Use of *SCI*-based publication counts

Recently Karandikar and Sunder[1] and Pichappan[2] have expressed some misgivings about the use of *Science Citation Index*-based publication counts. I would, however, like to argue that the stand that the total number of papers published from a country should not be used as a science indicator is extreme. There is, I think, a strong risk of throwing out the baby with the bathwater.

In the keynote address delivered by Ahmed H. Zewail[3], a Nobel Laureate, at the TWAS 8th General Conference, New Delhi, 22 October 2002 he says: 'In the past five years, the scientific community worldwide has published about 3.5 million research papers. Europe's share is 37%. The US share is 34%. The Asia-Pacific share is 22%. Other places – representing 70–80% of the world's population living largely in developing countries – have contributed less than 7% of the scientific articles.' All these numbers come from *SCI*. To cite another example, Robert May, then Chief Scientific Adviser to the UK Government, has used publication counts when he compared the scientific investigations of nations[4]. Such comparisons of national and regional publication outputs are common in science policy circles. For example, the *Third European Report on Science & Technology Indicators 2003* proudly states 'The EU is now the largest producer of scientific papers, outstripping even the US.' It further states that in 2001, EU-15 accounted for 37.2% of world publications, USA 31.0% and Japan 10.1%, and that between 1995 and 1999, EU recorded a growth of 3.3%, while NAFTA had to contend with zero percent growth. The same report says that between 1995 and 1999, India recorded a negative growth of 0.3%, whereas China and South Korea recorded growths of 13.7% and 16.2% respectively.

When one deals with a large sample – a country the size of India – such numbers are reasonably good and valid. Of course, the statistical reliability of scientometric analysis results will decrease in the process of transition from macro to micro level; at the micro level, in particular, scientometric evaluations should be interpreted with extreme caution.

Karandikar and Sunder also are concerned about bibliometrics being projected as a science by its practitioners. Some three or four decades ago, an introductory course on economics – at least in colleges in southern India – used to begin with a lecture on 'Is economics a science or art?' I think that times have changed. Now what matters is what we can do with our knowledge and expertise (in whatever area) rather than such categorization. Disciplinary boundaries are vanishing fast, and Garfield spoke of 'research fronts' as a more meaningful way of looking at growth of knowledge[5].

As Sarukkai points out[6], there is much mathematization of economics and social sciences. Mathematics is applied to solve problems in conflict resolution, disarmament, diffusion of innovation, technology substitution, and urbanization[7]. Bruce Alberts, President of the US National Academy of Sciences, at the New Delhi meeting of TWAS noted: 'If we need science to solve the problems of the world, then the answer is not simply science but in a particular science that is place-based, multidisciplinary and acknowledges the importance of social sciences.'[8] We must not discourage the evolution of new tools and techniques for the evaluation of performance in science. For example, the economics of R&D is now a respectable area for work among economists, thanks to the pioneering work of people like Zvi Griliches[9], Edwin Mansfield, Nathan Rosenberg, Partha Dasgupta and Paul David. We also have thriving schools of sociology of science, history of science and philosophy of science. Science studies are picking up as well and there is an active Society for the Social Studies of Science (4S). I agree. Social sciences, as they deal with people and far more complex issues, cannot be as simple and straightforward as arithmetic; but then arithmetic cannot solve even the most elementary problems we face in real life, and – fuzzy or not – we need to use the social sciences.

Simply because some people do not use scientometrics intelligently, we need not abandon scientometrics. I am sure that Karandikar and Sunder agree that there are bad mathematicians and bad physicists. Indeed, a few years ago the Institute of Mathematical Sciences could not select a single mathematics Ph D student although there were a few hundred applicants. The faculty found none of them good enough. Obviously we are not doing well enough in mathematics.

Pichappan seems to both agree and disagree with those who see a crisis in Indian science. He attributes motives to some unspecified authors for 'drawing the data that would support our preconceived attitudes and beliefs'. Unfortunately the data he has provided do not support the conclusions he has drawn. He is surprised to hear that 'the number of papers published in Asia, South Korea, and China are increasing whereas those in India and US are on decline!' Note the exclamation mark. 'Will anyone accept this?' he asks. Anyone with a little commonsense and basic intelligence would. What the data indicate is that China and South Korea are publishing more now than before and the United States is publishing less now than before. There should be no difficulty in accepting this. The data presented by him do not say that China and Korea are doing better than the US. (He may do well to remember that in the early part of the last century, US was not a major centre of scientific research, and American students used to go in large numbers to Europe and the UK for higher studies in science, but today the US is among the world leaders. Which means US caught up with and overtook the rest, which is what China and Korea are trying to do now.)

Pichappan asserts that the reason for the rapid rise in the Chinese and Korean outputs of papers is the increased coverage of journals from these countries in *SCI*, and the reason for the decline in the number of Indian papers is the decrease in the number of Indian journals covered in *SCI*. That is simply not true. The data he has presented in table 1 of his article are taken from *Science and Engineering Indicators 2002*, Appendix table 5-41, although he has not acknowledged the source explicitly. The footnote to the table on page A5-86 of the NSF report clearly states 'Publication counts are from a 1985 set of journals classified and covered by the Institute of Scientific Information's Science and Social Science Citation Indexes.' It is standard practice to use a 'constant set of journals'; in this case NSF experts have considered only journals that have been covered by *SCI* every year from 1985 to 1999. Very few Indian, Chinese and Korean journals have been covered in *SCI* in each of these 15 years. Therefore, a very large proportion of the increase in the number of papers from China and South Korea are published in overseas journals and not in home country journals. Notably, Raghuram and Madhavi had shown that the decline in India's publication output could not be attributed to journal coverage in the *SCI*[10]. According to Pichappan, there are more than 2000 Indian S&T journals. That again depends on what is considered a scientific journal. [If he has taken the number from the INSDOC *Directory of Scientific Periodicals*, the number includes annual reports, popular and news magazines, etc. and many others which do not publish any original research.] How many of them are really scientific journals in the sense that *Current Science* or *Pramana* is?

According to a recent estimate by Stevan Harnad, there are about 20,000 S&T journals. But *SCI* CD-ROM edition, which is most often used in such studies, covers only about 20–25% of that number. A very large number of journals published in the US and Europe are also not indexed in *SCI*. The list of journals covered is also not static. Journals are constantly evaluated and some are removed while new ones are added. If many Indian journals have been dropped it is not due to prejudice! If many Chinese and Korean journals have been added, it is simply because they measure up to the standards set. I have been on the editorial board of *Current Contents* since 1977 and I know how objective the process of journal selection is. [Incidentally, two Chinese journals recorded an impact factor of greater than 1.0 (one of them greater than 2.0) in 2002, whereas no Indian journal has recorded an impact factor of greater than 0.7.]

Let me now give some data based on the 1985 ISI constant set of core journals. These are not vitiated by changes in journal coverage in *SCI*. The National Science Foundation uses such data routinely for giving policy advice to the US President and the Congress. Here is what the *Science and Engineering Indicators 2000* says on pages 6-46: 'The world's key scientific and technical journals exercise a degree of quality control by requiring articles submitted for publication to undergo peer review. Thus, the volume of different countries' articles in these peer-reviewed journals is a rough indicator of their level of participation in the international S&T arena. In addition, the distribution of their articles across fields reveals national research foci.' According to this report, worldwide publication of scientific and technical articles averaged about 515,700 per year during 1995–97, a 12% increase over 1986–88. Over the 1995–97 period, five nations produced approximately 62% of the articles in the 1985 *SCI* set of journals: US 34%, Japan 9%, UK 8%, Germany 7% and France 5%. Not only are *SCI* data used for counting the number of papers published and to determine a country's share in the world, but also to estimate whether the per cent share is increasing or decreasing.

The same report also talks about Asian countries: 'Recent economic problems notwithstanding, Asia has emerged as a potent high-technology region. Its output of scientific and technical articles in refereed journals grew rapidly over the past decade, providing evidence of a robustly developing indigenous S&E base. From 1986–88 to 1995–97, the Asian nations' world share of publications rose from 11 to 14%, amid contradictory trends. Japan's output rose 35%, while China's more than doubled. However, India's output continued to decrease, a matter of concern to the nation.'

The *Science and Engineering Indicators 2002* reinforces these trends (between 1986 and 1999), again using data from the 1985 constant set of journals: 'Another region that witnessed very strong gains was Asia, where output nearly doubled during this period, primarily in the eastern half of Asia. …China, a country with a far lower per capita income level compared with NIEs, registered a threefold gain in its publication output. …a 7% decrease in India's output, a matter of concern to the nation.'

The decline is not only seen from *SCI* data. Even in *Chemical Abstracts*, which aims to be a comprehensive service, India's output has declined from a 3.5% high to the current 2.4% world share. The NSF and the European Report on S&T indicators have pointed out the decline in India's output of research papers and the rapid increase in the output of China, South Korea and Brazil; a fact that many senior scientists have also acknowledged in expressing concern about the state of scientific research in India. The main point that Pichappan wants to make is that 'science auditing is complex', 'decisions should not be based on just one parameter' and 'all contributing factors require scanning'. Nothing new. It is for this reason that:

(i) The NSTMIS Division of the Department of Science and Technology gathers data (financial, manpower, publication, patent, sector and so on) regularly and brings out *R&D Statistics* and *S&T Data Book*.
(ii) I have been advocating for many years now that we should set up an Observatory for Science and Technology in India (OSTI).
(iii) The Principal Scientific Adviser to the Government of India, and the Indian National Science Academy (INSA) have independently commissioned some studies that will augment what DST-NSTMIS is already doing.
(iv) INSA has commissioned the National Council of Applied Economic Research (NCAER) to compile *India Science Report* by December 2004 and INSA has appointed a committee, with P. Rama Rao as chairman, to monitor the progress of the work.
(v) The Indian Academy of Sciences had brought out a report on higher education in science and is now looking at the contribution of women to science.

So when the science leaders and the government see a crisis and express concern about the health of science in India, it is not on the basis of 'just one parameter'.

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