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Comments on "The Limits of Statistical Modeling"

by

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Comments on "The Limits of Statistical Modeling" by David Freedman

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David Freedman's impressive paper reveals well his deep understanding of not only statistical techniques and their uses but also of scientific methodology and its philosophy. On visits to Berkeley over the years, I have had the opportunity to talk with David and to learn much from our friendly and constructive conversations. He was a great member of the intellectual community and his passing is a huge loss to us all.

In particular, I would have enjoyed discussing his paper, "The Limits of Statistical Modeling" with him, especially his final sentence, "The goal of empirical research is---or should be---to increase our understanding of the phenomena, rather than displaying our mastery of technique." Also, in his wide ranging discussion, he has identified crucial obstacles to progress in several areas of social science research, including econometrics. The overall message conveyed reflects his fruitful and productive life. It questions commonly accepted methodologies and makes a plea for the development of alternatives more solidly grounded in data, appropriate statistical methods and scientific methodology. In particular, Freedman has stressed the difficulties of verifying many assumptions made in regression analyses and the impact that incorrect assumptions can have on the validity of conclusions, one general important theme of his research. In this regard, I can identify deeply with his point of view since I too have been engaged in developing sound alternatives to conventional methods that are often based on weak foundations and lead to unsatisfactory results.

In what follows, I shall attempt to respond to some of the fundamental issues raised by David by discussing a number of principles and procedures that I believe are important in promoting progress in understanding, predicting and possibly controlling phenomena in all areas of research. First, note that Karl Pearson's (1938) "Unity of Science Principle," namely that any area of study, be it physics, astronomy, economics, political science, etc., can be scientific if scientific methods are employed in producing, analyzing and learning from data. Now it may be asked, "Where can one learn about the methodology of science?" In this regard, I, and many others, recommend highly Sir Harold Jeffreys' classic book, Theory of Probability, that first appeared in 1939 with many subsequent editions, the last appearing in the Oxford U. Press Classics Series, 1998. Note that the well known mathematician and statistician, I. J. Good wrote, "In my review(Good 1962b) I said that Jeffreys' book on probability "is of greater importance for the philosophy of science and obviously of greater immediate practical importance, than nearly all the books on probability written by professional philosophers lumped together." I believe that this is still true, though more professional philosophers have woken up." (quote from Zellner (1989), p. 32; see also reviews of Jeffreys' work by S. Geisser and D.V. Lindley in this volume,) Also, the recent paper, "Harold Jeffreys' Theory of Probability Revisited," by C.P., Robert, N. Chopin and J. Rousseau (2008) to appear in Statistical Science with discussion presents a chapter by chapter review of Jeffreys' book and concludes that it is indeed a classic work. Note that Jeffreys, along with many other physical scientists use the term "probability theory" rather than "statistics" to denote the area of work in which measurements are made and used to describe phenomena and to evaluate old and new models that may be useful in description, explanation, prediction, control, etc. because they do not like the word "statistics" according to some because Lord Rutherford, a famous physicist, is remembered as saying, if you need statistics to analyze your data, redesign your experiment.

Briefly, Jeffreys' work is fundamentally important because it was undertaken to provide a fruitful framework for scientific research not only for the physical sciences but also for all areas of study, including the biological sciences and social sciences, about which David Freedman is so concerned. Some points that emerge from Jeffreys' and others' works that appear very important are:

1. Formal Learning Model: In analyzing and learning from data, be it regression or other data, it is important to use a good, explicit learning model. As has been pointed out many times in the literature, many researchers do not use a formal learning model and thus learn informally. Bayesians use, and sometimes misuse, Bayes' Theorem as a formal learning model that has been logically justified in several different ways and shown to work well in many estimation, testing, prediction and other studies; see for example the many empirical examples in Jeffreys' book and many Bayesian texts (a listing of texts is available at http://www.bayesian.org, the homepage of the International Society for Bayesian Analysis).

2. Simplicity Postulate: Simpler models will probably work better in explanation and prediction. See Jeffreys (1948, p. 4 and p.47) and Zellner et al (2001) for discussions of the concept of simplicity, measures of simplicity, and the results of a poll of Nobel Economic Prize winners that showed that almost all of them favored a "sophisticatedly simple" approach in modeling rather than complicated approaches. Note that it is important the models be "sophisticatedly" simple because some simple models are stupid. As regards examples of relatively simple models that have worked well in economics and econometrics, there are Marshallian demand and supply models that have been widely used world-wide for many years to analyze the operation of product and factor markets. Also there is the recent formulation of Marshallian Macroeconomic Models, implemented with disaggregated data, that are a synthesis of relatively simple disaggregated Marshallian industrial models and elements of macroeconomic theory to form large, but relatively simple, models that explain and predict fairly well and can be used for analyzing alternative policies; see, e.g.

Zellner and Chen (2001), Zellner and Israilevich (2005) and Ngoie and Zellner (2008).

3. Predictive testing of models is central in science, as is well known but not implemented enough in empirical work. Also, as noted in my invited review paper on concepts of causality, published in K. Brunner and A.H. Meltzer, eds. (1979), the famous philosopher of science, Herbert Feigl (1953) presented a critical review of concepts of causality in the literature and concluded that the following definition is most appropriate and useful: "The clarified (purified) concept of causation is defined in terms of "predictability according to a law (or more adequately according to a set of laws)." (p. 408). In view of the central role of prediction in the definition of causation and in many other areas, it is regrettable that many statistical analysts do not check the predictive performance of their models. Indeed in terms of the exchange between Keynes and Tinbergen on econometric models' performance that David Freedman discussed in his paper, it is noteworthy that Christ(1951) did compare and discuss the predictive performance of one of Klein's macro econometric models vis a vis that of a benchmark random walk model and found that it did not perform very well and thus, as Milton Friedman noted in his discussion, needed reformulation.
4. Since "laws" are fundamental in defining causality and in other respects, as David Freedman recognizes, a fundamental issue is how do we produce laws, e.g., Newton's and Einstein's laws, Marshall's laws of demand and supply, etc. ? In my work over the years, I have suggested, in accord with Hadamard's (1945) findings, that generation of more unusual and surprising facts, some contradicting old laws and beliefs, will probably inspire many to generate new theories to explain the unusual facts that can then be tested with much new data. For further discussion of this process and information about eight ways to produce unusual facts, see Zellner (1984, 9-10).

5. One class of unusual facts that Franz Palm an I have emphasized in our theoretical and empirical work, summarized in Zellner and Palm (2004) and Zellner (2004) is that often some purely statistical univariate and multivariate time series models, e.g. Box-Jenkins arima or transfer function models or variants of statistical multivariate time series models forecast future outcomes, e.g. the next period real GDP growth rate, reasonably well. In our structural econometric, time series analysis (SEMTSA) approach, we use economic theory to formulate "causal" multivariate dynamic economic models that mathematically imply the statistical model that forecasts reasonably well. Thus, using our methodology, we produce causal models, e.g. our Marshallian Model, , mentioned above. Or if we have a causal time series econometric model, we check it using time series model identification and diagnostic testing procedures in efforts to improve its performance in explanation, prediction and policy-making. See Zellner and Palm (2004) for further discussion of these procedures and applications.
6. Last, there is the issue of which statistical inference procedures to use in estimation, testing, prediction, model combining, decision-making, etc. Over the years, much of my research has been directed at evaluating the comparative performance of Bayesian and non-Bayesian procedures and have concluded that Bayesian procedures have performed better. This is not to say that Bayesian procedures are perfect and indeed in Zellner (1988)) a new information theoretic derivation of Bayes' theorem and discussions of it by Jaynes, Kullback, Hill and Bernardo, are provided. In more recent research, using the approach in Zellner (1988) that produced Bayes' theorem, by varying the conditions of the optimization problem, new, optimal learning models have been derived. By having a broader range of optimal learning models on the shelf, some that do not require use of a prior distribution, statisticians and other scientists will become more effective in learning from data and solving inference and decision problems.

In summary, thanks to David Freedman for giving us such a stimulating paper, his life's work and being a wonderful person.

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