Council of Canadian Academies
Conseil des académies canadiennes

Understanding the Expert Panel's Methodology
The State of Science and Technology in Canada, 2012

Overall:

- In selecting the methodologies for this assessment, the Panel sought to create a suite of complimentary approaches and measures that would capture information about different aspects of the Canadian research system, including research outputs (publications and patents) and impacts (citations, reputation and training of students).

- In total, the Panel used a number of different methodologies to conduct this assessment, including: bibliometrics (the study of patterns in peer-reviewed journal articles); technometrics (the analysis of patent statistics and indicators), an analysis of highly qualified and skilled personnel; and opinion surveys of Canadian and international experts.

- To draw comparisons among the results derived through the different methodologies, and to integrate the findings, a common classification system was required. The Panel selected a classification system that includes 22 research fields composed of 176 sub-fields, which included fields in the humanities, arts, and social sciences.

- Overall, the multi-lens methodology used within the report provides a detailed and thorough approach to assessing the magnitude, quality, and trends of Canadian science and technology in comparison to other advanced countries. As a result, this report is one of the most comprehensive assessments of Canadian science and technology ever undertaken.

- Recognizing that some measurement tools used by the Panel (e.g. bibliometric measures) are a less relevant way of measuring science and technology strength in the humanities, arts, and social sciences, where research advances may be less often communicated in peer-reviewed journal articles, the Panel made considerable attempts to evaluate measures such as books and book chapters, exhibitions, and esteem measures such as international awards. However, the Panel was hampered by a lack of available data. As a result, the information and data collected did not meet the Council's high standards and was excluded from the assessment.

- The Panel determined two measures of quality, a field's international average relative citations (ARC) rank and its rank in the international survey, to be the most relevant in determining the field's position compared with other advanced countries. Based on these measures of quality, the Panel identified six research fields in which Canada excels. These fields are (in alphabetical order):
    1. Clinical Medicine
    2. Historical Studies
    3. Information and Communication Technologies (ICT)
    4. Physics and Astronomy
    5. Psychology and Cognitive Sciences
    6. Visual and Performing Arts

Key Methodologies Used by the Expert Panel

Bibliometric Analysis (the study of patterns in peer-reviewed journal articles)

- Bibliometric analysis has several advantages, namely, that it is built on a well-developed foundation of quantitative data and it is able to provide information on research productivity and impact.

- For this assessment, the Panel relied heavily on bibliometrics to inform their deliberations. The Panel commissioned a comprehensive analysis of Canadian and world publication trends. It included consideration of many different indicators of output and impact, a study of collaboration patterns, and an analysis of researcher migration. Overall, the resulting research was extensive and critical for determining the research fields in which Canada excels.

- Standard bibliometrics do not identify patterns of collaboration among researchers, and may not adequately capture research activity within an interdisciplinary realm. Therefore, the Panel used advanced bibliometric techniques that allow for the identification of patterns of collaboration between Canadian researchers and those in other countries (based on the co-authorship of research papers); and clusters of related research papers, as an alternative approach to assessing Canada's research strengths.

Chapter 4 provides in-depth information on bibliometrics. Chapter 6 provides the results from the advanced bibliometric analysis conducted by the Panel. Chapter 9 provides results broken down at the provincial level. The online appendices also provides detailed information on each methodology used by the Expert Panel.

*Technometrics (analysis of patent statistics and indicators***)**

- Technometrics is an important tool for determining trends in applied research. This type of analysis is routinely used by the Organisation for Economic Co-operation and Development (OECD) and other international organizations in comparing and assessing science and technology outputs across countries.

- In 2006, the Expert Panel on Science and Technology used technometrics to inform their work. In an effort to ensure consistency between the 2006 and the 2012 assessments, technometrics were once again used as a measurement tool.

- The 2012 Panel commissioned a full analysis of Canadian and international patent holdings in the United States Patent and Trademark Office (USPTO) to capture information about Canada's patent stock and production of intellectual property relative to other advanced economies. Canadians accounted for 18,000 patented inventions in the USPTO, compared to 12,000 at the Canadian Intellectual Property Office during the period 2005-2010.

  Chapter 7 provides the results of the technometric analysis of patents and other related measures. Chapter 9 provides results at the provincial level.

Opinion Surveys

- To capture a full range of Canadian science and technology activities and strengths, two extensive surveys were commissioned to gather opinions from Canadian experts and from the top one per cent of cited researchers from around the world.

- A survey of Canadian science and technology experts was conducted for the 2006 report. In 2012 this exercise was repeated, however, the survey was modified with three key changes:
  - respondents were pre-chosen to ensure those responding were experts in Canadian science and technology;
  - to allow comparisons of bibliometric data, the survey was based on the taxonomy of 22 scientific fields and 176 sub-fields; and
  - a question regarding the identification of areas of provincial science and technology strength was added.

- To obtain the opinions of international science and technology experts regarding Canada's science and technology strengths, the Panel conducted a survey of the top cited one percent of international researchers. Over 5,000 responded to the survey, including Canadians. This survey, combined with the results from the bibliometric analysis were used to determine the top six fields of research in which Canada excels.

  Chapter 5 provides information and findings based on the two opinion surveys.

Research Capacity

- The Panel conducted an analysis related to Canadian research capacity. This analysis drew evidence from a variety of sources including bibliometric data and existing information from publications by organizations such as the OECD and Statistics Canada.

- The Panel was also able to look at various Canadian research capacities which included research infrastructure and facilities, trends in Canada's research faculty and student populations, the degree of collaboration among researchers in Canada and other countries, and researcher migration between Canada and other countries.

  Chapter 8 provides an analysis of highly qualified and skilled personnel and research infrastructure, and Chapter 9 provides an examination of science and technology at the provincial level.

Report and related products:

- The State of Science and Technology in Canada, 2012 (full report)
- Executive Summary
- Report in Focus
- Appendices
- News Release
- Media Primers
  - Canada on the Global Stage
  - Science and Technology across Canada
  - Understanding the Expert Panel's Methodology