

# THE KEY ROLE OF COLLABORATIVE WORK IN THE GROWTH OF BRAZILIAN SCIENCE IN THE LAST TEN YEARS

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The Brazilian scientific production and its international impact increased considerably in the last 10 years. This increase occurred in spite of a reduction in the resources for science in the same period. The data show that the explanation for this apparent paradox lies in the active process of international and national collaboration which increased in this same period. Collaborative work was supported by several programs of the Brazilian agencies. Advantages and possible drawbacks of the intensification of scientific collaboration for the Brazilian science are discussed.

## Introduction

Brazilian scientific production in the international context has grown in the last few years, as indicated by the Institute of Scientific Information® data base.<sup>1</sup> This has occurred in spite of a tight scientific budget which has shrunk in recent years.<sup>2</sup> A possible reason for the increase in international publications may be the trend for collaborations, which has permeated many areas of investigation. Although no general survey has been made on the growth of collaborations in Brazil, this tendency is notorious and has been supported by specific programs of Brazilian scientific agencies. In part, this seems to follow an international pattern that affected even industry, also interested in embarking on collaborative research.<sup>3</sup> We set out to investigate the influence of collaborative work both on the rate of scientific publications and on its international impact, as measured by citation rate. The outcome of this work indicates an important role of collaborative work both at international and national levels.

### Methods

The results are based on a National Science Citation Report of the Brazilian papers published in the Institute of Scientific Information (ISI)-indexed journals, 1981-1993. A total of 48,335 bibliographic items were assessed. The data base was transferred to a Microsoft Access 2 software<sup>®</sup> for analysis and Table construction. The citation rate for publications of a given year corresponds to the total number of citations of these publications recorded in the ISI-data base in the following two years.

### Results

Brazilian investment in science has suffered a significant decline of 35% from 1986 to 1992.<sup>2</sup> In spite of that, there was an increase of 40% in international publications in ISI-indexed journals (Fig. 1). Moreover, the citation rate, which was roughly equal to the number of publications from 1981 to 1987, increased to 1.43 fold the number of publications in 1991. This is a real increase and not merely a reflection of an overall worldwide growth, since the share of main stream journal articles increased from 0.29% in 1981 to 0.46% in 1993<sup>1</sup> and to 0.65 in 1994.<sup>4</sup>

In searching for a possible explanation for this phenomenon we reasoned that an increase in collaborative research, which became evident in recent years in Brazil, might be considered an important factor. In Figure 2 the Brazilian publications were sorted in non-collaborative (one single affiliation), national collaboration (one or more Brazilian affiliations) and international collaboration (at least one foreign affiliation). It can be seen that the non-collaborative publications remained steady in the 1981-1993 period and that both national and international collaborative publications increased in this same period and were, in fact, responsible for the overall increase in publications. This trend becomes more evident if the increase is depicted as percentages of the 1981 values (Fig. 3). It can be seen that publications arising from international collaborations increased almost 250%, and those from national collaborations increased slightly less than that.

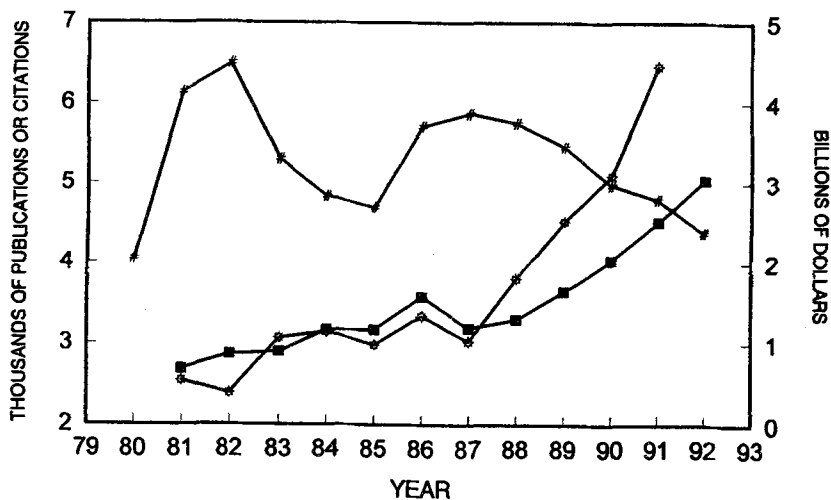


Fig. 1. International publications (■), citation rate (✱) and science resource (#) in Brazil, in the 1980-1993 period

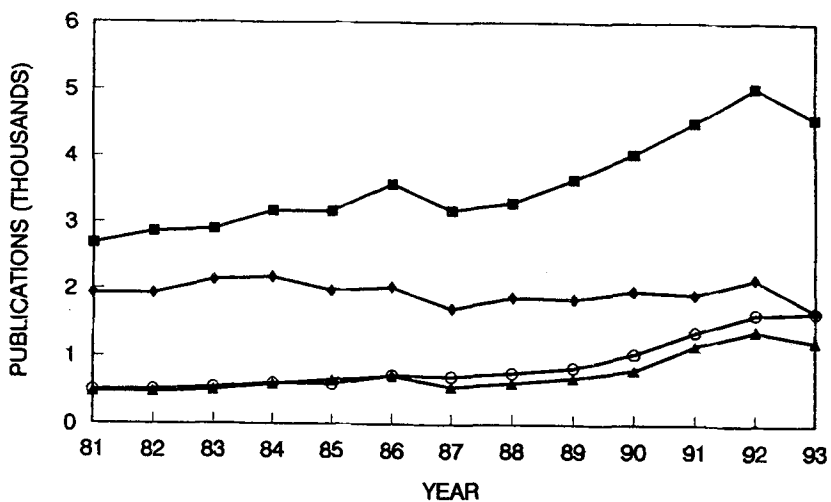


Fig. 2. Collaborative and non-collaborative publications in Brazil. Total (■); non-collaborative publications (◆); international collaborations (○); national collaborations (▲)

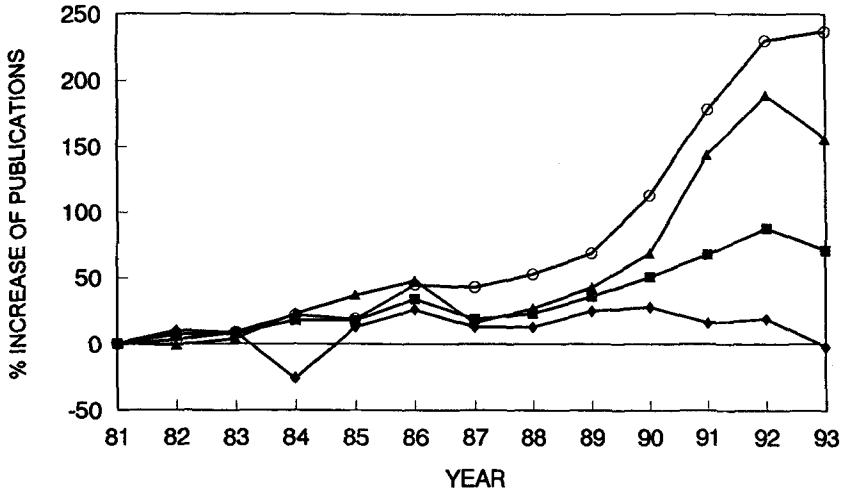


Fig. 3. Percentage of increase of collaborative publications based on 1981 values. Total (■); non-collaborative publications (◆); international collaborations (○); national collaborations (▲)

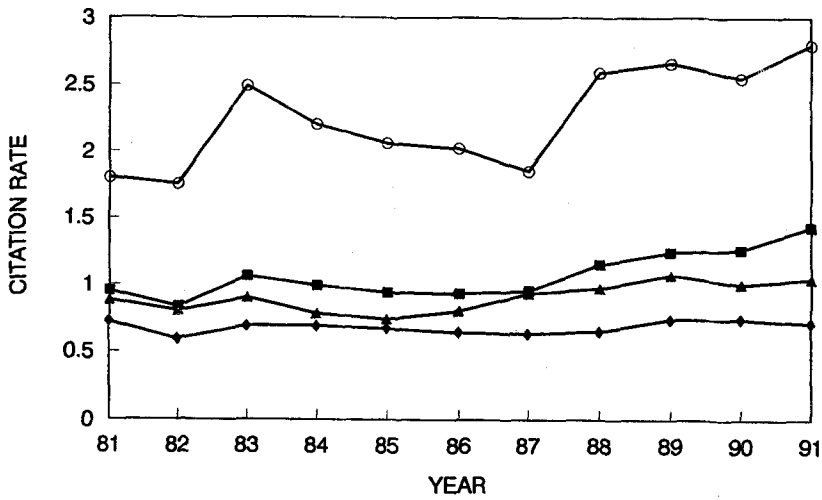


Fig. 4. Citation rates for collaborative and non-collaborative publications. Total (■); non-collaborative publications (◆); international collaborations (○); national collaborations (▲)

The next question is to determine if these collaborations were also responsible for the higher impact attained by Brazilian publications in recent years. Figure 4 shows that in the 1982-1991 period the citation rate for international collaboration papers was on average four times that of non-collaborative papers. An interesting point is that papers in collaboration among Brazilian investigators also attained higher impact (1.6 fold) as compared to the non-collaborative papers. Therefore, it is clear that the increase in collaborative research, added to the higher citation rates that the resulting publications tend to attain, explain the significant growth in impact of the Brazilian publications shown in Fig. 1.

Table 1  
Brazilian publications arising from international collaborations (1981-1993)

Country	Number of publications	Number of citations	Number citat./ Number public.*	Share of col-laboration (%)	Share of ISI-indexed articles**
United States	4075	29259	7.18	37.9	30.82
France	1437	6772	4.71	13.3	5.65
United Kingdom	1177	6749	5.73	10.9	7.92
Germany	953	4622	4.84	8.9	7.18
Canada	708	3798	5.36	6.6	4.30
Italy	616	2471	4.01	5.7	3.39
Argentina	456	1974	4.33	4.2	0.35
Japan	310	1679	5.41	2.9	8.24
Chile	233	973	4.18	2.1	0.18
Switzerland	214	968	4.52	2.0	1.64
Sweden	158	1050	6.64	1.5	1.84
Mexico	148	534	3.61	1.4	0.33
Netherlands	129	935	7.24	1.2	2.28
Venezuela	89	347	3.89	0.8	0.09
Uruguay	32	112	3.50	0.3	0.01

\* The figures in the fourth column correspond to the total of citations and publications in the 1981-1993 period and cannot, therefore, be directly compared with the citation rates of the Fig. 4.

\*\* Ref. 4.

Table 1 shows the countries of origin of the investigators with whom Brazilian scientists most established collaborations. The extent of collaborations follows roughly the pattern of scientific production of these countries, the most notorious exceptions being the Latin American countries Argentina, Chile, Mexico, Venezuela

and Uruguay, which all together comprise ~9% of the collaborations and share only 0.96% of the ISI-indexed articles.<sup>4</sup> In the case of Japan the phenomenon is the opposite, since it shares only 2.9% of the collaborations and is responsible for 8.24% of the ISI-indexed articles.

### Discussion

Brazilian scientists have been on a continuous battle over the years to convince policy makers of the need for more resources for science. However, in spite of the formal recognition by the government of the importance of science and technology for the development of the country, economic crisis and compelling priorities have made it difficult to increase the share of science in the national budget. In fact, in recent years we have witnessed a fall in science investment (Fig. 1). It is remarkable that the Brazilian agencies that provide grants for research, fellowships and salary supplement to scientists have increased pressure for better publication profiles in spite of the adverse circumstances. Specially in hard sciences, publishing in the mainstream international journals has become a determinant factor for career progress.<sup>5</sup>

In keeping with this demands these agencies have created programs of international collaborations: the "sandwich" fellowships program from CAPES\* and CNPq, which allows Brazilian graduate students to perform part of their work in a foreign laboratory; the BID-USP program, which supported visits of Brazilian scientists from the University of São Paulo abroad and visits of foreign scientists to the University; similar visiting programs are supported by CNPq and FAPESP. In addition, CAPES and CNPq spend a large allowance of their budgets to support full graduate studies of Brazilian students abroad. This is more properly defined as a training program than a collaborative research program, although very frequently, on their return, the Brazilian young scientist tend to keep a collaboration with their former advisors.

All these programs, added to the demand for international visibility, have generated the impressive increase in collaborative work shown in Figs 2 and 3, plus

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\* Abbreviations: CAPES, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Quality Improvement of University Professors); CNPq, Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for the Scientific and Technological Development); BID, Banco Interamericano do Desenvolvimento (Interamerican Development Bank); USP, University of São Paulo; FAPESP, Fundação de Amparo a Pesquisa do Estado de São Paulo (São Paulo State Foundation of Support to Research).

the remarkable growth of impact depicted in Fig. 1. It is also noteworthy that local collaboration had a significant effect on citation rate, although to a lesser extent than international collaboration.

The extent of collaboration with Latin American countries is still modest, even more if we consider the proximity of two countries with tradition in science like Argentina and Chile. Table 1 shows that the quality of the work originated from collaborations with these two countries must be high as judged by the citations rates that these publications achieved. It is expected that with more intensive trade and business agreements arising from the MERCOSUL program (a local version of the European market), cultural and scientific interaction among these countries will be facilitated.

One important question that is beginning to be considered is how much will collaboration invalidate the important driving force in science created by competition. The intuitive answer is that groups working in collaboration will be competing against other groups, also working in collaboration.

In this scenario the possibility of Brazilian scientists tasting the search of scientific findings at the frontiers of science is increasing as a function of more international collaboration. Although this is of great importance for the overall progress of Brazilian science and technology, there are two points which deserve further insight and discussion. One is the likelihood of Brazilian partners playing a secondary role in these collaborations. Although enlarging the scientist's publication lists and citation rates, a lack of leadership when operating these collaborations may be detrimental in terms of development of a scientific community. A second point, which has long worried some Latin American sociologists,<sup>6</sup> is that an excessive fixation on the mainstream of international science will leave little room for investigation of problems more related to our contingencies to which foreign scientists would be less attracted.

### References

1. J. LETA, L. DE MEIS, A profile of science in Brazil, 1995 (unpublished).
2. COORD: S.N. BRISOLLA, *Indicadores quantitativos de ciência e tecnologia no Brasil*. Nucleo de Pesquisa em Ciência e Tecnologia/UNICAMP, 1994.
3. P.H. ABELSON, Industrial interactions with universities, *Science*, 252 (1991) 9.
4. W.W. GIBBS, Trends in scientific communication, *Scientific American*, August, (1995) 92-99.
5. R. MENEGHINI, Brazilian production in biochemistry. The question of international versus domestic publication, *Scientometrics*, 23 (1992) 21-30.
6. O. VARSAVSKY, *Ciencia, Política y Cientificismo*, Centro Editor de America Latina, S.A. Buenos Aires, 1969.