

Scientific collaboration

Scientific collaboration of the Mercosur countries as an indicator of Latin American regional activity

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This study investigated the trends in international scientific collaboration of the four Mercosur countries — Argentina, Brazil, Paraguay and Uruguay — both among themselves and with other partners, prior to and after 1991 when the alliance was officially formed. Two databases were used — the mainstream Science Citation Index (SCI) and the regional Periodica. Intra-Mercosur collaboration was better represented in the SCI than in Periodica. SCI data show a general upward trend for intra-Mercosur collaborations from 1980 to 1995, specifically with respect to bilateral co-authorships between Argentina and Brazil. This is particularly notable since 1986 when two important scientific and technological collaboration programmes were established between these two countries. The importance is discussed of interpreting quantitative data in the light of contextual qualitative information on the countries under study.

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COLLABORATION IN SCIENCE is a phenomenon known to be as old as modern science itself (Beaver and Rosen, 1978), and collaborative efforts involving scientists of more than one country have been noted as early as the 19th century (Beaver and Rosen, 1979¹). Although international collaboration has been increasing since then, its recent annual growth rate of 7–8% has no precedent (CNRS, 1993). A number of factors have been pointed out as contributing to the increase in international partnerships in science.²

Particularly noteworthy for its novelty is the fact that international collaboration has been fostered and stimulated by governmental initiatives.³ This is largely because of the importance that science and technology have acquired for economic competitiveness and the globalisation of the economy (Chesnaï, 1986; Ohmae, 1985).⁴

This new world order with its consequent greater degree of internationalisation of science is affecting the countries of the North and those of the South differently. The former are collaborating more in scientific activities likely to lead to technological innovation,⁵ while the latter tend to be involved in scientific partnerships either for geo-political reasons⁶ or because they contain certain specific environments or facilities that are fundamental for scientific advances but which cannot be found elsewhere.⁷

The identification of the motivation and the extent of collaboration in science can be a useful tool for science policy in many ways. First of all, it reveals various aspects of the way science works and is

organised in a specific country, for instance: the degree of internationalisation of different scientific fields; the preference of specific fields for single or collective work; the existence of links developed in the process of training researchers. Secondly, collaboration data can help in the design of specific policies to meet desirable goals, for instance: creating specific programmes for involving researchers from all over the world in biodiversity research in the Amazon (something that can never be accomplished with local researchers only); creating programmes of the type of ESPRIT (European Union information technology programme).

In addition, collaboration information can be used for policy analysis, that is, as a desired output of a specific action, for instance: has collaboration between Brazil and Argentina in molecular biology increased? and can it be attributed to the Brazil/ Argentina Biotechnology Protocol? Finally, it can be useful as an indicator of more general policy initiatives, for instance: how successful has the post-doctoral abroad scholarship programme been which was created by a country's national council? has it been useful to establish and foster partnerships with foreign research groups?

Despite their policy relevance and potential application, collaboration indicators and particularly those of international collaboration, have not received much attention from research. This is true as far as both their conceptual and methodological aspects are concerned. What is meant by collaboration in science is not beyond dispute.⁸ However, very few would deny that a co-authored publication is one important result of a collaborative effort.⁹

Also, because other outcomes of collaboration are much more difficult to measure, co-authorship of articles has often been used as an expression of collaboration in science.¹⁰ There are, however, a number of methodological and technical problems associated with this measure, the most important being that most databases do not register the institutional origin of all the authors. As the *Science Citation Index* (SCI) files do provide such information, this is the most widely used database for international collaboration studies.

With this picture in mind, the present study was designed to investigate the trends in international collaboration of the four Mercosur (The Southern Common Market) countries — Argentina, Brazil, Paraguay and Uruguay — both among themselves and with other partners, prior to and after 1991.¹¹ The main objective was to identify the impact that the constitution of the block might have had on the scientific collaboration practices involving the four countries.

Choice of databases

The first problem was the choice of the database. The SCI database has been consistently pointed out as inadequate for studying science in the peripheral

Results from basic research are of interest to specialists world-wide, while interest in applied results is often limited to a handful of local experts: likewise, regional databases are likely to be a better source of research in applied areas

countries, yet there are not many others available. It is well documented that scientific research from developing regions such as Latin America (LA) is published predominantly through national journals, especially with respect to the more applied scientific fields (Narváez-Berthelemot, 1995).

While results from basic research are of interest to specialists anywhere in the world, interest in applied results is often limited to a handful of local experts. For the same reason, regional databases are likely to be a better source of research in applied areas (Narváez-Berthelemot *et al*, 1993). The only exception to this generalised pattern is with respect to research published with scientists outside the region when results are more likely to be written up in the international literature.

It was decided to make a comparison of the information from SCI and Periodica, the only multidisciplinary scientific Latin American database available for consultation. The Periodica database is produced from the relatively extensive collection of Latin American scientific journals received by the Special Services Library (Biblioteca de Servicios Especializados) of the National University of Mexico (Universidad Nacional Autónoma de México). This collection, which constitutes the most comprehensive and representative regional periodicals collection, has been systematically used as a source for bibliographical analysis for over 20 years.

Nevertheless some countries or sub-regions are still under-represented.¹² Of a total of 1,076 journals analysed in 1994, 237 titles (22%) were from Brazil, 124 (11.5%) from Argentina, 26 (2.4%) from Uruguay and only one title (0.09%) from Paraguay, while Mexico was represented by 338 titles (31.4%). Taking into consideration the relative scientific sizes of the Latin American countries, it is clear that Mexico, the country of publication, is over-represented compared to Brazil and Argentina. However, the Periodica data-base has wide Latin American coverage registering over 40,000 contributions to the scientific periodicals of the region between 1989 and 1993, the years studied in this research.¹³

One of the main problems associated with the provision of services on LA information is the difficulty of locating and regularly acquiring the source journals because of erratic publication schedules, lack of continuity, poor distribution and lack of adequate

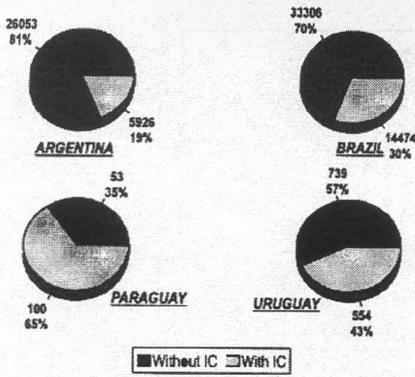


Figure 1. Papers in international collaboration (IC) with Mercosur countries

Source: SCI (1980–1995)

dissemination with respect to many Latin American titles. The fact that production of the Periodica database is located within a Mexican higher education institute ensures that the file covers Mexican literature quite comprehensively. The coverage is also likely to be representative of the other major Latin American scientific powers, such as Argentina, Brazil, Chile and Venezuela but probably quite poor with respect to the smaller countries of the region whose scientific production is limited.

However, Periodica, unlike other bibliographic databases except for SCI, includes, from 1987 onwards, all author addresses, which makes it a unique tool for analysing Latin American international and regional collaboration.¹⁴

International co-authorship patterns

There are distinct patterns between the two more productive countries in the mainstream scientific literature, namely Brazil and Argentina (30% and 19%, respectively) and the two that are much less visible, Uruguay and Paraguay (65% and 43%, respectively) with regard to the percentage of papers published in international collaboration (Figure 1). In general, the larger the production of papers the smaller the percentage of papers published with institutions from other countries, suggesting that the scientifically smaller countries rely heavily on international co-operation for producing research visible through mainstream publications.

The explanation for the fact that Brazil publishes a greater percentage of its mainstream scientific papers in international collaboration than does Argentina lies in the vigorous overseas postgraduate training programme implemented by the Brazilian research funding agencies. This is particularly true at the federal level, but also significant in the case of the state of São Paulo.

Created together with the agencies in the 1950s, the overseas post-graduate programme (for PhD and post-doctorate training) funded by the Brazilian

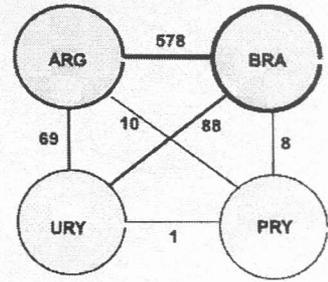


Figure 2. Papers published in co-authorship among Mercosur countries

Source: SCI (1980–1995)

government reached over 6000 scholarships granted every year from 1990 onwards.¹⁵ No programme of similar dimensions can be found in Argentina or in any other Latin American country. As a consequence, an increase in the number of internationally co-authored Brazilian papers has resulted from the research published by the Brazilian students with their foreign doctoral supervisors and institutions.¹⁶

The larger countries also dominate the intra-Mercosur collaborations which are mainly between Argentina and Brazil, 578 papers in all (Figure 2). Uruguay is the next most important participant with slightly more co-authorship with Brazil (88 papers) than with Argentina (69 papers). Paraguay showed little intra-Mercosur collaboration with only ten papers written with Argentinian scientists and eight with their Brazilian colleagues.

The role played by each country can be related to its scientific size. Almost all interactions are bilateral, 82% of which are between Argentina and Brazil, with only one paper involving all four countries (Figure 3).

The general trend is for the collaborations to have increased during the 16 years of the study specifically with respect to the number of papers in bilateral co-authorship between Argentina and Brazil (Figure 4). This increase is particularly marked between

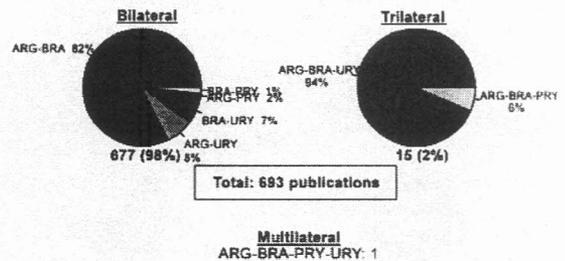


Figure 3. Papers published in co-authorship among Mercosur countries in bilateral, trilateral and multilateral collaboration

Source: SCI (1980–1995)

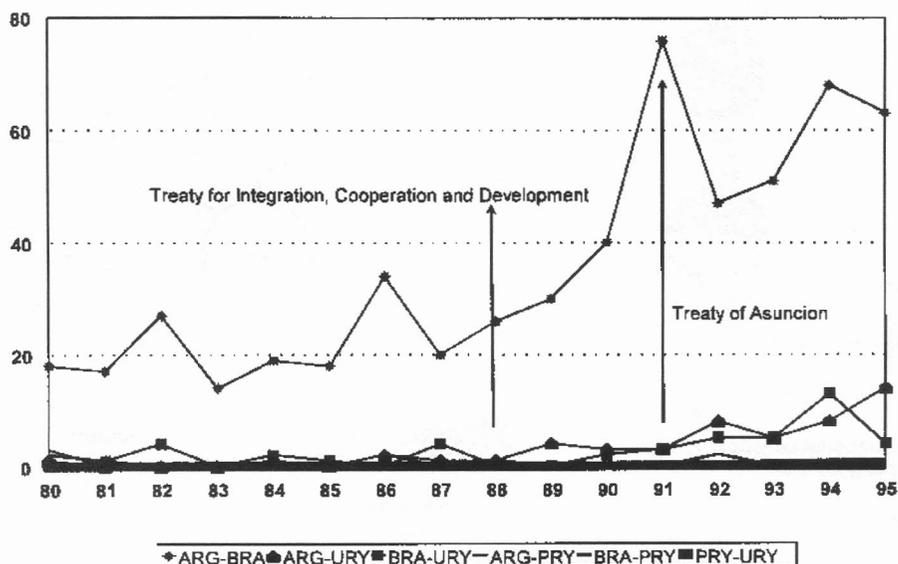


Figure 4. Annual distribution of papers published in bilateral co-authorship among Mercosur countries

Source: SCI (1980–1995)

1988, the year the Treaty for Integration, Co-operation and Development was signed by these two countries, and 1991 when the Mercosur was formally constituted with the signing of the Treaty of Asuncion by the four member countries. The intra-Mercosur activity of Uruguay both with Argentina and with Brazil showed a tendency to increase from 1991 onwards.

The role played by other countries in the intra-Mercosur collaboration is illustrated by Figure 5. Almost a third involved the participation of at least one other non-Mercosur partner. Notwithstanding, almost 500 papers were published in the mainstream literature between 1980 and 1995 involving Mercosur-only partnerships.

From 1980 to 1990 the Mercosur countries collaborated mainly with the countries of two major economic blocks: the European Union (EU) and the North America Free Trade Agreement (NAFTA), 40% and 41%, respectively. Only 4% of papers were

with other Latin American countries.

In spite of the reputed poor coverage of Latin American research by SCI this mainstream database registered more 1987–1992 papers by the Mercosur countries than did the regional database, Periodica (Figure 6). This was the case with respect to both the total number of publications in international co-authorship of each of the four Mercosur countries and the number of intra-Mercosur papers, although it was more marked in the former case.

For instance, while a total of 5,565 Brazilian papers in international collaboration were found in SCI, the equivalent figure for Periodica was only 132. However, the corresponding totals with respect to papers co-authored by Argentina and Brazil were 252 in SCI and 14 in Periodica. No papers from Paraguay were found in Periodica whereas SCI registered 38 in the six-year period.

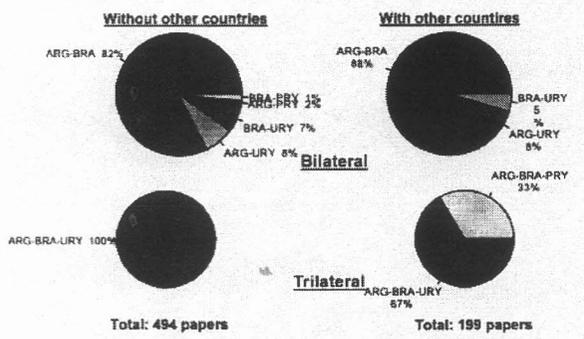
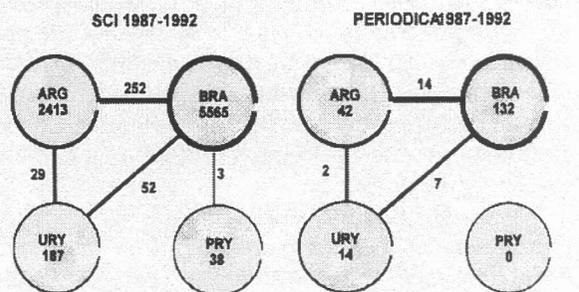


Figure 5. Papers published in co-authorship among Mercosur countries in collaboration with other countries

Source: SCI (1980–1995)



Figures in the circles refer to the total number of publications in international co-authorship each individual Mercosur country.

Figure 6. Papers published in co-authorship among Mercosur countries: comparison between international SCI and regional periodica databases

Sources: SCI (1980–1995); Periodica (1987–1992)

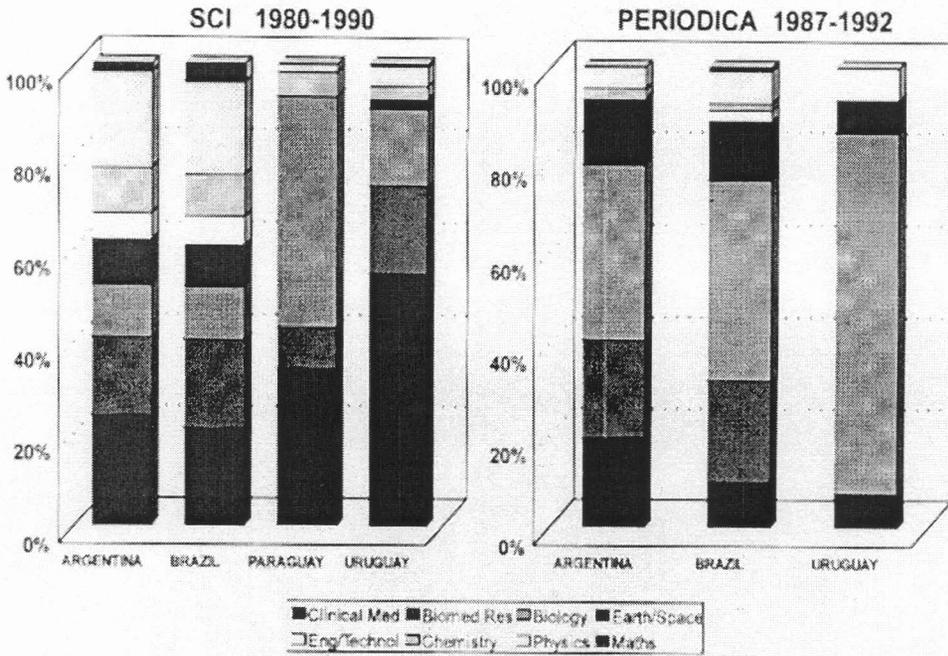


Figure 7. Field distribution of papers published in international collaboration of Mercosur countries: comparison between international SCI and regional Periodica databases

There were notable differences in the field distribution of papers published in international collaboration by the four Mercosur countries between SCI and Periodica (Figure 7). Papers recovered from the regional database showed a marked emphasis on the life sciences (clinical medicine, biomedicine and biology), similar to that found for Uruguay and Paraguay in the international literature. On the other hand, SCI papers published by the scientifically more advanced countries of Argentina and Brazil covered a much wider range of fields including the exact sciences of physics and mathematics.

The annual trends from 1987–1992 in the production of bilateral publications between the Mercosur countries show quite different pictures in the two databases (Figure 8). The documents registered in the international database show definite trends, such as

the gradual increase already seen in Figure 4 for bilateral papers from Argentina and Brazil. The small numbers of bilateral intra-Mercosur contributions registered in the regional database makes even small fluctuations notable without showing any consistent pattern.

The field distribution of these bilateral papers in the two databases (Figure 9) is similar to that already described for documents published in international collaboration by the four Mercosur countries (Figure 7). Again the field emphasis of the regional papers is on the life sciences with very little contribution being made to other fields. Although papers published internationally are also predominantly in the life sciences, other fields, such as physics, earth and space sciences, and chemistry, also assume importance.

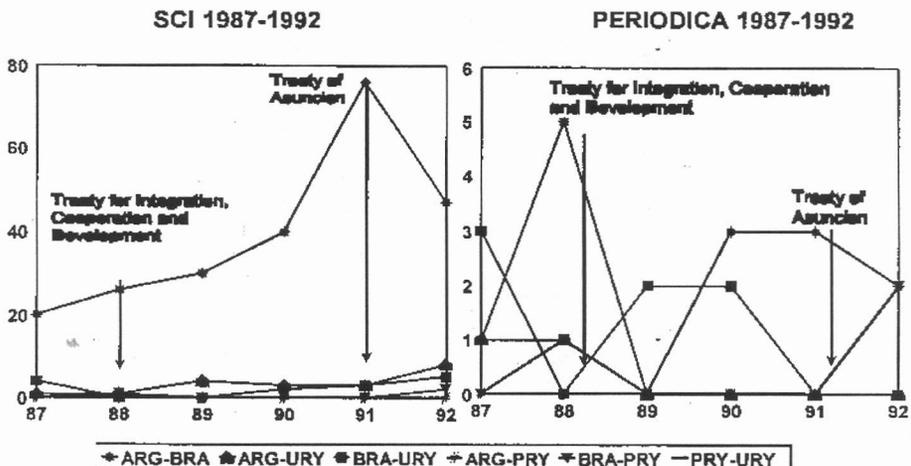


Figure 8. Annual production of papers published in bilateral co-authorship among Mercosur countries: comparison between international SCI and regional Periodica databases

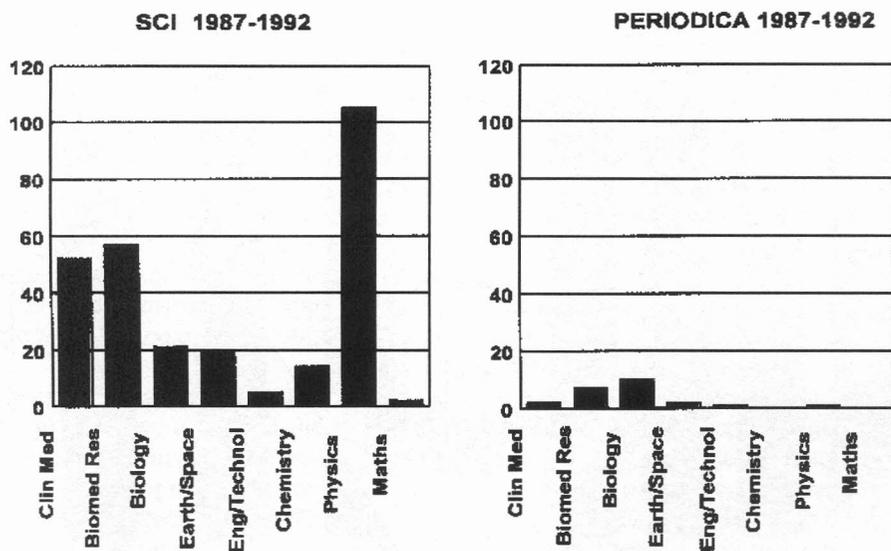


Figure 9. Field distribution of papers published in bilateral co-authorship among Mercosur countries: comparison between international SCI and regional Periodica databases

Implications for intra-Mercosur collaborations

The different patterns of research between Argentina and Brazil on the one hand and Uruguay and Paraguay on the other, can be attributed to basic differences in the research carried out between the larger and smaller nations of the developing world. The least developed countries of the third world tend to concentrate their limited research efforts on applied projects that generally have relevance only at local level. International scientific co-operation of these countries will be aimed at gaining help with these projects. The larger developing countries with more adequate research infrastructure and human resources are in a position to carry out more fundamental research of interest to a wider and more international scientific audience.

It is clear from the figures that the pictures of international collaboration practices of the four Mercosur countries drawn from the two databases are quite different from each other. Which one to use for the purposes of policy is the question that comes immediately to mind. There is no single answer to this; rather it will depend on the purpose of the analysis. On the one hand, this decision implies the need to know the general criteria of data selection and acquisition, as well as the inherent biases and limitations of each database. On the other, it requires the identification of the specific policy issues that need to be addressed.

In this study, we required multidisciplinary scientific databases recording institutional addresses of all authors with adequate coverage of research from the four countries of the Mercosur. These requirements narrowed down our options to the two databases selected, which actually complemented each other, in that SCI covers mainstream journals published predominantly outside the region, while Periodica limits its coverage to regional titles. Nevertheless, it is likely that both databases give only a partial picture of the

scientific production and international collaboration of the individual Mercosur countries.

Considerations of subject area will also affect the choice of database. Thus, for instance, when we want to assess the impact of a joint Mercosur research programme on some aspect of local agriculture, it is probably more useful to use Periodica or some other regional database, because this is not a typical paper sent for publication in mainstream journals by Latin-American authors only.¹⁷ However, if such a programme has received funds from an international organisation and has the participation of advanced country researchers as well, then, SCI database should also be looked at.

The reason is that, as stated earlier, collaborations between Latin American and advanced country researchers are more likely to be published in English and in mainstream journals. Other policy questions can find more reliable responses using SCI database only. For example, the impact of the Brazilian programme of doctoral and post-doctoral training abroad on international collaboration patterns can best be assessed with SCI information.

The question to be asked now is whether the data collected from either database say anything about the impact of the creation of Mercosur on the collaboration activities involving the four countries? Data taken from Periodica show no pattern, that is, co-authored publications involving researchers from more than one Mercosur country seem to be contingent, and do not respond to policies of any kind. As for the SCI database, it seems that the establishment of the block in 1991 has not yet produced results in this arena — perhaps it still too early to look for such effects. Actually, interviews carried out in institutions of the four Mercosur countries as part of this project revealed a few instances when research collaboration initiatives have been established but have not yet rendered publications of any kind.¹⁸

On the other hand, there is a constant increase in the collaboration between Argentina and Brazil from 1986 onwards, when two important scientific and technological collaboration programmes were established between the two countries: the Brazilian/Argentinean Centre for Biotechnology (CABBIO) and the Schools of Informatics. It is likely that this increase is at least partly due to the activities derived from such programmes. CABBIO in particular was so successful in the first years of its implementation that, when the Treaty for Integration, Co-operation and Development between Argentina and Brazil was signed in 1988, biotechnology was picked up as the field where efforts should be concentrated.

The validity and accuracy of studies carried out on the scientific production and institutional co-authorship patterns of developing regions depends on the availability of databases which can be used to obtain complete and reliable source data. In the specific case of Latin America, several initiatives are underway to enhance the visibility of the region's journals.¹⁹ Of particular relevance is LATINDEX, a regional information system based on a co-ordinated network of national resource centres, each taking responsibility for the collection of bibliographical information in all knowledge areas from their respective countries or regions of Latin America and the Caribbean.²⁰ One of the proposed products of this initiative is an electronic index of the scientific production of regional journals that can be used to generate appropriate S&T indicators as well as providing the raw data for the analysis of regional S&T activity.

However, it is essential to remember that to understand collaborative scientific efforts it is not enough to look at quantitative data alone. These must be interpreted in the light of contextual qualitative information about the countries being analysed, such as political and cultural affinities, science policy initiatives and the implementation of S&T co-operative programmes between different countries.

Micro-analysis should be carried out to look behind the bibliometric data to shed light on the motivations, mechanisms and benefits of individual collaborations and how these affect the patterns of intra-country partnership. In the particular case of the Mercosur countries a detailed analysis is required of the institutions involved and the specific research areas where the collaborative activities are taking place. This information can then be placed in the specific context of the Mercosur alliance and other strategic bilateral and multilateral programmes for the integration and co-operation between these four countries.

Notes

1. In this paper the authors point out that the first collaborative research paper was published in 1665.
2. For an extensive list of the factors promoting collaboration in

science see Katz (1994). It has been argued that such factors — which can be grouped under the categories of economic, cognitive and social — have varying relative importance in explaining either field-to-field or country-to-country differences in the rates of collaboration (Luukkonen *et al.*, 1992).

3. The novelty lies in the fact that until very recently international collaborative projects were nearly always born out of direct, spontaneous initiatives between researchers (Miquel, 1991). Also international collaboration was granted only a marginal position in the science and technology policies of most countries (CNRS, 1993). Today, however, different inter-governmental science programmes have been established (such as the ESPRIT and FAST programmes of the EU) with the explicit objective to foster collaboration both between the academic and productive sectors and among different countries.
4. As the argument goes, the costs and the increasing rate of innovation in the science-based industries make it very difficult for firms to do their own basic research. The solution was their association to fund basic research and separately develop internal capability to explore the results of such research.
5. For a list and discussion of international projects aimed at increasing industrial competitiveness of advanced countries see Mytelka (1992). Also, Miquel (1991) has shown that, for OECD countries, collaboration in engineering and technology increased more than in any other field from 1986 to 1990.
6. Scientific collaboration involving advanced and developing countries tends to follow the pattern of economic and political influence. Thus, Japan has very strong scientific links with its neighbouring countries (see Okubo and Miquel, 1992), while the USA is the main research partner of Latin America (see Narváez-Berthelot *et al.*, 1992).
7. This is the case, for example, for: tropical forests; geological, oceanographic and atmospheric special conditions; astronomical observation. For this point see Ailes *et al.* (1988).
8. For a discussion of the various meanings and definitions of scientific collaboration see Katz and Martin (1997).
9. Yet even here it is important to remember that different countries, fields of knowledge, institutions and even research teams have significant different traditions and criteria for granting authorship for any collaborator. The relationship between thesis supervisor and graduate student is a clear example: in some fields, advisors see graduate students as collaborators, often publishing together the results of the doctoral research. This is not so in the social sciences: thesis research is seen as the graduate student's property, no matter how much the advisor has contributed to (or collaborated in) its development: consequently, the graduate publishes alone. On this point see Temporary Consultative Committee (1991).
10. For some authors (Leclerc *et al.*, 1992), international collaboration is the collection of co-operative research work developed by two or more countries and identified by co-authored publications.
11. The Southern Common Market (Mercosur) was officially formed in March 1991 with the signing of the Treaty of Asunción by Argentina, Brazil, Paraguay and Uruguay. Although basically a framework for economic integration, science and technology co-operation ranks high on the agenda and is seen as an instrument to foster economic development of the region. The Treaty for Integration, Co-operation and Development signed by Argentina and Brazil in 1988 had set the stage for a Southern Common Market.
12. For a general panorama of the visibility of regional journals see Cetto and Alonso-Gamboa (1998).
13. Data provided by Octavio Alonso-Gamboa, editor-in-chief of *Periodica*.
14. *Periodica* is produced as a printed index and can be consulted in CD-ROM format or on the website: <http://www.dgbibio.unam.mx>. In the present study the 1993 CD-ROM was used.
15. Graduate training abroad is funded in Brazil by the National Research Council (CNPq) and CAPES (Brazilian Agency for Graduate Education) at the federal level and by FAPESP (São Paulo State Research Support Agency) at the state level. Data concerning the number of overseas scholarships granted by each agency from 1990 may be found in Brasil/MCT (1997).
16. A consistent finding of bibliometric studies in Brazil is that publication in mainstream journals by Brazilian researchers is most often in partnership with foreign scientists and reflects work relations established during the former's training abroad (see, for example, Velho and Krige (1984); Meneghini (1992)).
17. An analysis carried out on the research and publishing trends

in cattle reproduction in the tropics showed that 85% of documents registered on this subject in the international CAB Abstracts database were from third world countries (Galina and Russell, 1987). Of the research journals most frequently employed, 15 were national journals not likely to be among mainstream titles (Russell and Galina, 1987).

18. A synthesis of the studies conducted in the Mercosur countries for this project, the methodologies used and the main results can be found in Velho (1997).
19. For a complete discussion of these initiatives see Cetto and Alonso-Gamboa (1998).
20. For further details of this project consult: <http://biblioweb.dgsca.unam.mx/latindex>.

References

- C P Ailes *et al* (1988), *New Directions for US–Latin American Co-operation in Science and Technology*, final report prepared for National Aeronautics and Space Administration, Arlington, VA, SRI project 3164.
- D de B Beaver and R Rosen (1978), "Studies in scientific collaboration: Part I. The professional origins of scientific co-authorship", *Scientometrics*, 1, pages 65–84.
- D de B Beaver and R Rosen (1979), "Studies in scientific collaboration: Part II. Scientific co-authorship, research productivity and visibility in the French scientific elite, 1799–1830", *Scientometrics*, 1, pages 133–149.
- Brasil/MCT (1997), *Indicadores Nacionais de Ciência e Tecnologia, Brasília* (Ministério de Ciência e Tecnologia).
- A M Cetto and O Alonso-Gamboa (1998), "Scientific periodicals in Latin America and the Caribbean: a global perspective", *Interciencia*, 23(2), pages 84–93.
- F Chesnais (1986), "Some notes on technological cumulativeness, the appropriation of technology and technological progressiveness in concentrated market structures", Vienna, mimeo.
- CNRS (1993), *Measuring Internationalization of Science* (Laboratoire d'Evaluation et des Prospective Internationales, CNRS, Paris) page 69.
- C S Galina and J M Russell (1987), "Research and publishing trends in cattle reproduction in the tropics: Part 1. A global perspective", *Animal Breeding Abstracts*, 55(10), pages 743–749.
- J S Katz (1994), "Geographical proximity and scientific collaboration", *Scientometrics*, 31, pages 1–43.
- J S Katz and B R Martin (1997), "What is research collaboration?", *Research Policy*, 26, pages 1–18.
- M Leclerc, Y Okubo, L Frigoletto and J Miquel (1992), "Scientific co-operation between Canada and European Community", *Science and Public Policy*, 19(1), February, pages 15–24.
- T Luukkonen, O Persson and G Sivertsen (1992), "Understanding patterns of scientific collaboration", *Science, Technology and Human Values*, 17, pages 101–126.
- R Meneghini (1992), "Brazilian production in biochemistry: the question of international versus domestic publication", *Scientometrics*, 23(1), pages 21–30.
- J F Miquel (1991), "Evaluation of international collaboration", *Science and Technology Policy Evaluation* (SPRU, Brighton) page 1.
- L K Mytelka (1992), "Strategic partnering: some lessons for Latin America", mimeo.
- N Narváez-Berthelemot (1995), "Internalisation de l'activité scientifique de l'Amérique Latine. Une approche bibliométrique comparative", Doctorate thesis, Université de la Sorbonne Nouvelle, Paris.
- N Narváez-Berthelemot, M Almada de Ascencio and J M Russell (1993), "International scientific collaboration: cooperation between Latin America and Spain, as seen from different databases", *Journal of Information Science*, 19, pages 387–394.
- N Narváez-Berthelemot *et al* (1992), "International scientific collaboration in Latin America", *Scientometrics*, 24, pages 373–392.
- K Ohmae (1985), *Triad Power: the Coming Shape of Global Competition* (Free Press, New York).
- Y Okubo and J F Miquel (1992), "International scientific collaboration of Japan, co-authorship analysis", *Journal of Science Policy and Research Management*, 6, pages 1–16.
- J M Russell and C S Galina (1987), "Research and publishing trends in cattle reproduction in the tropics: Part 2. A third world prerogative", *Animal Breeding Abstracts*, 55(11), pages 819–828.
- Temporary Consultative Committee (1991), *Postgraduate Research Training Today: Emerging Structures for a Changing Europe*, Report of the Temporary Consultative Committee on New Organisational Forms of Graduate Research Training, Netherlands Ministry of Education, Culture and Science.
- L Velho (1997), "Síntese do Projeto Levantamento da Cooperação em C&T no Âmbito do Mercosul", Ministério de Ciência e Tecnologia, Brasília.
- L Velho and J Krige (1984), "Publication and citation practices of Brazilian agricultural scientists", *Social Studies of Science*, 14, pages 45–62.