Impact of access to e-resources through the UGC-INFONET Digital Library Consortium on research output of member universities

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Over the last several years, the UGC-INFONET Digital Library Consortium has been providing Indian universities with electronic access to national and international scholarly journals. These journals span wide areas of natural and physical sciences, social sciences and humanities, and address a long-standing need of the university community for access to scholarly publications. In this article, we describe some details of this programme and examine the impact it has made on research and development activity in the universities. The research output data from three citation indices, namely Science Citation Index, Social Sciences Citation Index and Arts and Humanities Citation Index for the first 50 universities to be made part of the programme have revealed that the number of research articles produced by these 50 universities has increased by more than 75% in past 5 years, i.e. from 2005 to 2009 in comparison to the previous block of 5 years, i.e. 2000 to 2004. While increase in research output is evident in all three major subject disciplines, i.e. science, social science and arts and humanities, increase in research output is significantly higher in science, compared to the other two disciplines. Moreover, a strong positive correlation is found between the number of articles downloaded by these 50 universities from e-resources accessible to them through the consortium and research articles published by them. We also comment on the influence of other factors such as number of researchers and level of research funding on this correlation.

Keywords: Digital library, e-resources, member universities, research output.

THE generation and transmission of knowledge through research has long been recognized as an essential requirement for a country's long-term growth and competitiveness as well as for creating capacity to solve social problems[1]. The quality and number of published research articles are regarded as a measure of success of individual scientists, researchers, academic institutes and the scientific establishment in general. Scientists and researchers, therefore, publish results of their work in the form of research articles in prestigious journals. In qualitative terms, accessibility and availability of print and e-resources impact quality of teaching and research, publications, etc. In quantitative terms, the research output of an institute can be measured in terms of the number of research articles published in high-impact journals, citations received by them, number of patents, number and amount of research grants and consultancies, number of research reports, number of honours and awards to faculty and researchers, number of research students and their placements, etc. Quantitative data for all the parameters mentioned above are difficult to get; however, the number of publications and citations received can be obtained and put to use most effectively to measure research output of an institute, which, in turn, reflects the impact of resources available to individuals, researchers and the institutes at large.

The research output of universities, institutes of higher learning, technical institutes and R&D institutes in India, in terms of research articles published by them, has increased substantially in the past few years essentially because of increased access to scholarly content made possible through consortia initiatives such as INDEST-AICTE Consortium, UGC-INFONET Digital Library Consortium, National Knowledge Resource Consortium and DAE Consortium.

In an era predominantly guided by the principles of accountability, return on investment, cost–benefit analysis and tangible benefits, libraries and library consortia all over the world face the challenge of demonstrating and

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quantifying their value to their funding agencies as well as to all their stakeholders[2]. Libraries and library consortia, therefore, must find ways and means to measure the value of their services and subscribed resources. Although there are several sources of bibliographic information, the most commonly used is the *Web of Knowledge* that hosts the *Science Citation Index* (*SCI*), *Social Sciences Citation Index* (*SSCI*) and the *Arts and Humanities Citation Index* (*A&HCI*). The three citation indices are internationally recognized databases that work as a filtering mechanism for estimating the quality and impact of research papers based on citations received by them. These indices, therefore, can be searched to determine the qualitative productivity of institutes. Unlike other indexing and abstracting services that are restricted to a few disciplines, *Web of Knowledge* covers almost all disciplines: *SCI Expanded* covers 8,269 scientific journals in about 174 disciplines, *SSCI* covers 2,847 journals in 56 disciplines and *A&HCI* covers 1,591 journals in 28 disciplines. Put together, the three indices cover 12,707 journals accessible on the *Web of Knowledge* platform[3].

Growth of library consortia in India

All educational institutes in India, especially the universities, face acute shortage of funds to subscribe to international scholarly journals. It is estimated that a typical university in India subscribes to less than 200 international journals, while some universities do not subscribe to any international journal. While there are around 50,000 scholarly journals published the world over, all research institutes and universities in India put together had combined subscriptions to only around 1,500 journals in print until a few years ago[4]. Many smaller colleges and institutes subscribe to fewer than a 100 journals. Most colleges, including those imparting postgraduate and doctoral programmes, do not have financial resources to subscribe to any international journal and their subscription list includes only a few Indian journals and some popular magazines.

In recent years, the accessibility to international journals in Indian universities and technical institutes has increased many fold with the setting up of a number of Government-funded library consortia which provide access to electronic versions of scholarly electronic journals. Prior to these consortia, access to e-journals was restricted to premier institutes like IISc, IITs, IIMs and a few Central Universities which were subscribing to a small number of e-resources, including bibliographic databases on CD-ROM, a few e-journals accessible free with subscription to their print versions and a negligible fraction of journals on subscription. After the launch of the 'Indian National Digital Library in Engineering Sciences and Technology (INDEST) Consortium'[5] in 2003 and 'UGC-INFONET Digital Library Consortium'[6] in 2004, availability and accessibility of e-resources increased phenomenally in centrally funded technical institutes (IITs, IISc, IIMs, IIITs, etc.) and universities, setting up a new culture of electronic access and browsing in educational institutes.

E-resources for the universities in India through the UGC-INFONET Digital Library Consortium

The UGC-INFONET Digital Library Consortium was launched by A. P. J. Abdul Kalam, the then President of India, in December 2003. It provides current as well as archival access to more than 7,500 core and peer-reviewed electronic journals and 10 bibliographic databases from 25 publishers, scholarly societies and aggregators, including university presses in different disciplines. A list of e-resources offered to the member universities is available at the Consortium website (http://www.inflibnet.ac.in/econ/eresource.php). The programme has been implemented in a phased manner. In the first phase that began in 2004, access to e-resources was provided to 50 universities which had Internet connectivity under the UGC-INFONET connectivity programme. In the second phase, 50 more universities were added to the programme in 2005 as additional universities got Internet connectivity through UGC-INFONET programme. So far, 195 universities that come under the purview of UGC have been provided differential access to subscribed e-resources. These e-resources cover almost all subject disciplines, including arts, humanities, social sciences, physical sciences, chemical sciences, life sciences, computer sciences, management, mathematics and statistics. The Centre has also initiated Inter-Library Loan (ILL) through JCCC (Jgate Custom Content for Consortium) that provides article-level access to all the articles published in journals subscribed by the Consortium, as well as in journals subscribed by 27 university libraries designated as ILL Centres of the INFLIBNET Centre.

The success of UGC-INFONET Digital Library Consortium has led to a demand for extension of the Consortium resources to the universities that are not under the purview of UGC. The Consortium, therefore, initiated its Associate Membership programme in 2009 with an aim to extend access to e-resources subscribed by the Consortium to private universities as well as to research institutes that are not funded by UGC. Under the scheme, such organizations can enroll themselves as 'Associate Members' of the Consortium and subscribe to resources of their choice available through the Consortium. The rates of subscription to e-resources are the same as those applicable to the Consortium for its core members. So far, more than 105 institutes have enrolled themselves as associate members and are subscribing to e-resources through the Consortium.

The website of UGC-INFONET Digital Library Consortium (http://www.inflibnet.ac.in/econ) provides an

interface to search e-journals subscribed under the Consortium as well as to search member institutes and corresponding e-resources subscribed for them.

Measuring research productivity: literature review

A number of implicit and explicit methods of measuring value, and quantitative and qualitative techniques have been used in studies to demonstrate that e-journal collections improve research, help faculty to be more productive and are valuable for several purposes[7,8]. One of the straightforward methods of determining the size of research output is to simply compile a weighted average of the various types of research publications produced by university staff[9–11], though raw data on number of publications do not reflect the quality of publications. Johnes and Taylors[12] measured research output using publications, citation analysis and research income. De Groot *et al.*[13], in their work on American universities, measured research output and quality (peer review). Cave and Kogan[14] suggested that research grants attracted by universities reflect the market value of the research conducted and, therefore, can be considered as a proxy for research output.

Examining the use and outcomes of print and electronic collections in the University of Pittsburgh library, King *et al.*[15] found that if all journal articles read by the faculty were taken into account, the current purchase cost (value) of used resources other than the library journal collection was US$ 13.48 million, whereas the investment by the University of Pittsburgh in its library collection was US$ 3.43 million. As such, the net benefit of the collection was US$ 10.05 million (US$ 13.48–3.43 = US$ 10.05) and the return on investment (ROI) for the University of Pittsburgh library is 2.91 : 1 (US$ 10.05 : US$ 3.43)[8]. Abbott and Doucouliagos[16] evolved a model to measure research output of major Australian universities depending on several inputs, namely research income, academic staff, non-academic staff and size of a university in terms of student enrolment, number of campuses, etc. The results of the study on Australian universities revealed that research income, academic staff and postgraduate students are all associated positively with research output.

MINES for Libraries (Measuring the Impact of Networked Electronic Services for Libraries), a standard online transaction-based survey, adopted as part of the New Measures Program of the Association of Research Libraries (ARL) in 2003, was used to conduct studies on the use and usage of networked resources by the members of academic library consortia[17]. Brinley[18,19], using MINES for Libraries, analysed the relationship between three variables, namely total R&D funding at the institute and total library expenditures; total library expenditures and library expenditure in support of sponsored research as a percentage of total library expenditure, and total R&D funding and library expenditure in support of sponsored research. Analysing these results, they found a high degree of correlation between R&D funding at the institute level and total library expenditures, but little or no correlation between the remaining two variables mentioned above.

In a comprehensive study commissioned by the Research Information Network (RIN)[20], UK[20], a strong correlation was established between information consumption (measured by page views) and number of publications produced from usage data provided by Elsevier's Science Direct and Oxford University Press. The RIN report also established strong correlation between cost of electronic journals and their usage in terms of number of downloads. The report divided the universities into three categories in terms of extent of usage, i.e. moderate, high and super users and observed a tentative link between e-journal usage and research outcome in terms of number of research papers produced, amount of research grants obtained, number of Ph Ds produced and cost per download. The RIN report provides a model to quantify the association between usage of e-journals and research outcome – doubling of downloads (100% increase) would result in increase in paper produced by 207%, Ph Ds awarded by 168% and income from research grants by 324%.

ROI is yet another approach to demonstrate the value of research information. An international team of experts is working on ROI in a multi-phase study of increasing complexity with funding from Elsevier Science[2]. In phase I, a pilot study at University of Illinois, Urbana-Champaign (UIUC), USA established a model for measuring the library's ROI[21]. The investigators collected 10 years of data on grant proposals, awards, expenditures and library budgets and concluded that ROI in terms of money awarded to grant recipients who used the UIUC library to prepare their grant proposals was US$ 4.38 for every US$ 1.00 invested in the library. In phase II of the study, the ROI model established in the UIUC pilot case study was applied to eight additional institutes in eight countries in North America, western Europe, Asia-Pacific and Africa[2]. The study confirmed that 'for every monetary unit invested in academic libraries, the parent institutes received a ROI in the range 15.54 : 1 to 0.64 : 1 in research grant income. Moreover, in six of the eight countries, the ROI for grants is more than 1 : 1. The ROI in the study was calculated using the entire library budget. If the portion of the library budget that is just related to e-collections is used, the ROI rates range from 155 : 1 to 6.4 : 1. The study also reported that in two North American universities, regression analysis using 10 years of data shows that an increase in the library budget correlated with increase in grant funding. Phase III of the study proposes to increase the focus to multiple

values and multiple ways the library provides ROI. Most of the phase 3 testing will be done in three universities in USA in association with ARL, which will develop ROI tools to be tested on universities participating in the study[2].

Scigliano[22] reported implementation of MINES for OCUL, a Consortium of 21 member libraries in the Canadian province of Ontario, Canada and its Scholars Portal that facilitates federated searching for over 130 databases, linking to more than 15,000,000 articles in over 8,400 scholarly journals. A correlation between use of Scholars Portal and sponsored research revenue was established, using data collected through MINES and Compendium of Statistics for 2004–2005 for data on revenue from sponsored research for each member institute. Using regression analysis, it was established that a 10% increase in sponsored research revenue is associated with a 0.00687 unit increase in usage of Scholars Portal electronic journals for sponsored research[22].

Measuring scientific productivity of 50 phase I universities in India: methodology

The *SCI*, *SSCI* and *A&HCI*, published by the Institute of Scientific Information (ISI), Thomson Press, Philadelphia were searched on the *Web of Knowledge* platform to find qualitative research productivity of 50 universities, covered under phase I of the UGC-INFONET Digital Library Consortium. These 50 universities have access to e-resources through the Consortium since its inception in 2004. The source articles which appeared in these three indices for these 50 universities were searched in blocks of five years beginning from 1975 to 2009 with an aim to compare the research output in the last block of five years, i.e. 2005–2009, when these universities were having access to e-resources through the Consortium, with previous blocks of five years when these institutes did not have the benefit of such access. All permutations, combinations and changes in the name of universities were used while searching for articles published by faculty and researchers in these universities to ensure that all research articles published by these 50 universities are taken into account. *Universities Handbook 2010* was used to find changes in the names of universities over the years[23]. Many variations in the names of universities and their physical locations were discovered during the searches. Some of the glaring examples are given below:

(i) Osmania University is spelled as Osmainia Univ., Osmana Univ., Osmania Univ., Osmanina Univ., Osmaniya Univ., Osmanja Univ., etc. Moreover, the university has a number of postgraduate campuses located in various other locations in Andhra Pradesh, such as Medak, Warangal, Secunderabad, Hyderabad, etc. Likewise, Panjab University is spelled as Punjab Univ, Panjab Univ, PU, etc. The location of the university is spelled as Chandigarh, Chandigrah, Chandigarth, Chandigarm, Candigarh, Chandigartl, Chandrigar, Chandirgarh, Chandligarh, Chandigargh, etc. All these variations were taken care of during formulation of search queries.

(ii) A number of variations were found in the spelling of Kashmir University. Moreover, there are two more universities carrying Kashmir University in their names, i.e. Sher-E-Kashmir University of Agricultural Science & Technology and Azad Jammu & Kashmir University. Besides allowing for spelling variations, care was taken that credit for publications of these two universities is not given to Kashmir University.

(iii) Several universities host other research institutes within their physical premises. For example, Jawaharlal Nehru University (JNU) in Delhi hosts the National Institute of Immunology, International Centre for Genetic Engineering and Biotechnology (ICGEB), Indian Institute of Mass Communication, National Institute of Plant Genome Research, Inter-University Accelerator Centre and South Eastern University. Care was taken that credit for publications of these institutes is not given to JNU.

(iv) Care was taken while using 'NOT' Boolean Operator in the search query because it reduces the results in cases of universities that have collaborative research papers with other universities. For example, in the case of Allahabad University, one record showed 'Italy' as country of location of the Institute. When 'NOT' Boolean operator was used to eliminate that record, it also eliminated 14 other records of collaborative work involving Allahabad University, Uttar Pradesh with other institutes from Italy.

(v) Problems were also encountered in the case of universities named after their cities/states, such as Tezpur University, University of Mysore, University of Kashmir, University of Hyderabad, etc. For example, Hyderabad University is spelt as University of Hyderabad or Hyderabad University. Location is also spelt as Hyderabad. The search query also fetched results from Agricultural University, Hyderabad and Maulana Azad National Urdu University, Hyderabad. Similarly, in the case of Tezpur University, the search query retrieved records of Agricultural University, Tezpur, besides search results for University of Tezpur.

Research output from 50 phase I universities

The total research output of 50 phase I universities, in terms of the number of research articles published in scholarly journals from 1975 to 2009, in blocks of five years, and for the country as a whole, is shown in Table 1. As discussed above, the numbers are based on data from the three citation indices *SCI*, *SSCI* and *A&HCI*. Over the last 35 five years, these 50 universities have produced 164,851 research articles, which is 24.73% of

Table 1. Number of research publications by 50 phase I universities compared with the total number of publications from India

Year	Research publications by 50 phase I universities	Total number of research publications from India	Percentage of publications from the 50 universities
1975–79	16,628	60,740	27.38
1980–84	20,066	75,166	26.70
1985–89	19,179	74,312	25.81
1990–94	19,418	79,490	24.43
1995–99	20,931	87,999	23.79
2000–04	24,861	105,846	23.49
2005–09	43,768	183,148	23.90
1975–2009	164,851	666,701	24.73

Table 2. The ten most productive universities in terms of research articles during the period 1975–2009

Science		Social science		Arts and humanities	
Banaras Hindu University	15,537	University of Delhi	1,277	University of Delhi	491
University of Delhi	13,591	Jawaharlal Nehru University	800	Jawaharlal Nehru University	296
Jadavpur University	8,942	Banaras Hindu University	364	University of Mumbai	195
Calcutta University	7,547	Calcutta University	316	Calcutta University	187
University of Madras	6,873	Panjab University	304	University of Hyderabad	167
Panjab University	6,793	Allahabad University	210	Jadavpur University	111
Aligarh Muslim University	6,730	University of Mumbai	207	Allahabad University	68
University of Rajasthan	5,242	Andhra University	194	Banaras Hindu University	65
University of Hyderabad	4,985	Aligarh Muslim University	189	Jamia Millia Islamia	56
Osmania University	4,978	University of Hyderabad	155	Osmania University and University Rajasthan	54

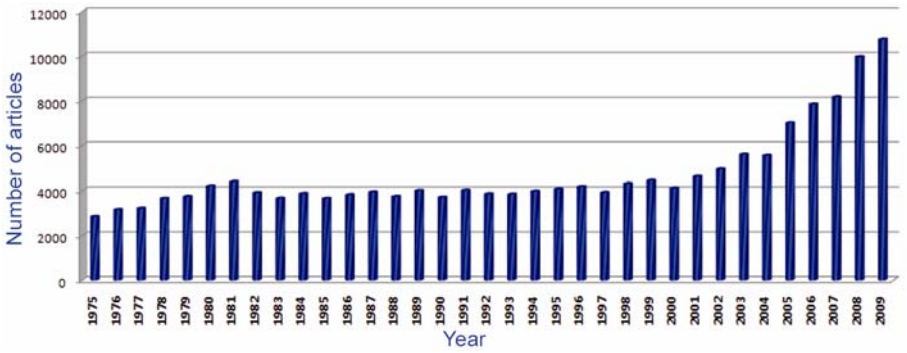

Figure 1. The annual number of research articles published by 50 phase I universities.

total research output consisting of 666,701 articles from India in the same period.

The 164,851 articles were cited 1,015,406 times, i.e. on an average every article was cited 6.16 times. Of the total number of articles, 158,411 (95%) were in science and technology, 5,792 (4%) in social science and 2,329 (1%) were in the field of arts and humanities. Table 2 lists the ten most productive universities each in science, social science and arts and humanities during 1975–2009. The number of research articles published by the 50 universities every year during the period is shown in Figure 1.

Figure 1 provides year-wise change in research output in terms of number of articles authored by faculty and researchers in 50 universities covered under phase I of the UGC-INFONET Digital Library Consortium. The number of articles published by each of the 50 universities in blocks of five years is provided in Appendix 1.

Analysis and discussion

It is seen from Table 1 that there is a sharp increase in the number of research articles published in the last block of five years (2005–2009), compared to the previous block. The rate of increase here is much greater than for any of the blocks considered over 25 years. Further analysis shows that the increase in the number of research articles varies to a great extent over the three major fields of study covered by the three indices used. The data are shown in Table 3 and depicted in Figure 2.

Data from *SCI* reveal a rather dramatic increase of 76.59% in the cumulative number of research articles in the last block of five years (2005–2009) in comparison to the previous block of 2000–2004. This may be compared with increase in the number of research articles from 15,538 in the block 1975–1979 to 42,741 in the last block

Table 3. Number of research articles published by 50 phase I universities in science, social science, and arts and humanities

Years	Number of research articles in blocks of five years							Percentage of increase in comparison to previous block of five years						
	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–09	1980–84	1985–89	1990–94	1995–99	2000–04	2005–09	75–79 05–09
Science	15,538	19,107	18,330	18,413	20,078	24,204	42,741	22.97	–4.07	0.45	9.04	20.55	76.59	175.07
Social science	1,101	820	703	814	710	641	1,003	–25.52	–14.27	15.79	–12.78	–9.72	56.47	–8.90
Arts and humanities	391	402	341	390	297	185	323	2.81	–15.17	14.37	–23.85	–37.71	74.59	–17.39
Total	16,628	20,066	19,179	19,418	20,931	24,861	43,768	20.68	–4.42	1.25	7.79	18.78	76.05	163.22

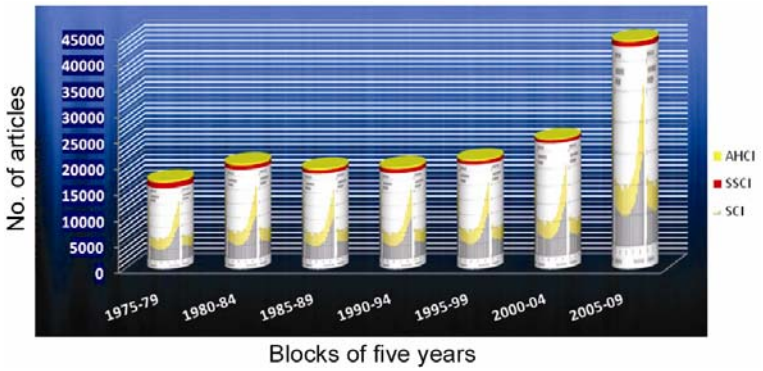

Figure 2. Total number of research articles published by 50 universities in blocks of five years.

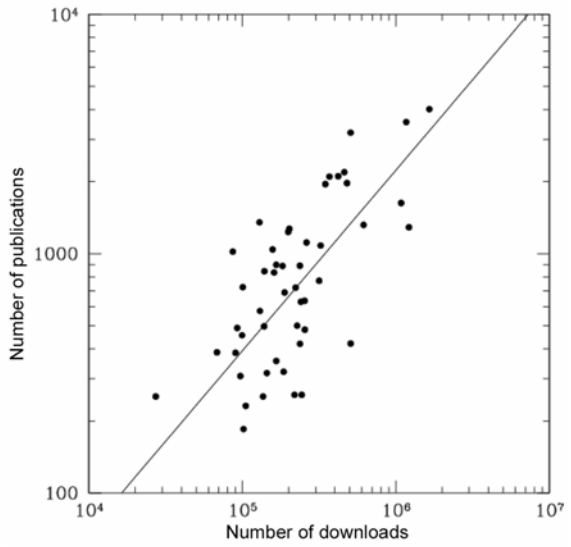

Figure 3. Correlation between number of articles downloaded and number of publications. The straight line shown, with equation $\log(p) = 0.76*\log(d) - 2.72$, is the best fit to the data.

of five years (2005–2009). This marks a cumulative growth of 175.07% or a compounded annualized rate of 11.85% over a period of 35 years in science and technology publications from the 50 universities in India. The increase in the last block is clearly in excess of this rate.

Data from *SSCI* show that there is an increase of 56.47% in the number of research articles produced in the last block of five years (2005–2009) in comparison to the previous block of five years. However, it is also seen that the actual number of research articles in social science has decreased from 1101 in the block 1975–79 to 1003 in the last block, marking an overall decrease of 8.90% over a period of 35 years.

Similar trends are evident in the case of arts and humanities. There is an increase of 74.59% in cumulative number of articles produced during the last block of five years in comparison to the previous block. However, over the longer term the number of articles has decreased from 391 in the first block to 323 in the last block, marking a decrease of 17.39% over a period of 35 years.

Overall, there is a 76.05% increase in cumulative number of articles in all the three areas of study in the last block of five years in comparison to the previous block, amounting to a cumulative increase in research productivity of 163.22% over a period of 35 years from 1975 to 2009. The corresponding compounded annualized rate of growth is 10.29%.

Correlation between number of articles downloaded and number of articles published by universities

The success of a programme to provide access to literature depends on the impact that it has on the extent and quality of research that is carried out in the institutes

Table 4. Cumulative data from six select universities

Year	No. of faculty	Research funding (in Rupees)	No. of Ph D students	No. of downloads	No. of publications
2005	4,748	1,077,723,512	2,168	253,939	1,497
2006	4,742	1,192,505,856	2,567	380,427	1,677
2007	4,875	1,679,716,402	2,709	490,027	1,705
2008	5,236	1,856,510,111	3,078	766,389	2,128
2009	5,260	2,833,236,538	3,555	896,720	2,457

where access is provided. We have seen above that there has been a significant increase in the number of research publications in various disciplines since the beginning of the UGC-INFONET Digital Library Consortium. An interesting question to ask is whether this increase is influenced by the easy access to scholarly publications that UGC-INFONET Digital Library Consortium has made available to the university system.

Figure 3 is a plot of the number of publications against the number of downloads by 50 universities in the five year period 2004–2009. A clear trend is seen for the number of publications to increase with the number of downloads even though there is some scatter. To get a measure of the statistical correlation between the two variables, without assuming any parametric relation between them, we evaluate Spearman's rank-order correlation coefficient r (see ref. 24) for the data points shown in Figure 3. This provides a non-parametric measure of the positive or negative correlation between the variables and would be zero if there is no association between the number of publications and the number of downloads. For the sample of 50 universities, the correlation coefficient is $r = 0.650$. The significance of this value, i.e. the probability of exceeding the correlation coefficient for a sample of 50 points selected at random from an uncorrelated population is 3.21×10^{-7}. To see how robust this result is, we have evaluated the correlation coefficient after omitting the points corresponding to the four highest downloads. We still get $r = 0.566$, which is significant at the 4.19×10^{-5} level. From Figure 3, it is obvious that a linear function would describe well the relation between the logarithm of the number of downloads (d) and the logarithm of the number of publications (p). The best-fit straight line relation between the variables is found to be $\log(p) = 0.76*\log(d) - 2.72$. This best-fit line is also shown in Figure 3. The Pearson correlation coefficient in this case with 50 points and 48 degrees of freedom is 0.680, which is significant at the 5.66×10^{-8} level. It is clear that there is a strong positive correlation such that institutes with a high download of research papers also have high rates of publication.

While the number of publications (p) is clearly correlated with the number of downloads (d), p will also depend on other factors like the number of researchers, including faculty and students, and the level of research grants. To see how strong the dependence of p on each one of these factors is, it is necessary to perform multiple correlation and regression analysis between p and d, and the other variables. We do not have access to all these data for the 50 universities in our sample, but have managed to gather data for the number of users (faculty and Ph D students) and research funding for six select universities. These are Banaras Hindu University (BHU), The MS University of Baroda, Aligarh Muslim University, Jadhavpur University, Pondicherry University and Punjabi University. The data given in Table 4 reveal that although there is no significant increase in the number of faculty and other researchers during the years under consideration, the amount of grant received has increased significantly from 2005 to 2009. It is presumed that the grant received is used on consumables, equipment as well as on library books and journals (in addition to the e-journals provided cost free to the universities under the UGC programme), all of which will positively affect the research outcome. We carried out multiple correlation analysis with the variables with the following results. For the six universities, the correlation coefficient between the number of publications and number of downloads (two variables) is 0.982, with significance 0.0028. The correlation coefficient between number of publications, number of faculty and number of downloads (one dependent and two independent variables) is 0.983, with significance 0.0026. The correlation coefficient between the number of publications, number of downloads, grants received and number of Ph D students (one dependent and three independent variables) is 0.987, with significance 0.0017. The increase in the correlation coefficient with increase in the number of variables is less. While these correlations indicate that the number of publications is influenced by all the variables considered, the quantitative results need to be confirmed and improved, since we have data on all the variables only for a small number of universities. Better data and sophisticated statistical analysis will lead to better insights on the strength of various dependencies.

Access to electronic journals was provided by UGC through a programme which was funded independently of other programmes, which also would have led to increase in the number of users and to improved infrastructure and facilities. Due to the technology used, it is a relatively

Appendix 1. Research publications of 50 phase I universities in blocks of five years

	University	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–09	All years
1	Aligarh Muslim University	940	1,008	906	758	683	860	1,752	6,907
2	Andhra University	823	766	643	488	444	569	739	4,472
3	Anna University	1	162	265	384	676	1,047	1,911	4,446
4	Avinashilingam University for Women	56	29	3	4	5	8	29	134
5	Banaras Hindu University	1,998	2,317	2,207	2,149	2,106	1,811	3,194	15,782
6	Bangalore University	245	270	225	144	196	381	599	2,060
7	Birla Institute of Technology and Science	190	141	69	33	92	194	568	1,287
8	Calcutta University	875	1,046	1,179	1,077	1,009	1,008	1,743	7,937
9	Cochin University of Science and Technology	41	123	212	309	407	557	963	2,612
10	Devi Ahilya Vishwavidyalaya	46	89	113	235	284	255	374	1,396
11	Gauhati University	65	98	75	82	123	158	316	917
12	Goa University	0	0	34	67	85	115	222	523
13	Guru Nanak Dev University	233	321	356	116	367	621	969	2,983
14	Jadavpur University	682	788	935	1,149	1,212	1,533	2,835	9,134
15	Jamia Hamdard University	0	0	0	48	129	284	649	1,110
16	Jamia Millia Islamia	7	17	45	115	215	307	800	1,506
17	Jammu University	98	146	165	135	211	233	410	1,398
18	Jawaharlal Nehru University	282	357	409	721	735	809	1,127	4,440
19	Jiwaji University	62	129	89	94	116	78	236	804
20	Karnatak University	282	313	367	364	296	441	729	2,792
21	Kurukshetra University	264	393	262	294	300	261	511	2,285
22	Kuvempu University	0	0	1	4	17	77	298	397
23	Madurai Kamaraj University	218	370	399	379	455	531	668	3,020
24	M.S. University of Baroda	342	466	429	391	408	448	788	3,272
25	Mahatma Gandhi University	0	0	12	85	261	333	372	1,063
26	Mangalore University	0	15	113	160	215	332	955	1,790
27	Manipur University	0	12	125	115	78	54	167	551
28	Nagpur University	290	288	254	216	163	143	353	1,707
29	North East Hill University	41	313	406	423	383	305	418	2,289
30	Osamania University	559	872	798	787	695	611	779	5,101
31	Panjab University	986	960	920	722	595	937	1,908	7,028
32	Pondicherry University	0	0	36	117	161	306	367	987
33	Pt. Ravishankar Shukla University	83	157	128	187	174	123	224	1,076
34	Punjabi University	264	258	238	181	389	363	528	2,221
35	Sardar Patel University	239	451	389	274	233	286	431	2,303
36	Shivaji University	129	179	195	261	290	364	651	2,069
37	Tezpur University	0	0	0	0	9	73	304	386
38	Thapar Institute of Engineering and Technology	3	5	2	29	47	97	348	531
39	Allahabad University	856	733	437	290	241	328	961	3,846
40	University of Calicut	105	148	179	141	110	130	228	1,041
41	University of Delhi	2,277	2,114	1,640	1,609	1,726	2,161	3,544	15,071
42	University of Hyderabad	105	482	562	825	913	937	1,441	5,265
43	University of Kashmir	81	130	125	50	42	41	211	680
44	University of Kerala	318	342	307	280	296	266	455	2,264
45	University of Madras	592	936	698	772	1,000	1,110	1,858	6,966
46	University of Mumbai	522	486	483	536	673	866	1,058	4,624
47	University of Mysore	344	457	345	319	366	599	1,209	3,639
48	University of Pune	247	401	526	645	604	588	1,192	4,203
49	University of Rajasthan	744	845	713	656	536	765	1,095	5,354
50	University of North Bengal	93	133	160	198	160	157	281	1,182
Grand total		16,628	20,066	19,179	19,418	20,931	24,861	43,768	164,851

simple matter to increase access to scholarly publications, since such access can be provided centrally, and the only prior requirements are access to the Internet and the availability of a campus-wide network. Our analysis shows that the performance as judged by the number of publications is indeed strongly correlated with the quantum of the access. All efforts should be made to ensure that this access is available on a long-term basis with provision for growth in terms of the number of universities covered as well as the quality and scope of publications provided. As the programme expands, and the number of users increases, the cost per user and per publication will decrease substantially.

Conclusion

Access to print as well as e-resources is known to make a qualitative difference to research, learning, staff deve-

lopment, and scholarly and R&D activities of an institute. Likewise, access to high-quality scholarly content to universities in India through UGC-INFONET Digital Library Consortium proved to be a boon to the research output of universities. It is evident that research productivity of universities benefiting from access to e-resources through the Consortium initiatives has increased significantly. The research output data from three citation indices, *SCI*, *SSCI* and *A&HCI*, for the first 50 phase I universities revealed that research articles produced by these universities have increased by more than 75% in past five years, i.e. from 2005 to 2009 in comparison to the previous block of five years. Moreover, a strong and positive correlation is found between the number of articles downloaded by these 50 universities from e-resources accessible to them through the Consortium and research articles published by them. Multiple correlation and regression analysis of data on six select universities has been used to estimate the influence of factors like the number of researchers, including faculty and research students, and level of research funding, on the number of publications from the universities. Citation data for 164,851 source articles published by these 50 universities reveal that the average number of citations per article is 6.16, which reflects the quality of the articles. The study can be further extended to other research productivity indicators such as Ph D theses produced and research grants received by all 50 universities that are benefitting from access to e-resources.

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