

since that time, see <http://www.nuclear-planet.com/corruption.pdf>.

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It is sad that Balaram has stepped down as the Editor of *Current Science*. Of

course, one cannot go on for ever. We will miss his incisive and instructive editorial very much. Personally, I learnt a lot reading them. A couple of my colleagues and I used to appreciate the column both for its scientific content and the style of the language, a rare combination indeed. And, he was forthright in expressing his opinion – I remember one such instance where he quoted Robert Southey's poem *After Blenheim* to

support his view. The journal escalated in its popularity during his tenure and it owes a lot to him.

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## Papers from India and China in *Nature*: the role of international scientific collaboration

Mahesh<sup>1</sup> studied how contributions from India and China to *Nature* have changed over the years. *Nature*, with its high impact factor and multidisciplinary orientation occupies an iconic position. Mahesh traced the contributions from India and China in this journal using the *Science Citation Index-Expanded* for the period 1945 till date. On a zeroth-order basis<sup>2</sup>, counting only the number of publications ( $P$ ), India and China have had 572 and 588 papers each. But on a first-order basis, when citations ( $C$ ) are used as a proxy for scientific performance, China is far ahead of India (75,688 versus 23,404). Thus if impact ( $i = C/P$ ) is used as a proxy for quality of scientific output, China's impact is 128.72 citations/paper while that of India is only 40.92 citations/paper. Further, Mahesh<sup>1</sup> shows that the number of papers India has published in *Nature* has actually fallen in recent years even while its total scientific output has increased across the board.

One aspect that does not easily reveal itself is the role that international collaboration plays. Papers from India and China that appear in *Nature* have significantly larger than usual international collaboration and consequently significant increases in impact. In this paper, we critically examine this issue. The extent to which co-publication through international collaboration enhances the value of scientific output of the two countries is calibrated using an index of foreign collaboration<sup>3</sup>. This can easily be done using a second-order analysis<sup>2</sup>. The second-order indicator<sup>2</sup> is  $X = C^2/P$ . As we shall see below, the truly indigenous papers from China and India contribute

only a small fraction of the total impact compared to papers with international collaboration.

Bibliometric data were accessed from the *Web of Science* (a Thomson Reuters product) on 14 June 2012. A publication window of five years (1996–2000) is taken and all the papers ( $P$ ) published in *Nature* where there is at least one author from India or China respectively, are counted. Then the total citations ( $C$ ) obtained by the papers in this journal during a citation window (chosen as the single year 2001) is found. The impact  $i = C/P$  will serve as a proxy for the quality of the output of each publication set. The performance of each country is then tracked using the  $(i, C, X)$  parameter space over a rolling window of five years (publication years 1996–2000 to 2006–2010, implying citation windows which are rolled from 2001 to 2011). Note that  $P$ ,  $C$  and  $X$  are the zeroth, first and second-order indicators of scientific performance. By rolling the windows thus it is possible to see how the performance of the two countries has evolved over this time-period. We now discriminate the papers into two categories, those where all the authors are from indigenous institutions (in this case Indian or Chinese) and those with foreign collaboration (where at least one author has an affiliation which is outside India or China respectively). Following Basu and Aggarwal<sup>4</sup>, any paper with at least one author with an address from India (or China) is taken as the total output  $P$  from India (or China) for that year. If a paper contains no address originating outside India (or China), then it is regarded as indigenous production  $P_1$ . The difference

is then taken as the foreign collaborative (international) output of the institution  $P_F$ . Whole counting is used throughout, i.e. full credit has been given to each institution regardless of the order or number of author names or relative positions of addresses.

The disaggregation into indigenous (Indian or Chinese) and international (foreign) is carried out thus:

$$P = P_1 + P_F,$$

$$C = C_1 + C_F,$$

$$i = C/P,$$

$$i_1 = C_1/P_1,$$

$$i_F = C_F/P_F,$$

From this we have

$$X = iC,$$

$$X_1 = i_1C_1,$$

$$X_F = i_FC_F,$$

and

$$E = X_1 + X_F$$

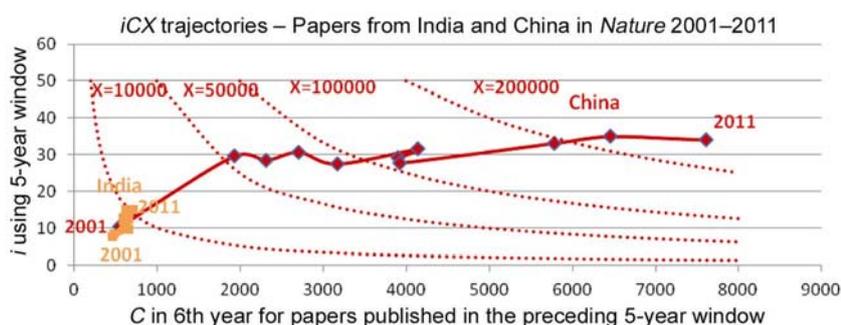
The interesting case where  $i = i_1 = i_F$  is one of perfect equality of collaboration. In such a case,  $E = X_1 + X_F = X$ . Where collaboration is between unequal partners, which is almost universally the case,  $E > X$ . This offers the following possible metric:

$$\text{IoFC} = X_F/E = X_F/(X_1 + X_F),$$

## CORRESPONDENCE

**Table 1.** Indices describing impact of foreign collaboration on papers from China and India in *Nature*

Window	Five-year publications window Sixth year citations window	2002–06 2007	2003–07 2008	2004–08 2009	2005–09 2010	2006–10 2011
<b>China</b>						
Total	Papers in 5-year window	134	141	174	184	223
	Citations in 6th year	3,902	3,925	5,778	6,451	7,606
With foreign collaboration	Papers in 5-year window	112	118	145	139	169
	Citations in 6th year	3,437	3,524	5,004	5,676	6,966
Without foreign collaboration	Papers in 5-year window	22	23	29	45	54
	Citations in 6th year	465	401	774	775	640
Second-order indicators	$X - I$	9,828.41	6,991.35	20,657.79	13,347.22	7,585.19
	$X - F$	105,472.94	105,242.17	172,689.77	231,776.81	287,131.10
	$X$	113,623.91	109,259.75	191,869.45	226,170.66	259,422.58
	$E$	115,301.35	112,233.52	193,347.56	245,124.03	294,716.29
Indices of foreign collaboration	IoFC: Index of foreign collaboration	0.915	0.938	0.893	0.946	0.974
<b>India</b>						
Total	Papers in 5-year window	50	47	47	47	42
	Citations in 6th year	600	599	664	710	630
With foreign collaboration	Papers in 5-year window	22	22	23	26	25
	Citations in 6th year	569	586	638	701	608
Without foreign collaboration	Papers in 5-year window	28	25	24	21	17
	Citations in 6th year	31	13	26	9	22
Second-order indicators	$X - I$	34.32	6.76	28.17	3.86	28.47
	$X - F$	14,716.41	15,608.91	17,697.57	18,900.04	14,786.56
	$X$	7,200.00	7,634.06	9,380.77	10,725.53	9,450.00
	$E$	14,750.73	15,615.67	17,725.73	18,903.90	14,815.03
Indices of foreign collaboration	IOFC	0.998	1.000	0.998	1.000	0.998



**Figure 1.** Comparison of impact of papers in *Nature* from India and China as *iCX* trajectories.

where IoFC is the index of foreign collaboration. Thus in the case of perfect equality of collaboration

$$\text{IoFC} = P_F / (P_I + P_F).$$

Figure 1 re-examines the analysis of Mahesh<sup>1</sup> by comparing the impact of papers in *Nature* from India and China as *iCX* trajectories. Even as recently as 2001, China and India were nearly at the same point, but over the last decade, China has sprinted far ahead in terms of quantity and quality. We next establish how much of the impact is due to co-

publication with foreign collaborators and how well the purely indigenous papers compare with the collaborative papers. We use the methodology proposed above to track the performance of China and India as the publication windows are rolled from 1996–2000 to 2006–2010, and citation windows are rolled from 2001 to 2011. From Table 1 we see that for papers in *Nature* from China, the degree of collaboration in exergy terms (IoFC) ranges from 89% to 97% whereas for India it is practically 100%.

Publication in iconic journals such as *Nature* is considered to be the pinnacle

of scientific achievement, especially in the newly emerging scientific powers like India and China<sup>1</sup>. While in recent years, China has grown as a scientific power far more rapidly than India has, the critical examination of the role of scientific collaboration in co-publication in top journals such as *Nature* reveals that China and India have excessively large indices of foreign collaboration. Indeed for India, it is so close to 100% that one conclusion that can be drawn is that publication of work of purely indigenous provenance from India in *Nature* rarely merits its true value and recognition.

1. Mahesh, G., *Curr. Sci.*, 2012, **102**, 127.
2. Prathap, G., *Curr. Sci.*, 2010, **98**, 995–996.
3. Prathap, G., *Scientometrics*, 2012, **95**, 563–570.
4. Basu, A. and Aggarwal, R., *Scientometrics*, 2001, **52**, 379–394.

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