Impact of SERC's funding on research

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The Science and Engineering Research Council (SERC), an organ of the Department of Science and Technology (DST), Government of India, promotes research in new and emerging areas of science and engineering by way of extending financial support to different agencies. During the financial year 1999–2000, SERC provided financial support amounting to approximately Rs 551 million to 270 project investigators in various disciplines of science and engineering. The present article examines the publication output of these investigators using *SCI* CD-ROM for the years 2000–02 and the citations received by these papers during 2000–03. Activity and attractivity profile of different agencies in different disciplines and their impact based on different impact indicators like citation per paper and relative quality index have been studied. The article also examines the communication behaviour of these investigators.

Keywords: Funding, impact, research, science and engineering.

OVER 80% of the financial support to scientific research in India comes from different government agencies and departments. Major agencies/departments funding scientific research in India are the Department of Science and Technology (DST), Council of Scientific and Industrial Research (CSIR), Department of Biotechnology (DBT), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), All India Council of Technical Education (AICTE), and University Grants Commission (UGC).

DST has been promoting research in new and emerging areas of science and engineering through the Science and Engineering Research Council (SERC) since 1975. The Council consists of eminent scientists and technologists from universities, industry and national laboratories. The objectives of the Council are:

- To promote research in newly emerging and frontline areas of science and engineering, including multidisciplinary fields.
- To promote selectively general research capability in relevant areas of science and engineering taking into account existing research capabilities of host institutions.
- To encourage young scientists to take up challenging research and developmental activities.

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These objectives are achieved by selectively supporting research projects of individual scientists, setting up units around outstanding scientists, organizing SERC Summer/Winter Schools and establishing sophisticated instrument facilities.

During April 1999–March 2000, SERC provided financial support to 270 project investigators in different disciplines of science and engineering working under the umbrella of various scientific agencies in the country. The total amount incurred by SERC on these projects was approximately Rs 538 million. In addition, SERC also funded 28 Summer/Winter Schools at different institutions, incurring a cost of about Rs 13 million. Thus, the total amount spent by SERC in the year 1999–2000 was Rs 551 million.

Objectives of the study

The present article investigates the publication output of the above funded projects during 2000–02 (three years) and examines the citations these papers received during 2000–03. Specific objectives of the study are as follows:

- To examine the activity and attractivity profiles of different agencies in different disciplines, namely chemical, physical, medical, biological, engineering and material sciences.
- To examine the distribution of output and its impact for different agencies using different citation impact indicators, as has been described in the succeeding paragraphs.
- To examine the pattern of funding and output in terms of papers produced and citations received per million rupees.
- To examine the distribution of output in different disciplines and to study their citation impact.
- To identify the most prolific institutions and study their impact.
- To identify the most prolific project investigators and study their communication behaviour as reflected by the pattern of publication of the papers in journals originating from different countries.

Methodology

SERC did not provide the list of the publications output of the funded projects. However, it provided names of the project investigators and their affiliations to which the funding was made. Using this information, papers published by these project investigators during 2000–02 were identified from the CD-ROM version of the *Science Citation Index* (*SCI*). However, mega-authored papers published by these project investigators, in international collaboration with a large number of countries, have been excluded from the study as their presence in the data confounded the results of the study. Citations for each published paper were also examined using the CD-ROM version of the *SCI* for the period 2000–03. Value additions in the data were made by adding the name of the publishing country of the journal, discipline of the journal as indicated in the *SCI* and impact factor of different journals.

It would be pertinent to mention here that the papers identified using the above methodology may necessarily not be the exclusive output of SERC-funded projects only, because a project investigator might be working on some research problem on his own or getting funds from other agencies as well. However, it would have been better to use the actual publication output resulting from these funded projects as has been done in one of the earlier studies on SERC-funded projects by Jain *et al.*[1] and AICTE-funded projects by Garg *et al.*[2].

Indicators of impact

The following indicators of impact suggested by Nagpaul[3] and used by Garg and Padhi[4] have been used for inter-field and inter-agency comparisons of quality.

Citation per paper

Based on the publication output and number of citations received by these papers, Citation Per Paper (CPP) for different disciplines, agencies or institutions has been calculated. CPP has been calculated using the following formula:

Total number of citations for an agency, institution or discipline/total number of papers for an agency, institution or discipline.

Number of high quality papers

CPP for different disciplines was calculated as the pattern of citation varies from discipline to discipline. Papers that received more than twice the CPP in different disciplines have been considered as high-quality papers.

Relative quality index

Relative quality index (RQI) is the ratio of the proportion of high quality papers (NHQ%) to the proportion of the publications (TNP%), where NHQ% = (number of high quality papers for an institution, discipline agency/total number of high quality papers) × 100 and TNP% = (total publications output of an agency, discipline, or an institution/total publication output for all agencies, disciplines or institutions) × 100.

The measure relates to the incidence of high quality papers in a field or by an institution or agency. RQI > 1 indicates higher than average value, whereas RQI < 1 indicates lower than average quality.

Besides the above indicators, impact of funding has also been examined in terms of papers produced and citations received per million of rupees.

Results and discussion

The present assessment of SERC-funded projects is based on the basic assumption that the count of publications in peer-reviewed scientific journals and their citations in the international literature are an accepted measure of scientific performance and can serve as a basic S&T indicator. Presented below are the results of the publications output and impact of the research output.

Activity profile of different agencies

We examined the activity profile of different agencies that were funded using the Activity Index (AI). AI was first proposed by Frame[5] and has been elaborated by Schubert and Braun[6]. It characterizes the relative research effort an agency devotes to a given subject field.

Mathematically,

$$\mathrm{AI} = \{(N_{ij}/N_{io})/(N_{oj}/N_{oo})\} \times 100,$$

where N_{ij} is the total number of publications of an agency i in discipline j; N_{io} the total number of publications of an agency i in all disciplines; N_{oj} the total number of publications of all agencies in discipline j; and N_{oo} the total output of all agencies in all disciplines.

AI = 100 indicates that the research effort of an agency in a given discipline corresponds precisely to the average of different agencies; AI > 100 reflects higher than average activity and AI < 100, lower than average effort dedicated to the disciplines. The major advantage of using AI over absolute count of publications is that it takes into account both the size of the agency as well as the size of the discipline.

The absolute number of publications and the values of AI for different agencies in different disciplines are given in Table 1. From the values of AI given in Table 1, it is observed that its distribution is highly skewed. Certain agencies concentrate their research effort only in one discipline, like the Department of Atomic Energy (DAE), while other agencies like academic institutions (ACADI), engineering colleges, ENGC, CSIR, and DST distribute their research efforts in more than one discipline.

Table 1. Publication output (activity index) of different agencies in different disciplines

Agency	Physical science	Chemical science	Biological science	Materials science	Engineering science	Medical science	Others	Total
ACADI	239 (105)	208 (126)	150 (122)	66 (96)	16 (28)	26 (46)	38 (86)	743
CSIR	18 (23)	63 (113)	50 (121)	38 (164)	40 (208)	22 (116)	19 (128)	250
ENGC	66 (88)	66 (122)	10 (25)	29 (128)	58 (309)	0 (0)	15 (104)	244
DAE	101 (302)	0 (0)	3 (17)	0 (0)	0 (0)	0 (0)	5 (77)	109
MEDC	0 (0)	3 (16)	17 (122)	0 (0)	0 (0)	62 (975)	2 (40)	84
DST	34 (148)	1 (6)	20 (161)	9 (130)	4 (69)	5 (88)	2 (45)	75
Others	13 (151)	0 (0)	4 (86)	0 (0)	0 (0)	1 (47)	10 (602)	28
Total	471	341	254	142	118	116	91	1533

ACADI, Universities and colleges including Indian Institute of Science, Bangalore; ENGC, Engineering colleges, including Indian Institutes of Technology; CSIR, Council of Scientific and Industrial Research; DST, Department of Science and Technology; DAE, Department of Atomic Energy; MEDC, Medical colleges. Others, State Government-funded institutions and Indian Council of Agricultural Research and other institutions.

Table 2. Citations (attractivity index) of different agencies in different disciplines

Agency	Physical science	Chemical science	Biological science	Materials science	Engineering science	Medical science	Others	Total
ACADI	625 (87)	724 (109)	508 (136)	127 (97)	26 (30)	47 (58)	90 (96)	2147
CSIR	35 (19)	262 (158)	93 (100)	58 (177)	49 (227)	13 (64)	28 (119)	538
ENGC	156 (73)	294 (151)	23 (21)	49 (127)	90 (354)	0 (0)	21 (76)	633
DAE	460 (273)	0 (0)	6 (7)	0 (0)	0 (0)	0 (0)	36 (165)	502
MEDC	0 (0)	7 (18)	32 (144)	0 (0)	0 (0)	89 (1839)	0 (0)	128
DST	118 (173)	1 (2)	50 (142)	20 (162)	3 (37)	8 (104)	3 (34)	203
Others	9 (99)	0 (0)	13 (277)	0 (0)	0 (0)	1 (98)	4 (340)	27
Total	1403	1288	725	254	168	158	182	4178

Further analysis of the data indicates that the main emphasis of research effort by the DAE is in physical science, while CSIR emphasized on engineering science followed by materials science. As expected, engineering colleges, including Indian Institutes of Technology emphasized on engineering science, while medical colleges concentrated in medical science. Research effort of DST is mainly spread among physical science and biological science.

Attractivity profile of different agencies

Attractivity profile of different agencies has been examined using Attractivity Index (AAI). Like the absolute publication output, the absolute impact is also confounded by the size of the agency and size of the field. Hence, AAI also suggested by Schubert and Braun[6], has been used. It characterizes the relative impact, the publications of an agency make in a given discipline, as reflected by the citations they attract.

Mathematically,

$$\mathrm{AAI} = [(C_{ij}/C_{io})/(C_{oj}/C_{oo})] \times 100,$$

where C_{ij} is the number of citations of an agency i in discipline j, C_{io} the number of citations of an agency i in all disciplines, C_{oj} the number of citations of all agencies in the discipline j and C_{oo} the number of citations of all agencies in all the disciplines.

AAI = 100 indicates that an agency's citation impact in a given field corresponds precisely to the average impact of different agencies; AAI > 100 reflects higher than average impact, and AAI < 100 lower than average impact. The values of total citations and AAI for different agencies and different disciplines are given in Table 2. It can be observed from Table 2 that AAI is also skewed like AI.

Based on the values of AI (Table 1) and AAI (Table 2) data can be classified into the following four categories.

(1) AI < 100 and AAI < 100, which implies that agencies under this category have less than average research effort and also earn less than average impact.

(2) AI < 100 and AAI > 100, which implies that agencies under this category have less than average research effort but earn more than average impact.

(3) AI > 100 and AAI > 100, which implies that agencies under this category have more than average research effort and also earn more than average impact.

(4) AI > 100 and AAI < 100, which implies that agencies under this category have more than average research effort but earn less than average impact.

Based on the above, different agencies in different disciplines have been classified into four categories (Table 3).

Table 3. Classification of different agencies based on AI and AAI values

Discipline	AI < 100 and AAI < 100	AI < 100 and AAI > 100	AI > 100 and AAI > 100	AI > 100 and AAI < 100
Physical science	CSIR, ENGC, MEDC	–	DAE, DST	ACADI
Chemical science	DAE, MEDC, DST	–	ACADI, CSIR, ENGC	–
Biological science	ENGC, DAE	–	ACADI, MEDC, DST	–
Materials science	ACADI, DAE, MEDC	–	CSIR, ENGC, DST	–
Engineering science	ACADI, DAE, MEDC, DST	–	CSIR, ENGC	–
Medical science	ACADI, ENGC, DAE	DST	MEDC	CSIR

Table 4. Distribution of citations

Number of citations	Number of papers	Total citations	Number of citations	Number of papers	Total citations
0	527	0	5	66	330
1	304	304	>5 – ≤ 10	174	1300
2	174	348	>10 – ≤ 20	63	886
3	136	408	>20	10	286
4	79	316	Total	1533	4178

Table 5. Impact indicators for different agencies

Agency	TNP	TNC	CPP	NHQ	RQI
ACADI	743	2147	2.9	101	1.1
CSIR	250	538	2.2	22	0.7
ENGC	244	633	2.6	25	0.8
DAE	109	502	4.6	27	2.0
MEDC	84	128	1.5	9	0.8
DST	75	203	2.7	10	1.0
Others	28	27	1.0	1	0.3
Total	1533	4178	2.7	195	–

TNC, Total number of citations.

Impact indicators for different agencies

Impact of the papers has been examined using citations received by the papers published. It is observed that 1533 papers got 4178 citations during 2000–03. The average rate of citation was 2.7. Further analysis of the data indicates that among the 1533 published papers, 527 (~34%) did not get any citation and the rest 66% got one or more citations. Among the 527 non-cited papers, 115 were published in 2000, 153 in 2001 and the rest 259 in 2002. This indicates that a major portion (49%) of the non-cited papers was published in 2002. It is possible that these papers may get citations in due course of time. The results of the citation analysis are given in Table 4. Among the cited papers, 49% was cited 1 to 5 times and the rest 16% cited more than 5 times.

Table 5 provides information about different impact indicators such as CPP, NHQ and RQI for different agencies. The average value of CPP was 2.7. Values of CPP for ACADI, ENGC and DST were close to average, while for DAE the value of CPP was almost twice the average value. The standing of different agencies judged from the values of RQI indicates that ACADI and DST have average incidence of high quality papers, as the value of RQI was equal to 1 and for rest of the agencies the incidence of high quality papers is less than average. For DAE, the value of RQI was equal to two. Relatively higher values of CPP and RQI in respect of DAE imply that it has outperformed other agencies. One of the possible reasons for this may be that DAE works in frontline basic research in the area of physical science and has published a large number of papers in journals originating from USA, which usually have high impact factor compared to journals published from other countries. This is also reflected by the values of AI and AAI provided in Tables 2 and 3.

Pattern of funding, output and citation impact

Distribution of funding according to different agencies (Table 6) indicates that maximum funding was provided to universities and colleges (~45%) followed by engineering colleges including Indian Institutes of Technology (IITs) (~13%), which got the maximum funding among the engineering colleges. Funding per project was highest for Department of Atomic Energy (DAE) followed by Department of Science and Technology (DST), and lowest for Indian Council of Agricultural Research (ICAR).

Analysis of the data indicates that on an average 3 papers are produced per million rupees. Among all the agencies the productivity of medical colleges (MEDC) is highest at about 7 papers per million rupees followed by Council of Scientific and Industrial Research (CSIR), engineering colleges including IITs (ENGC) and universities and colleges (ACADI). For other agencies listed in Table 6, the productivity per million rupees is less than average.

Examination of the citation pattern indicates that average citation per million rupees is about 8. Like the pro-

Table 6. Distribution of funding according to agencies

Agency	Project	Amount* (%)**	Funding/project*	Papers	Papers/million	Citations	Citations/million
ACADI	140	241.57 (45)	1.73	743	3.1	2147	8.9
ENGC	42	71.12 (13)	1.69	244	3.4	633	8.9
CSIR	45	65.29 (12)	1.45	250	3.8	538	8.2
DST	9	63.99 (12)	7.11	75	1.2	203	3.2
DAE	6	53.73 (10)	8.95	109	2.0	502	9.3
MEDC	8	11.69 (2)	1.46	84	7.2	128	10.9
Others	20	30.66 (6)	1.53	28	0.9	27	0.9
Total	270	538.05 (100)	2.00	1533	2.8	4178	7.7
WSS	28	12.96	–	–	–	–	–
Grand total	298	551.01					

WSS, Winter–Summer schools; *Rupees in million; **Rounded-off to the nearest whole number.

Table 7. Impact indicators for different disciplines

Discipline	TNP	TNC	CPP	NHQ	RQI
Physical science	471	1403	3.0	64	1.1
Chemical science	341	1288	3.8	45	1.0
Biological science	254	725	2.8	34	1.0
Materials science	142	254	1.8	17	0.9
Engineering science	118	168	1.4	10	0.7
Medical science	116	158	1.4	16	1.1
Others	91	182	2.0	9	0.8
Total	1533	4178	2.7	195	–

ductivity of papers per million rupees, the citations per million rupees also follow almost similar pattern except for DAE, where the number of papers published per million rupees is less than average, but their citations are well above average. The reason for this has already been explained earlier.

Distribution of output according to discipline and their impact

Analysis of data indicated that the 270 SERC-funded projects resulted in 1533 publications during 2000–02. Among these, maximum number (31%) of publications was in physical science followed by chemical science. The output in these two disciplines constituted about 53% of the total output. Biological science and medical science together constituted about 24% of the total output. Rest 23% output was scattered in other disciplines, of which materials science constituted about 9%. This implies that the maximum funding by SERC goes to institutions engaged in research in the area of physical science.

Analysis of data for different impact indicators (Table 7) indicates that the value of CPP is highest for chemical science (3.8), followed by physical science (3.0). For biological science, CPP is close to the average and for all remaining disciplines it is less than the average. RQI for physical science and medical science was slightly higher than 1, which indicates that these disciplines have more than average incidence of high quality papers. For engineering science, the value of RQI < 1, which implies that the incidence of high quality papers was less than the average.

Prolific institutions and their impact

Funding was provided to 103 institutions under different scientific agencies, including universities, Indian Institutes of Technology and Indian Institute of Science. Among these, 15 institutions did not publish any papers. Institutions that have contributed ~2% or more of the total output have been considered as prolific. Based on this parameter, it was observed that 16 institutes contributed 30 or more papers each over a period of three years. These institutions contributed 62% of the total output of the SERC-funded projects and received 73% of the total citations. This indicates that the research output as well as citation impact of SERC-funded projects was highly skewed and concentrated among few institutions. Table 8 lists these 16 institutions with their total number of publications, total citations, CPP and RQI. Analysis of the data for various impact indicators indicates that CPP was more than average for 11 institutions and less than average for 5 institutions. Institutions for which the value of CPP was less than average are: All India Institute of Medical Sciences, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Anna University, Central Food Technological Research Institute (CFTRI), and Indian Institute of Technology (IIT), New Delhi. Highest value of CPP was found in the case of Tata Institute of Fundamental Research (TIFR), followed by Indian Institute of Science and Panjab University. The reason for the high value of CPP for TIFR has already been explained earlier. The standing of different institutions on the basis of incidence of high quality papers judged from the values of RQI indicates that all institutions, except Jadavpur University, Indian Institute of Chemical Technology, Anna University, CFTRI and IIT, Delhi have higher than average incidence of high quality papers as the value of RQI > 1.

Table 8. Impact indicators for prolific institutions

Institution	TNP	TNC	CPP	NHQ	RQI
Indian Institute of Science, Bangalore	179	722	4.0	36	1.45
Tata Institute of Fundamental Research, Mumbai	106	490	4.6	26	1.86
Indian Institute of Technology, Kanpur	77	291	3.8	11	1.15
Delhi University, Delhi	71	206	2.9	10	1.10
Indian Institute of Technology, Mumbai	69	211	3.1	9	1.37
Panjab University, Chandigarh	53	211	4.0	10	1.35
Jadavpur University, Kolkata	50	181	3.6	8	0.94
National Chemical Laboratory, Pune	48	155	3.2	8	1.11
All India Institute of Medical Sciences, New Delhi	47	78	1.7	5	1.26
Indian Institute of Chemical Technology, Hyderabad	45	113	2.5	2	0.53
Alagappa University, Karaikudi	37	109	2.9	6	1.44
Sanjay Gandhi PGIMS*, Lucknow	37	50	1.4	4	1.12
Anna University, Chennai	34	38	1.1	2	0.52
Burdwan University, Bardhman	34	120	3.5	5	1.39
Central Food Technological Research Institute, Mysore	32	62	1.9	3	0.75
Indian Institute of Technology, New Delhi	30	23	0.8	0	0.00
Total	949	3060	2.8	145	–
Others	584	1118	1.9	50	0.63
Grand total	1533	4178	2.7	195	–

*Post Graduate Institute of Medical Sciences.
TNP, Total number of papers; TNC, Total number of citations; CPP, Citation per paper; NHQ, Number of high quality papers; RQI, Relative quality index.

Table 9. Frequency distribution of output according to project investigators

Number of papers	Number of project investigators	Number of papers	Number of project investigators
0	67	7	12
1	37	8	6
2	32	9	7
3	15	10	2
4	22	11–15	20
5	12	16–20	12
6	12	>20	14

Output of project investigators and their pattern of communication

Frequency distribution of the publications output for the 270 project investigators given in Table 9 indicates that 67 project investigators did not publish any paper during 2000–02 and 14 published more than 20 papers, constituting about 31% of the total output; of this 97 (50%) were high quality papers. These papers received 1712 citations, constituting about 41% of total citations. Appendix 1 provides the list of prolific project investigators contributing more than 20 papers along with their number of high quality papers and citations these papers received. Appendix 2 provides the list of highly cited papers that received 20 or more citations.

The pattern of communication of published output of SERC-funded projects has been examined by analysing the distribution of output according to the publishing country of the journals used for publication by the project investigators. Analysis of the 1533 papers published by SERC-funded project investigators indicates that these papers were scattered in more than 600 journal titles published from 24 different countries, including India. The distribution of scientific output according to publishing country of the journals indicates that the share of publications appearing in journals published from abroad was about 92% and the rest 8% appeared in Indian journals. The number of papers published in Indian journals was less because the number of journals indexed by *SCI* in its database was low compared to journals published abroad. Among the journals published from abroad, the proportion of papers that appeared in journals from USA was 37%, and the share of papers in journals published from the UK was 25%. Thus, 62% of the total papers resulting from SERC-funded projects have appeared in journals published from these two most scientifically advanced countries. Further, in the disciplines of biological science and physical science, journals published from USA were preferred, while in case of medical science, engineering science and chemical science, journals published from UK were preferred (Table 10). This indicates that the papers published by SERC-funded project investigators were

Table 10. Distribution of output according to publishing country of the journals

Discipline	USA	UK	NLD	India	SWIT	Germany	Others
Physical science	216	63	132	16	–	14	30
Chemical science	86	123	34	52	10	24	12
Biological science	130	55	32	12	1	16	8
Materials science	26	34	36	–	42	4	–
Engineering science	33	50	14	–	8	9	4
Medical science	45	44	5	4	12	2	4
Others	23	11	6	37	1	1	12
Total	559	380	259	121	74	70	70
%	36.5	24.8	16.9	7.8	4.8	4.6	4.6

NLD, The Netherlands; SWIT, Switzerland.

Appendix 1. Most prolific project investigators

Investigator	Institute	Number of papers	Citations
A. Gurtu	Tata Institute of Fundamental Research, Mumbai	61 (19)	307
R. K. Shivpuri	Delhi University, Delhi	43 (10)	192
J. M. Kohli	Panjab University, Chandigarh	43 (10)	109
V. S. Narasimham	Tata Institute of Fundamental Research, Mumbai	37 (6)	141
R. K. Gupta	Sanjay Gandhi Post Graduate Institute of Medical Science, Lucknow	37 (4)	50
A. Gopalan	Algappa University, Karaikudi	37 (6)	109
P. Balaram	Indian Institute of Science, Bangalore	36 (13)	242
C. Sinha	Burdwan University, Bardhman	34 (5)	120
R. Varadarajan	Indian Institute of Science, Bangalore	26 (12)	194
S. Mitra	Jadavpur University, Kolkata	25 (5)	72
G. A. Ravishankar	Central Food Technological Research Institute, Mysore	24 (2)	51
V. Kumaran	Indian Institute of Science, Bangalore	23 (1)	39
B. K. Chaudhuri	Indian Association of Cultivation of Science, Kolkata	22 (4)	61
U. P. Singh	Banaras Hindu University, Varanasi	21 (0)	25
Total		469 (97)	1712

( ) Number of high quality papers.

Appendix 2. Highly cited authors

Project investigator	Journal	Number of citations
P. Jain	*Phys. Lett. B*, 2000	52
U. S. Bhalla	*Science*, 2002	27
S. Umaphathy	*J. Phys. Chem. A*, 2001	26
P. Balaram	*Proc. Natl. Acad. Sci. USA*, 2000	24
R. Varadarajan	*FEBS Lett.*, 2000	23
S. Mitra	*J. Chem. Soc. Dalton Trans.*, 2000	23
D. J. Choudhury	*Phys. Lett. B*, 2001	21
D. J. Choudhury	*Phys. Lett. B*, 2002	21
R. Murugavel	*Inorg. Chem.*, 2000	20
A. Gurtu	*Eur. Phys. J. C*, 2000	20

well connected to the mainstream science, because papers that appear in international journals are better connected to the mainstream science than those in domestic journals, as these have limited circulation and readership compared to international journals. Appendix 3 lists journals most commonly used by SERC project investigators and Appendix 4 provides list of journals with impact factor >5.

Findings

- Maximum funding has been provided to universities and colleges (~45%) followed by engineering colleges (13%). Among engineering colleges, IITs got the maximum funding. Funding per project was highest for DAE and lowest for ICAR. On an average 3 papers were produced per million rupees and average citation per million rupees was about 8.
- Maximum output was in physical science followed by chemical science, both constituting about 53% of the total output. Biological science and medical science together constitute about 26% of the total output.
- About 92% of the papers appeared in journals published from abroad. Among these, about 62% appeared in journals published from USA and the UK.
- Maximum number of papers were from academic institutions (universities and colleges) followed by the output from CSIR.
- Among the 1533 papers, published 34% did not get any citation and the rest 66% got one or more citations.

Appendix 3. Most commonly used journals

Journal	Papers	Country	Impact factor
Physics Letters B	78	The Netherlands	4.298
Physical Review Letters	62	USA	7.323
Physical Review D	53	USA	4.358
Current Science	37	India	0.533
Indian Journal of Chemistry A	34	India	0.504
Tetrahedron Letters	23	UK	2.357
Chemical Communication	23	UK	4.038
Polyhedron	22	UK	1.414
Inorganic Chemistry	20	UK	2.950
Journal of Biological Chemistry	20	USA	7.368
Proceedings of the Indian Academy of Sciences: Chemical Sciences	16	India	0.420
Chemical Engineering Science	15	UK	1.224
Transition Metal Chemistry	15	The Netherlands	0.949
Materials Chemistry and Physics	14	Switzerland	0.778
Physical Review E	14	USA	2.397
Pramana: Journal of Physics	14	India	0.324
Physical Review C	13	USA	2.848
Biochemical Biophysical Research Communication	12	USA	2.935
Journal of Crystal Growth	11	The Netherlands	1.529

Appendix 4. Journals with impact factor more than 5

Journal	Country	Impact factor
Science	USA	26.682
Chemical Reviews	UK	21.044
Accounts of Chemical Research	USA	12.781
EMBO Journal	USA	12.459
Proceedings of the National Academy of Sciences of the United States of America	USA	10.896
Cancer Research	USA	8.460
Bio-essays	USA	7.888
Molecular and Cellular Biochemistry	The Netherlands	7.700
Angewandte Chemie International Edition	Germany	7.671
Journal of Biological Chemistry	USA	7.368
Physical Review Letters	USA	7.323
FASEB Journal	USA	7.252
Nucleic Acids Research	UK	7.051
Journal of High Energy Physics	Italy	6.854
Oncogene	UK	6.737
Journal of the American College of Cardiology	USA	6.374
Journal of the American Society of Nephrology	USA	6.337
European Physical Journal, Part C	USA	6.162
Journal of the American Chemical Society	USA	6.079
Chemical Biology	UK	5.987
Mutation Research	The Netherlands	5.783
Neuro-image	USA	5.624
Developmental Biology	USA	5.558
Nuclear Physics, Part B	The Netherlands	5.409
Journal of Molecular Biology	UK	5.359
Abstract Papers of the American Chemical Society	USA	5.220
Cancer Epidemiology Biomarkers and Prevention	USA	5.140

- Sixteen institutions contributed 62% of the total output of the SERC-funded projects and received 73% of the total citations.
- Fourteen project investigators published more than 20 papers, constituting about 31% of the total output.
- Activity and attractivity profiles of different agencies were highly skewed as some agencies concentrated only in one discipline while others concentrated in more than one discipline.

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ACKNOWLEDGEMENTS. We thank the Department of Science and Technology, New Delhi for providing financial support to carry out the study. We also thank the two anonymous referees whose comments have helped improve the manuscript.

Received 27 November 2006; revised accepted 24 July 2007