Comparative evaluation of research in the India, Taiwan and China C9 universities using CWTS Leiden Ranking 2018 data

The Centre for Science and Technology Studies (CWTS) Leiden ranking 2018 (http://www.leidenranking.com/) reports the scientific performance of 938 major universities from 55 countries covering eight sliding four-year time windows, from 2006–2009 to 2013–2016 using data curated from Clarivate Analytics' Web of Science (WoS). A Higher Educational Institution (HEI) is included only if it has least 1000 publications in the period 2013–2016 from the WoS database. Arguably these are the best research-intensive universities in the world. There are 24 universities from India, 18 from Taiwan and 147 from China. The Leiden data allow us to compare research progress longitudinally. Here, we shall do so for India's 24 cohort, Taiwan's 18, and restrict attention only to the 9 elite universities of China known as the C9 League (https://en.wikipedia.org/wiki/C9_League). Table 1 is a compilation of this list.

A note about the C9 League will be in order here. It is a cluster of nine elite universities in mainland China. They receive substantial funding from both national and local governments to build new research centres, improve facilities, hold international conferences, attract world-renowned faculty and visiting scholars, and help Chinese faculty attend conferences abroad. Although faculty from the C9 League account for only 3% of the country's researchers, they receive 10% of national research expenditure and produce 20% of the nation's academic publications as well as 30% of total citations (https://en.wikipedia.org/wiki/C9_League).

We follow the methodology used earlier[1]. The primary size-dependent indicator in the Leiden data 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 a university's highly cited publications. If normalized with the world average, one can compute a figure q which is a size-independent proxy for the quality of a university's output.

P is the number of bibliometrically fractionalized papers published by a HEI during the chosen window (i.e. publications co-authored by multiple institutions are fractionally attributed). The proportion of top 10% publications (*PPtop 10%*) is arguably the most robust and 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 $q = PPtop\ 10\%/10$ allows one to normalize this proxy, such that a value of 1.00 is the expected global norm. It is a size-independent, dimensionless indicator.

As primary indicators, P is a measure of the size of output and q is a proxy for quality of output. P is then a zeroth-order

Table 1. The 24 universities from India, 18 universities from Taiwan and the C9 League from China

| India's 24	Taiwan's 18	China's C9
Aligarh Muslim University	Chang Gung University	Fudan University
All India Institute of Medical Sciences	China Medical University, Taiwan	Harbin Institute of Technology
Anna University	Feng Chia University	Nanjing University
Annamalai University	Kaohsiung Medical University	Peking University
Banaras Hindu University	National Central University	Shanghai Jiao Tong University
Indian Institute of Science	National Cheng Kung University	Tsinghua University
Indian Institute of Technology (Indian School of Mines), Dhanbad	National Chiao Tung University	University of Science and Technology of China
Indian Institute of Technology, Bombay	National Chung Cheng University	Xi'an Jiaotong University
Indian Institute of Technology, Delhi	National Chung Hsing University	Zhejiang University
Indian Institute of Technology, Guwahati	National Sun Yat-sen University	
Indian Institute of Technology, Kanpur	National Taipei University of Technology	
Indian Institute of Technology, Kharagpur	National Taiwan Normal University	
Indian Institute of Technology, Madras	National Taiwan Ocean University	
Indian Institute of Technology, Roorkee	National Taiwan University	
Institute of Chemical Technology	National Taiwan University of Science and Technology	
Jadavpur University	National Tsing Hua University	
National Institute of Technology, Rourkela	National Yang-Ming University	
Panjab University	Taipei Medical University	
Postgraduate Institute of Medical Education and Research		
Thapar University		
University of Calcutta		
University of Delhi		
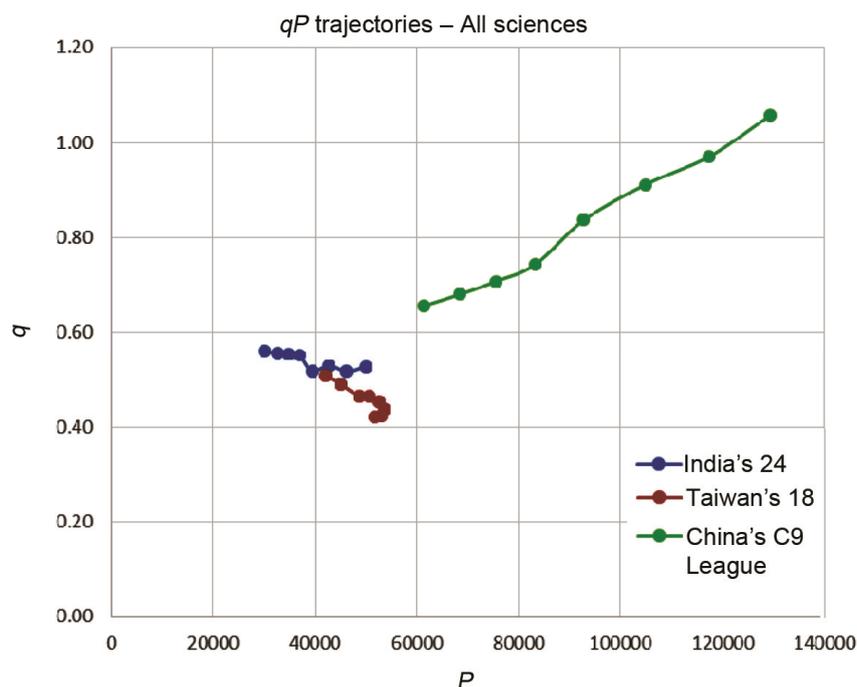
Figure 1. The longitudinal performance of the three cohorts from the 2006–2009 to the 2013–2016 window. The aggregated output of the C9 cluster measured in *X* terms is five times more than that of the Indian cohort and six times more than the Taiwanese cluster. On the quality proxy, the Taiwanese cluster is on a decline, the Indian cluster is struggling and both are below the global norm. China's C9 performs at much higher than the global norm and has been making excellent progress.

size-dependent indicator of performance and qP a first-order indicator of performance[2]. From this we can compute a scalar 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 research context. For each country or cluster, the scalar values of all their HEIs in the Leiden list can be aggregated as a total X score.

CWTS Leiden Ranking provides bibliometric data for five major areas and also aggregates them into a total 'All sciences' category. In the present exercise, we report the results for this category for the HEIs from the three cohorts in Table 1. Figure 1 shows the longitudinal performance of the three cohorts from the 2006–2009 to the 2013–2016 window using a two-dimensional representation. The aggregated output of the C9 cluster measured in X terms is five times more than that of the Indian cohort and six times more than the Taiwanese cluster. On the quality proxy, the Taiwanese cluster is on a decline, the Indian cluster is struggling and both are below the global norm. China's C9 League performs (2013–2016 window) at levels just above the global norm and has been making excellent progress.

1. Prathap, G., *Curr. Sci.*, 2014, **106**, 1467–1468.
2. Prathap, G., *Scientometrics*, 2011, **87**(3), 515–524.

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