The 10,000 crore club redux

Prathap[1] identified 20 leading higher educational institutions on their perceived potential to join the ranks of the best universities in the world using a matrix totalization procedure with data from NIRF (National Institutional Ranking Framework) 2017. We now have the bibliometric and econometric data for NIRF 2018 and it is worth repeating this exercise to see the new composition of that list. The eponymous figure of 10,000 crores comes from the Government intention to provide Rs 10,000 crore to 20 varsities to make them 'world class'.

NIRF launched in 2015 by the Ministry of Human Resource Development (MHRD), Government of India, is the country's own system of ranking higher educational institutions (HEIs) using India-specific parameters. The ranking for 2018 came out recently and considers five broad parameters: teaching, learning and resources; research and professional practices; graduation outcomes; outreach and inclusivity, and perception. Within each category several sub-parameters are identified.

NIRF 2018 (https://www.nirfindia.org/2018/OverallRanking.html) ranks 200 institutions according to their overall NIRF score. In the present exercise, we select 25 of the top-ranked institutions from the overall category. Using the methodology outlined earlier[1], we find out if the research performance of these 25 institutions as well as their earnings related to innovation activities (sponsored research and consultancy) are commensurate with the inputs (faculty and total expenditure) deployed by them. A simple output–input ratio becomes a measure of how the totalized input is productively (or efficiently) translated to output[1,2]. The top 20 from this are arguably the best candidates to join the 10,000 crore club.

From NIRF data the two key inputs taken cognizance of are the total number of regular faculty, F, and total expenditure, S, for three years (2014–2017). The key outputs are the total earnings, E, for three years (2014–2017) and the total bibliometric output, X, measured in units of exergy[3]. Since inputs and outputs are in incommensurable units, we use a procedure of space transformations using matrix multiplications that totalize the input and output and allow productivity measures to be defined in terms of these totalized distance measures[4].

Table 1 shows the multi-dimensional input and output in terms of total expenditure, S (in crores of rupees), Total number of regular faculty, F, exergy of research output, X, and total earnings, E (also in crores of rupees), for the 25 institutions chosen from NIRF 2018. Matrix transformations[4] allow us to project the information in the institution-input and institution-output spaces to an institution space, and then derive totalized input and output measures[2]. For this, fractionalizing using the conservation rule and recursive improvement using the network properties have been employed[2]. Table 2 displays the totalized input and

Table 1. Multi-dimensional input and output in terms of total expenditure, S (in crores of rupees) total number of regular faculty, F, exergy of research output, X, and total earnings, E (also in crores of rupees) for the 25 institutions ranked in NIRF 2018

	Expenditure 2014–17	Regular faculty	Exergy	Total earnings
Institution	S	F	$\sum X$	E
Indian Institute of Science, Bangalore	1604	430.00	429,155	1118.88
Indian Institute of Technology, Madras	1829	607.00	178,363	760.73
Indian Institute of Technology, Bombay	1344	618.00	277,563	885.05
Indian Institute of Technology, Delhi	1393	508.00	267,063	402.85
Indian Institute of Technology, Kharagpur	1135	694.00	282,753	401.89
Jawaharlal Nehru University	1162	652.00	97,557	126.36
Indian Institute of Technology, Kanpur	965	436.00	178,161	318.24
Indian Institute of Technology, Roorkee	794	456.00	264,546	197.42
Banaras Hindu University	2446	1619.00	241,276	204.81
Anna University	718	945.00	106,034	230.23
University of Hyderabad	457	402.00	107,523	178.72
Indian Institute of Technology, Guwahati	1033	436.00	159,743	114.61
Jadavpur University	578	643.00	162,434	164.32
University of Delhi	1941	1055.00	337,555	154.29
Amrita Vishwa Vidyapeetham	1676	1695.00	42,634	190.41
Savitribai Phule Pune University	1129	686.00	189,069	204.61
Aligarh Muslim University	1866	1427.00	135,975	30.59
Manipal Academy of Higher Education	3760	2586.00	42,297	152.52
Jamia Millia Islamia	913	689.00	66,400	66.06
Bharathiar University	183	294.00	91,315	47.47
Calcutta University	708	573.00	105,653	205.53
Indian Institute of Technology, Hyderabad	308	183.00	45,052	93.68
King George's Medical University	1071	428.00	70,257	35.63
Vellore Institute of Technology	1540	1720.00	95,141	38.44
Indian Institute of Science Education and Research, Kolkata	183	105	212,621	42.05
Total	30,735	19,887	4186,137	6,365

Table 2. Totalized input and output measures after fractionalizing using the conservation rule and recursive improvement and ranked according to the productivity measure

Rank	Institution	Totalized input	Totalized output	Totalized *O–I* ratio
1.	Indian Institute of Science Education and Research, Kolkata	0.006	0.026	4.58
2	Indian Institute of Science, Bangalore	0.037	0.144	3.94
3	Indian Institute of Technology, Bombay	0.037	0.108	2.89
4	Indian Institute of Technology, Madras	0.045	0.086	1.93
5	Indian Institute of Technology, Roorkee	0.024	0.045	1.84
6	Indian Institute of Technology, Kharagpur	0.036	0.065	1.81
7	Indian Institute of Technology, Delhi	0.035	0.064	1.80
8	Indian Institute of Technology, Kanpur	0.027	0.047	1.76
9	University of Hyderabad	0.018	0.027	1.54
10	Indian Institute of Technology, Hyderabad	0.010	0.013	1.36
11	Bharathiar University	0.010	0.014	1.30
12	Jadavpur University	0.026	0.031	1.22
13	Calcutta University	0.026	0.029	1.12
14	Savitribai Phule Pune University	0.036	0.038	1.06
15	Indian Institute of Technology, Guwahati	0.028	0.027	0.97
16	Anna University	0.036	0.031	0.88
17	University of Delhi	0.058	0.049	0.84
18	Jawaharlal Nehru University	0.035	0.021	0.61
19	Banaras Hindu University	0.081	0.043	0.54
20	Jamia Millia Islamia	0.032	0.013	0.40
21	King George's Medical University	0.028	0.010	0.37
22	Amrita Vishwa Vidyapeetham	0.070	0.021	0.30
23	Aligarh Muslim University	0.066	0.017	0.25
24	Vellore Institute of Technology	0.069	0.013	0.19
25	Manipal Academy of Higher Education	0.126	0.018	0.14
	Total	1.000	1.000	1.00

output after the multi-dimensional input and output have been projected to an institution space and recursive iteration (also known as repeated improvement) performed[1,2,4]. Indian Institute of Science (IISc), Bengaluru which accounted for 13.9% of the totalized output of the 25 comparator institutions before recursion, had increased its share to 14.4% after the recursive improvement. On the input size, Manipal Academy of Higher Education accounts for 12.6% of the totalized input before recursion and this decreased to a 12.6% share after repeated improvement.

The Indian Institute of Science Education and Research, Kolkata and IISc are seen to be the best institutions from the productivity or efficiency point of view. They are followed predictably by the various IITs. Note that faculty size and expenditure are totalized into a single input term, and earnings and bibliometric output are totalized into a single output term for each institution.

All the matrix operations here are performed with a cohort of 25 institutions and this restriction is due to the use of Excel spreadsheets alone. The matrix algorithms are general, and if a computer algorithm is used there need be no restriction on the number of institutions assessed by this totalization procedure.

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New distributional record of the northernmost *Myristica* swamp from the Western Ghats of Maharashtra

Myristica swamps are freshwater swamps represented by any of the members of the Myristicaceae family like *Gymnacranthera canarica* and *Myristica fatua* Houtt. var. *magnifica*[1,2]. These are known to be the remnant of primeval forests of the Western Ghats with a history of over 140 million years[2]. Myristica swamps were described from Travancore[3], and later from the valleys of Sendurney, Kulathuppuzha and Anchal ranges from Southern Kerala[4]. Similar swamps were further reported from elsewhere in the Western Ghats[5–7] of Karnataka. The report of high endemism associated with the swamps[8–11] and the presence of red-listed species of plants in the myristica swamps[12,13] highlights the