Making progress, but not rapidly: is India's academic research outcome commensurate with its GERD?

The recent article by Arunachalam *et al.*[1] on 'Chemistry research in India: making progress, but not rapidly' prompted Vijayan[2] to comment that this applies to Indian science as a whole partly because of the very low support for science in terms of Gross Expenditure on R&D (GERD)[3].

The Centre for Science and Technology Studies (CWTS) Leiden Ranking 2017 (http://www.leidenranking.com/) based on Thomson Reuters' Web of Science (WoS) data, which covers seven sliding four-year time windows from 2006–09 to 2012–15, reports the scientific performance of 902 major universities from 54 countries. A higher educational institution (HEI) is included if it had at least 1000 publications in the period 2012–15 from the WoS database. From India, 20 have made the cut. Both size-dependent and size-independent indicators of output and impact are presented. The primary size-dependent indicator is the number of publications P of a university. The Leiden list also records the number of highly cited publications of a university, which happens to be a size-dependent indicator. The size-independent indicator which can be derived from this is the fraction or percentage of the highly cited publications of university. If normalized with the world average, one can compute a figure q-, which is a size-independent proxy for the quality output of a university.

Although the Leiden Ranking scrupulously refrains from aggregating different dimensions of university performance into a single overall indicator, the transparency and rigour of the methodology allows us to independently compute composite indicators of performance, as has been done earlier in these pages[4,5].

P is the number of bibliometrically fractionalized papers published by the HEIs during the chosen window (i.e. publications co-authored by multiple institutions are fractionally attributed). The proportion of top 10% publications ($PP_{\text{top 10\%}}$) is arguably the most robust, size-independent proxy or indicator for quality of publications. This is the proportion of the publications of a university that, compared with other similar publications, belongs to the top 10% most frequently cited. The procedure has a normalizing effect across fields, publication year and document type. The ratio $q = PP_{\text{top 10\%}}/10$, allows one to normalize this proxy, such that a value of 1.00 is the expected global norm.

Note that P and q are primary indicators, one a measure of size of output and the other a proxy for the quality of output. P is then a zeroth-order indicator of performance[6], and it is possible to combine this to obtain a first-order indicator of performance qP and a second order indicator of performance $X = q^2P$. In this manner, the quantity term (P) and the quality term (q) in the Leiden datasets can be integrated into a single scalar composite term that serves as the best size-dependent proxy for total performance in the research context. For each country, the scalar values of all their HEIs in the Leiden list can be aggregated as an X-score.

In the present exercise, we report the results for 902 HEIs from the Leiden ranking 2017 using only the fractionalized data for the 2007–15 window. From Vijayan[2], we also have figures for GERD in billions of US dollars in PPP terms. It is an easy exercise to draw a scatter plot relating the dispersion between X and GERD for each of the 53 countries for which Leiden and GERD data are available (Figure 1). Figure 1 shows that India, which has the sixth highest GERD outlay, is at the shoreline in a skyline–shoreline scatter plot of the X–GERD dispersion for the countries in Leiden Ranking 2017. The presence of South Korea and Japan, which are recognized as advanced technological economies, at the shoreline of performance indicates that many other factors apart from GERD affect scientific performance.

To sum up, as correctly pointed out by Vijayan[2], it is desirable to take into account not only the level of support but also other factors when assessing performance.

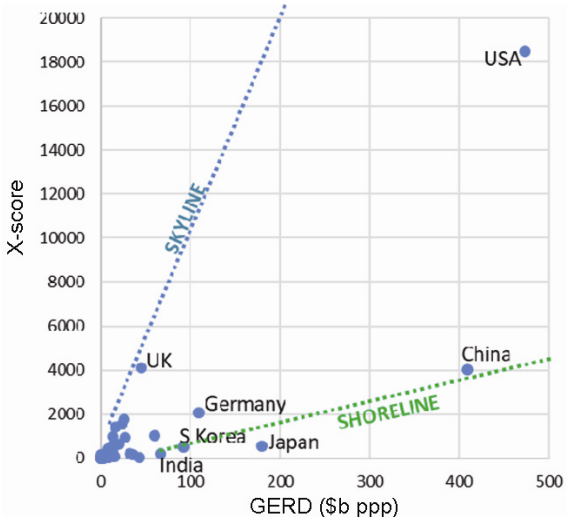

Figure 1. A skyline–shoreline scatter plot of the X versus GERD dispersion for countries in Leiden 2017.

1. Arunachalam, S., Madhan, M. and Gunasekaran, S., *Curr. Sci.*, 2017, **112**, 1330–1339.
2. Vijayan, M., *Curr. Sci.*, 2017, **112**, 2352.
3. https://en.wikipedia.org/wiki/List_of_countries_by_research_and_development_spending
4. Prathap, G., *Curr. Sci.*, 2013, **104**, 407–408.
5. Prathap, G., *Curr. Sci.*, 2014, **106**, 1467–1468.
6. Prathap, G., *Curr. Sci.*, 2010, **98**, 995–996.

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