Research performance of central universities in India

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This article presents the research performance of the 39 central universities in India. The research publication data, indexed in the Web of Science, for the 39 central universities for a 25-year period (1990–2014) are used for analysis. The data are computationally analysed to identify productivity, productivity per capita, productivity per crore rupees grant, rate of growth of research output, authorship and collaboration pattern, citation impact and discipline-wise research strength of these institutions. Research performance of the central universities is measured and compared with two top-ranking world universities, namely University of Cambridge and Stanford University. While older well-established big universities such as University of Delhi and Banaras Hindu University perform better than newer universities, some relatively smaller universities, such as the university of Hyderabad have impressive research performance. What is disturbing is that combined research output of all central universities taken together is less than that of either of University of Cambridge or Stanford University alone. The results also provide discipline-wise research strengths of all the universities.

Keywords: Central universities, publication data, research performance, scientometrics.

A well-educated population equipped with relevant knowledge, attitude and skill is essential for economic and social development in the 21st century[1]. Similarly, research and innovation form the key to national development in the modern era of knowledge-based economies. All the developed countries realized the importance of the link between higher education, research and innovation well in time and took necessary initiatives and steps for strengthening this sector. Across the world, universities are considered as places where education, research and innovation happen. Therefore, a suitable higher education and research infrastructure is now essential for development and progress of a country. In India, there are about 700 universities at present catering to the higher education needs of the country[2]. These include central universities (CUs), State Universities, Deemed to be universities and private universities. Of these 700 universities, 39 are CUs receiving maintenance grants from the University Grants Commission (UGC) and are under the purview of the Ministry of Human Resource Development (MHRD), Government of India (GoI). These CUs are relatively better funded in comparison to majority of the State Universities and other higher education institutions in the country.

It is painful to observe that most of Indian higher education institutions (including CUs) do not figure in the international rankings of universities. Therefore, no credible reports of research performance assessment of majority of Indian universities are available. It is in this context that we have computationally analysed the research output of the 39 CUs in India, particularly in light of the fact that they are one of the best-funded institutions of their type. We have obtained research output data of publications indexed in the Web of Science (WoS) for all 39 CUs and performed a detailed computational analysis. We analysed the parameters of research productivity, citedness and citation impact, authorship patterns, etc. The analytical results were compared with performance parameters of two multidisciplinary universities (University of Cambridge, UK and Stanford University, USA). Research productivity per capita and per crore rupees spent was also computed for the CUs. Further, we have done a discipline-wise mapping of the research strength of the CUs, which is useful for identifying the top performing universities in a particular discipline.

Several previous studies have performed scientometric analysis of research performance of Indian institutions. A ranking of Indian engineering and technological institutions based on their research performance was made during 1999–2008 (ref. 3). In a subsequent study, top 25 universities in India were ranked using an index comprising research output and quality[4]. Raghuraman *et al.*[5]

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Table 1. Detailed statistics of 39 Central Universities in India

University	Year of establishment/ conversion	Existing faculty strength[#]	Budget: plan and non-plan grant under the XI Plan (2007–2012)	TP	PPC	Output per crore INR
Aligarh Muslim University (AMU)	1920	1057	2257.64	2860	2.71	1.27
Assam University (ASU)	1994	342	330.49	480	1.41	1.46
Babasaheb Bhimrao Ambedkar University, Lucknow (BBAU)	1996	102	180.04	239	2.35	1.33
Banaras Hindu University (BHU)	1916	1205	2928.32	4733	3.93	1.62
Central University of Bihar (CUB)	2009	77	20.25*	42	0.55	2.08
Central University of Gujarat (CUG)	2009	62	62.25*	61	0.99	0.98
Central University of Haryana (CUH)	2009	33	89.5*	0	0	0
Central University of Himachal Pradesh (CUHP)	2009	70	28*	28	0.4	1
Central University of Jammu (CUJ)	2009	43	11.5*	3	0.07	0.26
Central University of Jharkhand (CUJh)	2009	93	101.5*	81	0.88	0.8
Central University of Karnataka (CUKa)	2009	60	218.5*	6	0.1	0.03
Central University of Kashmir (CUK)	2009	49	15.25*	0	0	0
Central University of Kerala (CUKe)	2009	39	42.75*	74	1.9	1.73
Central University of Orissa (CUO)	2009	18	81*	8	0.45	0.1
Central University of Punjab (CUP)	2009	40	66.5*	56	1.4	0.85
Central University of Rajasthan (CUR)	2009	98	66.5*	98	1	1.48
Central University of Tamil Nadu (CUTN)	2009	28	199.5*	69	2.47	0.35
Dr. Harisingh Gour Vishwavidyalaya (HGV)	1946/2009	223	310.81	14	0.07	0.05
Guru Ghasidas Vishwavidyalaya (GGV)	1983/2009	234	225.47	223	0.96	0.99
Hemwati Nandan Bahuguna Garwal University (HNBGU)	1973/2009	307	331.03	25	0.09	0.08
Indira Gandhi National Tribal University (IGNTU)	2007	86	133.54*	10	0.12	0.08
Jamia Millia Islamia (JMI)	1920/1988	697	968.19	1676	2.41	1.74
Jawaharlal Nehru University (JNU)	1969	510	1154.2	1721	3.38	1.5
Mahatma Gandhi Antarrashtriya Hindi Vishwavidyalaya (MGAHV)	1997	65	140.82	0	0	0
Manipur University (MNU)	1980/2005	161	365.73	296	1.84	0.81
Maulana Azad National Urdu University (MANUU)	1998	197	256.51	2	0.01	0.01
Mizoram University (MZU)	2001	297	409.44	175	0.59	0.43
Nagaland University (NLU)	1994	181	243.89	64	0.36	0.27
North Eastern Hill University (NEHU)	1973	350	702.3	591	1.69	0.85
Pondicherry University (PDU)	1985	378	516.54	1033	2.74	2
Rajiv Gandhi University (RGU)	1984/2007	123	141.54	94	0.77	0.67
Sikkim University (SKU)	2007	69	94.58*	38	0.56	0.41
Tezpur University (TZU)	1994	210	373.32	1040	4.96	2.79
The English and Foreign Languages University (EFLU)	1958/2007	197	308.39	22	0.12	0.08
Tripura University (TPU)	1987	143	205.09	163	1.14	0.8
University of Allahabad (UOA)	1887/2005	341	951.6	984	2.89	1.04
University of Delhi (DU)	1922	753	2567.22	5539	7.36	2.16
University of Hyderabad (UOH)	1974	412	870.79	2481	6.03	2.85
Visva Bharati (VB)	1939	516	788.11	802	1.56	1.02

[#]Faculty strength data according to UGC Report[10]; it may exclude values for affiliating colleges. *Budget includes only plan grant values as non-plan grant values are not available. TP, Total papers; PPC, Publication per capita.

compared the research performance of a few Indian institutions with international institutions in some chosen disciplines. Prathap[6] tried to benchmark research performance of the Indian Institutes of Technology (IITs) using research output data for 1981–2011 from WoS and Scopus bibliometric databases. Nishy *et al.*[7] performed an impact–citation–exergy (iCX) trajectory analysis of leading research institutions in India for some top performing institutions. Recently, Kaur and Mahajan[8] presented a case study of ranking of medical institutions in India for quantity and quality. Most of these works focus on top performing Indian institutions, such as IITs and a few other premier research-intensive institutions. In a recent study, Basu *et al.*[9] proposed a composite ranking system specially designed for a regional set of universities. They used Indian CUs as their dataset. To the best of our knowledge there are no previous research results available which focus on detailed analysis of the research performance of the 39 CUs in India. In the present work we have tried to do research performance assessment of the 39 CUs in India using standard scientometric and data analysis techniques. Our approach has also drawn inputs from the previous research performance assessment exercises for Indian institutions as listed above.

Table 2. Indicator values and statistical results (2010–2014)

Institution	TP	TC	ACPP	HiCP	ICP	*h*-Index	*P*-index
AMU	2860	14,080	4.93	41	923	36	41
ASU	480	1379	2.88	0	66	15	16
BBAU	239	1133	4.75	1	51	15	18
BHU	4733	26,024	5.5	56	893	48	52
CUB	42	102	2.43	0	23	5	6
CUG	61	141	2.32	1	14	6	7
CUH	0	0	0	0	0	0	0
CUHP	28	33	1.18	0	4	3	3
CUJ	3	2	0.67	0	0	1	1
CUJh	81	139	1.72	0	18	7	6
CUK	0	0	0		0	0	0
CUKa	6	0	0	0	1	0	0
CUKe	74	117	1.59	0	39	4	6
CUO	8	10	1.25	0	1	2	2
CUP	56	196	3.5	2	13	8	9
CUR	98	164	1.68	0	45	6	7
CUTN	69	202	2.93	1	29	7	8
DU	5539	28,535	5.16	71	1268	49	53
EFLU	22	11	0.5	0	2	1	2
GGV	223	567	2.55	1	56	10	11
HGV	14	19	1.36	0	4	2	3
HNBGU	25	156	6.24	0	4	7	10
IGNTU	10	6	0.6	0	1	2	2
JMI	1676	8537	5.1	16	376	33	35
JNU	1721	7892	4.59	14	325	32	33
MANUU	2	1	0.5	0	0	1	1
MGAHV	0	0	0	0	0	0	0
MNU	296	1008	3.41	4	43	14	15
MZU	175	546	3.12	1	41	11	12
NEHU	591	1617	2.74	1	105	15	16
NLU	64	92	1.44	0	5	6	5
PDU	1033	4288	4.16	8	233	26	26
RGU	94	231	2.46	0	25	9	8
SKU	38	101	2.66	1	16	6	6
TPU	163	270	1.66	0	22	8	8
TZU	1040	4375	4.21	10	186	23	26
UOA	984	4888	4.97	3	128	28	29
UOH	2481	12,836	5.18	23	556	36	41
VB	802	3283	4.1	5	152	23	24

TP, Total papers; TC, total citations, ACPP, average citations per paper; HiCP, highly cited papers; ICP, internationally collaborated papers.

Data collection and methodology

We have collected the research output data for the 39 CUs from WoS index for the 25-year-period, i.e. 1990–2014. We have selected CUs under the purview of MHRD, GoI. The Indira Gandhi National Open University (IGNOU), New Delhi was excluded as it has a different nature and purpose. Similarly, few other centrally funded institutions under the purview of other ministries have also been excluded. The research output data were collected through an institution-based search using search strings of the form: CU = INDIA AND OG = (ALIGARH MUSLIM UNIVERSITY OR ALIGARH MUSLIM UNIV OR ALIGARH UNIV) Time span = 1990–2014 Indexes = SCI-EXPANDED, SSCI, A&HCI. The data collected correspond to documents of different types, namely article, book review, review (meeting abstract, article, proceedings paper, note, editorial material, letter, etc. We obtained a total of 59,339 records, in which the number of unique records was 58,781. Each record in the data had 60 fields containing the metadata of documents such as Authors (AU), Document Title (TI), Year Published (PY), Author Address (C1), Abstract (AB), Cited References (CR), Total Times Cited Count (Z9), etc.

In addition to the research output data, we also collected other relevant data on faculty size, existing faculty strength as on 1 January 2014 (ref. 10) and total plan and non-plan grants for XI plan 2007–2012 (ref. 11) for the 39 CUs. Table 1 lists these 39 CUs along with their year of establishment, faculty strength and total research output for the period 2010–2014.

We performed a systematic analysis of collected data by computing different scientometric indicators. For each university, we have shown total papers (TP) and total citations (TC) data and computed average citation per paper (ACPP), productivity per capita (PPC), number of highly cited papers (HiCP), number of international collaborative papers (ICP), *h*-index and *P*-index. The HiCP was computed using the citation count of the whole dataset. A paper from a CU constitutes a HiCP instance if it belongs to the top 1% cited papers among the total set of research papers from all CUs in the corresponding period. ICP instances were identified by analysing the author affiliation full address field and referring to those papers which have at least one author from outside India. We have computed the indicator values for the full 25-year period (1990–2014) and also for five-year periods (e.g. 2010–2014). We have performed exergy-based analysis of the research performance of some of the top performing CUs during 2010–2014 to correlate the analytical results with a different proven methodology. Further, we have categorized the research output data for each of the Universities into 14 broad disciplines (subject areas) and then identified universities having strong presence in each of the disciplines. All analyses were performed computationally by writing programs in R and using other standard data analytics and visualization software.

Research productivity

Among the 39 CUs in India, some have been established more than 100 years ago, while some others only recently, i.e. 5–6 years ago. Further, the faculty strength of these universities also varies a lot. It is, therefore, natural to expect that their research productivity levels will have large differences. These differences can be clearly observed from Table 1, which shows the research output for the total 25-year-period for all the 39 CUs along with their faculty strength. Because a good number of universities in the set are new, it would be reasonable to analyse the data for the most recent five-year period (2010–2014). Table 2 provides the direct and computed indicator values and other statistical results for the CUs for 2010–2014 period. We can observe that University of Delhi (DU) ranks at the top on majority of the indicators such as TP, TC, HiCP and ICP. Banaras Hindu University (BHU) is in the second place after DU on indicators TP, TC, HiCP, etc. BHU's ACPP value is slightly better than DU. Aligarh Muslim University (AMU) and University of Hyderabad (UoH) are in the top bracket on many indicators. UoH obtained an impressive performance in terms of ACPP, *h*-index and PPC indicators. We observe that out of top 15 most productive universities, majority are old and well known. However, a few new and/or smaller universities have done reasonably well on some of the assessment parameters. The entire set of 39 CUs taken together contributed between 8% and 9% to total research output from India for the corresponding period.

To analyse PPC, we have drawn a research output versus faculty strength plot in Figure 1, which marks the position of all the 39 CUs. The bubble sizes are proportional to TC values of the respective universities (greater size denoting higher total citation). We can observe that DU, BHU, UoH and AMU obtain favourable places in the plot, whereas a good number of universities have less than 200 teachers producing less than 200 papers in the five-year block. Figure 2 shows the proportionate share of contribution of each CU during the 25-year period and most recent five-year period. We can observe that about 65% of the total output of CUs during the 25-year period is contributed by the four older universities (DU, BHU, AMU and UoH) only. For the most recent five-year period, the total contribution of these four universities is about 60%. It can be seen from Table 1 that only two universities (DU and UoH) have per capita output value greater than five, indicating that on an average one paper per year per faculty is obtained in them. In order to understand the worldwide standing of the CUs research performance, we have compared the indicator values of the top performing CUs with two top-ranking world universities selected, namely University of Cambridge, UK and Stanford University, USA. Table 3 presents indicator values for these two universities. Tables 2 and 3 show that top performing Indian CUs are nowhere close to the research performance of these two universities. Though it is expected that Indian CUs will not be able to match the research performance of one of the best-funded universities established centuries ago, the difference in indicator values is huge. We observe that for the 2010–2014 period, University of Cambridge produced 42,462 and Stanford University produced 43,247 research papers. These values are more than seven times higher than the top-performing CU in our dataset. In fact, we can see that these values are higher than the combined output of all 39 CUs during the period (aggregated number is 25,831). The TC and ACPP values follow similar differentiation between the two sets.

Authorship and collaborative patterns

We have analysed the authorship pattern and international collaboration pattern among the research output from the CUs. Figure 3 plots the percentage of multi-authored papers produced by the 39 CUs taken together and the average value for the total Indian research output. The observed trend in general is towards multi-authored papers, similar to the general trend in the total Indian research output. The percentage of multi-authored papers has been on a continuous rise in both curves. While in 1990 around 80–85% of papers are multi-authored, we observe that the number of multi-authored papers as a

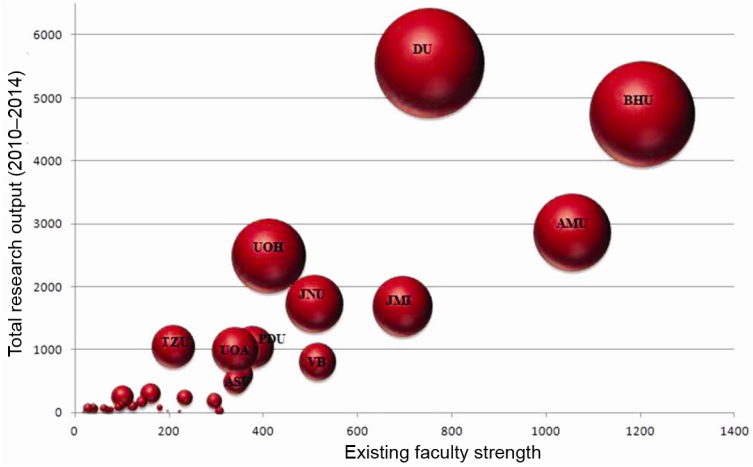

Figure 1. Research output–faculty strength plot (2010–2014).

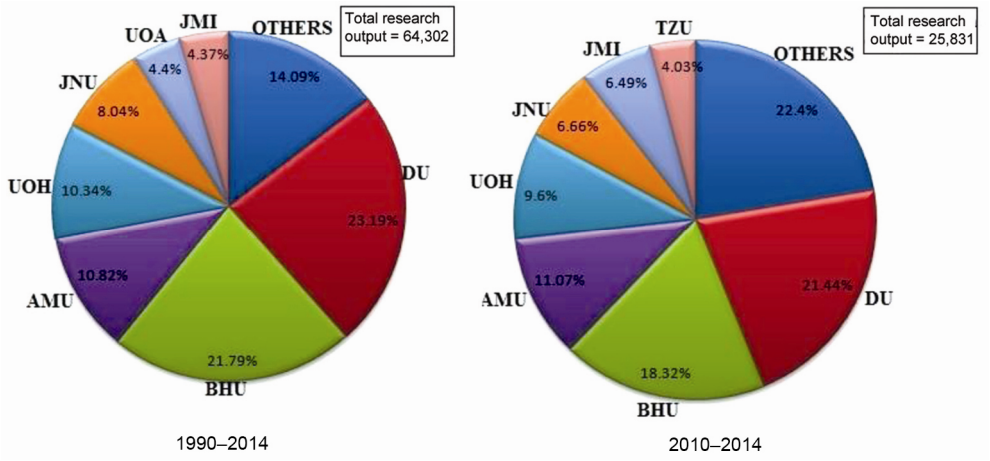

Figure 2. Proportionate share of some universities in the total research output of the entire set: (left) 1990–2014 period and (right) 2010–2014 period.

percentage of total research publications is more than 95% in 2014. The ICP instances of the 39 CUs also follow a similar pattern with that of the values for total Indian research output. We observe a steep increase in ICP instances between 1998 and 2000. Around one-fourth of the publications are now ICP instances. It has been stated in previous studies that ICP instances are likely to have higher impact than non-ICP instances[12]. It is, therefore, a good sign for Indian CUs that a good percentage of the research output nowadays is internationally collaborative. At the level of individual universities, we can see from Table 2 that DU has the highest number of ICP instances (1268), followed by AMU (923) and BHU (893) during 2010–2014.

Citedness and citation impact

We computed the cited percentage for total research output from India and that from the CUs. Figure 4 plots the year-wise cited percentage of aggregated research output from India as a whole and of all the CUs taken together. We observe that approximately 70–80% of research output from CUs is cited (except for the most recent years where the citation window available is not sufficient). This citedness percentage of research output of CUs is similar to the pattern of citedness of research output for the whole of India (with a slight positive edge in certain years). We also computed TC and ACPP for CUs and compared them with the values of India's research output and also with those of the two model Universities. Table 2 provides the TC values for different CUs. We can see that DU has received the highest number of citations with TC value of 28,535, followed by BHU with a TC value of 26,024. In terms of ACPP, HNBGU leads with a value of 6.24, followed by BHU (5.498), UoH (5.174), DU (5.152) and JMI (5.094). We have computed HiCP counts and found that only 6 out of the 39 CUs contribute more than 10 highly cited papers in the set. We also computed *h*-index values for all the CUs. The highest *h*-index value

Table 3. Data for two universities placed high in the ARWU World Rankings (2010–2014)

University	Year	TP	TC	ACPP	*h*-index
University of Cambridge, UK	2010	7596	179996	23.70	146
	2011	8290	152747	18.43	129
	2012	8690	131625	15.15	115
	2013	8822	78923	8.95	90
	2014	9064	48966	5.40	63
Stanford University, USA	2010	7633	210390	27.56	174
	2011	7999	179717	22.47	153
	2012	8687	139406	16.05	123
	2013	9134	92286	10.10	94
	2014	9794	55418	5.66	69

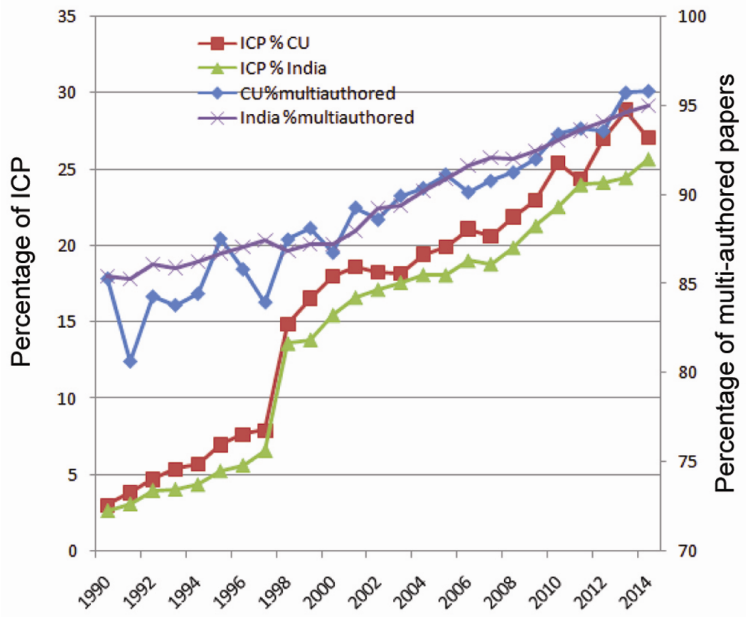

Figure 3. Percentage of multi-authored papers and international collaboration papers instances (year-wise).

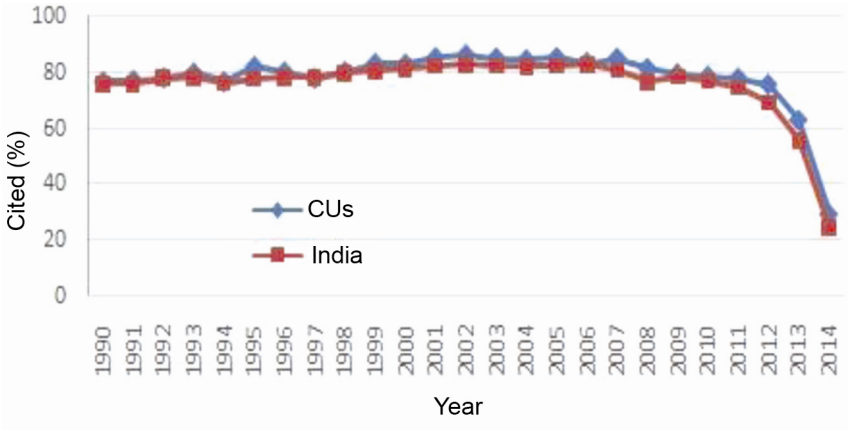

Figure 4. Cited percentage of research output of the 39 central universities and India as whole (year-wise).

was obtained by DU (49) followed by BHU (48). Approximately, half of the universities in the set had *h*-index values less than 10.

When we compared the citation indicators of CUs with those of the two model universities selected (values provided in Table 3), differences similar to that of

Table 4. Correlation matrix among different performance indicators

	TP	TC	ACPP	HiCP	ICP	PPC	Output per crore	*h*-Index	*P*-index	Faculty strength	Budget
TP	1	0.99	0.62	0.98	0.97	0.82	0.56	0.91	0.91	0.86	0.95
TC	0.99	1	0.6	0.98	0.97	0.8	0.54	0.89	0.9	0.85	0.94
ACPP	0.62	0.6	1	0.55	0.6	0.71	0.63	0.82	0.83	0.67	0.62
HiCP	0.98	0.98	0.55	1	0.98	0.76	0.49	0.84	0.85	0.83	0.94
ICP	0.97	0.97	0.6	0.98	1	0.79	0.55	0.88	0.89	0.86	0.94
PPC	0.82	0.8	0.71	0.76	0.79	1	0.8	0.87	0.88	0.58	0.69
Output per crore	0.56	0.54	0.63	0.49	0.55	0.8	1	0.7	0.71	0.43	0.41
h-index	0.91	0.89	0.82	0.84	0.88	0.87	0.7	1	0.99	0.87	0.88
P-index	0.91	0.9	0.83	0.85	0.89	0.88	0.71	0.99	1	0.87	0.88
Faculty strength	0.86	0.85	0.67	0.83	0.86	0.58	0.43	0.87	0.87	1	0.94
Budget	0.95	0.94	0.62	0.94	0.94	0.69	0.41	0.88	0.88	0.94	1

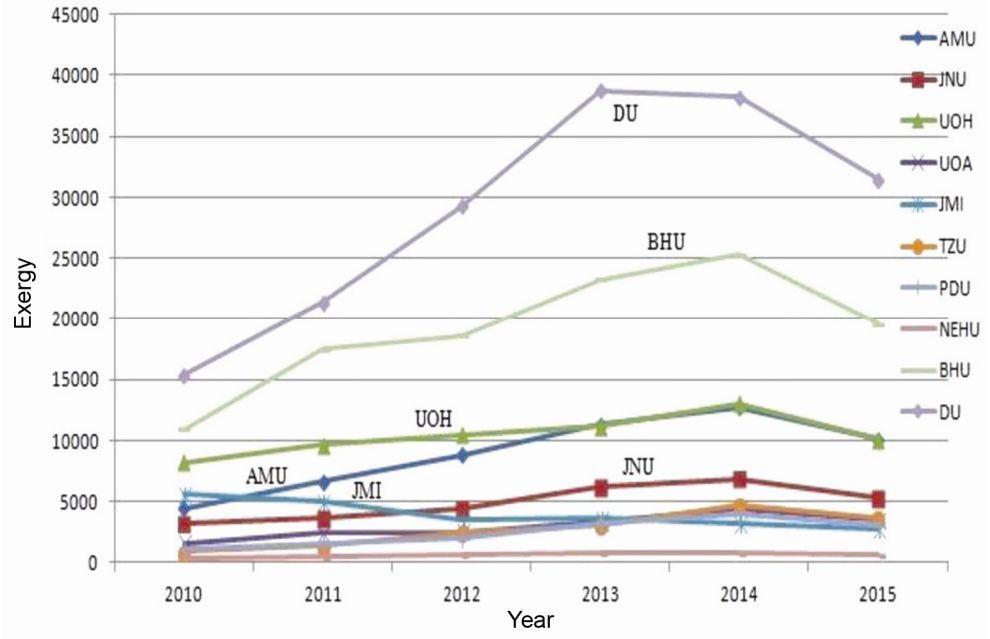

Figure 5. Exergy curve for the ten most productive universities (2010–2014).

productivity were observed. ACPP for both University of Cambridge and Stanford University, was at least twice the value of the top performing CU. The TC values showed similar differences. DU had TC value of 28,535 during the five-year period (2010–2014) compared to TC value for 179,996 for University of Cambridge for the year 2010 alone. Also, the highest *h*-index value among CUs during 2010–2014 was 48 compared to the lowest annual *h*-index value of 69 and highest annual *h*-index value of 174 for Stanford University during 2010–2014. The *h*-index value, being a measure of both quantity and quality, shows the drastic difference in performance of the two sets.

Based on our observation that some of the CUs perform much better than majority of other CUs; we did a detailed analysis of research performance of these top performing universities in recent years. For this purpose, we performed an exergy-based analysis[7] of the 10 most productive CUs during the 2010–2014 period. Figure 5 plots the exergy curves for the 10 Universities for the period 2010–2014. The curves show the time trend of citation-based performance measure of exergy of the 10 CUs. We can observe from the figure that DU, BHU and UoH represent the top three curves. AMU and JNU follow these universities. It can be seen that DU and BHU made major gains in performance during 2010–2013. The curves for the other five universities are somewhat flat, indicating status quo in their performance levels over the period.

Correlation among different indicators

The performance indicators computed for the CU data show some degree of correlation. We have, therefore,

computed correlation among several performance indicators. Table 4 shows correlation among various performance indicators computed. The most interesting observation perhaps is the high correlation between budget and several performance indicators such as TP, TC, HiCP and ICP. It also has a high correlation with faculty size, which is natural to expect as a large university will have more faculty and hence will require higher budget compared to a smaller university. However, high correlation between budget and TP can be taken as an observation about the importance of funding in research. Higher the funding, higher is the research output of a university. We can also observe high correlation of ICP with TC and HiCP, indicating the impact of international collaboration on citation impact[12]. One variable that shows a smaller correlation (<0.5) with other variables is the output per crore variable, which does not correlate well with either faculty size or budget. This may be taken as an indication that research performance of faculty members in different universities varies due to other parameters (such as teaching duties, academic freedom, etc.), which are specific to different universities.

Discipline-wise research strengths

While the analytical outcomes described above help in the assessment of overall research performance and competence of CUs, they do not provide information about which CU is performing well in which subject area. We have, therefore, assessed the research performance of CUs in different subject areas/disciplines. This analytical outcome could be useful in identifying research strengths of different CUs. The total research output of the universities was classified into 14 broad disciplines (www.viveksingh.in/publications/wos14.pdf, as proposed in: Rupika *et al.*[13]). First, we identified the discipline-wise distribution of the total research output of 39 CUs taken together. Figure 6 plots the distribution of total research publications of the CU set into 14 different disciplines, for the periods 1990–2014 and 2010–2014. We observe that physics and chemistry have the highest amount of research done during the 25-year period. This is followed by biology and medical sciences. For the plot of last five years' data, we observe similar growth in different disciplines. One interesting observation (from the data) is that more than 35% of research work in all disciplines has been done during the last five years.

After identifying the discipline-wise distribution of total research output of the CU set, we identified disciplinary research strength of different CUs in the set. Figure 7 shows the normalized research strengths (in the range 0–1) of CUs in different disciplines. We can observe that BHU and DU are placed at top in several disciplines, while other universities such as JNU, UoH and AMU are placed high in a few disciplines. For example, in social sciences, DU and JNU are the best performers. Similarly, in agricultural sciences, BHU is at the top followed by DU and AMU. Several other patterns can be observed from the figure. This analysis of research outputs according to subject areas may be used for identifying the university which has the potential for excellence in a particular discipline. The discipline-wise analysis can be helpful in instituting programmes for differential funding to a university. This discipline-wise analysis may also help potential students in choosing a university for their doctoral research and higher studies in a particular discipline.

Summary and conclusion

We have performed a computational analysis for a comprehensive assessment of the research performance of the Indian CUs. The analysis focused on important indicators of research productivity, authorship and collaboration pattern and citation impact. Data on per capita and per crore rupees spent were also computed. The results showed that DU performs best on most of the indicators among the 39 CUs, followed by BHU. Research performances of UoH and JMI were also good on some of the indicators. We have also categorized research output of each of the 39 CUs into 14 broader disciplines and computed research productivity levels of all the universities in these 14 disciplines. We observed that the overall top performing universities do not necessarily perform better in all disciplines. For example, while DU and BHU perform well overall, in certain disciplines JNU, JMI, AMU and UoA do better. Universities like MNU, TU, TXU have also performed reasonably well in some disciplines, specially taking into account their small size.

The analysis showed that there is a substantial difference in performance levels of few Universities (say 6–7)) vis-à-vis rest of the CUs. This can be explained by the fact that many of the universities in the set are new. What is, however, more alarming is the fact that even the best performing Indian CUs are miles behind research performance levels of the two top ranking world universities (Stanford University and University of Cambridge). Considering the fact that the top-ranking CUs are one of the highest funded universities among more than 700 universities in India, the difference in performance levels and underlying causes need to be pursued seriously. It is also necessary to take initiatives for improving some of the top performing Indian CUs so as to take them to the level of international universities. Filling up vacant teaching/research positions with competent and right-minded people is one task that needs immediate attention.

In the context of the analytical results presented above, it would also be relevant to look at levels of funding for higher education and research in India vis-á-vis the corresponding values for developed countries, which could be one of the many reasons for low performance of

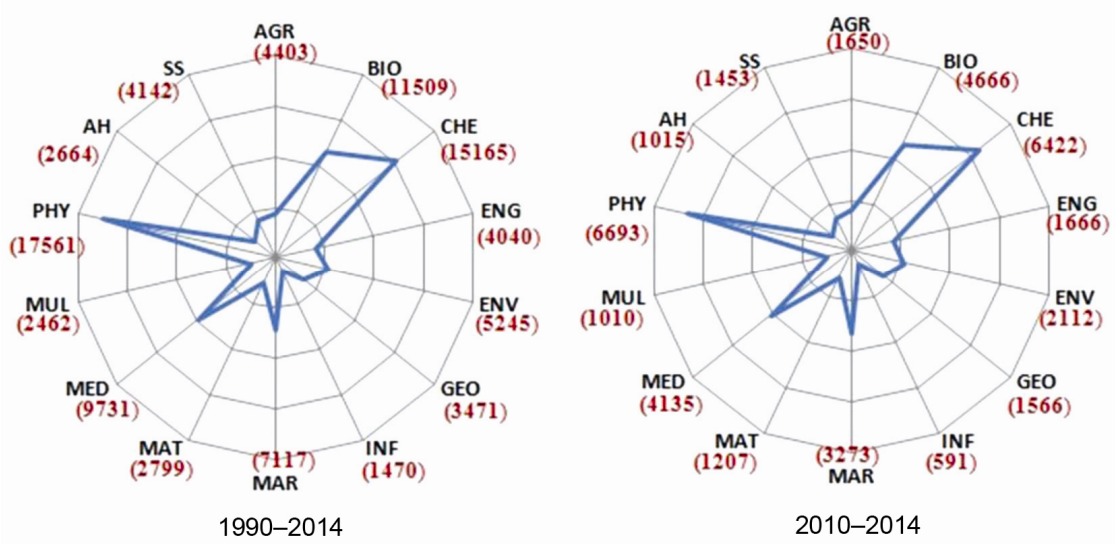

Figure 6. Discipline-wise mapping of research output of the 39 CUs.

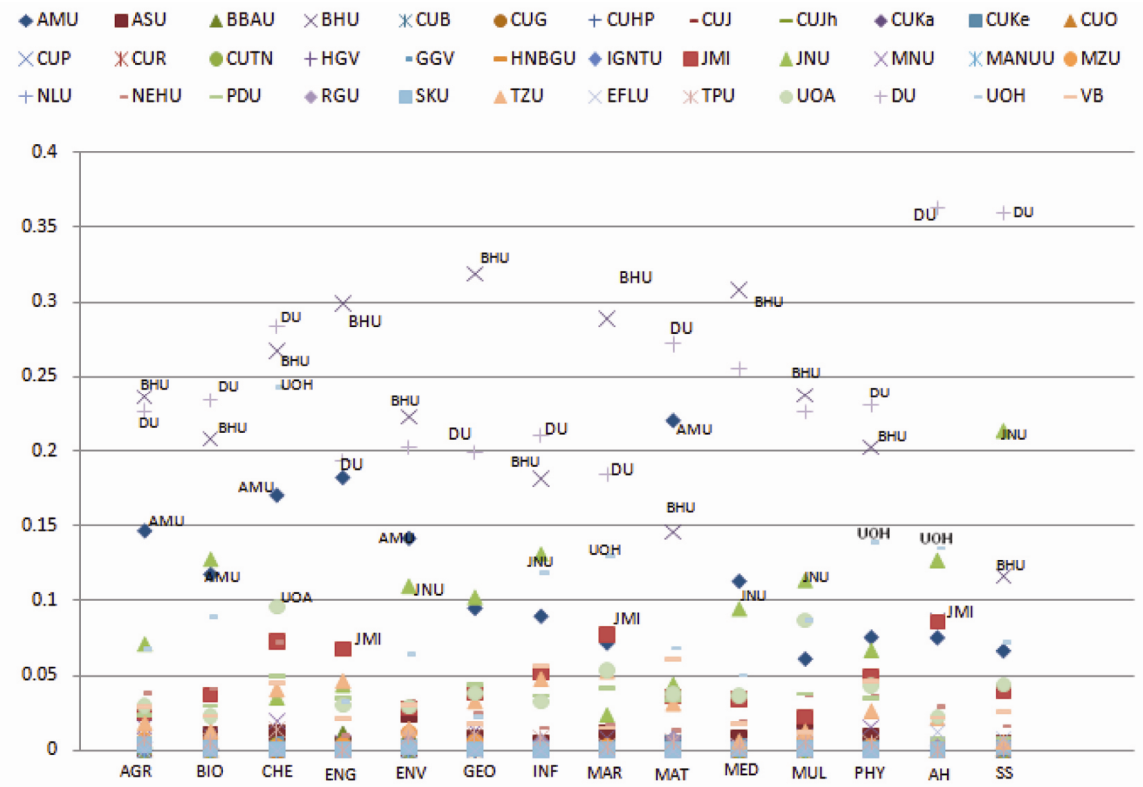

Figure 7. Discipline-wise research output positions of the 39 CUs (1990–2014).

Indian universities. The total expenditure on education as percentage of GDP for the year 2010–11 in India has been 3.55% (ref. 11). On the other hand, the expenditure on education as percentage of GDP for some other countries in the same period was as follows: USA (5.6%), UK (5.6%) and Australia (5.1%)[14]. India still spends around 3.5% of its GDP on the education sector as against 6% recommended by the Kothari Commission in 1966 and reiterated by Central Advisory Board on Education in 2006. The expenditure on higher education in India stands at 0.83% of its GDP, which is much less than the values for developed countries (e.g. USA spending 1.36% of its GDP on higher education). It would also be relevant to look at gross expenditure on research and development (GERD) data for India and some developed countries. Unlike EU (having GERD value as 2% of GDP) and

Organisation for Economic Co-operation and Development (GERD as 2.4% of GDP), India spends only about 0.8% of its GDP on research and development. India's GERD values are the lowest among the BRICKS countries[15]. The research workforce in Indian universities is also low compared to that in USA, China and some other developed countries. In terms of student enrolment, according to the 2011–12 values, only 1% of the total enrolment in higher education is in research and 12% in postgraduate programmes. The central government contributes about one-fourth of total governmental spending on education in India, though it has a major share in research funding. The statistics points towards the fact that organized and planned efforts by the governments are necessary in the higher education sector so as to improve the overall environment in which Indian higher education institutions are operating at present. In the modern time of globalized world and knowledge-based economies, it becomes more important that we initiate a systematic and sincere effort to improve the Indian higher education system, particularly the multidisciplinary universities.

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