of bedrock: sturdy clay and porous limestone. The most notable feature of limestone is that carbonic acid, which is created by decaying plant matter washed into the ground, "eats it away" (i.e., dissolves it). As the limestone weakens, entire sections of the ground may sink into large holes. It is not hard to believe that Orangia limestone is the road engineer's nightmare: it costs time and money to reinforce a limestone foundation not to mention the cost of dragging out heavy equipment from sinkholes. On the other hand, clay, which is equally likely to be underground when the excavators start digging, makes for a good foundation and cheap road construction.

Unfortunately, it is currently too costly to determine exactly which parts of a road construction project will be on limestone and clay. Experienced contractors usually have a good "hunch" as to the proportions of the two types of bedrock in any given area (some may have worked there before, or may know of sinkholes). Estimates regarding the softness of the bedrock are

privately known to the contractors and are positively correlated with the true quality of the bedrock, which no one knows.

The Auction. The attributes of a given construction project, including the description of the work and the ODOT cost point estimates, are advertised to independent contractors. The description and cost estimates of hundreds of past, current, and future projects are publicly available at the website of ODOT. Independent contractors browse through the available project descriptions and decide whether they want to submit bids for certain projects. A contractor's bid for a given project is simply the lowest price for which the contractor is willing to undertake the project as specified by ODOT. The bid can differ from the cost estimate of ODOT (can be higher or lower), and contractors can decide not to bid for certain projects. In fact, according to ODOT's experience, larger projects tend to attract more bidders.

Bids are submitted by mail or online, and contractors are not told how much the other contractors have bid. Each road construction auction has a specific deadline, after which ODOT determines the winner of the contract as the contractor who submitted the lowest bid. The contractor has to carry out the project exactly according to the prior specifications, and gets paid the winning bid, that is, the price he bid.

Bid rigging. One practical problem that ODOT encountered during a decade of auctioning road construction contracts is that the bidders sometimes try to fix the outcome of the auction in advance in order to reduce competition and drive up prices. This activity, which is illegal on the bidders' part, is called bid rigging. Recently, the Orangia State Attorney General conducted an investigation that uncovered widespread price fixing among contractors. Your fine colleagues at ODOT believe that the possibility of bid rigging will continue to be a concern in future auctions.

Data. In odot.xls you have data on 133 road construction auctions that took place in the recent past in Orangia. The variables are the following:

Price	The amount of winning bid (in 10,000 dollars).
FairPr	The overall cost estimate of the project calculated by ODOT engineers, which they call "fair price" (in 10,000 dollars).
Bidders	The number of contractors that chose to participate in the auction.
Rigged	Dummy that equals 1 if the Attorney General determined that the bidders rigged the auction (colluded), 0 if not.
Length	The length of the road construction project (in miles).

FxCost The ODOT estimate of the project's fixed costs, i.e., costs independent of the length of the project, like the costs of structures (in thousands of dollars).

Days The ODOT estimate of the duration of the construction (in days).

Fit a regression model to the data, with the dependent variable **Ratio**, computed as the ratio of **Price** to **FairPr**, against the explanatory variables **FairPr**, **Bidders**, **Rigged**, **Length**, **FxCost**, and **Days**. Examine whether there is curvature or heteroskedasticity problem. Help Bob answer the following questions based on this regression.

(i) Give your best estimate and a 90% confidence interval of what will happen to the ratio of the actual price to the estimated cost if the number of days for a project decreases by 250, holding the other independent variables fixed.

(ii) Can you claim at the usual 5% significance level that an increase in the number of bidders, holding the other independent variables fixed, will on average decrease the ratio of the price of a project relative to the ODOT estimate?

(iii) Would it be legitimate, at the usual 5% significance level, to drop the variables **FairPr** and **FxCost** out of the regression, if you wanted to do so? If the answer is yes, write down the new estimated regression equation.

(iv) One of your colleagues, Stan, draws your attention to a potential problem in the regression. He claims, "Almost all of the jobs the attorney general classified as rigged took place during the hot summer months. Everyone knows that jobs in the hot weather are harder to do, and therefore command a greater premium over estimated costs than jobs done at other times of the year."

(a) If Stan is right then what is wrong with the regression?

(b) Suppose you can gather data regarding the time of year each job took place and use it to create a new variable, **HOT** (= 1 if the job took place during the hot summer months and = 0 otherwise). If Stan is right, what will change (and how) when you include **HOT** as an additional independent variable in the regression?

For answering following, you must build your own regression models, if necessary. Remember to check the soundness of your specifications (linearity and homoskedasticity). Use a significance level of at least 20% when deciding to drop variable(s).

(v) Develop a sound regression model to estimate and predict the winning bid (**Price**) on the final contract for 2018, which has the characteristics below.

- The estimated cost is $10,000,000, of which $7,000,000 is due to fixed costs.
- The 4 contractors interested in the project are expected not to rig the auction.

(a) Write down the estimated regression equation and explain how you came to choose it.
(b) Give a point estimate for the winning bid and provide an interval that will contain the winning bid with 90% confidence.
(c) How confident are you that in this project the winning bid will come in "under budget" (so that Bob will earn his bonus)?

(vi) ODOT has a road reconstruction project that is in the early planning phase. Just before putting the job up for auction, it is learnt that building an additional pedestrian bridge will be necessary as part of the project. This change will not affect the duration of the job or the length of the road, but it will increase fixed costs (**FxCost**) by 15% and overall estimated costs (**FairPr**) by 5%.

ODOT hasn't put the project up for bidding yet, and your goal is to estimate the percentage increase in the winning bid (the **Price** of the contract) that will ultimately result from the change in projected costs.
(a) What regression would you use to estimate the increase in Price? Write down the estimated regression equation, and explain how you arrived at that regression.
(b) Using your regression in part (a), what is your estimate for the percentage increase in the Price of this contract?