Chapter 5

Determining Factors of International Collaboration in Science & Technology Results of a questionnaire survey

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Abstract

This chapter is based on the results of a questionnaire survey conducted in the frame of the EULAKS project. It primarily seeks to better understand 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) and the extent to which the internationalisation of their activities have contributed to increasing the transfer and production of knowledge. One of the main findings stresses the growing homogenisation of the determining factors such as international scientific mobility in the two continents. This survey also reveals the win-win character of such collaborative schemes. Overall LAC and EU researchers acknowledge the numerous outcomes and benefits derived from international collaboration.

1. Method and sample

1.1 The questionnaire

A *web questionnaire survey* was sent to a large sample of scientists (14,406) composed of:

3,997 researchers who answered a preliminary questionnaire sent to scientists in EU countries and LAC countries and had published at least one publication indexed in the Web of Science in co-authorship with a scientist from the other country grouping (EU countries and LAC countries) during 2003-2007;

4,687 researchers whose e-addresses had been provided by scientists who had answered the preliminary survey;

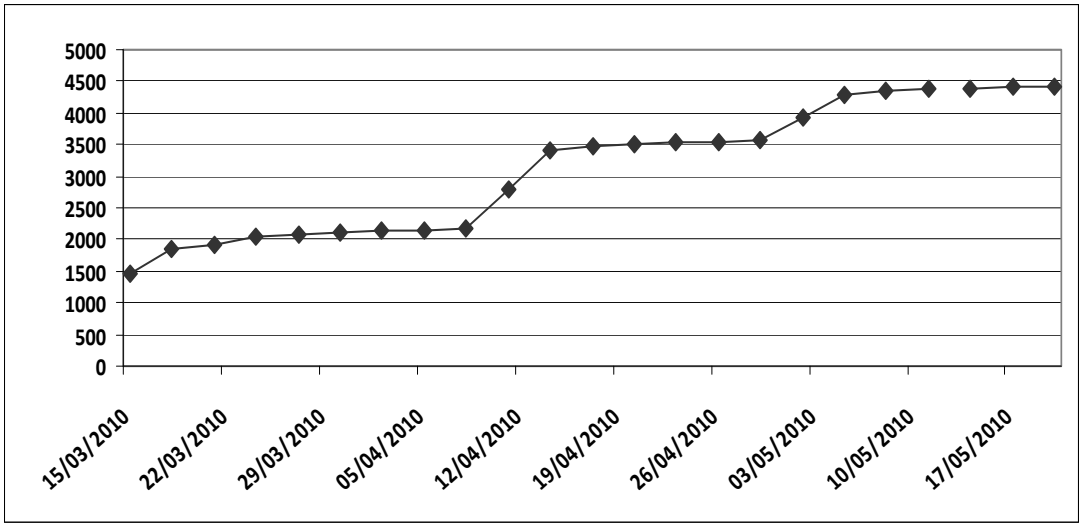
5,722 researchers from LAC and EU who applied jointly to EU calls for proposals within the Framework Programme (FP) 6 and 7.

The questionnaire was circulated between 15 March and 17 May 2010. Two reminders were sent (12 April and 3 May). Altogether more than 30% of the targeted scientists (4425) completed the questionnaire satisfactorily (see chart 1).

The open source application "Lime Survey" http://www.limesurvey.org/ was used to circulate the questionnaire. Altogether 55 countries participated: 29 in Europe (see footnote 1) and 26 in Latin America.[1]

Despite the very high response rate, the results of this survey, based on an uncontrolled sample, cannot be deemed representative of the targeted population. However, the characteristics of the group show a fair distribution among the countries and reflect their level of scientific development; not surprisingly more respondents come from the most scientifically developed countries. Likewise, the repartition of respondents in terms of e.g. research areas and gender, are more or less in line with the characteristics of the targeted populations and can be interpreted through different histories and states of scientific development in the respective countries.

Figure 1. Pace of responses



1.2. The sample

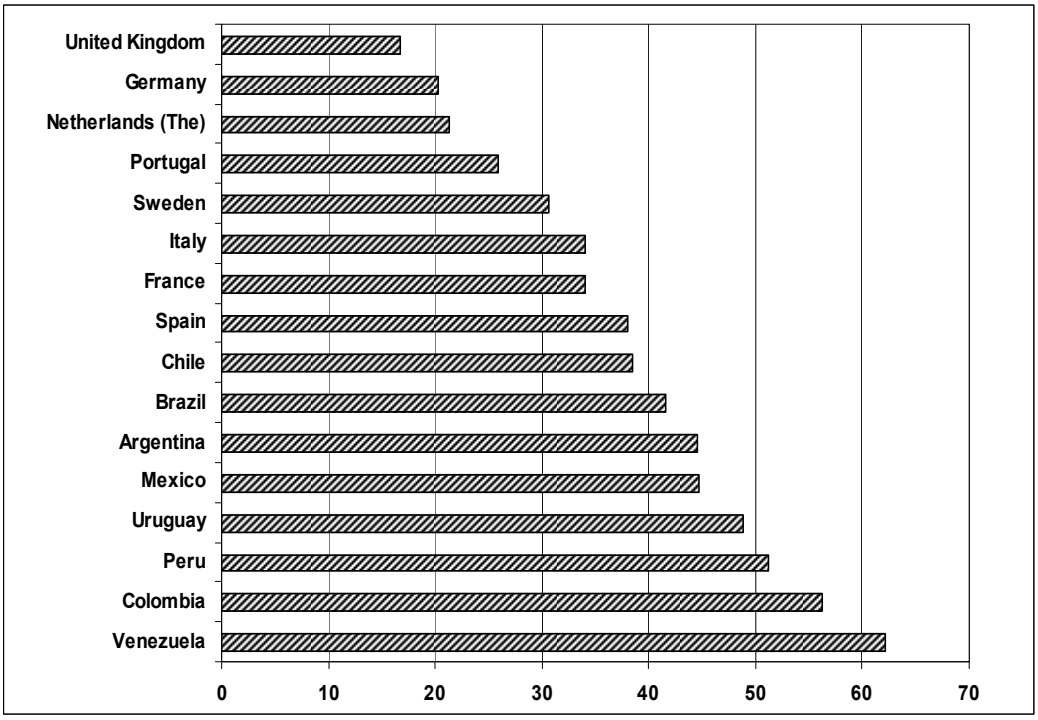
The response rate, was good, but was not evenly distributed (chart 2). The average response rate was better in the LAC countries (35.9%) than in the EU countries (22.2%)[2]. The most likely reason for these unbalanced rates is related to the fact that LAC scientists felt a greater interest in the survey since, for their own scientific careers, this specific LAC-EU

[1] The 26 Latin American countries are: Antigua & Barbuda, Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, San Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Vincent & the Grenadines, Surinam, Uruguay, Venezuela.

[2] The e-mail addresses of the invited scientists did not provide country identification in 19.72% of the cases. To calculate the answering rates, we applied the *pro rata* geographic breakdown observed for the known addresses to these generic addresses.

collaboration is needed much more by LAC scientists than by their EU colleagues. This assumption was confirmed by the results of the present survey: scientists working in LAC demonstrate higher levels of motivation and satisfaction regarding international collaboration (charts 40, 41 and 50).

Figure 2. Response rates by country (at least 50 responses per country)



2. The surveyed population

2.1. Countries where the responding scientists work

As mentioned above, the questionnaire was completed by 4425 scientists working in 55 countries (29 countries in EU and 26 LAC countries). Nearly 4/5th of the respondents (78.35%) work in the first ten main countries and include the top scientific producers and the top LAC-EU S&T collaborators of the two country groupings namely (by decreasing order of number of responses) Brazil, Mexico, Argentina, Chile and Colombia for the LAC and Spain, France, Italy, Germany and the United Kingdom for the EU (Figure 3).

Figure 3.The main countries of work of the responding scientists

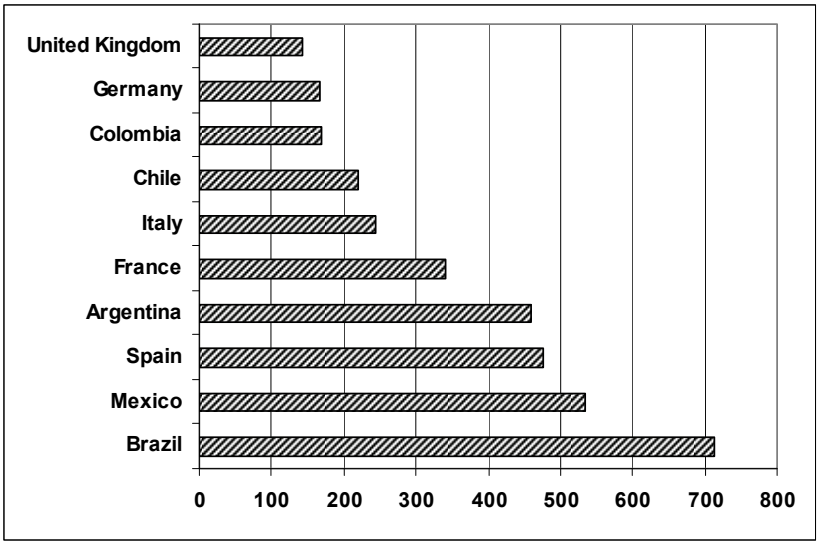


Table 1. Other countries of the responding scientists (between 10 and 100 answers)

Country	Nb	Country	Nb	Country	Nb
Venezuela	95	Ecuador	43	Switzerland	20
Uruguay	85	Austria	37	Norway	17
Netherlands (The)	68	Poland	35	Romania	17
Peru	64	Costa Rica	33	Hungary	13
Portugal	61	Greece	31	Nicaragua	13
Sweden	52	Denmark	29	Czech Republic	11
Cuba	44	Bolivia	26	Paraguay	10
Belgium	43	Finland	26	**Total**	**873**

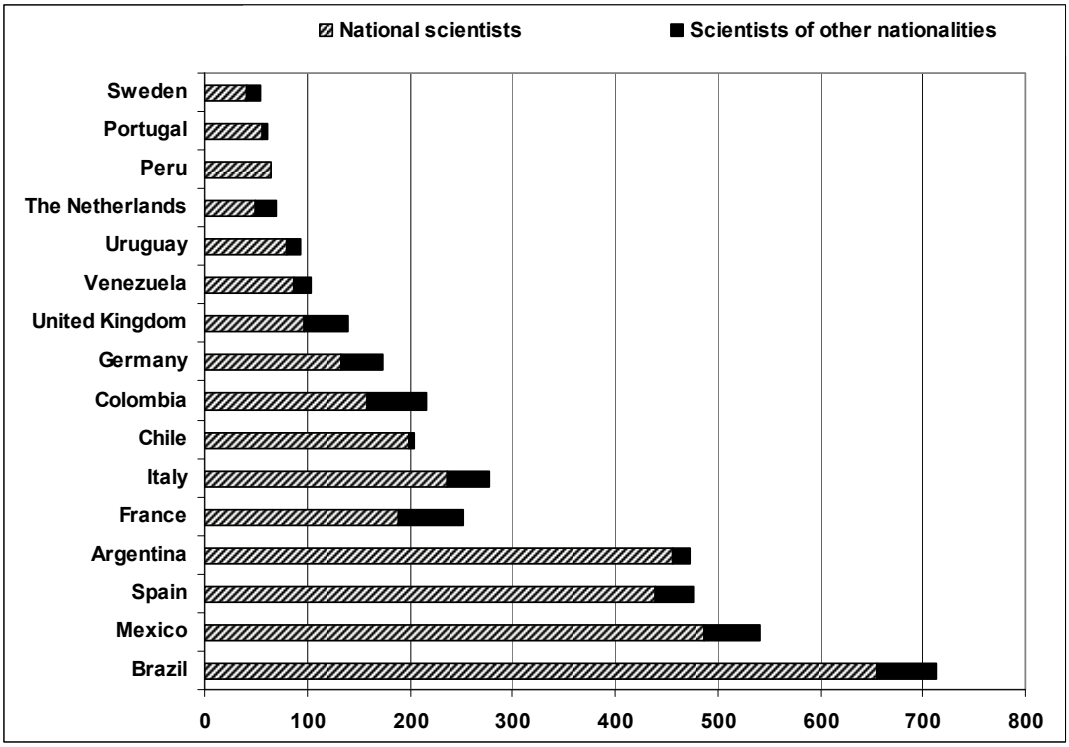
2.2. The country of nationality and the scientists' mobility

The repartition in the aforementioned countries does not completely fit in with the nationalities of the respondents: for the LAC countries 2499 out of 2550 respondents are LAC nationals, while for the EU countries the rate is 1864 out of 1875. The remaining 62 scientists who filled in the survey are nationals of countries outside LAC and EU. They work on one of the two continents and are engaged in a collaborative effort with the other continent.[3]

[3] In this chapter we use the two groups (workers and nationals) alternatively as a global reference to compute the percentages. For the countries where people are working we use the definition "Countries of institutions" and for the countries of nationality we use "Countries of nationality". When talking about individuals, we use the definitions "LAC scientist" or "EU scientist" when referring to the region where people are working and "LAC national" or "EU national" when referring to the nationality (mostly to compute mobility).

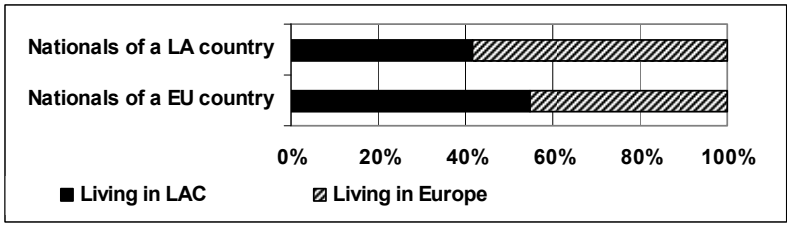
Nevertheless, and not surprisingly, most respondents are nationals of the country of the institution where they work. Although, almost 1 out of 10 (9.3%) declare being a national of another country (Figure 4). This percentage varies significantly from country to country. Whereas all scientists working in Peru are Peruvian nationals, close to one-third (30%) of the scientists working in UK state that they are nationals of another country. Overall, the percentage of scientists working in a country other than their country of nationality is smaller in LAC countries, apart from Colombia where 34% of the responding scientists working in national institutions are of foreign origin. The rate is 16% in Uruguay and Venezuela, 10% in Mexico, 8% in Brazil, close to 4% in Argentina, and just under 3% in Chile. In institutions located in EU countries the percentage of non-nationals is higher, except in Spain (8%) and Portugal (10%). In other EU countries: Italy has 16% non-national scientists, France 18%, Germany 23%, The Netherlands and Sweden 27% and, as already mentioned, United Kingdom 30%.

Figure 4. Number of respondents according to nationality and country of work



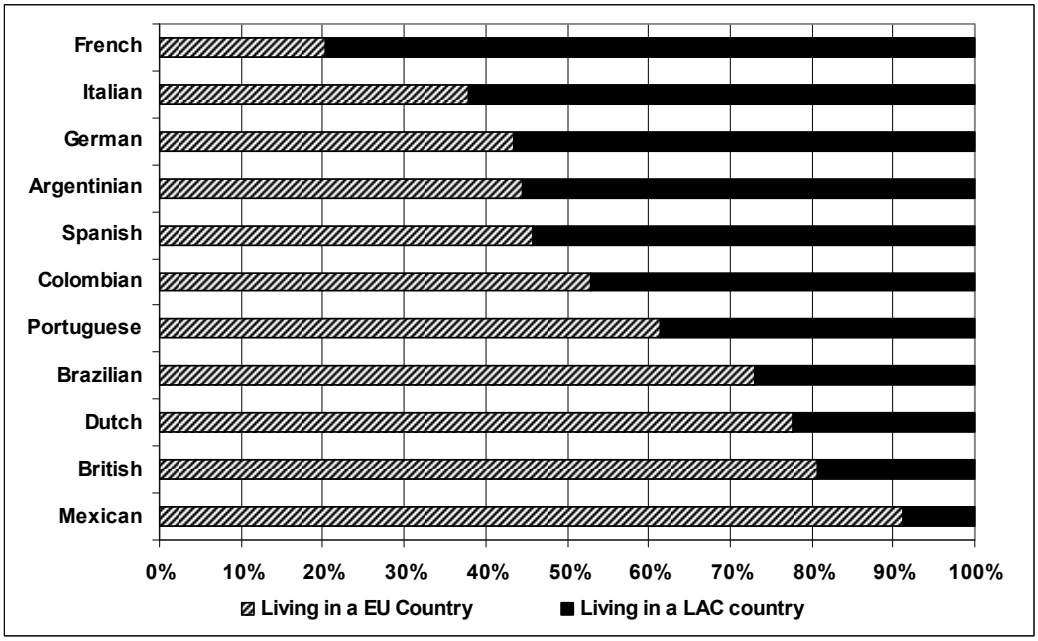
But this does not imply cross migration: all non-nationals in EU are not of LAC origin and *vice versa*. When analysing the total sample (4425 responses), scientists of EU nationality appear to be more mobile than LAC scientists and dominate the group of expatriates (EU 64%, LAC 36%). Among the EU scientists 55% place their country of residence in LAC and 45% in another EU country while the LAC scientists are proportionately more settled in EU (58%) than in another LAC country (42%) (Figure 5).

Figure 5. Repartition of the diasporas in the two continents (in %)



This general observation hides a more heterogeneous situation. More French, Italian, German and Spanish as well as Argentinean, Peruvian and Chilean scientists from the diasporas tend to live in a LAC country, while British, Dutch, Portuguese and Swedish as well as Mexican, Brazilian, Uruguayan scientists from the diasporas tend to live in Europe (Figure 6).

Figure 6. Regions of residence of the diasporas (in %)

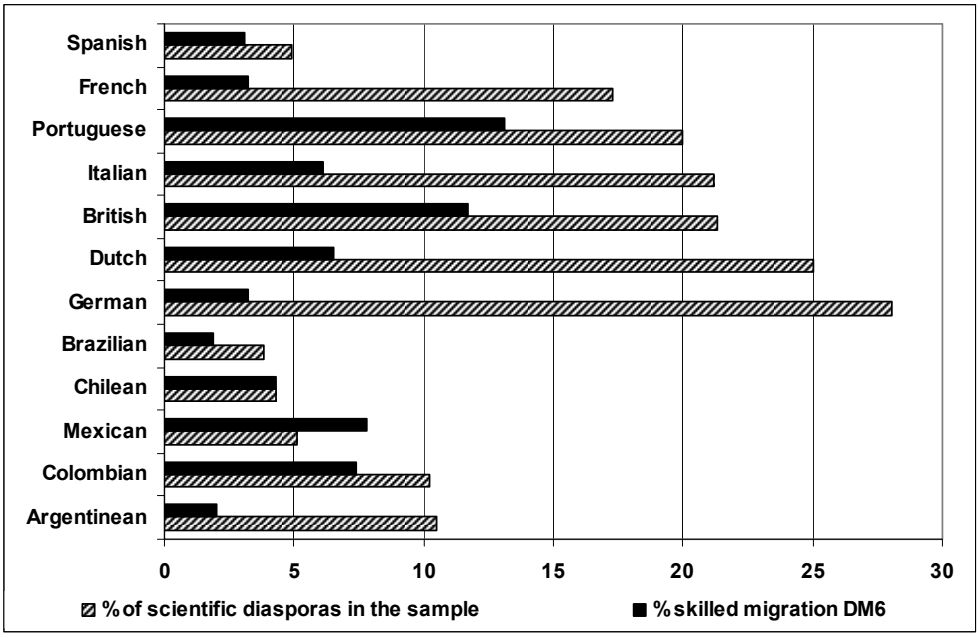


The cross-border movement of researchers constitutes another factor contributing to the growing internationalisation of science and technology. Whilst the migratory flow of researchers (and indeed of highly-skilled workers more generally) is as old as science itself, there is convincing evidence that the mobility of highly qualified people increased during the last decades (Dumont, Spielvogel, Widmaier 2010). It is also likely that scientists' mobility followed the same accelerating pace, although it is difficult to measure statistically the proportion of researchers as a subgroup of the highly-skilled workers. Among non-OECD countries the impact of the international mobility of the highly skilled is diverse. The largest

developing countries seem not to be significantly affected and indeed may benefit from indirect effects associated with this mobility (Docquier & Rapoport 2007) such as return migration, technology watch and transfers, easier access to collaboration, etc. At the other end of the spectrum, some of the smallest countries, especially in the Caribbean and in Africa, face significant 'emigration rates' of their elites (Docquier & Marfouk 2006). Indeed the smaller the national highly-skilled resource base, the higher the percentage of highly-skilled expatriates. As might be expected, countries that suffer long civil wars, such as Haiti, and / or military regimes, such as Argentina, Chile and Uruguay, have also suffered from the emigration of their scientists.

The comparison of the migration rate of our sample with the only available reference today on highly-skilled migration for all countries (including non-OECD countries), the DM06[4], shows that the mobility of the population in our survey is far greater than that of the population reported in statistics on highly-skilled migration (Figure 7). However, the data selected for the comparison in the DM06 do not focus on the precise same category of population. The only possible choice in DM06 is the category of migrants having completed a tertiary education curriculum (regardless of level)[5].

Figure 7. Relative importance of the scientific diasporas (in the sample) compared to the highly-skilled migration from the same countries (as evaluated in the DM06 base in 2000)



[4] DM06 is a database compiled by Docquier and Marfouk (2005) from the OECD and World Bank joint database on migration: DIOC-E http://go.worldbank.org/RFRQAN6B01). This database takes account of non-OECD countries for the year 2000 in an attempt to measure South-South migration also.

[5] A second selection was made on the subgroup of people who left their country after having completed their education and after the age of 22.

Some assumptions can be made to explain the great mobility of the survey population:

1) The selected group observed in the DM06 is based on ISCED classification levels 5 and 6[6]. Given that level 6 represents a very small share of the whole category, calculating the percentage on the sum of the two levels automatically lowers the rate of the smallest level (level 6).

2) The very high mobility of the survey population may be inherent in the selection itself: scientists who co-published with foreign colleagues may be more mobile than their colleagues.

3) The lack of data to measure international mobility of scientists does not obviate the postulate) (Mahroum, 2000) that the population of PhD holders working in science and technology is more migratory than the average of the general tertiary educated people. Several reasons support this view:

Historically, science has no nation (Loemker 1976)[7] and scientists have been circulating between universities since the middle ages (Kibre 1948, Dedijer 1968)[8]. The elite migration is part of "normal" scientific mobility so vital to knowledge flows (Crawford *et al.* 1993).

The migration of scientists today is usually funded by several schemes and programmes (Ackers & Gill 2008).

The presence of foreign students and scientists in universities nowadays is an indicator of the degree of the institutions' attractiveness and excellence (Baumgratz-Gangl 1995).

3. Gender and age

Overall, slightly more than one-quarter (26.4%) of the respondents are women (Table 2). Women are better represented in LAC countries (29.2%) than in EU countries (23.0%)

Table 2. Repartition of gender of respondents in EU and LAC countries

Gender	EU	LAC	Total
Males	904 (77%)	943 (70.8%)	1847 (73.7%)
Females	270 (23%)	388 (29.2%)	658 (26.3%)
Total	1174 (100%)	1331 (100%)	2505 (100%)

Ref: Countries of institutions

[6] UNESCO's International Standard Classification of Education (ISCED) is an instrument which presents standard concepts, definitions and classifications for six education levels. Usually, only people with levels 5 (people who completed at least one tertiary education curriculum) and 6 (PhD holders and researchers) rank in the category of Highly-Skilled Personal. Scientists with a PhD and researchers belong to level 6 and are rarely separated from level 5 in international statistics. http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

[7] Reference is made to the famous letter from Leibniz on the subject of "making sciences flourishing": "In this I make no distinction of nation or party ... The country which does this best will be the country dearest to me, since the whole human race will always profit from it" (Foucher de Careil, 1712, Oeuvres de Leibniz, VII, 503) cited by Loemker, 1976.

[8] Scientists in this survey give reasons for migration that do not depart from the oldest tradition: scientists move to the places where science is best.

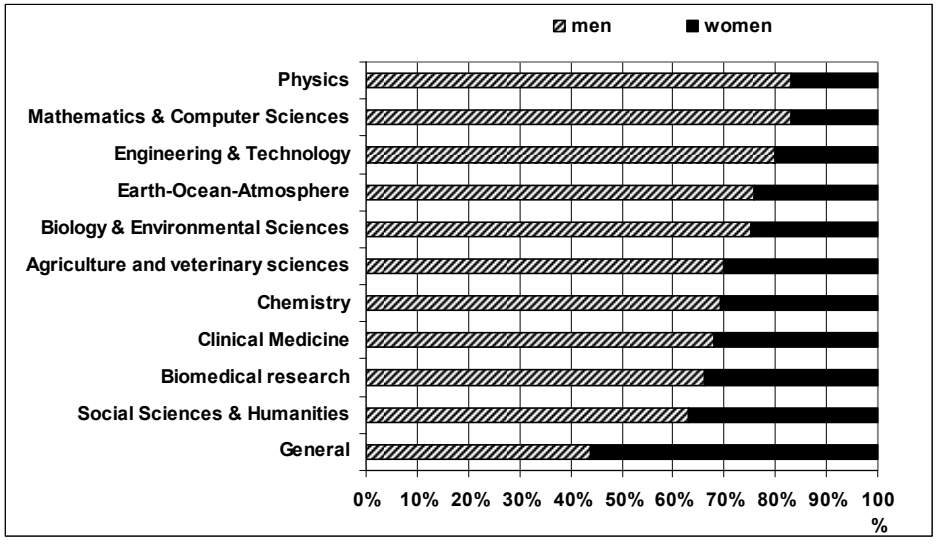
Whilst the participation of women in S&T has increased in the world during the last decades, only five countries have achieved gender parity, and they are all in Latin America: Argentina, Cuba, Brazil, Paraguay, and Venezuela[9] (UIS 2009). According to available data:

- Women represent slightly more than one-quarter of researchers (29%) worldwide (UIS 2009),
- In LAC countries 46% of the researchers are women (UIS 2009),
- In the EU (27 countries) 30% of researchers are women (OST 2008).

A recent study also indicates that female scientists are less likely to collaborate internationally than their male counterparts (NSF 2009). Thus, based on a longitudinal survey that follows recipients of research doctorates from U.S. institutions until age 76, NSF found that 30% of them collaborate internationally, (23% female and 33% of male). Assuming that this behaviour is likely to be the same in EU and in LAC countries, we can conclude that the participation of women in our survey is more or less representative of the participation of women in international S&T activities in LAC and EU countries.

The participation of women respondents, according to research discipline, also follows the overall distribution of gender in or LAC and EU countries albeit at a slightly lower level. This is also probably due to the fact that women are less likely to collaborate internationally than men (see above). Thus, the participation of women in Physics, Mathematics & Computer Sciences (17%) and Engineering & Technology (20%) is much lower than in Clinical Medicine (32%), Biomedical research (34%) and Social Sciences & Humanities (37%) (Figure 8).

Figure 8. Gender participation according to research disciplines



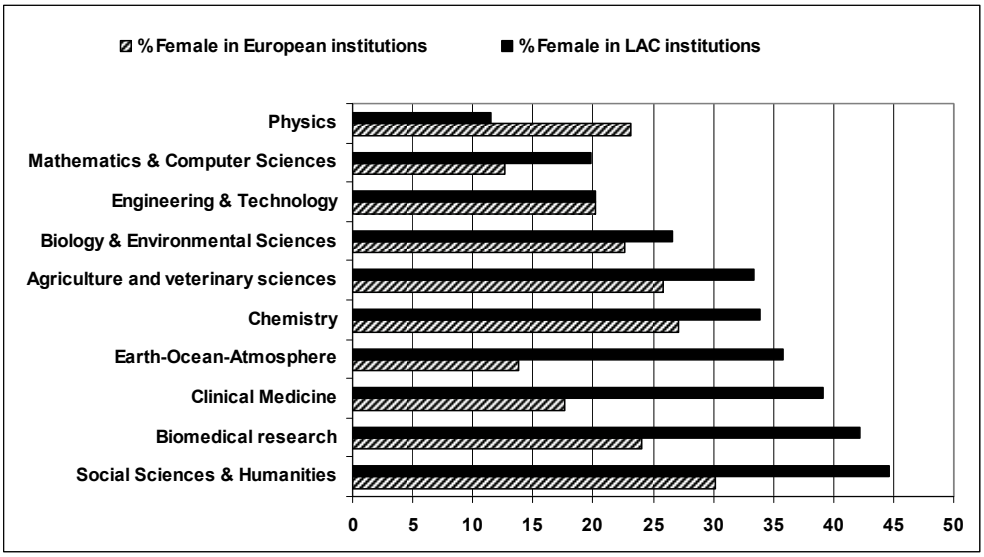
Ref: Countries of institutions

[9] In contrast, men accounted for approx. or more than 70% of researchers in Chile, Guatemala, Honduras and Mexico.

Interestingly enough, women are more likely to participate in disciplines in which, according to the NSF study (NSF 2009), they are less likely to collaborate internationally. As shown in the later study, scientists with degrees in engineering and the physical sciences are more likely to collaborate internationally than scientists with degrees in other sciences and in particular Social Sciences & Humanities.

However, the participation of women may vary substantially between Europe and Latin America, depending on the discipline (Figure 9). "Social Sciences & Humanities" is the only discipline with higher numbers of women participating in both Latin America (44.6%) and Europe (30.2%). The disciplines with the lowest participation of women in Latin America are "Physics" (11.5%) and "Mathematics & Computer Sciences" (19.8%). In Europe the participation of women is: "Physics" (23.1%), "Mathematics & Computer Sciences" (12.7%), "Earth-Ocean-Atmosphere" (13.8%) and "Clinical Medicine" (17.6%). "Engineering & Technology" is the only discipline with virtually the same female participation level in Europe (20.3%) and in Latin America (20.2%).

Figure 9. Relative participation of women according to main disciplines in EU and in LAC

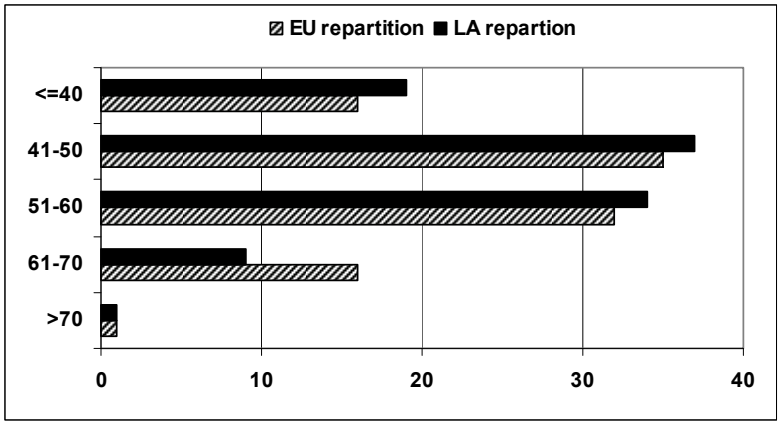


Ref: Countries of institutions

As for age, more than two-thirds of the respondents (69%) are between 40 and 60 years, the peak being in the age group of 40-49 years (36%). Only 18% of the researchers in the overall survey population are below 40 years of age, and there are no marked differences in age repartition between respondents from EU and LAC (Figure 10).

The survey population is older than the overall population of scientists in both EU and LAC (UIS, 2009). This would tend to confirm that researchers in the middle of their career (40 years and older) are more likely to collaborate internationally than those who are in early or late stages of their career.

Figure 10. Respondents' participation according to age

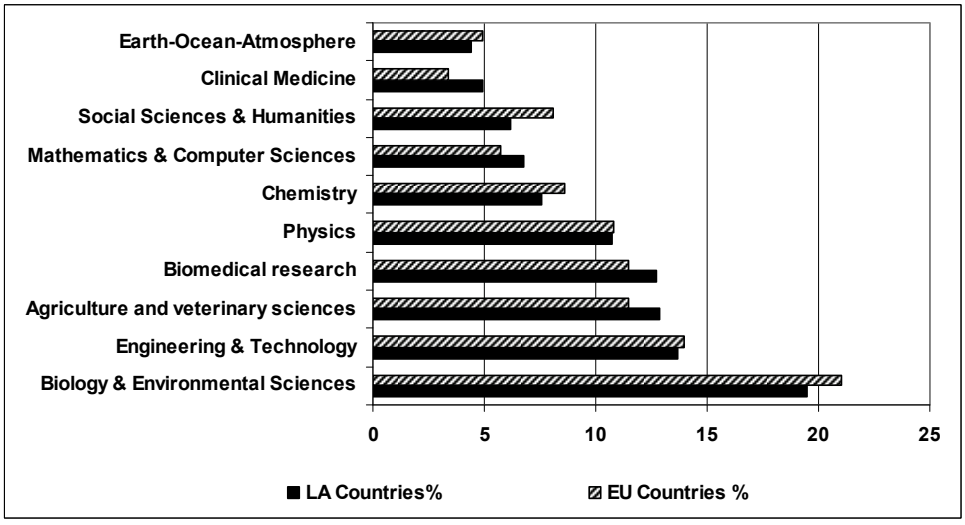


Ref: Countries of institutions

4. The scientific disciplines

The top research areas for S&T collaboration between EU and LAC countries among the respondents is "Biology & Environmental Sciences" (20.1%) followed by Engineering & Technology (13.9%), Agriculture and Veterinary Sciences (12.3%), Biomedical research (12.2%), and Physics (10.7%). In all other research areas, the respondents account for less than 10% (Figure 11).

Figure 11. Relative percentage of respondents by scientific fields in EU and LAC countries



Ref: Countries of institutions

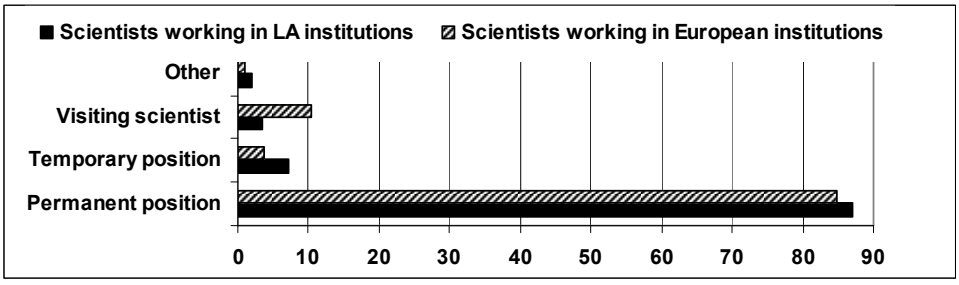
The fact that "Biology & Environmental Sciences" is the preferred area of collaboration between EU and LAC researchers is not surprising for LAC researchers, since it is the strongest scientific field for LAC countries whose scientific production, measured in number of publications, amounted to 6% of world science in 2006 (OST 2008). It is more surprising for EU for which "Biology & Environmental Sciences" is the weakest field of all, although it accounted for 35.6% of the world-share in 2006. Conversely, EU is the leading world-contributor in mathematics (42.7%), medical research (41.9%), and physics (41.1%) (OST 2008). In other words, the relative importance of the scientific disciplines in our population (*cf*. Figure 11) is more in line with the priorities of the LAC countries than with those of the EU countries[10].

Figure 11 shows that there are no marked differences between the proportion of respondents from EU and LAC countries and that the scientists in the survey participated more or less in the same proportion in all scientific fields.

5. Institutional affiliations and professional activities

The majority of the scientists who participated in the questionnaire survey have a permanent position (87% in EU and 85% in LAC) in a research or higher education institution. Relatively few are visiting scientists (4% in EU and 10% in LAC) or have a temporary position (7% in EU and 4% in LAC) (Figure 12). There are relatively more respondents with temporary positions in EU and more respondents working as visiting scientists in LAC. The category "other", which represents an even smaller proportion (1.4%), is mainly composed of 21 PhD students, 20 retirees, and 13 Emeritus.

Figure 12. Nature of position



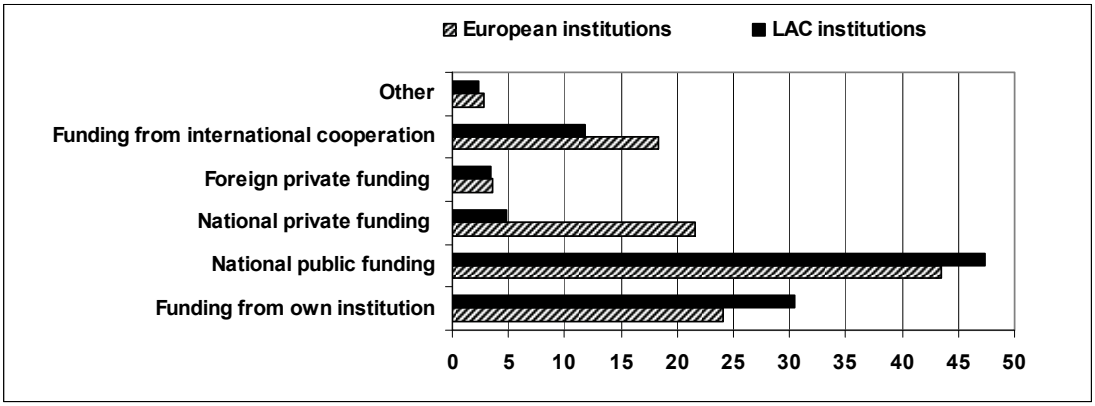
Ref: Countries of institutions

Both in LAC and EU, public or institutional funding mainly finances the research budgets. In 2009, for over one-third (36.9%) of the LAC respondents, national public funding provided 60-100% of their laboratory's budget. The second most important funding source for both LAC laboratories (30.4%) and EU laboratories (24.1%) was "funding from their own institutions". The main differences in funding sources for the two groups were in the two next sources, i.e. "national private funding" and "funding from international cooperation" from

[10] It should however be noted that the relative importance of scientific disciplines in our population differs slightly with the results presented in chapter 4 based on co-authorship analysis.

which EU laboratories received much more (respectively 21.6% and 18.2%) than the LAC laboratories (respectively 4.8% and 11.8% - Figure 13).

Figure 13. Relative importance of different funding sources in the laboratory's budget for 2009



Ref: Countries of institutions

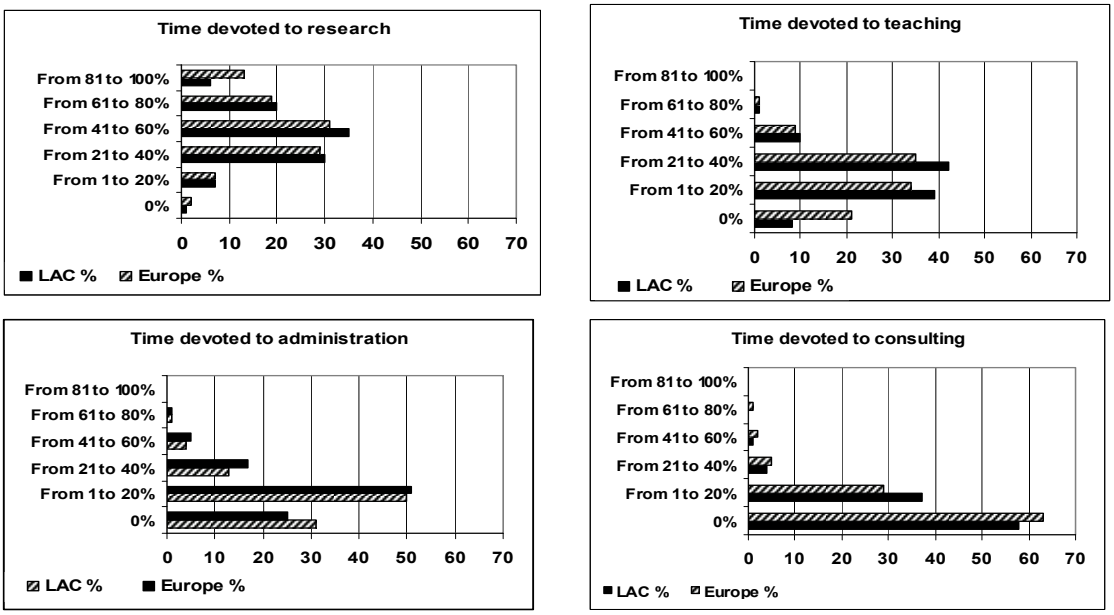
Research is the main activity of the respondents. They spend more time on research than on teaching and other activities (e.g. administration and consulting). For 60.2% of the whole group, research occupies at least 50% of the working time (for almost 77% it occupies at least 40% and for 41% of them, at least 60%).

One-third of them (35% for LAC and 31% for EU) devote between 41 and 60% of their time to research and nearly one-fifth (20% versus 19%) report spending 61-80% of their time on research. Those spending as much as 80-100% on research are relatively more numerous in EU countries (13%) than in LAC countries (6%). Very few (1.42%) state that they spend no time at all on research (Figure 14).

They spend much less time on teaching. More than 600 of the respondents (13.8%) declare that they spend no time at all on teaching. More than one-third of them (35% in EU and 42% in LAC) spend between 21-40% of their time on teaching. There are far more scientists in EU spending no time at all on teaching (21%) than in LAC countries (8%). Whereas research in LAC countries is predominantly carried out in higher education institutions, there is a significant number of researchers in EU belonging to research institutions who have no teaching obligation at all.

Time devoted to administration is even less important although 50% of the respondents declare spending 1-20% of their time on administrative duties. A large majority (59% in LAC and 63% in EU) declare having no consulting activities. The bulk of those who are engaged in consulting spend less than 20% of their time on this activity. They are relatively more numerous in LAC (37%) than in the EU (29%).

Figure 14. Percentage of time devoted to research, teaching, administration and consulting

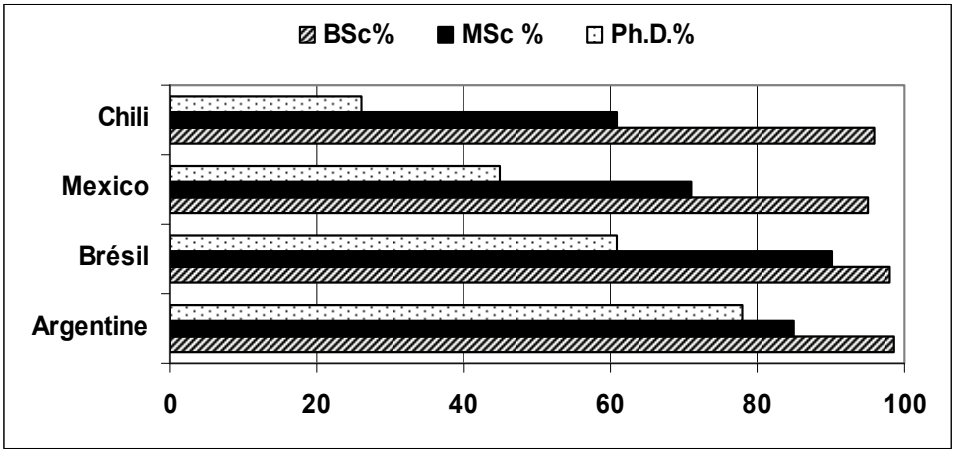


Ref: Countries of institutions

6. The history of mobility prior to international collaboration

The relative importance of studies at home compared to studies abroad for the three main degrees (BSc, MSc and PhD) in Latin America was calculated for the nationals of the four main science producer countries in Latin America (Brazil, Mexico, Argentina and Chile) which are also the LAC countries with the best developed higher education and the graduate/post-graduate systems. The results (Figure 15) show that the BSc is nearly always obtained in the country of nationality (between 95% in Mexico and 99% in Argentina) – the same holds true for the MSc although at a slightly lower level (between 61% in Chile and 90% in Brazil) – but that the four countries differ considerably for the PhD, (between 78% of national scientists who obtained their PhD in Argentina, 61% in Brazil, 45% in Mexico and only 26% in Chile).

Figure 15. Relative importance of BSc, MSc and PhD degrees obtained by scientists in their home country in Argentina, Brazil, Mexico and Chile



Ref: Countries of nationality

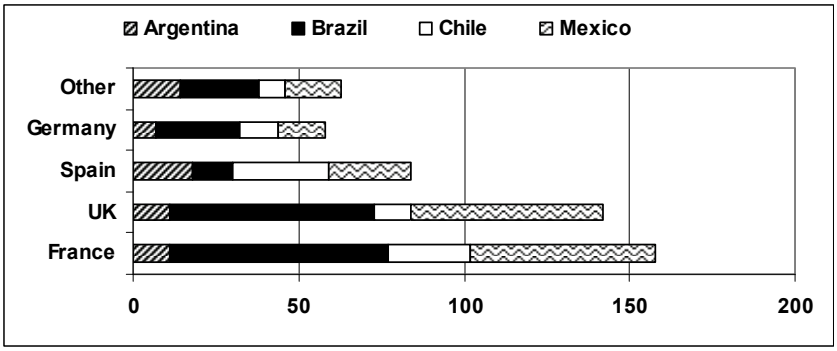
Overall, for these four Latin American countries, there are slightly more PhD degrees obtained at home (57%) than abroad (43%). Among the latter nearly two-thirds (64%) were obtained in a EU country, 28% in North America[11], 5% in another Latin American country (mainly Brazil, Mexico and Argentina) and 3% in another country (Japan, Russia, New Zealand, Israel and Australia). The overall relative domination of EU for PhD studies abroad could possibly be explained by the main bias of our survey population composed of LAC and EU scientists who published co-authored papers with scientists from the other region[12].

The main host countries for PhD studies in EU are, by decreasing order of importance: France, UK, Spain and Germany (Figure 16). France is first or very close to first with UK for Brazil and Mexico. Spain is the preferred country for Argentina and Chile. Germany follows but at a much lower level. These four EU countries concentrate the bulk (87.5%) of PhD studies carried out in EU. The other countries, but at a much lower level, are Austria, Belgium, Italy, The Netherlands, Norway, Portugal (for Brazil only), Sweden and Switzerland.

[11] Overwhelmingly in the USA (92%).

[12] Comparisons with available statistics, however, tend to indicate (at least for Mexico and Chile) that the geographical distribution of PhDs observed in the survey population is very similar to more comprehensive statistics reported for Mexico (Etienne Gérard, personal communication; Villaseñor Amésquita *et al.*, 2009), and not very far away from the results obtained in one national survey for Chile (Asenjo et Correa, 2005).

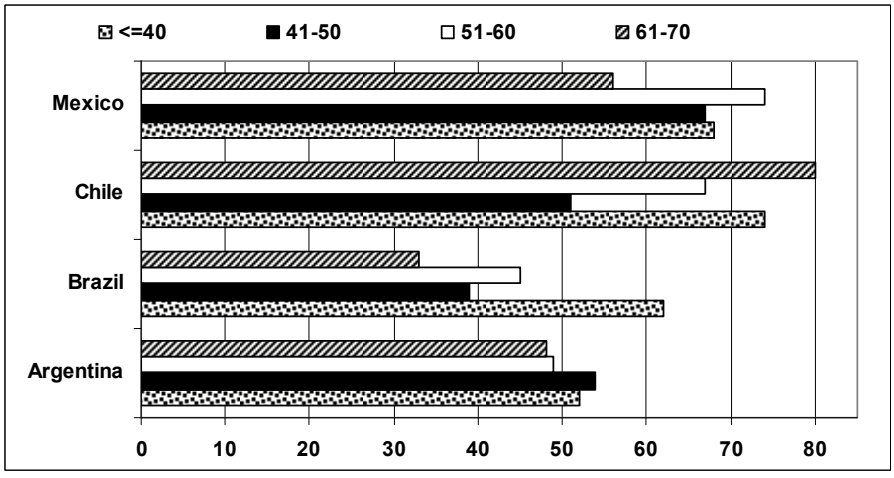
Figure 16. Main countries for PhD degree in EU for scientists from Argentina, Brazil, Mexico and Chile



Ref: Countries of nationality

Based on the assumption that in LAC the younger generations of scientists are unlike the older generations that were more or less obliged to go abroad to study at the doctoral level because of the lack of educational facilities within the country, we tried to see if a change in behaviour could be observed in the surveyed population by breaking the results down into age categories. Surprisingly, no major differences could be noticed. Nevertheless, the following chart (Figure 17) shows that slightly more of the younger generation studied for a PhD at home, although the difference, except for Brazil, is not really significant. Consequently, in the LAC surveyed population, the decision to study abroad is not perceived today as being correlated with the level of development of the national higher education system, regardless of population age.

Figure 17. Relative importance (in %) of PhDs obtained at home, according to age category

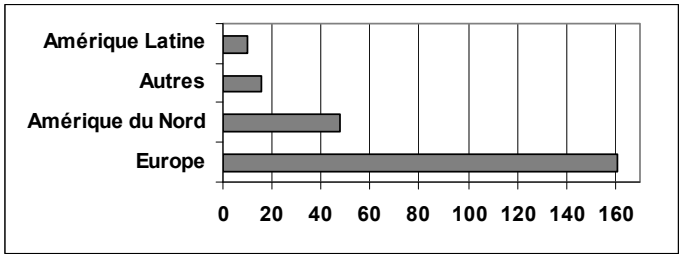


Ref: Countries of nationality

A variety of situations can also be observed in the EU surveyed population where a large majority of scientists from UK (60%) and France (57%) completed their studies at home

while three-fourths of the scientists in Germany (75%) and Italy (77%) went abroad. Spain occupies a position in between. About 12.53% went to another country to complete their PhD, mainly to another EU country but also to other continents (Figure 18). These results confirm that, given its age composition, the sample of EU scientist (mainly middle age scientists) is also very migratory, a trait that existed even before the development of international collaboration.

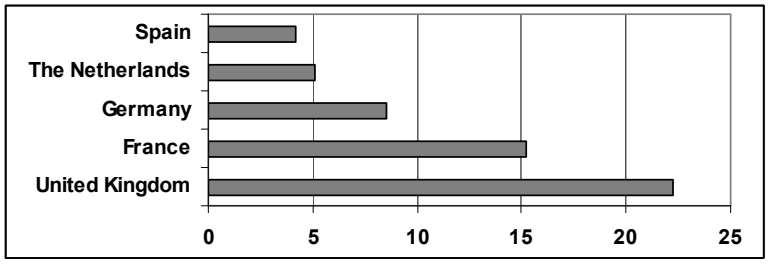
Figure 18. Receiving continents for EU PhD candidates



Ref: Countries of nationality

The receiving country for EU PhD candidates in EU in decreasing order is: UK with 22%, France 15%, and Germany 9% (Figure 19).

Figure 19. Receiving countries for EU PhD candidates (%)

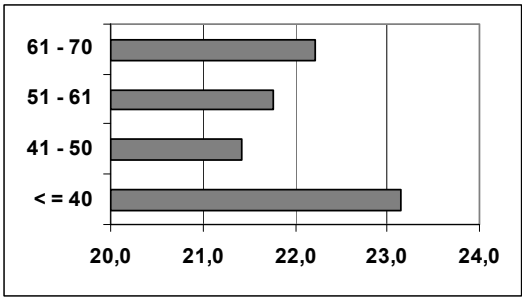


Ref: Countries of nationality

The major part of this mobility being inside EU borders, we tried to check if the EU initiatives favouring students' mobility[13] through EU could have impacted the mobility of the youngest generation of the sample, i.e. under 40 years of age.

[13] The Erasmus (European Region Action Scheme for the Mobility or University Students) programme and the Socrates programme launched respectively in 1987 and 1994.

Figure 20. Repartition by age categories of expatriation frequency for PhD (in %)

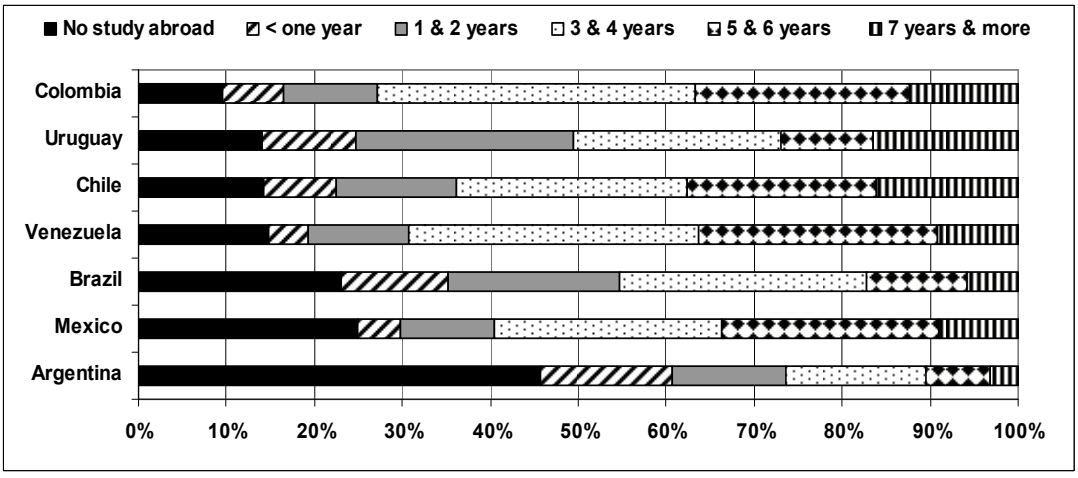


Ref: Countries of nationality

The results (Figure 20) do not reveal any major difference between generations (only one point between the youngest and the oldest generation). That is not enough to conclude that the EU programmes could have had an effect on the international mobility for PhD students in this population. This again could tend to confirm that the mobility of scientists is an intrinsic phenomenon rather than one linked to political incentives.

The time spent abroad for studies varies greatly between countries as well as between continents. In LAC, 12% of the scientists spent less than one year abroad for non-degree short-term studies and eight percent (8%) spent seven years and more abroad for studies. In between there is slight peak of around four years (11%) corresponding mainly to scientists who study abroad for their PhD. There is a large disparity between the countries: in Argentina only 26% of scientists went abroad three years and more, while a large proportion of the scientists from other countries (72% for Colombia, 60% for Mexico and 51% for Uruguay) went abroad for longer periods, between three years and over seven years (Figure 21).

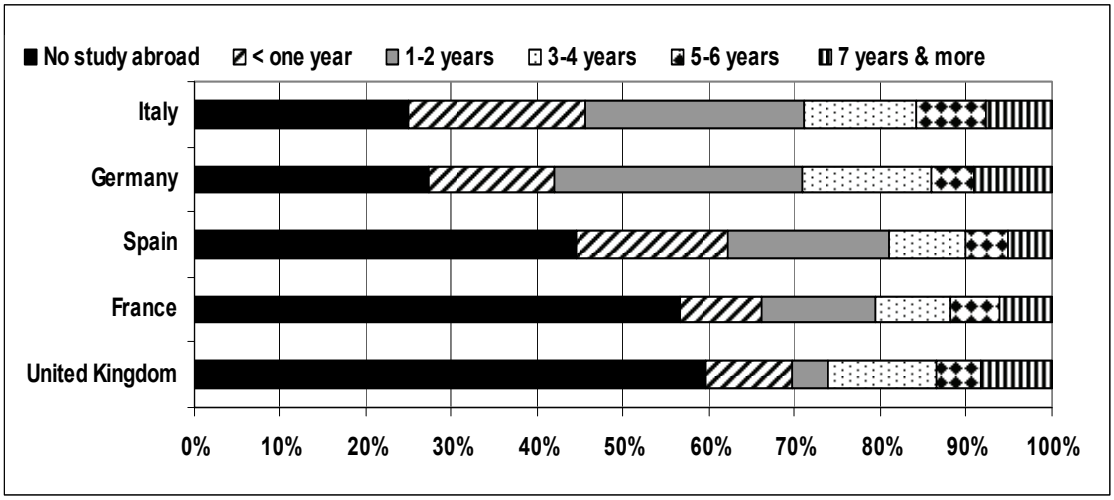
Figure 21. Relative importance of study periods abroad for some of the main Latin American countries



2144 respondents: Ref: Countries of nationality

A variety of situations can also be observed in EU, but despite student mobility, the EU sample shows less migratory movement than the LAC sample. The proportion of studies completed at home in EU countries, is much greater on average (15.1% against 6.8%) and the duration of study periods abroad is shorter (18% of LAC scientists spent 3 years and more abroad for studies as against only 8.8 % of EU scientists) (Figure 22).

Figure 22. Relative importance of study periods abroad for the main EU countrie

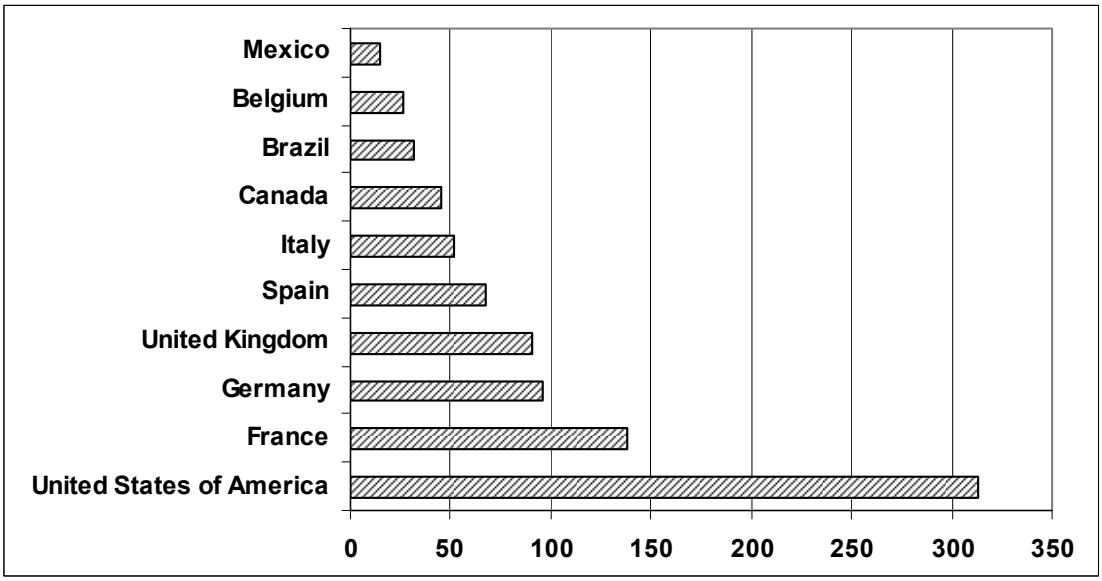


1405 respondents: Ref: Countries of nationality

This very high degree of international mobility is confirmed by the frequency of the post-doc studies carried out abroad. In the whole surveyed population, 42.2% did their post-doc abroad. There are relatively fewer women scientists (39.5%) than men (45.1%) but the difference is not as important as we may have expected. Overall, slightly more scientists based in a EU institution (45%: 46.9% male and 41.5% female) did a post-doc, compared to scientists based in a Latin American institution (40%: 43.5% male and 38.1% female). The relative frequency of post-doc studies abroad however varies from country to country: 55% of the scientists based in Spanish institutions did a post-doc, but only 27% in Italy (in between: France 52%, Germany 48% and UK 36%).

In LAC institutions, Brazilian scientists were more likely to engage in post-doc studies (53%) than scientists from other LAC countries (Argentina 48%, Mexico 33%, Chile 30%). For these four Latin American countries, Western Europe is the main destination for post-doc studies (54.3%) followed by North America (36.4%), elsewhere in Latin America (6.1%) and other countries (3.2%) (Figure 23). It is noteworthy that more than half (35 out of 60) of the post-doc studies in LAC took place in the scientist's country of work, e.g. 21 out of 28 in Brazil.

Figure 23. Top 10 host countries for post-doc studies for LAC national scientists

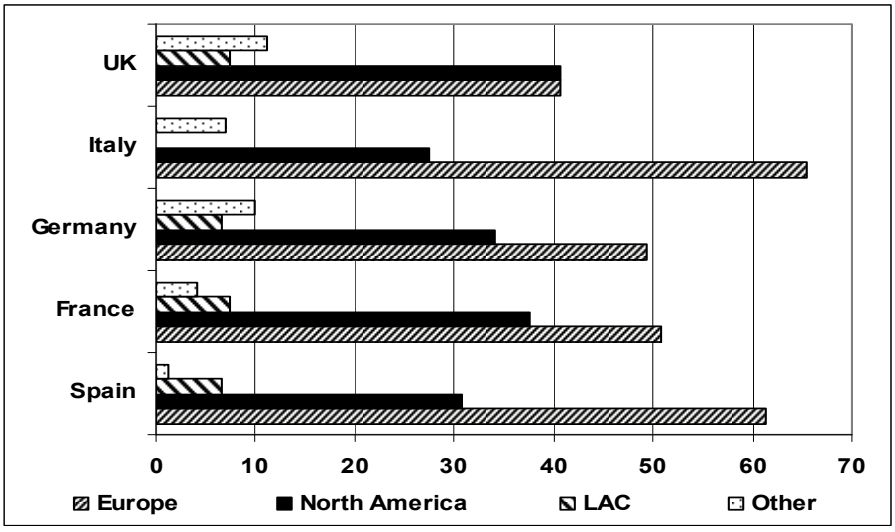


Ref: Countries of nationality

A comparison of earlier percentages with those observed for PhD studies shows that significantly fewer post-docs studied in EU (54.3%) than PhD students (64%) and significantly more studied in North America (36.4% compared to 28%). The number of post-docs who studied in LAC and/or other countries are more or less comparable.

For the five main science producers in the EU (Spain, France, Germany, Italy and UK), Western Europe is the main destination for post-doctoral studies, with a marked preference for another EU country (Figure 24). This confirms the importance of intra-European mobility in S&T. Overall one-third (33.2%) of the EU scientists selected North America (USA 85.4% of them) to carry out their post-doctoral studies. This percentage is comparable to the one obtained for the LAC scientists (36.4%). USA is particularly attractive for UK and France scientists. There are relatively few (6.2%) who selected a LAC country. Their preferred destinations in LAC were Mexico, Brazil, Cuba and Venezuela. When asked about motivations for study venues in LAC, 46% chose “the reputation of the host country institution likely to promote my career” and 35% “the scientific expertise developed in the host country”. 81% of them received financial assistance from the following sources: their home country, their host country, or a special fund.

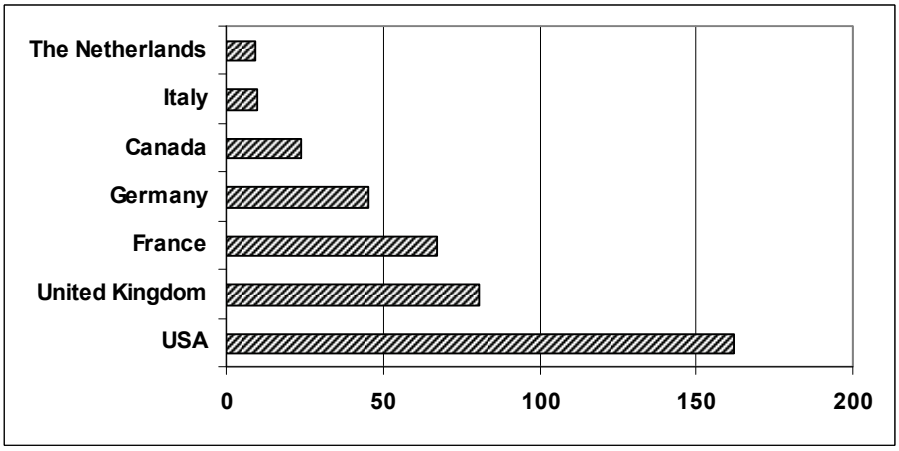
Figure 24. Post-doc host regions for scientists from main EU countries (%)



Ref: Countries of nationality

Figure 25 lists the top seven host countries for post-docs for EU national scientists from Spain, France, Germany, Italy and the UK. These seven countries host 50% of the total post-doc studies by EU nationals. USA with 20.5% is, by far, the preferred country of destination followed by UK (10.3%), France (8.5%), Germany, Canada, Italy and The Netherlands.

Figure 25. Top 7 Post-doc host countries for scientists from main EU countries



Ref: Countries of nationality

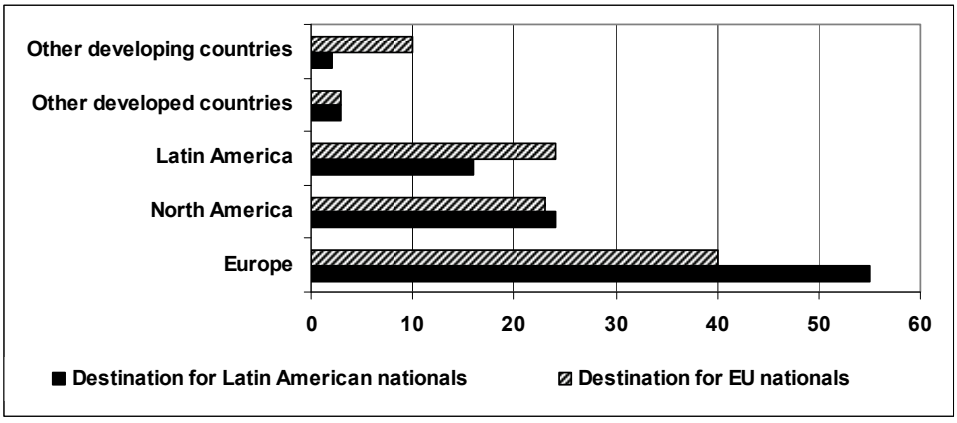
To trace the further international mobility of the respondents, the following question was asked: “Have you made other stays abroad exceeding 6 months”. A third of the whole surveyed population answered “yes” (32% of the LAC nationals and 37% of the EU

nationals). The results show that the nature of these stays is overwhelmingly for professional reasons (only 5% of the respondents stayed for non-professional reasons).

In the four big scientific LAC countries, Mexican scientists showed the strongest propensity to expatriate during their career. Almost 40% of them made one or more stays abroad, followed by Brazilians (32%), Chileans (31%), and Argentineans (27%). This trend is even more common in the main scientific EU countries where 44% of the French surveyed population "emigrated" during their career path, followed by Germans (38%), British (32%), Italians (31%) and Spaniards (30%).

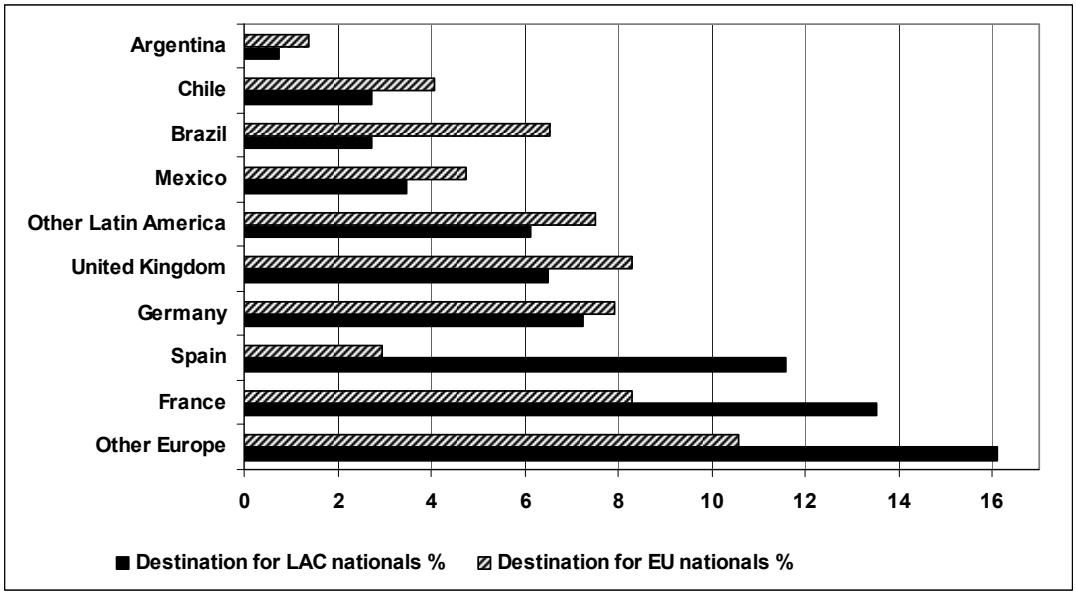
A look at the total number of expatriations, 1323 LAC scientists and 1011 Europeans, in Figure 26 shows that EU is, for both groups, the preferred destination for extended stays abroad (55% for LAC scientists and 40% for EU), followed by North America, with almost the same proportion in the two groups (LAC 20.71%, EU 20.27%). The situation is different for extended periods of stay in LAC (16% for LAC scientists and 24% for EU) and even moreso in the developing countries where it appears that the quota of EU scientists prone to travel to these countries is much higher (10% of EU and only 3% of LAC scientists). Of course this situation can be traced to one of the biases of the sample, which was constructed on the bases of scientific collaboration between LAC and EU. But the fact that the EU scientists are staying for long periods of time in Latin America, as well as in Africa (7% of the whole EU group) indicates the interest of EU scientists who answered the survey to collaborate with scientists from countries less scientifically developed than their own.

Figure 26. Regions of destination for long stays abroad (in %)



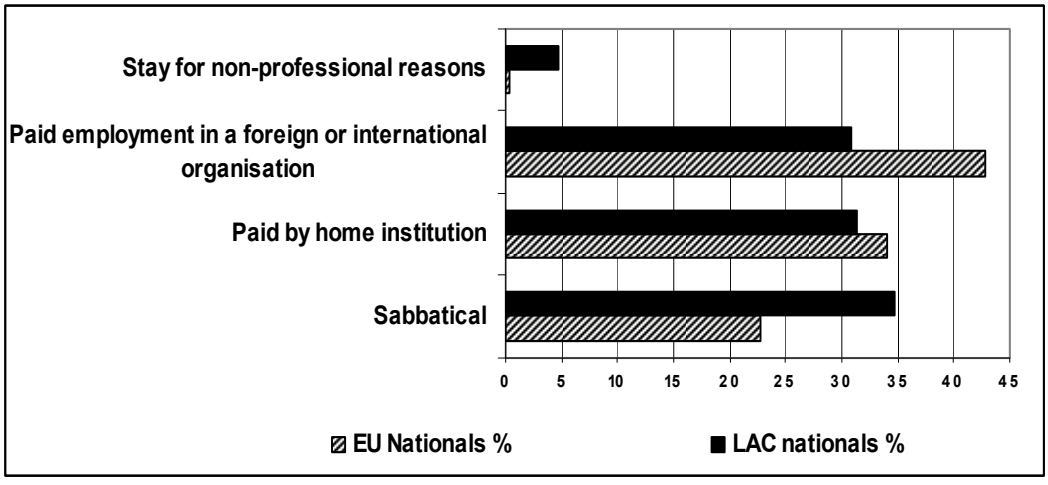
In Europe, France is the preferred country of destination for the two groups of expatriate scientists (LAC 13.4%, EU 8.3%). UK presents the same level of attraction for EU scientists (8.3%), followed by Spain for LAC scientists (11.6%). In LAC, Brazil is the most attractive country for EU scientist (6.5%), followed by Mexico (4.75%) and Chile (4.6%) (Figure 27).

Figure 27. Preferred countries of destination for stays abroad exceeding 6 months, in %



The nature of these stays is largely for professional reasons. The major differences between the two groups can be seen in "Sabbatical", an opportunity used by 35% of the LAC sub-group to migrate (23% for the EU sub-group) and "Paid employment by foreign or international institution" which benefits 43% of EU sub-group against 31% of the Latin American group (Figure 28).

Figure 28. Nature of stays abroad exceeding 6 months (in %)



1479 respondents

Almost 20% of this population claims “other reasons” for extended stays abroad (12% of the EU nationals and 26% of the Latin Americans). Surprisingly, the main reasons mentioned are still of a very scientific and professional nature: “visiting scientist, visiting professor or visiting fellow”, “scientific training”, “scientific exchange”. When these reasons are listed under “Other reasons”, they probably take place within the framework of academic exchanges with bilateral funding. Inter-institutional agreements generally stipulate a breakdown of the costs according to the following: travel and local salaries are often paid by the sending institution while additional wages and accommodation allowances are provided by the institution of destination. “Fellowships” are also mentioned quite often (47 times for LAC nationals and 16 times for EU) since the scientist may not consider them as salaries. International cooperation is mentioned 15 times (10 times by EU scientists and 5 times by Latin Americans).

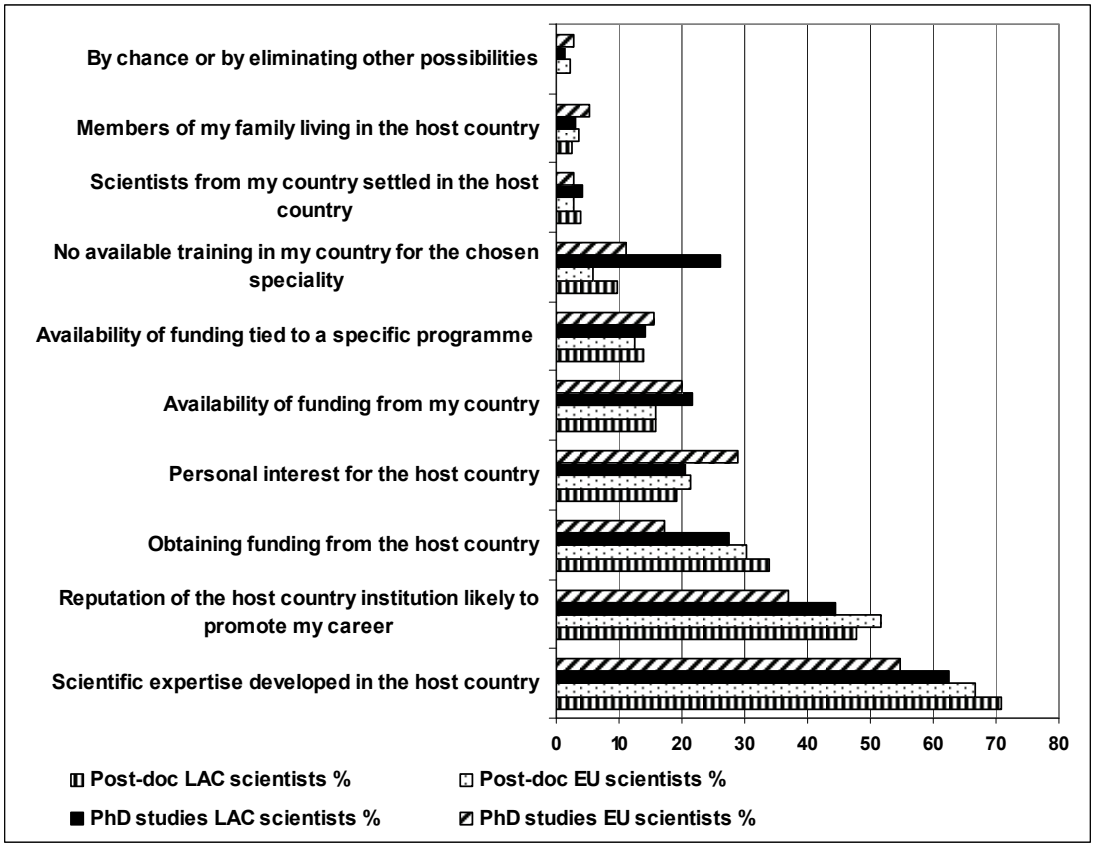
7. Main reasons for international scientific mobility

The questionnaire on international scientific mobility proposes several – scientific, personal, other – reasons for going abroad to study and for staying abroad for post-doc studies. –The respondents were free to select as many reasons as they wanted. Remember that a large majority (68.8%) of the scientists from both continents left their countries to study abroad mainly at the PhD level (76.8% LAC and 58.5% EU) and close to half of them (41.9%) went abroad for a post-doc (40% LAC and 44.4% EU).

The responses quite clearly showed that this migration was strongly connected to a scientific goal (Figure 29). The dynamics of the mobility were not based on what the scientists wanted to escape from but on what they hoped to gain by moving, e.g. a minority of the respondents (apart the category of LAC scientists who went abroad for studies) gave “no available training in my country for the chosen speciality” as the reason for going abroad. Although the older generations of scientists in almost all LAC seemed more or less forced to go abroad to study at the doctoral and postdoctoral levels because of lack of available training in their home country, they did not express it that way in general not even at the post-doc level; only 9.7% of the LAC scientists selected this reason as motivation for their expatriation.

The main motivations for the two groups were related to the scientific gains they expected from their stay abroad; this was more strongly felt by the group working in LAC. As observed in other case studies, (Millard 2005, Zucker and Darby 2006) the search for excellence was the main determinant in mobility. “The scientific expertise developed in the host country” received the highest votes with 70.9 % of positive answers from LAC scientists at the post-doc level and 62.6% at the PhD level, and 66.8% from EU at post-doc level and 54.6% at PhD level. In the same vein, “the reputation of the host country institutions likely to promote my career” was underscored by almost half of the population (respectively 47.7 % and 51.6 % at the post-doc level and 44.4% and 36.9% at the PhD level). The least important reasons by far were linked to the fact that the scientist had relatives and acquaintances abroad: “members of my family living in the host country” or “scientists from my country settled in the host country” was mentioned on average 3.6% for LAC and 1.6 % for EU. The latter result tends to indicate, despite the fact that a tangible number of scientists are working in a country other than their country of nationality, that the family and S&T diasporas play a very marginal role in the choice of going abroad and selecting an institution for PhD and post-doc studies.

Figure 29. Reasons why scientists went abroad for PhD and post-doc studies (in %)



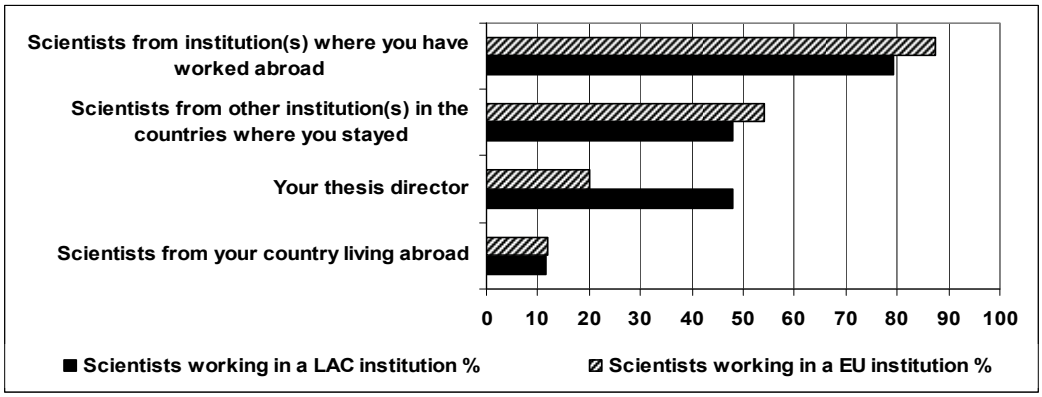
In between, there are a number of additional reasons considered as important such as "personal interest for the host country" with 28.8%, for EU at PhD level. It is noteworthy that most of the EU scientists could choose "Excellence" as the reason for their studies without needing to travel abroad if they so wished. "Funding obtained from the host country" is also an important reason for moving abroad. An average of 27% of the surveyed population selected this reason for expatriation, but there was a major difference between continents and between levels of study: 17% of the EU at PhD level and 34% of Latin Americans at the post-doc level. "Availability of funding from my country" received an average of 18.3%. This motivation seems to be more important at the PhD level (around 20% for both groups) than at the post-doc level (around 16% for both groups). If the three questions related to the availability of funding ("from home country", "from destination country" or "tied to a specific programme") are combined, an average of 63.5% of the LAC scientists and 55.5% of the EU scientists link their time abroad to the accessibility of funding. For the EU scientists, the percentage is even higher; 81% for scientists who made extended stays (studies and other reasons) in LAC. This aspect gives another perspective to the factors determining international mobility.

8. International collaborations: nature, frequency and permanency

Altogether, 3814 scientists (86.2%) of the surveyed population (88.8% of LAC scientists and 82.8% of EU) spent long periods of time, i.e. over 6 months, abroad for study or post-doc. To what extent did these stays abroad contribute to the promotion of international collaboration? With whom and in what institutional context did these collaborations take place? How permanent are they?

First of all, more than nine out of ten (90.3% for LAC scientists and 92.3% for EU) have published scientific papers with colleagues met during long stays abroad. Undoubtedly, this first result confirms that going abroad for studies and post-doc research or extended stays significantly contribute to the publication of scientific papers in co-authorship with foreign scientists met during these stays abroad (Figure 30).

Figure 30. With what colleagues known or met abroad did you publish in co-authorship (%)?



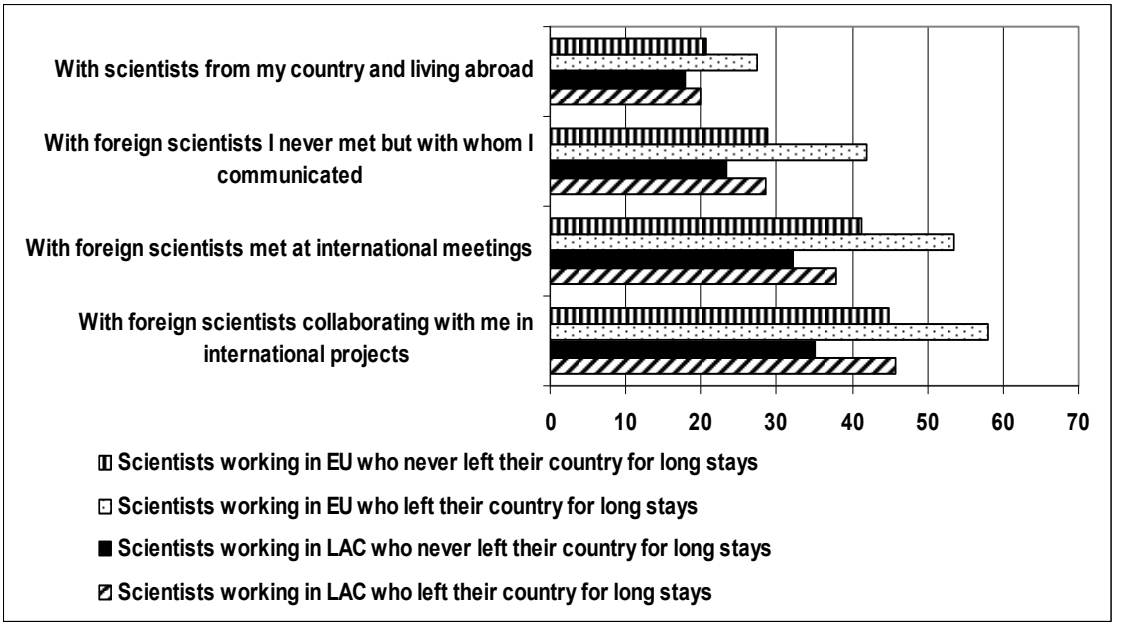
The percentage of the surveyed scientists who have not gone abroad for extended periods of time is, on average, only 14% (11.4 % in LAC national groups and 17.3 % in EU), but obviously, these scientists also collaborate and co-publish with foreign colleagues (Figure 31).

Who are the foreign colleagues with whom these scientists collaborate or co-publish? Figure 30 shows that they are, to a very large extent, colleagues from institutions in which the scientists have worked abroad (79.4% of scientists working in LAC institutions and 87.3% of their colleagues working in EU institutions), followed by colleagues from other institutions in the countries where the scientists stayed (48% LAC and 54% EU). It is surprising that 48% of the scientists working in LAC institutions have co-published with their thesis director while the figure for Europe is only 20%. Collaboration with the members of the scientific diasporas is the last choice of the respondents: around 12% for both groups.

The surveyed scientists were also asked whether they collaborated or co-published with scientists abroad who they had not met during their extended stays abroad. The majority of them (54% for LAC and 63% for EU) did in fact collaborate or co-publish sometimes or often with scientists abroad who they had not met during their extended stays abroad. These

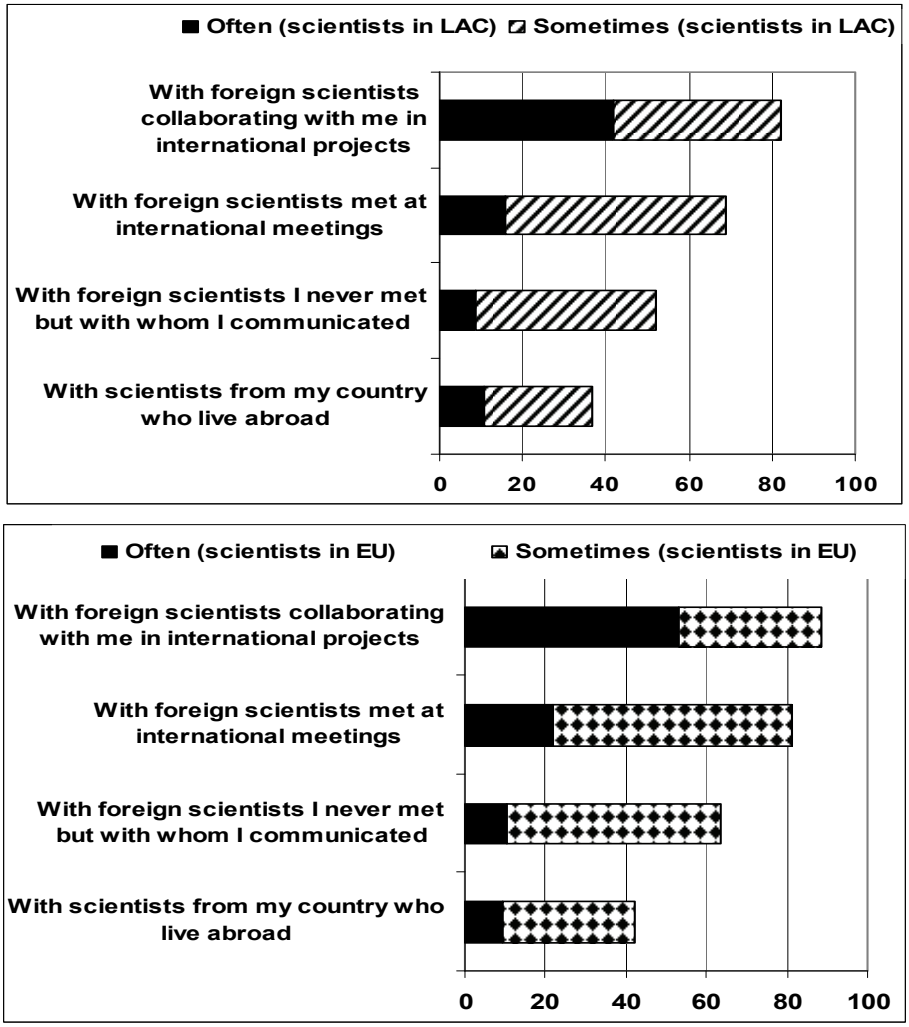
foreign colleagues (or colleagues living abroad) are by decreasing order of importance: "foreign scientists collaborating with them in international projects" (49.2% of the whole sample: 55.6% of scientists working in EU and 44.5% of those working in LAC), followed by "foreign scientists occasionally met at international meetings" (43% of the whole sample: 50.9% EU and 37.3% LAC), then by "foreign scientists they never met but with whom they communicated (e.g. through internet)" (27.4 % of the whole sample: 26.5% in EU and 28.1% in LAC), and in some cases, "scientists from their country living abroad" (22.7% of the whole sample: 26.5% in EU and 20% in LAC) (Figure 32).

Figure 31. Collaborations with colleagues not known during extended stays abroad, in %



In order to find out how international mobility can impact collaboration with colleagues not encountered before collaborating, we broke the sample into two groups: the internationally migratory scientists (those who had emigrated for more than 6 months to another country, regardless of reason) and the sedentary scientists who did not leave their country for extended stays (13.7% of the whole sample, 11.2 in LAC and 17.2% in EU). The results show, sometimes with a fair margin, that international mobility stimulates international collaboration with people not known prior to collaboration (Figure 31). In the two continents and for all types of collaboration, the "extended stays abroad" scientists collaborated more with colleagues not known or occasionally met shortly prior to collaboration.

Figure 32. Frequency of collaboration with scientists not known during extended visits abroad (in % of selected group)



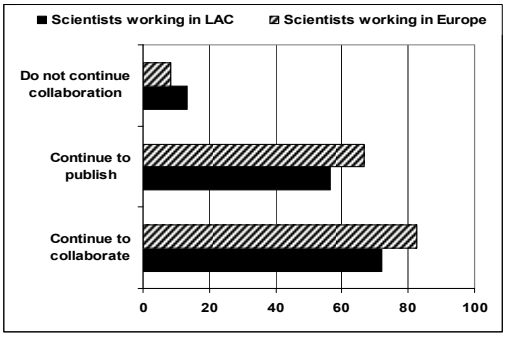
The collaboration observed in the two groups (Figure 32) shows, once again, that the difference between the scientists working in LAC and those working in EU is not significant since 44% of the scientists working in LAC and 55% of those working in Europe collaborate either often or sometimes "With foreign scientists in international projects". Since international projects aim at creating international links of cooperation, it is not surprising that in both groups collaboration with colleagues not known prior to collaboration was given top priority in these schemes. Conversely, again in relation to the total surveyed population, only one-fifth of the scientists working in LAC and slightly more than one-fourth of those working in EU collaborated either often or sometimes with members of their national scientific diasporas.

These collaborations are mainly longstanding (Figure 33). Only a small number of scientists on both continents ended collaboration after it had begun: 15.7% of the scientists working in

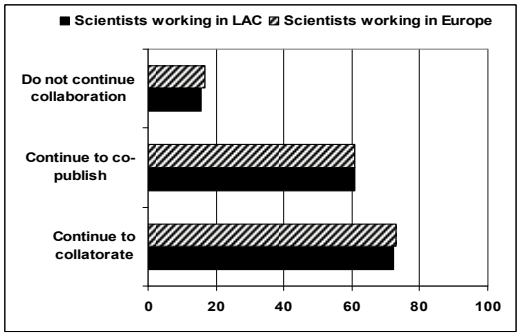
a LAC and 16.2% of those working in Europe put an end to their collaboration with people they knew from their extended stays abroad, and 13.4% in LAC and 8.2% in EU terminated their collaboration with people they had not met during their extended stays abroad.

Figure 33. Persistence of collaboration (%)

Collaboration with colleagues known during long stays abroad



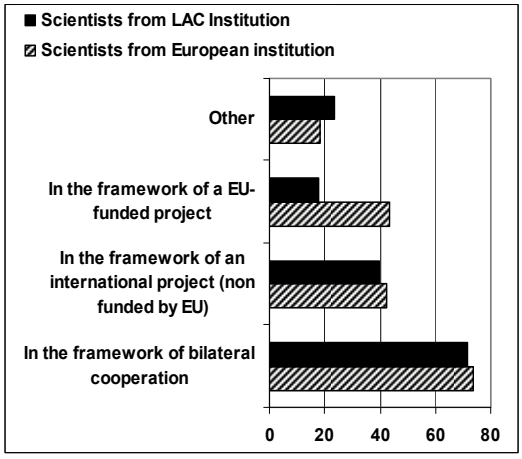
Collaboration with colleagues not known during long stays abroad



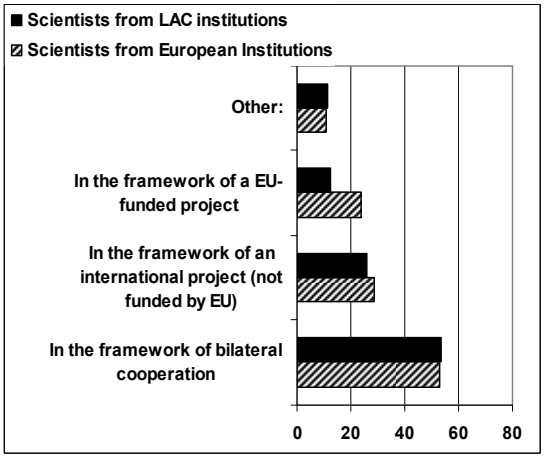
The major part of these collaborations takes place, as shown in Figure 34, as part of bilateral cooperation and even more so for collaborations with colleagues not known during long stays abroad. Many countries have developed such bilateral cooperation schemes over the last two decades, and numerous universities, both in EU and LAC promote these collaboration opportunities.

Figure 34. Institutional framework for collaboration (%)

With colleagues known during long stays abroad



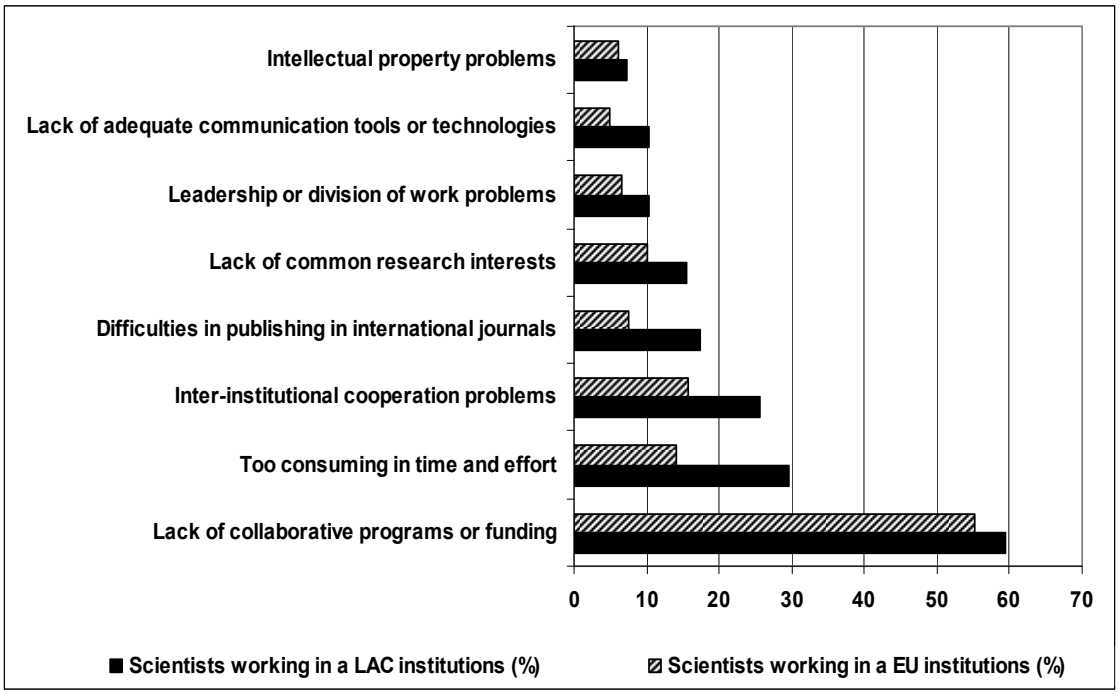
With colleagues not known during long stays abroad



The second most important institutional framework is an international project (not funded by EU) with the same relative importance in Europe and Latin America. EU-funded projects are in third position, but benefit scientists working in EU far more than scientists working in LAC.

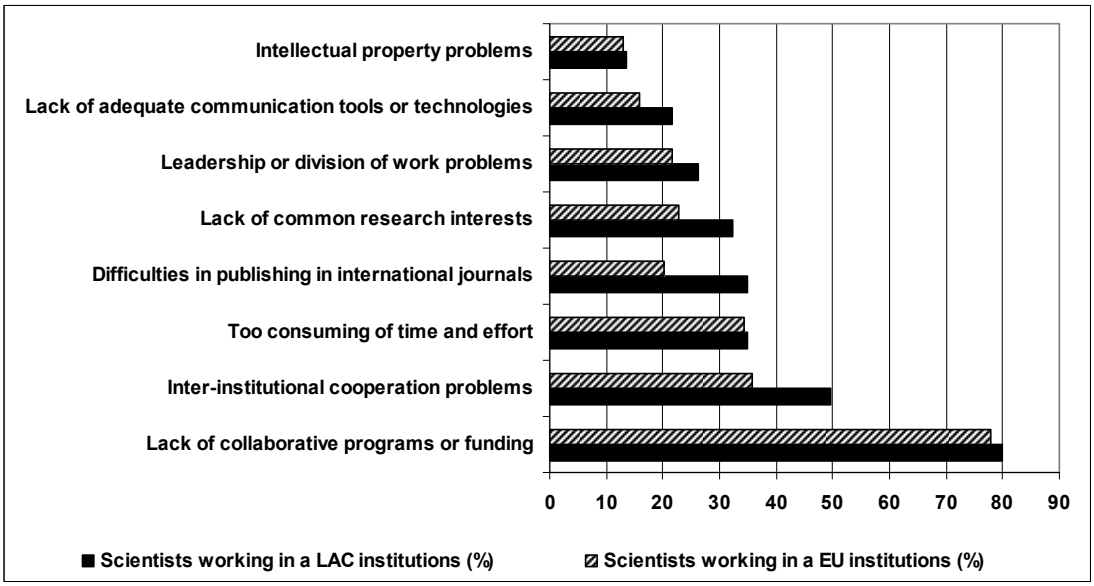
A series of perceived difficulties were proposed in an attempt to measure the main constraints to collaborating or co-publishing with foreign scientists. They were rated from 1 = insignificant to 5 = major. Here again, the responses do not differ greatly between the scientists working in EU and in LAC (Figure 35).

Figure 35. The main difficulties in collaborating or co-publishing with foreign scientists
(in % based only on responses "important")



Actually, most of the proposed potential difficulties were not perceived as such by the respondents except for "lack of collaborative programmes or funding" that was considered as a main difficulty on both continents. Analysing the results obtained when adding the response "moderately important" to the ones computed in Figure 35 (i.e. "important" and "major") gives a different figure and the "inter-institutional cooperation problems" becomes a difficulty for half of the scientists working in LAC countries (compared to 36.8% for scientists working in Europe). "Too time- and effort-consuming" is evenly perceived as a problem for a large third of each group (35% in LAC and 34% in EU) while "difficulties in publishing in international journals" and "lack of common research interest" are considered more as problems by scientists working in LAC countries (respectively 34.7% and 32.4% in LAC versus 22.9% and 20.2% in Europe).

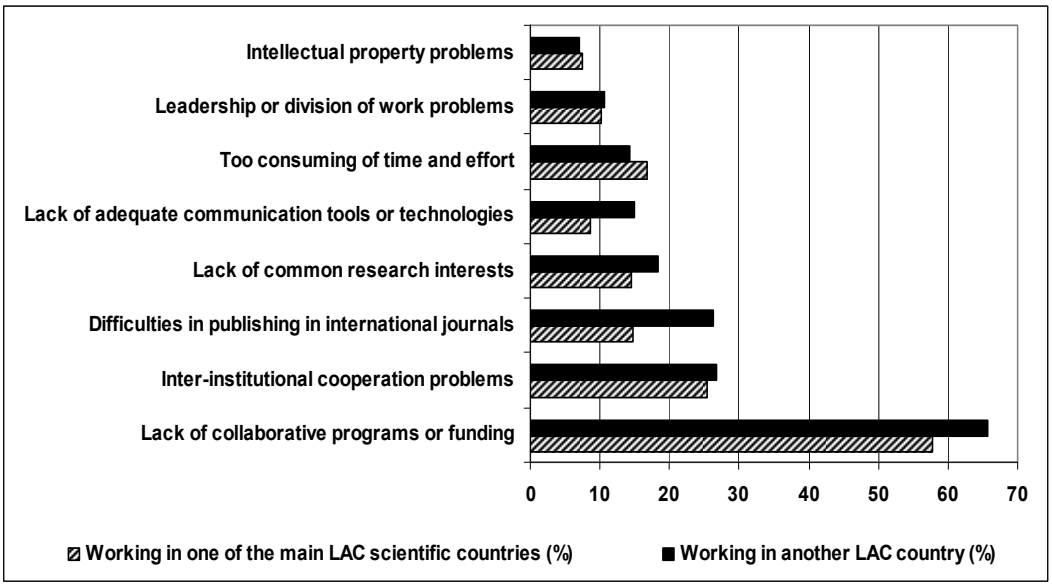
Figure 36. The main difficulties in collaborating or co-publishing with foreign scientists (in % based on responses "moderately important", "important" and "major")



To refine these results, we sub-divided the surveyed population and only selected the main scientific countries on both continents (4 in LAC and 5 in EU[14]). But amazingly, the results were not very different, apart for the proposed reason "too time and effort-consuming" that remained exactly at the same level for scientists working in Europe but decreased significantly for those working in LAC (from 30% to 17%). The four main scientific LAC countries and the remaining countries of the continent were then further sub-divided in order to test the homogeneity versus heterogeneity of the results over the whole Latin American and Caribbean region. The results (Figure 37) show three significant differences: the scientists working in the less developed scientific LAC countries expressed more "difficulties in publishing in international journals", than their colleagues working in more developed scientific LAC countries (26.2% versus 14.7%), the "lack of collaborative programmes or funding" also affected them to a larger extent (65.6% versus 57.7%) as well as the "lack of adequate communication tools or technologies" (15% versus 8.7%).

[14] Argentina, Brazil, Chile and Mexico for LAC; France, Germany, Italy, Spain and United Kingdom for EU.

Figure 37 The main difficulties in collaborating or co-publishing with foreign scientists (in % based only on "important" and "major") for scientists working in LAC countries

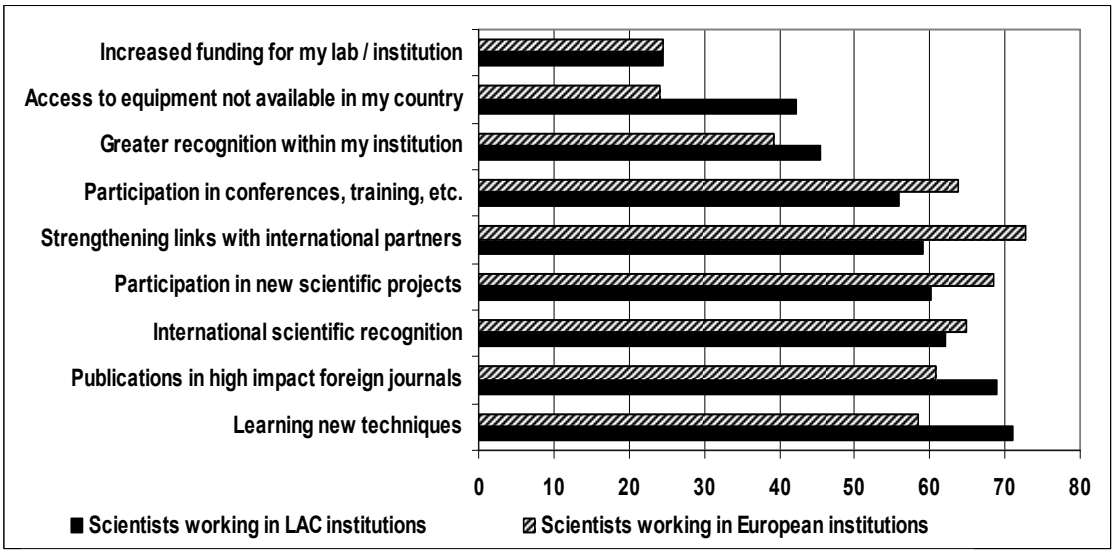


9. International collaboration: impacts and outcomes

In an attempt to characterise the main outcomes of international collaboration, a series of outcomes were proposed to the surveyed scientists from which they could choose everything that applied to their specific situation (Figure 38). Although the relative importance of many of the proposed outcomes is not very significantly different for LAC and EU scientists, there were some distinct trends. The main outcomes for EU scientists were related to social and scientific networking activities: "strengthening links with international partners" (72.7%), "participation in new scientific projects" (68.4%) and "participation in conferences, training, etc." (63.8%). For LAC scientists, international collaboration tended to generate more tangible outcomes such as "learning new techniques" (71%), "publications in high impact journals" (69%) and "access to equipment not available in my country" (42,3%).

Other outcomes of importance for both groups of scientists were "international scientific recognition" (62% LAC and 64.7% EU and 62% and to a lesser extent "greater recognition within my institution" (45.5% LAC and 39.3% EU) and eventually, "increased funding for my lab / institution" (24.4% LAC and 24.6% EU).

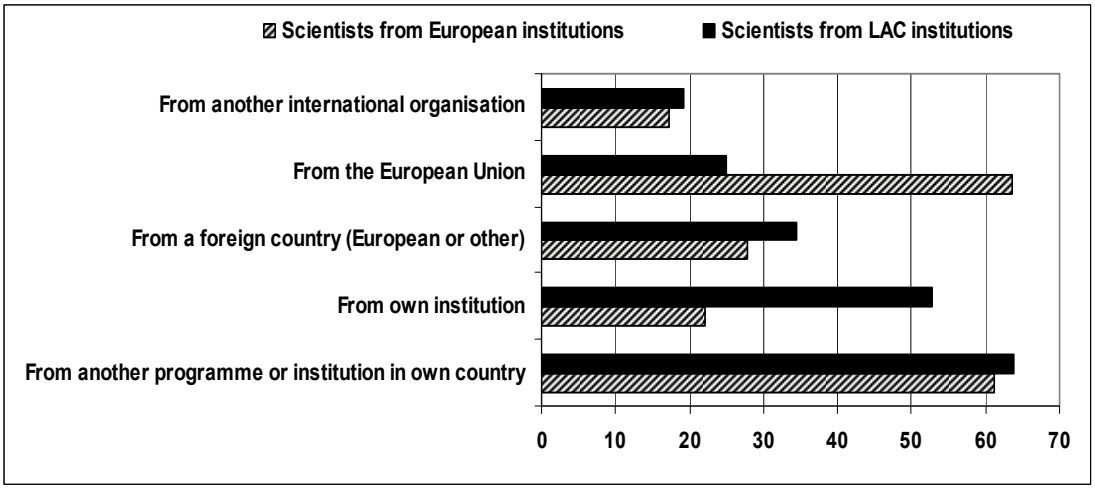
Figure 38. Main outcomes of international collaboration (%)



As for the preceding question, a breakdown was made of both the four main scientifically-developed LAC countries and the other countries in the continent in an attempt to investigate whether the level of scientific development of the LAC countries could impact the scientists' perception of the outcomes derived from international collaboration. The results showed that the answers from the two groups were quite similar but with a slightly higher percentage of positive opinions in the scientifically less developed countries. These positive differences range from 1.4% for "strengthening links with international partners" to 5.5% for "learning new techniques", 6.2% for "access to equipment not available in my country", 6.6 % for "increased funding for my laboratory / institution", 7.4% for "publications in high impact foreign journals" and 11.1% for "participation in conferences, training etc.".

For 1084 respondents (24.5% of the surveyed population), international collaboration resulted in increased funding for the scientists' laboratories or institutions (Figure 39). Nevertheless, very clear differences are to be noted between EU and LAC groups for two funding sources: the European Union and the home institution. Not surprisingly, increased funding from the European Union is particularly important for EU institutions (63.6%), and much less important for LAC institutions (24.9%). Conversely, increased funding "from the home institution" is much more important for LAC institutions (52.7%) than for EU institutions (22.0%), and increased funding "from another programme or institution in the home country" is important for both LAC (63.7%) and EU (61.2%) scientists. Finally, increased funding "from a foreign country (EU or other)" is of lesser importance (34.5% for LAC and 27.8% for EU) and increased funding "from another international organisation" is even less important (19.1% for LAC and 17.1% for EU)

Figure 39. Main sources of increased funding for my laboratory / institution resulting from international collaboration (%)

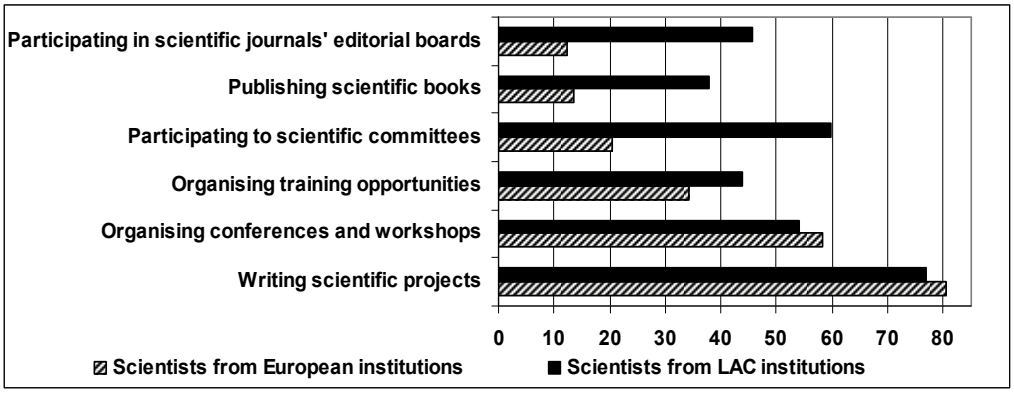


Among other additional scientific outcomes that are generated by international cooperation (Figure 40), the most important for both groups is “writing scientific projects” (80.6% for those working in Europe and 76.9% in LAC). This result very strongly confirms the common allegation on the subject: the more you collaborate internationally, the more opportunity you have to meet new colleagues, exchange ideas, “write new projects” and access new funding schemes in collaboration with foreign colleagues. The second is ”organising conferences and workshops”, which is almost at the same level on the two continents (58.1% in EU and 54.1% in LAC).

The other four additional outcomes identified are far more important for scientists working in LAC, in particular, “participating in scientific committees” and “participating in the editorial boards of scientific journals” (positive opinions respectively LAC 59.9% and 45.8%, Europe 20.4% and 12.3%). “Organising training opportunities” and “publishing scientific books” (respectively LAC 43.8% and 37.8%) are also two important outcomes of international collaboration for scientists working in LAC. It is worth highlighting that the four last outcomes bring recognition of the scientist by the international scientific community.

We again divided the two LAC groups and again – apart from “participating in the editorial boards of scientific journals” which dropped to 4.2% in the scientifically less developed countries – all the results showed a slightly but real intensification of the positive perception of outcomes by this group, the major difference being the increased levels of agreement for “organising workshops” (+14.9%) and “organising training opportunities” (+10.7%).

Figure 40. Additional outcomes of international cooperation



10. Collaboration and publications

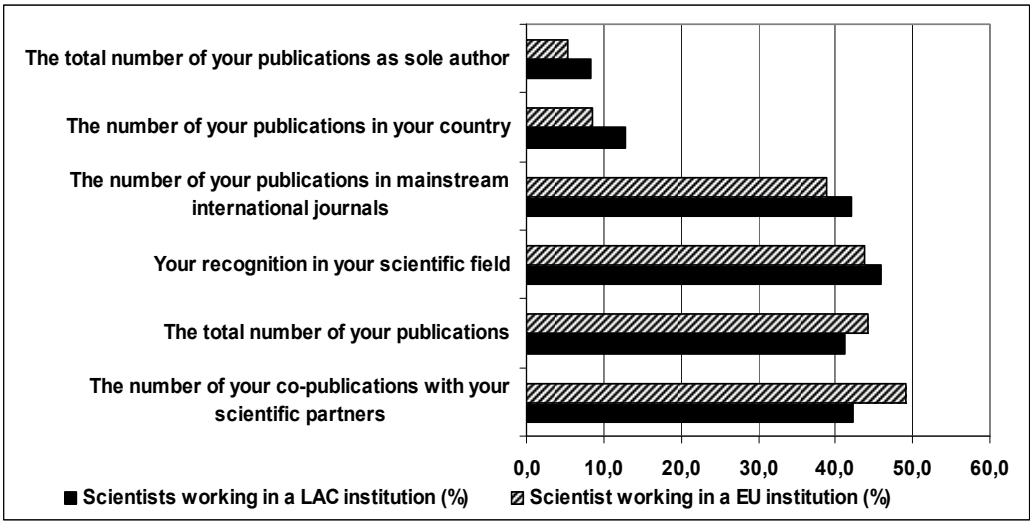
More than half of the LAC scientists (52.9%) and more than two-thirds of the EU scientists (70.5%) publish in more than one language. English is the first language of publication[15] followed by Spanish, French and Portuguese. Two-thirds (66.3%) publish in English and half (50.9%) publish in Spanish[16]. One-tenth only publish in French (10.6%) or Portuguese (10.5%) and even less are limited to German (5.9%) or Italian (4.2%).

Since scientific publications are one of the main outputs that scientists generally expect from collaboration, we examined how international collaboration between the two regions could contribute to increasing personal publication levels. According to a very large majority of the respondents, collaboration contributed (with a marginal difference between the two regions) to increasing their publication rate. More than 70% of the two groups acknowledged that collaboration contributed to increasing, either “moderately” or “a lot”, their “recognition in their scientific field” (75.1% in LAC, 77.6% in EU), “the total number of their publications” (72.2% in LAC, 70.9% in EU), “the number of their co-publications with their scientific partners” (70.8 in LAC, 77% in EU) and “the number of their publications in mainstream international journal” (69.7% in LAC, 76.7% in EU). Not surprisingly, only their “publication in their home country” and “the total number of their publications as sole author” generated a small number of positive opinions. International collaboration, thus, is a win-win process in which the partners on both sides can benefit substantially.

[15] English is used as the first publication language by more than half (55.5%) and as a second language by more than one-tenth (13.1%) of the LAC scientists compared to half (53.7%) and one-tenth (9.8%) of the EU scientists.

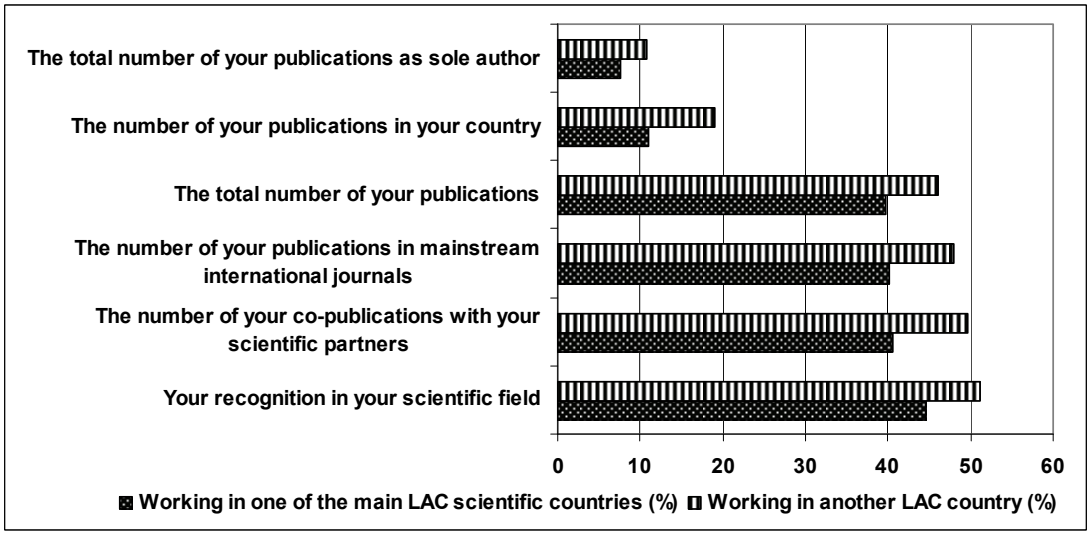
[16] Spanish is used as the first language by 31.5% and as the second language by 39.5% of the LAC scientists. Not surprisingly Spanish is not widely used in publishing by the EU scientists either as their first language (10.5%) or their second language (13.6%).

Figure 41. Scientific activities that collaboration with foreign scientists contributed to increasing "a lot" (% of scientists working in LAC and EU).



Whereas scientists working in EU are generally more numerous in recognising that collaboration helped them either "moderately" or "a lot", isolating the response "a lot" gives a slightly different perspective. It shows that more scientists working in LAC felt that collaboration contributed to boosting their publication outputs. This is supported by Figure 41 that presents the statistics based exclusively on the response "a lot".

Figure 42. Scientific activities that collaboration with foreign scientists contributed to increasing (% of two groups of LAC countries).

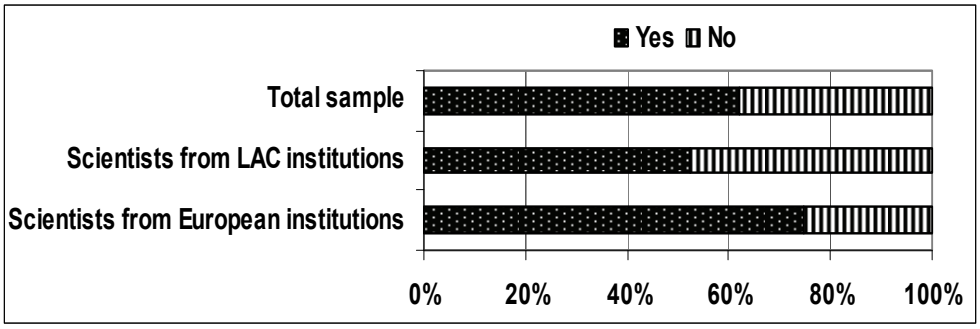


The latter is amplified by the breakdown of the LAC population into the two sub-groups (the most scientifically developed countries and the other countries). The results (Figure 42) tend to prove that the contribution of international collaboration to helping scientists get published is greater in countries that are scientifically less developed.

11. Involvement in calls for proposals to promote international scientific collaboration

While a large majority (61.9%) of scientists in the surveyed population responded to calls for proposals involving international scientific collaboration, the magnitude of this participation differed between the two regions: 74.8% in EU, 52.4% in LAC (Figure 43). The proportions were the same for the main scientific countries in both continents (4 in LAC and 5 in EU). The breakdown between the four main scientific LAC countries and the other LACs shows, surprisingly, that the propensity to respond to calls of proposals tends to be slightly higher in the scientifically less developed countries (56.7%) than in the four main scientifically developed countries (51.5%)[17].

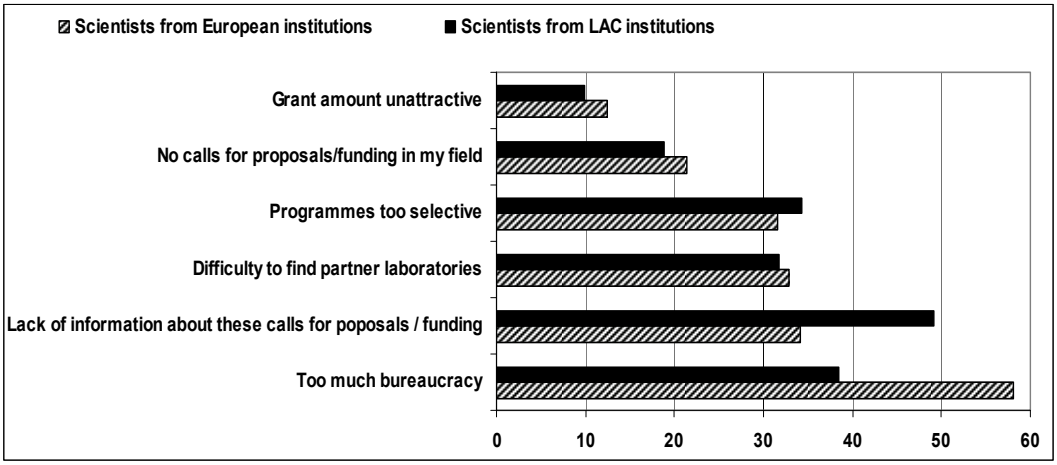
Figure 43. Responses to calls / tenders involving international scientific collaboration



The 1686 scientists (38.1%) who reported that they had never participated in any calls for proposals provided responses that followed a very similar pattern in LAC and EU, except for the two most important reasons: “too much bureaucracy” and “lack of information” (Figure 44). More than half of the scientists working in EU institutions (58.1%) selected “too much bureaucracy” while the figure in LAC institutions was slightly over one-third (38.4%). Conversely, “lack of information about these calls for proposals / funding” was a more important reason for scientists working in LAC (49.2%) than in EU (34.1%).

[17] This point may confirm that scientists working in the scientifically more developed LACs are slightly less dependent on international funding and have more access to national support schemes.

Figure 44. Reasons why scientists do not participate in calls for proposals involving international scientific collaboration

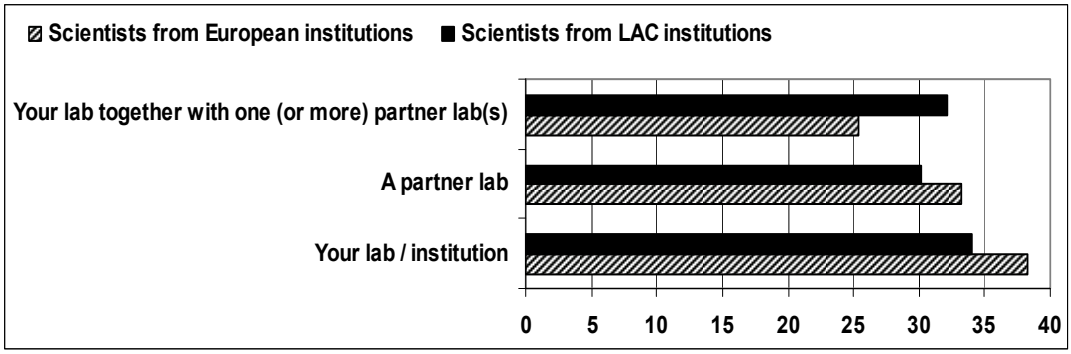


"Difficulty to find partner laboratories" and "programmes too selective" were reasons brought up by approximately one-third of the respondents, in both regions. The last two reasons "no calls for proposals / funding in my field" and "grant amount unattractive" were less often applicable with positive answers of about 20% and 10% respectively. A number of other reasons were also provided by a minority of scientists (6%). The most important "other reasons", by order of importance, were lack of need, lack of interest, lack of time, language problems, and enough funding available from national or bilateral funding programmes. Some scientists also blamed the programmes themselves: "non-transparent and confusing decision process", "most programmes support travel grants while we need funds for field work and analysis" or even "EU-Framework Programmes are a complete bluff and do not stimulate real collaboration".

In an attempt to estimate the level of participation of the respondents in these international collaborative programmes, a series of questions were asked about the functioning of the projects: distribution of roles, tasks and budget. The scientists were asked to tell about their most recent involvement in a call for proposals. Only non-EU international calls for proposals are presented here in order to avoid the systematic bias caused by the unequal collaboration between EU and non-EU laboratories in EU projects.

The responses to the question "who initiated the project?" indicated that projects were initiated in approximately the same proportion in both surveyed regions by the scientists' laboratories and institutions (EU 38.2%, LAC 34.0%), a partner laboratory (EU 33.3%, LAC 30.2%) or the scientists' laboratory together with one or more partner laboratories (EU 25.4%, LAC 32.2%). In sum, for approximately two-thirds of the scientists (LAC 66.2%, EU 63.6%) the project was initiated by their laboratory or institution alone or together with one or more partner laboratories (Figure 45). Here again, the responses provided by scientists in EU and LAC institutions were very similar.

Figure 45. Who initiated the project (all calls for proposals combined)



Although the majority of the scientists (EU 56.0%, LAC 53.4%) participated as partners in the projects, a large percentage of them (EU 41.8%, LAC 41.0) considered themselves to be project coordinators. Very few, as shown in Figure 46, are (or were) sub-contractors (EU 2%, LAC 2.1%).

Most of the scientists in the two regions were directly involved in the budget allocation: EU 84.5%, LAC 72% (Figure 47). For 21% of those working in Europe, this decision was taken by their own laboratories while for 63.5% of them it was taken jointly by their own and their partner laboratories. To a lesser degree, this was also the case for scientists working in LAC (own lab 18.6% and own + partner labs 53.4%

Figure 46. Roles of participants in the projects (in %)

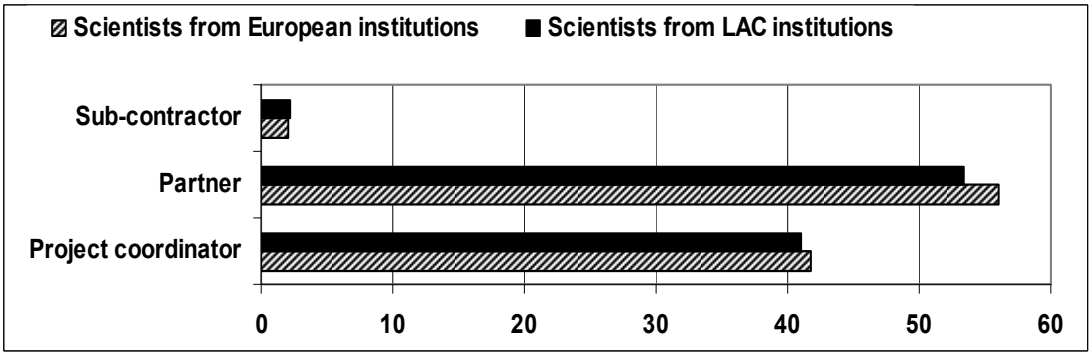
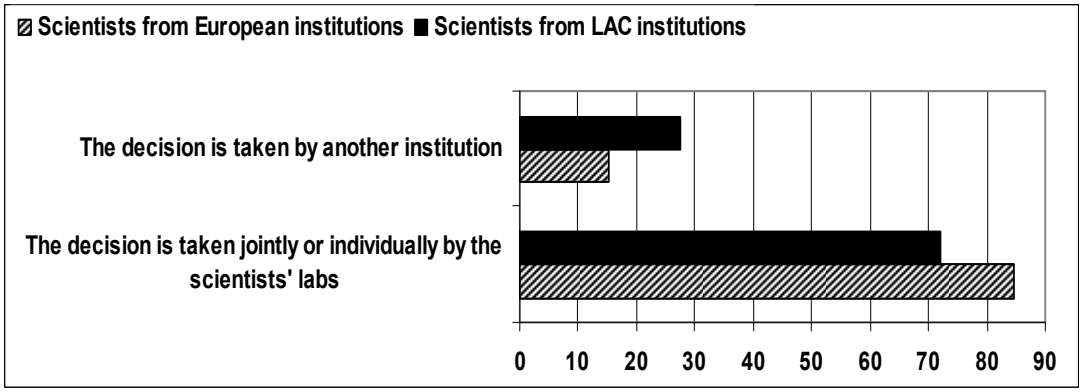


Figure 47. Who decided (or decides) about budget allocation



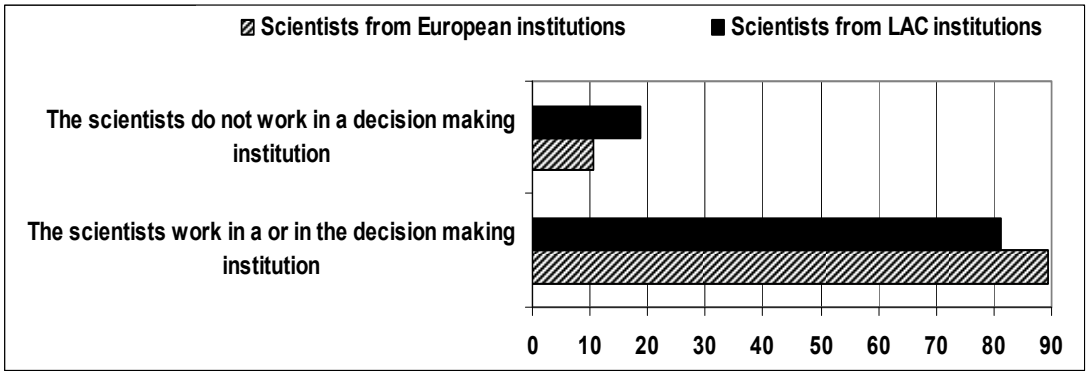
On the other hand, budget allocation was more likely to be decided by "other" in LAC (27.7%) than in Europe (15.2%), namely by "one or more partner laboratories" for 22.5% of scientists working in LAC and by "other" in 5.2% of the cases, while in Europe we find 12% for scientists working in EU and 3.2% for "other". Since the difference in responses between the two continents was greater for this activity than for any other (12.5%), we tried to find an explanation by breaking down the results of the two LAC groups. But the results showed no difference at all between the two groups of countries (the scientifically more developed and the other countries)[18].

The question about the "decision of distribution of tasks" (Figure 48) shows a much similar pattern, with a large majority of the scientists being involved in decision-making: EU 89.4%, LAC 81.3%. For 16.7% of those working in Europe the decisions are taken by their own laboratory while for 72.6% of them it is taken by their own laboratory together with the partner laboratories. This is also the case for scientists working in LAC, but to a lesser degree (respectively own lab 15.6%, own + partner lab 65.7%). Conversely, this decision is more likely to be taken by "others" in LAC (18.7%) than in Europe (10.6%).

On the whole, the responses concerning decisions about the distribution of roles, budgets and tasks in international projects between EU and Latin American scientists tended to indicate that the asymmetric relationship, which was a burning issue in the 1970s and 1980s, has changed into a more equal partnership.

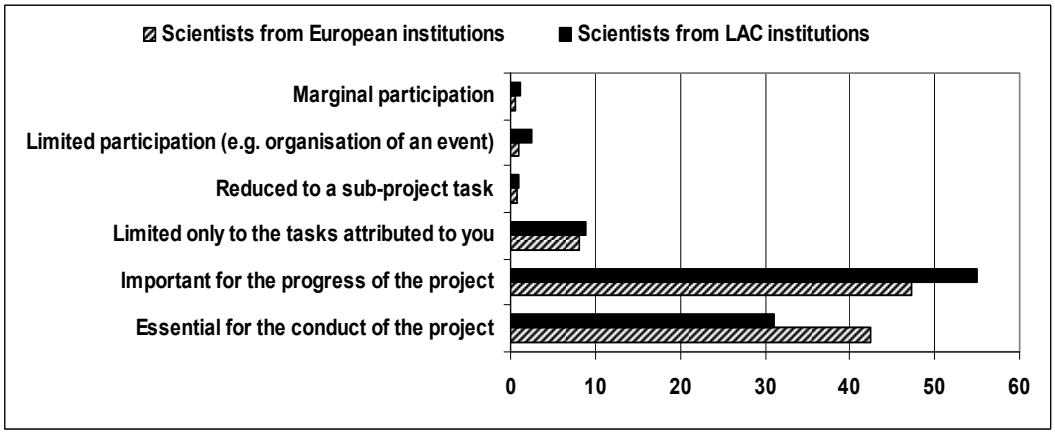
[18] This aspect has been discussed many times by the interviewed scientists in LAC, who observed, with regret, that their lack of participation in budgetary decisions put them in a position inferior to that of their foreign partners.

Figure 48. Who decided (or decides) about the distribution of tasks? (all calls for proposals combined)



A range of questions linked to the quality of involvement and contribution were asked in an attempt to check the level of satisfaction in participating in international programmes. The results show a very high level of satisfaction with the involvement in the projects in both regions; 83% of the scientists in LAC and 88% of the scientists in EU felt that they were able to get involved as much as they wanted. For the respective 17% and 12% who could not, their main reason was linked to lack of time, followed by insufficient support from their home institution and a somewhat deficient level of communication between the partners. The other reasons we heard were more marginal (around 20 people each): these people would have gotten more involved if "the subject had been different", if they "had better mastered the process flow" or if they "had been involved from the project design stage".

Figure 49. Level of contribution to projects



The responses given in the two regions about the level of individual contribution to the projects (Figure 49) almost follow the same pattern, but indicate that scientists working in Europe are more likely to rate their contribution as “essential” (Europe 42.4%, LAC 31.1%).

Nevertheless, the majority of the respondents (EU 89.6%, LAC 86%) rate their contribution to the project either “important for the progress of the project” (EU 47.5%, LAC 54.9%) or “essential for the conduct of the project”. The other levels of contribution proposed were considered as much less important. A small number of respondents (under 10%) felt that their contribution was “limited only to the tasks attributed to them” and even fewer, that their contribution was a “limited participation”, “reduced to a sub-project task” or even “marginal participation” (around or under 1%). Here again we made a breakdown of the results between the two LAC country groups and once again the differences were very marginal. The scientists working in the more scientifically developed countries tended to give slightly more value to their role in the collaboration: 91.3% rated their contribution as either “essential for the conduct of the project” (36.9%) or “important for the progress of the project” (54.4%), compared to 86% for the scientists working in the other scientifically less developed LAC countries: “essential for the conduct of the project” (35.2%) or “important for the progress of the project” (50.8%).

A number of reasons were suggested to characterise motivations to participate in an international call for proposals (Figure 50). Almost all the motivations were considered as “important” or “essential” by the majority of the respondents in the two regions, apart from “access to new technologies / competences not available in my country” which, not surprisingly, is the last one given by people working in EU (45.3%) but ranked second for people working in LAC (74.8%). In both regions, the most important criterion was money: ”access to international funding” (EU 80.9%, LAC 75.7%). Globally, the proposed motivations are more explicitly acknowledged in LAC (between 61% and 76% of positive opinions expressed for all proposed motivations): “participation in an international expert network” ranked third in the LAC region (74.6%) and second in EU (67.3%), followed by “greater mobility through PhD programmes, fellowships, research grants, etc.” (LAC 73.1%, EU 62.5%), “increased scientific visibility” (LAC 71.9%, EU 66.1%), “publications in mainstream scientific journals” (LAC 68.7%, EU 55.1%) and last, “making my research fit into a more global scheme on, e.g. climate, energy, biodiversity, etc.” (LAC 60.9%, EU 53.9%).

The breakdown between the two LAC groups shows no major differences in the LAC region apart from “access to international funding” that is more important for the scientifically less developed countries (75% against 66.6%), thereby confirming that scientists working in the scientifically more developed LAC countries are slightly less dependant on international funding and have more access to national support schemes. For the other motivations, the repartition is quite (more or less) even between the two sub-groups.

These motivations are curtailed by difficulties that restrict the scientists’ involvement in such projects (Figure 51).

The limiting factors are not the same in the two continents but five reasons were supported by more than 50% agreement in both continents (there are seven reasons in Europe): “calls / tenders are too selective” was considered as a limiting factor by more than 60% of respondents (Europe 64.5%, LAC 62%) followed by “difficulties in finding partners / building consortium”, which is more frequent for LAC scientists (69.2%) than for their colleagues in Europe (57.2%). The third limitation, “difficulties related to accounting and financial rules in

my institution" is, surprisingly, acknowledged equally by scientists in Europe (53.5%) and in LAC (55%). The last two reasons were supported by more than 50% on both continents, but with major regional differences: "poor knowledge of scientific calls / tenders" is much more of a problem in LAC (73.3%) than in Europe (51.5%). The same applies to "lack of knowledge or training on how to submit a project proposal" that is a difficulty for 58% of the scientists working in LAC and 50.1% of those working in Europe. "Lack of time", the predominant reason for scientists in Europe not to engage in such projects (69.6%), is less important in LAC (41.3%). "Insufficient amount of funding" was supported in over half the answers in Europe but not in LAC (Europe 51.8%, LAC 41.3%).

Figure 52 shows that scientists working in scientifically less developed countries have less opportunity to participate in international calls for proposals. Although the differences between the two LAC groups are rather small, the results suggest that international collaboration is even more needed in the scientifically less developed countries, especially because of the difficulties listed below, as well as the motivations and above all, the outcomes and benefits.

Figure 50. "Essential" and "Important" reasons that motivate scientists to participate in international calls for proposals (in %)

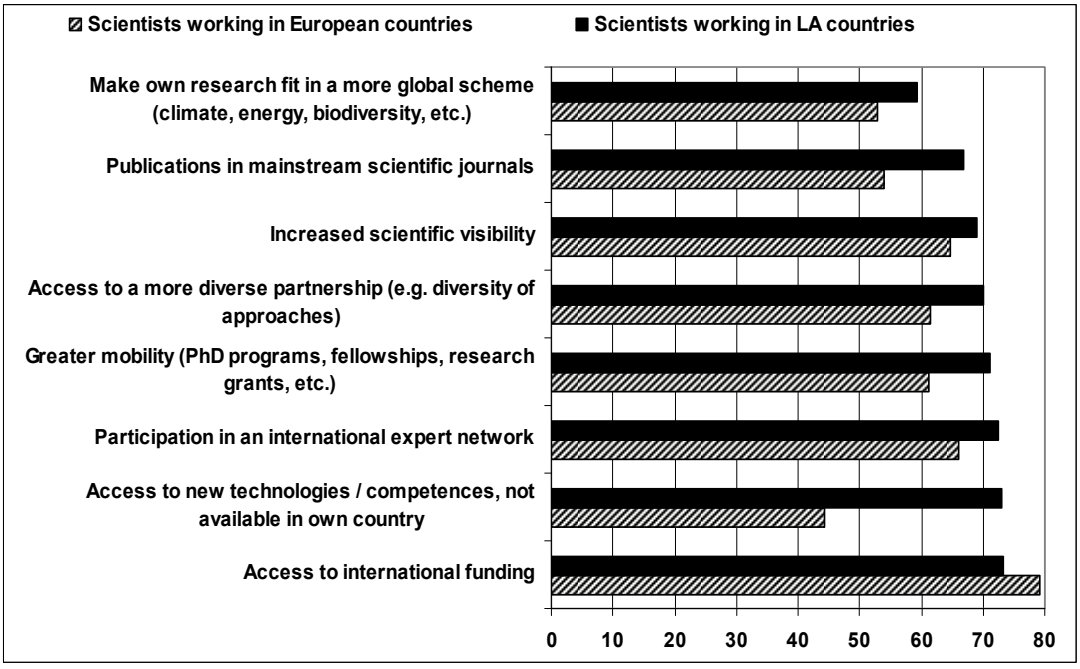


Figure 51. "Restrictive", "very restrictive" and "crippling" reasons that limit scientists' participation in international scientific calls for proposals (in %)

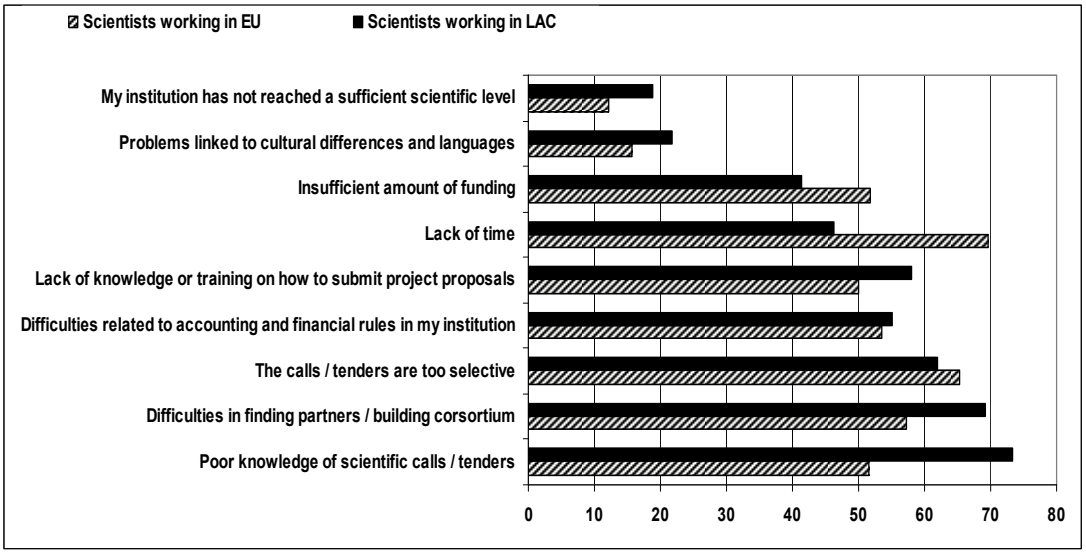
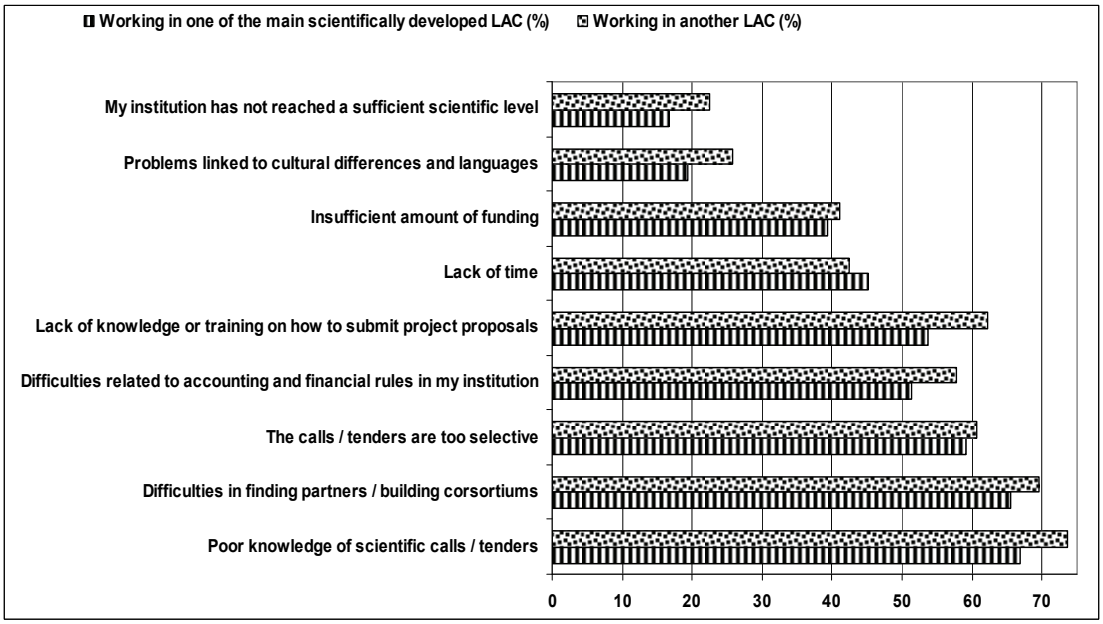


Figure 52 "Restrictive", "very restrictive" and "crippling" reasons that limit scientists' participation in international scientific calls of proposals for the two LAC country groups (in %)



Conclusion

The main findings of this survey on international collaboration between LAC and EU are summarised below and developed more extensively in this concluding section:

The asymmetry of collaborations, which was recognised as a source of tension and a burning issue in the 1970s and 1980s, has developed into a more equal partnership.

The relative importance of scientific disciplines concerned in the collaboration is more in line with the LAC priorities than with the EU's.

The surveyed population is older than the overall population of scientists in both EU and LAC. This would tend to confirm that researchers in their mid career stages (40 years and above) are more likely to collaborate internationally than those who are in their early or late career stage.

The survey confirms that female scientists are less likely to collaborate internationally than male scientists. Interestingly and perhaps logically, they are more likely to participate in disciplines in which they are less likely to collaborate.

International mobility correlates with increasing international collaboration.

International collaboration is a win-win process that benefits all the partners.

International collaboration, once established, is a longstanding activity.

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.

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.

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).

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.

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.

Apart from the fact that the preferred areas of collaboration between EU and LAC researchers are related to the scientific fields which are predominant in LAC[19], the major result of this survey, reported as no.1 in the list above, tends to prove that in the main sectors of international scientific collaboration, the asymmetry of relations, which was highlighted as a burning issue in the 1970s and 1980s, has been turned into a more equal partnership between the two continents. This has been clearly demonstrated in several

[19] Like "Biology & Environmental Sciences", which is the strongest scientific field for LAC countries whose scientific production measured in number of publications corresponded to 6% of world science in 2006 (OST 2008).

sections of this chapter on the various stages 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.

The 4475 scientists who answered the survey[20] belong to quite homogeneous categories in the two continents. There are no marked differences in age repartition between respondents from EU and LAC countries[21] and in the two regions; the surveyed group is also older than the overall scientific population. This would tend to confirm that researchers in mid career stages (40 years and above) are more likely to collaborate internationally than those who are in the early or late career stages. Women represent slightly over one-fourth of the respondents[22]. Research is the main activity of the respondents, i.e. they spend more time on research than on teaching and other activities such as administration and consulting)[23].

The survey confirms the great mobility of scientists even prior to international collaboration, although with differences depending on the country and the continent. At the time of the survey, slightly less than 10% of the surveyed population could be considered as being part of the S&T diaspora (meaning that they are living in a country other than their country of nationality). Compared with the figures on high-skilled migrants reported today, this percentage is very high (particularly for the five scientifically most advanced LAC countries), but since the sample is not representative, this high rate of expatriation can only confirm the strong propensity for mobility of the surveyed population, which is composed of active researchers eager to collaborate internationally. It may however introduce a more general question: is the S&T PhD holder category potentially more internationally mobile than the rest of the highly qualified populations? The answer is “most likely yes”.

International mobility is also a permanent feature throughout the scientist’s career: altogether 86.3% of the survey population spent long periods of time abroad (for study, post-doc or other stays exceeding six months), namely, 88.8% of LAC national scientists and 82.8% of EU. For both continents, EU countries are the preferred destination for extended stays abroad for 48.6% of the scientists (LAC 55%, EU 40%) followed by USA (20.5% with almost the same breakdown in both continents). The situation is slightly different for long stays in LAC or in other developing countries; the percentage of scientists working in Europe who are likely to live for extended stays in these countries is much greater (EU 24% against 16% in LAC, and EU 10% against 3% in other developing countries).

Professional advancement is, by far, the main reason for this strong migratory trend. The dynamics of mobility are not based on what one wishes to escape but on what one wishes to

[20] The best response rate was from LAC countries with an average of 44.8% compared to EU countries with an average of 27.7%. This can probably be correlated to the fact that researchers in LAC show greater motivation to participate in international collaborative programmes and greater satisfaction regarding the outcomes of their participation.

[21] More than two-thirds of the respondents (69%) are between 40 and 60 years old, the peak being in the category 40-59 years old (36%). Conversely, researchers below 40 years of age represent only 18% of the overall surveyed population.

[22] A recent study indicates that female scientists are less likely to collaborate internationally than male (NSF, 2009). Thus, based on a longitudinal survey that follows recipients of research doctorates from U.S. institutions until age 76, NSF found out that while 30% of them do collaborate internationally, respectively 23% of female and 33% of male do so.

[23] For 60.2% of the all group, research occupies at least 50% of the working time (for almost 77% it occupies at least 40% of their time and for 41% of them, at least 60%).

gain from the move. Seeking "the scientific expertise developed in the host country" is the reason that attracts the highest rate of positive opinions among both LAC and EU respondents, especially among the post-docs (68.8% for the group as a whole). Even EU scientists who prepare their PhD or post-doc in one of the four main LAC scientifically developed countries explain that their mobility is motivated, but to a lesser extent, by the assumption that "the reputation of the host country institution will promote my career" (46%) and because of "the scientific expertise developed in the host country" (35%). Nevertheless for this group, the main reason relates to funding[24].

S&T diaspora living in the countries of destination play a very insignificant role in scientists' mobility choices and a limited role in initiating and establishing collaboration. Overall, very few scientists connect their choice of destination with the existing diaspora in the target country (respectively 3.4% for PhD students and 3.3% for post-docs). When it comes to collaboration or co-publications with members of the diapora, the proportion varies from 12% (equally distributed between the two regions) for collaboration with previously known countrymen abroad, to 18% to 24% (the latter for EU scientists) for collaboration with countrymen settled abroad who were not known previous to collaboration. This helps put the impact of the S&T diaspora in international scientific activities into perspective showing that it is not of major importance in decisions of scientific migration and scientific collaboration.

Scientific collaboration between the two continents is often the result of scientists' mobility. Over 90% of the scientists have published scientific papers with colleagues met during long stays abroad[25]. The latter are mostly colleagues from institutions in which the visiting scientists have worked while abroad (48%)[26], followed by colleagues from other institutions in the countries where they stayed (54%). A relatively high percentage (48%) of the scientists working in a LAC institution co-published with their thesis director while the figure was a mere one-fifth (20%) for their colleagues working in Europe.

While results emphasise the fact that stays abroad boost international collaboration, another important finding of this survey shows that collaboration today is not necessarily connected with personal links established during stays abroad (or during visits by foreign colleagues to the scientist's institution). Actually, the large majority of scientists surveyed (61% LAC scientists and 63% EU scientists) did collaborate or co-publish with scientists abroad whom they had not met during their extended stays abroad[27].

Although mobility is not enough to explain international collaboration, it amplifies its magnitude. In the surveyed population the scientists who had never gone abroad for long stays (13.7% of the total sample) collaborated and co-published less than their colleagues who emigrated during or after their studies. The latter co-published and collaborated more frequently not only because it was easier to develop partnerships with colleagues met during their long stays abroad (for more than 90%) but also because they were more prone or had

[24] 81% of them received funding from their home country, their host country, or a special fund.

[25] 90.3% for scientists working in LAC and 92.3% for scientists working in Europe.

[26] 79.4% for scientists working in LAC and 87.3% for scientists working in Europe.

[27] These foreign collaborators (or collaborators living abroad) are by decreasing order of importance: 1) foreign scientists collaborating with them in international projects (53.2% for EU scientists and 41.6% for LAC scientists), 2) foreign scientists met at international meetings (22% for EU-based scientists and 15.8% for LAC-based scientists), 3) scientists from their country living abroad (9.6 % for EU and 10.9 % for LAC), 4) foreign scientists they never met but with whom they communicated e.g. through internet (10.5% for EU scientists and 8.7% for LAC scientists).

more opportunities to team up with colleagues whom they did not know prior to collaboration (colleagues participating in the same international projects, colleagues met occasionally at conferences, or colleagues who they did not meet but with whom they communicated)[28].

Once collaboration has been started it usually lasts[29]. Collaboration is generally organised within the framework of bilateral cooperation (71% in LAC and 74% in EU), or else as part of international projects (20% in LAC and 25% in EU). On both continents, the only reported difficulty in collaborating or co-publishing with foreign scientists that was perceived as "important" or "major" by more than 50% of the respondents was the "lack of collaborative programmes or funding"[30].

This collaboration was roundly supported by a very high level of positive opinions at both ends of the collaborative chain. It was recognised as a true win-win process in which scientists reported that they benefited greatly e.g. from the outcomes. Despite a very high level of satisfaction on both continents, some distinct trends could be identified. The main outcomes for scientists working in EU were related to social and scientific networking activities[31] while for those working in LAC, satisfaction was correlated more with tangible outcomes[32]. More than 70% of the two groups acknowledged that collaboration had helped them in their scientific activities[33].

While a large majority (61.9%) of scientists in the overall survey population responded to calls for proposals involving international scientific collaboration, the extent of this participation differed clearly between the two regions: 74.8% for scientists working in EU institutions, 52.4% for those working in LAC. Those who never participated in any calls for proposals explained their non-participation in a similar manner on both sides of the ocean: "too much bureaucracy" and/or "lack of information". Unexpectedly, more scientists working in EU (58.1%) than in LAC (38.4%) felt that the programmes suffered from "too much bureaucracy". Other reasons like "difficulty in finding partner laboratories" and "programmes too selective" were given by approximately one-third of the respondents in both regions.

Analysing the scientists' participation in calls for proposals gives a very balanced picture of the two country groupings. The responses indicate that for approximately two-thirds of the scientists (LAC 66.2%, EU 63.6%) the project was initiated by their laboratory or institution

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[28] The margin between the two groups ranges from 2.1% for collaboration with expatriate LAC countrymen (who were not known previous to collaboration), to 35.4% for collaboration with colleagues participating in the same international project.

[29] A small percentage of the scientists on both continents ended their collaboration: 15.7% in LAC institutions and 16.2% in Europe for collaboration with people the scientists knew from their long stays abroad and respectively 13.4% and 8.2% for collaboration with people the scientists did not know during these stays.

[30] The other proposed difficulties did not receive strong support from the surveyed population apart from "too consuming of time and effort" for the scientists working in LAC (almost 30%) and "inter-institutional cooperation problems" which were perceived as an important or a major problem by more than one-fourth of the respondents in the two continents (25.4% in LAC and 26.8 in EU).

[31] Like "strengthening links with international partners" (72.7%), "participation in new scientific projects" (68.4%) and "participation in conferences, training, etc." (63.8%).

[32] Such as "learning new techniques" (71%), "publication in high-impact journals" (69%) and "access to equipment not available in my country" (42.3%).

[33] The collaboration helped to increase either "moderately" or "a lot" their "recognition in their scientific field" (LAC 75.1%, EU 77.6%), "the total number of their publications" (LAC 72.2%, EU 70.9%), "the number of their co-publications with their scientific partners" (LAC 70.8, EU 77%) and "the number of their publications in mainstream international journals" (LAC 69.7%, EU 76.7%).

alone or together with one or more partner laboratories. While the majority of the scientists (EU 56.0%, LAC 53.4%) were partners in the projects, a large proportion of them (EU 41.8%, LAC 41%) reported that they were project coordinators. The vast majority of the scientists in both regions were directly involved in budget allocation (EU 84.5%, LAC 72%) and task assignment EU 89.4%, LAC 81.3%).

On "involvement in the projects", the results show a very high level of satisfaction in both regions;83% for LAC scientists and 88% for scientists working in Europe felt that they were able to get involved as extensively as they wanted. For the LAC 17% and EU 12% who could not, the first reason they gave was linked to "lack of time", followed by "insufficiency of support by their home institution" and a somewhat "deficient level of communication between the partners". The responses given in the two regions about the level of individual contribution in the projects almost follow the same pattern, but scientists working in Europe were more likely to rate their contribution as "essential" (EU 42.4%, LAC 31.1%). Nevertheless, a large majority of the respondents (EU 89.6%, LAC 86%) rated their contribution to the project either "important for the progress of the project" (EU 47.5%, LAC 54.9%) or "essential for the conduct of the project" (EU 42.4%, LAC 31.1%).

The leading reason for scientists to participate in such international schemes in both regions was money, i.e. "access to international funding" (Europe 79.3%, LAC 73.2%). The second motivation was not the same for the two regions: "access to new technologies / competences not available in my country" motivated 72.9% of the scientists working in LAC, but, not surprisingly, ranked last for the scientists in EU (44.4%). Globally LAC scientists seemed more highly motivated to participate in international calls for proposals than their colleagues in EU; all the motivation questions (except "access to international funding") received more positive answers from scientists in LAC than in EU[34]

Although many scientists are highly motivated to respond to calls for proposals involving international collaboration, their participation is often restricted by a number of difficulties. The limiting factors are not the same in nature or scope in the two continents, but at least five reasons received over 50% agreement on both continents: "the calls/tenders are too selective", scientists have "difficulties in finding partners/building consortiums", and "difficulties related to accounting and financial rules in their institution" (the latter equally in the two regions). Particularly in LAC countries, scientists reported to have "insufficient knowledge of scientific calls/tenders" and "insufficient knowledge or training on how to submit a project proposal".

Acknowledgements

The authors wish to thank Shirley Ainsworth for the selection from the WoS (Web of Science) of scientists in EU countries and LAC countries who had published at least one publication indexed in the Web of Science in co-authorship with a scientist from the other country grouping (EU countries and LAC countries).

[34] "Participation in an international expert network" came in third position in the LAC region (74.6%) and second in EU (67.3%), followed by "greater mobility (PhD programmes, fellowships, research grants, etc.)" (LAC 73.1%, EU 62.5%), "increased scientific visibility" (LAC 71.9%, EU 66.1%), "publications in mainstream scientific journals" (LAC 68.7%, EU 55.1%) and eventually "make my research fit in a more global scheme (climate, energy, biodiversity, etc.)" (LAC 60.9%, EU 53.9%).

References

Ackers L., B. Gill, 2008, *Moving People and Knowledge. Scientific Mobility in an Enlarging European Union,* Cheltenham: Edward Elgar.

Asenjo J. A., R. Correa, 2005, Relaciones Internacionales de la Ciencia Chilena, In: Allende, J. E., J. Babul, S. Martinez and T. Ureta (Eds.). *Análisis y Proyecciones de la Ciencia Chilena 2005*. Academia Chilena de Ciencia, Santiago, Chile. pp. 133-140

Baumgratz-Gangl G., 1995, Developments in the Internationalization of Higher Education in Europe, in Blumenthal P, C. Goodwin ., A. Smith, U. Teichler, *Academic Mobility in a Changing World*, Jessica Kingsley Publishers Ltd., London, pp. 103-127.

Crawford E., T. Shinn, S Sörlin, 1993, The Nationalization and Denationalization of the Sciences: An Introductory Essay, in Crawford E., T. Shinn, S Sörlin (eds.), *Denationalizing Science*, Dordrech, Kluver, pp. 1-42.

Dedijer S., 1968, Early Migration, in W. Adams (ed.) *The Brain Drain*, MacMillan Co, New York, pp. 9-28.

Docquier F., H.Rapoport, 2007, *Skilled migration: the perspective of developing countries*, CReAM Center for Research and Analysis of Migration, Discussion Paper Series, CDP No 10/07. http://www.econ.ucl.ac.uk/cream/pages/CDP/CDP_10_07.pdf

Docquier, F., A. Marfouk, 2006, International migration by educational attainment (1990-2000), In C. Ozden and M. Schiff (eds). *International Migration, Remittances and Development,* Palgrave Macmillan: New York. Also available at http://perso.uclouvain.be/frederic.docquier/filePDF/DM_BookWB.pdf .

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

Kibre P., 1948, *The Nations in the Medieval Universities*, Medieval Academy of America, Cambridge Mass.

Loemker Leroy E., 1976, Gottfried Wilhelm Leibniz: Philosophical papers and letters, D. Reidel Pub.

Mahroum, S., 2000, Highly skilled globetrotters: mapping the international migration of human capital. *R&D Management*, 30 (1), 23-31.

Millard, D., 2005, The impact of clustering on scientific mobility. A case study of the UK Innovation. *Journal of European Social Science Research*, 18 (3), 343-359.

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.

OECD and World Bank, joint database on migration: DIOC-E

http://go.worldbank.org/RFRQAN6B01.

OST, 2008, Rapport biennal.

http://www.obs-ost.fr/fr/le-savoir-faire/etudes-en-ligne/travaux-2008/rapport-biennal-edition-2008.html.

UIS, 1997. http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

UIS, 2009, *A Global Perspective on Research and Development.* Unesco Institute for Statistics. UIS Fact Sheet, October 2009, N°2.

http://www.uis.unesco.org/FactSheets/Pages/default.aspx

UIS, 2011, Classifications, bulletin d'information, n° 27.

http://www.uis.unesco.org/Education/Pages/isced-new-classificationFR.aspx

Villaseñor Amésquita, M. G., T. J. Guzmán Acuña, and G. Medrano de Luna, (2009*). El académico mexicano: Un breve esbozo de sus formación a tráves de la encuesta La Reconfiguración de la Profesión Académica en México*. . Communication to Congreso Nacional de Investigación Educativa, 21-25 Septiembre, 2009. http://www.rdisa.org.mx/index.php?option=com_content&view=article&id=12&Itemid=25.

Zucker, L., M. Darby, (2006). *Movement of Star Scientists and Engineers and High-Tech Firm Entry,* NBER Working Paper No. 12172, April 2006.

Gaillard Jacques, Gaillard A.M., Arvanitis Rigas. (2014)

Determining factors of international collaboration in science and technology : results of a questionnaire survey

In : Gaillard Jacques (ed.), Arvanitis Rigas (ed.). Research collaboration between Europe and Latin America : mapping and understandig partnership

Paris : Ed. des Archives Contemporaines, 107-156. ISBN 978-2-8130-0124-5