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Statistics Canada

The Relationship between Statisticians and Statisticians[1]

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I appreciate the honour of the invitation as after-dinner speaker at this 1985 annual meeting of the Statistical Society of Canada.

The honour is unfortunately accompanied by a responsability, to say something worthwhile. That is not an easy task. I thought I would approach that job in stages. So first I invented a title. Then I thought I would try to figure out what the title meant. And that was to be my speech. Regrettably, I am still unsure what the title means. But I won't let that deter me. Of course, as Yogi Berra said, "If you don't know where you're going you may not get there".

There are many people called statisticians who carry out a very diverse set of activities which are labelled statistics. In fact, at various times in my unplanned career, I have been various kinds of statisticians. That fact of language poses the question: What are the relationships among these various kinds of statisticians and statistics?

Specifically let me identify two types of statistical activity, namely probability statistics on the one hand and the work of statistical information development, carried out by statistical agencies, on the other hand. What do I mean by probabilistic statistics? Without any attempt to be precise, I mean to encompass the discipline commonly covered in standard texts and lectures including notions of analyses of variance, tests of goodness of fit, design of experiments, variance components, Bayesian estimation and so forth.

The results of the work of statistical agencies, like Statistics Canada and the Manitoba Bureau of Statistics and the U.S. Bureau of the Census, you read in the newspapers every day.

These two kinds of work are *perceived* as related, and I believe *are* related. You might say the relationship has both a *real* and an *imaginary* part – and I am not at all clear what aspects fall into which category.

Let us take a look at some of the manifestations of these two categories – which one might also label as *white collar statistics* and *blue collar statistics* (which terms are used purely to avoid laborious repetition of awkward phrases like "probability statisticians").

The Statistical Society of Canada seems to be predominantly an organization of white collar statisticians. A recent study indicated

66% academic membership
21% government agencies.

The Statistical Society of Canada lists 32 persons from Statistics Canada as members, out of 2,000 professionals.

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Registration at this meeting likely consists mainly of white collar statisticians - interested primarily in the arena of probability statistics. Not only are there only a very few persons (8) from Statistics Canada, I must also report that there was only minimal interest of supervisors at Statistics Canada in sending persons to the meeting.

Let us look at examples of output from these two categories. The official journal of the Statistical Society of Canada is the Canadian Journal of Statistics. It is a quarterly. The official release announcement vehicle of Statistics Canada is the daily, which appeared 256 times last year.

A comparison of titles of publications is fascinating. For the Canadian Journal of Statistics, I selected at random fifteen key words from 122 which represented the articles published in 1983.

Here is a sample list of what white collar statisticians are writing and reading about:

Abundance distributions
Asymptotic properties
Central Wishart distribution
Chi-squared distribution
Critical values
Decision theory
Growth-curve analysis
Linear filter
Logistic process
Longitudinal studies
Multivariate linear model
Shift estimation
Spatial time series
Structural properties
Weighted least-squares estimator

Those topics are household words at this conference. But they are *not* the topics of blue collar statistical output - and many, perhaps most, blue collar statisticians would have no understanding of, or concern with, these topics, at all.

Some indication of the output of Statistics Canada is provided by the releases announced in the daily of April 29, 1985.

- total number of pigs in Canada (over 10 million)
- the number of tonnes of barley exported (over 150,000 during March 1985)
- the number of square metres of mineral wool shipped (over 6 million)

A further indication of Statistics Canada output is the table of major statistical indicators, which is updated each week in a publication, statistical highlights, sent to ministers and deputy ministers. These indicators include:

Gross National Product
Housing Starts
Bank Rate
Unemployment Rate
Consumer Price Index Increase
Weekly Earnings

And the measures relating to economic, business, trade, financial, social and labour sectors of Canadian Society.

Statistics Canada turns out statistical studies on topics such as divorce in Canada, health of Canadians, the status of women, current economic indicators, science and technology indicators, language characteristics of Canadians and so on.

I want to make it clear that I am *not* engaged in making an assessment of the relative value of these two types of outputs. Both types of work are socially desirable, as indicated by the fact each has supporting social constituencies. By definition, each is socially justified.

But what I *am* engaged in is trying to analyze the nature of relationship between these two types of activities, both of which are labelled *statistics* and carried out by people who are called *statisticians*.

We could of course simply write it off as a case of homonysm - that is the same word being used with two entirely different meanings. Or we should simply continue to ignore this discrepancy. But neither of those is wise or productive.

You are all familiar with the classic work on the advanced theory of statistics by Kendall and Stewart. Volume I involves 396 pages of text plus tables and index. These 396 pages deal with theoretical constructs of probability statistics and mathematical derivations of various formulae.

The introductory quotation to the book is attributed to O. Henry and reads as follows:

> "Let us sit on this log at the roadside", says I, "and forget the inhumanity and ribaldry of the poets. It is in the glorious columns of ascertained facts and legalized measures that beauty is to be found. In this very log we sit upon, Mrs. Sampson," says I, "is statistics more wonderful than any poem. The rings show it was sixty year old. At the depth of two thousand feet it would become coal in three thousand years. The deepest coal mine in the world is at Killingworth, near Newcastle. A box four feet long, three feet wide, and two feet eight inches deep will hold one ton of coal. If an artery is cut, compress it above the wound. A man's leg contains thirty bones. The tower of London was burned in 1841."
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> "Go on, Mr. Pratt", says Mrs. Sampson. "Them ideas is so original and soothing. I think statistics are just as lovely as they can be." (The handbook of Hymen).

I think the quotation is lovely. And the book is, of course, an excellent example of scholarly clarity. But I do wonder what is the connection between the quotation and the text? Do the authors see a close connection? Is the quotation - which reflects work like that of the blue collar statistician-intended to justify, or motivate, the superstructure of probabilistic statistics which follows?

Do the authors believe that the constructs and formulae of their text on probabilistic statistics serve to guide or validate the work of blue collar statisticians - of statistical agencies? Or do they believe that the discipline of probability statistics is justified because its technology has been used to produce the output of statistical agencies?

What is *real* and what is *imaginary* in this relationship?

There is something of a conundrum in the relationships between the work of white collar statistics and blue collar statistics. The apparent outlook seems to be that:

- The information product is valid because it uses approved methodology.
- The methodology has status because it derives from a formulated theory.
- But the statistical theory involves constructs and mathematical logic, usually based on various unverifiable assumptions.!

What justifies the assumptions, the constructs and the theory?

In scientific work, more generally, a theory is justified as good by the usefulness of the products produced by technology derived from the theory.

Indeed, technology is often invented without *theory* and widely accepted because of its utility. Bronze and Damascus steel were developed because of their useful properties, and not because of a mathematically consistent theory of metallurgy.

To assess whether probabilistic statistics is good, we should ask whether it provides a technology to produce products that are useful and valuable.

Instead, statisticians tend to ask the inverse question, namely whether the work of blue collar statistics is valid according to the precepts of probability statistics.

Probability statistics has produced a wide variety of concepts and models and methodologies. These include areas such as:

Decision making under uncertainty
Subjective probability
Science of inference
Likelihood inference
Bayesian estimation
Time series analysis
Hypothesis testing
Tests of significance
Confidence estimation
Estimation of sampling errors
Classification methods
Regression analysis
Variance components
Design of experiments
Sample survey design
Unbiased estimators

and so on.

Many authors have asserted that the most fundamental concept in applied probabilistic statistics is the *objective assessment of uncertainty.*

But I must tell you that that notion – however appealing and philosophically profound – does not comport with the reality of the work and mandate of statistical agencies.

Let me try to establish by example the social importance of the work of blue collar statisticians. You can make a test of your own. Make a list of what you believe to be the issues of interest to Canadian Society. Your list will include matters of employment and unemployment, income of the elderly, status of women, economic growth, trade and balance of payments, family formation, population distribution, government deficit, etc.

On examination you will find that, for the large majority of such issues, your perceptions, your knowledge and your understandings depend quite directly on the statistical information produced by blue collar statisticians, *mainly* at Statistics Canada. A similar assessment would apply in any country in the world.

To emphasize this point further by a specific example, I would like to summarize some of the uses of the consumer price index.

The consumer price index is updated each month by Statistics Canada based on monthly observations of prices of a designated market basket of goods and services. The consumer price index is the most commonly used indicator of the rate of inflation. It is often referred to as the cost of living index. The consumer price index has a direct or indirect effect on nearly all Canadians. It, or individual components of which it is weighted average, is used in the calculations or definitions of income taxes, labour contracts, family allowance payments, old age security pensions, rental agreements, insurance coverage, spousal support payments, child support payments, payments to children of war veterans, student loan repayments, and many other contractual or regulatory arrangements.

To get back to the matter of objective error estimation – supposedly the central feature of probability statistics: Statistics Canada does not produce a statistical measure of the error of the consumer price index estimate. We do *not* publish interval estimates of consumer price index. We do not test the hypothesis of no change in consumer price index from month to month. We do not produce composite estimates which would supposedly reduce random error variance.

From time to time we are queried or criticized about this, even by people who are not statisticians or scientists. It seems that, having heard so often about the results of public opinion polls, members of the public have now begun to expect an error estimate to accompany published estimates. The phrase "19 times out o f 20" is now a part of the vocabulary of most newspaper readers. Of course, public opinion polls have been going on for a long time; George Gallup found a record of one taken back in 1824, when a pennsylvania newspaper published results of what was called a "straw vote taken without discrimination of parties". Modern communications and computer technology have resulted in a proliferation of polls. Because of their popularity, there has been an increase in public awareness of the fact that a statistician (or somebody.) can conduct a sample survey, make inferences, and put a measure of uncertainty on estimates.

An audit of Statistics Canada in 1983 by the Auditor General of Canada, touched on the subject of measuring the quality of statistics. The report recommended that Statistics Canada develop and disclose more measures of quality for its statistics. The agency's formal reply was that this "recommendation could not be fully implemented, since 'measures of quality' for many statistics - particularly those of a composite nature - are impossible to produce". It would be more realistic, said the Statistics Canada response, to supply "a full *description* of available information related to possible quality limitations, including, of course, quality measures when they are available".

Statistics Canada would publish more error estimates if we felt we could. It is not that we would mind admitting the possibility of error. As professor R. C. Bose used to say to his students "to err is human. Therefore, statisticians are human".

However, the usual error estimates depend on assumptions which vastly oversimplify the situation. For example, the labour force sample households, not independent individuals who have equal chances of being selected. Also, by design, the households themselves do not have equal chances of being sampled; the sampling ratio is approximately 1 in 125 at the national level, but can be as high as 1 in 24 for provinces with small populations. Can we assume, then, that all individuals are independent and have an equal probability of being unemployed? Data are gathered by means of an interview, and either the interviewer or the respondent may make an inadvertent or even a deliberate mistake. Can we ignore all possible sources of error except sampling error? Members of a given household are sampled for six consecutive months, with 1.6 of the households rotating into and out of the overall sample each month. Thus, in any month, different respondents have responded to the questionnaire different numbers of times. Can we assume that the six responses are independent over time? Sometimes, during the six months of sampling, families move away from, or move into, a particular dwelling being sampled. And, of course, there are the usual problems of non-response, outliers, and errors of data entry, computation, and printing, etc. Concern about how to handle deviations from the "usual" assumption of statistical theory is a major continuing preoccupation of some of Statistics Canada's blue and white collar statisticians.

So, on the one hand, probability statistics has contributed the appealing and important concept of objective estimation of error; and moreover the public has been educated to accept the concept and to expect it to be implemented.

On the other hand, there are many very influential and prominent statistical products produced by people called statisticians for which such measures *are not* provided, and cannot be provided at the present time.

Abstractly, there seem to be several options!

(a) Statistical agencies and probability statistics might agree to stop sharing the label "statistics" and abandon the notion of connectivity.

(b) Probability statistics could address its efforts to produce technology to deal with the reality of complex statistical information development.
(c) Statisticians might undertake a public reeducation campaign to cancel the beliefs that neat and objective measures of statistical uncertainty are possible.

As a practical matter, only option 2 can be considered. And it also holds greater promise of productive consequences for *all* statisticians of all varieties.

In an article in science last year, Ian Hacking, a philosopher of science, commented that "the quiet statisticians have changed our world – not by discovering new facts or technical developments but by changing the ways we reason, experiment and form our opinions about it".

It is gratifying to read such an assessment of the significance of probabilistic statistics as pioneered by Fisher, Neyman, Pearson, Wald and others.

But, in the vein of my topic tonight, I want to point out that there is another cadre of "quiet statisticians" – the blue collar statisticians of statistical agencies – who have also contributed to changing the world; but precisely in the manner inverse to Mr. Hacking's assessment.

Blue collar statisticians *do* discover new facts.

They *do* establish new concepts.

They *do* invent operational definitions and implement them for public consumption.

They *do* pioneer technical developments – in computing, electronic dissemination of information, computer graphics, classification systems, national accounting frameworks and so on.

Again I want to remind you my intention is not to make, or to imply, an assessment of comparative value. The issue is: what is *real* and what is *imaginary* in the relationship of blue collar statistics and white collar statistics?

Most of what blue collar statisticians do does not in reality derive from, or directly relate to, the constructs and theories and beliefs associated with probability statistics. And yet – the blue collar statisticians are somehow persuaded or coerced into paying lip service to a supposedly fundamental connectivity to those concepts.

At the same time, the white collar statisticians continue with a vague belief that if only more of the blue collar statisticians could achieve academic respectability then probability statistics would *really* impact importantly on statistical agencies.

The synergy which may be latent in the more effective relationship of the blue collar and white collar statisticians will not be developed without effort from both groups.

I don't have the wisdom to offer any revelationary proposals.

Better channels of communication are obviously needed. In that spirit, Statistics Canada has established a program of fellowships and internships.

Also in that spirit, Statistics Canada has established a network of advisory committees, including one on statistical methodology.

A number of probabilistic statisticians are on contract as consultants to Statistics Canada.

I expect there is much more opportunity for expanding seminar exchanges and working collaborations between Statistics Canada and Universities.

There is a need for improved intellectual tolerance in both groups. Perhaps the criteria and standards for publishing need to be modified.

Perhaps the basis for judging the acceptability of research grants by the Natural Sciences and Engineering Research Council of Canada should be changed.

Perhaps training programs could usefully be modified. Perhaps Statistics Canada should offer a prize for productive developments related to outstanding areas of need in the operation of statistical agencies. Maybe we should have a continuing list of the ten most wanted solutions as an incentive, and communication mode, to probability statistics researchers.

Maybe the Statistical Society of Canada should establish a tradition that every year the after-dinner speaker at the annual meeting should talk about "the relationship of statisticians and statisticians".