Chapter 1

Science and technology collaboration between Europe and Latin America: towards a more equal partnership?

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Introduction

Latin America countries (LAC) and Europe are linked by historical ties dating back to the Spanish conquest. These ties continued over the centuries. As a result, the two continents share very close cultural affinities and common views on many issues (Eeuven 2005). As the first colonial outpost of the early-modern European world, Latin America has long witnessed complex processes of cultural cross-pollination, suppression, and adaptation. This leads Latin American authors to argue that it cannot be labelled non-Western without serious qualifications (Cueto & Cañizares Esguerra 2008). LAC have indeed developed S&T collaborations with Europe since the rise of their scientific development. These relationships became institutionalized at the beginning of the 20th century. Between the 1940s and the mid-1970s, LAC witnessed an accelerated process of institutionalization and professionalization of research. Scientific cooperation was first based on hiring foreign research to training or granting scholarships for training abroad, a process that was supported by international technical assistance to Latin American universities and research centres. As illustrated in this book, the notion of international cooperation became more visible in the 1980s and a new type of cooperation was accepted that supported the "theory of mutual benefit" over that of "technical assistance" (cf. chapter 2). In this way, LAC joined a trend that existed at a more global level in the explicit and implicit notions on the role and modalities of cooperation, that we have analyzed earlier (Gaillard 1999). Drawing on the results presented in this book, we will argue that the asymmetry of relations, which was often reported in the 1970s and 1980s, has turned into a more equal partnership between the two continents. The book will also try to decipher some of the reasons behind this more balanced cooperation.

In the early 1980s, the European Union began a political dialogue and encouraged parallel agreements with a few LAC. The first European Framework Programme EU-STD1 "Science, Technology and Development" (1984), contributed to strengthening international collaboration between scientists from Europe and from Argentina and Mexico, which were among the first LAC countries to benefit from this initiative. The 1986-1990 Consolidated Activities Report defines the aims of international scientific cooperation between the Europe and the scientific communities in the lesser developed parts of the world as the development of strong and durable links that enable work to be carried out at the international level, but with the advantage of scientists remaining in their home institutions. The benefit for the European scientists is described as the access provided to new

intellectual environments and the opportunity to apply their skills to a different range of conditions and problems (European Commission 1992). The EC's Seventh Research Framework Programme emphasises new opportunities for scientific cooperation between Europe and LAC, with focus on "innovation and technology for sustainable development and social inclusion" using an integrated approach that embraces the environmental, economic and social dimensions and a balanced involvement of research teams and relevant stakeholders from Europe and the LAC region in the consortia (European Commission, 2011).

The European Union - Latin American Research and Innovation NETwork (EULARINET) reflects this policy. EULARINET is a 4-year project started in 2008 to establish a co-ordination platform composed of leading EU and LAC policymakers, programme managers, eminent researchers and representatives of research entities, universities, the private sector, and civil society. Its purpose is to contribute to the identification of S&T policies and priorities, to define specific activities to promote, support and stimulate participation of LAC researchers in FP7 and to strengthen international S&T cooperation (EULARINET 2011). EULARINET recognises and takes into account the achievements of past and current co-operation with multilateral programmes such as CYTED (*Ciencia y Tecnología para el Desarrollo*) involving Spain and Portugal and 19 LAC countries and national programmes implemented by institutes such as the German *Deutsche Forschungsgemeinschaft* (DFG) and the French *Institut de Recherche pour le Développement* (IRD).

However, not all international scientific partnerships occur under the umbrella of cooperation programmes. According to several authors (e.g. Wagner 2008), the decision to work together is essentially a personal one based on mutual interests and complementary skills, and international collaboration functions as a global self-organising system through collective action at the level of researchers themselves (Leydesdorff & Wagner 2008). The latter views of scientific collaboration stressing and focusing on the individual researcher alone need to be qualified. The researcher is presented as the hero of international collaboration taking decisions where individual interests would be the main driver; the pitch of this explanation is based on the idea that the individual recognizes potentially interesting collaborators and is able to evaluate and size the expected outcomes of the planned collaborations. This could probably be the case for experienced and relatively senior researchers who enjoy world repute. It does not reflect the case of younger researchers who usually do not have access to all potential choices for initiating successful and fruitful collaboration. Moreover, for an individual to be able to objectively "choose" his collaborations, he/she needs to be embedded in his/her local environment, institutionally, politically and economically. The existence of a local scientific community as well as the institutionalization of scientific activity play a very important role here since it is through the participation in local training and local scientific teams that the young individual scientist can become increasingly involved in international collaborations. Personal decisions are important but choices are also influenced by other factors that go far beyond what we are usually ready to accept when assuming that international scientific collaborations are beneficial. A possible way to examine what constrains and influences decisions to collaborate would be to scale the issue at different levels:

- the national policy environment (and more recently the policy environment and instruments at the researchers' institution, which are usually related to the national level) that directly affects the decision to collaborate on the basis of the tools and

instruments available for the scientific collaborations but also, indirectly, on the basis of the national political and economic context;

- the international level involving wider networks of collaborations through which scientists can find opportunities for international collaborations. This level should include global issues as well as actors that are very active at an international level (e.g., the large pharmas);
- finally, the individual level, choice of discipline, career pattern and personal contacts.

By using these different levels and the multiplicity of roles scientists can play, we can go beyond the limits of the above-mentioned 'heroic' and individualistic vision of international collaboration. As we will argue here, this heroic vision is related to a situation of research that is not valid in most Latin American countries.

1. Brief literature review

International cooperation and mobility has almost become an essential element of academic career and impact. But despite a long history of cross-border cooperation between researchers worldwide, there are very few large empirical studies on the main drivers of international collaboration in science and technology (S&T).

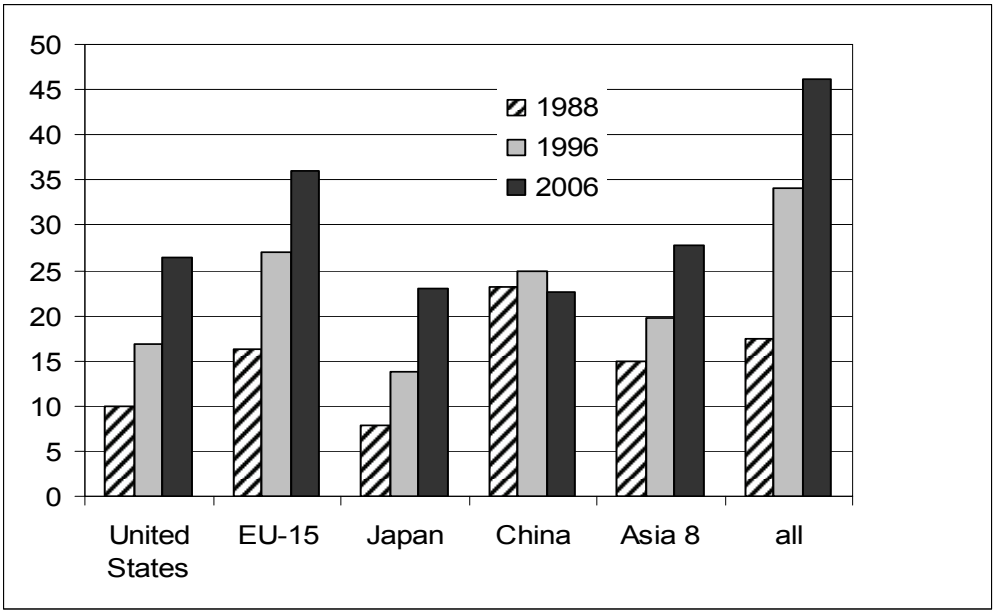
The determining factors of international collaboration in S&T are based on a wide range of rationales that go beyond the sole S&T rationales and objectives (Gaillard 2001; Wagner 2008). International co-authorships, for example, occur along clearly discernible geographic lines, suggesting that extra-scientific factors (for example, geography, politics, language) play a strong role in determining who collaborates with whom in the international scientific community (Frame & Carpenter 1979). Luukkonen *et alii* (1992) identify social, historical, geopolitical and economic factors as potential drivers of international collaboration in S&T. In a book published some ten years ago, we argued that S&T cooperation policies for development (as part of development aid policies) are based on a variety of complex factors that are often interdependent, including political, diplomatic military, economic humanitarian and scientific factors (Gaillard 1999:272). When analysing the rationales behind international research collaboration, a more recent study published by the European Commission distinguishes between "the narrow Science, Technology and Innovation (STI) cooperation paradigm" and the "broad research cooperation paradigm" (Boekholt, Edler, Cunningham & Flanagan 2009). In the former paradigm, the purpose of the drivers is mainly "to improve the quality, scope and critical mass in research by linking national resources and knowledge in other countries". In the later paradigm, other non-science policy objectives interact with the "intrinsic" science-oriented objectives. For example, the urgency of tackling global societal challenges has led to discussion on more global research programmes. Other drivers such as diplomacy and historical cultural ties between countries and development or bilateral aid have long influenced the choice of partners and may still constitute a backstage influence.

As a result of the growing complexity of science, the ease of face-to-face contact, the Internet, and government incentives, S&T activities are being conducted in an increasingly international manner (Figure 1 below). The indicator most often used to capture the scale or

intensity of international collaboration in S&T is co-publications of authors from two different countries. Co-publication analysis can tell us something about the relative importance of international collaboration that leads to tangible outputs (publications) and the nature of the cooperation in terms of countries and disciplines (e.g. Adams, Gurney & Marshall 2007; Edler, Fierb & Grimpe 2011; Edler & Flanagan 2009; Glänzel 2001; Mattsson, Laget, Nilsson & Sundberg 2008; Schmoch & Schubert 2008).

In 2006, for instance, 30% of the world's scientific and technical articles had authors from two or more countries, compared to slightly more than 10% in 1988. One-quarter (26.6%) of articles with U.S. authors had one or more non-U.S. co-authors in 2006; the percentage is more or less similar in the Asia-8[1] and slightly lower for China and Japan (NSF and OST 2008). Between 2001 and 2006, international co-publications increased in all countries except China, Turkey and Brazil. The higher EU-15 level (36% in 2006) partly reflects the EU's emphasis on collaboration among the member countries as well as the relatively small science base of some EU members. Other countries' high levels of collaboration (46% in 2006) reflect science establishments that may be small (e.g. developing countries) or that may be in the process of being rebuilt (e.g. Eastern European countries).

Figure 1. Share of scientific publications with international co-authorship, by country/region (1988, 1996 and 2006)



Source: Thomson ISI and SCI, NSF and OST computing 2008 (Gaillard, 2010)

[1] Asia-8 is composed of South Korea, India, Indonesia, Malaysia, Philippines, Singapore, Taiwan and Thailand.

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 (Lewison, Fawcett-Jones & Kessler 1993; Narváez-Berthelemot, Frigoletto & Miquel 1992), followed by Fernández and co-workers (Fernández, Gómez & Sebastián 1998). In more recent years Lemarchand has looked at the co-author networking of Ibero-American countries for the period 1973-2006 (Lemarchand 2008). The co-production of Spain with LAC has received special attention (De Filippo, Morillo & Fernández 2008; Fernández, Agis, Martin, Cabrero & Gómez 1992) as has the intraregional collaboration of LAC institutions (Russell, Ainsworth, del Río, Narváez-Berthelemot & Cortés 2007; Sancho, Morillo, de Filippo, Gómez & Fernández 2006). Other studies have included international co-authorship patterns as part of a general analysis of scientific production within the LAC region (Santa & Herrero-Solana 2010).

Figures two and three illustrate the relative growth of the share of publications co-signed with foreign authors in the LAC countries in 1985 and 2010-2012 respectively. They indicate a rapid and tangible increase in internationalisation of science in all countries. In general, with the exception of Guyana, the larger the country and the national scientific community, the smaller the share of publications signed with foreign co-authors.

Thus, Brazil, the LAC country with the largest scientific community and highest scientific production, has the lowest share of scientific publications in international co-authorship (co-signed with foreign co-authors), although this share rose from less than 20% in 1985 to 33.5% in 1995, but it then fell to 26.5% in 2011-2012. As mentioned earlier, Brazil is one of the very few countries (with China and Turkey) that experienced a relative decrease of its share of scientific publications co-signed with foreign co-authors during the last decade.

All other LAC countries continued to increase their share of scientific publications co-signed with foreign co-authors during the last 20 years although the top scientific producers (including also Chile, Argentina and Mexico) have been experiencing a downturn during the last few years (cf. chapter 3).

Further, within this increasingly globalised scientific literature, the internationally co-authored papers receive a higher citation impact than papers written by national authors (Glänzel, Debackere & Meyer 2008)[2].

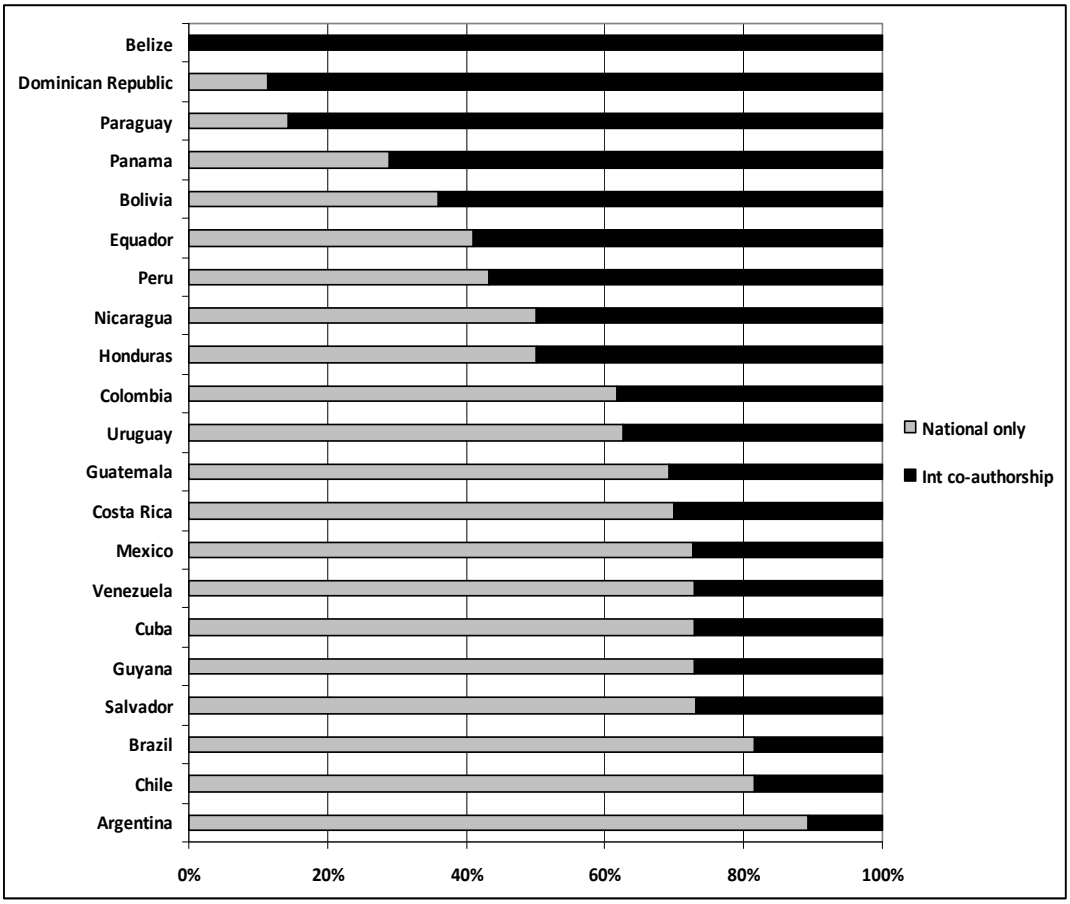
Other patterns of international scientific co-operation are worth considering:

- the more basic the field of research, the greater the proportion of international co-authorships (Frame & Carpenter 1979);
- the larger the national scientific enterprise, the smaller the proportion of international co-authorship (Frame & Carpenter 1979);
- humanities and social sciences remain rather less internationalised than natural sciences (Hogan, Zippel, Frehill & Kramer 2010);

[2] More recently Schmoch and Schubert (2008) have raised doubts as to whether the higher citation counts observed for international co-publications are a strong and unambiguous indicator of higher quality, given that higher citation can also be a result of the larger size of a community and the international nature of its work.

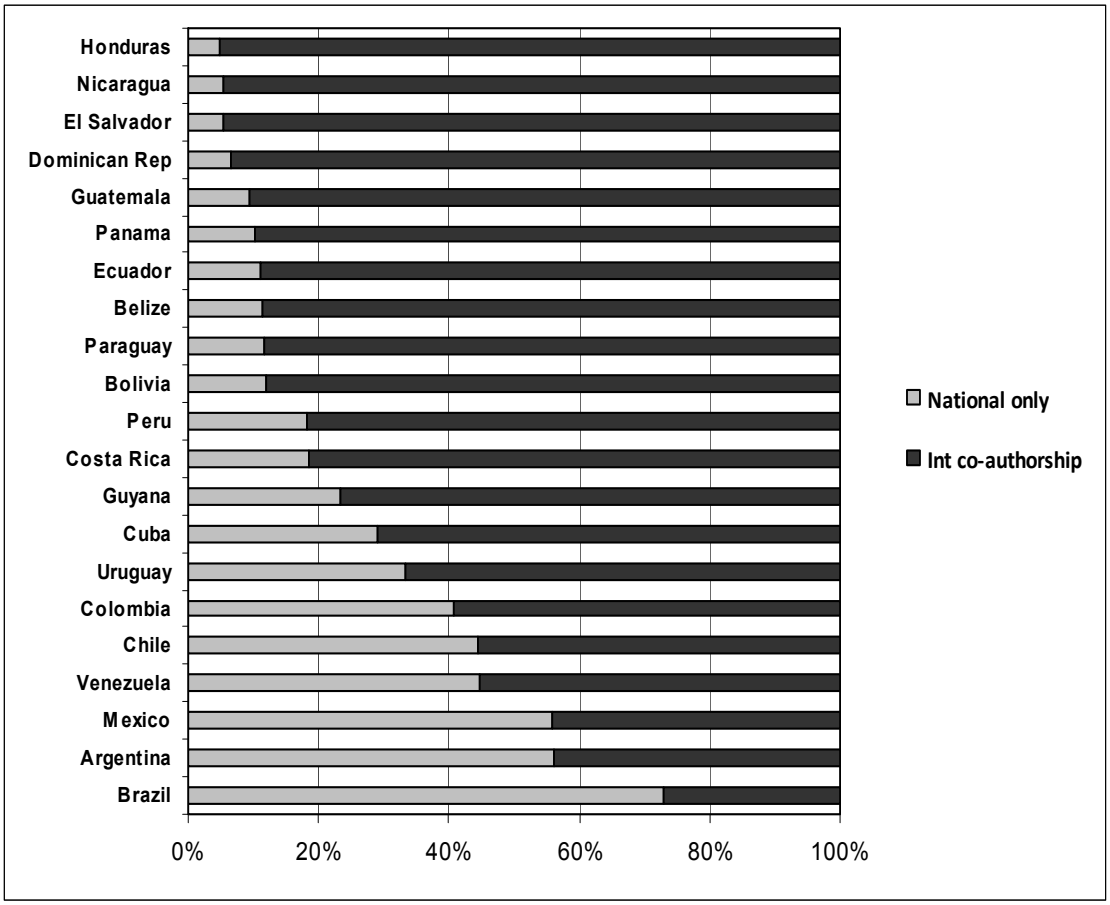
- scientists from non-English speaking and less developed countries experience particular difficulties in "breaking into" international journals covered by WoS/SCI (Arvanitis & Gaillard 1992; Gibbs 1995).

Figure 2. Share of scientific publications with national and international co-authorship in LAC countries in 1985



Source: WOS and UNAM computing, 2010

Figure 3. Share of scientific publications with national and international co-authorship in LAC countries in 2011-2012



Source: WOS and UNAM computing, 2013

There are many reasons for researchers to want to engage in international collaboration. The following list compiled by Edler and Flanagan (2009) attempts to convey what broad consensus exists in the literature on international collaboration about motivations and drivers although the relative importance attributed to these motivations by different authors may vary. Amongst the motivations and drivers emphasised in the recent literature (e.g. Archibugi & Iammarino 1999; Beaver 2001; Bozeman & Corley 2004; Edler, Fierb & Grimpe 2011; Edler & Flanagan 2009; UNCTAD 2005; Wagner 2006; Wagner 2008) include:

- access to and acquisition of cutting-edge and complementary know-how,
- access to foreign technology markets

- the sharing of costs and risks with international partners, especially when large infrastructures are needed for basic science (e.g., particle accelerators) or product development (e.g., international telecommunication networks),
- a combination of skills and data located in different countries to tackle issues too complex for researchers from one location,
- the identification of solutions to complex scientific and technical problems that could not be solved with domestic resources alone,
- access to funds from foreign institutions and/or programmes,
- access to skilled individuals who might have an interest in pursuing opportunities for research in another country (recruiting),
- access to endemic research subjects, such as natural or social phenomena, etc. which are limited geographically,
- a desire to influence regulatory regimes or standards,
- improvement of the impact and visibility of one's research (see above).
- fun and pleasure.

A longitudinal survey that follows recipients of research doctorates from U.S. institutions until age 76, NSF found out that 30% of the recipients collaborate internationally, (23% of the female and 33% of the male recipients) (NSF 2009). This rare dataset on international collaboration derive of the National Science Foundation's 2006 Survey of Doctorate Recipients (SDR), analysed by sex, research/teaching faculty status, sector of employment (industry, government, academia), minority status, citizenship, presence of children in household, field of study of doctorate, and year of doctorate receipt. Selected results of the data indicate that:

- research faculty have a higher rate of international collaboration than teaching faculty;
- doctorates employed in business/industry are more likely to collaborate internationally than those employed in government or academia;
- female doctorates are less likely to collaborate internationally than male doctorates;
- the presence of children in the household does not deter female doctorates from international collaboration but their presence appears to be associated with increased international collaboration among male doctorates;
- there is little difference in international collaboration between doctorates that are U.S. citizens and doctorates that are not U.S. citizens;
- doctorates with degrees in engineering and the physical sciences are more likely to collaborate internationally than doctorates with degrees in other sciences;
- doctorates that are in mid-career stages are more likely to collaborate internationally than doctorates that are in early or late career stages.

- in an international collaboration, foreign collaborators are more likely to travel to the Unites States than for U.S. collaborators to travel abroad.

The cross-border movement of researchers constitutes another factor contributing to the growing internationalisation of science and technology. Whilst the migratory flow of researchers is as old as science itself, there is convincing evidence that the mobility of highly educated people has increased during the last (Dumont, Spielvogel & Widmaier 2010). The impact of the international mobility of highly educated people in non-OECD countries may vary from country to country. The most developed countries do not seem to be significantly affected and may indeed benefit from the direct or indirect outcomes of the emigration of their elite (in terms of remittances, return, transfers of technology and scientific watch) (Docquier & Rapoport 2007). On the contrary, in small countries like Caribbean and small African countries that suffer a critical shortage of skills, the emigration of highly educated people severely affects the countries given the fact, well documented now, that the smaller the national resource base of highly skilled people, the higher the percentage of highly skilled expatriates (Docquier & Marfouk 2006).

The conclusion to this brief literature review is that there is no single factor driving S&T international cooperation and/or collaboration. In most cases, there is a cumulative set of factors and/or actions by multiple actors that shape the geographical, institutional and thematic focus of international partnerships in S&T.

2. Contents of the book: summary of the main results

The chapters compiled in this volume are tacking stock of several complementary studies developed within the framework of an EC-funded coordination and support action programme called EULAKS (Connecting Economic Research on the Dynamics of the Knowledge Society in the European Union and Latin American and Caribbean Countries (EULAKS) to map, analyse and understand the main trends and characteristics of S&T Collaboration between Europe and Latin America.

These studies include a survey of policies and programmes developed by Latin American countries to promote international cooperation (1960 to today), a bibliometric analysis of co-authorships between Europe and Latin America (1984-2007), a review of FP6 and FP7 projects involving Latin American countries as well as the results of a questionnaire survey and in depth interviews of Latin American scientists. These studies are summarized below.

2.1. Policies and programmes developed by Latin American countries

The second chapter authored by Feld, Casas, López, and Vessuri compares the cooperation policies and strategies of several countries of the region i.e. Argentina, Brazil, Mexico and Venezuela, starting with the institutionalization of science and technology policies from the 1940s to the 1970s and continuing with a selection of priority areas to form a common strategy in the 1970s and 1980s.

Between the 1940s and the mid-1970s, Latin America underwent a reconfiguration of research activities, during what was called the “golden era” of national science. This implied, on the one hand, an accelerated process of institutionalization and professionalization of research and, on the other, the consolidation of science and technology policy through the

creation of new government agencies, such as the national research councils (first in Brazil and Argentina, and later in Mexico and Venezuela). To a large extent, the scientific cooperation policy of these new institutions was based on hiring foreign researchers to train national scientists or allocate scholarships for training abroad. The "golden era" of national science coincided with the "golden age" of international technical assistance to Latin American universities and research centres, led by several national public organisms and American foundations, and also overseen by international agencies such as the International Council of Scientific Unions (ICSU)[3], the United Nations Educational, Scientific and Cultural Organization (UNESCO), and somewhat later the Organization of American States (OAS).

After the 1970s some of the changes occurred in the paradigm of science policy and in the notion of international cooperation; they became more visible in the 1980s. While cooperation aimed at increasing the "critical mass" of human resources and the infrastructure sustaining research activities, the new paradigm, spread by international organisms and adopted locally in the 1970s/1980s, implied the integration of international cooperation into the national science and technology policy and priorities. Progressively, cooperation was redirected to be of "mutual benefit" rather than of "technical assistance". This trend coincides with the changes in cooperation modalities at a more global level (Gaillard 1999): until the 1970s the international cooperation was characterized as "technical assistance", between 1970 and 1980 as "Problem solving" and since 1980 it was based on a principle of "mutual benefit. In Latin America, the "technical assistance" mode fostered some cooperation projects, initiated by the countries themselves, between Argentina and Brazil without intervention of other foreign / international agencies. Substantial changes took also place in the 1990s, within the frame of globalization processes, and research internationalization that led to new forms of collaboration, both with North America and the European Union, in the framework of large international networks and the internationalization of higher education.

Since the mid 1990s, responding to European policies, several Latin American countries set up collaborative funds with the framework programs to support initiatives of collective projects proposed by Latin American research teams in consortium with several European groups. Examples are the *Fund for Scientific and Technological Research* (FONCyT), in Argentina, or in Mexico the European Union *Fund of International Cooperation in Science and Technology European Union-Mexico* (FONCICYT). These initiatives reinforce the tendency of Latin America to cooperate with developed countries as shown by bibliometric studies of co-publication in the next section. However, during recent years, some countries of the region have also begun to establish bilateral agreements with developed and developing countries thus strengthening also south-south cooperation. In a more complex scheme, Argentina and Brazil have also diversified the scope of their international relationships: scientific and technological agreements have been signed with China, Angola, Mozambique, Israel, Russia, Cuba, and various other African countries.

Another major trend focused on the reconnection and use of the diaspora of national scientists living abroad. In 2003, Mexico launched the Networks of Talents for Innovation aimed at integrating the Mexican diaspora and creating business opportunities based on innovation, and the *Raices* Program (Network of Argentine Researchers and Scientists

[3] In 1998 the name was changed to International Council for Science but the acronym, ICSU, remained the same.

Abroad) was created in Argentina in the mid-2000s. Among the older such experience is the Caldas network set-up in the nineties but the national council of science of Colombia.

Finally a third trend stems from the need for in-depth transformation in the region to achieve social inclusion. Following this trend, new strategies to orient scientific cooperation are being developed to achieve not only social inclusion, but also to alleviate poverty, and confront local and regional social problems.

2.2. Bibliometric analysis of co-authorship (1984-2007)

The objective of the third chapter authored by Russell and Ainsworth is to map the characteristics and trends in collaborations 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 starting in 1984, the year of the first European Framework Programme STD1 “Science, Technology and Development”.

As shown in this chapter, 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. This represents a steady increase in overall production of mainstream papers and in the LAC region’s rank, expressed as a percentage of world output. With the growth of overall production, the percentage of the world share of publications (science areas only), from the LAC region rose in recent years, from 1.5% in 1990 to 4.29% in 2008 indicating a small but increasing presence on the world stage.

Brazil is by far the regional leader in number of 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 second position from Argentina at the beginning of the 1990s and increased its lead from the turn of the new century onwards. Both Argentina and Chile significantly decreased their percentage of contribution, Argentina from 21-13% (2,020-7,001) and Chile from 13-8% (1,279-4,319).

With regard to international co-authorship patterns all regions and the top four producers showed a similar trend. 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 percentage for Mexico rose from its 1984 level (26%) until 1998 when it levelled off at 40% while Argentina showed a steep rise from a mere 10% at the beginning of the study period reaching percentages similar to Mexico by 2007.

The top four LAC producers which contributed 80% of the total output of 182,941 papers in international collaboration (excluding social sciences), followed similar overall patterns with respect to their scientific disciplinary focus for the period as a whole. 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%), Mexico (22%) and Argentina (22%). Biology is an important area of collaboration in all four countries (Argentina, 19%; Mexico (16%); Brazil, 16%; Chile, 15%). Engineering is given more weight by Mexico (12%) than by the other countries (Brazil, 10%; Argentina, 8%; Chile; 7%).

Taking the period as a whole we see more LAC papers co-authored with European partners (98,155) than with the US and Canada (87,540). 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) 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 internationally co-authored papers than Europe: North America, 56% and Europe, 40%. By 1993, the number of papers co-authored with Europe had overtaken that with the US and Canada and in 2007, Europe had a 53% share and North America 46%.

The partnership with the EU-15[4] is dominant with respect to the four regions and the four most productive countries. In all instances EU-15 countries account for more than 80% of internationally co-authored papers except in the specific case 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. All other countries accounted for 4,000 or less papers.

France is the leading collaborating country of the EU-27[5] 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. 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. However, 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 Great Britain and 1905 for Germany.

2.3. A review of Framework Programme 6 and 7 projects involving Latin American countries

In this third study and fourth chapter, all projects funded by FP6 and FP7 up to April 2010 in which Latin American groups and institutions participated were considered and analyzed. Basic statistics such as total number of projects and the magnitude and distribution of the funds involved, as well as specific features such as thematic distribution and the concentration of projects in specific geographical areas -such as the capital cities-and the existence of dominant elites or institutions in each field were considered.

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[4] EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom

[5] EU-27 (*from 1 January 2007*): EU-15 + Poland, Czech Republic, Cyprus, Latvia, Lithuania, Slovenia, Estonia, Slovakia, Hungary, Malta, Bulgaria, Romania.

The results show that the participation of the leading Latin American countries is far from being marginal: considered together, Argentina, Brazil and Mexico are involved in as many projects as Germany and France, two of the leaders (along with United Kingdom) in European research. Measured by their participation in number of projects, Brazil would rank as the 6th most important participating country and Argentina or Mexico 7th.

Not surprisingly, the participation is far from homogeneous throughout time, by country and by scientific disciplines. On the one hand, the more scientifically developed countries are the most active in their scientific collaborations in European projects: both in FP6 and in FP7 the four largest countries (Argentina, Brazil, Chile and Mexico) accounted for 75% of the Latin American share. On the other hand, the disciplinary pattern shows an important increase in SHS (almost double) and in Engineering as disciplinary fields. These two disciplines account for half of the Latin American participation in European projects. The basic disciplines (Chemistry, Biology, Physics) are also increasing and, together, represent almost a quarter (with a steeper increase in Physics). The most noticeable decrease is in Agricultural Research and Earth Sciences. This, according to the authors Kremer and Levin, seems to contradict the “local advantage”, centred around the use of the special conditions obtaining in developing countries, in terms of plant or animal species, soils, privileged vantage points, and so on. On the contrary, with the exception of the social sciences, research seems to be directed more towards "universal themes" in which Latin American groups make a contribution to the general cognitive objectives of the projects.

The situation described above needs to be explained more completely: besides the increase in Engineering, most of the themes are naturally and strongly oriented towards European priorities, which are increasingly geared to very specific and applied purposes defined by European scientific communities, governments, and – last but not least – the firms that industrialize the knowledge derived from these projects. Thus, the authors argue that the Latin American groups would be producing knowledge whose industrial application will benefit European societies.

One should also remember that contributions from Latin American countries to European projects increased from 5% (FP6) to 12% (FP7), while European contributions remained more or less constant. A continent-wide impact study based on well-documented case studies would be welcome to confirm or refute the observation that the LACs produce knowledge that only benefits European countries. The outcomes of such a study may be more complex and less one-sided than the authors suggest.

The unit costs per project are decreasing, along with the average number of groups per project, which dropped from 18 to 11 from FP6 to FP7. This means, for example, in Agriculture, Biology or Earth Sciences projects, whose average costs are the highest, (around 4.5 million euros), that each group received an average amount of around 400,000 euros. And in the Social and Human Sciences, which have the lowest cost per project, the per-project cost was around 180,000 euros. The figures are significant for a local group, but not enough to explain the strong desire of Latin American groups to participate. Besides the potential economic benefits, the continued participation of Latin American groups can be explained by referring to the social and cognitive integration strategies, which are designed to increase visibility, and improve interchange opportunities and access to information and data, and, indeed, such participations offers the best chance to publish in international journals. All of these outcomes are highly valued achievements in all local contexts.

2.4. The questionnaire survey

This chapter is based on the results of a questionnaire survey sent out in 2010 and aimed at understanding the main determining factors for initiating, promoting and enhancing international collaboration in S&T among the individual researchers in Latin American and Caribbean (LAC) countries and the European Union countries (EU). Answers were received from a huge number of scientists (4425) representing almost 36% of the Latin American researchers (2250 individuals) and 22% of their European colleagues (1875 individuals) invited to participate. The most likely reason for these unbalanced rates is related to the fact that LAC scientists were more interested in the survey since their LAC-EU collaboration was much more important than to their scientific careers than it was for their EU colleagues'. This assumption was confirmed by the results themselves: scientists working in LAC demonstrated higher levels of motivation and satisfaction regarding their international collaboration.

This survey tends to prove that the asymmetrical relations in the main sectors of international scientific collaboration, which was highlighted as a burning issue in the 1970s and 1980s, have turned into a more equal partnership between the two continents. This has been clearly demonstrated in several sections of this chapter 5 on the various facets of collaborative scientific activities, e.g., decisions about the distribution of roles, budgets and tasks in international projects. This also appears throughout the survey in the way scientific activities and interests in cooperation as well as advantages and disadvantages of such collaborative schemes are perceived in the two regions.

Some other important findings of this survey indicate that:

1. international collaboration correlates with increasing international mobility;
2. international collaboration is a win-win process that benefits all the partners;
3. international collaboration, once established, is a longstanding activity;
4. the more scientists collaborate internationally, the more opportunities they have to meet new colleagues, exchange ideas, write new projects, and access previously unsolicited funding schemes;
5. the motivations and expectations related to participation in international calls for proposals involving scientific collaboration are very high, and the declared derived outcomes are very significant in both continents;
6. the motivations, expectations and benefits of collaboration but also the difficulties of collaboration are higher in the scientifically less developed LAC countries than in the four major LAC scientific countries (Argentina, Brazil, Chile and Mexico);
7. the diaspora plays a very insignificant role in the decision to undertake extended stays abroad for scientific studies and a limited role in the decision to collaborate and in the choice of scientific partners;
8. international collaboration addresses and involves very dedicated and goal-oriented individual scientists in all countries, scientists who seek to increase and improve their scientific capacities and develop greater international recognition.

2.5. Interviews of Latin American biologists and agriculturists

This fifth study and sixth chapter are based on 74 interviews of Latin American scientists conducted in 2009 and 2010 in Argentina, Costa Rica, Chile, Mexico and Uruguay. All interviewed scientists were working in the field of biology applied to agriculture (or agriculture-related sciences) with a particular emphasis on animal and aquatic resources production and reproduction. They all have (or had) scientific relations with Europe at some stage of their career.

The study aims at analysing and gaining a better understanding of the importance of S&T collaboration at the level of the individual researchers in Latin America through the reconstruction of their personal scientific trajectories. In particular, it seeks to understand the main determining factors initiating, promoting and enhancing international collaboration in S&T. It also intends to illustrate the extent to which their mobility boosted the internationalisation of their activities and contributed to placing their institution (sometimes their country) in the global stream of knowledge circulation.

To sum up the major findings of this study, we are presenting (see below) the main initiating factors and derived consequences of international collaboration from the point of view of the Latin American researchers we interviewed.

A large majority of the scientists interviewed (except for Argentinean) went abroad for further studies. Reasons to expatriate for studies are mainly twofold: the search for excellence, and opportunity. The “search for excellence” factor is linked to the fact that a more advanced scientific environment provides greater stimulation and more opportunity to learn. The “opportunity” factor may be linked to a professor, a visiting researcher, a diplomatic representation, etc. It can also emerge in the course of a scientific workshop or a conference. The same reasons explain the choice of the post-doctoral students abroad. The search of excellence is probably the main reason and “opportunity” is also linked to a desire for excellence.

One of the main outcomes of these early expatriations is the networking effect. The majority of interviewed people kept contact with their PhD supervisor and continued to collaborate with this person and/or colleagues from the same institution as long as they continued to share common scientific interests. The relationship is not only longstanding and fruitful but may also open other paths and give rise to other collaborations. It is not uncommon that international collaborations started with colleagues known when studying abroad grow into inter-university agreements. This is even stronger among post-doctoral students abroad: the feeling of belonging to a group which operates as a network of excellence, the mutual recognition of the members and the perpetuation of the links through generations (by the students) reinforce the rewarding effects of networking.

Other stays abroad like sabbaticals and trainings (training sessions/courses…) are oriented more towards answering limited research issues: training workshops in the frame of a cooperation project, analysis of endogenous samples, acquisition of a new technique not available locally, etc. These stays do not apparently mobilize the same expectations from the researchers. They usually happen once the careers are designed and are perceived more as pleasant and stimulating ways to cope with research problems, learn new techniques and advance in the making of science. Although they may be great “sources of inspiration”; they do not have the same networking effect.

International collaboration is not the only privilege enjoyed by scientists trained abroad. Some determinants of such collaborations were clarified in the interviews. Developing scientific activism is one of them. Among the interviewed biologists those who worked with a militant commitment (environment preservation for example) belonged to international scientific active networks. The same applied to researchers working on topics of strong commercial interest, like salmon diseases. Other scientists happened to be at the right place at the right moment (working in marine biology in the Strait of Magellan at the time of the oil spill for example). A few others worked on relevant research topics in very specific environments (effects of altitude, endogenous fauna for example). Another important way to be associated with international collaboration without spending long stays abroad is to be noticed at international conferences.

All interviewed researchers agreed that participating in conferences was a very important and stimulating scientific activity, even critical for some of them in order to compensate for the narrowness of their scientific discipline locally. Many collaborations start among the conference participants, even with people never met before. The networking power of conferences has to be acknowledged since the collaborations initiated or enhanced there, according to the interviewed researchers, are usually long lasting.

The researchers who respond to international tenders (and sometimes succeed) have their own "alert" systems or are informed by foreign colleagues or learn about the tender at an international conference. Their laboratories compete at the international level not only for funding but also for visibility on the international scientific stage. The availability of national funding programmes for science in the five countries where the interviews were conducted reduces the interest of participating in big calls of tender (too much time for too little reward). For several interviewees, the scientific interest of such programmes was not even evident. The majority of the interviewed researchers give priority to small-scale bilateral collaboration based on personal relationships (the inter-university agreements deriving from lasting relationships nurtured by networking). The interviewed researchers also emphasized the fact that often their international collaborations take place outside official frameworks.

The researchers unanimously acknowledged the paramount importance of the human factor in collaborations. "You collaborate with friends", "we became friends", "we got along very well" were the most recurring types of sentences on this subject. When they talked about their scientific partners coming to visit they said "I invite them to my home and vice versa". One researcher said: "*The rewards of international collaboration have been tremendous in my opinion… If I am asked 'what is the main reward I've had from my career' I would say that it is the people I've met*."

The outcomes of international collaboration are not only on the human side, at the individual level they are, obviously and above all of a professional nature: learning new techniques, publishing in high impact journals, learning to compete at international level, enhanced networking activities, better access to funding, international (as well as national) recognition, etc. At the country level, the benefits are also major. Some reference laboratories have been funded in Latin America by young expatriates who returned home with foreign funding to enhance research and international partnership in their disciplines. The international networking gave rise to many inter-institutional partnerships; the exchange of professors and of students, PhD sandwich programmes, training abroad are just some of the results of this tremendous networking. For the less scientifically developed countries of the region,

international collaboration at the individual or institutional level made it possible for scientists to perform sophisticated research. Without this opportunity they perhaps would not have returned to their country to work in science.

The analysis of the interviews concludes that there is no single factor driving S&T international cooperation activities. In most cases, there is a cumulative set of factors and/or actions by multiple actors or situations that shapes the geographical, institutional and thematic focus of international cooperation in S&T. Yet, the most powerful drivers are scientific excellence and mobility and the capacity of networking. The networking power of conferences and post-doc stays abroad are particularly important in initiating long-lasting scientific collaborations. A good personal relationship is also of paramount importance in scientific collaborations. Ultimately, "You collaborate with friends", and meeting people through collaboration is also acknowledged as a very important reward.

3. Conclusion: Towards a more equal partnership?

The different studies presented in this book confirm the multiplicity and interdependency of the range of reasons that determine international scientific collaborations. It demonstrates, however that, contrary to the most commonly accepted postulate, the researchers' individual interest is not solely at stake when he or she engages in international collaboration activities. The fact that, very often, collaborations "relate to individual's own resource stock which can be used to gain a competitive advantage" (Rijnsoever (van), Hessels & Vandeberg 2008) is not sufficient to conclude that the dynamic of collaborations is strictly individually driven. The individual researchers who seem to be at the heart of the collaborations need additional factors at least as important as their individual commitment to be able to engage in collaboration. These conditions relate to their professional and institutional environment: level of equipment, status of researcher, the promotion and evaluation systems, the institutional base to collaborate widely, etc. Thus the individual researcher who is the heart of international collaborations should be seen as someone who is embedded into his/her local environment.

Results of the questionnaire survey seem to depict scientists as a relatively homogeneous group both in EU and in LAC. They tend to value the same motivations and to expect to reap the same types of benefits from the international cooperation: more publication, more projects, more resources, better recognition at international level. This can also be explained by the fact that Latin American countries have considerably upgraded their research institutions by creating better research centres, giving more funding to research and paying more attention to the uses of research and the tools and instruments of international cooperation. The institutionalization process, at least in the larger countries of LAC, has been gradually creating larger (if not better) institutions, doctoral degree programmes, and opportunities for post-docs who in turn become clients for international funding, which are sources for more funding and for collaborations with renowned scientists from other countries. Apparently, in this context, a strategy of connecting to the worldwide scientific networks seems to be a fruitful strategy. Nonetheless, we should insist that it only makes sense when there is a solid institutional basis. This radical change of scenario at the national level has, thus, profound consequences on international collaborations giving rise among other things to many inter-institutional partnerships; the exchange of professors and of

students, PhD sandwich programmes, training abroad to mention only some of the results of this tremendous networking connecting individuals and institutions.

The policies have also changed at the international level. Richer countries, or "donors" as they used to be known, had a focus on research for development. The aim was to support the creation and strengthening of research capabilities in developing countries. Capacity building was the main aim and this was thought of as part of a larger strategy for collaboration with unequal partners who asked for this help (Gaillard 1994). This does not seem to be the dominant paradigm anymore, and although the "science for development" has not totally disappeared, it now very commonly coexists with support programmes that consider international collaborations as partnerships between equals. In this new policy context, funding for research and international collaboration is no more than an additional opportunity for funding research *tout court.* Even between Europe and African countries, there are policy documents that focus on the 'co-ownership', 'co-design', 'co-funding' of research projects.[6]

With this perspective, the results of the online survey are not surprising and can explain the way scientists portray their place on the chessboard of collaborations and the role they play in projects obtained in response to international calls for proposals. Analysing the scientists' participation in calls for proposals clearly indicates that the level of commitment and responsibility for all-important decisions in the project is the same on both continents. They also feel very much involved in the projects and express a very high level of satisfaction in both regions.

Does that mean that the previously well-known dissymmetry between the rich developed countries and the developing world do not exist anymore? L. Busch had already claimed that the "Third World" makes no more sense when funding flows to biotechnology firms instead of agricultural research (Busch & Gunter 1996). What happens is we now find a much larger variety of research contexts and policy instruments and no more this policy specialization where research was meant for the rich and "research for development" was aimed for the developing world. The net result of international collaborations is not a collection of cooperative actions that aimed at providing input to development; it is rather a large international network of scientists that share common research practices, similar evaluation patterns, and quasi-identical legitimating discourses vis-à-vis their mother institutions. This large network is a network of equals and global issues are best tackled inside this world net. Kreimer and Zabala (2008) have claimed that the researchers from the periphery are entering this network in a foot of inequality: they would become voluntarily dependent and subordinated to the large centres of research that regulate the flow of science and structure the international network. Local legitimacy, support for research, access to sophisticated equipment, would depend on entering this worldwide network of research.

We partly agree but it very much depends upon the science fields and areas of activity. The survey partially supports the claim that access to more material aspects seem to be more important to LAC scientists than to the Europeans, who enter into collaborations with LAC scientist for less tangible benefits. What the latter seek is to participate in the knowledge

[6] See for example the documents discussed by the Monitoring Committee (MoCo) for "Euro-Mediterranean Cooperation in Research, Technology and Demonstration", a policy forum that was created between European countries and the South and East Mediterranean countries (Morini, Rodriguez, Arvanitis & Chaabouni 2013).

accumulation of LAC. LAC scientists no doubt seek to enter in scientific collaborations also to get local recognition. In many areas, there seems to be competition between international and local recognition, or, as Sari Hanafi (2011) has put it bluntly: 'publish internationally and perish locally or publish locally and perish internationally'. International collaborations, when they rely on local capabilities do not seem to lead to this terrible alternative. Rather, domains where capacity building has been strong are also those where LAC scientists no longer tend to be subordinates of the Europeans but are also drivers of mainstream themes and topics.

On the other hand, international collaboration being strongly correlated with geographical mobility, scientists having spend periods of time working outside their national frontiers are familiar with the working culture of their counterparts. These scientists usually join international networks as soon as they start studying or do their post-doc abroad. The ties established then are active and longstanding. The derived advantages of these early links are depicted as: reinforced feeling of being a member of a network (often considered as a network of excellence), enhanced capacity to compete at the international level, better ability to start new relationship while being in conference or other connecting situation. Furthermore, the scientists recognize that the more they collaborate internationally, the more opportunities they have to meet new colleagues, exchange ideas, write new projects, and access previously unsolicited funding schemes.

It is essential to take into account the fact that working conditions of scientists in the larger countries of Latin America (Argentina, Brazil, Chile and Mexico), responsible for 80% of international co-authored papers between Europe and LAC and 75% of the FP projects, have improved in a tangible manner compared to a decade ago. And not only are the career prospects better; the capacity of the local scientific community to judge on the value of their national fellows in areas that once were scarcely populated makes a great difference. It is thus not only a matter of being well connected to the outside: it also a matter of being able to gather sufficient interest around one's professional area. As F. Beigel (2010) has very convincingly argued that "peripheral academic circuits" in LAC have not had lesser international impact because of an incapability to reflect upon their own reality, but rather because their scientific communities have been obliged to manage political and organizational difficulties incurred by their own academic systems.

In brief, we have seen that both at the national level, as well as at the international level, it is the very meaning of international collaboration that changed for the scientists in countries where once there were only few researchers, fewer institutions and universities or academic institutions were barely interested into carrying out supporting research activities; where once research was possible because of the support of foreign donors; in these non-hegemonic countries, the fundamental changes have also obliged to reflect on a new perspective: how is it possible to integrate the knowledge that exists locally, and not only the scientific knowledge, into the perspective of research? Latin America has recently rediscovered its own knowledge resources (Arellano Hernández, Arvanitis & Vinck 2012) not only because of the international scene, where indigenous knowledge has become a new and fashionable topic, but also because of local health, agriculture and food security considerations. It can be easily argued that the new research areas have been occupied by Latin American scientists not only as a response to external pressure[7] but also because of

[7] see the case of GMOs in Mexico studied by Jean Foyer (2008), or the protection of biodiversity (Aubertin & Vivien 2006)

their own capacity to enter these debates. International collaborations have always played an important role in the creation of this analytical capacity, sometimes as a resource and sometimes as a constraint.

Finally, the existence of multiple funds that support collaboration, which are reviewed in this book, is posing a governance issue that is not related to programme management but to the way these programmes are articulated with other considerations, such as the usefulness and pertinence of the research topics to local social, economic and politically-sensitive problems. In fact, this very central issue, that has always been at the forefront of policy consideration in LAC (see for example in Venezuela, Arvanitis 1996)), is now becoming part of the large international projects and is being taken into consideration in the design of research projects. Obviously, these issues merit more attention in the future. All those past and ongoing transformations at national and international levels contribute to postulate that the asymmetry of relations, which was highlighted as a burning issue in the 1970s and 1980s, is definitely been turning today into a more equal scientific partnership between the two continents.

References

Adams, J., K. Gurney & S. Marshall (2007), 'Patterns of international collaboration for the UK and leading partners (Summary report)', in, London: A report commissioned by the UK Office of Science and Innovation.

Archibugi, D. & S. Iammarino (1999), 'The Policy Implications of the Globalisation of Innovation', *Research Policy,* 28(3), pp.317-36.

Arellano Hernández, A., R. Arvanitis & D. Vinck (2012), 'Global connexity and circulation of knowledge. Aspects of Anthropology of Knowledge in Latin America', *Revue d'Anthropologie des Connaissances,* 6(2), pp.1-28.

Arvanitis, R. (1996), *La relación incierta. Investigación aplicada y desarrollo en Venezuela*, Caracas: Fondo editorial FINTEC.

Arvanitis, R. & J. Gaillard (1992), 'Vers un renouveau des indicateurs de science pour les pays en développement', in R. Arvanitis & J. Gaillard, eds, *Les indicateurs de science pour les pays en développement / Science Indicators for Developing Countries,* Paris: Editions de l'ORSTOM, pp.9-36.

Aubertin, C. & F.-D. Vivien, eds (2006), *Le développement durable. Enjeux politiques, économiques et sociaux*, Paris: Etudes de la documentation française, La documentation française, IRD éditions.

Beaver, D.D. (2001), 'Reflections on scientific collaboration (and its study): Past, present, and future', *Scientometrics,* 52(3), pp.365-77.

Beigel, F. (2010), 'Reflexiones sobre el uso del concepto de campo y acerca de la 'elasticidad' de la autonomía en circuitos académicos periféricos', in F. Beigel, ed, *Autonomia y dependendia acdémica: universidad e investigación científica en un circuito periférico (Chile y Argentina 1950-1980),* Buenos Aires: Editorial Biblos, pp.13-44.

Boekholt, P., J. Edler, P. Cunningham & K. Flanagan, eds (2009), *Drivers of International collaboration in research. Final Report* Luxembourg: European Commission, DG Research, International Cooperation (EUR 24195).

Bozeman, B. & E. Corley (2004), 'Scientists' collaboration strategies: implications for scientific and technical human capital', *Research Policy,* 33 pp.599-616.

Busch, L. & V. Gunter (1996), 'Le Tiers monde est-il encore nécessaire ? Biotechnologie, robotique et fin de la Guerre froide', in R. Waast, ed, *Les sciences au Sud. Les Conférences (vol1),* Paris: ORSTOM, pp.42-62.

Cueto, M. & J. Cañizares Esguerra, eds (2008), *An introduction to history of science in non-Western traditions*, Seattle: History of Science Society.

De Filippo, D., F. Morillo & M.-T. Fernández (2008), 'Indicadores de colaboración científica del CSIC con Latinoamérica en bases de datos internacionales', *Revista Española de Documentación Científica,* 31(1), pp.66-84.

Docquier, F. & A. Marfouk (2006), 'Measuring international migration by educational attainment, 1990-2000', in C. Özden & M. Schiff, eds, *International Migration, Remittances and the Brain Drain,* New York: Macmillan and Palgrave, pp.151-99.

Docquier, F. & H. Rapoport (2007), 'Skilled Migration: The Perspective of Developing Countries', in, Bonn/Washington, DC: IZA Discussion Paper No. 2873; World Bank Policy Research Working Paper No. 3382. Available at SSRN: http://ssrn.com/abstract=625259.

Dumont, J.-C., G. Spielvogel & S. Widmaier (2010), 'International Migrants in Developed, Emerging and Developing Countries: An Extended Profile', in: OECD Social, Employment and Migration Working Papers No.114, www.oecd.org/els/workingpapers.

Edler, J., H. Fierb & C. Grimpe (2011), 'International scientist mobility and the locus of knowledge and technology transfer', *Research Policy,* 40 pp.791-805.

Edler, J. & K. Flanagan (2009), 'Drivers of policies for STI collaboration and related indicators. A Review of Key Themes from the Literature', in: Manchester Institute of Innovation Research.

Eeuven, D. (2005), *Union Européenne-Amérique-Latine*, Paris: Geopolitis, GERM (Groupe d'Etudes et de Recherche sur les Mondialisations) http://www.mondialisations.org/.

EULARINET, E.U.-L.A.R.a.I.N. (2011), ' http://www.eularinet.eu/site/info_about_the_project/language:eng (accessed 24 February 2012)'.

Fernández, M.-T., I. Gómez & J. Sebastián (1998), 'La cooperación científica de los países de América Latina a través de indicadores bibliométricos', *Interciencia,* 23(6), pp.328-3.

Fernández, M.T., A. Agis, A. Martin, A. Cabrero & I. Gómez (1992), 'Cooperative research projects between the Spanish National Research Council and Latin American Institutions', *Scientometrics,* 23(1), pp.137-48.

Foyer, J. (2008), 'Diversité naturelle et culturelle face aux défis des biotechnologies: enjeux et controverses au Mexique', in: IHEAL, Paris 3 Sorbonne Nouvelle: 658.

Frame, J.D. & M.P. Carpenter (1979), 'International Research Collaboration', *Social Studies of Science,* 9(4), pp.481-97.

Gaillard, J. (1994), 'North-South Research Partnership: Is Collaboration Possible Between Unequal Partners ?', *Knowledge and Policy,* 1994(7), pp.2.

Gaillard, J. (1999), *La coopération scientifique et technique avec les pays du sud. Peut-on partager la science?*, Paris: Karthala.

Gaillard, J. (2001), 'Stakes and New Prospects for North-South Scientific Cooperation Policies', in R. Arvanitis, ed, *Theme section: Science and Technology http://www.eolss.com/,* Encyclopedia of Life Support Systems: EOLSS Publishers/UNESCO, pp.http://www.eolss.net/.

Gibbs, W. (1995), 'Lost Science in the Third World', *Scientific American,* 273(2), pp.76-83.

Glänzel, W. (2001), 'National characteristics in international scientific co-authorship relations', *Scientometrics,* 51 pp.69–115.

Glänzel, W., K. Debackere & M. Meyer (2008), 'Triad' or 'tetrad'? On global changes in a dynamic world', *Scientometrics*.

Hanafi, S. (2011), 'University Systems in the Arab East: Publish Globally and Perish Locally Vs. Publish Locally and Perish Globally', *Current Sociology,* 59(3), pp.291-309.

Hogan, A., K. Zippel, L.M. Frehill & L. Kramer (2010), 'Report of the international workshop on international research collaboration. Report prepared with funding from the National Science Foundation OISE-0936970 and HRD-0811170. http://www. dac. neu. edu/zippel/nsf-workshop/docs/FinalReport_Oct22_2010. pdf', in.

Kreimer, P. & J.P. Zabala (2008), 'Quelle connaissance et pour qui ? Problèmes sociaux, production et usage social de connaissances scientifiques sur la maladie de Chagas en Argentine', *Revue d'Anthropologie des Connaissances,* 2(3), pp.413-40.

Lemarchand, G. (2008), 'The long-term dynamics of co-authorship scientific networks: Iberoamerican countries (1973-2006). http://arxiv.org/pdf/1001.2837 (accessed 24 February 2012)'.

Lewison, G., A. Fawcett-Jones & C. Kessler (1993), 'Latin American Scientific Output 1986-1991 and International Co-Authorship Patterns', *Scientometrics,* 27(3), pp.317-36.

Leydesdorff, L. & C. Wagner (2008), 'International collaboration in science and the formation of a core group', *Journal of Informetrics,* 2(4), pp.317-25.

Luukkonen, T., O. Persson & G. Swertse (1992), 'Understanding Patterns of International Scientific Collaboration', *Science, Technology & Human Values,* 17(1), pp.101-26.

Mattsson, P., P. Laget, A. Nilsson & C.-J. Sundberg (2008), 'Intra-EU vs. ea-EU scientific co-publication patterns in EU', *Scientometrics,* 75(3), pp.555-74.

Morini, C., R. Rodriguez, R. Arvanitis & R. Chaabouni, eds (2013), *Moving to the future in the Euro-Mediterranean Research and Innovation partnership - The experience of the MIRA project*, Bari & Paris: Options Méditerranéennes (Series B - Studies and research), CIHEAM.

Narváez-Berthelemot, N., L.P. Frigoletto & J.F. Miquel (1992), 'International scientific collaboration in Latin America', in R. Arvanitis & J. Gaillard, eds, *Les indicateurs de science pour les pays en développement / Science Indicators for Developing Countries,* Paris: Editions de l'ORSTOM, pp.333-56.

NSF (2009), 'Women in International Science and Engineering Research Collaboration PowerPoint Presentation by John Tsapogas, American Association for the Advancement of Science, Women and Minorities Breakfast, February 14, 2009', in.

Rijnsoever (van), F.J., R. Hessels & L.J. Vandeberg (2008), 'A resource-based view on the interactions of university researchers', *Research Policy,* 37(8), pp.1255-66.

Russell, J.M., S. Ainsworth, J.A. del Río, N. Narváez-Berthelemot & H.D. Cortés (2007), 'Colaboración científica entre países de la región latinoamericana', *Revista Española de Documentación Científica,* 30(2), pp.180-98.

Sancho, R., F. Morillo, D. de Filippo, I. Gómez & M.-T. Fernández (2006), 'Indicadores de colaboración científica inter-centros en los países de América Latina. Interciencia, 31(4): 284-292.', *Interciencia,* 31(4), pp.284-92.

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

Schmoch, U. & T. Schubert (2008), 'Are international co-publications an indicator for quality of scientific research?', *Scientometrics,* 74(3), pp.361-77.

UNCTAD (2005), 'World Investment Report 2005. Transnational Corporations and the Internationalization of R&D', in, New York and Geneva: United Nations.

Wagner, C. (2006), 'International Collaboration in Science and Technology: Promises and Pitfalls', in L. Box & R. Engelhard, eds, *Science and Technology Policy for Development. Dialogues at the Interfaces;,* London/New York/Dehli, pp.165-76.

Wagner, C. (2008), *The New Invisible College. Science for Development*, Washington D.C.: Brookings Institution Press

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