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"European FP7 Research Project: hard and soft mobility of Higher Education Sector (HES) researchers out and in the ESPON Space"

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1. Introduction

The Mobility and Career Paths of Researchers in Europe (MORE, 2010a) Project identifies a relationship between the degree of mobility of university students, those who follow a PhD course and finally researchers. In fact, the published results of the interviews confirmed that researchers who have a significant international mobility began to go abroad as university students. It could also be advisable to reverse the problem whereas for greater international success of researchers it should promoted and facilitated the international mobility of university students. MORE (2010a) suggests that the increased international mobility of researchers, also in relation to their age and sex, is also the result of increased attention in recent years by the EU in encouraging mobility of students. The mobility is studied in relation to the territory and the scientific area of reference. Even the qualitative analysis on the different characteristics of the mobility components confirm the positive effect that early mobility can have on the mobility of the working age. The interest in the mobility of researchers is justified by the fact that this involves a considerable increase in the exchange of information, knowledge and therefore of innovative phenomena connected. Innovation means more ability to move into international markets and therefore greater supply of jobs. This requirement, expressed in the first instance by multinational enterprises, was then taken up by the European states as they inserted it in a document known as the Lisbon Strategy launched in 2000. To overcome the difficulties which operational delay implementation have caused to the Lisbon Strategy the EU has published a Renewed Lisbon Strategy for the period 2008-2010. A period which coincides with the effects of an international economic crisis not yet over. Among the objectives set out in this new document, there were two concerning the policy of "investment in knowledge" to implement a "fifth freedom" of European citizens to free movement of knowledge. This had to be achieved by helping to create a European Research Area and to improve conditions for scientific innovation. International mobility is a characteristic feature of the careers of many European researchers working in the High Education Institution (HEI). According MORE (2010b) more than half (56%) of researchers in the EU27 have had experience of international mobility of at least 3 months at least once in their careers. More than half of these, then 29% of the total, were abroad during the last three years.

According to statistics published by Eurostat in 2007 there were about 2.2 million researchers in the EU27 amounted to 1.4 million full-time equivalent researchers (FTE). In the EU there were 6 FTE researchers per 1000 population, 9 in the U.S., 11 in Japan and 2 in China (MORE, 2010C). The definition of researcher was the subject of lengthy discussions. At first (OECD, 1995) it was preferred to refer to the concept "Human Resources in Science and Technology" as defined by the Canberra Manual. More recently (OECD, 2002) the Frascati Manual refers to the concept "R & D personnel", which is now the basis for data collection in the OECD member countries. The MORE Project also considered as "mobile researchers" those who have spent at least three months in a country different from that in which they gained the highest level of education.

Despite the importance that is attributed to the mobility of researchers according to ILO (2003) there is not yet a systematic way in which countries collect and process data of "researchers migration flows" at the international level. For this reason, the EC has promoted in 2007 the FP6 Specific Support Action "Integrated Information System on European Researchers" (IISER) in order to create a system of indicators, released in Europe, able to interpret the stocks, flows, careers and mobility using existing DB.

In this part of the TIGER research report, to highlight the mobility of researchers, examined the researches funded by the Framework Programme 7 (FP7) of the European Commission for the period 2007-2013. The study considered 3,570 FP7-funded research involving 15,500 European HEI countries. This development was then compared with 100 FP7 projects where the Sapienza participates in networks with other 670 HEI. The choice of FP7 was made because this type of European research projects have some interesting features for those wishing to study the mobility of highly skilled. The FP7 call for proposals are finalised to select all of good quality scientific projects, are premised international collaboration, and in many of the projects there is, in addition to HEI researchers, also the participation of companies as partners, stakeholders or end users. Each project proposal is the result of a network of knowledge articulated at the international level, which is more structured once the project enters the implementation phase, and that somehow continues even after the project ended. The FP7 projects do not involve the financing of travels and meetings between researchers, which is the task of other funding lines of the EC, but allow scientific meetings every six months for a period of more or less a work week and the mobility of scientific and cultural flows continues throughout the duration of the project, which usually ranges from 2 to 4 years. Contemporary communication technologies allow the use of the network through web and video connections, such as Skype, and weekly if not daily contact by e-mail. The report is

completed by maps in which countries shall not be deemed static receptors of research funding, but a network of centres of mobility flows on which researchers move. They confront their different skills, scientific and cultural sensitivity, and then produce scientific innovation.

2. Among the highly skilled human mobility: from migrants to transients

The mobility of researchers in the HES or otherwise of those could be considered highly skilled has begun to attract the attention of the scientific literature since the phenomenon, after the end of the Second World War, has taken some quantitative importance for the attractiveness of enterprises and institutions in the United States who have begun to expand internationally. Examining this phenomenon Watanabe (1969) used for the first time the term "brain drain" to indicate the flow of skilled personnel from less industrialized countries to the more industrialized North. In fact, as noted by Glaser (1978), the flow also occurred in developed countries. For example from the UK to the U.S., because the American HES offered better wages, a more advanced cultural and scientific environment, and therefore better opportunities for individual cultural growth and career (Montanari, 1993a). In the decades since the phenomenon of greater scientific interest was that of skilled international migration. Salt and Ford (1993) wrote that the phenomenon of highly skilled migration, although still small scale, then it would inevitably have taken on larger dimensions of the growing needs of industries to capture human expertise and add value to their activities. Shuttleworth (1993) confirmed that the operation of a global economy requires the transfer of scientific and managerial experience from one country to another. The phenomenon began to be better identified in social research since the mid-eighties with the work of Salt (1984) who had identified a stream of "brain exchange" between the countries of North Western Europe. Findlay (1988) analysing the characteristics of international migration in the UK had detected a growing number of skilled individuals, which he calls not migrants but 'transients', which the Oxford Dictionary defines "lasting only for a short time, impermanent" . The transition from skilled migrants to skilled transients has completely changed the problem of the phenomenon because there was no longer the need to work permits, and the features and stickiness illustrated in the work of J. Salt and A. Singleton (1995) were overcome. These situations, started with the skilled migration to the U.S. in the fifties, have evolved and were later identified as phenomena of brain drain, and of brain and brain overflow exports. After the fall of the Berlin Wall in 1989 and the profound changes occurring in all countries of

Eastern Europe has also added the phenomenon of brain waste (Montanari, 1993b; Rhode, 1993; Balaz and Williams, 2002). The phenomenon that is considered in this report could be considered in the statistics as international tourism. In fact the researcher move to a country, different from his resident place, more than a day, few days or a few weeks, in a hotel, a bed and breakfast or rent an apartment and he is considered a tourist. In reality it is a typical flow of human mobility in which work simultaneously overlaps with study and recreation activities. These overlays can also occur at different times and in some cases may even become permanent changes of residence.

3. The researchers networks and the participation at the European FP7 projects

FP7 projects were chosen because they interpret the best of the EU Lisbon Strategy, which identifies knowledge as the element to transform the EU as the most dynamic economy in the world. The knowledge is based on three inter-related elements: research, education and innovation. The EC FP7 program divides projects into four categories: Cooperation, People, Ideas and Capacities. "Cooperation" supports trans-national research based on comparative analysis and aims to gain or consolidate leadership in key areas of research and technology. The "Cooperation" projects are based on networks of researchers working in different countries which according to the type of call for tenders may be inside or outside the EU. "Ideas" is based on border researches conducted by a limited number of researchers. "People" aims to strengthen from a quantitative and qualitative point of view human potential, stimulate research and encourage researchers to stay in Europe, and possibly even attracting international researchers in Europe. "Capacities" aims to help European research also through collaboration between universities, research institutes and private sector.

The sample consists of 3570 research projects among those funded in the period 2007-2011, 1,018 of these in "Cooperation", 1,734 in "People", 688 in "Ideas" and 133 in "Capacities". Including participants and coordinators we considered 9,899 research teams in "Cooperation", 3,055 in "People", 743 in "Ideas" and 782 in "Capacities" totalling 15,497 units of research variously distributed in countries across five Continents. Only few countries are not participating in the EU's FP7 research network (Fig. 1).

European FP7 Projects. Global networks of ESPON space research teams

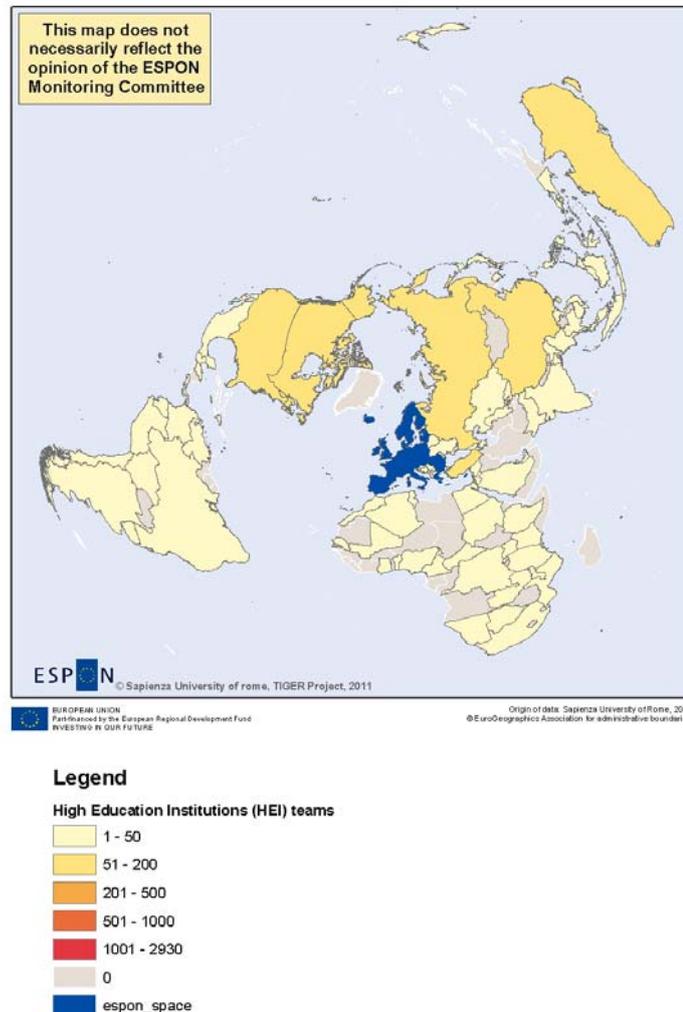


Fig. 1 – European FP7 Projects. Global networks of ESPON space research teams

Among the non-European countries where there are several research groups in contact with European HEIs, there is Israel (381), U.S. (197), Turkey (159), China (84), Canada (58) and Australia (55). It was not compared the international cooperation of European countries with that of USA. It can be confirmed that the issue of mobility of high-skilled employees between USA and EU is very timely since there is a growing decline in Europe of high-skilled employees. According to Tritah (2008) the number of employees in the U.S. from Europe in the field of knowledge-based economy, in particular engineers, researchers and university teachers, is increasing.

European FP7 Projects. Global networks of ESPON space research teams

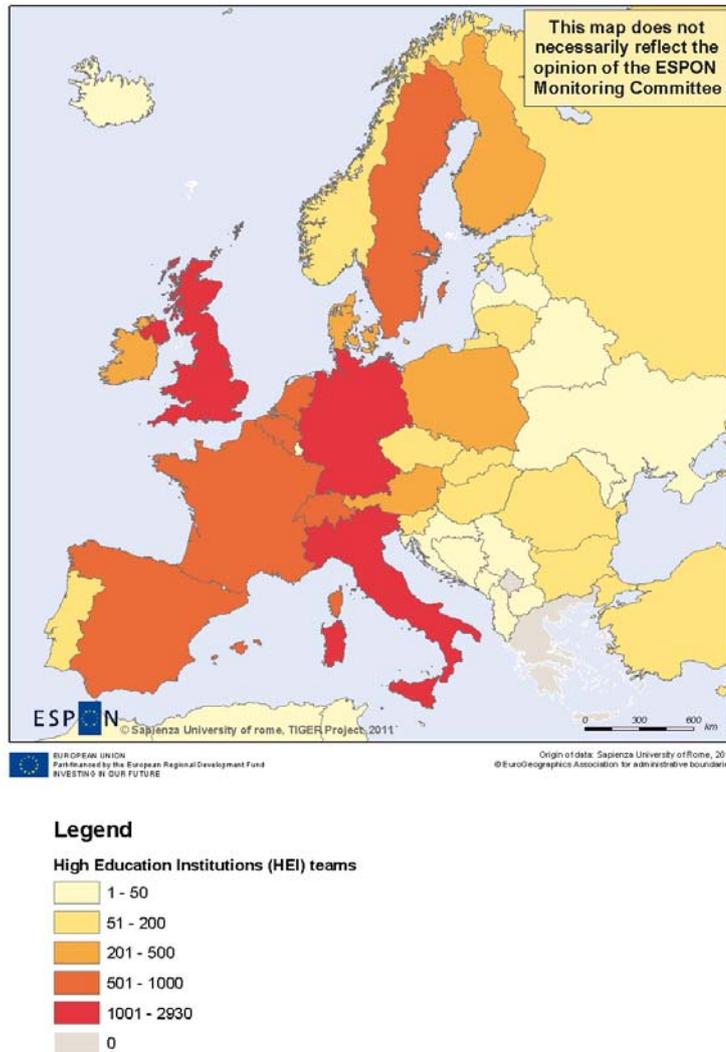


Fig. 2 – European FP7 Projects. Global networks of ESPON space research teams.

Figure 2 shows that countries participating with a larger number of HEIs to FP7 projects are UK (2,930), Germany (1,907) and Italy (1,210). To help understanding the logic of participation, the number of FP7 research groups in each country has been linked to Gross Domestic Expenditures on R & D as percentage of GDP in each country. The values were calculated for the units that are coordinators of the project (Fig. 3).

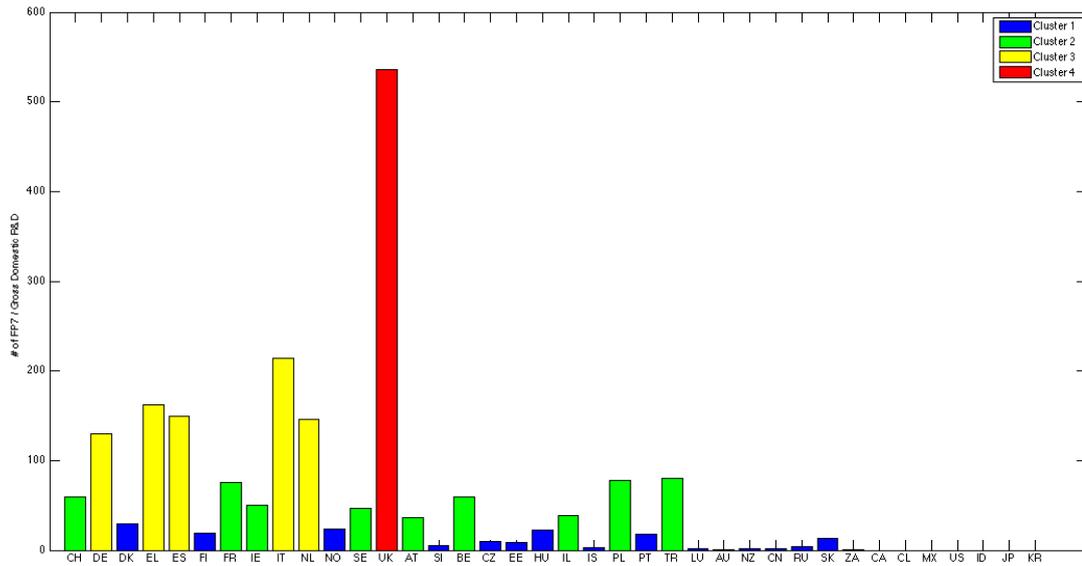


Fig. 3 – European FP7 projects. Number of teams and GDE in R&D. The case of the coordinator teams

It turns out that the highest ratio in the cluster exists on the UK and there is then a group of countries that are part of a second level cluster, Italy, Greece, Spain, NL and Germany. But when it is taken on the values of the partners units (Fig. 4),

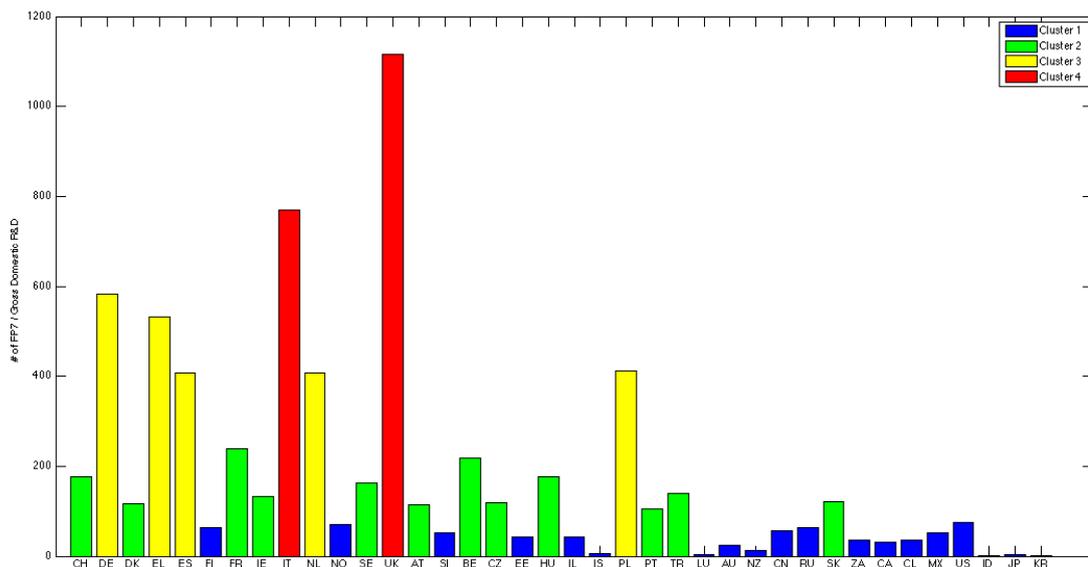


Fig. 4 – European FP7 projects. Number of teams and GDE in R&D. The case of the partner teams

UK and Italy are part of the first cluster, while Germany, Greece, Spain, NL and Poland are in a second cluster. If it is considered the total number of units, coordinators and partners, (Fig. 5) UK is in the first cluster and Italy, Greece, Spain, NL and Poland are in a second cluster.

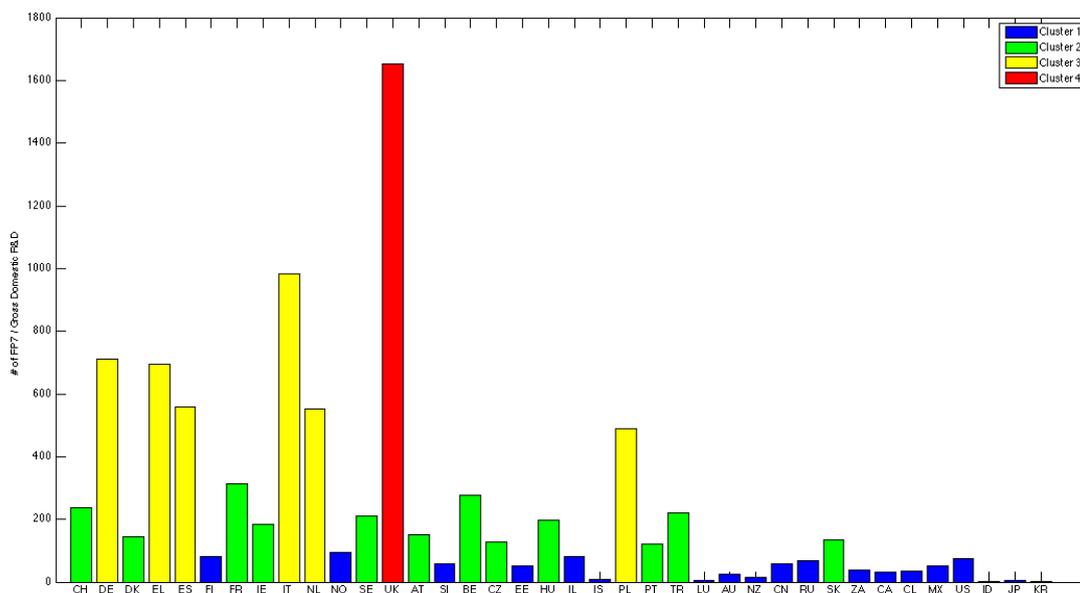


Fig. 5 – European FP7 projects. Number of teams and GDE in R&D. The case of the coordinator teams and the partner teams

These results show the good performance of the UK compared with a substantial investment in R & D whereas the performance of Germany, NL and France is lower than expected. In the case of Mediterranean countries a wider international activities has to do with the increased difficulty of finding resources for research in their countries.

4. The Rome Sapienza University (Sapienza) case study

4.1. quantitative results

The case study of Rome Sapienza University (Sapienza) was organized in two parts. A quantitative analysis of a sample of 100 research units reported in the month of August 2010 and a qualitative analysis performed in 2011 by interviewing the coordinators of FP7 projects

referring to a Sapienza Department.

The Sapienza FP7 projects are 68 in "Cooperation", 17 in "People", 7 in the "Ideas" and 8 in "Capacities". 25 of these projects were coordinated by researchers who are working in Sapienza departments, of which about 50% in "Cooperation". More than 75 per cent of the projects involves departments of the Faculty of Engineering and the Faculty of Sciences, the rest involves departments of the Faculty of Architecture, Pharmacy, Philosophy, Medicine and Political Science. In total, the units involved, other than of Sapienza are 579 in 57 countries across 5 continents (Fig. 6). About 50 percent of the units is located in 6 European countries (Figure 7).

European FP7 Projects. Global networks of Rome La Sapienza University teams

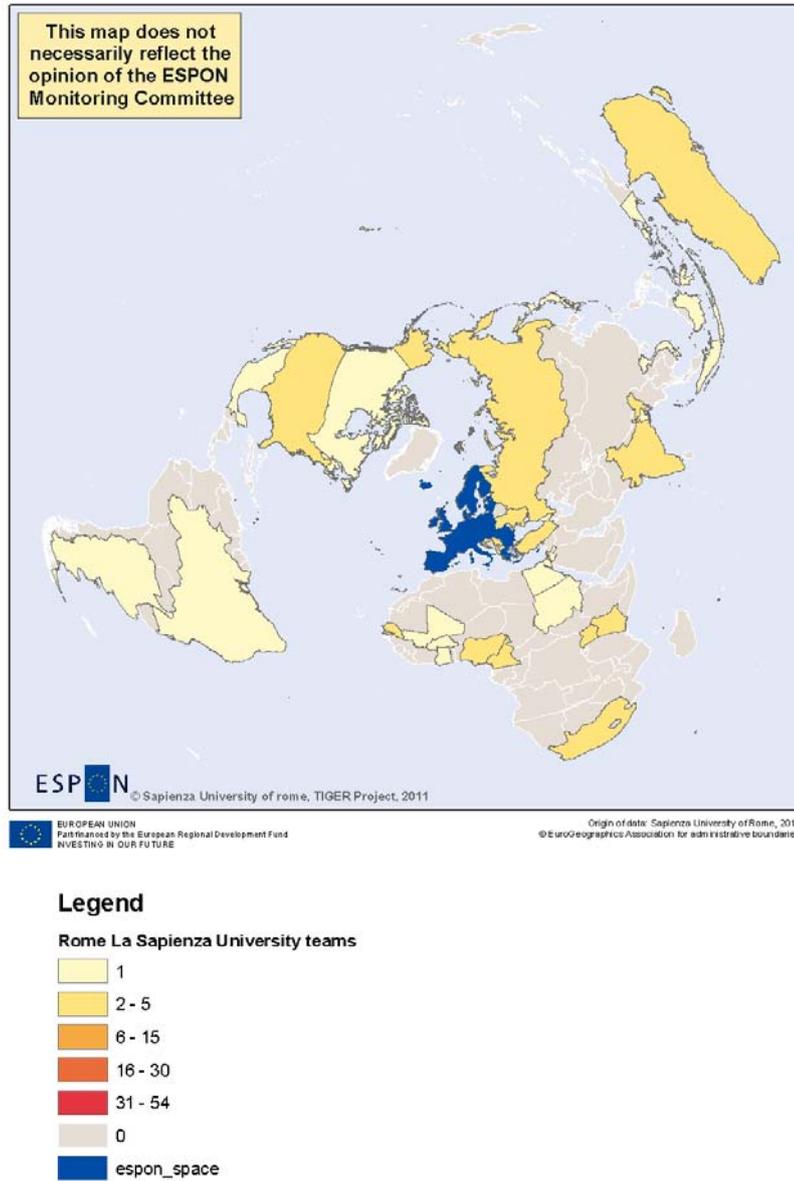


Fig. 6 – European FP7 Projects. Global networks of Rome La Sapienza University teams

European FP7 Projects. Global networks of Rome La Sapienza University teams

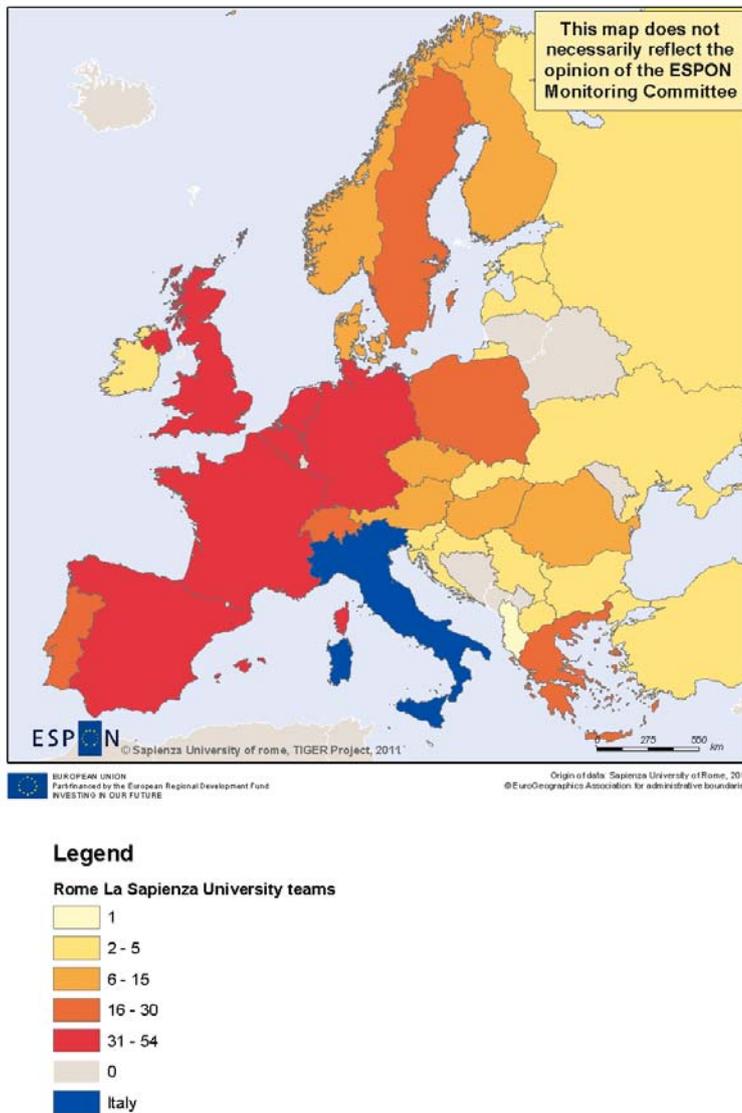


Fig. 7 – European FP7 Projects. Global networks of Rome La Sapienza University teams.

4.2. relations among FP7 projects data

4.2.1 Introduction

Purpose of the present section is to detect relations among FP7 projects data and, in particular, to put into evidence the role of Sapienza when the project coordinator is a member of

Sapienza or when some other institute leads the given project. FP7 projects were selected in the period 2010-2011 and regard only the projects where one or more departments of Sapienza University of Rome are partners. Data were collected by Cordis FP7 internet site (<http://cordis.europa.eu/fp7/>). Several parameters were associated to any project in order to have an unambiguous numerical representation of each project. The used parameters are: Sapienza is coordinator (binary), Sapienza departments are more than one (binary), number of institutes participating to the projects (integer), European contribution (integer, in euros), project duration in months (integer), number of country participating the project (integer). Moreover, for each one of the 57 countries involved in at least one of the examined projects, it was indicated the presence or absence of that country in the given project (binary). In general, a data pattern associated to any project is composed by 63 numerical parameters. In a specific further analysis, countries were grouped in 3 main groups: ESPON countries (EU countries, Norway, Switzerland), non-ESPON countries, United States.

4.2.2 Materials and methods

The analysis was performed by the use of Kohonen's Self-Organizing Maps (SOM) and some statistical tool for a better comprehension of the neural network results. SOM is a powerful tool that allows to perform some specific operations on high dimensional data, such as data dimensional reduction and invariance of topological relations among patterns. In particular, after a learning phase the SOM neural network allows high dimensional data to be represented on a two dimensional plane and the neighboring relations among patterns are preserved so that close patterns remain close even when their dimensionality is reduced. One of the problems faced when dealing with high-dimensional data as FP7 patterns is the difficulty to embed data into a space geometrically equivalent to the original one whose dimensionality is sufficient to maintain the correct neighboring and distance relations between points. The application of SOMs on FP7 data is a suitable choice in order to perform a data-driven multivariate analysis. Numerical analysis were performed by Matlab 2011 and the freeware SOM toolbox package SOM_TOOLBOX (<http://www.cis.hut.fi/somtoolbox/>).

Two main experiment were performed on the mentioned data. In the first one, 99 patterns describing the FP7 projects and composed by 63 parameters were computed by a SOM with 48 hexagonal cells (8 rows, 6 columns). The second experiment, as mentioned in the previous section, the relations among three main groups of countries involved in FP7 projects were analyzed: ESPON countries, non-ESPON countries and United States.

4.2.3 Experiment 1

A 6x8 hexagonal cells SOM was used for the computation of an input data matrix composed of 99 patterns, each one describing 63 numerical characteristics. This experiment was performed in order to detect the role of Sapienza University of Rome in the context of leading coordination, EU contribution and partnerships whit other countries and institutes. After a learning phase and a fine-tuning phase, the SOM distributed data as in the figures -...

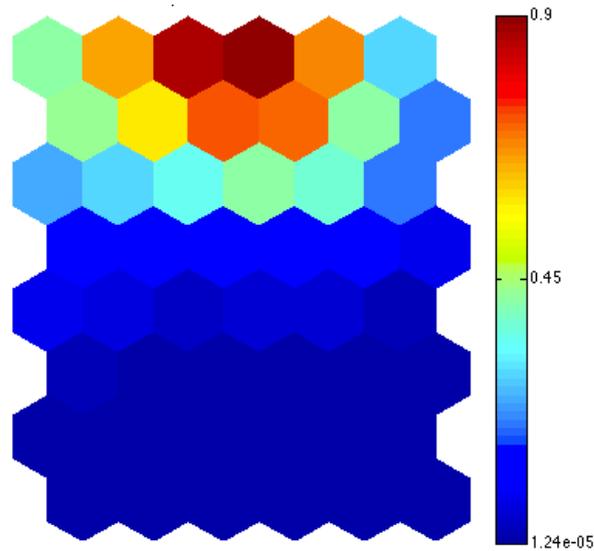


Fig. 8 – Sapienza Coordinator (binary variable)

Figure 8: Sapienza Coordinator. This characteristic shows the role of coordination in the specific project of a department of Sapienza University. Data are binary (1: Sapienza is coordinator, 0: some other institution is coordinator). The region describing this feature is mainly distributed in the upper part of the grid.

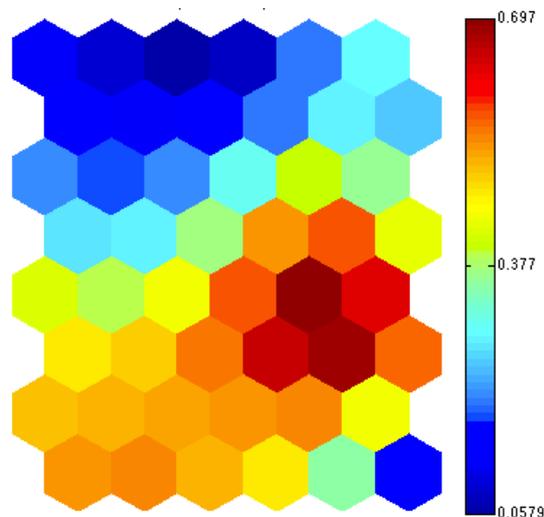


Figure 9 – Other departments of Sapienza are involved in the project (binary variable)

Figure 9: Other departments of Sapienza are involved in the project. This scheme represents the case when there is more than one department of Sapienza in the same project. Territory is very slightly superimposed to the Sapienza Coordinator region, revealing a significant trend of Sapienza departments to participate to FP7 projects mainly with only one department partner. The correlation between Sapienza Coordination and Other Departments of Sapienza is -0.27. The same correlation calculated when at least one of these two features is present is -0.89 ($P=1.2 \cdot 10^{-20}$), revealing a strong decorrelation.

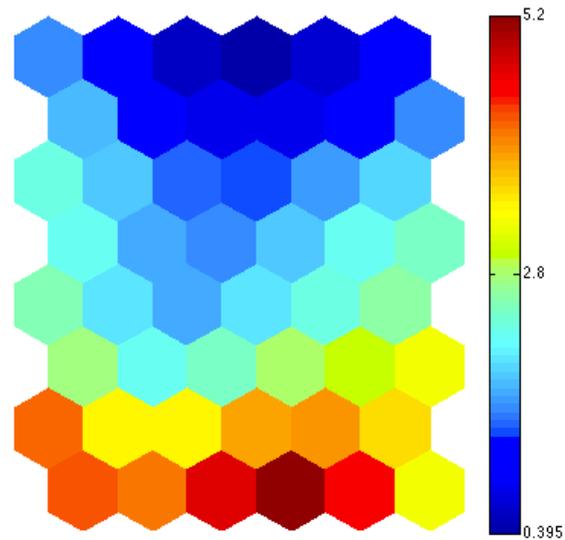


Figure 10 – Number of other Italian Institutes (numerical variable)

Figure 10: Number of other Italian institutes. In this picture, the region occupied by the feature connected to the amount of Italian institutes involved in the project is showed. These institutes may be university departments not in Sapienza or, more in general, scientific institutes or private firms. Even in this case, when Sapienza is coordinator the amount of other Italian institutes is lower than in the opposite case. Statistical correlation is -0.35 ($P=3.5 \cdot 10^{-4}$).

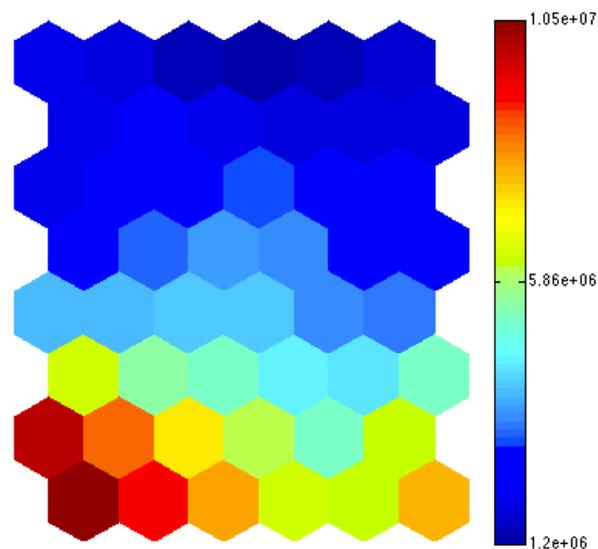


Figure 11 – EU Contribution (numerical variable, in euros).

Figure 11: EU contribution in euros. This features is the amount of euros granted by Europe institution to the specific project. A very similar behavior to the previous pictures may be observed by comparing the Sapienza Coordination region to the EU contribution region. Correlation is -0.34 ($P=4.6 \cdot 10^{-4}$), once more revealing a reduced amount of grant when Sapienza is coordinator.

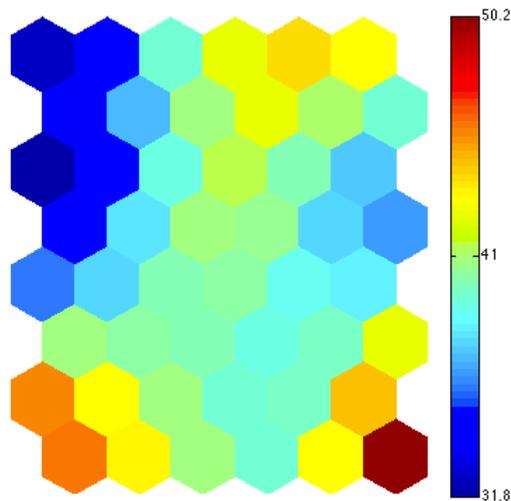


Figure 12 – Project duration (numerical variable, in months)

Figure 12: Project duration in months. In this picture, the SOM distributed this characteristic in a fairly uniform way. The cases when Sapienza is coordinator contain either long or short term projects, as in the opposite situation. Correlation is very close to zero ($R=0.01$).

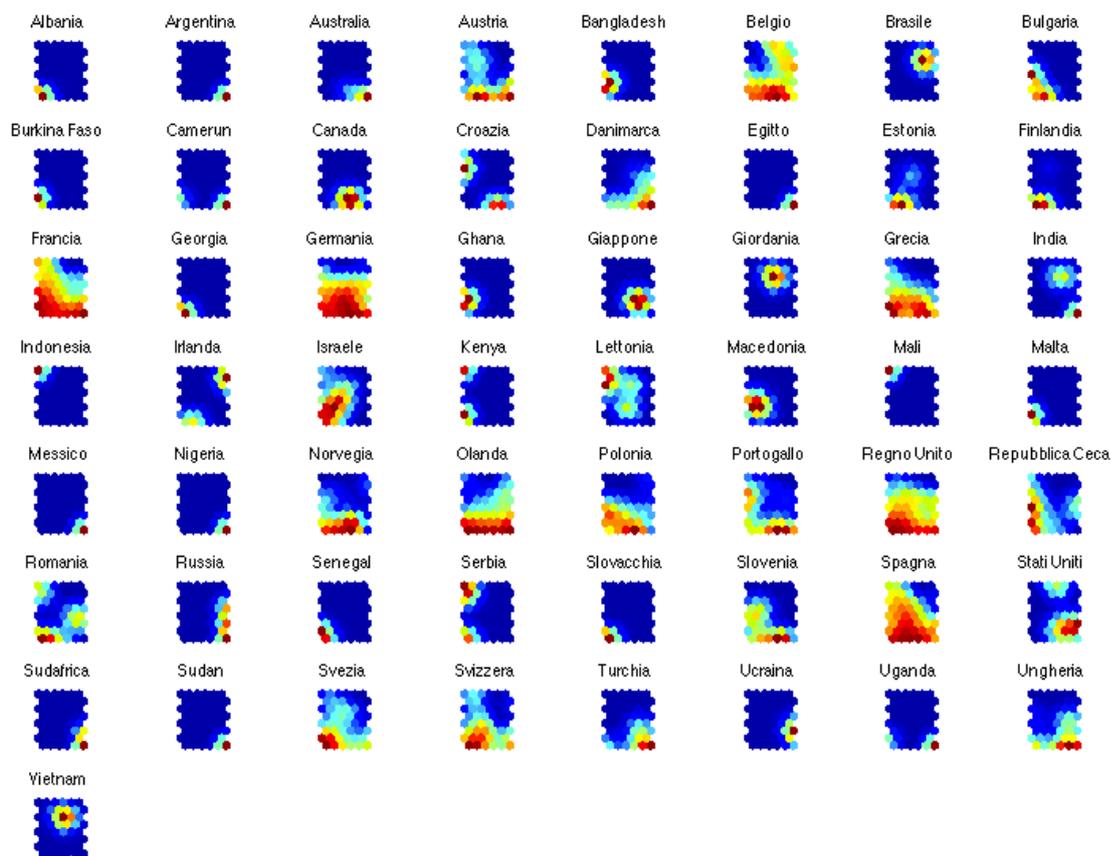


Figure 13: Countries involved in projects (binary variable)

Figure 13: Countries involved in projects. SOM distributed the presence of countries participating to the different projects trying to preserve their mutual proximity in terms of data distribution on the 2-dimensional grid. By comparing each scheme with the Sapienza Coordination scheme, an efficient description of partnerships may be revealed, in accordance to the original data.

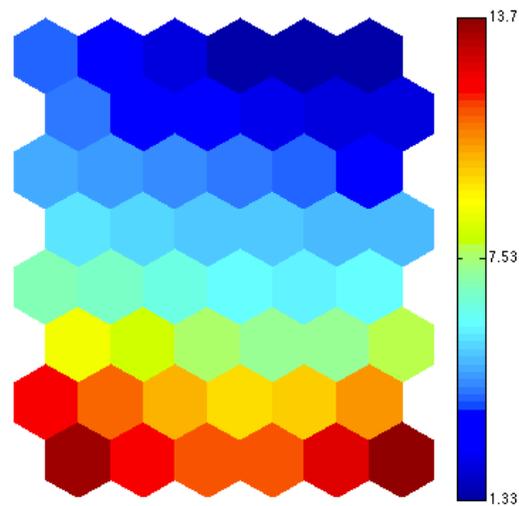


Figure 14: Number of countries (numerical variable)

Figure 14: Number of countries. This characteristic describe the amount of countries involved in the project. Once more, when Sapienza is coordinator, in general a lower amount of international partners are involved ($R=-0.41$, $P=2.1 \cdot 10^{-5}$).

Several experiments were conducted by modifying the network topology (200, 400 and 1000 cells) and by removing some characteristic by the training data (Sapienza Coordination, Countries). No significant differences in results were observed.

4.2.4 Experiment 2

In this experiment, data were composed by some characteristic present in the previous experiment (Sapienza Coordinator, Other departments of Sapienza, Number of other Italian institutes, EU contribution and Project duration), whilst international partnership feature was grouped in three main groups: ESPON countries (EU countries + Norway and Switzerland), non ESPON countries and United States. Results are described in the following pictures.

4.3 Qualitative analysis

An in-depth interview was conducted with 8 international coordinators of FP7 "Cooperation" projects, because the number of participants, amount of investment and number of years are more challenging and at the same time the most significant in terms of mobility of researchers. These researchers are all Italians, born in Italy and graduated at the Sapienza. Their age is between 45 and 65 years.

4.3.1 the story of their integration into the international comparative research

Regardless of age, common experience is that it has begun to participate in international cooperation projects already during the period of the doctoral school. The younger remembered having attended the school with a doctoral tutor who in turn was already engaged in international research. The older researchers have participated in projects under previous Framework Programmes since the Second (STEP). In order to better participate in these activities all have spent long periods abroad more or less from the school's doctoral research, and also by students of the degree courses. The stories of these researchers speak of a long period of time when there has been an on-going collaboration with foreign countries through flows of ideas, cultures, and innovation and when necessary also of people. The training period is considered important for the establishing of human knowledge relationships which were essential for building research networks. A scientific collaboration also based on human sympathy and mutual respect is essential when a new research project is proposed. Mutual knowledge of the scientific capabilities of each speeds up the drafting of new projects and is also appreciated by the referee as a guarantee of future project development. Over time, from one project to another, the network of researchers has not been drastically changed, but on a core of an already experienced small group, new contributions are tested and new involvements experimented .

4.3.2 the project preparation

Obviously, the preparation work is commensurate with the complexity of the project and the number of partners that make up the proposal. The period so it can vary from 6 to 12 months. Usually there is an advantage when a team is already working on a subject which is then chosen by the Commission for a call for tenders. It might therefore seem the result of an accident that the theme of the call is already being considered by a network of researchers. But usually it happens when potential research groups are kept in touch, there is the participation to meetings and scientific congresses and an exchange of information is constant. To participate in the right "randomness" it is necessary to stay right on the "crest of the wave." To maintain the correct interpretation of events and scientific phenomena is sometimes also necessary to hold meetings aimed at refining the goals and share the objects and purposes of the project.

4.3.3 problems, expectations and results

In the case of large projects problems must be anticipated. Conflicts in research projects can

be managed and solved, but the best solution is to anticipate them. A project involving a dozen HEIs implies the presence of very different disciplines and subjects. In addition, each HEI is based on individuals and small groups who rotate during the years following the needs of different WPs issues. The units can be placed in universities, in public and private research institutes and in private companies. A large project, with 30 or 40 partners, will certainly have fielded the work of several hundreds of researchers. The scientific authority of the promoter of the project, good organization and constant communication of information is a guarantee for a limited number of problems and conflicts and favour their solution. To facilitate the funding of meetings before and during the course of a project it is necessary to activate other forms of funding and to look for other lines of EC researches.

4.3.4 The perception of the activities

The parameters for the evaluation of HEIs now widespread in all Europe make it much more meaningful and rewarding the participation in European research projects, in particular in the FP7 projects which represent the top. But there is still a significant difference among HEIs in European countries. In some cultural and administrative realities competitiveness is more rewarding. This is reflected also in the way how each HEI communicate outside their own successes. A particular attention on the communication of project proposal successes is a tool for rewarding those who participate in research and also an element of accreditation of each successful HEI in the European landscape. It is not evident that a lot of energy is devoted by Sapienza to this activity.

4.3.5 the future

For teams that have the responsibility of a FP7 research project the future always begins in the present. The activity of Sapienza teams of success is a continuum of communications, reflections and updates in order to participate in other projects in sequence. The competition to win European projects is such that it is not possible to allow breaks. The knowledge of those who have already participated in the projects must find continuity in the undergraduate, graduate, and finally in the new generations of researchers.

4.3.6 Conclusions

Interviews confirmed that knowledge is based on the mobility of information, ideas and people. There is no innovation without a steady stream of people, ideas and knowledge. Mobility in this sense must be at the same time hard and soft. These phenomena are by their

very nature difficult to be identified with the traditional tools of statistical data which needs to be clearly identified in space and time. The Sapienza researchers interviewed were throughout their professional life promoters of mobility, but their activities can be identified only by a few weeks or months spent abroad, which allowed to calculate them in official statistics as tourists. Researchers who are now on the verge of retirement have started doing international research in the seventies, when the phenomenon began. In the seventies, the communication was essentially hard. International researchers were physical travellers, with the great difficulties due to high costs and considerable complications at frontiers. Communications took place with letters that needed days or weeks to cross Europe. Everything was slower and needed large amounts of time to be prepared. Today, advances in ICT have made communication easier and faster, but still important is the personal relationship and direct contact between researchers.

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FINAL TECHNICAL REPORT 3: Extra-EU mobility pilot study, Brussels, April 2010