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The CFEC paper presented in Naknek was a statistical study that attempted to determine whether permit stacking in Bristol Bay caused the price of set net permits to rise. The conclusion of the author was that stacking did cause set net permit prices to rise; however, there are so many statistical problems with the model that its results must be questioned. This note will highlight a few of those problems.

The statistical technique used in the CFEC paper was multiple regression analysis. Regression analysis can be used to both (1) explain the relationship between a dependent variable (permit price) and one or more independent variables (price of Atlantic salmon, presence/absence of permit stacking), and (2) predict the path of a single dependent variable. It is important to determine what the model will be used for before it is constructed. In particular, many statisticians argue that if the purpose of the model is to simply to predict the future value of a variable, it does not matter how the model is constructed; all that matters is whether it "works." If the model is used to explain the relationship between variables, it is important to pick variables that have a theoretical relationship.

For example, if your aim is to predict the path of the stock market (the dependent variable), then it would be acceptable to input the length of women's skirts as an independent explanatory variable as long as your model "works." In fact it is true that shorter skirts tend to portend better stock prices -- but few would argue that it is a "causal" explanatory variable. There is a statistical *correlation* between stock prices and skirt length but not a *causal* link between the two variables. If your aim is to explain *why* stock prices are rising you'd do better looking at interest rates, economic growth, government deficits and so on as explanatory variables.

One of the key "explanatory" variables in the CFEC permit stacking/permit price model was the price of Atlantic salmon. When the author was asked why he included it, he replied that it was included because he needed something that fit the model. He said nothing about the causal relationship between Atlantic salmon prices and permit prices -- because there isn't one. If the purpose of his model is to explain the cause of permit price increases, then he must be able to provide a theoretical causal connection between Atlantic salmon prices and permit prices.

Another causal variable in the model was an artificial binary variable set to zero before permit stacking and one when there was permit stacking. Binary variables -- also called dummy variables -- are common and often useful in econometric models. Their main use is to check for structural shifts. But the nature of this study makes their use suspect: Permit stacking was used in only the last two years of the study so the binary variable had a zero value for all but the last two years. Having non-zero values only for the last two years of analysis makes it impossible to determine whether there was in fact a structural shift, or whether there was a "blip" that will return to normal in subsequent years whether permit stacking continues or not. My point is that dummy variables are not very useful when applied to the beginning or end of a time series of data.

Regression models, especially those characterized by a paucity of data and autocorrelation -- as is the case with this model -- have very strenuous data requirement. In particular, the explanatory variables must not exhibit a statistical property known as multicollinearity. Multicollinearity exists when the explanatory variables have a statistical relationship between themselves. If multicollinearity does

exist, then dropping one of the explanatory variables and running the model again will change the coefficients on the remaining variables, and change the interpretation of the results. This is in fact what happened when the author, at my recommendation, did subsequent statistical analysis during the Naknek meeting. Multicollinearity makes it difficult to determine the impact of the explanatory variables -- or even whether individual variable have any impact at all.

Permit stacking may affect permit prices. Or it may not. I simply do not know. But I do know this: The CFEC model has so may statistical problems that it cannot be used to assess the relationship between permit stacking and permit prices.

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