Econometrics and Research in Agricultural and Resource Economics

by James A. Chalfant

Econometrics is usually defined as "economic measurement" in textbooks. Typical uses listed are: 1. describing some aspect of the economy; 2. testing hypotheses about some aspect of the economy or from economic theory; and 3. forecasting the economy's future. This note describes some applications of econometrics, and its role in research in the Department of Agricultural and Resource Economics.

A student in the Department of Agricultural and Resource Economics is required to learn econometrics, with courses in statistics as prerequisites. Effectively, econometrics has an operational definition as "applying statistics to problems in economics." Students in the biological sciences would instead typically learn biometrics, students in sociology would learn sociometrics, etc. While the techniques used are generally similar, if not the same, the particular emphasis in econometrics, and the reason that it exists as a distinct field of study within economics or agricultural and resource economics, has to do with the particular types of problems of estimation and inference that occur with economic data. Training in econometrics is therefore considered as fundamental to conducting and interpreting research as is training in economic theory.

Work in econometrics spans a wide spectrum of activities, from data collection and improvement to the theoretical analysis of the properties of new estimation techniques. Usually, agricultural economists depend on both the collectors of primary data and those working on the theoretical properties of new techniques, in carrying out their research. However, faculty and students sometimes are involved in collecting data, and also sometimes must develop new statistical or econometric methods appropriate for their particular research problem. Economic models might generate predictions such as these:

- As wage rates rise in the United States, relative to those in Mexico, increased immigration will occur.
- As taxes on alcoholic beverages rise, quantities consumed will fall.
- Promotion of an agricultural commodity increases the demand for that commodity, as does an increase in the perceived health benefits of consuming it.
- Research into new crop varieties or production practices leads to increased yields.

For all of these rather common-sense outcomes, it is not enough for policymakers and those in the industry to know these effects, in order to make informed decisions; they need answers to this question: *by how much?* For instance, in deciding on levels of funding for agricultural research, legislators would benefit from measures of the rate of return to that spending; similarly, commodity groups promoting agricultural commodities need to know the effects of promotional expenditures, to decide whether to increase expenditures on particular types of promotions. Obtaining such estimates typically requires econometric analysis.

Most of us are familiar with the typical medical experiment, in which some patients are given a placebo, others a new drug, and the experiment is *double-blind,* meaning that even those giving the medication do not know which patients are in which group. The dosage levels and other drugs taken are chosen as part of the experimental design, and do not vary with the individual participants. Such experiments are designed to hold *every other factor constant,* meaning that there are no other differences between the treatment and control groups. If successfully designed and carried out, such experiments can give the researcher an accurate estimate of the effects of the drug, and these effects are not *confounded* with some other effect.

With virtually every economic data set and every econometrically estimated effect, there is no such control. Economists rarely get to design their own experiments, but instead use data generated by markets and by the behavior of producers and consumers. For instance, in determining the effects of a change in the tax on wine, we could simply look at the change in consumption of wine from last year to this year, and the change in average prices, to learn about the price-sensitivity of wine demand. However, if we fail to recognize that some consumers may be increasing wine consumption due to increases in the price of a substitute beverage, or news about red wine's beneficial health effects, we'll misstate the own-price effect. What characterizes economic experiments (and therefore econometrics) as an area of study distinct from other experiments is that *other things are not held constant*. Economic variables are interrelated in complex and unknown ways, and it is the objective of research to discover the nature of these interrelationships.

For example, a study of red wine consumption might begin like this. Using aggregate data on *per capita* consumption of red wine, and an index of red wine prices, a simple model relating quantity consumed to price may be constructed. The Law of Demand implies a negative correlation between price and quantity consumed. A complicating factor is that the Law of Supply implies a *positive* correlation between prices and quantities supplied. Because observed quantities are actually market equilibrium quantities that reflect both consumers' and producers' responses to price changes, observed changes in price and quantity together need not correspond to demand changes alone or supply changes alone, and the estimation techniques used must take this problem into account. In short, even after accounting for the various other factors causing a change in consumption, other than the one of particular interest, the researcher must account for the fact that it is not always clear which variable causes another variable to change. Do prices change first and then quantities respond, or do prices change because quantities change? In reality, they both are changing together over time.

Econometrics therefore involves the study of *simultaneous equations models*, for instance, the joint modeling of both the supply and demand of a particular product (and perhaps the supply and demand of products that are related on either the supply side or the demand side). In the red wine example, the use of such models is necessary because the price may have changed not only because of a change in the tax on wine, but because of demand shifts. Biased estimates of the price sensitivity of red wine demand would result, if this were not recognized. To relate this problem to the drug trial described earlier, if patients who took the drug also engaged in some other beneficial activity, the measured response would capture not only the effects of the drug, but the effects of the other behavior, and the result would be a predicted effect of the drug that would not describe its true effects, in the absence of the other behavior. The result would be erroneous predictions about the drug's effectiveness.

Further complications include the fact that the effect predicted probably will happen only over time—for instance, an increase in the tax on wine may lead to reduced consumption, but presumably only gradually. Most agricultural economists would expect there to be a short-run effect on consumption that is relatively smaller than the ultimate, long-run effect on consumption. However, during the adjustment period, there will likely be other changes, in prices, income, etc., that also affect the demand for wine. Measuring a single phenomenon such as the sensitivity of wine consumption to taxes is complicated by the fact that the "experiment" of raising the tax is not a controlled one, in which all other determinants of wine consumption are held constant. Econometricians have resorted to more sophisticated modeling of the time-series properties of the data, as a result.

A final set of concerns could be grouped in the general category called *structural change*. Since per capita consumption is observed only annually or perhaps quarterly, in the typical demand study, the effects of taste changes, changes in product characteristics, etc., must be accounted for somehow, if the nature of the demand for the product in question is changing over time. Red wine is a good example of a product where structural change may have occurred; if there are consumers who have increased their red wine consumption due to perceived beneficial health effects, they may be less price-sensitive than other wine consumers without such perceptions, or less price-sensitive than they were in the past. This would cause a change in the relationship between price and quantity, leaving the researcher in the difficult position of using the same data set to estimate the nature of the relationship *and* detect how the relationship is changing over time. Other examples of agricultural products where demand has changed over time, for reasons other than relative prices of commodities or income, might include pork, which has become leaner over time; eggs, where both health concerns and the evolution of breakfast habits over time both appear to have played a role; and any commodity where promotion, health concerns, or quality change has occurred.

Thinking about the complications of even a relatively simple problem like the wine-demand example described above shows that econometric analysis is a challenging and difficult task. Therefore, it is understandable why the popular press (like economists) jokes about how bad economists are at forecasting or reaching agreement on the effects of complex events such as NAFTA, the Kyoto agreement concerning global warming, or the latest Farm Bill. However, it is important to understand econometrics to appreciate both the power and the limitations of the research tool.

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