Assessing the quality of higher education institutions in India: an alternative framework

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Various stakeholders use the ranking of Higher Education Institutions (HEIs) as a measure of quality. This is evident from numerous ranking efforts – both of the government (National Institutional Ranking Framework (NIRF) of the Ministry of Human Resources Development (MHRD), the National Academic Accreditation Council (NAAC) and the National Board of Accreditation (NBA)) and the private sector. Developing countries like India should assess the academic quality by working with parameters that are globally acceptable, transparent to all stakeholders and not amenable to the control of lobby groups. One such parameter is publications in reputed international journals indexed by databases like Scopus and Web of Science is also considered by the NIRF. However, in contrary to the NIRF method, we propose that instead of considering the total publications the computations should be based on the publication rate (number of publications per teacher) to control the faculty size bias. Besides using the NIRF 2017 data, we observed that higher density of Ph D students increases both the number and the quality of publications and HEIs that invest more, tends to have a higher publication rate. Therefore, we conclude that the Indian HEIs should increase the number of Ph D students and access better funding in order to improve their global presence.

Keywords: National Institutional Ranking Framework, publication rate, ranking HEIs, Scopus.

THE assessment of Higher Education Institutions (HEIs) has a long history where the United States of America (USA) and the Europe have been pioneers. The objective of ranking was primarily to draw prospective students, funding institutions and policy-makers towards HEIs that are doing well[1]. The credit of ranking of universities, though indirectly, goes to J. M. Cattell who in his compilation titled 'American Men of Science', ranked American universities based on the number of eminent scientists[2]. In the UK, the first research assessment was undertaken in 1986 which eventually got institutionalized in 1992 as the research assessment exercise and transformed into a research excellence framework from 2008. Unlike UK, USA has no official ranking of institutions but there are numerous reputed private agencies that undertake this.

The beginning of global institutional ranking can be traced back to 2003 when the Shanghai Jiao Tong University published the 'Academic Ranking of World Universities' (ARWU). This was mainly undertaken to measure the gap between Chinese and 'world class' HEIs. Simultaneously, in 2004, the UK's Times Higher Education (THE) supplement published its first world university ranking. Subsequently many new ranking products at national and international levels emerged. Researchers opine that the ranking systems that gives importance to research performance could lead to deleterious effects on institutional diversity and quality[3,4]. The narrow focus of some of the ranking methods on research work implies that they ignore the teaching part[5].

This paper critically evaluates four Indian national ranking agency methodologies and proposes an alternative framework for the ranking of HEIs in India to provide a less-biased playing field, simplify the process and bring rankings in line with many international agencies. We use an econometric model to measure academic productivity in India and discuss how it can be used in the Indian system.

Global HEIs ranking agencies

We discuss six global-ranking efforts in brief that represent a small segment of a growing industry. ARWU uses six indicators based on four criteria, namely, quality of education, quality of faculty, research output and per capita performance to rank world HEIs. From 1200 universities,

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ARWU ranks the best 500. The THE ranks the world's top 400 universities based on three missions: teaching, research and knowledge transfer and uses 13 indicators grouped in five categories. Qucacquarelli Symonds (QS) Ranking (2009) has developed the QS World University Rankings wherein HEIs are grouped according to four criteria such as size, age, subject range and research intensity. QS offers a star rating by examining 52 indicators covering four core criteria (teaching, employability, research and infrastructure) and three advanced criteria (internationalization, innovation and engagement). The University Ranking by Academic Performance (URAP) (2009) was developed by the Middle East Technical University (METU) and covers approximately 10% of all HEIs. It is the global ranking of universities based on bibliometric data from Web of Science (WoS). The Centre for Science and Technology Studies (CWTS) published the Leiden University Ranking (2011–12). The 2016 ranking included 842 universities from 53 countries and is based on WoS database. HEIs with more than 1000 fractionally counted WoS indexed core journal articles are considered. The Centre for World University Ranking (CWUR) (2012) started with the aim of rating top 100 global universities and expanded to the top 1000 HEIs in 2014 using eight indicators to rank World's top HEIs.

Indian HEIs ranking agencies

India has a large HEI sector under three broad categories of ownership – central, state and private. Indian institutional ranking began with various private initiatives that ranked business schools. The first official effort towards accrediting HEIs started in 1994 with the establishment of the National Academic Accreditation Council (NAAC) and the National Board of Accreditation (NBA). The second important official effort came from the Ministry of Human Resource Development (MHRD), Government of India, when it started a nation-wide ranking of HEIs in 2016, i.e. National Institutional Ranking Framework (NIRF). A second round of rankings was released in April 2017. NIRF has made a laudable effort to make ranking a transparent and replicable exercise.

There have also been pioneering efforts from the non-government sectors – two prominent weeklies *India Today* and *The Week*. There are a few other individual efforts which are not institutionalized[6].

India Today follows a multi-stage process involving surveys, interviews, expert opinions and factual data. The overall score for HEIs is derived with a 50% weightage each to perception score and to the factual score. The overall score is indexed to 100 to rank HEIs. *The Week* follows a separate ranking system for multidisciplinary and technical HEIs. It invites information from HEIs as well as experts. A perception score based on experts' opinion and a factual score based on data submitted by universities is combined. Ranks are awarded based on the sum of the perceptual score (out of 400) and factual score (out of 600).

NIRF's ranking method of HEIs is based on five broad parameters, namely: (i) teaching, learning and resources; (ii) research and professional practices; (iii) graduation outcome; (iv) outreach and inclusivity, and (v) perception. NAAC does not provide a direct ranking but provides a criterion-wise weighted cumulative grade. This grade allows us to create a ranking system and compare it with NIRF, *The Week* and *India Today*.

A comparison of the methodology used by *India Today*, *The Week* and NIRF 2017 reveals that NIRF is more objective in nature as it gives approximately 80–90% weightage to factual (as different from perception) data. *India Today* and *The Week* gives large weightage to perception, which are prone to personal biases, opinions and other subjective criteria. We therefore restrict our analysis to NIRF.

Data and methods

In April 2017, NIRF published a list of the top 200 HEIs but provided individual ranks to the top 100 and the remaining 100 were split into two groups 101–150 and 151–200 without assigning individual ranks.

We have used information from the NIRF 2017 factsheets on aspects such as: number of teachers and students, annual expenditure (capital and operational), number of publications, citation details, etc. Information on when the HEI was established was taken from the UGC website or HEI's homepage.

Analysis

We have tried to analyse if the task of ranking Indian institutions can be made more efficient, objective and less resource-intensive. An exhaustive measure of quality will need a much bigger effort like the Research Excellence Framework in the United Kingdom that took five years and came with a huge bill of about 246 million pounds[7]. It is unlikely that a similar effort will be envisaged in India in the near future.

HEIs have the objective of knowledge creation and dissemination through teaching, research and extension. However, assessing teaching quality is fraught with measurement errors with no satisfactory way to quantify. In keeping with many earlier contributions, we argue that an efficient way to evaluate institutional academic performance is to rely on third party validation and based on quality publications. This is a good indicator and is quantifiable[8]. NIRF has used the WoS, Scopus and *Indian Citation Index* (ICI) for computing publications. However, using aggregate number of publications is fraught with size bias. HEIs differ in terms of the number

Table 1. Top 10 HEIs ranked according to NIRE and 3 alternate measures based on publication rate (Scopus)

NAAC	NIRF 2017	Alternate rank 1: Scopus publication rate (using NIRF 2017 data)	Alternate rank 2: performance index using top 25 percentile publication (x)	Alternate rank: index using top 25 percentile publication controlling for size of faculty (Mod_x)
JNU	IISc	JNCASR	IISc	JNCASR
University of Hyderabad (UoH)	JNU	IISc	University of Delhi (UoD)	Institute of Chemical Technology (ICT)
Jadavpur University (JU)	Banaras Hindu University (BHU)	ICT	JU	MGU
Andhra University	JNCASR	BrU	BHU	Periyar University
SYMBIOSIS International University	JU	Anna University (AU)	Panjab University	Indian Institute of Space Science and Technology
Guru Nanak Dev University	AU	JU	Homi Bhabha National Institute	Goa University
SRM University	UoH	BnU	AU	Vidyasagar University
University of Mysore	UoD	UoH	Calcutta University	The Gandhigram Rural Institute
Amrita Vishwa Vidyapeetham (AVV)	AVV	MGU	Vellore Institute of Technology	BrU
International Institute of Information Technology, Hyderabad	Pune University	KU	UoH	BnU

of teachers, number of students, age of the HEI, etc. The quantum of funding plays an important role in determining the quality and quantity of research which in turn could determine the number of publications, etc. This could bias opportunities for smaller HEIs with lesser funding in obtaining better ranks. The rational method would be to compare the publication rate – i.e. number of publications per teacher rather than absolute number of publications for HEIs. This list could be further grouped by the nature of HEI, but that is not the objective of this study.

In the NIRF 2017 factsheets we have institution-wise information on the number of publications in WoS, Scopus and *ICI*. Since there is a possible duplication of journals in these three lists we choose to use the Scopus database as it covers a wider number of journals representing science, social science and humanities. If we divide the number of Scopus publications by the number of teachers in each HEI, we get the Scopus publication rate (average number of Scopus publications per teacher). An alternative ranking would emerge if we use this publication rate (Table 1). The Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) displaces the Indian Institute of Science (IISc), Bangalore, at the top and the Institute of Chemical Technology (ICT) takes the third place. Jawaharlal Nehru University (JNU) that ranks first in NAAC and second in NIRF 2017 drops to 33. The top 10 positions are all taken by the central or state funded HEIs and private HEIs drop out of this top 10 list. Bharathiar University (BrU), Bharathidasan University (BnU), Mahatma Gandhi University (MGU), and Kalyani University (KU) (ranked 28, 88, 67 and 66 respectively, in NIRF 2017) now enter the top ten.

It has been argued that publications in WoS and Scopus are not adequate indicators of research quality as this is achieved only if the publications are in the most cited journals. NIRF has provided data on the 'top 25% highly cited papers (top 25)'. We use a performance index x which measures the total number of publications (indicator of output) by the square of the proportion in the top journals (indicator of quality) (eq. 1)[8].

$$x = \frac{\text{Publications in the top 25\% } \textit{Scopus} \text{ journals}}{(25 \times \text{total Scopus publication})^2} \times \text{Total Scopus publication.} \quad (1)$$

Even though the index could be theoretically scale-neutral, it too may have the same bias that the NIRF rank suffers from – favouring larger institutions. So, in addition to the performance index x we use a modified productivity index (termed mod_x), to control the faculty strength by dividing each entry in the formula above by total number of teachers (eq. (2)). Therefore

$$\text{Mod\_}x = \frac{\text{Publications per teacher in the top 25\% Scopus journals}}{(25 \times \text{Scopus publication rate})^2} \times \text{Scopus publication rate.} \quad (2)$$

On simplifying we get

2A Mod_x = x/(number of faculty).

This leads to a linked question: what are the factors that explain the publication rate, the performance index (x) and productivity index (mod_x) for HEIs? In order to respond analytically to this question we rely on an econometric model based on a production function approach used in economics.

The production function is a workhorse in economics which is used to explain an outcome caused by anticipated explanators[9]. Quantity produced is dependent on the factors of production (normally labour, L, and capital, K and other factors). A modified version of the production function (eq. (3)) suggests that the output per person (q) is dependent on capital per unit of labour (and other factors).

$$q = \theta(k), \tag{3}$$

where $q = Q/L = f(K/L, 1)$, $k = K/L$ and $q = \theta(K/L)$.

The Cobb–Douglas Production function (eq. (4)), used in theoretical and empirical applications due to its desirable properties would take the following form[10]

$$q = Ak^{\alpha}, \tag{4}$$

where A is technology parameter and α is the proportion of output attributable to capital (also the output elasticity).

To estimate the parameters using regression analysis we use a linearized log–log form (eq (5)).

$$\ln q = \ln A + \alpha \ln k. \tag{5}$$

The econometric models (eq. (6)) allow for a random error that measures deviation of the predicted value from its observed value and captures relevant variables excluded for this estimation[11].

$$\ln q = \ln A + \alpha \ln k + \varepsilon, \tag{6}$$

where ε is the random error.

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 X_{2i} + \varepsilon_i, \tag{7}$$

(expanded from eq. (6)) to allow for log as well non-log variables such as explanators, and the interpretation of β would differ accordingly).

Equation (7) states a modified (combination) log-log and log-level regression model with the dependent variable ($\ln Y_i$) and some independent variables (X_{1i}) are taken in log form while some other continuous variables are taken as absolute values (eq. (8)).

$$\begin{aligned}\text{ln\_publication rate} &= \beta_0 + \beta_1.\ \text{Foundation year} \\ &+ \beta_2.\ \text{Total\_teachers} + \beta_3.\ \text{Total\_teachers\_sq} \\ &+ \beta_4.\ \text{Annual expenditure per teacher} \\ &+ \beta_5.\ \text{Student\_PG\_teacher} + \beta_6.\ \text{Student\_PG\_teacher\_sq} + \beta_7.\ \text{Student\_PhD\_teacher} \\ &+ \beta_8.\ \text{Student\_PhD\_teacher\_sq} + \varepsilon_i\end{aligned} \tag{8}$$

Equation (8) states the exact form used for our regression analysis. The summary statistics and regression results may be seen in Tables 2 and 3 respectively. The coefficient parameters associated with a log-variable are interpreted as elasticity measures, whereas independent variables without log transformation represent a relative change measure. The log transformation of publication rate (per capita number of papers published in Scopus journals per faculty as presented in the NIRF factsheets) is used here as the dependent variable (Model 1). In alternate specifications of this model, we also use the quality index (log of x) (model 3) and its modified version (log of mod_x) as dependent variables (model 2). Unobserved heterogeneity has been taken care of while estimating the model.

We use a box plot to identify the outliers in the following institutional variables – publication rate, foundation year, number of teachers, average annual expenditure per teacher, students per teacher (separately for PG and Ph D) (Figure 1). The rectangle in each sub-graph is drawn to represent the first and third quartiles, and the horizontal line inside the box indicates the median value. The lower and upper quartiles are shown as horizontal lines on either side of the rectangle. The two lines below and above the box indicate the values that are 1.5 times the inter quartile range (IQR) from the lower/upper quartile respectively. The variable names are indicated on the vertical axis of each plot. We find that there are outliers (the dots seen above the 1.5 IQR lines) in all the six variables. However, randomly dropping outliers could also bias our estimates; therefore we retained all the observations.

We then plot the association between Scopus publication rate (log value on the vertical axis) and some of its probable determinants (Figure 2 *a–e* where *a* is the foundation year, *b* the number of teachers (log value), *c* the average annual expenditure per teacher (log value), *d* the students per teacher (PG) and *e* is students per teacher (Ph D)).

We find that the mean publication rate for all institutions in our sample works out to 2.9. The 24 Central HEIs are ahead at 4.2 but the 41 State HEIs are not far behind at 3.4. The 35 Private HEIs trail at 1.5. The average number of teachers reported by the top 100 HEIs is 606 (Table 2) including the private (842), state (417) and central (584) institutions and they differ significantly. The same is true for the average reported student size – the central HEIs are at the top (4384), the state universities are slightly smaller (3945) and the private HEIs are the smallest (1888). Central institutions are on an average endowed with larger funding per teacher (expenditure in millions) (4.7) in comparison to state (4.5) and private (2.4) institutions.

The results of our econometric analysis suggest that HEIs which have a higher number of Ph D student-teacher ratios enjoy a higher publication rate but this tapers off beyond a threshold (negative coefficient of squared variable). The PG student-teacher ratio does not seem to have any significant impact on publication rate.

Table 2. Summary statistics of variables used in regression analysis

Variable	Mean	Standard deviation	Minimum	Maximum
Scopus_publication rate (ln)	0.65	0.9	1.78	3.36
X(ln)	–3.0	1.4	–6.5	0.04
Mod_*x* (ln)	–21.3	2.6	–26.15	–12.29
Foundation year (ln)	7.58	0.018	7.53	7.61
Total faculty	605.9	537.2	38	2893
Annual expenditure per teacher in 2015–16 (Rs millions)	3.8	2.9	0.06	19.7
Student_PhD per teacher	1.9	2.8	0	18.9
Student_PG per teacher	5.52	5.2	0.39	21.8

Table 3. Results of regression analysis

	Model 1	Model 2	Model 3
Variables	Scopus publication rate (ln)	Mod_x_ln	x_ln
Foundation year (ln)	–4.59	–0.967	–0.843
Total faculty	–0.000982**	–0.0067***	0.00021***
Total faculty (sq)	3.04e–07**	1.64e–06***	–5.73e–08***
Annual expenditure per teacher	3.43E–08	1.79e–07***	1.30e–08*
Student Ph D per teacher	0.347***	0.569***	0.063***
Student Ph D per teacher (sq)	–0.0161***	–0.0293***	–0.0036***
Student PG per teacher	–0.0028	0.0111	–0.011
Student PG per teacher (sq)	0.000649	0.000302	0.0004
Constant	35.24	–12.44	6.31
Observations	100	99	100
R^2	0.502	0.793	0.415
Adjusted R^2	0.459	0.775	0.363
F-value	15.46***	53.15***	6.522***

Robust standard errors in parentheses; $***P < 0.01$, $**P < 0.05$, $*P < 0.1$

Interestingly, publication rate declines as the size of the faculty increases but again here, there is a threshold effect and it would start rising beyond a threshold level (positive co-efficient of the squared variable). The age of the HEI does not have a significant impact on the publication rate.

Interestingly, instead of the publication rate if modified productivity index (mod_*x*) was used as the dependent variable (discussed earlier) we would arrive at exactly the same conclusions (as we did for the publication rate) with one difference: HEIs that spend more per teacher report a higher quality publication rate (positive coefficient of average annual expenditure). These results may imply that a higher Ph D student density helps in raising publications but higher level of expenditure helps in improving quality publications.

If the performance index (*x*, model 3) was used without adjusting the size of the faculty (mod_*x*, model 2) a similar result will emerge from the mod_*x* with one significant difference – coefficients emerge with one significant per teacher improve quality publications[12]. However, the difference is that a larger faculty size improves the overall performance (up to a threshold). This implies that as long as rankings do not account for differences in faculty size, HEIs that spend more and invest in larger faculty will gain by having more quality publications up to an extent.

Discussion and conclusion

Considering the methods adopted by international ranking agencies like Leiden, our analysis suggests that NIRF (and others) should consider moving towards a bibliometric-based system of ranking to avoid subjectivity and improve the efficiency and transparency in the process unless they are willing to invest large sums like the REF exercise. Many others have used bibliometric data and some have ranked central HEIs in India[13]. Our analysis extends this to the state-funded and private HEIs in addition to the central ones using the NIRF (2017) database.

One major reason why ranking is undertaken is to about students seeking admissions to HEIs. Some researchers have explored if ranking affects applicant behaviour towards HEIs. In the UK, only a modest link was found by some between the two while others found no impact on student applications[14,15]. We did not address this question and remains a gap in the Indian literature although there is anecdotal evidence that perceived reputation does have an impact on the number of applications.

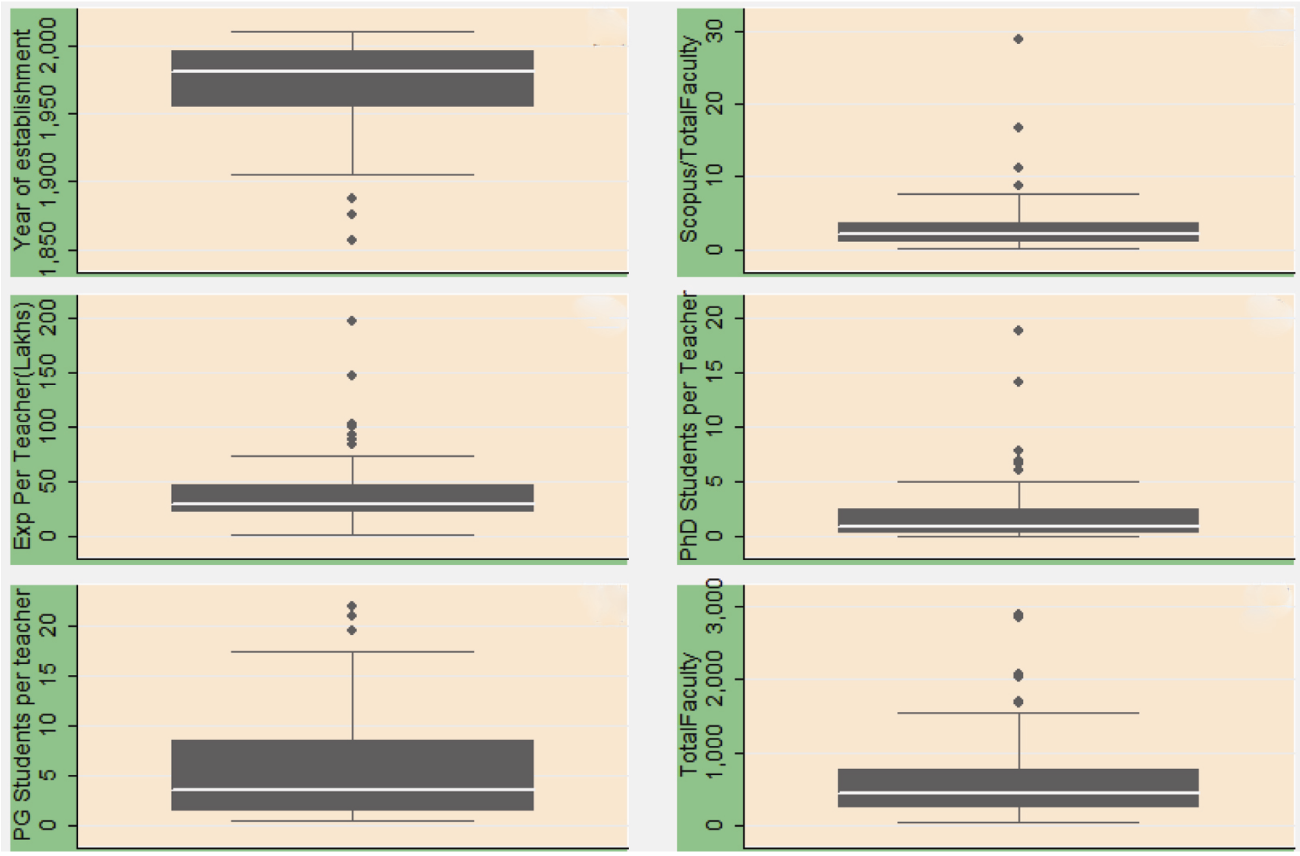

Figure 1. Box plot select variables (with outliers).

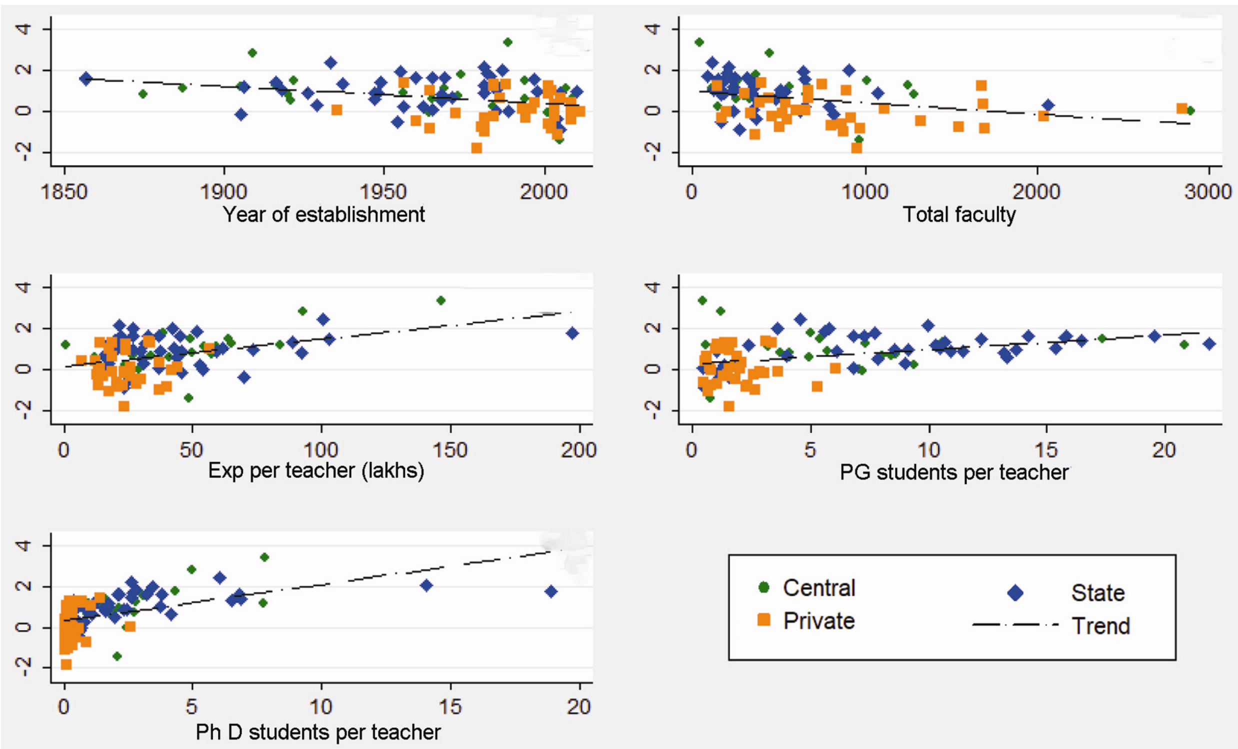

Figure 2. Two way graph of publication rate (Scopus) with select variables.

Our findings from the econometric exercise have important policy implications for managers of higher education in India.

(a) The government has announced a slew of financial benefits to high 'ranking' HEIs. There is a need for rethinking financial allocation to institutions as smaller institutions may require better financial support for greater research output[16].

(b) We see clear evidence that HEIs that spend more on average, tend to have a higher quality publication rate. Therefore, if Indian HEIs are looking to increase their global presence in terms of quality publications, they need to be better funded as there is a direct relationship between budgetary allocations for higher education and scientific output.

(c) A higher density of PhD students help in increasing the publication rate as well as the two indices of quality publications but is subject to congestion (as a threshold effect exists after there is a counter effect).

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ACKNOWLEDGEMENTS The authors would like to acknowledge comments on an earlier version from Gangan Prathap and two anonymous referees of the journal whose comments have substantially helped improve the paper.

Received 10 July 2017; revised accepted 1 September 2017

doi: 10.18520/cs/v114/i06/1167-1173