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Enhancing Knowledge Spillovers Through International R&D Networking: The Case of Turkey's Participation in the 6th EU Framework Programme

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Abstract

EU Framework Programmes (FPs) have gradually become the driving force behind the formation of dynamic networks, in which, organizations involved in pre-competitive R&D networking projects and such cooperation serve as a channel for knowledge spillovers. Our study focus on such knowledge spillovers generated through FPs? and the effect of absorptive capacity is empirically explored. Finally, RTD hubs and their links to Turkey have been studied to develop relevant policy recommendations on the way of enhancing knowledge spillovers.

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Abstract

EU Framework Programmes (FPs) have gradually become the driving force behind the formation of dynamic networks, in which, organizations involved in pre-competitive R&D networking projects and such cooperation serve as a channel for knowledge spillovers. Our study focus on such knowledge spillovers generated through FPs' and the effect of absorptive capacity is empirically explored. Finally, RTD hubs and their links to Turkey have been studied to develop relevant policy recommendations on the way of enhancing knowledge spillovers.

Keywords: R&D Networks, Knowledge Spillover, EU Framework Programme, Absorptive Capacity, RTD Hubs.

JEL Codes: D85, O38

Introduction

Technological innovations are brought as a result of processing enormous amount of knowledge. Thanks to widely distributed sources, innovative firms tend to seek knowledge beyond their boundaries. Thus, firms rarely bring significant innovations to market in isolation (Schibany and Polt 2001). Instead they generate their innovations through interactions –ordinary or complex- with different actors within the firm’s environment. In such settings, networks can become the locus of innovation (Powell and Grodal, 2006).

The typical firm’s environment in general consists of the individual firm’s suppliers and clients. Although, the supplier-buyer linkages are crucial for successful innovations, innovative networks are usually too complex to be reduced only to these value-added chains (Dumont and Tsakanikas 2001). Government agencies, research institutions, universities, NGOs and even the international actors take part in those innovative networks. Firms or other economic agents utilise knowledge produced by similar agents and combine it with the stock of knowledge available in their organizations. Therefore creating links to access such knowledge is vital. European Framework Programmes serve as a platform to create necessary links with knowledge suppliers. Those links also lead to an increase in knowledge spillovers.

In this study, we used the 6th Framework Programme (2002-2006) data to analyze the knowledge spillovers among countries. The knowledge spillovers concept has been defined by (Griliches 1991) as “working on similar things and hence benefiting much from each other’s research”. Therefore, R&D collaborations can be used as a proxy for knowledge spillovers (Schibany and Polt 2001) Due to fact that, spillovers do not only depend purely to knowledge and some competencies are also vital, we define the role of absorptive capacity in such spillover effects. Empirical results suggest that absorption capacity has a significant effect on the level of knowledge spillover and therefore some policy recommendations are stated in the last section to enhance the knowledge spillovers especially for the Turkish experience.

Finally, we also argue that knowledge spillovers among countries affected whether participants are taking the role of RTD hubs or they develop links with the already available hubs. The empirical test applied to IST (information society technologies) sub-field of FP6, in which few European institutions taking the role of hubs (Malerba, Vonortas, et al., 2006). Based on empirical results, some policy recommendations were added for Turkish R&D policy makers to highlight the importance of linkages with Hubs.

Historical Background- Evolution of the European Framework Programmes

In the late 1980s and early 1990s network policies became very popular, in particular in reply to Japanese policies (DeBresson and Amesse 1991). But in fact ironically Japan took the networking policies originally from western countries. After World War I, in the UK Cooperative Research Associations (RAs) were established (Freeman 1991), which were then copied by France, Germany and many others.

Japanese imitated these European developments much later (DeBresson and Amesse 1991). The law passed in 1961 to set up the “Engineering Research Associations” (ERAs) envisaged cooperation between government laboratories, and various makers of parts and components, especially in the automobile industry (Freeman 1991). Consequently, from the 1970s onwards Japan has moved rapidly to increase its share of the world’s science and technology production.

The apparent success of ERAs and Japanese way of innovating (Dora 1988), led to widespread imitation of this technique of organisation and funding, both in Europe and on United States in 1980s (Freeman 1991). At that time, EU firms were supplying only 40 per cent of their own market and 10 per cent of the global market (Peterson 1991), and a technological gap debate began to emerge in Europe.

The first important step towards the transition to a rationale based upon support for industrial competitiveness followed the appointment of Viscount Davignon (a Belgian with considerable industrial experience) as the Commissioner responsible for

the internal market and industrial affairs from 1977 to 1981 and for both industry and science and technology from 1981 to 1985 (Georghiou 2001).

In 1980, the Commission convened a meeting of senior managers from 10 companies to discuss the future of the European information technology industry. This in turn led to the establishment of a Round Table, now of 12 large companies, at the end of 1981, supported by a body within the Commission, the Information Technologies Task Force-Big 12 Roundtable (Peterson 1991). The Round Table strongly endorsed the Commission's concerns for their sector and brought pressure upon their national governments to support the launch of the pilot phase of the ESPRIT programme (a collaborative R&D initiative in the field of information technology). This became the archetype for future industrially-oriented programmes of the EU (Georghiou 2001). The EC funds up to 50 per cent of approved ESPRIT projects, which include firms from at least two member states (Peterson 1991). The fundamental feature of ESPRIT was that the basic "pre-competitive" rationale whereby companies would co-operate only in research which was sufficiently far from the market that they would be free to compete with their erstwhile partners at a subsequent stage (Georghiou 2001).

The ESPRIT was seen as a success of the Big 12 Roundtable it inspired large non-IT manufacturers, to form a similar group. The Gyllenhammar group brought together 20 leading manufacturers. The combined weight of the Gyllenhammar group and Big 12 shaped the second phase of ESPRIT (Peterson 1991).

Single European Act (SEA) approved in 1987 provided a base for EU policy in research and technological development (Georghiou 2001). After that, in 1992 Treaty on European Union (Maastricht Treaty) strengthened the Framework Programmes by making them the umbrella for all RTD actions of the Community. The 4th Framework Programme (1994-1998) was established based on this rationale.

Following that, the "European Paradox" (Caracostas and Muldur 1998) was idealized whereby European scientific performance in relation to investment in science is seen

as excellent but technological and commercial performance has steadily worsened since the mid 1980s. The EC endorsed the Fifth Framework Programme (1998-2002) based on that ideology.

In early 2000, European Commission launched a challenging policy document, Towards a European research area (CEC 2000), which called into question Europe's ability to achieve the transition to a knowledge-based economy and which linked this underachievement to the lack of a coherent European policy on research. The proposed solution was the creation of a "European research area" (CEC 2000), which was followed by the launch of 6th Framework Programme (2002-2006).

Currently running program has been the 7th Framework Programme (2007-2013). It is designed to build on experience and lessons learned in FP6 towards the creation of the European Research Area, and carry it further towards the development of the knowledge economy and society in Europe (CEC 2005).

Historical Background- Turkey's participation in to the EU Framework Programmes

Turkey has taken several major steps in harmonising its science and research policy to those of the European Community. European Commission's 2007 Progress Report states that "good progress has been achieved in the area of science and research. Turkey was seen as a well prepared candidate country for accession in this area and noted that it is well advanced in designing and applying an integrated research strategy" (CEC 2007).

With a view to boost R&D in Turkey the Supreme Council for Science and Technology (the main actor of policy making) has taken the decision to gradually increase the Gross Expenditure on Research and Development (GERD) as a percentage of GDP from 0.67% (2002) to 2% in 2010, to increase private expenditure on Research and Development as a percentage of GERD from 28.7% (2002) to 50% and to raise the number of full-time highly qualified scientists from around 24,000 (2002) up to

40,000 (CEC 2006). According to the Screening Report on Science and Research Chapter, Turkey's targets and concrete actions are considered as they are in compliance with those of the Lisbon Strategy and expected to help to increase Turkey's GERD as a percentage of GDP.

Besides that Turkey has taken several actions in the scope of the Lisbon Strategy as means to push R&D investments, improving the efficiency of the protection of intellectual property, using public procurement to foster research and innovation, offering tax exemptions for R&D investments, enhancing R&D funds for SME's and promoting also curiosity based research, young entrepreneurship and network creation through special programmes (CEC 2006). Turkey also has launched several international brain circulation activities such as a sabbatical leave, grants and scholarships and participates in various mobility programmes of European Research Area. Turkey is also taking part in the European Network of Researcher's Mobility Centres, called ERA-MORE (Yetis 2008).

In programme level Turkey is a founding member of COST and EUREKA and a member of many European research based entities such as ESF, EMBC and EUROHORCS (TÜBİTAK 2008). Turkey participated in the 4th and 5th Framework Programme on a project basis and was an associated country to the 6th Framework Programme (FP6) as well as in currently ongoing 7th FP. In national level TÜBİTAK ensures coordination of EU Framework Programmes, she has taken various actions to increase its participation in Framework Programmes, such as info days, providing grants for researchers, special actions for SMEs, organising networking events via its liaison office in Brussels, publications and web based instruments, such as databases for researchers. TUBİTAK also promotes the collaboration activities of EC Joint Research Centre (JRC) where around 200 Turkish researchers participated to JRC workshops and more than 30 Turkish researchers were employed at the JRC institutes for temporary stays since 2004 (JRC 2008).

As a result of learning process and more active research policy in Turkey itself, and enhanced role of TÜBİTAK, with more means in the national budget for research and

a re-structuring of the internal ways and means to improve its research potential in the institutes, universities and industry, a considerable increase in Turkey's participation in FP6 and as well as in FP7 projects is reached. During the FP6, around 500 Turkish partners and more than 2000 researchers were engaged R&D collaboration activities with their European counterparts (TÜBİTAK 2006). Besides, in starting year of FP7 (2007) some 140 Turkish partners and around 600 Turkish researchers were involved in newly funded collaboration projects (BTYK 2008).

Although there is an increasing participation in last years, Turkey's performance in FP6 remained below the desired levels. TUBITAK lists (BTYK, 2006) the following as the main problems encountered by Turkish researchers in FP6:

- visa requirements from Turkish researchers;
- excessive bureaucracy in project management;
- lack of "National Detached Experts" and in-service trainees from Turkey in EC;
- low levels of participation by Turkish organisations in official and non-official networks;
- a considerable portion of the FP6 budget is allocated to large-scale projects and not enough Turkish organisations participate in these strategic projects;
- due to the budgetary limitations in some instruments, in which the participation levels of Turkish researchers were relatively high, even projects passing the threshold could not be retained for funding;
- researchers in other countries do not understand that Turkey, with the status of associated candidate country, can participate in these projects.

Besides the problems of encountered for effective participation ERAWATCH Country Report-2007 lists three impacts of participating in Framework Programmes. First, it led to increased awareness of research and innovation among all stakeholders. Second, it helped develop better coordination mechanisms with a strong public-private partnership for research. Third, it helped the development of favourable legislation for research and researchers (ERAWATCH 2007).

Theoretical Background

Knowledge Spillovers

Accelerated technological changes over the last decades have forced many organizations to adapt their technological competence level, in order to survive within the global competitiveness race during which the capability to develop new technologies seen to be the major issue. However, the needed knowledge to generate such technologies is highly distributed. Therefore, creating links to access such knowledge is vital. Knowledge spillovers occur at that stage because knowledge created by an economic agent is typically not fully contained within that agent and thereby also creating value for other agents (Karlsson, Flensburg and Hörte 2004).

The knowledge spillovers concept has been defined by (Griliches 1991) as “working on similar things and hence benefiting much from each other’s research”. In this process proximity between firms tends to increase the probability of spillovers, and several scholars contributed the literature in this aspect covering agglomeration economics, regional innovation systems, and clusters. For the sake of this paper, we will not deepen this side of the issue, but the knowledge networks.

Cooperation, and linkages between firms, also leads to an increase in knowledge spillovers (Hörte 2004). The cooperative activity may take the form of formal agreements such as joint venture or alliances, but can also take place in less formal ways. In this paper we simply refer to International R&D Cooperation in the form of FPs’ projects.

The most important effect of the FPs is that they have gradually become the driving force behind the formation of dynamic networks which go beyond formal collaboration since they bring together researchers from the best laboratories in European firms and give private firms the opportunity to benefit from a larger pool of resources than is available in a single nation (Dumont and Tsakanikas 2001).

These R&D collaborations can be used as a proxy for knowledge spillovers (Schibany and Polt 2001). Following the study of (Dumont and Tsakanikas 2001) we computed knowledge spillovers using linkages between the pre-competitive collaborative R&D projects generated within the EU Framework Programmes. We argue that mapping those projects allow us to measure spillovers among countries.

At this stage we need to make a distinction between “embodied” and “disembodied” R&D spillovers based on the (Griliches 1991) typology. Spillovers are qualified as embodied when they relate to the purchase of equipment, goods and services. Embodied spillovers are generally measured through input-output tables, supplemented by survey data or data on R&D expenditures, or by flows of international trade (OECD 1992). Disembodied spillovers are described by (Griliches 1991) as “... ideas borrowed by research teams of industry i from the research results of industry j ”. Therefore our empirical study is concentrated on disembodied spillovers generated via FPs’ projects.

The basic hypothesis used to compute knowledge flows is that the number of cooperative links between countries serves as a proxy for the underlying knowledge flows. To make it measurable, eligible costs defined as those necessary expenditures for the completion of the funded project action (CORDIS 2007) are used as a proxy for generated knowledge that is ready to flow. In order to normalize this figure, purchasing power parities (PPP) are taken into consideration. The rationale behind that was the cost incurred are not comparable without the PPPs based on the fact that neither the personal unit cost nor the other cost statements (cost of goods) are unique in different countries. As an illustration, the average cost of personal in Turkey was around 2.000 € while in the Nordic countries this figure raises to around 5.000 €.

From an efficiency perspective, the firm’s position in a network is more important than the multiplicity of its contacts (Dumont and Tsakanikas 2001). Therefore in R&D projects there are greater knowledge flows from the partners to the prime contractor than in the other direction. To reflect this in the study of (Dumont and

Tsakanikas 2001), they used a leverage to make a distinction between coordinators and partners of the projects by which they multiple the knowledge flow with 2 for coordinators and 1 for partners. Contrary to that, we will not use such a leverage factor. Instead we assume that the centrality can be observable via eligible costs. It is a well known argument that coordinators' eligible costs are higher than the partners'. Therefore there is no need to use such a factor during the calculations. However, the centrality issue was discussed to test the reliability of the statistical results on the following pages while taking into consideration the "hubs in FPs projects".

Learning is affected by what we already know (Powell and Grodal, 2006). Therefore we are obliged to take the absorption capacity into account. The concept of absorptive capacity was first coined by (Cohen and Levinthal 1990) to refer a firm's ability to identify, assimilate and exploit knowledge from external sources. (Zahra and George 2002) elaborated the concept further, suggesting that absorptive capacity involves the abilities to acquire, assimilate, convert, and exploit knowledge. They also made a distinction between potential (PACAP) and realized (RACAP) absorptive capacities. According to them, PACAP makes the firm receptive to acquiring and assimilating external knowledge. It captures (Cohen and Levinthal 1990) description of a firm's capability to value and acquire external knowledge but does not guarantee the exploitation of this knowledge. RACAP on the other hand, reflects the firm's capacity to leverage the knowledge that has been absorbed. Therefore, absorptive capacity refers not only to the acquisition and assimilation of information by an organisation but also to the organisation's ability to exploit it (Kastelli 2006).

For PACAP we identify two proxies. Although (Cohen and Levinthal 1990) used R&D expenditures as the unique proxy, following some scholars, we believe that when firms do not engage in R&D, they still have an absorptive capacity up to a certain extent (Waalkens, Jornaand and Postma 2004). This directly linked to human capital. Therefore, we measure the PACAP as a function of both R&D expenditure and full-time equivalent researchers.

If some economic actors are more skilful than their counterparts, then their level of skills should be taken into account while measuring ACAP. Following the RACAP notation we proposed to use number of publications over FTER and number of patents over GERD to diversified level of skill to utilize per unit knowledge with the given level of GERD and FTER.

Finally the theory of (Ulph and Katsoutacos 1998) was used to calculate spillovers as the product of the absorptive capacity and the knowledge flow. The graphical representation of the knowledge spillover represented in Annex-I.

Hubs in R&D Networks

Network study and hubs were among top rated research topics in late 90's. Networks connectivity is controlled by a few important nodes, or hubs, that tend to have a large number of ties and also there is a higher probability that a new node will get connected to a node already exhibiting a large number of connections (Protogerou, Caloghirou and Siokas 2007). (Barabási and Albert 1999) also stated that in many real world networks, some nodes have far more links than would be predicted if the number of links per node were randomly distributed. Similarly, (Malerba, Vonortas, et al., 2006) proved that relatively few European companies called hubs dominated the IST theme of FP6.

Hubs are connectors that links many networks. Hubs dominate the structure of their networks, and thus somehow structures their networks (Wagner and Leydesdorff, 2005). Thus, real networks seem to display more clustering than what is expected of random networks. Therefore, hub is an organization in a specific network where it has many links and/or it connects the otherwise unconnected parts of the network.

Hubs within their scientific networks are attractive collaborators (Wagner and Leydesdorff, 2005). According to the (Barabasi 2002) actors display preferential attachment: when choosing between two possible links, they will seek to connect to the more connected member. Therefore we can argue that when someone is

seeking a collaborator, they will seek someone who is already highly connected and therefore has access to resources and reputation.

Several studies highlight the importance of hubs as the key success factor to embed industry innovation (Malerba, Vonortas, et al., 2006), (Ernst&Young 2005). Also several RTD policies such as the FinNano programme encourage and supports international networking and mobility while also links national 'hubs' of expertise to international networks where it is assumed that connections with hubs participants to build up and to see the technologies that are in development or exploitation (EC 2005).

Using data for hubs in Malerba, et al (2006) we argue that the more links with top-rated EU IST Network Hubs means reflects more involvement in EU IST RTD projects. In order to prove this based on data of funded IST projects in FP6 we compare Greece, Czech Republic and Turkey's links with hub organizations of FP6. Then, we present some policy recommendations for Turkish R&D policy makers to highlight the importance of linkages with RTD Hubs.

The Data in the Model

The 6th Framework Programme run between 2002 and 2004, and funded around 10.000 projects of which 2.422 were research projects under the 7 thematic priorities. Within these 2.422 projects, more than 30.000 participants were involved. In our study we analyze such 30.000 partnerships to measure the knowledge spillovers. The thematic distribution of the partnerships was shown on Annex-2.

As discussed in the theoretical background section of the paper, eligible costs were used as a proxy for generated knowledge. And as stated before in order to normalize these figures, purchasing power parities (PPP) were taken into consideration. The source of PPPs was EUROSTAT service of the European Commission. Those statistics were given on Annex-3. The spillovers are calculated as a product of knowledge flow

and absorptive capacity. Each absorptive capacity had four dimensions as discussed in theoretical section. Those dimensions were shown in Annex-4.

As stated in theoretical background section, hubs of the IST sub-field of FP6 used to identify linkages to them. For this (Malerba, Vonortas, et al., 2006) study were used and the list of hubs was given in Annex-5. All data, except the list of hubs, were provided by the EU Framework Programmes National Coordination Office of the Scientific and Technological Research Council of Turkey (TUBITAK).

Findings

Knowledge Flow vs. Know Generation

Networks are highly effective mechanisms for incorporating tacit knowledge, but they seem to be a somewhat neglected channel for knowledge spillovers. This can be explained by the fact that most scholars define spillovers as externalities without considering “voluntary” spillovers (Dumont and Tsakanikas 2001). The idea behind the EU’s RTD policy is the promotion of co-operation (Georghiou 2001) and as a policy tool of this, the EU Framework Programmes provide a platform for such “voluntary” spillovers.

Between the years 2002-2006, 128¹ organizations from Turkey voluntarily participated in the R&D projects of the 6th Framework Programme. Those organizations got the chance both to generate knowledge and also to benefit from knowledge flows generated by other organizations involved in the same project. One assumption of this study is that knowledge flow occurs between the participants of the same projects, while others (non-participants) benefit only from the outputs of the projects such as publications and patents. Therefore we handle the knowledge only generated and distributed within the specific project network and eligible costs were used as proxy for generated knowledge as theorized in previous section.

¹ There were also several organizations involved in non-R&D projects of FP6.

Annex-6 illustrates both generated knowledge (GK) and knowledge flow over generated knowledge (KF/GK) ratio for each country in which GKs are the aggregated eligible costs of each country's participants. After sorting all values bases to GK, we have seen that after a certain point the fluctuation of KF/GK ratio is high, Area-2 in the graph. The countries fit into Area-1 generate 90% of the knowledge and act as the source of knowledge flow. Consequently, inwards knowledge flow, as a ratio of own GK, for Area-1 countries is less than Area-2 countries which benefit from KF much compared to GK but not from the knowledge spillovers yet.

The fluctuation of GK/KF ratio in Area-2 means that networking with whom, affect the level of knowledge flow. Some may expect that co-operating with more central actors tend to foster the knowledge flow. We will deeply analyse this issue in the following hub discussion.

Knowledge Absorptive Capacity affects the Spillover

By definition, inward knowledge flow is never fully absorbed by the organization added to its knowledge stock. Some knowledge flows could not pass the boundaries as a result of the organizations absorptive capacity. Therefore we assume that similar happen in our case for EU FPs.

Theoretically, as discussed earlier, knowledge spillover is the product of knowledge flow (KF) and absorptive capacity (AC). Hence, the critical issue is to define empirically what the value of AC is for each of the participating countries. We previously tried to theorize the dimensions of AC and use some proxies to calculate the ACs. Annex-7 represents the AC data which were used to define the knowledge spillover at the end.

None of the economic actors fully benefit from external knowledge even the knowledge generated within a formal network. Every organization has an AC less than 100%, means that the knowledge spillover is always less than the knowledge flow. To realize the matter we create a hypothetical country with the highest possible figures whose AC is 100% and then we calculate the rest comparing to it.

According to our calculations the highest AC belongs to Germany with a rate of 59% while Turkey ranked 16th among 33 country.

One of a critical judgement is that, some knowledge-based societies did not rank high as expected. The reason behind that is FTER which is a vital dimension of AC. For instance, although Finland has high ratio for researchers per million inhabitants, its nominal FTER remain low due to fact that Finland is a small country. As a result the AC ratio is relatively small to process all external knowledge created within the FP network. Based on the calculations the amount of knowledge flow to Finland (7.6 B€) is higher than its GERD amount (6.9 B€), which makes it reliable to have lower AC than expected. To make a comparison, although its size relatively affects the AC, Turkey's low level of available researchers do not let the knowledge flow to be fully absorbed. Therefore, we may conclude that to fully benefit from knowledge spillover which is the major externality of networking; policy interventions should focus on creating links with key actors and investing in AC in a synchronized way.

Links to Hubs

We argue that high number of links with Hub organisations increases the participation of a hypothetical country in EU Framework Programmes. Therefore relative importance of hub organisations on increasing involvement in EU funded collaboration projects as well as knowledge diffusion was tested.

We traced our judgement in projects funded under FP6 IST programme where we have used data coming from the study of (Malerba, et al. 2006). Although their study lists 41 hub organisations (Annex-8) which were active in FP6 IST programme, the number of hub organisations in our study was decreased to 30² after a robustness

² This study was based on FP6 IST call 1 and call 2 in thematic priorities 1, 2 and 3, as well as Innet dataset and EP-CESPRI dataset European Patent Office data. Since latter two include companies involved in privately funded alliances and cross-organisational patent citations we have made robustness check on data of funded FP6 IST projects from 2003 to 2006. Based on robustness check with data available for all of thematic priorities in FP6 IST we have decreased the number of hub organisations to 30.

check (Annex-11). Those organisations are located in 11 EU member states³ where Alcatel and ST Microelectronics are present not only with their parent companies but also with one of their subsidiaries.

For us it is important to distinguish subsidiaries of multinational corporations (MNC) from their parent companies because we are tracing measure the spillover in a country base. In our study the list of Hubs in IST projects has been consolidated by considering each subsidiary or research lab as an independent unit. In contrary study of (Malerba, et al. 2006) considers multinational corporations (MNCs) according to the ultimate parent company where for example Nokia-Italy has been considered as part of the Nokia group. Since, their robustness check states that results do not change in a substantial way and are relatively not sensitive to how subsidiaries are considered (i.e. as a part of parent company or an independent unit) we have not adopt their way on this head.

In order to test the hypothesis we have constructed a model which measures the links of a hypothetical country's organisations with Hubs of FP6 IST area. We have focused in three countries (Czech Republic, Portugal and Turkey) to see whether more ties with hubs bring more involvement in the programme.

In FP6 IST area Turkey was involved in 20 R&D projects⁴ with 28 Turkish partners where in 15 of them Turkish organisations have partnerships IST Hubs (Annex-9). It can be argued that there is a German dominance in Turkish interactions with Hubs, where only 3 of 15 projects do not contain German originated Hubs. It is also interesting to see that interactions with German organisations are ascended by Fraunhofer where the research organisation is present in 9 projects with Turkish partners. Although it seems that Turkish organisations are well connected with Fraunhofer researchers, Turkish researchers are involved in only 5% of projects which also involve researchers from Fraunhofer in FP6 IST. Concerning the rest of

³ Interestingly among those 11 countries which have hub organisations there is no country from new member states of EU.

⁴ IP or STREP

Hubs⁵ in the list, this proportion is less than 5% which shows that Turkish organisations do not interact sufficiently. Turkish organisations have interactions with 16 of Hubs which are not so strong ties. Moreover, the number of project based links is not sufficient where only two hubs have more than two project bases connections with Turkish organisations. Also, hub density which is hubs per project with Turkish partners is very low (1.3). Based on the findings about Turkish case we observe low level of interactions with all Hubs which signs the lack of visibility, not enough promotion of Turkish R&D in several European arenas and also low level of networked position.

Czech Republic was involved in 57 IST RTD projects in FP6. Czech Republic has more than two interactions with 23 of total 30 Hubs where Czech organisations perform well especially with Fraunhofer, CNRS and Thales (Annex-10). We observe that Czech researchers were successful to conduct links with most of the IST RTD Hubs where their projects involve interactions with 29 of 30 IST RTD Hubs with a hub density of 2.4, so increase in hub density also brings high performance in FP6 IST.

Portuguese case is also inline with our judgement, Portuguese research organisations have hub density of 2.6 and they were involved in 96 FP6 IST RTD projects (Annex-11). As a reflection of high density they have interactions with all of the IST RTD Hubs and maintained more than two interactions with 27 of 30 IST RTD Hubs. Therefore, this prove our hypothesis on impact of interaction level with hubs on number of partnerships in FP6 IST where for both Czech and Portuguese the inward knowledge flow over generated knowledge ratios are high (KF/GK). Besides we observed that, Hubs funnel their home country organisations in FP6 IST projects. We found that while the number of partners per projects from France in average is 2.3, the number of French partners per project with a presence of at least one French hub increases to 3.0. For the German case same ratios are 2.8 and 3.7 respectively.

⁵ 29 Hubs we have focused.

Another interesting finding of our test was about Greek position where rank list of our study surprisingly included three organisations from Greece⁶. It is a higher involvement than expected on basis of their GDP and national RTD investment. The performance of Greece in FP5 and FP6 was also noticed by the European Commission and therefore the Commission run a study (Wagner, Thomson and Oortwijn, 2004) to analyse this situation. The study found that:

1. Although Greece do not present a considerable proportion in international scientific literature, Greek authors of IST literature are well known reflected by strong publication record in Europe and good citation rate.
2. Greece has highest growth rate in IST RTD investments in early 2000's.
3. Greece increased the number of research personnel at rates higher than any other EU country.
4. Since 1996 Greece has sent more students to study in other EU countries than any other European country, so Greek Diaspora researchers in Europe is actively contributing to involvement of Greece in EU RTD Programmes.
5. In the late 90's Greek Government launched new programmes to attract collaborators. Also Greek Technology Foresight Programme raised the awareness and need with foreign partners.

While supporting our judgement the Greek case also show that high networked position can lead the emergence of IST RTD hubs.

Conclusions and Policy Implications for Turkey

The literature seems to confirm that belonging to a network not only reduces the cost of information, but also avoids being subject to subsequent exclusion and entry barriers (DeBresson and Amesse 1991). This rational channelled Turkey to be associated in FP6, and has guided its researchers to take active roles in R&D projects. Since then this is the first study to attempt to analyze Turkey's participation and its potential gain from knowledge spillovers generated with such international R&D networking programme.

⁶Institute Of Communication and Computer Systems, Centre For Research And Technology Hellas and Foundation For Research and Technology - Hellas

Some scholars argue that: “EU cost subsidies may be counterproductive to knowledge sharing and patent subsidies could be more effective” (Pérez-Castrillo and Sandonís 1997), while the others thought that: “the FPs have been instrumental in keeping Europe in the technological race” (Dumont and Tsakanikas 2001). Although the efficiency of the European Research Policy and its policy tool, EU FPs, are debatable, we considered that at least, EU Framework Programmes have gradually become the driving force behind the formation of dynamic networks. Therefore FPs give valuable opportunities for Turkey to channel knowledge flow inwards.

Although Turkey gained R&D funds and know-how via spillovers, our study investigate that she is performing under its potential. While ERA model emphasizes exchange and forming networks with corresponding institutions, both in research and training programmes, Turkish researchers have limited personal contacts with EU researchers. Therefore, in order to be able to effectively exploit the knowledge and information diffused or created within the research network, it is needed to be prepared to invest internally for improvement of the absorptive capacity.

Capacity building is a crucial topic for more enhanced involvement in networks and efficient knowledge diffusion. (C.-S. Wagner, 2006) highlights the importance of institutional capacity building: *“Local links also increase the likelihood that knowledge creation focuses on issues relevant to the developing countries rather than on issues that concern only scientists in advanced countries. [Therefore] the question for developing countries is not how to get into collaborations with Germany, the UK or the US, but how to take applicable knowledge from the network (no matter where it is located), make it relevant to local needs and problems, and tie it down”*. In line with this argument, since 2004, with the establishment of National Science and Technology Strategy for the years 2005-2010 (BTYK, 2004), Turkey has invested in capacity building and gradually has improved its scientific activities both in academia and industry.

But there are challenges to be overcome. We argue that, one of the dimensions to improve is to enhance the development of national networks⁷. There are several benefits of such intention. First, this will initiate to create critical mass on several technological issues that need to accumulate knowledge to overcome. In addition to that, it may tend to enhance networking capabilities of Turkish actors which may foster the international networking activities. Therefore one policy implication is to foster national networks. For this purpose we propose to change the industrial funding mechanism of TUBITAK which is currently not have any discrimination for whether the project is only include one partner or many based on the funding ratios.

As it is well known, the main obstacle against the knowledge spillover is the low level of absorptive capacity. Our empirical study suggest that, the main challenge is the number of patents per million € GERD, as proxy for knowledge utilization of a country which constitutes one dimension of AC. While, the legislative promotion of academic personnel boosts the number of publications per full-time researchers, same impact has not been seen for the patent data. This is clearly because of the low level of private sector participation in such R&D activities, which directly affects the AC ratio. Since 2004, the private sector share in R&D activities has been increased and we assume that in following years this will positively affect the patent application and then AC.

The European Commission's new regulation called "Community Framework for State Aid for Research and Development and Innovation" (CEC 2007) may have a positive effect on building R&D networks in Turkey. This regulation aims "to make it easier for Member States to better target the aid to the relevant market failures⁸". One of the defined market failure in the legislation is the coordination failure, and this regulation emphasis necessary funding mechanisms to overcome this type of failures. In short, the amount of public subsidiary will be increased if the R&D

⁷ More focus and awareness rising on ISBAP type programs are needed. ISBAP is a special program funded by TUBITAK that aims to facilitate the establishment of sectoral or regional networks.

⁸ The regulation defined the market failure as such: "A 'market failure' is said to exist when the market, if left to its own devices, does not lead to an economically efficient outcome. It is in those circumstances that state intervention, including state aid, has the potential to improve the market outcome in terms of prices, output and use of resources.

projects are cooperation based and in contrast the isolated in-house R&D activities will be funded with very low levels. As a policy implication we propose to harmonize this acquis to Turkish systems as soon as possible, which may foster knowledge flow towards Turkey in medium-term.

Although in the early 20th Century Turkish higher education had been based on a model inspired by Europe (in particular the German model), in the period after the Second World War it has come increasingly to look to the American model (Godelier and Gallie 2005). This was true with respect to preference of best Turkish students to go to the USA and even, in many universities, to the recruitment of academic staff that was expected to have American doctorates. In order to overcome the limited spillover from European countries there is a need for more Europe-trained researchers who would build ties for more enhanced collaboration with European organisations. Therefore an enhanced strategy for brain circulation with emphasis on Marie Curie Actions⁹ among European countries and Turkey will be beneficial for both sides for better integration of Turkish RTD community into ERA.

Efficient knowledge flow often requires proximity, effective communication and some shared values like cultural similarities where they can reflect diffusing technological knowledge and innovations more rapidly. Empirical research has shown that there is a positive link between such spillovers and the proximity of RTD activity (Saublens 2007). Therefore Turkey should pave the way to increase its R&D collaboration activities with her European neighbours especially with Greece. Remembering that Greece has three IST RTD hubs in European R&D networks, Turkey's¹⁰ link(s) with those organisations should be increased.

Besides their leading role in EU IST RTD Alcatel, Nokia, Philips, ST Microelectronics, Siemens and Thales can be regarded as Hubs in Turkish IST market considering their business relations and ecosystem in Turkey. From this point of view those

⁹ A fellowship program under FP6 to facilitate mobility of researchers

¹⁰ Turkey has just one link with Greek IST RTD hubs which is the Centre for Research and Technology Hellas

corporations who are simultaneously among leaders of EU IST RTD fora in Europe can act as Gatekeepers¹¹ for better involvement of their counterparts and subsidies from Turkey in FPs.

In conclusion, international collaboration is replacing other models as the preferred method of building scientific and technological capacity. Indicators show that the amount of networking between advanced and developing country researchers is rising (Wagner, et al. 2001). Those cooperation, and linkages between organizations, leads to an increase in knowledge flows, such as the FPs in which Turkey's association has given the opportunity to benefit. Our analysis and policy implications built on that results suggest that absorptive capacity and developing link with network hubs should be the hot topics for policy makers in coming days.

¹¹ A Gatekeeper is defined to be an organisation which plays the role of Hub in more than one network.

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Annex-1: Mathematical Definition of Spillovers (spillover to J)

$$SO_j = \sum KF_{ij} * ACAP_j \quad \text{where;}$$

ACAP: $f(PACAP, RACAP)$ where;

PACAP: $f(GERD, FTER)$ and RACAP: $f(Pu, Pa)$

Agent j: Receive Knowledge,

Agent i: Send Knowledge,

SO: spillover,

KF: Knowledge Flow (eligible costs in purchasing power parities -PPP),

ACAP: Absorptive Capacity,

PACAP: Potential Absorptive Capacity,

RACAP: Realized Absorptive Capacity,

GERD: Gross domestic expenditure on R&D in PPP (^I),

FTER: Full-time equivalent researchers (^{II}),

Pu: Scientific Publications (^{III}) over FTER,

Pa: European Patents (^{IV}) over GERD,

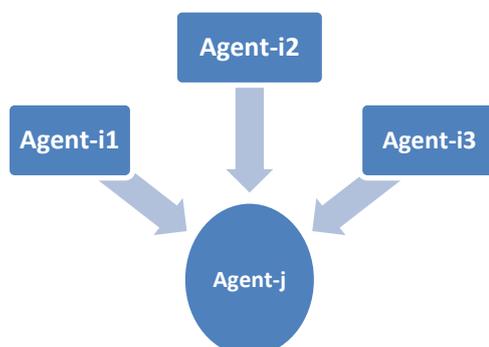
^I: <http://epp.eurostat.ec.europa.eu> EUROSTAT web page

^{II}: Science, technology and innovation in Europe, EUROSTAT, 2008

^{III}: OECD Science, Technology and Industry Outlook, 2006

^{IV}: Science, technology and innovation in Europe, EUROSTAT, 2008

Figure 1: Graphical Representation of Knowledge Spillover



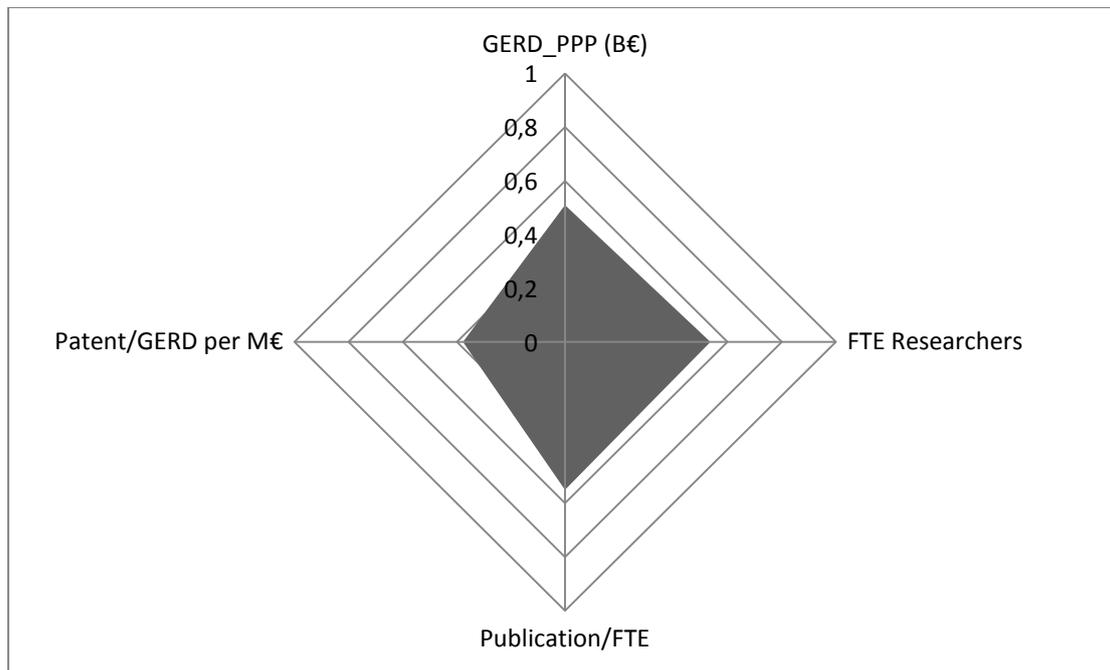
Annex-2: Thematic Distribution of Partnerships

Thematic Priority	# of partnerships
1. Life sciences, genomics and biotechnology for health	4.673
2. Information society technologies	9.637
3. Nanotechnologies and nanosciences	4.486
4. Aeronautics and space	2.970
5. Food quality and safety	1.825
6. Sustainable development, global change and ecosystems	7.177
7. Citizens and governance in a knowledge-based society	1.059
Total Number of Partnership	31.827

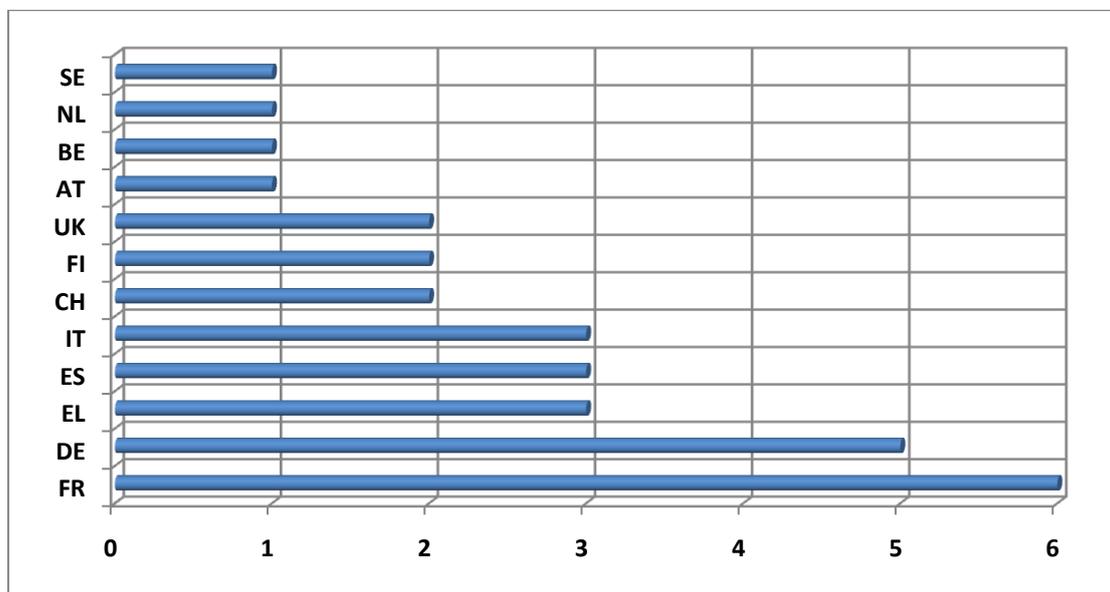
Annex-3: PPP Values of Each Country (source: EUROSTAT)

CODE	DESCR	PPP	CODE	DESCR	PPP
AT	Austria	125,5	LV	Latvia	58,5
BE	Belgium	115,9	LT	Lithuania	62,2
BG	Bulgaria	39,2	LU	Luxembourg	274,6
HR	Croatia	56,6	MT	Malta	76,2
CY	S. Cyprus	91,7	NL	Netherlands	129,8
CZ	Czech Republic	82,4	NO	Norway	181,1
DK	Denmark	119,8	PL	Poland	54,6
EE	Estonia	71,7	PT	Portugal	73,2
FI	Finland	115,8	RO	Romania	41,9
FR	France	108,8	SK	Slovakia	70,9
DE	Germany	111,7	SI	Slovenia	89,2
EL	Greece	97,7	ES	Spain	104,3
HU	Hungary	62,7	SE	Sweden	124,5
IS	Iceland	125	CH	Switzerland	136,9
IE	Ireland	142,8	TR	Turkey	42,2
IL	Israel	133,8	UK	United Kingdom	113,6
IT	Italy	98,5			

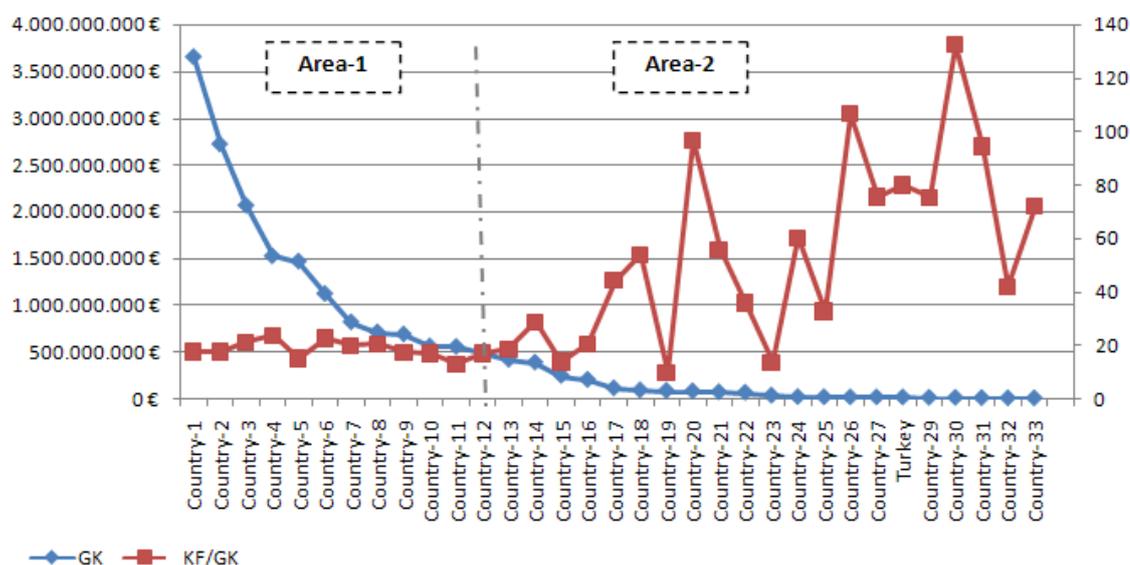
Annex-4: Absorption Capacity (an illustrated example)



Annex-5: IST RTD Hubs per Country



Annex-6: Generated Knowledge and Knowledge Flow



Annex-7: Absorptive Capacity

rank	code	country	AC	rank	code	country	AC
1	DE	Germany	0,593	18	EL	Greece	0,010
2	FR	France	0,254	19	IE	Ireland	0,010
3	UK	United Kingdom	0,243	20	CZ	Czech Republic	0,010
4	IT	Italy	0,149	21	PT	Portugal	0,007
5	NL	Netherlands	0,102	22	SK	Slovakia	0,007
6	AT	Austria	0,084	23	BG	Bulgaria	0,007
7	CH	Switzerland	0,072	24	HR	Croatia	0,006
8	SE	Sweden	0,071	25	SI	Slovenia	0,004
9	ES	Spain	0,063	26	RO	Romania	0,003
10	FI	Finland	0,046	27	LT	Lithuania	0,003
11	BE	Belgium	0,044	28	IS	Iceland	0,002
12	IL	Israel	0,044	29	EE	Estonia	0,002
13	DK	Denmark	0,037	30	LV	Latvia	0,002
14	PL	Poland	0,020	31	LU	Luxembourg	0,002
15	NO	Norway	0,018	32	CY	S. Cyprus	0,000
16	TR	Turkey	0,015	33	MT	Malta	0,000
17	HU	Hungary	0,011				

Annex-8: Hubs Defined by Breschi, Cassi, Malerba, Vonortas

Hubs	Hubs
ALCATEL IND	NOKIA IND
ARISTOTLE UNIVERSITY OF THESSALONIKI HE	PHILIPS IND
BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS HE	SCHLUMBERGER IND
CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS REC	SIEMENS AG IND
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE REC	STMICROELECTRONICS IND
CHALMERS UNIVERSITY OF TECHNOLOGY HE	SWISS FEDERAL INSTITUTE OF TECHNOLOGY HE
DAIMLERCHRYSLER AG IND	TECHNICAL UNIVERSITY OF CRETE HE
DEUTSCHES FORSCHUNGSZENTRUM FÜR KÜNSTLICHE INTELLIGENZ GMBH (GERMAN RESEARCH CENTER FOR ARTIFICIAL INTELLIGENCE)	TELEFÓNICA INVESTIGACIÓN Y DESARROLLO SOCIEDAD ANÓNIMA UNIPERSONAL IND
ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE HE	THALES COMMUNICATIONS IND
FIAT IND	THE UNIVERSITY OF SURREY HE
FOUNDATION FOR RESEARCH AND TECHNOLOGY - HELLAS	UNIVERSIDAD POLITÉCNICA DE MADRID HE
FRANCE TELECOM IND	UNIVERSITÀ DEGLI STUDI DI ROMA "LA SAPIENZA" HE
FRAUNHOFER-GESELLSCHAFT REC	UNIVERSITÀ DEGLI STUDI DI SIENA HE
HEWLETT-PACKARD IND	UNIVERSITÄT DUISBURG-ESSEN HE
IBM IND	UNIVERSITAT POLITÈCNICA DE CATALUNYA HE
INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE REC	UNIVERSITÉ CATHOLIQUE DE LOUVAIN HE
INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS REC	UNIVERSITY OF SOUTHAMPTON HE
INTERUNIVERSITAIR MICRO-ELEKTRONICA CENTRUM VZW REC	VIENNA UNIVERSITY OF TECHNOLOGY HE
KUNGL TEKNISKA HÖGSKOLAN (ROYAL INSTITUTE OF TECHNOLOGY) HE	VODAFONE IND
MICROSOFT IND	VTT TECHNICAL RESEARCH CENTRE OF FINLAND REC
MOTOROLA IND	

Annex-9: Hubs which interact with Turkish organisations

Rank	Hubs	# of projects w/ TR
1	FRAUNHOFER	9
2	SIEMENS-DE	3
3	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	1
4	CENTRO RICERCHE FIAT SOCIETA CONSORTILE PER AZIONI	1
5	DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH	1
6	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	1
7	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	1
8	FRANCE TELECOM-FR	1
9	INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE	1
10	TECHNISCHE UNIVERSITAET WIEN	1
11	TELEFONICA-ES	1
12	THALES-FR	1
13	UNIVERSIDAD POLITECNICA DE MADRID	1
14	UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"	1
15	UNIVERSITY OF SOUTHAMPTON	1
16	VALTION TEKNILLINEN TUTKIMUSKESKUS	1

Annex-10: Hubs which interact with Czech organisations

Hubs	# of projects/ CZ
1 FRAUNHOFER	19
2 CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)	9
3 THALES-FR	9
4 SIEMENS-DE	8
5 TELEFONICA-ES	8
6 UNIVERSITAT POLITECNICA DE CATALUNYA	8
7 DAIMLERCHRYSLER AG	5
8 EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	5
9 THE UNIVERSITY OF SURREY	5
10 UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"	5
11 CENTRO RICERCHE FIAT SOCIETA CONSORTILE PER AZIONI	4
12 INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE	4
13 KUNGLIGA TEKNISKA HOGSKOLAN	4
14 NOKIA-FI	4
15 PHILIPS-NL	4
16 VALTION TEKNILLINEN TUTKIMUSKESKUS	4
17 DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH	3
18 ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	3
19 FOUNDATION FOR RESEARCH AND TECHNOLOGY - HELLAS	3
20 FRANCE TELECOM-FR	3
21 INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	3
22 TECHNISCHE UNIVERSITAET WIEN	3
23 UNIVERSIDAD POLITECNICA DE MADRID	3
24 CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	2
25 INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS	2
26 STMICROELECTRONICS-IT	2
27 ALCATEL-DE	1
28 ALCATEL-FR	1
29 UNIVERSITY OF SOUTHAMPTON	1

Annex-11: Hubs¹² which interact with Portuguese organisations

	Hubs	# of projects PT
1	FRAUNHOFER	26
2	FRANCE TELECOM-FR	19
3	TELEFONICA-ES	19
4	SIEMENS-DE	16
5	INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE	13
6	THE UNIVERSITY OF SURREY	12
7	ALCATEL-DE	10
8	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	10
9	UNIVERSIDAD POLITECNICA DE MADRID	10
10	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS	9
11	VALTION TEKNILLINEN TUTKIMUSKESKUS	9
12	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)	8
13	KUNGLIGA TEKNISKA HOGSKOLAN	8
14	PHILIPS-NL	8
15	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	6
16	THALES-FR	6
17	UNIVERSITAT POLITECNICA DE CATALUNYA	6
18	NOKIA-FI	5
19	ALCATEL-FR	4
20	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	4
21	CENTRO RICERCA FIAT SOCIETA CONSORTILE PER AZIONI	4
22	DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH	4
23	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	4
24	DAIMLERCHRYSLER AG	3
25	STMICROELECTRONICS-FR	3
26	STMICROELECTRONICS-IT	3
27	UNIVERSITY OF SOUTHAMPTON	3
28	FOUNDATION FOR RESEARCH AND TECHNOLOGY - HELLAS	2
29	TECHNISCHE UNIVERSITAET WIEN	1
30	UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"	1

¹² Portuguese organizations interact with all hubs in FP6 IST. Therefore Annex-11 also lists all hubs used in our study.