ROYAL STATISTICAL SOCIETY

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The impact of academic statistics as shown through 'impact case studies' submitted to the 2014 REF

Summary

Our exploration of the REF 2014 Impact Case Study database is intended to provide further context and evidence in support of the Royal Statistical Society (RSS)'s strategic goal "for statistics as a discipline to thrive, so that methodology is advanced, applied and made accessible"[1]. We find that statistical research featured relatively strongly in case studies submitted to the Mathematical Sciences UoA, and that these were submitted from a range of disciplines and departments, not exclusively from departments of Mathematics and Statistics. Just over one third (35%) of the case studies found in our search were submitted to the Mathematical Science UoA, however more than half (64%) of the case studies that we found were submitted to other panels, for example under Business and Management, Computer Science, Economics, Geography, and Engineering. Cases extracted from the REF database may therefore help to illustrate the range of cross-disciplinary contributions that can be made by statisticians, data analysts, statistical methods and training. However, the case studies identified in our search are selective and not representative – for example, the strength of statistics in certain fields such as clinical medicine appear to be poorly represented by way of our search criteria. Our extracts and analysis are presented to complement previous information and remarks in the RSS' report on the *Future of Academic Statistics in the UK*[2].

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Terminology

- REF – Research Excellence Framework (provides the framework by which case studies are submitted)
- HEI – Higher Education Institution (the case studies were chosen and written by Higher Education Institutions)
- UoA – Unit of Assessment (each case study was submitted to a subject panel, these were known as units of assessment. There were 36 UoAs, split between four groups)
- RSA – Research Subject Area (case studies highlighted the main research areas, some named more than one)
- RSS – The Royal Statistical Society

[1] Royal Statistical Society *Strategic Plan 2014-18* (PDF), available from: http://www.rss.org.uk/Images/PDF/about/strategy-summary_flr.pdf (accessed December 2016)

[2] McConway, K. (2013) *Remarks on the Future of Academic Statistics in the UK* (PDF), available from: http://www.rss.org.uk/Images/PDF/influencing-change/RSS-report-Academic-Statistics-in-the-UK-revised.pdf (accessed December 2016)

Introduction

In 2013 a report by Kevin McConway for RSS on the Future of Academic statistics in the UK[3] sought to further investigate a reported decline in statistics departments in higher education institutes (HEIs). McConway notes a reported decline in statistics within mathematical science departments, yet also remarked that statistics is important in collaborative research and is "a very applied discipline with strong links elsewhere". He implied that there may be a wider basis for developing a research career in statistics, and for considering the health of the discipline: "It is certainly the case that the predominant route into academic statistics is through groups in the mathematical sciences. But one has to ask whether it needs to be like that."

HEFCE in collaboration with Kings Policy Institute and Digital Science have since produced an analysis and a searchable database of the Impact Case Studies submitted to the Research Excellence Framework (REF)'s 2014 assessment cycle: http://impact.ref.ac.uk/CaseStudies/. Impact case studies were newly introduced to the 2014 REF to pinpoint research that UK HEIs consider to have had impact beyond academia. The case studies, the majority of which have been made available in the HEFCE database, are therefore intended to illustrate impacts of academic research across the UK and internationally with regard to the economy, society, culture, public policy and services, health, the environment, and quality of life. For this study we undertook some simple analysis of the REF impact case study database, to highlight the part that the discipline of Statistics appears to have across the full range of cases submitted.

Analysis

Our table provides links to 308 case studies that might be identified as 'statistical', selected by the following criteria: those where statistics was identified as a research subject area (or RSA), and those that were published in statistical journals (compiled from the American Statistical Association, Wikipedia, and the SCI Index) and subsequently submitted to REF2014.

Our exploration of this data found that the case studies that were submitted to the Mathematical Sciences UoA were often clearly produced from a range of university departments, and not purely in departments of Mathematics and Statistics. In the REF 2014 assessment, the Mathematical Sciences panel considered the quality of statistical submissions to be high. The panel wrote[4]: "A substantial proportion of the outputs in statistics, probability and operational research was world-leading and helped to shape the international research agenda. Strength in core statistical methodology was broad, notably in computationally intensive methods and the analysis of high-dimensional data."

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[3] McConway, K. (2013) Remarks on the Future of Academic Statistics in the UK (PDF), available from: http://www.rss.org.uk/Images/PDF/influencing-change/RSS-report-Academic-Statistics-in-the-UK-revised.pdf (accessed December 2016)

[4] REF2014 (2015) *Research Excellence Framework 2014: Overview report by Main Panel B and Sub-panels 7 to 15* (PDF), available from: http://www.ref.ac.uk/media/ref/content/expanel/member/Main%20Panel%20B%20overview%20report.pdf (accessed December 2016)

It is also the case that 198 (64%) of the total case studies that our table identifies from the database were submitted to UoAs other than Mathematical Sciences - for example under Business and Management, Computer Science, Economics, Geography, and Engineering.

We conclude from this that while the Mathematical Sciences UoA captured a good number of 'statistical' impact case studies (to the extent that our criteria here identified them) and drew cases for impact from a range of departments and disciplines, statistics is likely to have impact across a wider range of disciplines and their submissions to other Units of Assessment in the REF.

Method and limitations

- The database that was used covers case studies submitted as part of the 2014 REF.
- The database only covers the examples of statistical research which institutions themselves chose to submit to the REF. Whilst this has positive aspects as you would expect this to show research that they are proudest of, it may lead to selection bias and will not illustrate the full range of statistical research outputs (*differences in selectivity*[5]).
- The details of 338 case studies were not available as they contain confidential information; have been redacted and removed since publication; or, are not included to satisfy re-use and licensing arrangements.

Details of our search are set out in Appendix 1. Whilst over 1308 case studies in the database were found with a keyword "statistic*" (to find statistics and statistical) these provided too many false positives, i.e. results for which no statistical research had been undertaken (some may have used statistical evidence in illustrating the impact, and not in the research section. Others may discuss use of statistical methodologies, without using the key word of statistics and therefore may not have been picked up through the searches. This may result in a number of false positives, as well as false negatives. Further searches, detailed in Appendix 1, were used to narrow down to the 308 case studies presented in our table.

The impact of statistics: Individual case studies

Eight different summary impact types were identified in REF 2014, and strong statistical research is represented in each category, illustrating the wide impact statistics can have. Below are seven briefly summarised examples of the case studies identified in our search.

[5] The number of Impact Case Studies required in each REF submission was determined by the number of staff included, as noted for example in this *Report from the RSS Working Group on Research Excellence Framework (REF) League Tables* [PDF], May 2015. Available from http://www.rss.org.uk/Images/PDF/about/press-releases/rss-press-release-ref-league-tables-report-11-05-2015.pdf

Election exit polls

UoA: Mathematical Sciences
Research Subject Area: Statistics; Political Sciences

Statistical research at the University of Warwick successfully predicted the outcome of the 2010 General Election through analysis following the 2005 election (after another successful prediction). A combination of the design of the exit-poll, modelling of data and calibration of probability forecasts across constituencies enabled the accurate forecast. The results predicted were a surprise to commentators and politicians, increasing the reach of the research as it were widely covered across TV, radio and internet channels. The research was published in the Journal of the Royal Statistical Society Series A and was read before the RSS at an RSS Ordinary Meeting.

Modelling epidemics

UoA: Mathematical Sciences
Research Subject Area: Statistics

The Maxwell Institute (University of Edinburgh and Herriot Watt University) used Bayesian computational methods to fit stochastic models for epidemic dynamics. These models have been applied to control programmes for pathogens of both humans and plants reducing incidence, cost, and mortality of bacterial infections in Scotland and has also been used in America to reduce the impacts of Sudden Oak Death.

Player performance index

UoA: Business and Management Studies
Research Subject Area: Statistics; Applied Economics

Quantitative analysis at the University of Salford led to the development of an objective football player performance index that is used to inform squad selection in the premier league and in online Fantasy Leagues. Statistical analysis is (possibly unwittingly) engaging members of the public across the globe! The research was published in the Journal of the Royal Statistical Society Series C.

Imaging of 'The Scottish 10' heritage sites

UoA: Art and Design
Research Subject Area: Statistics; Artificial Intelligence and Image Processing; Geomatic Engineering

The Glasgow school of Art has used novel processes of data acquisition, processing and management and the development of modelling techniques to create 3D digital images of Scotland's 5 UNESCO World Heritage Sites to inform their conservation and management. They have also mapped 5 other sites – the Sydney Opera House, Mount Rushmore, Nagaski, Rani ki Vav and Eastern Qing Tombs – which has kick started a range of collaborations between Scotland

and other countries. The images are also being used in education and supporting international tourism.

Weather prediction

UoA: Mathematical Sciences
Research Subject Area: Statistics; Oceanography; Maritime Engineering

The development of ENDGame by the University of Exeter has allowed the Met Office to use advances in representation of wave propagation representation, for example and statistical methodologies. This has led to more accurate weather forecasting: the economic value of the forecasts is in excess of £600m pa while having far reaching policy impacts.

Cerebral Palsy

UoA: Mathematical Sciences
Research Subject Area: Statistics; Public Health and Health Services

Research by the University of Warwick has applied statistical models for survival analysis to cerebral palsy. This has had significant influence in medical and legal professions, as the lead researcher has been called as an expert witness in assessing life expectancy damages impacting compensation totalling up to £450m. This has also helped ensure that patients receive the best care for the rest of their lives. The work was submitted through Mathematical Sciences (UoA) and allocated to the Statistics and Public Health and Health Services Research Subject Areas. Research was published in Journal of the Royal Statistical Society Series C.

‘Now casting’

UoA: Business and Management Studies
Research Subject Area: Statistics; Econometrics

The London Business School has developed statistical methods to allow for the predicting of the present day. This is important because many key economic statistics are only available after a time delay. They have also developed methodologies incorporating big data. This has allowed more accurate and earlier estimates before the official figures become available, and is used by central banks and policy institutions in the decision making processes. The work was submitted through Business and Management Studies (UoA) allocated to the Statistics and Econometrics Research Subject Areas.

Appendix 1: Search details

Mathematical Science (UoA) + Statistics (RSA)

This search categorised roughly half of the case studies within Mathematical sciences as statistical (110 out of 209). 39 institutions submitted these case studies, out of 158 institutions that we might expect to have high impact mathematics and statistics departments.

Search: Statistics (RSA)

This search incorporates those case studies originating from inter-departmental teams. Out of the resulting 255 case studies:

- 79 institutions submitted one or more of the case studies found in this search.
- 15 case studies with statistics as an RSA were submitted by the University of Oxford – the most submitted by any institution.
- Some institutions submitted very few case studies overall but included at least one case with statistics as an RSA. These show a level of interest in statistics that we might not otherwise expect. These include WestCHEM (the joint research school in chemistry of the Universities of Glasgow and Strathclyde), the Glasgow School of Art, Heythrop College and Buckinghamshire New University.
- Almost half of HEIs did not submit any case studies in this search. Sometimes the absence of statistical case studies is in keeping with the university's specialism, such as the Royal Academy of Music, however his group also included larger universities which submitted large numbers of case studies overall to the REF.
- Of the 36 Units of Assessment, three quarters (75%) were represented in the results of this search.
- The low presence of statistics in Clinical Medicine and Psychology, Psychiatry and Neuroscience may be explained by the strength of submission of health statistical work to the Mathematical Sciences UoA instead. (The top 20 UoAs for statistical submissions are charted in Appendix 2)

Search: Statistics Journals

This search used a list of Statistical journals (compiled from the American Statistical Association, Wikipedia, and the SCI Index) to look specifically for research that was published in 'statistical journals'. This search found 129 case studies, of which 48 were not listed as having statistics as a Research Subject Area. The inclusion of statistical journals greatly increased the number of Economics and Econometrics and Business and Management studies listed. The use of a journal search did not increase the number of Clinical Medicine and Psychology, Psychiatry and Neuroscience case studies. This could be the result of a number of respected medical journals, for example the British Medical Journal, not being classified as statistical in the available Indexes.

Table showing outcomes of a variety of keyword searches undertaken

Keyword search	Number of case studies	Comments
“statistic*”	1308	There provided too many false positives, i.e. results for which no statistical research had been undertaken.
“statistics”	813	
“statistical”	647	
“Research: “statistic*”	665	
Research Subject Area - Statistics	255	Use for more general analysis
references: statistic* AND research: statistic*	157	Use for search for specific case studies on high impact
Unit of Assessment; Research subject area = statistics	106	
“Royal Statistical Society”	59	
Journal search	129	Across a comprehensive list of statistical and probability journals.
“References: “*Journal of the Royal Statistical Society”*	40 (+2 using abbreviation)	

Appendix 2: Chart to illustrate the presence (or lack of) statistical submissions across the Units of Assessment