

JSM 2014, Boston

Communicating Statistical Findings to Consulting Clients Operating in a Decisionmaking Climate: Best and Worst Practices

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Decision Making Under Uncertainty

In considering decision making, statistical consultants need to bear in mind three important points.

The first point is that almost every decision we make is under uncertainty. A corollary is that we never have complete information on which to base decisions.

The second point is that (fortunately) most of the decisions we make have minimal long term consequences. However, a few have significant consequences, for better or worse, to impact our personal lives or our business.

The third point is that sometimes we (the statistical consultants) must just say no. An experienced manager will make better decisions based on his or her experience than with “the help” of bad data.

Consulting statisticians, especially those in an academic environment, sometime forget that supervisory personnel, even in universities, have to make decisions in real time without the luxury, as one of my university colleagues had, of spending years working on a single problem.

A good consulting statistician needs to recognize that decisions are based upon more than a careful analysis of the data and an appropriate inference. We may wish the contrary but we live in a complex world. I once had a US Congressman tell me that a course of action he was urged to take would be the right one but if he did, he might lose the next election.

Any good manager knows that he or she is going to make wrong decisions. A job of a good consulting statistician is to help the manager minimize the number of wrong decisions.

As statisticians, we often fail to recognize that most of our clients understand uncertainty and risk at some level even if they cannot quantify it. We just need to do a better job of ascertaining their level of understanding and putting the uncertainty associated with their problem in an appropriate context. For example, most people running for elected office at a state or national level understand the uncertainty associated with polling. What sometimes happens is that their prior believe overwhelm even properly collected and analyzed data. It is awfully easy for even experienced decision makers to put more weight on the data that points in the direction associated with a prior belief than the converse. I had such an experience a number of years ago as a consultant for the Professional Golf Association.

Statistical significance is a tough issue. Most of my work is in the energy, environment, and earth science areas but I have done some work with educational statistics and polling. In these and many other areas it is next to impossible to obtain a properly designed experiment and anything approaching a random sample. Even in highly controlled laboratory experiments, much can go wrong. When everything goes correctly, statistical significance often is

misinterpreted. For example, a p-value is a summary of the analysis of an experiment *assuming the null hypothesis is correct*. A p-value of 0.05 may really indicate a level of significance of 0.11 or greater. The best explanation of a p-value that I have seen is by Regina Nuzzo, Statistical Errors, Nature, v. 506, p. 150-152, Feb 2014. In my experience, appropriate graphics are more meaningful to a client for expressing uncertainty than numerical values. A consultant needs to emphasize that in most situations, numerical values should serve only as guidelines.

Dependency is often overlooked when considering uncertainty. In many earth and environmental science applications, spatial dependency is a factor, which can significantly increase uncertainty. So, before we get to a decision point, it is necessary that the statistical consultant and client consider all important sources of uncertainty.

Risk and uncertainty are sometime confounded. If I am playing a game of chance for pennies, there is uncertainty but essentially no risk. If I am playing with \$1,000 chips there is still the uncertainty but now with considerable risk. ***Decision makers often are more interested in risk than uncertainty.***

The best paper that I have seen recently on communicating uncertainty is “Environmental decisions in the face of uncertainty,” by the Board on Population Health and Public Health Practice, Institute of Medicine, National Academy Press, http://www.nap.edu/catalog.php?record_id=12568. While, as the name suggests, it is aimed at the health sciences, I think most of the comments are generally applicable.