BUILDING EXPERTISE IN MATHEMATICAL STATISTICS WITHIN THE AUSTRALIAN BUREAU OF STATISTICS THROUGH PARTNERSHIPS WITH ACADEMICS

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ABSTRACT:
Australian Bureau of Statistics recognises the critical importance that its statistical products and services are underpinned by defensive statistical methodology. To this end, the Australian Bureau of Statistics has developed strong partnerships with academics and universities in order to assist with the recruitment of graduates and their development into research leaders in mathematical statisticians. This paper describes the details of the partnerships since 2004 and some of the important benefits.

1. INTRODUCTION

This chapter discusses existing the partnerships between the Australian Bureau of Statistics (ABS), Australia's National Statistical Agency (NSA), and academics with expertise in mathematical statistics. While this chapter is written from the perspective of the ABS, the benefits of such partnerships would naturally apply to other NSAs. Use of the term, *mathematical statistics* here is restricted to the design of sample surveys, econometrics and analysis of those data typically collected by an NSA.

What is the ABS, as an NSA, trying to achieve? The ABS' mission is to *assist and encourage informed decision making, research and discussion within governments and the community, by leading a high quality, objective and responsive national statistical service*. Meeting such a mission requires that the ABS deliver statistical products and services of high quality. Measuring the quality of a statistical agency's statistical products and services has been discussed in the literature (see Brackstone, 1999). Delivering high quality statistical products and services into the future requires building *expertise*.

The role of a mathematical statistician (see Linacre, 1995) within the ABS is to ensure its products and services are informative and relevant to user's needs, have a high level of statistical integrity and are cost effective. While the ABS' mission and the role of its mathematical statisticians are largely unchanged in recent times, the world is rapidly changing. There is increasing competition for a reducing pool of mathematical statisticians. There is a greater range of products and services provided by other agencies and organisations, which are natural competitors of ABS' products and services. There has also been an explosion of administrative data, increasing computing power, budget reductions and increasing sophistication of analysts who demand greater quality products and services.

This rapidly changing world presents a new set of challenges to the ABS in terms of recruitment and training of mathematical statisticians, demands on current levels of expertise and ability to innovate. This chapter considers how the ABS partners with academics to help address these challenges. Section 2 discusses the significant ways in which ABS funds academic activities. Sections 3, 4 and 5 discuss the direct benefits to the ABS from funding academic activities in terms of attracting graduates, training professional statisticians, and developing technical leaders. Section 6 discusses some of the indirect benefits from funding universities. Section 7 mentions challenges for the future including some barriers to effective partnerships between ABS and academics.

For a detailed account of the methodological development in the ABS during the eighties and nineties, see Chapter 7 of Informing a Nation – The Evolution of the ABS (see reference list).

2. FUNDING ACADEMIC ACTIVITIES

Statistical methods typically applied within ABS and other NSAs form only a part of the broad field of statistics. As a result, attracting academics with the right expertise and experience with whom to partner can be challenging. An academic with the right expertise may not reside within Australia, given its relatively small population and geographic isolation. The ABS has taken an active role in partnering with academics through its funding arrangements, which are now mentioned.

With a view to enhancing ABS' capability in survey methods and techniques, since 2004, the ABS has fully-funded a professorial position in Survey and Statistical Methodology at the University of Wollongong (UoW) in Australia. A world class professor with expertise and extensive prior experience with statistical agencies was appointed to the position. Since the appointment, the professor has improved the expertise of the ABS' mathematical statisticians by questioning the status-quo, encouraging innovation, and by encouraging the development of sound and defensible methods. Moreover, the ABS has been fortunate that a small, but influential, number of academics at UoW have previously held senior roles at ABS. Historically, this has led to strong links between ABS and UoW. Strong links between NSAs and universities in other countries are also common (e.g. ONS with Southampton University and Statistics Canada with Carlton University).

An emerging objective for the ABS is to *unlock the value in administrative data* collected by commonwealth government agencies. This presents two major statistical challenges: integrating multiple sources of administrative data, perhaps using record linkage or data fusion; and facilitating access to analysts, within the community and government, to the data without disclosing information about people or organisations within Australia. There is limited academic expertise and experience in these fields of statistics within Australia. To attract such expertise, the ABS has committed to part-fund two professor positions, which have been advertised internationally. Recruitment of the sponsored professors is well advanced and is being managed by Queensland University of Technology (QUT) and the University of Technology Sydney (UTS), which are members of the Australian Technology Network (ATN) of technology universities. The ABS signed a memorandum of understanding (MOU) with the ATN in February 2012 to fund these positions Under the MOU, the ABS Chairs will spend about 20% of their time to help ABS build its capability on data integration and disclosure avoidance techniques by: presenting training courses, collaborating and providing advice on key projects, reviewing the literature, attending and commenting on technical reports.

The ABS contributes to funding academic activities in other ways mentioned below:

(a) Providing full or partial funding for PhD scholarships. For example, the ABS has agreed to supplement the scholarships for up to two PhD students at UTS or QUT who are conducting research that is relevant to the ABS' methodology work program.
(b) Contributing to research by providing cash and in-kind contributions. For example, the ABS is an industry partner in a Linkage Project into Productivity Measurement with Professor Kevin Fox as the lead investigator.

3. ATTRACTING GRADUATES

The ABS has about 100 mathematical statisticians. The role played by universities in developing this pool of statisticians has been critical- all have a university degree and 25% have a doctoral or post graduate degree.

Many organisations and agencies are competing for university graduates in this field. A large component of ABS recruitment is made up of university graduates. The ABS aims to recruit graduates with strong analytic, conceptual and communication skills who have demonstrated an aptitude for mathematical statistics.   To achieve this aim the ABS has a number of strategies.

(a) Encourage teaching of statistics at universities, particularly in those areas of statistics applied at the ABS.

The UoW is a world leader in statistical and survey methodology. It provides a range of undergraduate courses on survey sampling and data analysis, and provides a post graduate certificate in statistics. These courses cover areas of statistics that are highly relevant to ABS. As a result the ABS has recruited a number of graduates from UoW with relevant training over the past decade. To a certain extent this is due to the fact that three UoW academics have continued to build upon the expertise developed during their earlier careers at ABS, and the funding arrangements it has with UoW, mentioned above.

The ABS, as a foundation partner of the ATN's Industry Doctorial Training Centre, has the opportunity to influence what subjects are taught to the Centre's PhD students, and the research topics of the students. In particular, the ABS has the opportunity to deliver a semester length course to IDTC PhD students on survey methodology.

(b) Encourage undergraduate students to study statistics

The ABS encourages students to study mathematical statistics at university. ABS awards a scholarship (comprising modest cash payment) to students with the highest mark in a statistics or mathematics subject to cover education costs (HECs fees and books); and provides a Cadetship (comprising a modest salary) to a small number of Honours students who are studying mathematical statistics and have a high level of academic achievement. The topic of the Honours research project, a requirement for many Honours courses, is negotiated between ABS, the student and the student's academic supervisor.

(c) Raising ABS' Profile at Universities

The ABS raises its profile at universities, through giving seminars, attending conferences and statistical society meetings. The ABS attends frequently attends career fares at universities.

Whilst the ABS does not have institutionalised arrangements for seconding academics (e.g. Professors) to ABS, in 2011 an Adjunct Professor was seconded to ABS for one year on a part-time basis. The objective of the secondment was for the ABS to learn from the Adjunct Professor's extensive experience in confidentiality. Collaboration during the secondment resulted in the submission of two papers on confidentiality to peer-reviewed journals.

4. TRAINING PROFESSIONAL STATISTICIANS

This section discusses the role of academics in training ABS' professional mathematical statisticians, who may have limited prior exposure to designing sample surveys, econometrics and analysis of data typically collected by an NSA.

4.1 DIRECTLY-FUNDED TRAINING

In return for funding the professorial position in Survey and Statistical Methodology , there are several ways in which UoW academics help to develop ABS' professional statisticians. These are mentioned below.

(a) University Training Courses

The UoW provide three training courses per year. Some training courses provided by UoW include:

- Principles and Practices of Methodological Research. This provides an introduction to the design-based and model based frameworks, and their roles in making inference. It provides a summary of the different statistical tools (e.g. Bootstrapping, Multiple Imputation) and how to evaluate the performance of a statistical method (e.g. simulation, hardware and software). It also describes how to manage research and how to disseminate the results (e.g. publication).
- Introduction to Multilevel Modelling for Repeated Measures Data. This course introduces multilevel models and their application within the computer package MLwiN using a mixture of lectures and computer workshops.
- Methods of Combining Data. This course considers model-based and design- based methods of making inference using more than one set of data (e.g. meta- analysis)
  Other courses include: Sample Design in Practice (sampling hard-to-reach populations), Advanced Survey Estimation, Detection and Treatment of Outliers and Logistic Regression. Importantly, the specific topics are decided upon through negotiation.

(b) One-on-One Meetings

One-on-one meetings typically involve a staff member raising a practical problem with an academic, who may abstract the problem within an established statistical framework and provide relevant references to published articles in the statistical literature.

(c) Project Advice

Academics have substantial input at the early stages of select projects. This input includes identifying the key statistical issues and references, providing ongoing advice during the project, and commenting on the project's final report.

(d) Comments on Technical Papers

Academics comment on project reports and technical papers. These comments focus on improving the statistical rigor and value of the work to the ABS.

(e) Review Articles

Academics write review articles which provide a broad overview of the literature on a particular statistical problem or method and identify key references. There is an explanation why the literature is important and how it could be useful to the ABS

(f)   Symposia

ABS and UoW organise an annual symposium, where experts and practitioners present talks on a particular theme of statistics. The 2012 symposium was on Analysis of Longitudinal Data and heard talks about the Household and Income Labour Dynamics in Australia and the Survey of Australian Children.

(g) Hosting academic visits

The ABS hosts visits by international academic experts. In 2012 the ABS hosted the Symposium on the Disclosure Risk of Linked and Longitudinal Data which heard presentations from leading experts in the field of data access and confidentiality. Also in 2012, the ABS funded world experts to deliver training courses on synthetic data for disclosure control and missing data.

(h) Methodology Advisory Committee

The ABS' Methodology Advisory Committee, comprising ABS senior executive in the Methodology area and leading academics in mathematical statistics, meets twice a year. At each meeting four papers are presented to the committee, where an academic on the committee will lead discussion of one paper to provide critique on the proposed methodology, methods or techniques to be used in the ABS. The papers can discuss cross-cutting and high-level statistical problems or, more commonly, focus on a proposed solution to a particular methodological problem.

4.2 INDIRECTLY FUNDED TRAINING

Academics also provide advice or training without direct funding from ABS. These are mentioned below.

- Academics have provided advice about the content of two significant training courses developed by the ABS (see Clarke, 2002 and Van Halderen & Bhattacharjee, 1998). The Survey Methods course is an introduction into sample designs and estimation, with an emphasis on relevant ABS applications. The course is designed to develop the fundamental technical skills required of a mathematical statistician at ABS. Survey Methods is a pre-requisite for the Model Assisted Methods (MAM) course.   MAM is about the role of models in sample designs and estimation and is built around the material in Särndal, Swensson & Wretman, (1992).
- For training and development purposes, there is an emphasis on giving staff experience in presenting at conferences. For example, the ABS offers an international trip to promising staff who have less than 10 years of experience and who have demonstrated strong potential for further development as a professional statistician. The trip typically includes attending conferences, universities and meeting with their counterparts in overseas NSAs.
- ABS staff may apply for up to 6 hours per week paid leave to study, provided the study is relevant to ABS' business, a course (e.g. PhD or Masters) at university without loss of income.
- The ABS often hosts Statistical Society meetings, which allow for formal and informal interaction with academics.

5. DEVELOPING TECHNICAL LEADERS

This section discusses how academics assist in developing technical leaders from professional statisticians. A technical leader is able to develop well-justified methods using established statistical frameworks to independently solve a complex practical problem. There is no formal *technical leader* position in the ABS, unlike some other statistical agencies such as Statistics New Zealand. The ABS has about five to ten technical leaders in mathematical statistics. Technical leaders are able to work collaboratively with academics at a high technical level. Some examples of how technical leaders are developed are now mentioned.

(a) Honorary Academic Positions

While somewhat less common, technical leaders have the opportunity to hold honorary academic positions (e.g. Senior Fellow). This allows ABS staff to jointly supervise PhD students. It also means that universities are able to provide full or part funding for ABS staff to attend conferences or cover other expenses (e.g. laptops)

(b) Triennial UoW Fellows Meeting.

A UoW Fellows Meeting includes four presentations and interactive discussion between Fellows and invited guests, which comprise academics and other technical experts.

(c) Collaboration

On occasion an academic may collaborate with an ABS technical expert on a topic of mutual interest. There are some examples of joint UoW-ABS journal papers being written.

6. INDIRECT BENEFITS OF FUNDING

Section 2 mentioned the significant ways that the ABS funds academic activities and Sections 3, 4 and 5 discussed some of the direct benefits of this funding. This section discusses the significant indirect benefits of this funding.

(a) Academics will build expertise in statistics within Australia by

- Attracting academics to their university for employment, short term secondments, or visits.

- Applying for research grants in topics relevant to ABS. These funds are used to recruit research fellows and PhD students in statistics, thereby increasing the pool of statisticians with skills in demand by the ABS.

- Conducting research for other agencies within Australia and internationally. This research can benefit the ABS. For example, the UoW professor, whose position was fully funded by the ABS, received a grant from Statistics New Zealand. The grant funded research which had direct applications in data integration (see section 2).

- Providing courses for undergraduate and postgraduate students

(b) Through funding, the ABS will raise its profile and reputation among academics and their students which will assist recruitment of graduates.

7. CHALLENGES FOR THE FUTURE

From the perspective of a statistical agency, the world is becoming more complex and therefore requires the ABS to keep its methodologists up to date with contemporary statistical methods, and perhaps develop these methods to tackle the attendant complex statistical problems. This means building partnerships with universities and academics with relevant technical expertise is more important than ever. While the ABS partnerships with academics have been very successful, there are some challenges for the future.

The current take-up of statistics in Australian universities presents challenges to the supply of capable graduates with relevant training in the future. To address this, the ABS is beginning to geographically decentralise its staff which, given technological advances, is becoming increasingly practical. This means that a preference for living close to family and friends is less of a barrier to working with the ABS than it has in the past. It also means that ABS' mathematical statisticians can be geographically closer to the academic expertise located across Australia. Historically, decentralisation of mathematical statisticians has long been resisted to some extent by Australia and other NSAs (e.g. Felligi, 2010 discusses this issue from the perspective of Statistics Canada).

There are perceived barriers to effective collaborations between academics and ABS. First, academics have restricted access to ABS' micro-data. Second, ABS' priorities generally change more rapidly than the research priorities of academics. Third, the focus of the ABS is on solving a particular problem while academics' focus is on solving a generic problem. Four, there are cultural differences arising from different priorities and skill sets. ABS will continue to work with the academics to find workable solutions to overcome these barriers to achieve mutually beneficial outcomes.

Not unlike many other overseas NSAs, ABS is facing tight budgets in the out-years, which pose interesting challenges to ABS to maintain the same level of engagement with academics, let alone expanding it. It will have to think very hard about striking the balance between the imperative of balancing annuals budgets and the longer term investment in its capability on mathematical statistics within Australia.

However, on a positive note, there has consistently been a rich source of interesting statistical problems facing the ABS. This coupled with our engagement with academics mean it is a natural research partner of academics now and into the future.

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