

The statistics profession in Costa Rica and its challenges

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Abstract

A description of the statistics profession in Costa Rica is made to highlight how several problems faced in the past have been confronted and how others still remain. The problems need to be addressed if professional statisticians want to become more useful to society. The existence of a College of Professionals in Economics, where for historical reasons, statistics graduates must belong, has contributed to exclude unqualified statisticians, solving an existing problem before 1970. Recent survey data collected from graduates and employers produced positive comments of employers about the competence of the statistics graduates, and a high degree of satisfaction among graduates concerning the academic training received in statistics at the School of Statistics of the University of Costa Rica. Part of the positive comments reflect changes in the curriculum, especially the introduction of professional practice courses and more familiarity with non-statistical competences. Besides technical competences, statistical consulting requires excellent oral and written communication, and familiarity with research methodology, research project management and formation in professional ethics. Particular attention should be given to statistical consulting. Statistics teaching should include frequent use of practical case studies and internships in public and private institutions and organizations, to bring students closer to real settings. Complex statistical analyses can be done nowadays with the help of statistical packages like SPSS, without the assistance of a statistician, with all the dangers involved. The unity of statistics may be affected in the future with new developments in data mining, software development and dangerous imbalance between theory and practice. An international conference gathering professional statisticians and employers from many countries and contexts, is very much needed to learn about their experiences, expectations and future challenges.

Keywords: problems; evaluation; threats; challenges

1 Introduction

In this paper we describe several important aspects of the statistics profession in Costa Rica, and offer some thoughts about its future. Two of the three authors have combined academic work with statistical consulting, and have acquired great experience interacting with different environments where statistics is widely used. The other has worked mainly as an academic statistician but is also interested in teaching statistics as an applied discipline. Recently, as members of a committee appointed to prepare a report to seek accreditation of the bachelor degree in statistics of the University of Costa Rica, we have had the opportunity to analyze data collected from statistics graduates and employers. This information has provided important information about the current status of the statistics profession in Costa Rica.

In Costa Rica statisticians are trained only in the School of Statistics of the University of Costa Rica. At present the School of Statistics offers a bachelor degree in statistics, and an M.Sc. in statistics with two emphasis: one professional and the other academic. Until 1994 the School of Statistics offered a degree called *Licenciatura*, which required an extra year over the bachelor degree.

The teaching of statistics initiated with the creation of the Faculty of Economic and Social Sciences of the University of Costa Rica in 1943. Teaching was responsibility of a section, transformed later into a department and finally into the School of Statistics. Since its inception, teaching was oriented to offer future graduates the fundamentals of descriptive and inferential statistics, survey sampling methodology, experimental designs, econometrics, governmental statistics and applications in economics, demography and agriculture. The School of Statistics also offered introductory statistics courses to other schools of the University of Costa Rica: economics, business administration, biomedical sciences, sociology, etc.

2 The statistics profession in Costa Rica

A peculiarity of the statistics profession, common to other professions in Costa Rica is that, by law, statistics graduates must belong to the *Colegio de Profesionales en Ciencias Económicas* (College of Professional in Economic Sciences) in order to exercise the profession in the public sector. Teachers in universities and statistics graduates working in the private sector do not need to comply with this requisite. The College was created in 1970 to promote the recognition and defense of the rights and prerogatives of its members, and also its protection. It contributed partially to solve one of the problems of the profession: the appointment of unqualified statisticians with professionals from other disciplines.

The statistics profession is acknowledged as such, with a detailed description of its functions, by the Dirección General de Servicio Civil de Costa Rica (Directorate General of Civil Service). This Directorate specifies (September 2012), in the so-called *Manual de Clases Anchas* (Manual of Broad Categories), three types of statisticians:

- Civil Service Statistician 1.
- Civil Civil Statistician 2.
- Civil Service Statistician 3.

The requirements demanded of each type are as follows:

- Statistician 1: only requires a bachelor degree in statistics.
- Statistician 2: besides the bachelor degree in Statistics, requires two years of experience in the field of statistics.
- Statistician 3: requires the *licenciatura* in Statistics and five years of experience in the field of statistics; or the bachelor degree in Statistics and the degree of Master of Science in Statistics, with or without emphasis, and two years of experience in the field of statistics.

It is relevant to highlight the definition of the nature and activities required of the statistician as described in the aforementioned *Manual*, which differ according to the specific type of statistician. For instance, the general activities of statistician 3, are stated as follows (Directorate General of Civil Service. Resolution DG-241-2012.p.20.):

“Design, supervise and execute investigations, projects, studies, analyses, consultancy and other activities, proper of the field of statistics in the different areas of government involvement, such as Economics, Health, Education, Security, Medicine, Management among others.”

“To conduct statistical research that demand great scientific rigor in the methodology and formulation of recommendations that are requested concerning diverse topics of interest derived from institutional work, aimed to produce diagnostics for decision making, improvement of procedures and methods, elaboration of theories or adaptation of existing ones to institutional needs ...”

A transitory extra pay is offered to the three types of statistician to make the base salary competitive and to promote also the recruiting of statisticians in government, where many statistics jobs were held by professionals other than statisticians.

Another recognition of the statistics profession in Costa Rica comes from the Costa Rican Classification of Occupations Manual (COCR-2010), an adaptation of the International Standard Classification of Occupations (ISCO-08) of the International Organization of Labor. This classification is used by the National Institute of Statistics and Census and the National Statistical System. In this Manual, the statistics occupation is given the code 2120 associated to the category: mathematicians, actuaries and statisticians.

3 The scope of the statistics profession

In Costa Rica, the main employers of statisticians are in the public sector. This sector consists of the central government (The President office and all the ministries), the Supreme Court of Justice, the Legislative Assembly, the Supreme Court of Elections, and many autonomous or semiautonomous institutions associated with energy and telecommunications, health, insurance, crude oil refining, public affairs control, public tariff regulation, social assistance, national statistics and census, economy (Central Bank of Costa Rica), financial and commercial activities (state banks), state universities, etc.

In the private sector, some of the main employers are: educational institutions (several private universities, and other educational centers like the Center for Tropical Agricultural Research and Higher Education), financial institutions (private banks, stock exchange, cooperatives, etc.), ONGs and international institutions doing research in several areas: general state of the nation, education, demography, health (UNICEF), marketing and public opinion firms (Cid Gallup, McKinsey & Company, etc.), technological and pharmaceutical firms (INTEL, Procter and Gamble, etc.).

In order to describe the scope of the statistical profession in Costa Rica, we will use a categorization offered by Bartholomew (1995). He identifies four types of statistics and suggests that no view of statistics is complete if any of them is excluded:

- I. The collection and presentation of numerical data, the statistics of censuses and of official publications, closely associated with the origin of the term statistics.
- II. The statistics of small random samples, of survey and experimental design and of formal inference.
- III. The statistics of modeling dynamic stochastic systems, e.g. linear structural relations models, risk analysis.
- IV. The statistics in areas of activities of great public interest: politics, management, the sciences, law, etc.

Although the categories overlap and are not exhaustive, as he acknowledges, his categorization is useful for our purposes. Types I and II are widely used in Costa Rica. Type III is more restricted, although it is very much needed in the environment of banks and financial institutions, where statisticians should claim more participation in modeling efforts in the analysis of time series and risk analysis.

Type IV statisticians are very much needed in the social sciences, particularly in sociology and political science, applying type III statistics. There is a serious shortage of this type of statisticians in Costa Rica. In general, statistical consulting in the area of the social sciences requires that statisticians take responsibility for the substantive aspects as well as the statistical ones, and become experts in the methodology of science associated with issues of variability and uncertainty. These statisticians should aspire to the status of social scientists broadening the perspective of the profession, as proposed by Goldstein (1984), a status they presently do not enjoy.

Private consulting is undertaken by professional statisticians, either individually or as part of consulting teams within private organizations with economic, marketing research or public opinion interests. Some professional statisticians undertake statistical consulting as an extra job. The School of

Statistics of the University of Costa Rica offers consulting services to students and faculty within the university, and to private and public institutions. Eventually, several contracts have been signed with municipalities, Central Bank of Costa Rica and other institutions, to undertake research projects of their interest.

In spite of the existence of a statistics profession which enjoys a well deserved prestige, research teams frequently lack a professional statistician among its members. The use of sampling surveys to gather information on many social problems is very frequent in Costa Rica, in the public and private sectors. However, the presence of statisticians in this type of studies should be higher to guarantee that the survey stages are executed according to the basic principles of survey sampling methodology, and that the data gathered has the quality required for the validity of the results.

Research workers frequently seek statistical advice concerning questionnaire design, actual selection of the probabilistic sample, and choice of an appropriate sample size for a specific study. Quite often the research worker is only interested in verifying if he or she has used the right formula or the right statistical table to determine the sample size in the simplest version of unrestricted random sampling. On other occasions, after deciding on the sample size, he uses a non-random scheme to draw the sample. This forces the consulting statistician, at best, to explain the research worker the complete process of the sampling design, the need to take into account the specific objectives of the study, the relevance of concepts such as measurability, practicality and optimum use of resources, and basic aspects of estimation.

Another problem frequently encountered in the analysis of survey, census or registry data, is that once the relevant data is gathered, the research worker seeks a statistician for advice on a particular analysis, but the variables used by his instrument do not meet the level of measurement required for the analysis sought. In other situations, the research worker simply turns to a statistician, handles him the instrument, usually a questionnaire, and ask for an opinion, without giving more information. The statistician is forced to enquire about the objectives of the study, the population of interest and other relevant information, in order to make the research worker realize their relevance at the moment of elaborating the instrument.

It should be obvious that certain research workers may conduct some investigations with just some advice from a statistician, but there are other investigations that can only be carried out with the participation of a statistician, e.g. feasibility studies of projects of sanitary sewage systems and potable water, models of public transportation systems, etc.

4 Evaluation of the performance of statistics professionals

Analysis of survey data gathered by the University of Costa Rica in 2014 has revealed important facts concerning the statistics profession, as given by bachelor degree graduates (some of them already registered in the M.Sc. statistics program of the School of Statistics) and their employers. The majority of the employers (90% or more) share the opinion that:

- Statistics graduates possess the required knowledge in statistics and computing to accomplish the tasks and responsibilities expected from them when hired.
- Statistics graduates also exhibit non-statistical qualifications like oral and written communication skills, team participation, research project management, and acquaintance with the code of ethics of its profession.
- There is a great congruency of the training received by bachelor graduates in the university with the tasks and responsibilities demanded from by the labor market.

The graduates were also very positive concerning their degree of satisfaction with the academic training received in the bachelor degree in statistics of the school of statistics of the University of Costa Rica. The high degree of satisfaction of employers reflects that the changes in the statistics curriculum of the bachelor degree in statistics introduced six years ago, produced the expected positive effects. For

instance, the introduction of two courses on Professional Practice that involve students in the design and execution of research projects in public and private institutions, the increased emphasis in the development of oral and written communication skills and internships in both types of institutions. Still, statistics teaching should include new courses based entirely on practical case studies to bring students closer to real settings.

Another very positive aspect of the statistics profession in Costa Rica is the lack of unemployment among the statistics graduates. According to the records of the School of Statistics, all the graduates from 1970 to 2014, a total of 472, managed to find a job just after leaving school. Recent data show that the demand of statisticians continues growing.

5 Threats and challenges

As many other professions, the statistics profession is exposed to threats by invasion of its field by other professionals, in spite of being protected by law and the College of Professionals in Economic Sciences. The College protects the profession in the public sector, but not in the private sector, where its influence is not compelling. Improper use of statistics in the private sector by non-statisticians may affect the prestige of the statistics profession.

Obviously, sociologists, social workers, nurses, etc. are entitled to apply what they have learnt in the statistics introductory courses. But beyond elementary descriptive and inferential statistics, they are not qualified to deal with more difficult problems such as complex sampling designs, multivariate analysis, time series modeling, etc. The introductory statistics courses taught in the School of Statistics at the University of Costa Rica, advice students to seek a professional statistician when their research problems require a higher level of statistical sophistication or expertise.

Paradoxically, within the University of Costa Rica, schools other than the School of Statistics, for instance, the School of Political Sciences, teach courses of elementary statistics to its own students with instructors that are not statisticians. The likely reason for this practice, may be the belief that better teaching is produced when the instructor knows the substantive field of application. In elementary courses this line of argument is obviously faulty.

Another threat to the statistics profession comes from ignorance of the status of the discipline and the qualifications of a professional statistician. The training received by statistics graduates incorporates not only statistical techniques but also experience in conducting research projects in economic, social and cultural settings, evaluation of costs of sample surveys, practice in writing technical reports and performing collaborative work.

With the advent of personal computers and informatics, the statistics profession has had access to sophisticated statistical techniques than were difficult or impossible to implement, and to a varied menu offered by statistical packages like SPSS or SAS, and languages like R. But packages like SPSS have been marketed to social scientists, and consequently the need to seek statistical consultancy has diminished accordingly. Complex statistical analyses can be done nowadays without the assistance of a statistician, with many the dangers involved.

On the other hand, the appearance of *data mining* as a new discipline may rob some identity to the statistics profession. In coming years with better and easier-to-use data mining software, the data analysis field may be less associated with the professional statistician. Data Science degrees offered by some universities may contribute also to blur the identity of professional statisticians.

The professional statistician will have to redefine himself to serve better to society. He will have to be more creative and knowledgeable in the new developments in Big Data and Data Mining, in order to contribute to the analysis of massive data bases in private and public banks, and other institutions and organizations, e.g. Costa Rica's public health insurance institution with massive data bases on all Costa Rican workers and employers contributing to social security, and the National Institute of Statistics and Census, with census and household surveys data.

6 Final remarks

The challenges that face the statistics profession demand an important revision of the teaching of statistics and the need to contact all data analysts that work in different fields with the purpose of integrating efforts to unify the discipline of statistics.

There is a shortage of international conferences on the exercise of the statistics profession, compared to conferences on technical and teaching aspects of statistics. A conference in which statistics professionals from many countries were invited to speak about their experiences and challenges would be most enlightening. It would also be very useful to give space in this conference to employers, in order to hear their evaluations of the statistics professional and suggestions for any improvement in their formation.

Concerns about the future of statistics has been the subject of many conferences and symposia. There are many positions. One position that we like is the one shown in the following extract, by Marie Davidian, taken from *A Report of the London Workshop on the Future of the Statistical Sciences, 2013*:

“The advent of Big Data, data science, analytics, and the like requires that we as a discipline cannot sit idly by ... but must be proactive in establishing both our role in and our response to the ‘data revolution’ and develop a unified set of principles that all academic units involved in research, training, and collaboration should be following ... There are many in our profession who are furious over ‘data science’ and the like and believe we should be actively trying to discredit these and work toward renaming anything having to do with data as ‘statistics.’ At this point, these new concepts and names are here to stay, and it is counterproductive to spend precious energy on trying to change this. We should be expending our energy instead to promote statistics as a discipline and to clarify its critical role in any data-related activity.”

Much of the identity problems of the statistics discipline originate in the very well known fact that statisticians have no field of their own. As Kish remarks (1978):

"..., statisticians have no field of their own from which to harvest their data Because we have no field of data of our own we cannot work without others, but they cannot do without us - or not very well, or for very long."

The statistics professionals would become more useful if they become more acquainted with the substantive subject from which they take their data, refuse to be mere technicians and aspire to become, for instance, social scientists if their field were that of the social sciences.

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