Research Collaboration between Europe and Latin America

Mapping and Understanding partnership

Scientific editors

Jacques Gaillard
Rigas Arvanitis

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Chapter 3

Mapping S&T Collaboration between Latin America and Europe: Bibliometric Analysis of Co-authorships (1984-2007)

Jane M. RUSSELL and Shirley AINSWORTH

Abstrat

The objective of the present analysis is to map the characteristics and trends in collaboration between Europe and the countries of Latin America and the Caribbean (LAC) through the co-publication of original scientific papers validated by a process of peer review and highly visible to the international scientific community. The analysis covers a 24 year period from 1984, the year of the first European Framework Programme STD1 "Science, Technology and Development" to 2007. We first take a global look at the international visibility and networking of research from LAC and go on to illustrate the role of collaboration with the European Union (EU) in this scenario compared to that of the North American countries of the US and Canada. Regional differences in international collaboration patterns within LAC are analysed as well as the main disciplines of co-authorship. The four most productive LAC countries of Brazil, Mexico, Argentina and Chile are selected for more detailed analyses. Results show a steady rise in the international presence of LAC research and in the production of collaborative papers with the EU in all main disciplinary areas associated with an expanding and more complex network of co-author links.

Introduction

Latin America and the Caribbean (LAC) have a long tradition of association with Europe. For over 500 years the region has sustained commercial and political links with the "Old World" (Martín, 2002). The historical and cultural ties that bind Spain, Portugal and to a lesser extent the UK and other European countries to the nations that make up this large and complex region of the Americas facilitate cooperation through a common language and a shared colonial heritage. According to Martín, support from Europe for activities of mutual interest in science and technology has increased considerably since 1980 (Martín, 2002) while Arenas Valverde refers to the necessity of greater development in the field of science and technology which led the European Community to join forces in the hope of achieving greater efficiency and competitiveness on a global scale (Arenas, 1991).

Several initiatives over the years particularly the different European framework programmes (Commission of the European Communities, 1992; European Commission, 201) and the EULARINET project (EULARINET, 2011) described in the introduction of this book have greatly facilitated the extent of collaboration between scientists from the LAC and their European colleagues. However, not all international scientific partnerships occur under the umbrella of cooperation programmes. More than ever in today's global networking

environment intricate webs of relationships are weaved between and among scientific communities which has led to a well-documented increase in scientific co-authorships between countries. Today's scientists collaborate because they want to, not because they are told to (Wagner, 2008) with cooperation programmes providing the necessary infrastructure and resources to facilitate and render operational the desire to carry out joint research, but the decision to work together is essentially a personal one based on mutual interests and complementary skills. While the number of internationally co-authored publications has grown linearly the growth in the number of addresses of internationally collaborating authors has been exponential suggesting that with time more institutions and authors join the international communication network which functions as a global self-organising system through collective action at the level of researchers themselves (Leydesdorff and Wagner, 2008).

LAC international collaboration has been the subject of several studies over the last two decades. Narvaez-Berthelemot *et al.* and Lewison and co-authors were among the first to study the international co-production of knowledge of the region (Narvaez-Berthelemot, Frigoletto and Miquel., 1992; Lewison, Fawcett-Jones and Kessler, 1993) followed by Fernández and co-workers (Fernández, Gómez and Sebastián, 1998). In more recent years Lemarchand has looked at the co-author networking of Iberoamerican countries for the period 1973-2010. (Lemarchand, 2008, Lemarchand, 2012). The co-production of Spain with LAC has received special attention (Fernández *et al.*, 1992; De Filippo, Morillo and Fernández, 2008) as well as the intraregional collaboration of LAC institutions (Sancho *et al.*, 2006; Russell *et al.*, 2007a). Other studies have included international co-authorship patterns as part of a general analysis of scientific production within the LAC region (Santa y Herrero-Solana, 2010). However we have been unable to uncover any studies focussed specifically on the co-publication of LAC with Europe.

The present study therefore is a retrospective analysis of the development and trends in international collaboration between Europe and LAC from 1984-2007. We do this by analysing the co-authorship patterns between the two regions in mainstream journals in the *Web of Science*. In keeping with international trends we would expect to find increasing collaboration between Europe and LAC with the main regional players, Brazil, Mexico and Argentina assuming defining roles. We look especially at the relative strengths of LAC co-authorship with the US and Canada, and that with the EU.

Methodology

Data Source and Coverage

Three Thomson Reuters citation indexes accessed through the Web of Science platform with the following journal coverage:

Science Citation Index (SCI): 7,100 journals in 150 disciplines

Social Science Citation Index (SSCI): 2,100 in 50 disciplines cover to cover plus 3,500 scientific and technical journals selectively indexed.

Arts & Humanities Citation Index (A&HCI): 1,200 cover to cover plus 6,000 scientific and social sciences journals selectively indexed.

http://thomsonreuters.com/content/science/pdf/Web_of_Science_factsheet.pdf

Search Strategies

Search strategies were executed against the Web of Science (WoS) version of the Thomson Reuters citation databases during August-September 2008 to identify all records from the Latin American and Caribbean region with any kind of international collaboration published within the period 1984-2007. 187,764 unique records were imported into a MySQL 5 database named Lakam. Each record was tagged with its corresponding WoS section, SCI, SSCI or AHCI, a repeatable attribute as a high level of record duplication exists between the three sections (approximately 45% duplication of SSCI with SCI, as well as A&HCI with SSCI in our sample).

Geographical Considerations

The address fields, both main affiliation and reprint, were utilized in Lakam, and those records with only one author but 2 different countries of affiliation, a practice more common in SSCI and AHCI, were included. The country segment of the records was cleaned of errors, USA was assigned to the older records lacking this in the country segment, and a locally constructed catalogue of the equivalent continents and regions run against Lakam. Both geographic and political subdivisions were taken into account.

The CIA World factbook (https://www.cia.gov/library/publications/the-world-factbook/) was consulted for the assignment of continents, and the Europa EU webpage (http://europa.eu/abc/european_countries/index_en.htm) for the member countries, subdivided into the original EU-15 and the newer EU-12 to permit a finer-grained analysis of data. Country name changes were dealt with pragmatically, the German Democratic Republic and the Federal Republic of Germany treated as Germany for the purpose of this study, and Great Britain reunited. The complexities of Balkan politics necessitated the decision to include Slovenia and Slovakia, for example, in the EU-12 subdivision, while Yugoslavia remains classified only as Europe together with Serbia, and Bosnia & Herzegovina. Cyprus, although geographically part of the Middle East, was assigned to Europe and more specifically EU-12 as a newer member of the EU. No attempt was made to take into consideration the date of accession in this bibliometric study.

Latin America was divided into regions adapting the classification employed in the Ranking Web of World Universities (http://www.webometrics.info/index.html): Southern Cone (Argentina, Brazil, Chile, Paraguay, Uruguay): Andes (Bolivia, Colombia, Ecuador, Peru, Venezuela): Central America and Mexico (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama): Caribbean (including Cuba and the Dominican Republic). The decision was taken to treat the Caribbean separately, and not as part of Central America as does the Ranking Web of World Universities, to facilitate the analysis of its behaviour.

Records from the Caribbean received special treatment given that they present multiple inconsistencies in the address fields. Geographical presence was deemed a priority, thus the records were edited so that islands which were previously European colonies or overseas or dependent territories, which may or may not have been represented correctly in the address fields, were assigned the name of the island as country and the Caribbean as continent.

Subject Considerations

All ISI subject categories were taken into account, and the Research Fields Courses and Disciplines (RFCD) classification scheme was utilized to assign the main disciplines (Butler, Henadeera and Biglia, 2006). This decision was taken in part due to the especially detailed Social Sciences equivalents. The translation of ISI subject categories from this paper was requested and kindly provided directly by Linda Butler.

Document counting

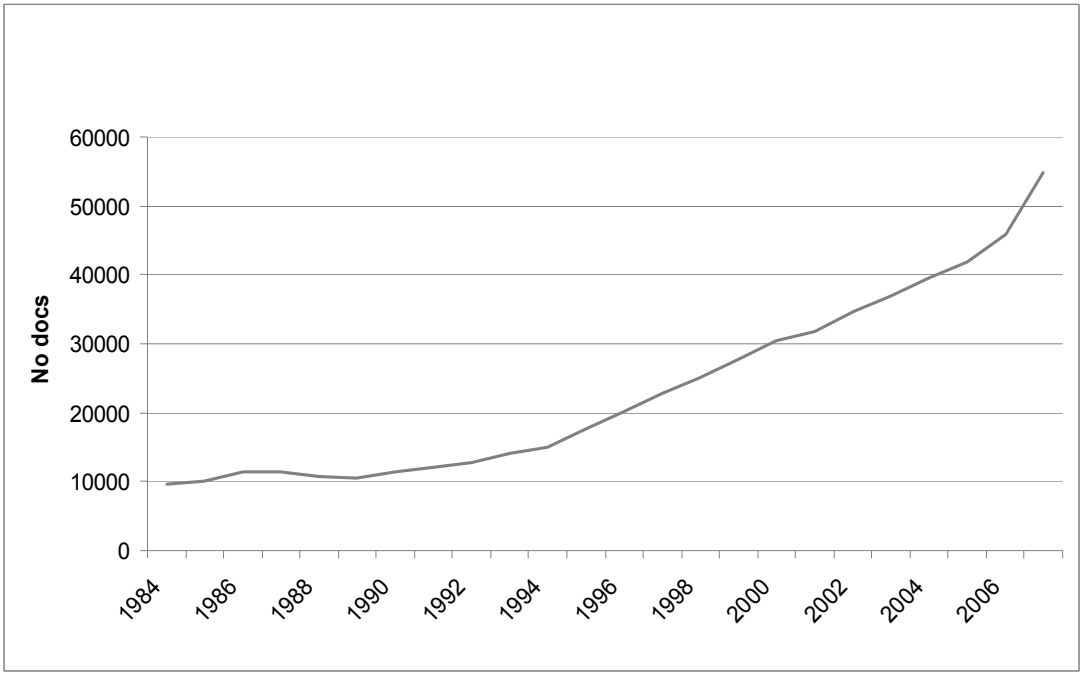
Unless otherwise stated results reflect the number of documents with occurrences of a given criteria.

Results

A Global View of Research from Latin America and the Caribbean (LAC)

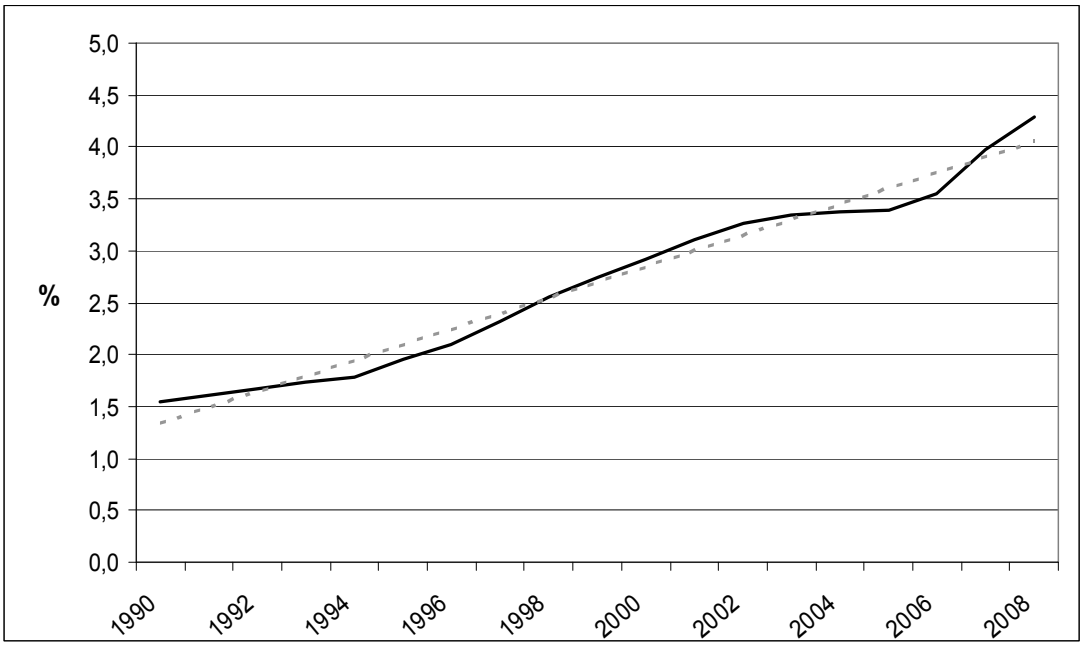
Latin America and the Caribbean (LAC) increased their mainstream scientific production in all knowledge areas from 9,641 papers in 1984 to 54,807 in 2007 indicating that 9.8% of the 559,151 unique documents registered in the three citation indexes in the 24 years analysed were published in the most recent year (Figure 1).

Figure 1. Total LAC production in all knowledge areas 1984-2007 (SCI, SSCI, A&HCI).



Not only did overall production increase but also the percentage of world share of publications (science areas only taken into consideration), at least in recent years, from 1.5% in 1990 to 4.29% in 2008 indicating a small but increasing presence on the world stage (Figure 2).

Figure 2. Latin American and Caribbean scientific production (SCI only) as a percentage of world SCI production 1990-2008.



Note: SCI total world production from RICYT:

http://www.ricyt.org/index.php?option=com_content&view=article&id=150&Itemid=20

In keeping with world trends the LAC region showed rapid expansion in co-authorship with other countries not only in terms of absolute numbers of papers but also as a percentage of total output. In 1984 only 1,868 mainstream papers were published as the result of international partnership, by 2007 this figure had risen tenfold to 18,770 (Figure 3). The equivalent percentages of total output were 19.4% for 1984 and 34.3% in 2007 (Figure 4).

Overall the Southern Cone countries were responsible for 69% of the total production of papers, a figure which varied little between the beginning and end of the 24 year period (69 and 72%, respectively). Central America and Mexico showed a slight increase (from 16-20% while the Andean countries and the Caribbean showed slight losses (9-8% and 6-3%, respectively) Nonetheless, all regions showed significant increases in the numbers of papers published during the period, Central America and Mexico, seven fold (1,550 to 10,745); Southern Cone, six fold (6,660 to 39,445) ; Andean region, five fold (891 to 4,134) and the Caribbean, three fold (577 to 1.795) (Figure 5).

Figure 3. Numbers of LAC publications in international collaboration in all knowledge areas 1984-2007.

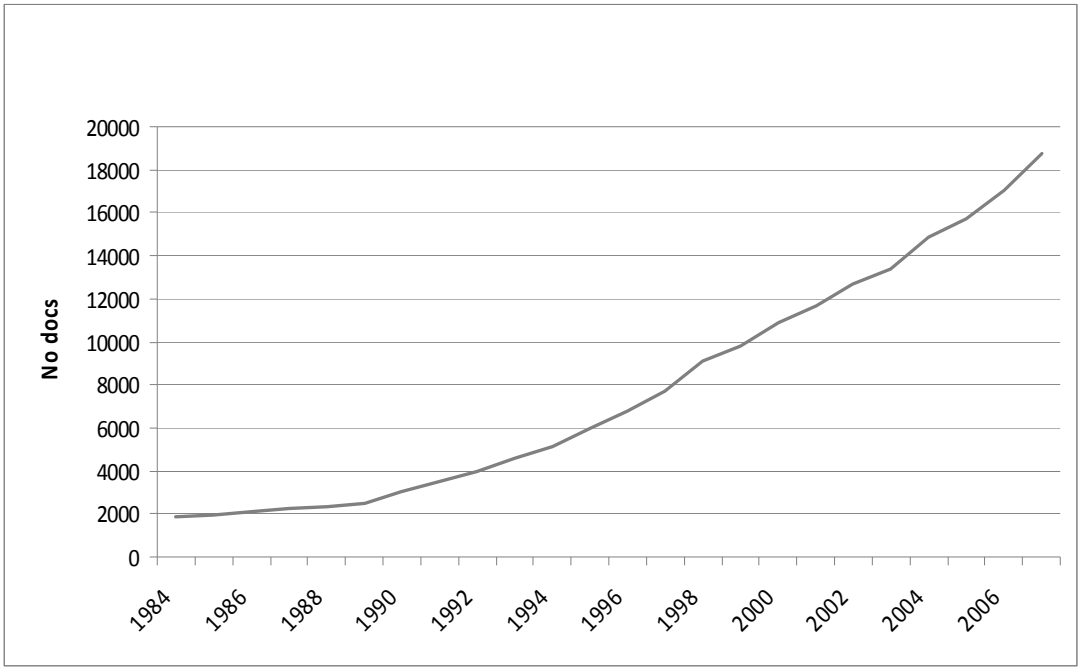


Figure 4. Percentage of total LAC publications in international collaboration in all knowledge areas 1984-2007.

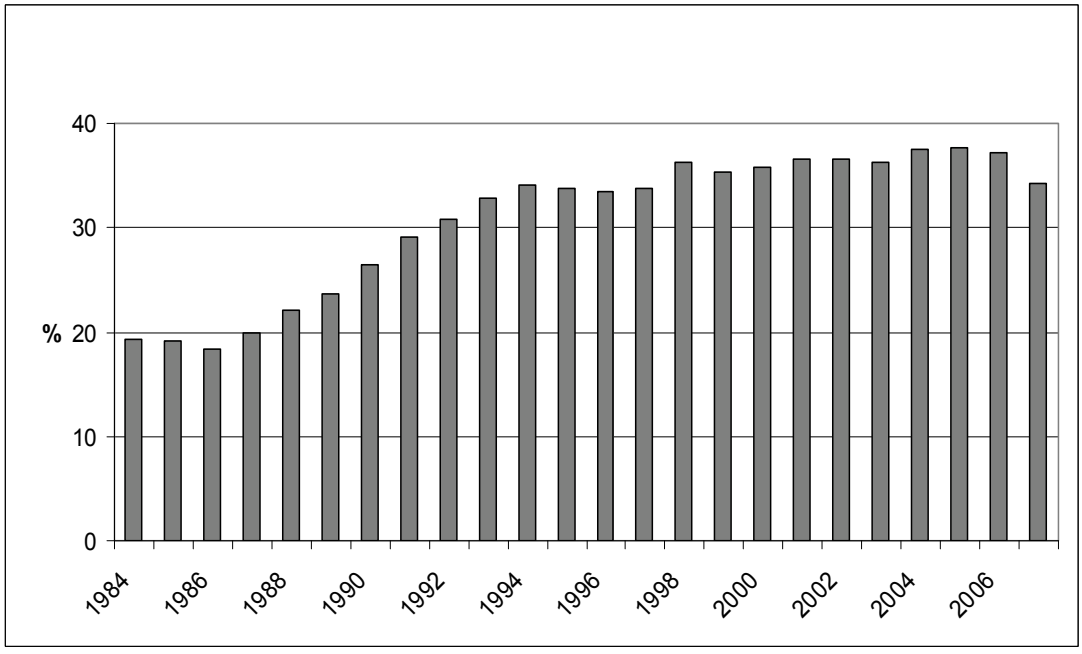
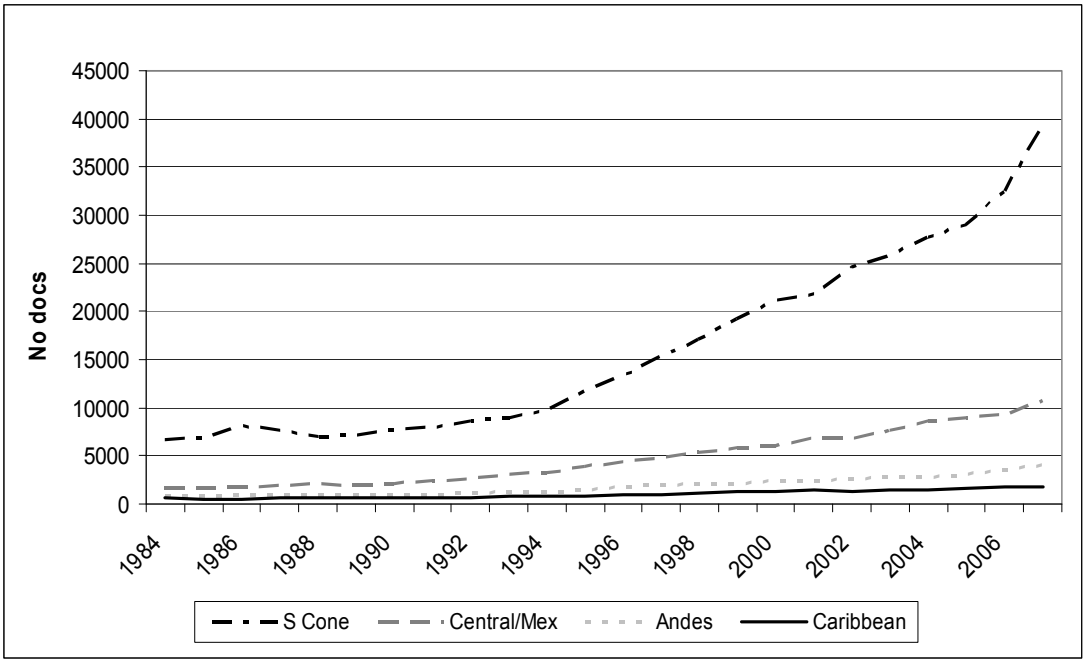


Figure 5. LAC production in all knowledge areas (SCI, SSCI, A&HCI) by region 1984-2007.



Brazil was the regional leader in papers published throughout the whole period of study increasing its dominance from 34% (3,312) of the total of LAC papers in 1984 to 52% (28,479) in 2007. Mexico took over second position from Argentina at the beginning of the 90s and increased its lead from the turn of the new century onwards (Figure 6). The consolidation of Mexican research as playing second fiddle to Brazil is also illustrated by an increase from a 14% (1,302) contribution to LAC science from the beginning of the period to an 18% (9,969) contribution at the end. Both Argentina and Chile decreased significantly their percentage contribution, from 21-13% (2,020-7,001) and from 13-8% (1,279-4,319), respectively.

With regard to international co-authorship patterns all regions showed a similar trend (Figure 7) as did the four top producers (Figure 8). As could be expected, the less productive regions and countries showed increasing reliability on international co-authorship to sustain or boost output. Brazil on the other hand, increased its percentage of internationally co-authored papers from 18% in 1984 to 34% by 1994, after which the role of foreign collaborators decreased, by 2007 only 26% of total production was in international co-authorship. The rise in the percentage for Mexico from 26% in 1984 levelled off after reaching 40% in 1998 while Argentina showed a steep rise from a mere 10% at the beginning of the study reaching percentages similar to Mexico by 2007.

Figure 6. LAC production in all knowledge areas (SCI, SSCI, A&HCI) by the four top producers 1984-2007.

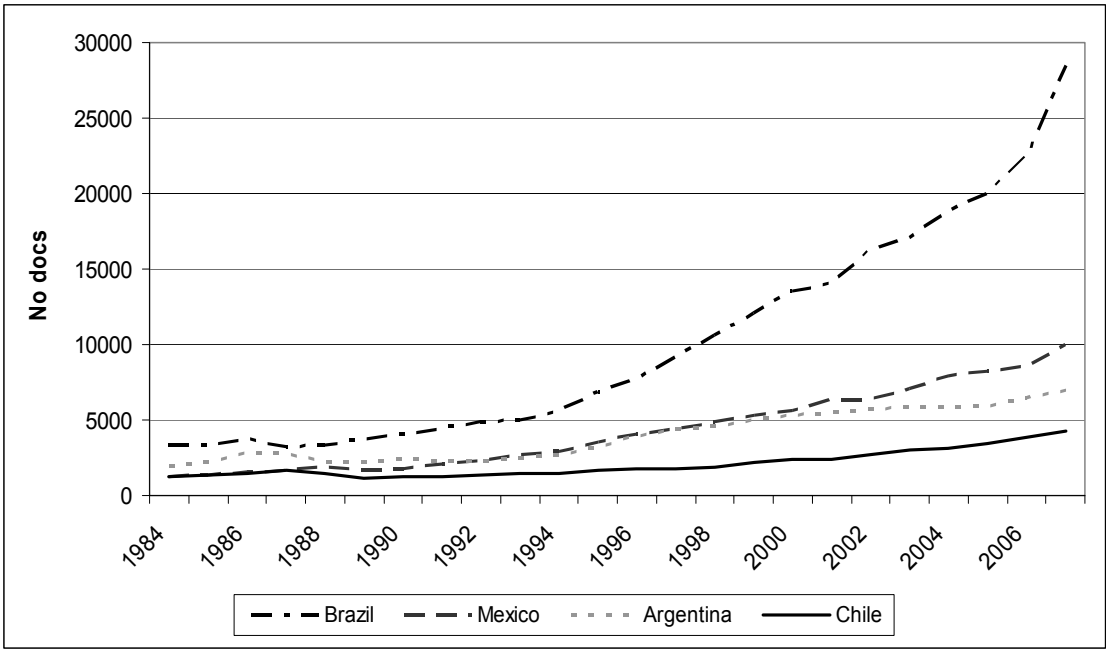


Figure 7. Percentage total production LAC with any international collaboration in all knowledge areas by region 1984-2007.

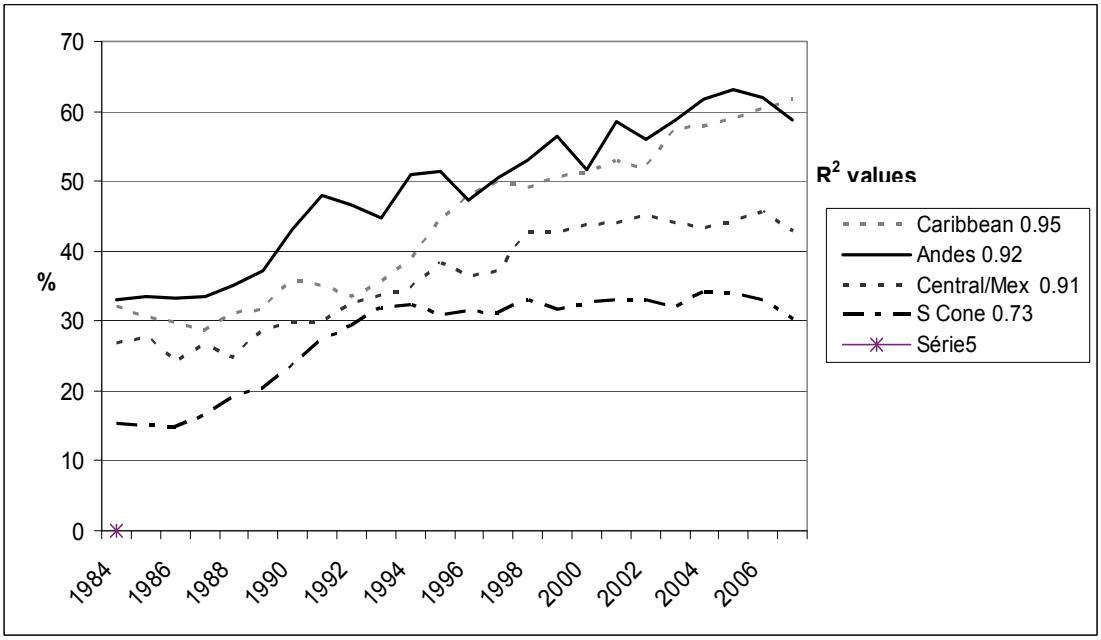
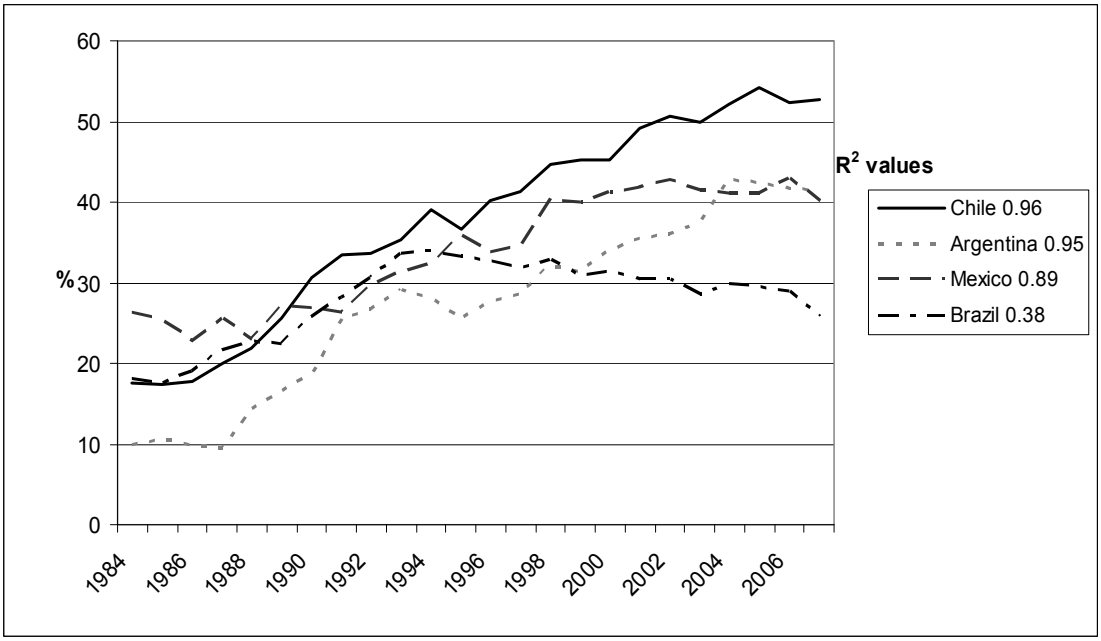
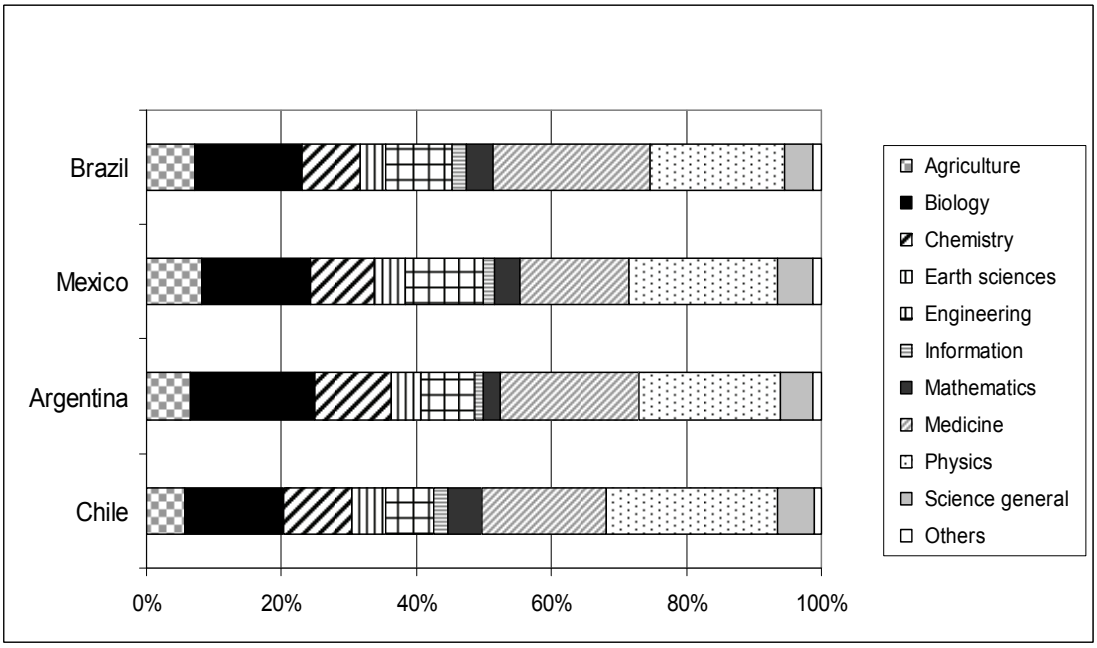


Figure 8. Percentage total production LAC with any international collaboration in all knowledge areas by the top producers 1984-2007.



Most Active Areas of Research Collaboration

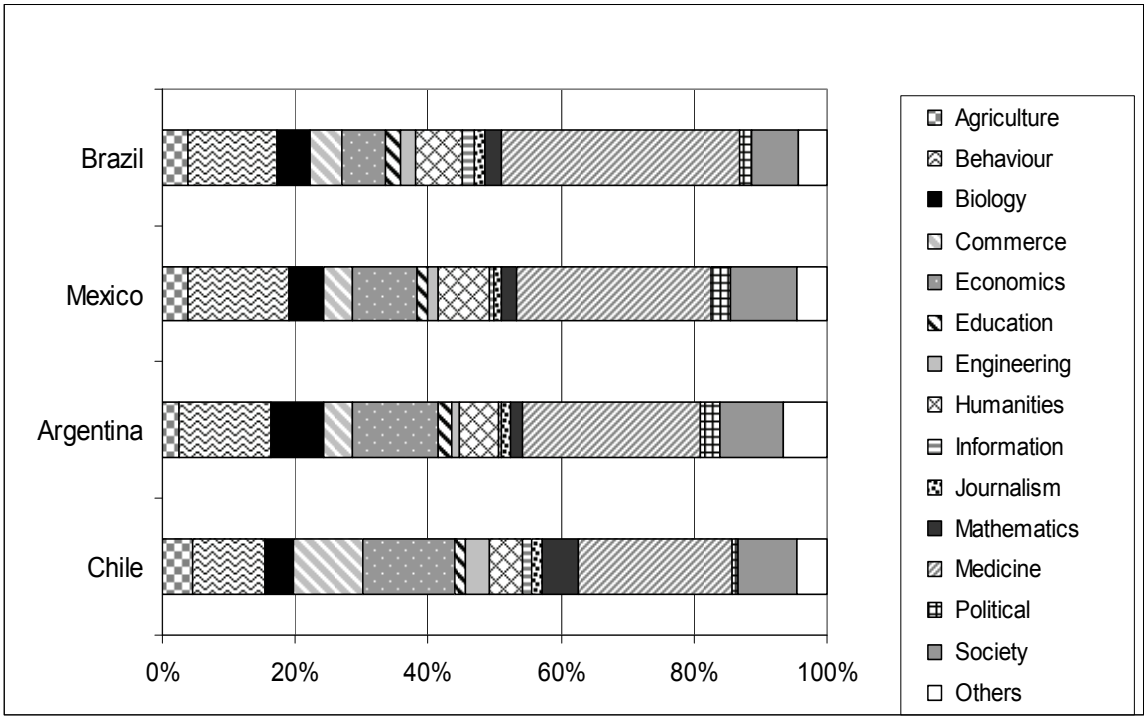
Figure 9 Main disciplines in Science of papers in international collaboration of the top producers 1984-2007.



The top four producers which contributed 80% of the total output of 182,941 papers in **Science** in international collaboration, show similar overall patterns with respect to their scientific disciplinary focus considering the period as a whole (Figure 9). Medicine, Physics and Biology are the main areas of collaboration with Medicine taking top priority in Brazil (23% of all papers) Physics in Chile (25%), in Mexico and in Argentina (both 22%). Biology is an important area of collaboration in all four countries (Argentina, 19%; Mexico and Brazil, 16%; Chile, 15%). Engineering is given more weight by Mexico (12%) than by the other countries (Brazil, 10%; Argentina, 8%; Chile; 7%).

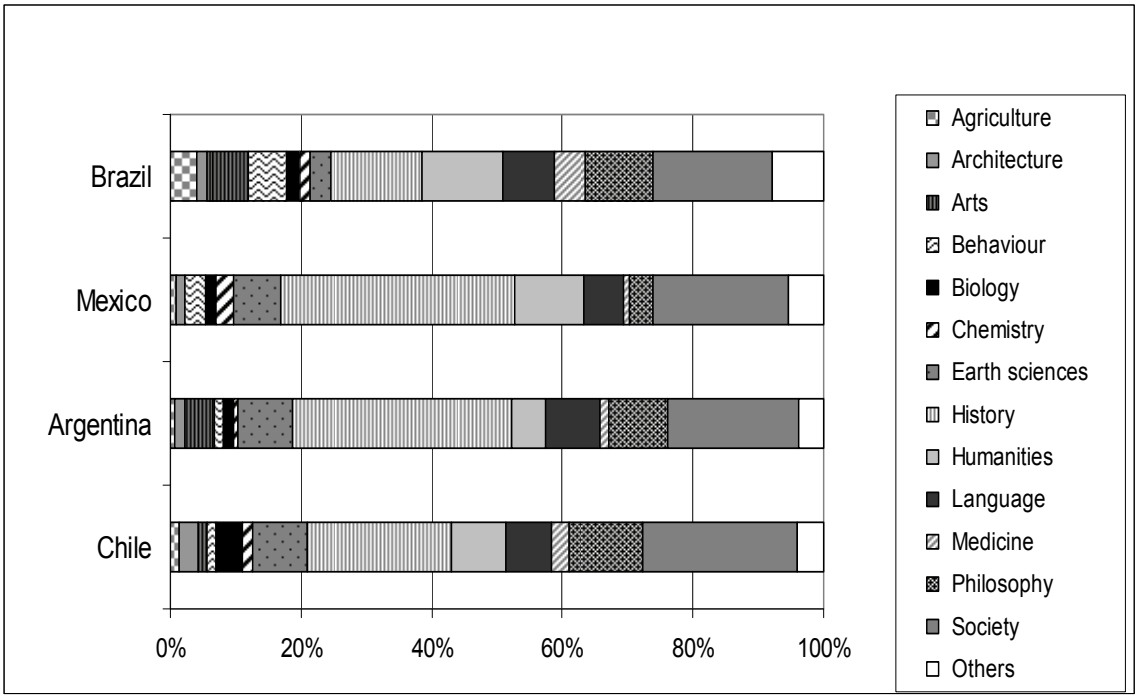
International collaboration in the **Social Sciences** show more varied disciplinary patterns, much due to the small volume of papers published in these areas in the mainstream literature, 8,812 in total (Figure 10). Social aspects of medicine take preference in all four countries, 36% of papers in Brazil, 29% in Mexico, 27% in Argentina and 23% in Chile. Behaviour papers take second place in Mexico, 15%, Argentina and Brazil, both 14% while in the case of Chile papers in Economics occupy second place with 14%, above Behaviour with an 11% share. Societal issues are a significant area of foreign collaboration also for Mexico with 10%, as well as for Chile and Argentina with 9% in each case. Economics, social aspects of the humanities, and Society account for 7% each in Brazilian international production.

Figure 10. Main disciplines in the Social Sciences of papers in international collaboration of the top producers 1984-2007.



With even smaller numbers, the 655 internationally co-authored papers in **Arts and Humanities** showed an even less consistent pattern between the four countries with the exception of History which had the largest share in Mexico, 36%, in Argentina, 34% and 14% in the case of Brazil (Figure 11). Societal issues followed in importance in Argentina and Mexico, both with 20% and with respect to Brazil, 18%. In the case of Chile, Society had a 24% share, slightly above that of History with a 22% share. Brazil showed a more even distribution of production over the different humanities disciplines. As distinct from **Science**, where Brazilian production was almost double that of Mexico, in **Arts and Humanities**, 189 were Brazilian papers with 167 from Mexico.

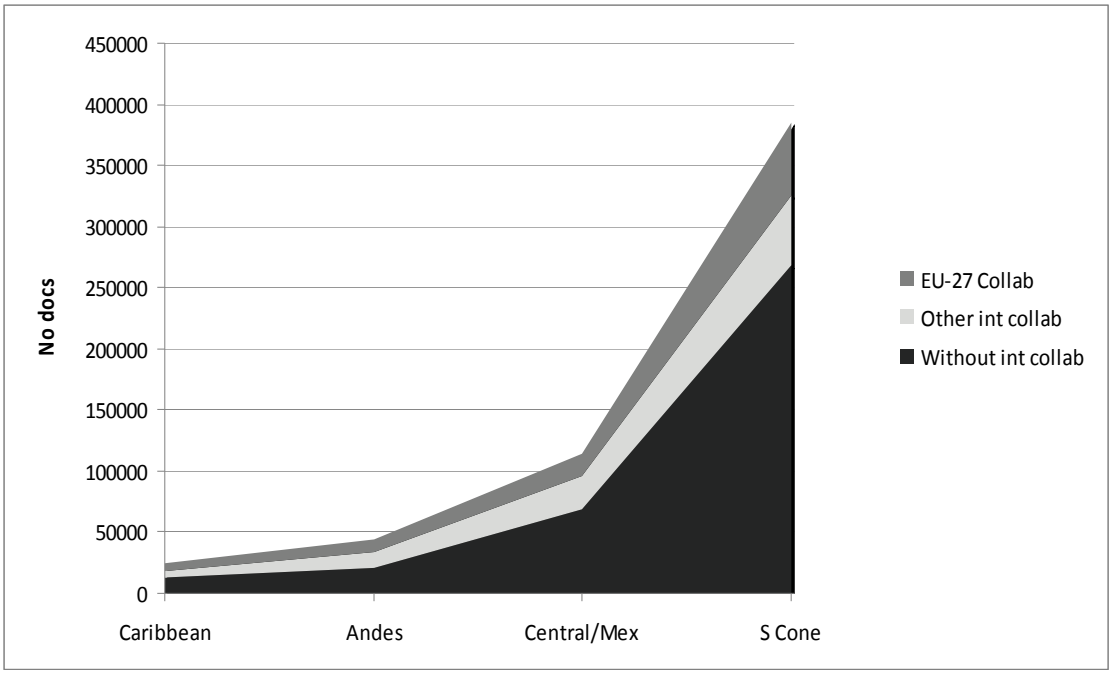
Figure 11. Main disciplines in the Arts and Humanities of papers in international collaboration of the top producers 1984-2007.



Relative Importance of International Collaboration for LAC

The majority of 1984-2007 papers involved only national institutions in all four regions (47% in the Andean region reaching 70% in the Southern Cone) (Figure 12). Although the EU-27 countries are essential partners for the whole of the LAC region once again we see important variations in the different regions and countries with respect to the relative weight of EU-27 co-authorship with respect to other international co-authorship.

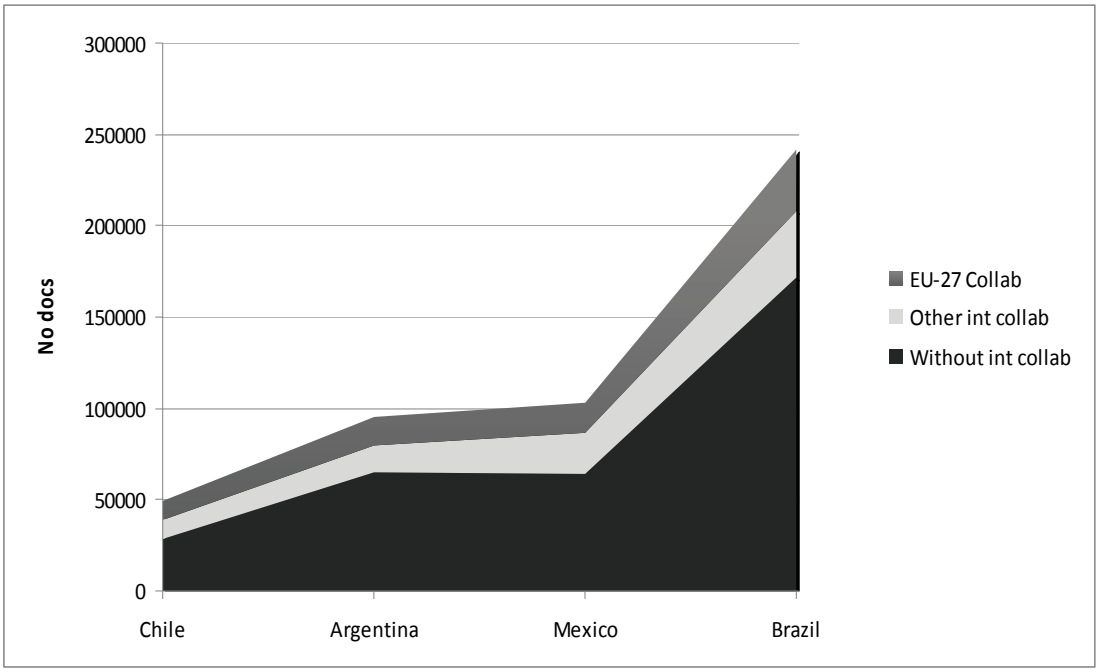
Figure 12. Relative weight of collaboration in total numbers of LAC publications with the EU-27 countries in all knowledge areas, by region 1984-2007.



Note: Other int collab refers to publications with no EU-27 involvement.

The Southern Cone, Argentina and Brazil showed an almost equal balance between EU-27 and other international partners considering the period as a whole while the Andean Region, Central America and Mexico showed a preference for partners other than those from the EU-27. The Caribbean, Chile and Argentina showed a slight preference for the EU-27 over other partners. However, when we look at annual trends we see a rising incidence of collaboration with the EU-27 even in countries such as Mexico traditionally more inclined towards partnership with the United States and Canada. In 1984, papers with the EU-27 countries were present in 7% of Mexico´s total mainstream production and in 27% of all internationally co-authored papers; by 2007 the respective figures were 17% and 43% (Figure 13).

Figure 13. Relative weight of collaboration in total numbers of LAC publications of the top producers with the EU-27 countries in all knowledge areas 1984-2007.



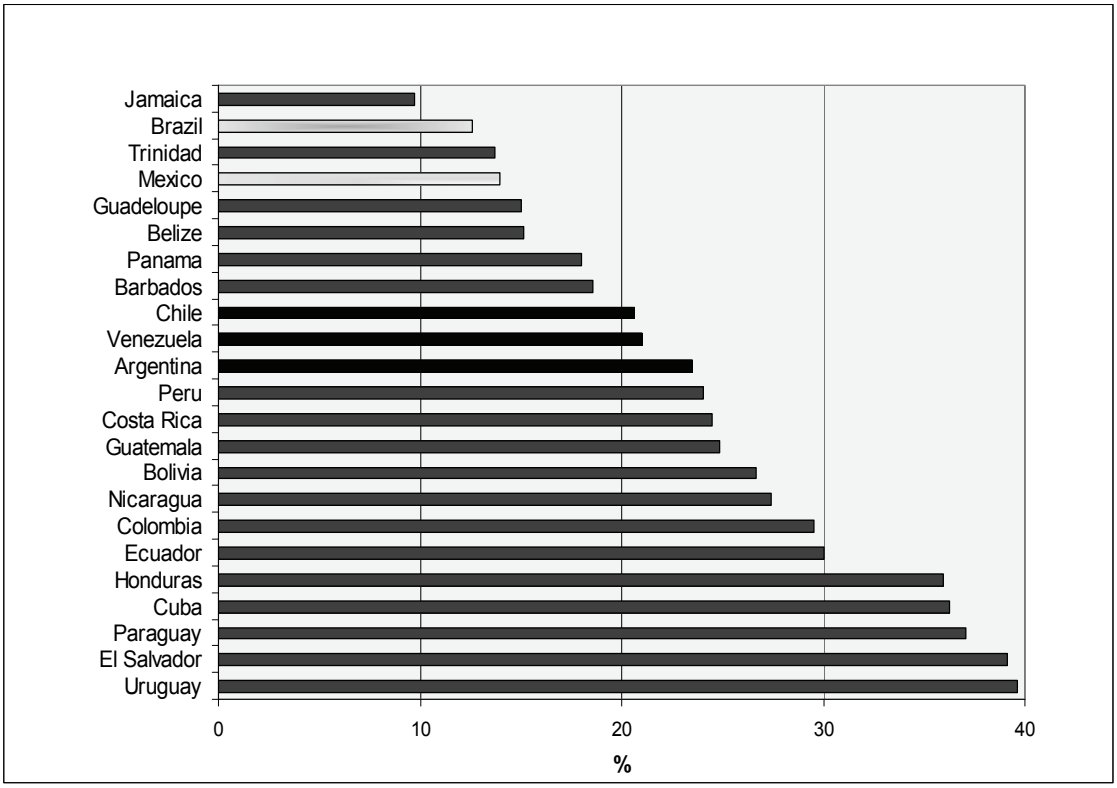
Note: Other int collab refers to publications with no EU-27 involvement.

Intraregional Collaboration

Intraregional collaboration plays a varied role in the region, and generally speaking, the more productive countries co-authored less regionally than the small producers, though there is an overall upward trend in all 23 countries analysed (Figure 14). Exceptions are the English and French speaking Caribbean countries which clearly prefer international collaboration with the mother country and North America.

In the case of large producers in the three year period from 2005-2007, a scarce 15% of Brazil's and 16% of Mexico's international collaboration papers involved at least one other country from the region while the equivalent figure for Uruguay was 45% and Costa Rica, 31%.

Figure 14. Intraregional collaboration as a percentage of all international collaboration 1984-2007.



LAC International Collaborative Research Networks

Taking the period as a whole we see more LAC papers co-authored with European partners than with the US and Canada, 98,155 and 87,540, respectively (Figure 15). However, regional differences exist, while the Southern Cone favours European counterparts, 54% of its internationally co-authored papers as opposed to 44% with the US and Canada, Mexico and Central America look more to North American partnership, 53% of papers compared to 45% with Europe (Figure 16) suggesting that geographical proximity could be a determining factor in this case. For the Caribbean we see a different trend, 55% collaboration with Europe and just 31% with North America pointing towards the possibility of colonial ties influencing the choice of international partners.

In 1984, the US and Canada were more frequent co-authors of LAC than Europe when North America had a 56% share of internationally co-authored papers and Europe, 40% By 1993, the number of papers with Europe had overtaken that with the US and Canada and in 2007, Europe had a 53% share and North America 46%.

Figure 15. Relative percentage weight of LAC collaboration by continent 1984-2007.

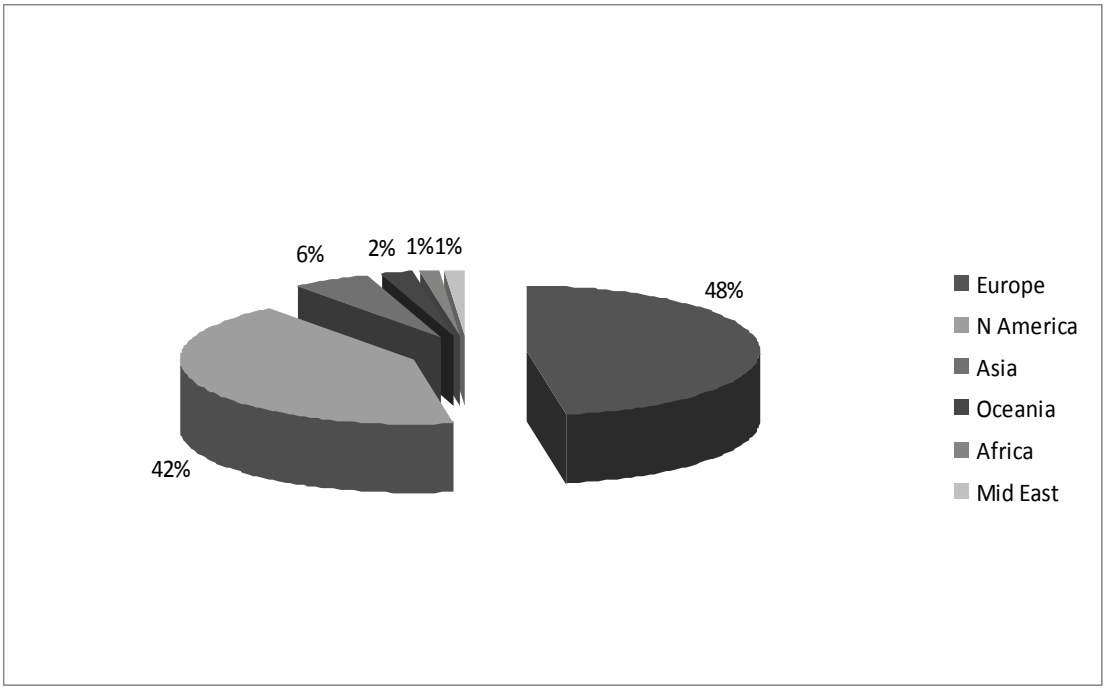
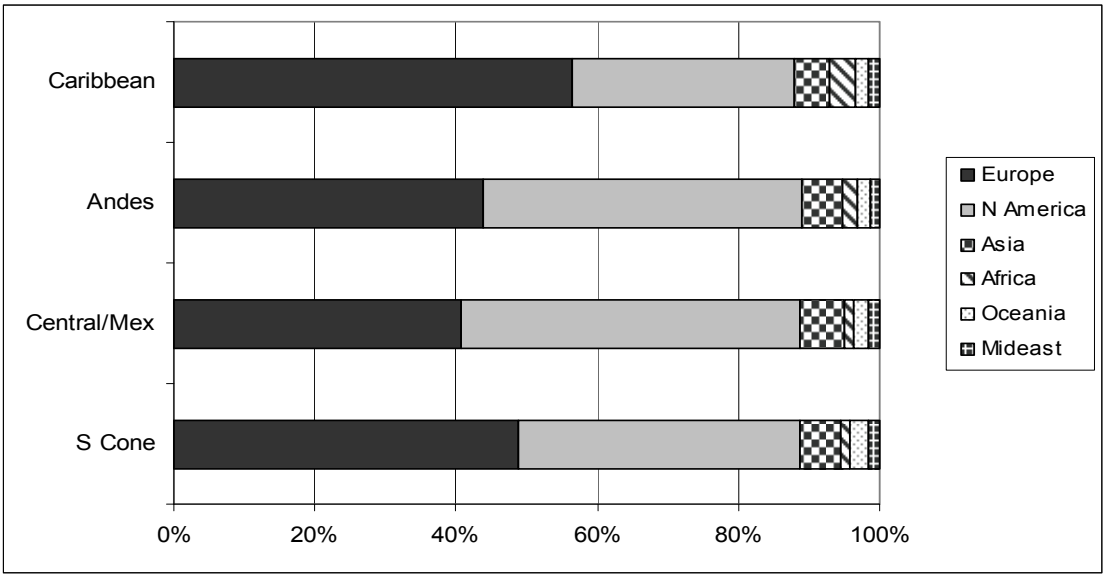
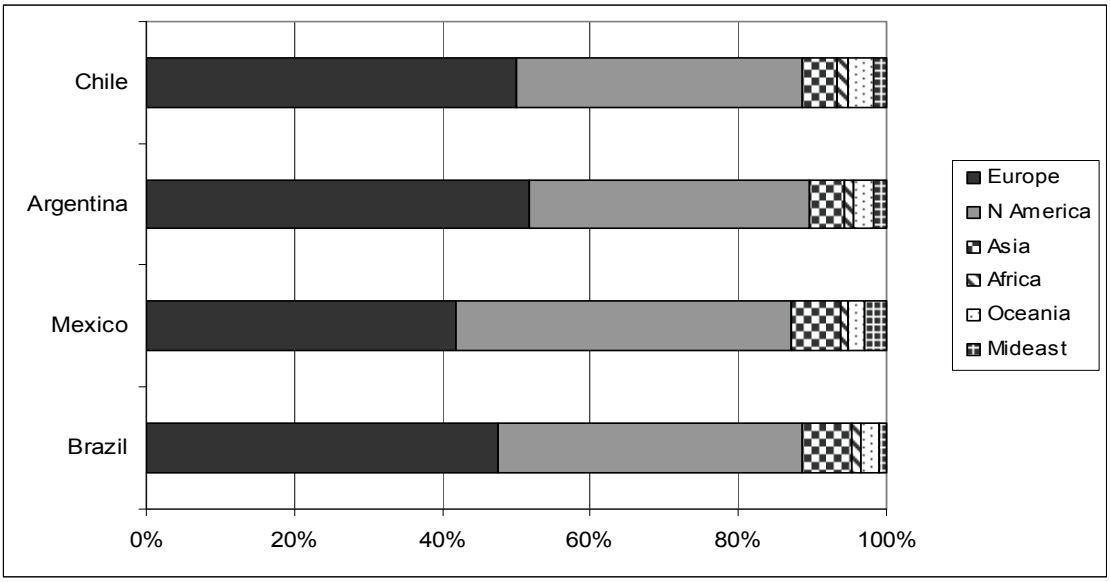


Figure 16. Relative percentage weight of LAC collaboration by continent, by region 1984-2007.



All three Southern Cone countries, Argentina, Chile and Brazil, showed more collaboration with Europe than with the US and Canada during the724 year period, while the opposite was true for Mexico (Figure 17).

Figure 17. Relative percentage weight of LAC collaboration by continent, top producers 1984-2007.

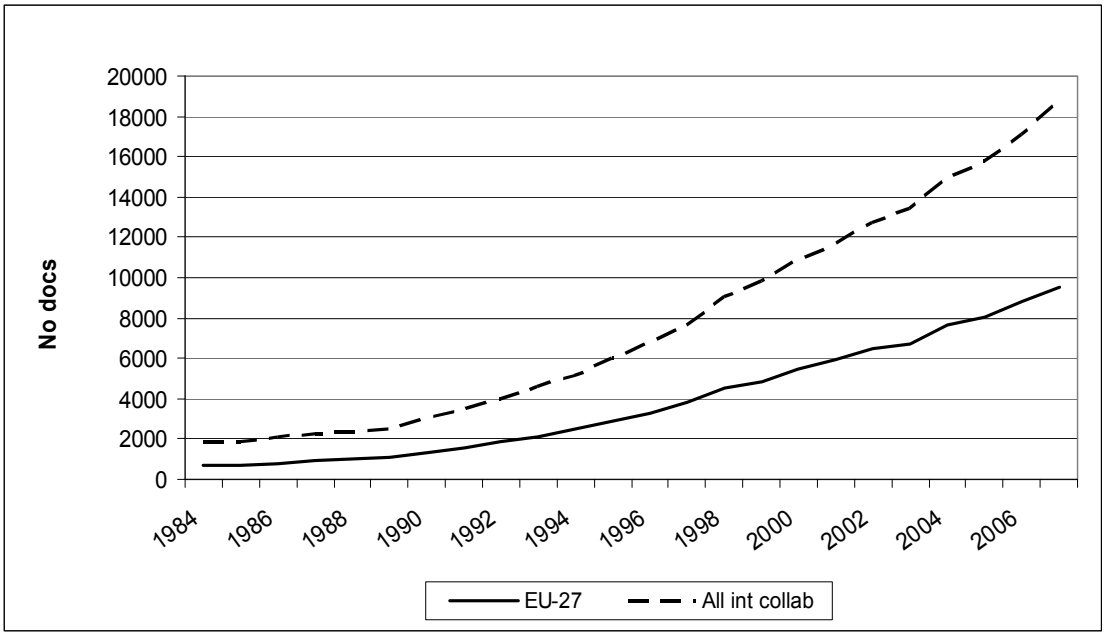


An increasing presence of the EU-27 was apparent since the start of the period accounting for 38% (705) of all LAC internationally co-authored papers in 1984 rising to 51% (9,501) in 2007 (Figure 18).

While the LAC publishes with virtually all European countries the preference for the original EU-15 is notable throughout the period with the EU-12 countries taking priority over all non EU European countries as a group (Figure 19).

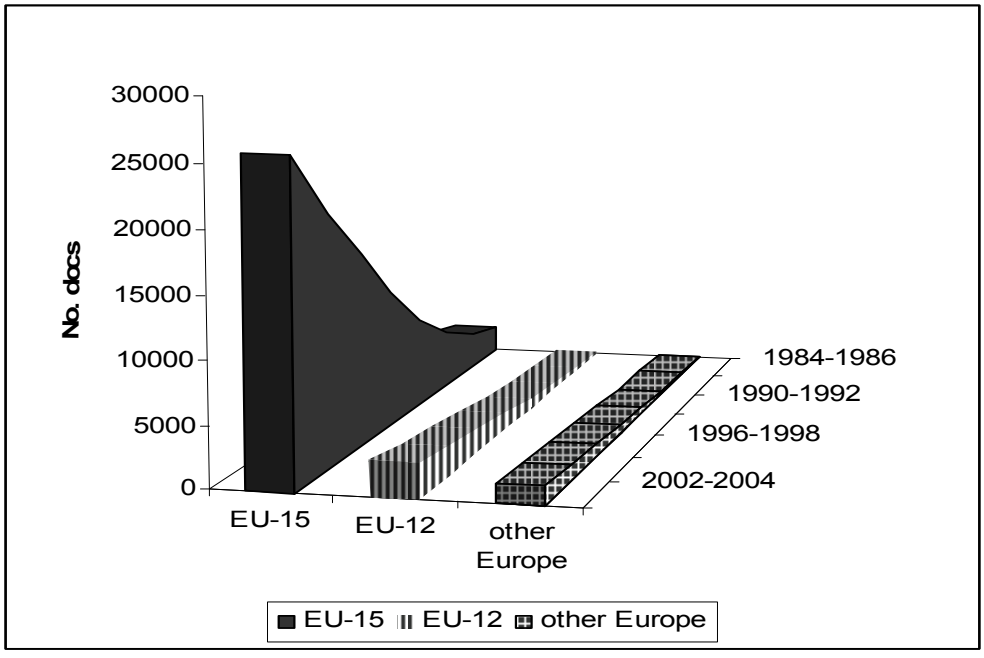
The partnership with the EU-15 is dominant with respect to the four regions and the four most productive countries (Figures 20-21). In all instances EU-15 countries account for more than 80% of internationally co-authored papers except in the specific cases of Mexico where non EU European countries assume a greater importance, a situation also reflected in the Central America and Mexico region. Brazil not surprisingly had the largest volume of papers published with the EU-15 countries, 33,389, followed by Mexico with 15,520, Argentina with 14,951 and Chile with 10,632 (Figure 22). All other countries accounted for 4,000 or less papers.

Figure 18. Relative weight of collaboration in total numbers of LAC publications with the EU-27 countries in all knowledge areas as compared to all international collaboration 1984-2007.



LAC Collaboration with Europe

Figure 19. Numbers of documents in collaboration with the three divisions of Europe 1984-2007



Note: Documents with authors from more than one of the divisions were counted more than once.

Figure 20. Percentage weight of collaboration of LAC publications with the three divisions of Europe, by region 1984-2007.

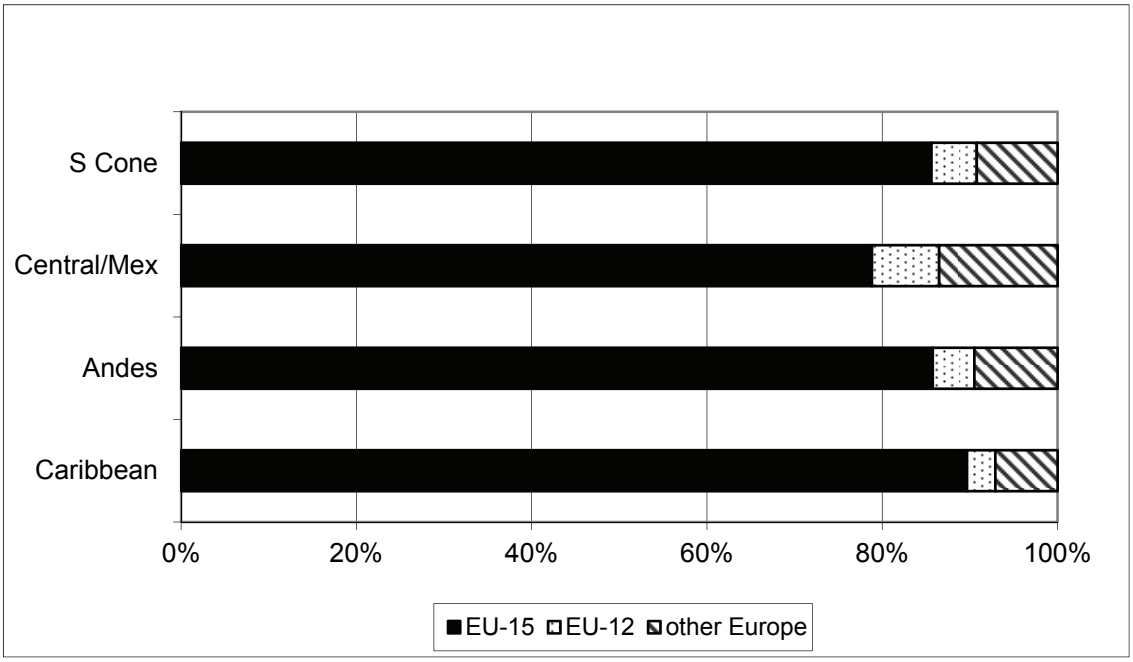


Figure 21. Percentage weight of collaboration of LAC publications with the three divisions of Europe, high producers 1984-2007.

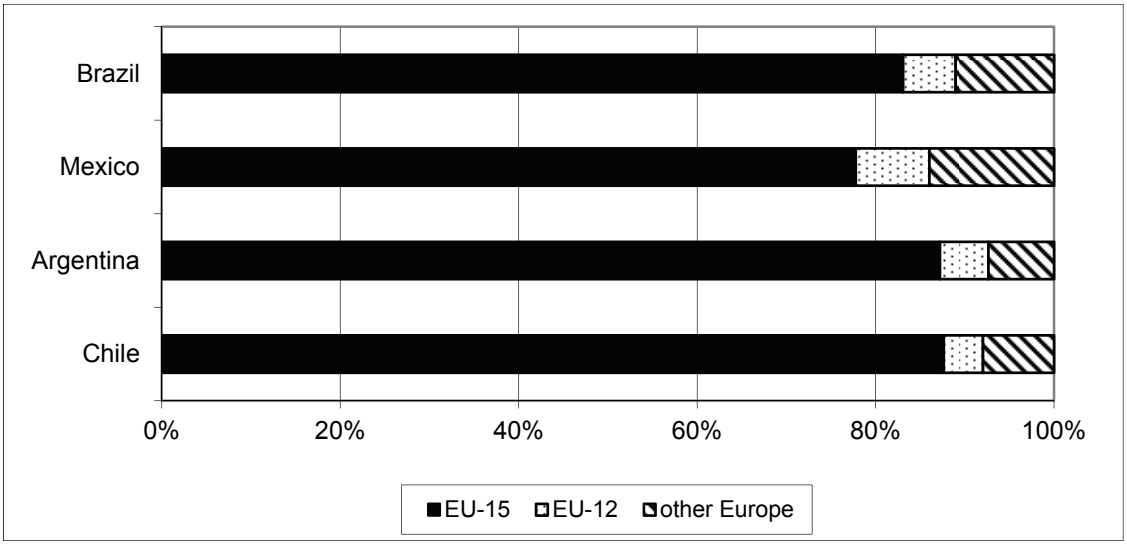


Figure 22. Countries of LAC with most collaboration with EU-15 by country and region1984-2007.

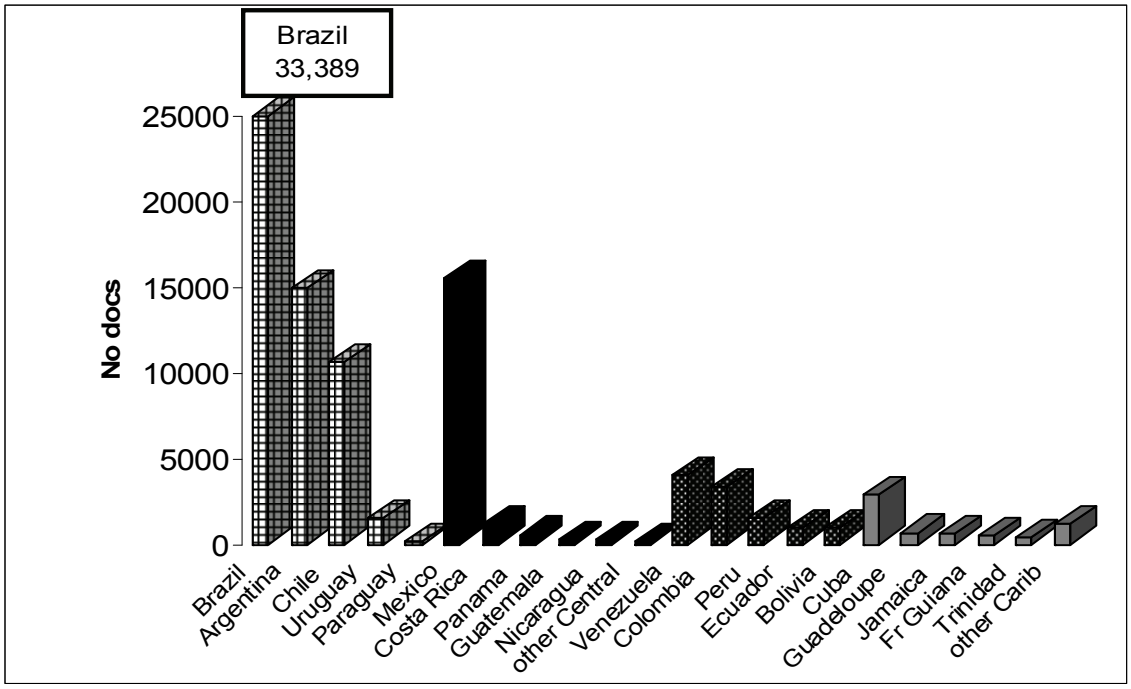
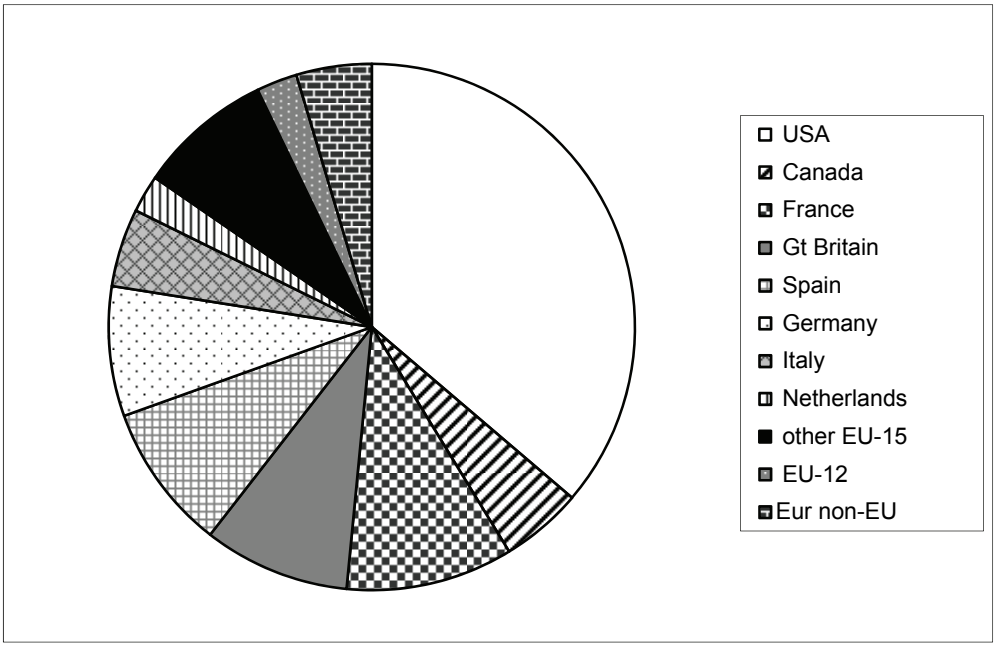
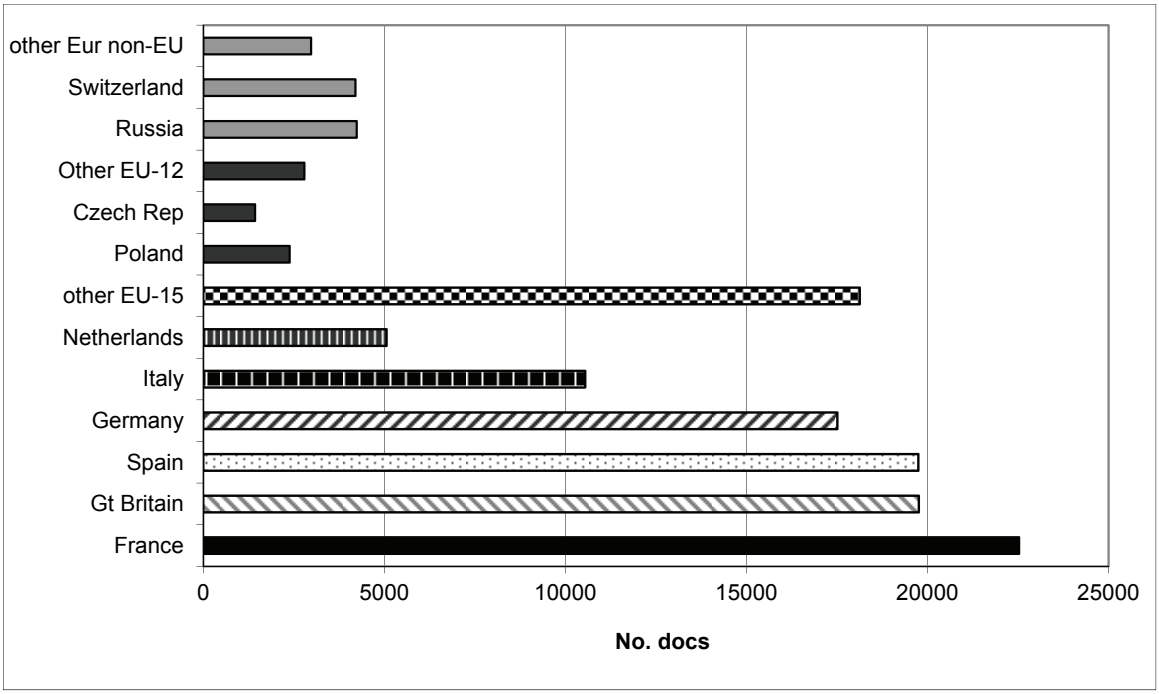


Figure 23. Countries of Europe and North America with most LAC collaboration by country and region 1984-2007.



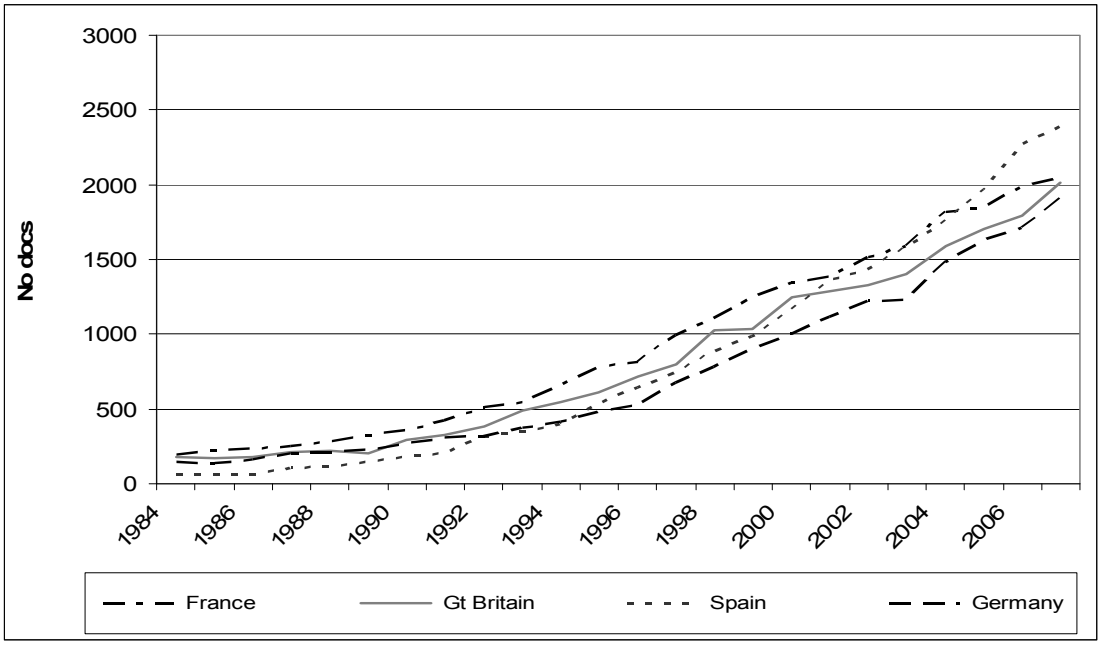
The porcentages of relative participation of the US, Canada and the various European countries are illustrated in Figure 23. The US leads the group with a participation of 36.2%, far outweighing that of any individual EU27 country. Leading the EU-27 participation is France with 10.3%, followed by Great Britain and Spain, both with 9%. Of the newer members of EU, Poland and the Czech Republic are the most frequent partners of LAC with 2,386 and 1,428 papers, respectively, small in comparison with the US total of 79,568 papers, France with 22,529, Great Britain with 19,756 and Spain 19,744 (Figure 24). Germany has 17,506, Canada and Italy trail with 11,037 and 10,544, respectively. All other countries have less than 5,000 collaborations with LAC, including the non-EU countries of Russia and Switzerland with 4,238 and 4,200 papers, respectively.

Figure 24. Countries and divisions of Europe with most LAC collaboration 1984-2007



The relative weight of the four main European partners changed over time. While in 1984 Spain occupied the fourth position with only 62 publications with LAC (compared to 197 for France, 177 for Great Britain and for 149 for Germany) in 2007 Spain had the most publications, 2,387 compared to 2,045 for France, 2,014 for GB and 1905 for Germany (Figure 25).

Figure 25. Main EU partners in LAC international collaboration 1984-2007.



Evolution of Mexico-EU-27 Collaboration

Figure 26. Collaboration of Mexico with European countries 1984-1989.

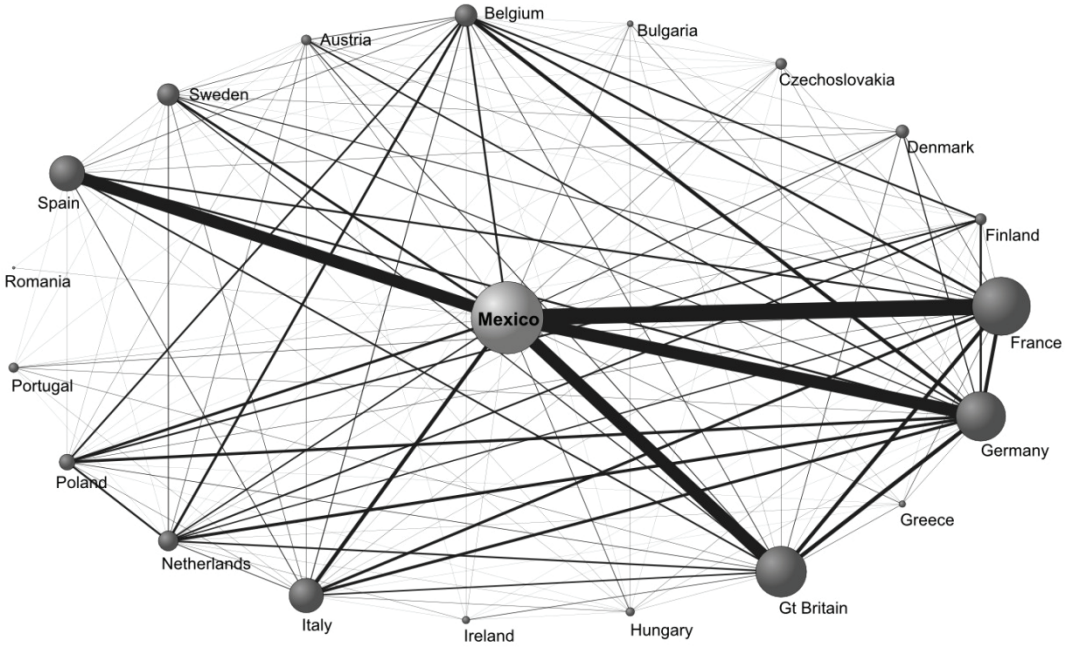
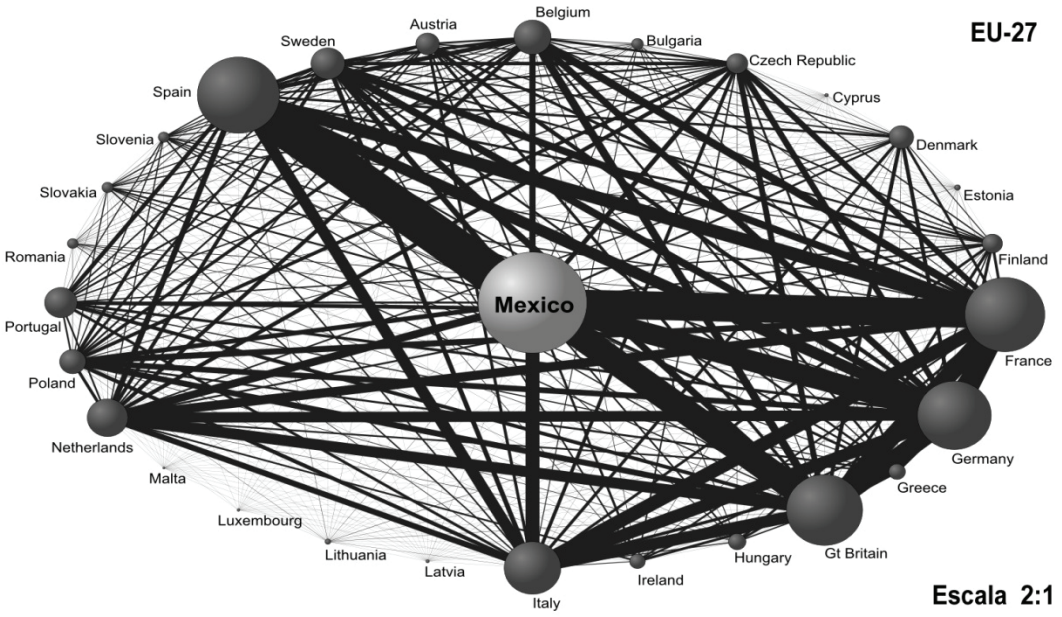


Figure 27. Collaboration of Mexico with EU27 countries 2002-2007.



Taking the first six year period of our study, 1984-1989, and comparing the density of the collaborative patterns using social networks analysis with that of the most recent six year period, 2002-2007, we find a progressively complex network of relations as illustrated by the case of Mexico with the EU-27 countries (Figures 26-27). While the main partners remain the same (France, Great Britain, Spain and Germany) the co-publication ties with other EU-27 countries have diversified, from 19 countries in the first period to 27 countries in the latter. Examples of new and significant partners are as could be predicted from the reorganization of Europe over the last two decades, the newly independent states of Slovakia and Slovenia, as well as countries such as Cyprus. Also worth a mention is the fact that Spain in the last period co-authored more papers with Mexico than any other EU-27 country, no doubt due to a series of factors which must take into consideration the re-establishment of diplomatic relations between Mexico and Spain in 1977 following the death of Franco but more importantly, the progress made by Spanish science since its incorporation into the EU in 1986.

Collaboration LAC with EU-27 and North America

Again looking at the overall regional picture for the 24 years, Brazil is the most frequent co-author of both North America (US and Canada) and the EU-27, than Mexico, Argentina or Chile (Figures 28-29), with little apparent intraregional collaboration, suggesting that a wide range of international partners goes hand in hand with strong scientific performance. Venezuela and Colombia also show a significant number of co-authorships with both the US and Canada, and EU-27.

Figure 28. LAC collaboration with North America 1984-2007.

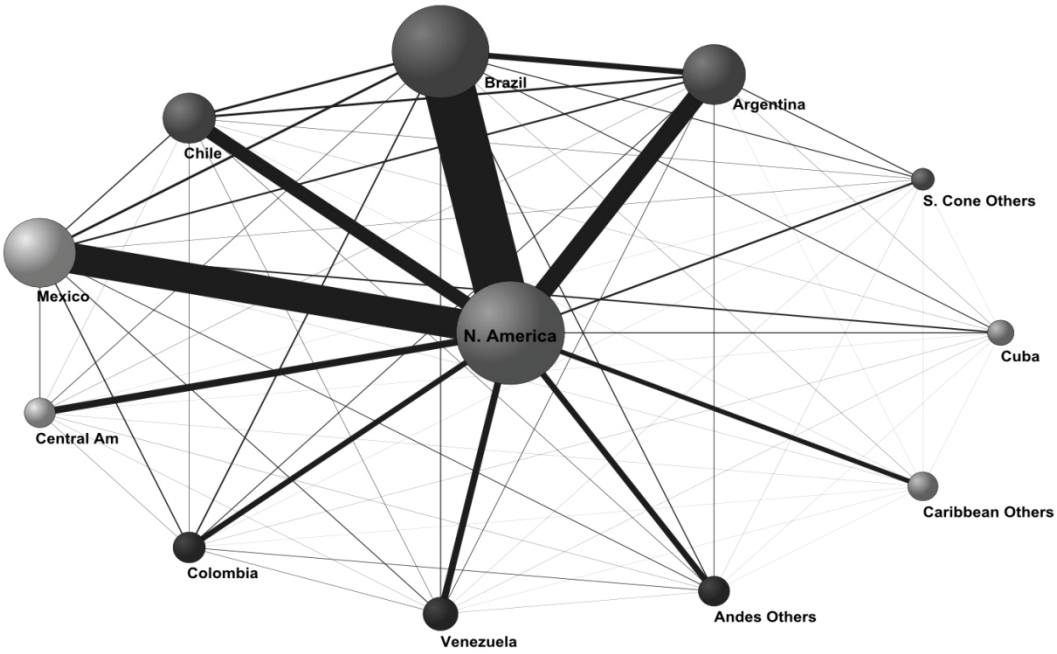
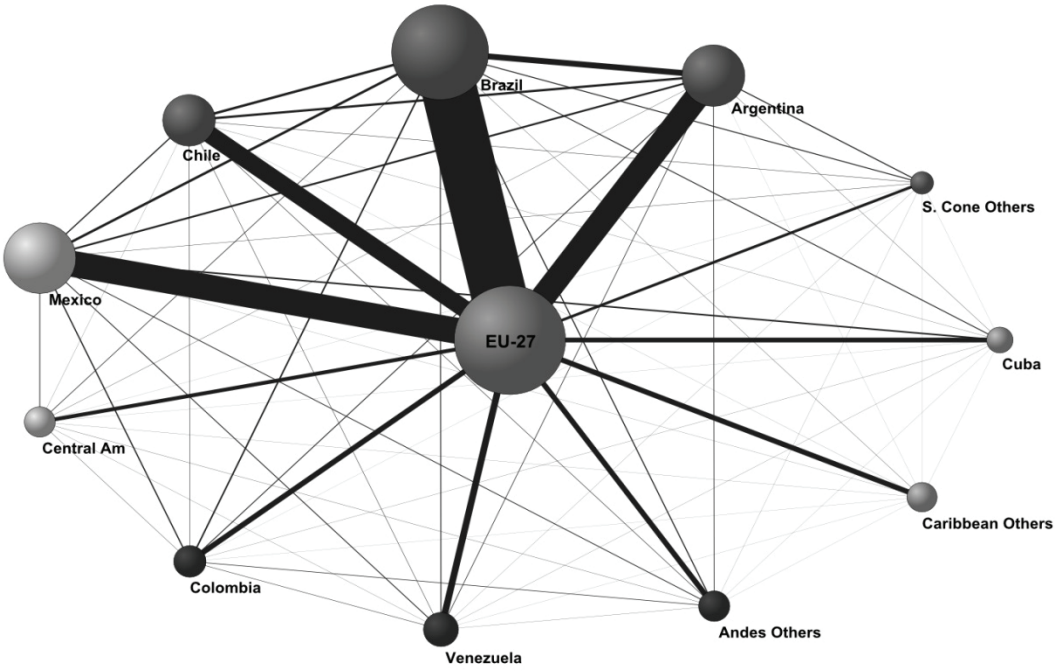
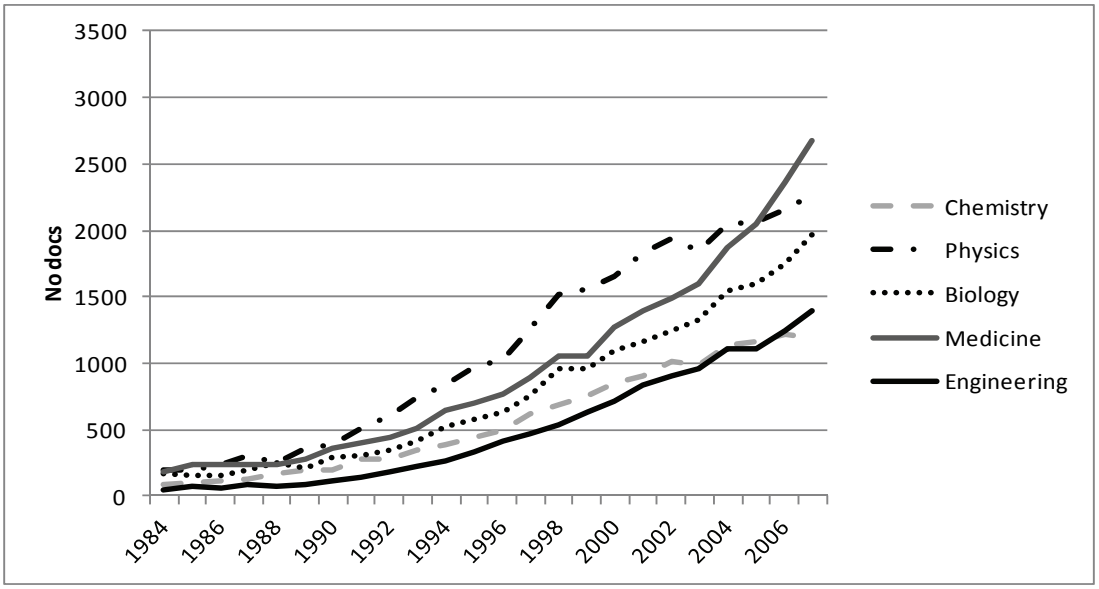


Figure 29. LAC collaboration with EU 27 1984-2007.



From 1984-1986 Medicine was marginally the area of most collaboration of the LAC countries with EU-27, from 1988 it was overtaken by Physics which remained the case until 2006 when Medicine underwent a resurge (Figure 30). All the main disciplines showed steady increases during the 24 years. By 2007 Medicine (2,672) was the area where most papers were published with EU-27, followed by Physics (2,264), Biology (1,964) and Engineering (1,389). The most prominent social sciences, arts and humanities themes in 2007 were Behaviour (119), Society (53), Commerce (48) and Economics (46). Information in the RFCD classification scheme is found together with Computing and Communication Sciences and not as Library and Information Science. Library Science is included under Journalism, Librarianship and Curatorial Studies.

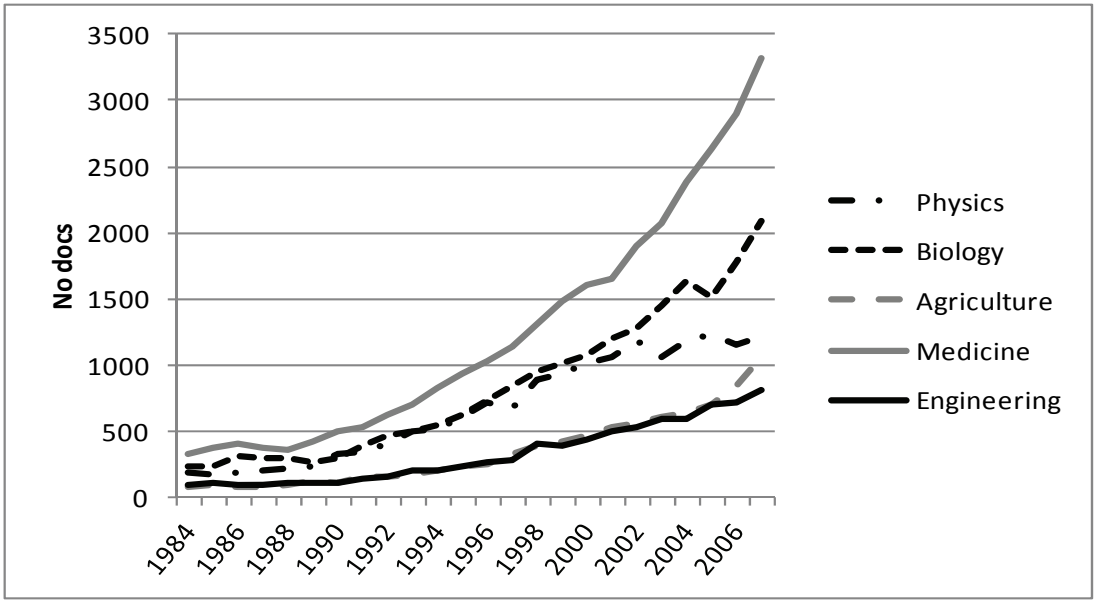
Figure 30. LAC-EU collaboration by main disciplines 1984-2007.



Medicine, Biology and Physics in that order were consistently the main areas of collaboration with the US and Canada throughout the 24 year period (Figure 31). The increase from 1984 to 2007 in the case of Medicine was ten-fold from 331 to 3,321 while Biology at nine-fold, (240 to 2,081) and Physics seven fold (183 to 1,212) showed lesser gains. In 2007, in the social sciences, arts and humanities Behaviour (137) was the subject of the greatest volume of papers, then Society (84), Commerce (68), Humanities (61) and Economics (53).

We can conclude that in general terms the disciplinary patterns of LAC international collaboration do not differ greatly between that with the EU-27 and that with the US and Canada. Developing regions of the world with small scientific communities have certain disciplinary strengths and weaknesses which will be reflected not only in total outputs but also in the collaborative patterns with different regions. This in turn will mainly reflect the strengths and weaknesses of the top producers, in this case, Brazil, Mexico, Argentina and Chile.

Figure 31. LAC-North America collaboration by main disciplines 1984-2007.



Discussion

A steady increase in overall production of mainstream papers and as a percentage of world output of the LAC region seen in the present study has also been noted by other authors. A study likewise conducted on *WoS* data from 1991-2003 showed marked differences between Latin American countries with respect to their percentage contribution to world scientific output, even within the region's most productive countries. On the one hand Brazil and Mexico showed the strongest increase, from 0.65% to 1.61% and from 0.26% to 0.70%, respectively while on the other the share of Argentinean, Chilean and Venezuelan publications grew but at a lower rate, 0.34% to 0.56%, 0.19% to 0.30% and 0.08% to 0.13%, respectively (Glänzel, Leta and Thijs, 2006). These same authors also reported similar trends to those found in our study with respect to the percentage share of papers in international co-authorship for the main scientific producers. While the share of scientific co-publications increased significantly in Mexico, Argentina, Venezuela and Chile, Brazil showed a downtrend. The notable increase in the share of internationally co-authored publications in Brazilian science during the 1980's as well as its decline in the 1990's seen in the present study has been previously reported by Leta and Chamovich, 2002. Our study confirms that this downward trend has continued well into the new century. Also noteworthy from Leta and Chamovich's data is that in the case of Brazil co-publication with Europe had surpassed that with Central and North America by the mid-80s.

The number of co-authorship links between the LAC and other countries as well as the number of countries involved in co-authorships has become increasingly complex even in the case of Brazil which appears to be coming much less dependent on international collaboration to boost mainstream production. In the present study we illustrate the fact by showing increased density of co-authorship networks for Mexican output with Europe

between the period from 1984-1989 and that of 2002-2007 while Glänzel et al. showed the number of links as well as the number of strong links among Brazil and other joint countries increased remarkably in the decade from 1991-2003 (Glänzel, Leta and Thijs, 2006)

In this context of increasing international output of LAC science and rising levels of international collaborative links, co-publication with the EU is seen to take on special importance. Notable players in this scenario are Brazil, Mexico, Argentina and Chile on the one hand and France, Great Britain, Spain and Germany on the other. While no individual EU country approaches the levels of co-authorship of the US with LAC, the region as a whole surpassed North America (US plus Canada) as the number one scientific partner of LAC. It is well documented that the world in general collaborates with the USA, 17% of all papers in international collaboration between 1996 and 2008 involved the USA (The Royal Society, 2011)[1] corroborating its central position in the global scientific network.

The decrease in percentage collaboration with the US of Mexico, a country known for its ties with its northern neighbour, found in the present study was also noted by Lemarchand (Lemarchand, 2008). In their study of Latin American international co-publication patterns from 1986 to 1991 Lewison and co-authors already referred to a strengthening of the European position in relation to that of the US. Furthermore they attributed an increase in the number of mainstream papers in collaboration with the EU to the programme of International Scientific Co-operation which had been active in many countries of the region since the mid-80s (Lewison, Fawcett-Jones and Kessler, 1993).

A steady increase in the production of collaborative papers between LAC and the EU was seen in all the main disciplinary areas with Medicine, Physics and Biology the subject of more papers in the natural sciences. Behaviour, Economics and social aspects of Medicine figured predominantly in the smaller dataset of papers in the Social Sciences. The scant representation of papers in the Arts and Humanities was mainly in History. Important disciplinary differences are seen among individual LAC countries with respect to their co-publication with the EU. Overall the disciplinary pattern of LAC collaboration with the EU differs little from that with the US and Canada.

Also evident from our study is that the smaller LAC countries rely more heavily on international and regional collaboration to boost scientific production than do their more productive neighbours. The percentage of national output corresponding to papers in international collaboration varies from one group of countries to another, smaller nations being known to have high levels of co-authorships with other countries. The recent report by The Royal Society suggests that the rapidly growing scientific nations such as China, India and Brazil are collaborating less than their developed counterparts whose research output is increasingly collaborative (The Royal Society, 2011). Our results demonstrate that papers in international collaboration as a percentage of total output have indeed become less significant for Brazil, dropping from a third in 1994 to a quarter in 2007.

An earlier study on the international cooperation of the European Union between 1985 and 1995 considered four LAC countries, Argentina, Brazil, Chile and Venezuela, in their sample of 10 developing nations. In 1995 as compared to 1985 the percentage contribution of the

[1] The Royal Society report bases its findings on publication data from Scopus published by Elsevier which together with the Web of Science from Thomson Reuters have the most comprehensive coverage of mainstream peer-reviewed scientific journals.

EU to the total output of papers in international co-authorship rose in all four where it represented around 20% (Glänzel, Schubert and Czerwon, 1999).

Towards the end of the period Spain overtook the other EU countries as the main co-author of LAC. Latin American collaboration with Spain in the sciences has increased enormously from when 12 papers were reported in international journals for 1980 and 192 ten years later in 1990 (Galbán and Gómez, 1992). The notable increase even in these initial years is credited in part to the launch of the CYTED programme in 1983. Our count of 62 papers for 1984, the starting year of our analysis, suggests that collaboration was already on the rise even before scientists had access to CYTED funding. The middle of the first decade of the 21st century saw the annual production of papers between LAC and Spain surpass the 2000 mark and by 2007 Spain was the most frequent EU partner for the region.

This finding is perhaps not surprising given the close relationship that Spain shares with Latin America based on long historical associations, a common culture, language, religion and strong investment and trade ties and taking into consideration the remarkable progress that Spanish science has made, particularly since its incorporation into the EU in 1986 making it an important player on the European research stage and on its way to a significant global role (Levine, 2010). Outside the central role played by the industrialised north, historical and linguistic ties between nations are known to determine where collaborations take place (The Royal Society, 2011). The resurgence of a special relationship between Spain and LA and the creation of an Iberoamerican community has brought considerable benefits for both players. In the case of Spain this has been in terms of the internationalisation of her economy and the strengthening of her global political position within the EU and in her relationship with the US. The European Union is the single most important instrument of Spanish foreign policy in Latin America and it is also the resource in which Latin Americans are most interested (Martin, 2002).

As far as intraregional co-authorship is concerned in a study covering the period 1999-2002, Sancho *et al*. drew attention to the lack of regional policies to promote inter-regional scientific networks, leading to a low level of regional collaboration compared to national and international collaboration (Sancho, 2006) with little variation in the period studied. Russell *et al.* (2007a) in a 30 year study of the region, found an increase of 2,000% in intraregional collaboration between the periods 1975-1979 and 2000-2004, and concluded that regional policies have had a positive effect on intraregional collaboration, and that those countries with a historical collaboration tended to formalize these links though regional agreements.

Our analysis covers only mainstream publications which many authors have suggested implies only partial coverage of total production in the case of developing regions of the world such as LAC where output is mainly via national journals poorly covered by sources such as the WoS (Narvaez-Berthelemot, Frigoletto and Miquel., 1992; Fernández, Gómez and Sebastián, 1998; Gaillard et al., 2001; Russell et al., 2007b). However, in the particular case of international co-authorship a recent study on Mexican production for the period 2000-2005 revealed a larger percentage of internationally co-authored documents (43.8%) in the total production of Mexico in non-Latin American journals in the WoS than in a regional database (5.1%). (Russell et al., 2008). This was the case not only in the sciences but also in the social sciences and humanities suggesting that papers co-published with foreign partners in all fields are much more likely to be published in mainstream journals than in national titles.

The picture that emerges from our study is that of a small but rising presence of LAC science on the world stage related to increasing and denser international collaborative networks and particularly to a greater involvement in papers co-authored with the EU. It has been alleged that the funding and sponsorship of the European Commission is a major factor in the fostering of international scientific collaboration and that collaboration of EU countries with non-member countries reflects the increasing role of the EU as a partner of advanced countries, as well as economies in transition and developing countries (Glänzel, Schubert and Czerwon, 1999). Our study reiterates the importance of European partners for LAC science in all major fields of study, particularly in recent years and mainly with respect to collaboration with Spanish, French, British and German institutions.

Acknowledgements

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References

Arenas Valverde, G. (1991) La cooperación científica y tecnológica entre la Comunidad Económica Europea y los países de América Latina: Evaluación ya perspectivas. En: La Cooperación Internacional y el Desarrollo Científico y Tecnológico: Balance y Perspectivas. BID-SECAB-CINDA, Santiago, Chile. p. 111-131.

Butler L, Henadeera K, and Biglia B. (2006). State and Territory based assessment of Australian research. Technical Paper. http://www.pc.gov.au/projects/study/science/docs/technicalpaper1 (accessed 24 February 2012)

Commission of the European Communities (1992). International Scientific Cooperation. Consolidated Report of Activities, 1986-1990. Directorate –General, Science, Research and Development. EUR 13970, Brussels. 191pp.

De Filippo, D., Morillo, F. Fernández, M.T. (2008). Indicadores de colaboración científica del CSIC con Latinoamérica en bases de datos internacionales. *Revista Española de Documentación Científica,* 31(1): 66-84.

EULARINET. European Union-Latin American Research and Innovation Networks (2011). About the project. http://www.eularinet.eu/site/info_about_the_project/language:eng (accessed 24 February 2012)

European Commission (2011). New opportunities for scientific cooperation between Europe and Latin America and the Caribbean. 2011. Work Programmes, 7th Research Framework Programme. http://ec.europa.eu/research/iscp/pdf/lac-focus2011_en.pdf (accessed 24 February 2012)

Fernández, M.T., Agis, A., Martin, A., Cabrero, A. and Gómez, I. (1992). Cooperative research projects between the Spanish National Research Council and Latin American Institutions. *Scientometrics*, 23(1):137-148.

Fernández, M.T., Gómez, I. and Sebastián, J. (1998). La cooperación científica de los países de América Latina a través de indicadores bibliométricos. *Interciencia*, 23(6): 328-337.

Gaillard, J., Russell, J.M., Fullberg, A., Narvaez Berthelemot, N. and Zink, E. (2001). IFS Impact in Mexico. 25 years of support to scientists. International Foundation for Science**,** Stockholm Sweden. IFS MESIA Impact Studies Report No. 3, 152 pp. http://www.ifs.se/IFS/Documents/Publications/MESIA%20reports/MESIA_3_IFS_Impact_Mexico.pdf (accessed 24 February 2012)

Galbán, C. and Gómez, I. (1992). La cooperación científica entre España e Iberoamerica en revistas internacionales. *Revista Española de Documentación Científica*, 15(4): 405-415.

Glänzel, W., Leta, J. and Thijs, B. (2006). Science in Brazil. Part 1: A macro-level comparative study. *Scientometrics*, 67(1): 67-86.

Glänzel, W., Schubert, A. and Czerwon, H-J. (1999). A bibliometric analysis of the international scientific cooperation of the European Union (1985-1995). Scientometrics, 45(2): 185-202.

Lemarchand, G. (2008) The long-term dynamics of co-authorship scientific networks: Iberoamerican countries (1973-2006). http://arxiv.org/pdf/1001. (accessed 24 February 2012)

Lemarchand, G. (2008) The long-term dynamics of co-authorship scientific networks: Iberoamerican countries (1973-2010). *Research Policy,* 41(2): 291-305.

Leta, J. and Chaimovich, H. (2002). Recognition and international collaboration: the Brazilian case. *Scientometrics*, 53(3): 325-335.

Levine, A.G. (2010). Advancing science in Spain: Not simply a Quixotic quest. AAAS/Science Business Office Feature. Focus on Spain. http://www.alainalevine.com/uploads/levine-Science-Spain-6-11-10.pdf (accessed 24 February 2012)

Lewison, G., Fawcett-Jones, A. and Kessler, C. (1993). Latin American scientific output 1986–91 and international co-authorship patterns. *Scientometrics*, 27(3): 317-336.

Leydesdorff, L. and Wagner, C.S. (2008). International collaboration in science and the formation of a core group. *Journal of Informetrics*, 2(4):317-325.

Martin, C. D. (2002). Las relaciones América Latina-Unión Europea: Antecedentes de la importancia e institucionalización del diálogo político. *Revista de Ciencia Política* (Santiago), 22(2): 46-64. http://www.scielo.cl/pdf/revcipol/v22n2/art04.pdf (accessed 24 February 2012)

Narvaez-Berthelemot, N., Frigoletto, L.P. and Miquel, J.F. (1992). International scientific collaboration in Latin America. *Scientometrics*, 24(3): 373-392.

Russell, J.M., Ainsworth, S., Del Río, J.A., Narváez-Berthelemot, N. y Cortés, H.D. (2007a). Colaboración científica entre países de la región latinoamericana. *Revista Española de Documentación Científica,* 30(2):180-198.

Russell, J.M., Gaillard, J., Narváez-Berthelemot, N., Zink, E. and Furó Tullberg, A. (2007b). "Seed money" and publication output in Mexican research: A case study of the International Foundation for Science (IFS) grantees. *Interciencia*, 32(1):14-22.

Russell, J.M., Madera-Jaramillo, Ma. J., Hernández-García, Y. and Ainsworth, S: (2008). Mexican collaboration networks in the international and regional arenas. *Proceedings of the Fourth International Conference on Webometrics, Informetrics and Scientometrics & Ninth COLLNET Meeting.* Humboldt-Universität zu Berlin, 29 July-1 August, 2008. http://www.collnet.de/Berlin-2008/Proceedings-WIS-2008.pdf (accessed 24 February 2012)

Sancho, R, Morillo, F., de Filippo, D., Gómez, I. and Fernández, M.T. (2006). Indicadores de colaboración científica inter-centros en los países de América Latina. *Interciencia,* 31(4): 284-292.

Santa, S. and Herrero-Solana, V. (2010). Producción científica de América Latina y el Caribe: una aproximación a través de los datos de Scopus (1996 – 2007).w *Revista Interamericana de Bibliotecología* (Medellín, Colombia), 33(2): 379-400.

The Royal Society (2011). Knowledge, Networks and Nations. Global scientific collaboration in the 21st century. RS Policy Document 03/11. London: The Royal Society. pp.114. http://royalsociety.org/policy/projects/knowledge-networks-nations/report/ (accessed 24 February 2012)

Wagner, C. (2008). The New Invisible College. Science for Development. Brookings Institution Press, Washington, DC. 157pp.

Research Collaboration between Europe and Latin America

Mapping and Understanding partnership

Scientific editors: **Jacques Gaillard and Rigas Arvanitis**

International collaboration has become increasingly important in carrying out research activities. This book, written by a large group of scholars from Europe and Latin America, maps, analyses and discusses research collaboration between the two continents during the last twenty years. The empirical material underlines the richness and the variety of the links that bind the two continents, well beyond the simplified views of science, either as the brainchild of global networking or as a result of dependence. The book also develops an innovative methodological approach, combining bibliometric analysis, social surveying, in-depth interviews, and a careful analysis of research programmes and policies. While arguing that the asymmetry of relations that once existed in cooperation has turned into a more equal partnership between the two continents, it deciphers some of the reasons behind this more balanced cooperation. It also challenges the view of science as a global self-organising system through collective action at the level of researchers themselves. On the contrary, the importance of policy, institutions, and previously developed research is highlighted and recognised.

Jacques Gaillard and **Rigas Arvanitis** are senior researchers, specialising on Science studies and Research policy at the Centre Population et Développement (Ceped), a unit of the Institut de Recherche pour le Développement (IRD) in Paris, France. They are also members of the Institut Francilien Recherche, Innovation et Société (IFRIS).

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