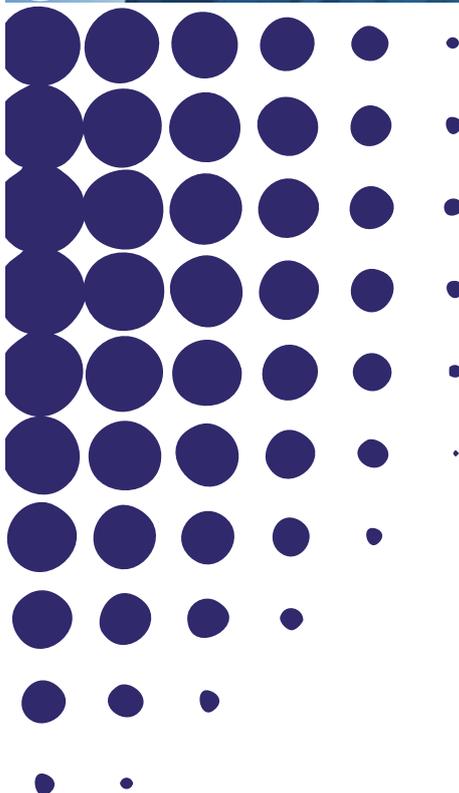


# WP4/13 SEARCH WORKING PAPER

## Knowledge diffusion between European Neighboring Countries and the European Union

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# Knowledge diffusion between European Neighboring Countries and the European Union

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## **Abstract**

This study aims at quantifying the intensity of knowledge flows between EU countries and ENC countries, and to assess the channels through which this diffusion occurs. To this aim, we suggest the use of different variables, each of them enlightening a specific aspect of the scientific and technological relationships between EU and ENC. Special emphasis is given to mobility, collaboration and knowledge networks.

The results point out the weak development of the channels for knowledge diffusion between EU and ENC and the central role played by some countries. However, the extent to which ENC are oriented towards the EU varies greatly according to indicator under consideration, pointing to different channels of knowledge diffusion. It is also worth mentioning that collaborations between EU and ENC are becoming more intense and the influence of the EU is increasing relatively to the one of the US. Moreover, even if most collaboration networks remain strongly focused on few countries, the network structures tend to some extent to become more homogenous.

**Keywords:** Knowledge flows, collaboration, networks, co-authorship, co-inventorship, IPR, Framework Programmes, mobility.

**JEL Classification:** O31, C31

## 1. INTRODUCTION

The ability to diffuse knowledge and to access external knowledge has long been recognized as a crucial mechanism for knowledge accumulation and economic growth (Lucas, 1988, Romer, 1990). Due to the public nature of knowledge, diffusion of ideas produces increasing returns that are at the root of growth dynamics. In this perspective, knowledge flows from European Union towards European Neighboring Countries is likely to help these countries to catch up.

Moreover, theoretical as well as empirical studies (Jacobs, 1969, Reagens and Zuckerman, 2001, Nooteboom et al., 2007) have pointed out that new knowledge creation benefits from cross-fertilization. Scientific, technological, cultural diversity is recognized as a key driver for innovation. To this regard, knowledge flows among EU and its neighbors could benefit to the whole area.

However, it is also acknowledged that there also exist strong hampering factors for knowledge diffusion. Spatial distance is probably the one that has been more thoroughly investigated (Jaffe, Trajtenberg and Henderson, 1993, Acs, Anselin and Varga, 1997, Peri, 2003, etc). But recent studies also point to the role played by other forms of distance. Cultural differences (Reagens Zuckerman and McEvily 2004), institutional and linguistic borders (Boshma, 2005), may prevent the diffusion of knowledge. Therefore, distance, in its various forms, may reduce knowledge diffusion between EU and ENC.

In this study, we therefore aim at quantifying the intensity of knowledge flows between EU countries and ENC countries, and to assess the channels through which this diffusion occurs and its hampering factors.

More precisely, the aim is to identify the ENC countries most strongly connected to the European Research Area, and to study what kind of distance matters for this connectedness.

In order to deal with these issues, the channels through which knowledge might diffuse have to be identified. In this respect, it is very important to make a distinction between intentional and unintentional knowledge flows. Fortuitous knowledge flows may result from pure knowledge spillovers. Due to the imperfect appropriability of knowledge, ideas may be freely available or at a lower cost than the cost faced by their producers. This is especially the case for the information included within patents or scientific publications. In addition, unintentional flows of knowledge may occur during other exchanges. In particular, they may be embedded in trade relationship, FDI, tourist flows, and so on. On the other hand, economic agents may aim at encouraging knowledge flows through voluntary actions. The aim of this study is to account for these intentional flows. Pure knowledge spillovers are dealt with in the CRENoS work in this work package, whereas

other aspects of knowledge diffusion based on trade, FDI, etc are investigated in other work packages of the SEARCH project (WP2).

The next section details the main channels of the voluntary flows of knowledge and derives from this theoretical analysis five main indicators of knowledge diffusion between EU and ENC. Based on these indicators, section 3 investigates the propensity of ENC to collaborate with the EU. It allows us to identify which neighboring countries are connected to which EU countries. Section 4 then studies the network structure that arises from these bilateral collaborations. It allows us to better specify the central role played by some EU and ENC countries in knowledge diffusion. The way this diffusion evolves over time is analysed in Section 5, pointed to the reinforcement of the overall connectedness of ENC towards the EU.

## **2. THEORETICAL MOTIVATIONS AND DATA**

The literature has identified two main channels for the intentional diffusion of knowledge both of them relying on interpersonal relationship. The common idea is that the most important vector of knowledge diffusion relies on face to face interactions, especially when knowledge has an important tacit component. These interpersonal relationships would in particular be favored by labor mobility on the one hand, and by collaboration network on the other. The higher labor mobility and the closer collaborative links between individual the greater the probability of knowledge flow (Singh, 2005). According to Zucker, Darby and Armstrong, 1994, Almeida and Kogut, 1999, ideas would be embodied into people and travel with them. Labor mobility would therefore enhance knowledge diffusion. Some recent studies confirm the positive role played by labor mobility on knowledge diffusion and knowledge accumulation (Agrawal, Cockburn and McHale, 2006, Miguelez and Moreno, 2012)

Two main distinct frameworks have been used to investigate the role played by collaborations in knowledge diffusion. The former relies on patent citations (Singh, 2005, Sorenson et al., 2006, Gomes-Casseres et al., 2006, Agrawal et al., 2008) while in more recent studies, several authors rely on collaboration models. The dependent variable is in this case the probability for two agents to collaborate, or the intensity of their collaboration, using either individual (Autant-Bernard et al. 2007, Frachisse, 2011) or regionally aggregated data (Ponds et al. 2007, Scherngell and Barber, 2009). The results demonstrate that the ability to create ties depends on several factors: geographical distance, but also, technological, cultural, institutional, etc.

In addition, beyond bilateral collaborations, individuals' position within the network, as well as the overall network architecture are acknowledged as key determinants of knowledge diffusion.

This view is supported by two different fields of the literature. Network formation theory on the one hand shows how network structure may favor knowledge diffusion (Cowan and Jonard (2004), Lin and Li (2010)), whereas applied social network analysis investigates the ability of individual to access knowledge according to their specific position within the network (Powell, Koput, Smith-Doerr (1996), Singh (2005), Bell and Zaheer (2007)).

In order to explore the intensity and mechanisms of knowledge diffusion between EU and ENC, we thus need to find data allowing us to account for mobility, collaboration and knowledge networks.

Obviously, no unique measure exists and data availability constraints are strong for both collaboration propensity and mobility of human capital. We therefore suggest the use of different variables, each of them enlightening a specific aspect of the scientific and technological relationships between EU and ENC.

Referring to previous studies, a first way to account for intentional knowledge diffusion would be to rely on co-authorship (Zucker, Darby, Armstrong, 1994, McKelvey, 2003). Scientific publications are indeed a direct measure of knowledge production and collaborations for scientific publications produce a natural indicator for knowledge sharing. To this aim, we use a French database that covers most of the international scientific journals, giving an accurate picture of the joint scientific activities of both EU and ENC countries. This is Pascal database (INIST-CNRS). Scientific publications cover however the more fundamental aspects of the research process. It is thus important to combine it with other indicators. A second indicator highly used in the literature is co-inventorship (Breschi and Lissoni, 2009). Our measure comes from OCDE.StatExtracts database and gives an exhaustive view of the patents granted at EPO. We also use R&D cooperation database, following several previous studies (Gomes-Casseres, Hagedoorn and Jaffe 2006). This last database comes from CORDIS and has been treated by the French ministry of Research. It registers the participations to Framework Programme projects. Although the FPs are a European policy tool oriented mainly towards EU countries, they also welcome non EU partners. To this respect, it provides us with interesting information on the connectedness of NEC to the European Research Area.

Based on these three datasets, we are able to identify knowledge production and diffusion at different levels of the innovation process. In addition to these scientific collaboration measures, we use patent database to build a slightly different indicator of relationship between EU and ENC, which we can refer to as Intellectual and Property Right collaborations. This is given by the number of patent applications by country of origin and it comes from WIPO Statistics Database

Finally, in order to capture human capital mobility, we rely on UNESCO data on students mobility.

### **3. PROPENSITY TO COLLABORATE BETWEEN EU AND ENC**

The objective of this part is to answer to two main questions: What are the ENC that collaborate most with European Countries? What can this tell us about the mechanisms underlying different channels of knowledge diffusion? To this aim, three collaboration areas are studied successively: co-inventorship, co-authorship and R&D cooperation. Then a special attention is devoted to intellectual property relationships. Finally, students' mobility is analyzed. Based on these 5 indicators, section 3.6 gives a general overview of the main drivers of ENC's propensity to collaborate with the EU.

#### **3.1 Co-inventorship: geographical distance, language and historical relations seem to be critical in the co-patenting architecture**

The analysis focuses first on the propensity to co-patent with abroad (§3.1.1.) before describing precisely co-patents between European and neighboring countries (§3.1.2).

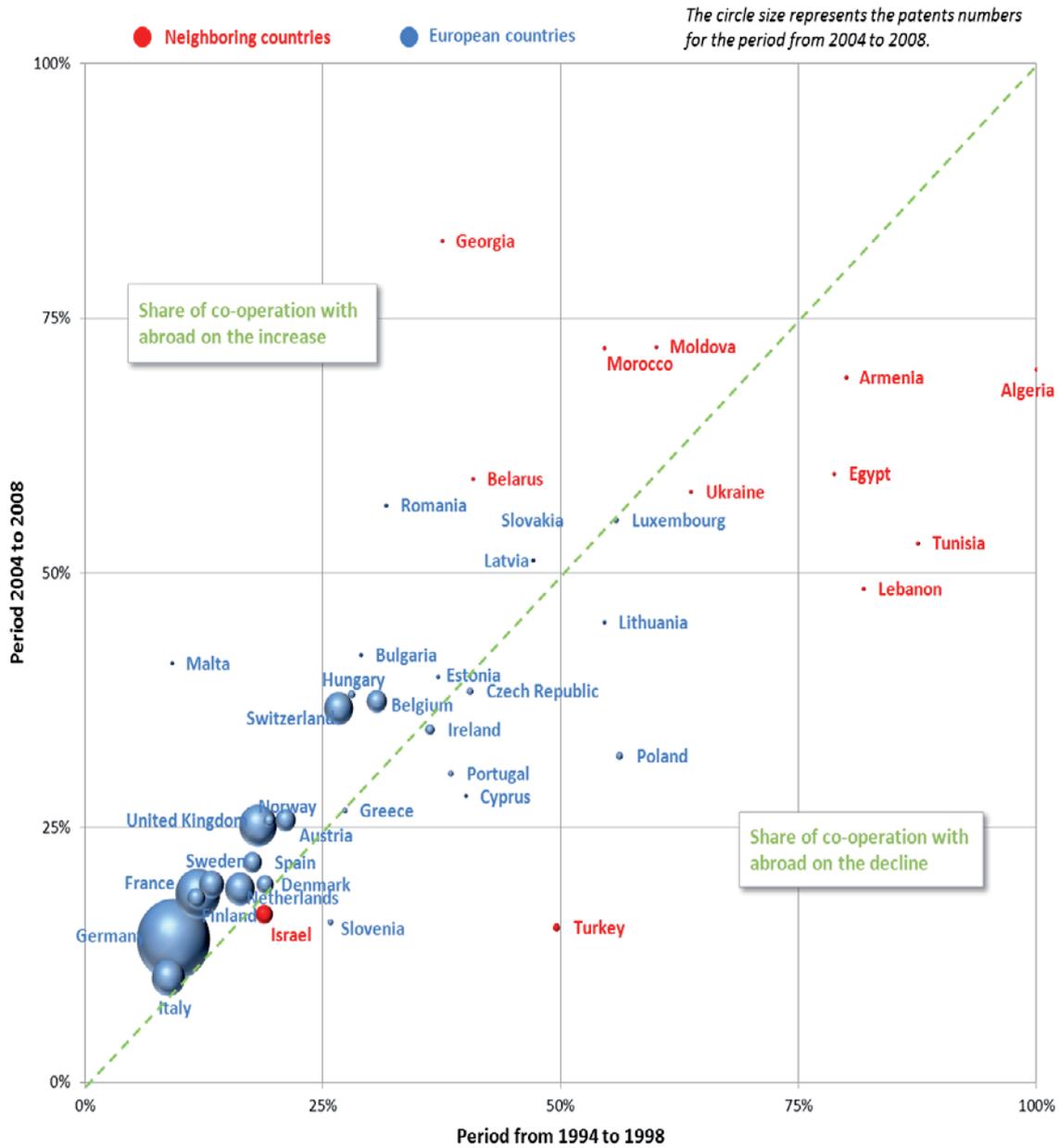
##### ***3.1.1 The propensity to co-patent with abroad depends on the level of technological potential***

For the period from 2004 to 2008, neighboring countries record the higher rates of EPO co-patents with abroad (figure 1). Conversely, the biggest patenting European countries have the lowest share of cooperation with abroad.

The figure 1 shows a well-known negative relation between the volume of technological activities and the share of external cooperation. Indeed, the lower the technological potential of a territory, the higher its share of external cooperation. A territory having few technological capabilities needs to cooperate more with other territories to capture and assimilate new knowledge. This is probably the case for almost all neighboring countries (except Israel and Turkey) and Eastern European countries for which the number of patents is low. Israel and Turkey have a cooperation rate similar to the biggest European Countries.

The evolution of abroad cooperation share between the period 1994 to 1998 and the period 2004 to 2008 is very different according neighboring countries. This share tends to increase for Georgia, Belarus, Morocco and Moldova and to decrease for Armenia, Algeria, Ukraine, Egypt, Tunisia, Lebanon and Turkey. For Israel, it remained stable. The position of Turkey is somehow specific as the external share was high between 1994 and 1998 but similar to the biggest patenting countries during the last period.

**Figure 1.** The share of cooperation with abroad in EPO patents for two periods: from 1994 to 1998 and from 2004 to 2008



Source: OCDE.StatExtracts

### ***3.1.2 The majority of neighboring countries are Europe-oriented in patent cooperation.***

A classification has been done to characterize countries according to their main partners over the period 2004-2008. The results point to various profiles among European countries and their neighborhoods (see table 1 in appendix).

The cartography (Figure 2) synthetizes the main profiles. It appears clearly that:

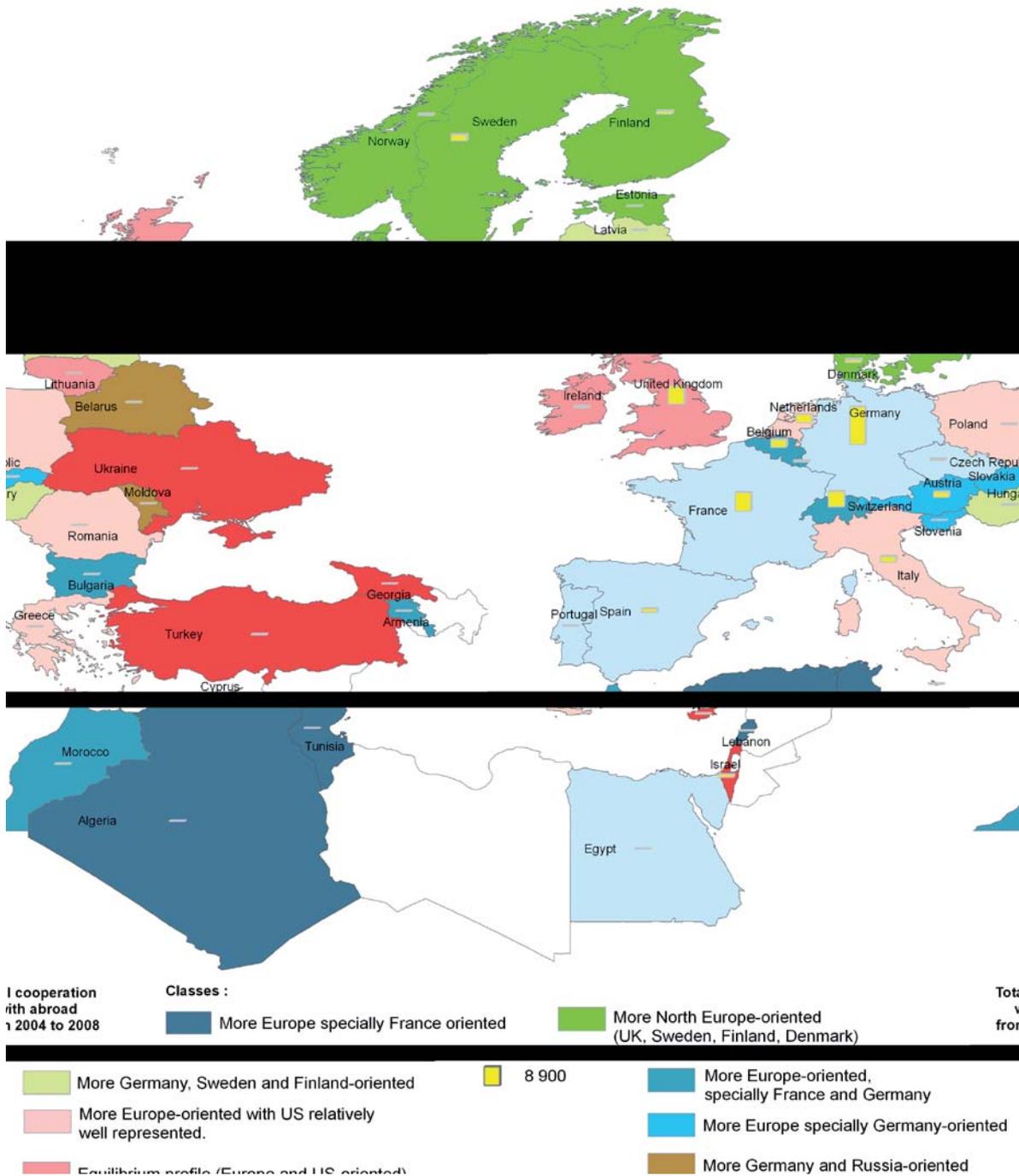
- The majority of neighboring countries are more Europe-oriented (in blue in figure 2), especially to those having the greatest number of patents. Their relationships with EU countries is however not uniform :
  - Some neighboring countries are strongly oriented towards France: Algeria, Tunisia, Lebanon
  - Others are strongly oriented towards Germany and France: Morocco and Armenia
  - While Egypt is oriented towards Germany, France and United Kingdom
  - And Belarus and Moldova towards both Germany and Russia.
- Only four neighboring countries are more US-oriented: Israel, Turkey, Georgia and Ukraine.

The importance of Europe in patent cooperation compared to the US can reflect the role played by the geographical distance first but also by the language and the historical relations between countries.

Among European countries, profiles are multiple too. The majority is more Europe-oriented. The differences are based on the level of the share of Europe, on the one hand, and the share of USA, on the other hand.

- Ireland, United Kingdom and Lithuania record the highest rate of cooperation with USA that can be explained for the two first countries by the proximity in terms of language.
- In the North of Europe, Scandinavian and Baltic states constitute a group in which countries copatent a lot between themselves. The United Kingdom is well represented too. The geographical proximity seems to play an obvious role in the geographical structuration of these cooperations.
- Others countries are more Europe-oriented due to the geographical proximity and cooperation opportunities created by the innovation potential of Europe. The share of USA is little more important for some countries like Italy, Greece, Romania, Poland, Belgium and the Netherlands.

**Figure 2.** Country profiles according to the distribution of patents by partner country for the period 2004-2008



**3.2 Co-authorship in scientific publications: a strong orientation of ENC towards Europe, probably due to both geographical, language and historical ties.**

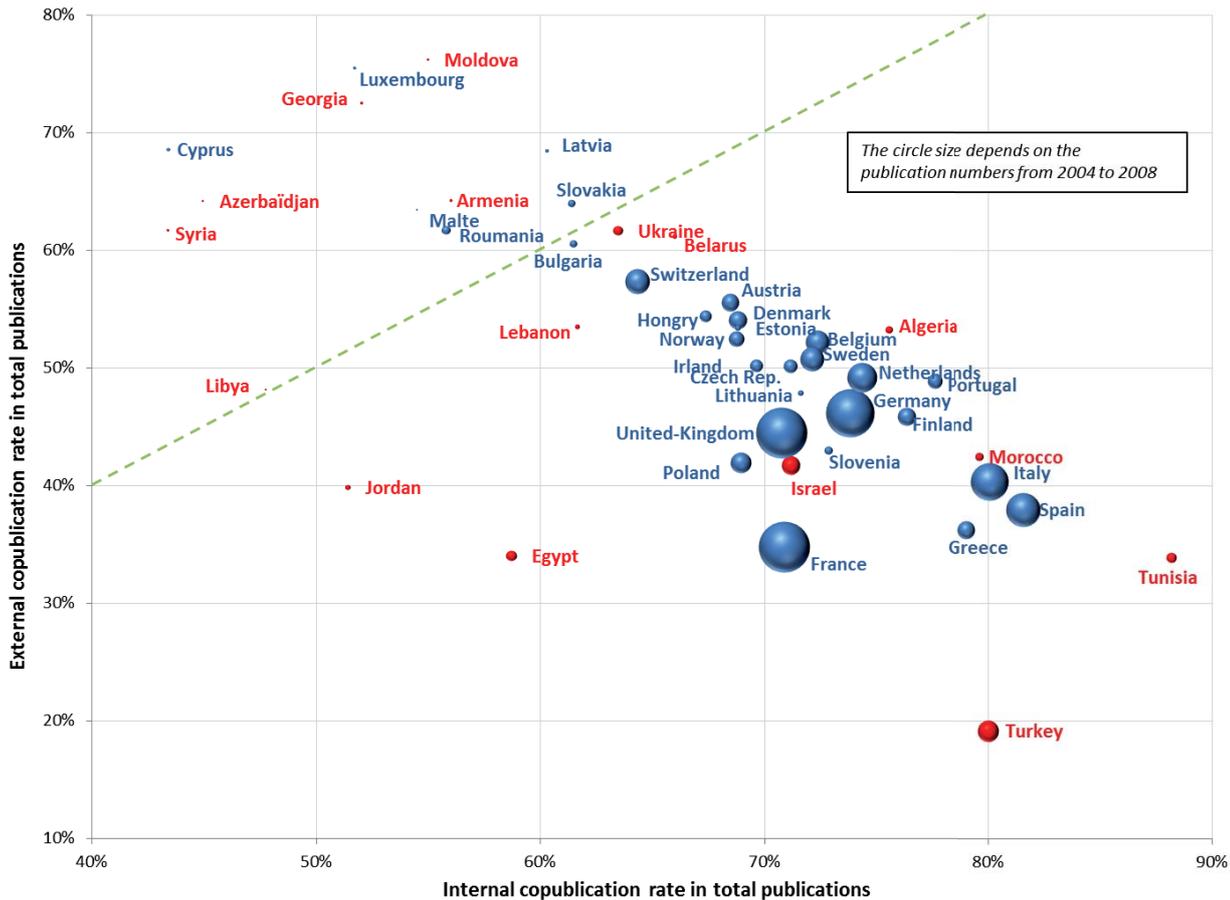
Like the previous section based on co-inventorship, the co-authorship analysis first emphasizes the propensity to cooperate with abroad (§ 3.2.1.), then it describes co-publications between European and neighboring countries (§ 3.2.2).

### ***3.2.1 Different profiles of neighboring countries in terms of propensity to co-publish with abroad***

The analysis of the propensity to co-publish with abroad (external copublication) compared to the propensity to co-publish with authors located in the same country (internal copublication) allows us to distinguish different groups among neighboring countries:

- Countries with low internal copublication and high external copublication rates: Georgia, Moldova, Azerbaïdjan, Armenia, Syria and Lybia. This group exhibits the typical profile of territories having a weak scientific potential. Indeed, these countries need to cooperate with abroad to access to new knowledge. These countries have a similar profile to the one of the following European countries: Luxembourg, Cyprus, Malta, Latvia, Romania and Slovakia.
- Countries with medium internal and external copublication weights: Ukraine, Belarus and Lebanon. These countries have a higher scientific potential than the previous group.
- Algeria, Morocco and Israel look like most of European countries with a high internal copublication rate and a medium external copublication rate. Thus, these countries combine both internal relationships which can be beneficial in terms of knowledge diffusion inside the country and external relations which allow them to access knowledge produced outside.
- Turkey and Tunisia have a specific profile given their level of scientific potential. The weight of their internal co-publication is very high while the weight of their external co-publications is low. To this regard, they might provide interesting opportunities of new collaborations to the EU countries.
- Jordan and Egypt record low rates for both internal and external copublications.

**Figure 3.** Internal and external copublication rates in total publications from 2004 to 2008



Source : Pascal Database (INIST-CNRS)

The sum of internal and external copublication rates in total publications is higher than 100% because a same copublication can associate authors located in the same country and authors located abroad.

### 3.2.2 A relatively high European orientation in copublication practices for a majority of neighboring countries

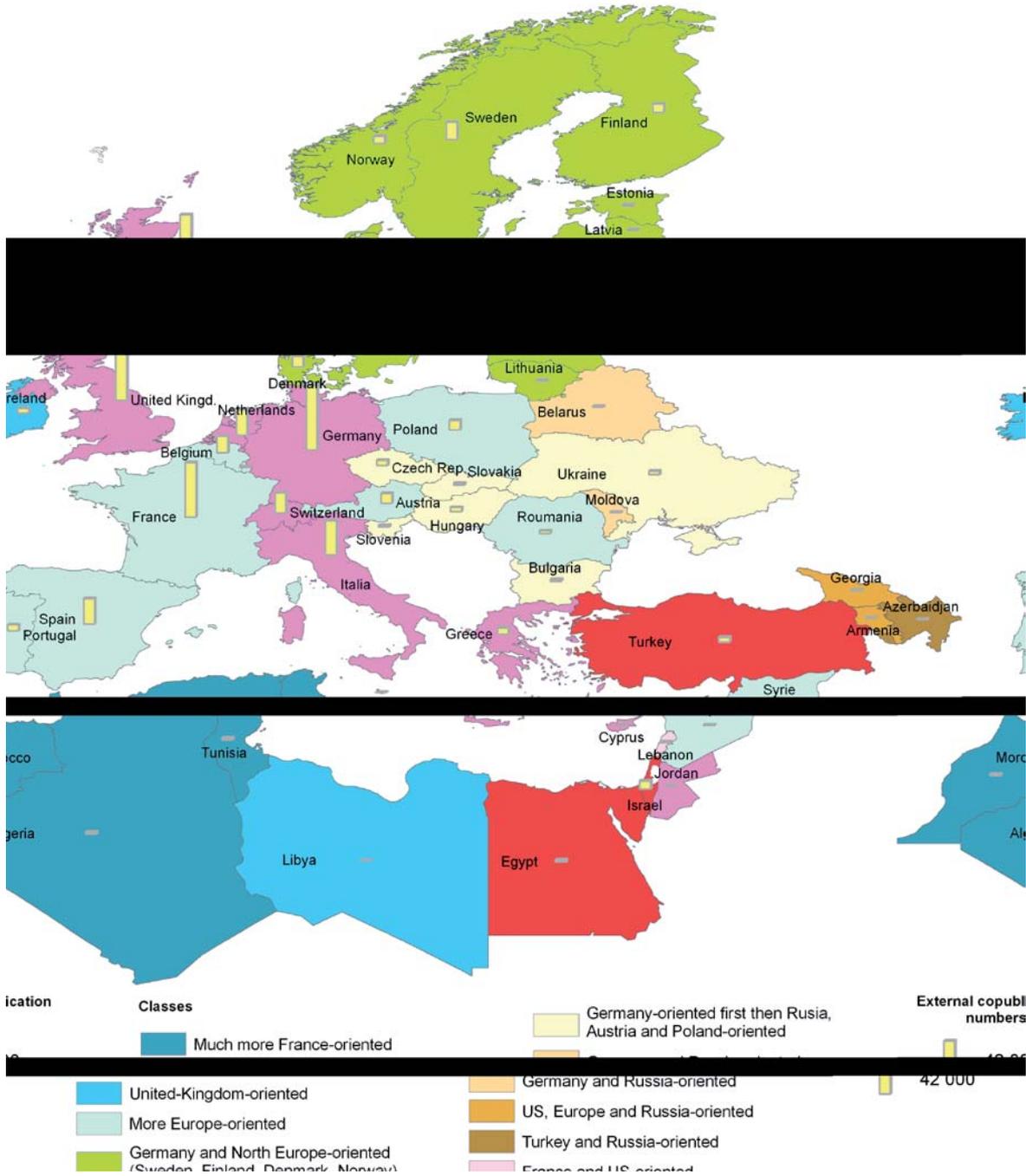
A classification has been developed to define country profiles according to their main partner in copublication activities for the period 2004-2008. According to this classification, different profiles exist among European countries and their neighbors (see table 2 in appendix).

The following cartography (figure 4) summarizes the main classes of profiles.

- 9 out of 16 neighboring countries are more Europe-oriented. Some differences are observed and seem to point out both geographical, historical and language dimensions in the collaboration architecture. 5 groups of countries can be distinguished :
  - A first group of countries is strongly linked with France (in dark blue): Morocco, Algeria and Tunisia to a lesser extent Lebanon.

- A second group mainly collaborates with United-Kingdom (in blue). Libya belongs to this group, together with Malta and Ireland.
  - Ukraine is also the only neighboring country of its class (in pale yellow), which contains 5 Eastern European countries. This group is mainly oriented towards Germany (and Russia, Austria and Poland at second step)
  - The fourth group is oriented towards Germany but also Russia (in pale orange) : Belarus and Moldova (alone in this class)
  - Finally, Syria does not exhibit any favored EU country for its collaborations. It therefore belongs to a group gathering 7 European countries (in pale blue).
- Contrary to previous countries, few are much more US-oriented (in red): mainly Israel and Turkey, then Egypt. Thus, the first and the third countries having already close ties with the US based especially on military cooperation, have also close ties in terms of scientific cooperation. None of the European countries is in this class.
  - Other countries have a balanced profile with a relatively good representation of USA and European countries (in pink). Jordan is in this case together with 7 European countries. The profile is balanced for Armenia and Georgia too (in orange) but with Russia also well represented.
  - Azerbaidjan has a very specific profile with Turkey and Russia as main partners.

**Figure 4.** Country profiles according to the distribution of publications by partner country for the period 2004 - 2008



### 3.3 R&D collaborations in FP

R&D collaborations are observed from Framework Programme (FP) projects. As the FPs are a European policy tool oriented mainly towards EU countries, the analysis slightly differs from the analysis developed in the previous sections.

The participation density (number of participations per 100 000 inhabitants) is first analyzed (§ 3.3.1.) before describing the geographical structuration of participation (§ 3.3.2.).

### ***3.3.1 Among ENC, only Israel records a participation density in FP5 and FP6 similar to European countries***

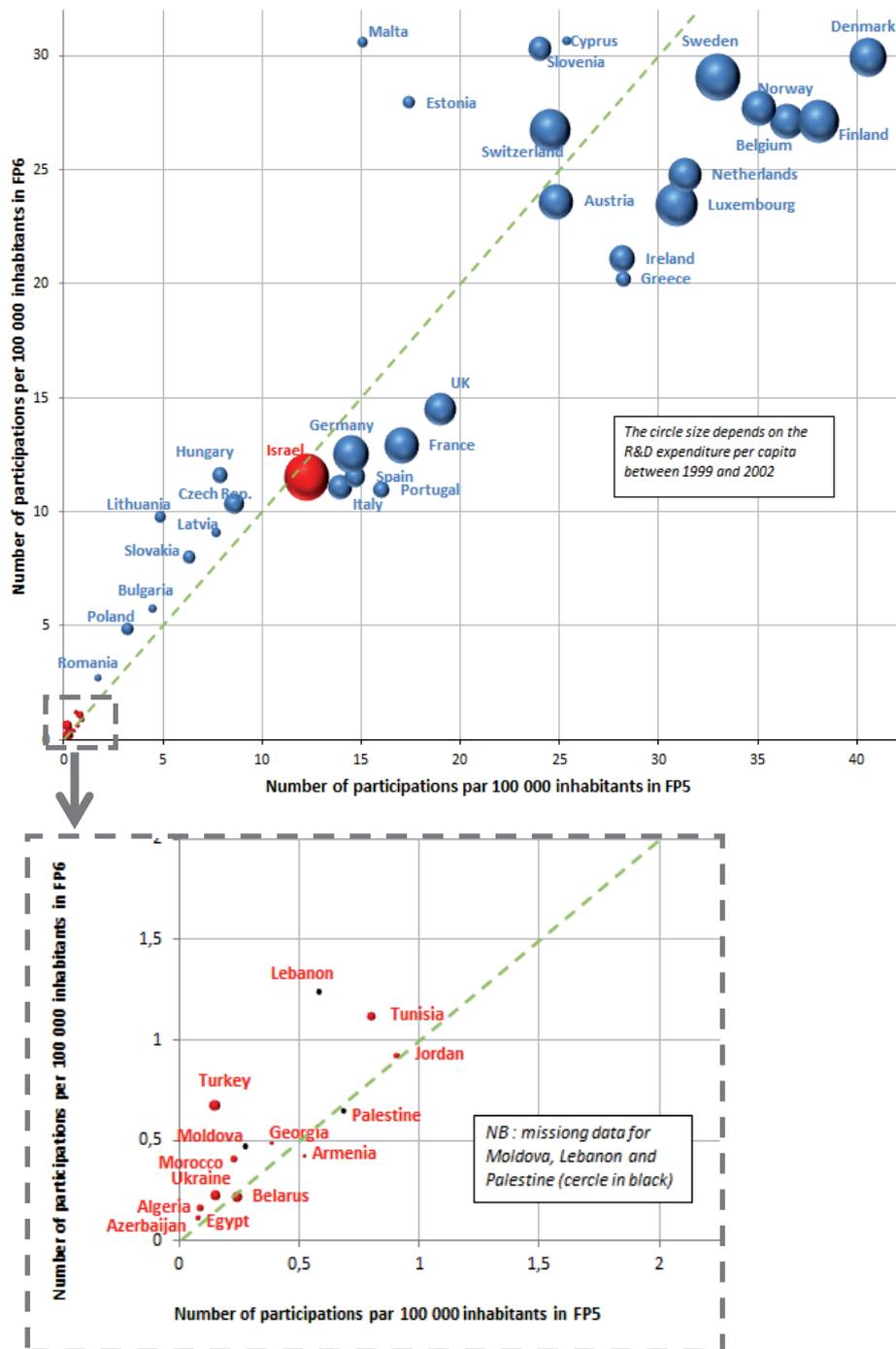
Not surprisingly, all ENC are much less involved in FPs than EU countries (figure 5). There is nevertheless one noticeable exception with Israel.

We can also observe that ENC share similar features with Eastern EU countries:

- Their level of R&D intensity is low, but they tend to increase their participation within FPs.
- Lebanon, Tunisia and Jordan perform best, confirming their European orientation.

Morocco, Algeria, Belarus and Moldova which have a strong orientation towards Europe both in scientific and technological cooperation, record however a weak participation density in FP.

**Figure 5.** Participation density in FP5 and FP6 and R&D expenditure



Source: PCRDT French Research Ministry - EuroLIO

### ***3.3.2 A mostly homogenous geographical distribution of partner countries for ENC***

In order to characterize the partners of ENC within FPs, the classification below (figure 6) has been done with the respective shares of West European countries, East European countries, Russia, North Africa and Middle-East in the cooperation distribution.

This classification concerns neighboring countries only in order to focus on their specificities and to get more accurate information on the geographical dimension of their partnership. European countries are excluded because the geographical repartition of participations is different. For EU and ENC, European countries are, of course, the most representative as FPs focus on them. The difference is based on the rank of neighboring countries. Indeed, in the ranking of partner countries for all EU, neighboring countries are placed far away: the first ENC is Morocco at the 41th rank. These last are better placed in the ranking for ENC: before the 40<sup>th</sup> position for a lot of them. Morocco, Tunisia and Turkey are even placed in the 20 most important partner countries. Given this strong difference in the ranking between EU and ENC, it was not possible to represent in the figure below the distribution of participations for both EU and ENC countries. Hence, the weight of neighboring countries in the participations of ENC is relatively high. This result shows that when a neighboring country participates to a project, there is often another close neighboring country which is associated.

Three country profiles can be distinguished:

- Israel is alone in a class. This country is more West Europe-oriented. ENC are weakly represented in its participations to FP projects.
- 7 countries are more East Europe- and Russia- oriented: Turkey, Ukraine, Armenia, Belarus, Georgia, Molodva and Azerbaidjan. The geographical and probably cultural and language proximities play a role.
- 8 countries are more North Africa and Middle-East oriented. Not surprisingly, this group includes: Palestine, Morocco, Egypt, Tunisia, Jordan, Algeria, Lebanon and Syria.

**Figure 6.** Participation distribution for neighbouring countries in FP6



Source: PCRDT French Research Ministry - EuroLIO

The total represents the overall distribution calculated from data concerning neighboring AND European countries.

**Legend :**

In red : the share of the partner country is very well represented (specialization index higher than 2)

In orange : the share of the partner country is well represented (specialization index higher than 1)

In blue : the share of the partner country is not well represented (specialization index less than 1)

### **3.4 Intellectual Property relationships are very different in terms of geographical dimension compared to technological and scientific cooperation**

The objective of this section is to observe in which external office, patents are filed by neighboring countries.

First of all, the analysis consists in comparing the share of the National office in patent applications and thus in observing the countries openness in terms of intellectual property protection (§ 3.4.1). Then, the aim is to assess whether countries are more Europe-oriented in terms of patent applications or more oriented towards other countries or group of countries like USA, Asia, Russia etc (§ 3.4.2.).

#### ***3.4.1 An essentially national protection of intellectual property for a lot of neighboring countries***

For a majority of neighboring countries, patents are almost all filed in the National office (figure 7). It is the case for Georgia, Algeria, Armenia, Morocco, Egypt, Belarus and Ukraine. For the period from 1995 to 1998, the share of the National office was 100% (except for Algeria and Morocco). This share is declining in the second period (2007-2010), revealing a larger geographical coverage of intellectual property protection. In the EU, Romania and Poland look like these neighboring countries.

For Turkey and Azerbaijan, the National office also represents a large share (77% and 68% from 2007 to 2010) and is decreasing.

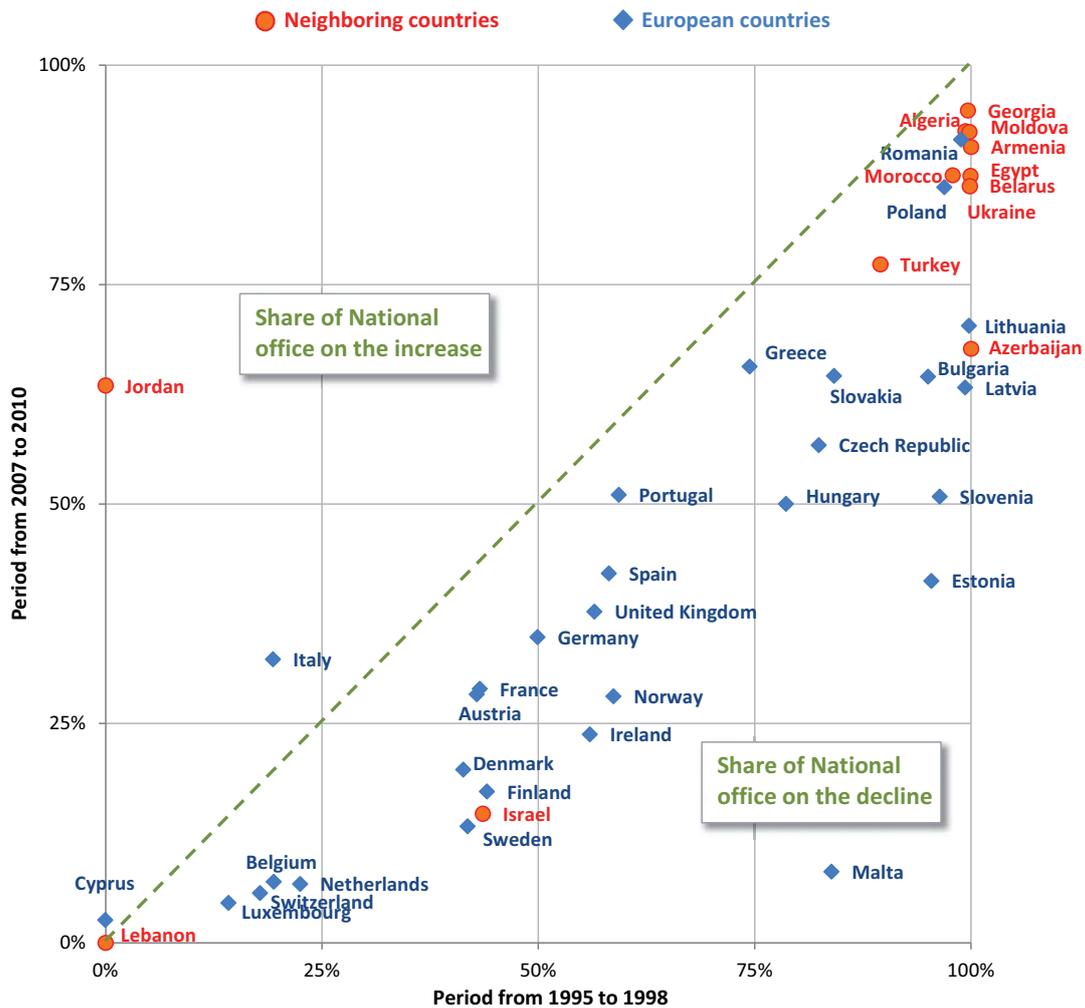
Lebanon is specific because none of its patents is filed in the National office for the two periods.

Jordan is specific too. Indeed, the share of National office has increased a lot between these two periods: from 0% to 64%.

Israel looks like the main European countries. The share of National office was 44% for the period 1995 to 1998 and has decreased to 15% as we move to the period 2007 to 2010. The most similar countries in EU are Denmark, Finland and Sweden.

No data is presented for Tunisia, Libya and Syria due to missing observations for patents filed in the National Office for the second period.

**Figure 7.** Evolution of the share of patents filed in National office by country



Source : WIPO Statistics Database, december 2011. Note: Counts are based on the patent filing date. Country of origin is the residence of the first-named applicant (or assignee).

Tunisia, Libya and Syria are missing because of missing values for the period 2007 – 2010.

**3.4.2 Few neighboring countries are really Europe-oriented in terms of intellectual property protection**

A classification is suggested in order to characterize each country according to the offices where patents are filed for the period 2007-2010. Only the main offices have been considered for this classification. The results obtained point out a variety of country profiles among neighboring countries (see table 3 in appendix).

The following cartography (figure 8) gives the main classes of countries. The classification has been essentially built from the distribution of patents according to three offices or groups of offices:

- EPO : European Patent Office

- USPTO: US Patent Office
- several Asian countries : China, Hong Kong SAR, India, Singapore, Viet Nam, Malaisie, Republic of Korea, Japan.

More detailed statistics are given in table 3.

The main insights are the followings:

- European countries, which generally have the greatest number of granted patents, exhibit :
  - either a **balanced profile** (in pale blue) : the shares of EPO, USA and Asian countries are very similar). This group includes: Portugal, Spain, France, Italy, Belgium, Denmark, Germany and Austria. This last country is a little specific with a relatively high share of patents in Germany.
  - or a more **Europe and Asia-oriented** profile (in blue) : the Netherlands, Switzerland, Cyprus, Luxembourg and Malta. Cyprus and Malta are slightly different with a relatively high share of patents respectively in Russia and in Germany.
  - or a more **USA and Asia** oriented profile (in orange): essentially countries in the North of Europe (United Kingdom, Ireland, Norway, Sweden and Finland) and Hungary.

None of the neighboring countries integrate these classes.

- The **more Europe-oriented neighboring countries are Algeria and Turkey** (in dark blue). The share of EPO patents is higher (respectively 38% and 42%) than for US and Asian countries. Among European countries, Latvia, Poland and Slovenia are relatively similar. For Algeria, France (15%) and United Kingdom (8%) are also well represented (see table 3).
- The **Eastern neighboring countries are more Asia and Russia-oriented** (in green) like Belarus, Moldova, Azebaidjan and Armenia or **especially more Russian** oriented like Ukraine. None of the European countries looks like them.
- **Some neighboring countries are more US-oriented** (in pale pink) like Morocco, Tunisia and Jordan. Nevertheless, for the two first countries, France is relatively well represented. Within the EU, the countries with a high share of USPTO patents are: Estonia, Lithuania, Czech Republic and Slovakia.
- Some countries are **much more US-oriented** (in red; USA represent more than 50% of patents applications): Egypt, Israel, Lebanon, Georgia and within the EU Romania and Bulgaria.
- **Lybia and Syria are very specific.** In Lybia (with only 6 patents), Germany is the most represented. In Syria (20 patents), patents are essentially filed in Egypt and Saudi Arabia.

These results are very different from those obtained with technological and scientific cooperation. In terms of intellectual protection, neighboring countries are more often US-oriented. Geographical proximity, language and historical ties seem less important than for scientific and technological relationships. Indeed, most of the countries which appeared as strongly related to the EU based on co-patenting and co-authorship are no longer Europe-oriented when intellectual protection is accounted for (Morocco, Tunisia, Egypt, Lebanon, and Armenia). Conversely, Turkey is much more US-oriented for cooperation than for intellectual property. Georgia and Israel remain US-oriented while Belarus and Moldova still appear Russia-oriented and cooperate a lot with Germany too. Compared to cooperation dynamics, the intellectual protection is more in the downstream phase of the research and innovation process and it is closely related to markets and exports dynamics which follow a different logic in terms of geographical dimension. Indeed, the geography of production and exports activities is less concentrated than one observed for scientific and technological collaborations (Peri, 2005).



The analysis of students' mobility and more precisely their countries of origin gives several country profiles which are different from those resulting from publications, patents, R&D and intellectual protection data. The geographical pattern strongly differs, pointing to different determinants of human capital flows compared to other knowledge flows.

It is worth noticing that none of the neighboring countries records a significant share of students from Europe only (figure 9). In some ENC, Europe can be over represented but with Asia. This is the case for Moldova and Belarus. In most ENC, other parts of the world are more represented. For instance, Asia only is over represented in the flows of foreign students of Armenia and Turkey while it is over represented together with other parts of the world in Azerbaidjan, Jordan, Georgia and Ukraine.

In addition, Africa is very more represented in Morocco.

Geographical proximity, especially the location in the same continent which leads to a cultural and often linguistic proximity, tends to play a greater part on student's mobility whereas scientific and technologic potentials seem to rely on other mechanisms of diffusion like commercial and historical relationships.

Figure 9. Origin of students by country

		Origin of students							Students numbers coming from outside
		Europe	Africa	Asia	North America, Central America and Caribbean	South America	Oceania		
<b>Europe very over represented</b>	Slovenia	95%	1%	3%	0%	1%		1613	
	Czech Republic	87%	2%	10%	1%	1%	0%	30483	
	Slovakia	87%	1%	11%	1%	0%		6311	
	Luxembourg	84%	8%	4%	1%	1%		1316	
	Estonia	84%	2%	10%	2%	0%		1087	
	Lithuania	84%	1%	13%	1%	0%	0%	2824	
<b>Europe over represented</b>	Austria	83%	2%	13%	2%	1%	0%	59617	
	Netherlands	81%	2%	13%	1%	2%	0%	23354	
	Denmark	76%	3%	18%	2%		0%	12278	
	Latvia	76%	1%	22%	1%	0%	0%	1586	
	Hungary	76%	3%	19%	3%	0%	0%	14518	
	Switzerland	74%	6%	11%	4%	4%	0%	33438	
	Belgium	74%	11%	11%	2%	2%	0%	13957	
	Poland	68%	5%	19%	8%	1%	0%	16863	
	Romania	59%	19%	21%	1%	0%	0%	10353	
	Italy	58%	12%	20%	2%	8%	0%	64066	
	Norway	56%	14%	23%	4%	2%	0%	13219	
	Malta	54%	14%	27%	4%	1%	1%	449	
<b>Europe and Asia over represented</b>	Moldova	55%	3%	43%	0%			1461	
	Belarus	55%	3%	42%		0%		5907	
	Bulgaria	51%	1%	46%	2%	0%	0%	9423	
	Germany	48%	10%	36%	3%	3%	0%	181946	
<b>Asia over represented</b>	Finland	40%	19%	35%	3%	1%	0%	12568	
	Armenia	34%	0%	66%				4149	
	United Kingdom	33%	10%	49%	7%	1%	1%	361504	
	Sweden	32%	8%	53%	4%	2%	0%	20576	
	Greece	32%	4%	62%	1%	0%	0%	20991	
	Turkey	29%	3%	67%	0%	0%	0%	18697	
<b>North and Central America very over represented</b>	Ireland	39%	6%	29%	25%	1%	1%	12937	
<b>South America very more represented (+ africa for Portugal)</b>	Spain	32%	11%	4%	13%	41%	0%	47488	
	Portugal	20%	47%	4%	2%	27%	0%	9128	
<b>Africa very more represented</b>	Morocco	1%	83%	13%	0%	0%	0%	7247	
	France	22%	46%	24%	4%	4%	0%	233785	
<b>Asia very more represented</b>	Azerbaijan	4%	1%	95%	0%			6316	
	Jordan	1%	6%	91%	1%	0%	0%	27157	
	Georgia	21%	0%	79%				480	
	Cyprus	17%	8%	76%	0%	0%		9779	
	Ukraine	23%	6%	71%				25795	

Source :UNESCO

### 3.6 Synthesis

The degree of European orientation for neighboring countries is very different according to the type of cooperation (figure 10). The share of Europe is the highest for scientific co-authorship, then for technological cooperation measured by co-inventorship. For these collaborations, European countries given their public and private research potential on the one hand, and higher physical proximity than USA on the other hand, can offer large cooperation opportunities for neighboring countries. These collaborations build upon historical and commercial linkages, and are favored by common languages.

For intellectual property that is to say the nationality of offices where patents are filled, the geographic dimension plays a lesser part than for the above mentioned collaborations. Europe is therefore less central. For student's mobility, the origin of student is mainly determined by the continent where the country is located.

The closest neighboring countries to the Europe considering these different dimensions seem to be: Algeria, Tunisia, Morocco and Lebanon. Conversely, the farthest countries are Azerbaidjan, Jordan and Israel.

R&D cooperations (FP) follow a rather similar pattern, except for Turkey and Israel which are strongly embedded in FP networks.

**Figure 10.** The European orientation degree of neighbouring countries according to the type of cooperation

	Scientific cooperations	Technological cooperations	Intellectual Property	Students mobility	FP6 participations
Algeria	++	++	+		+ (566)
Tunisia	++	++	-		++ (874)
Morocco	++	++	-	--	++ (1071)
Lebanon	++	++	-		+ (388)
Libya	+		+		
Armenia	+	++	--	-	- (161)
Belarus	+	+	--	+	+ (348)
Moldova	+	+	--	+	- (224)
Ukraine	+	-	--	--	++ (1030)
Syrie	+		-		- (196)
Georgia	+	--	--	--	- (234)
Turkey	-	-	+*	-	+++ (3449)
Egypt	-	+	--		+ (681)
Israel	-	-	--		+++ (4541)
Jordan	-		-	--	+ (396)
Azerbaijan	-		--	--	-- (97)

**Legend for scientific, technological cooperations, intellectual property and students mobility**

	scientific, technological cooperations, intellectual property and students mobility	PF6 Participations
+++		More than 3000
++	More than 75%	From 800 to 1 100
+	Between 50% and 75%	From 300 to 800
+*	Between 40% and 50% but well represented (index specialization superior to 1)	
-	Between 25% and 50%	From 100 to 300
--	Less than 25%	Less than 100

Source : Pascal database (INIST-CNRS) for scientific cooperations (the weight of Europe in copublications), WIPO Statistics Database for Intellectual Property (share of patent in EPO or in European National Offices), OCDE.StatExtracts for technological cooperations (the weight of European Union in copatent), UNESCO for student mobility. French Ministry of Research for FP participation.

#### **4. KNOWLEDGE NETWORK STRUCTURE BETWEEN EU AND ENC**

Beyond bilateral collaborations, individuals' position within the network as well as the overall network architecture are acknowledged as a key determinants of knowledge diffusion. This section investigates the main features of co-inventor network, co-author network and R&D collaboration network.

##### **4.1 Co-inventor network between European and neighboring countries is mainly structured around 5 countries: Israel, Turkey, Ukraine, Egypt and Belarus**

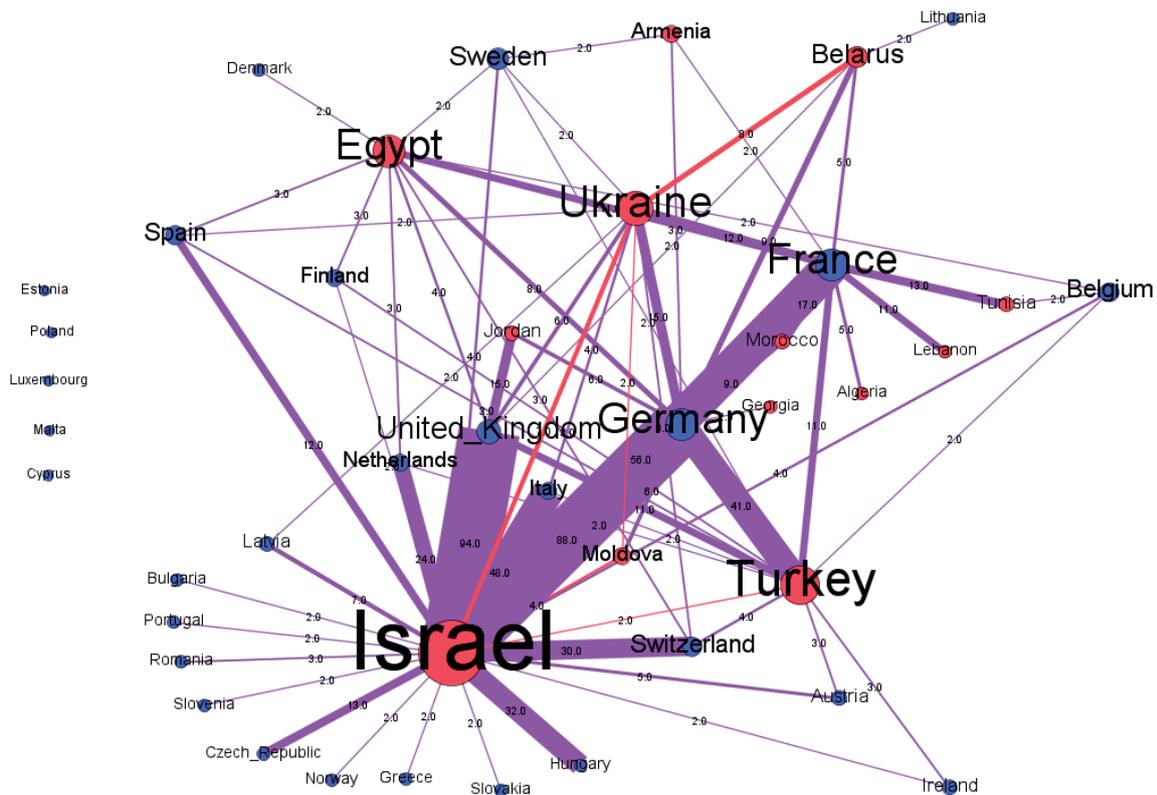
The graph built from co-inventorship (figure 11) between neighboring countries on the one hand, and between ENC and European countries on the other hand, allows observing the position of countries in the network. Figure 11 represents relationships between neighboring and European countries and between neighboring countries superior to 1 only. Relations between European countries are not represented for a best visualization of cooperation between neighboring and European countries.

The graph shows that cooperation mainly occurs between ENC and EU. Very few relations superior to 1 exist between ENC (ties in red). Indeed, inter-ENC ties are observed only between:

- Israel on the one hand and Ukraine, Turkey and Moldova on the other hand,
- Ukraine on the one hand, and Moldova and Belarus, on the other hand,

Among ENC, Israel holds a central position then to a lesser extend Turkey, Ukraine, Egypt and Belarus. Among the EU, France, Germany and then United-Kingdom, Sweden and Spain are central in cooperation relationships with ENC.

**Figure 11.** Patent Cooperation with European Countries involving neighboring countries from 2004 to 2008 (tie number >1)



Source: OCDE.StatExtracts

**Legend:**

The node size depends on the degree of countries that is to say the number of countries the country is related to.  
 Red nodes: neighboring countries; blue nodes: European countries.

**4.2 Co-authorship between European and neighboring countries are mainly structured around 3 countries: Israel, Turkey and Ukraine**

The network structure for copublications is slightly different (figure 12).

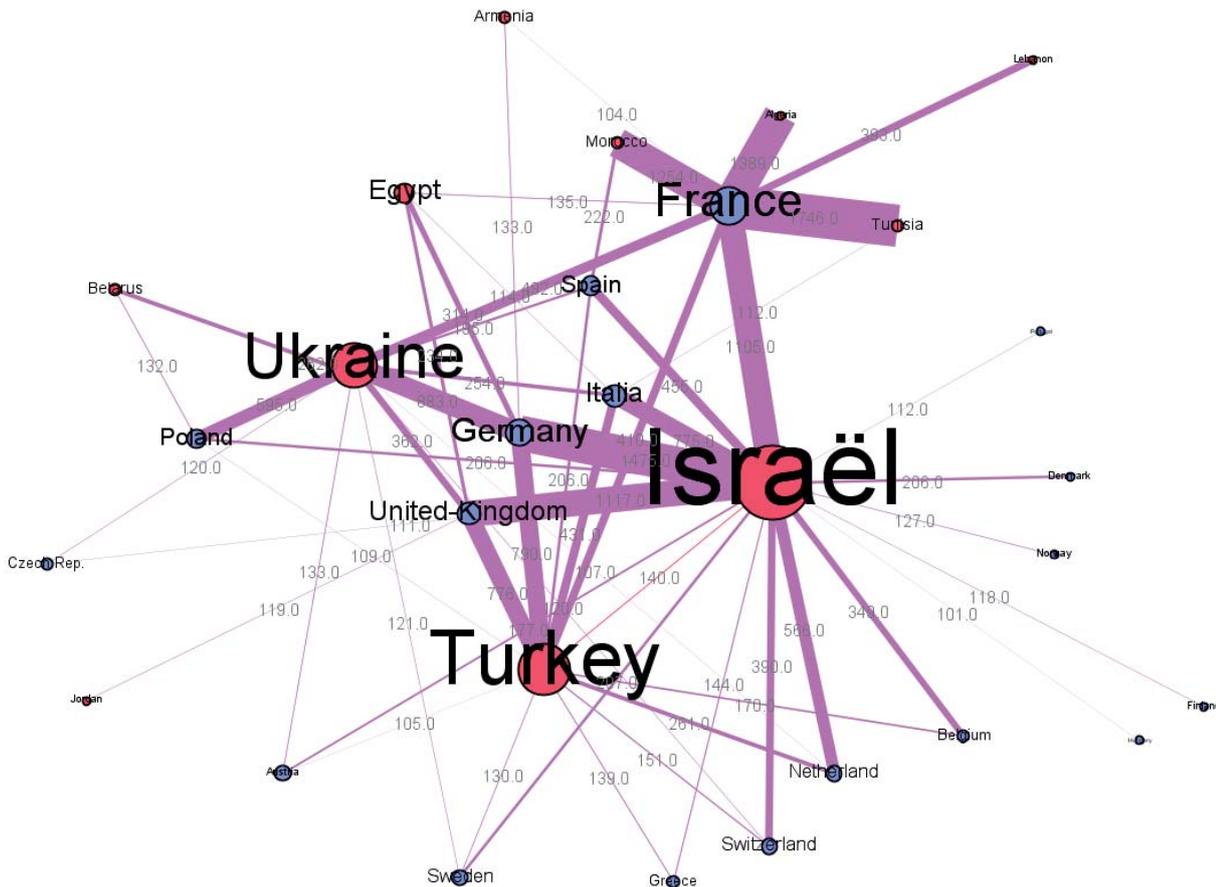
Like co-patent, scientific cooperation between neighboring countries is rare. The most important relations are observed between:

- Belarus and Ukraine : 262 copublications
- Israel and Turkey : 140 copublications
- Azerbaidjan and Turkey : 95 copublications
- Israel and Ukraine : 69 copublications
- Morocco and Tunisia : 66 copublications.

Among ENC, Israel is again the most central neighboring country in the network. Turkey and Ukraine have a central position two.

France, Germany, United-Kingdom and to a lesser extent Italia are central in the network of copublications involving neighboring and European countries.

**Figure 12.** Publication cooperation with European Countries involving neighboring countries from 2004 to 2008 (tie number >100)



Source: Pascal database (INIST-CNRS)

Legend:

The nodes' size depends on the degree of country that is to say the number of countries the country is related to.

Red nodes: neighboring countries; blue nodes: European countries.

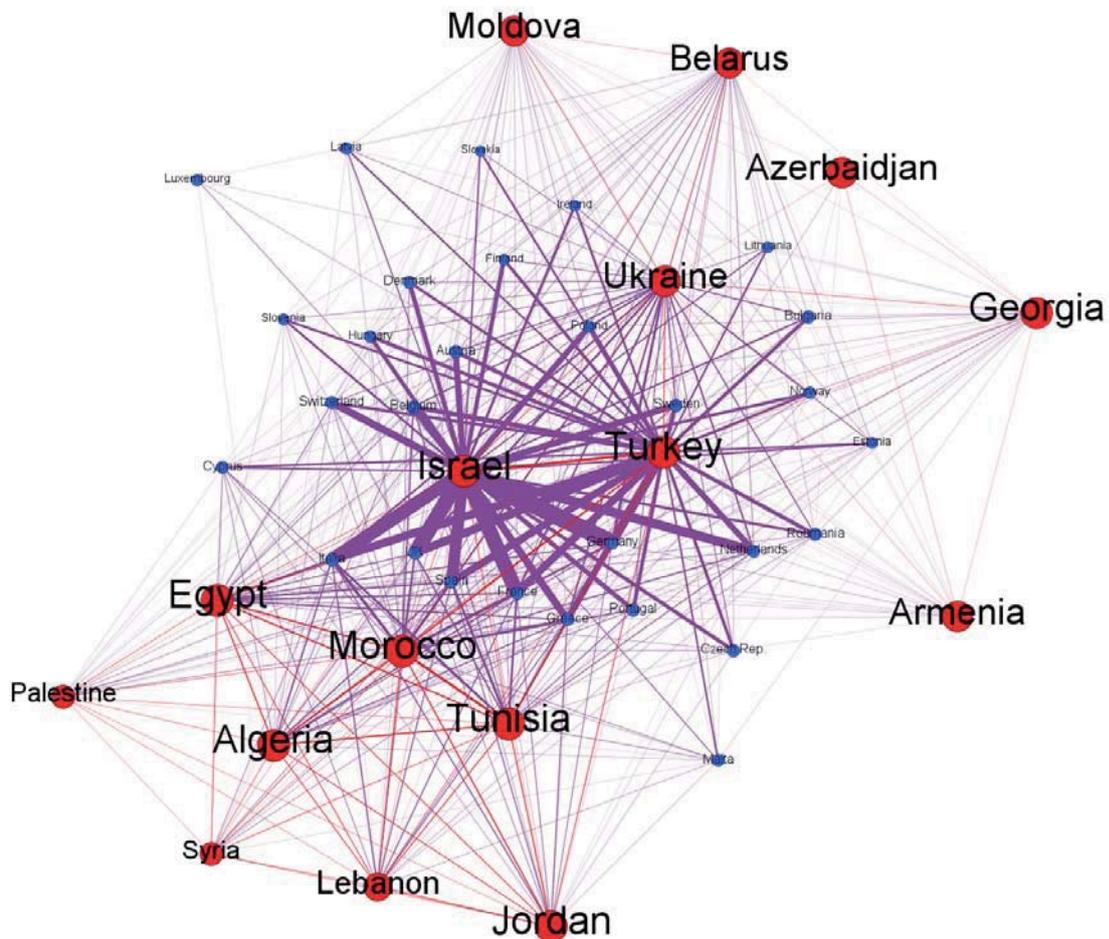
### 4.3 A more homogenous network for R&D collaborations of ENC in FP projects

In FP6, there is a lower heterogeneity among ENC in the network as each ENC cooperates with a lot of countries (figure 13). Some countries with less participation collaborate with as many countries as Israel.

This result is due to the fact that the Framework Programme consists in developing cooperation between several countries. Nevertheless, Israel and Turkey have a more central position given their participation number. As we observe before in § 3.3.2., ENC are connected to European countries as well as to other ENC. Therefore, when a ENC cooperate in a project, it seems that

there is finally a larger impact on the development of relationships between neighbouring countries than between ENC and EU.

**Figure 13.** FP6 cooperation with European Countries involving neighboring countries (relation numbers >2)



Source: PCRDT French Research Ministry - EuroLIO

Legend:

The nodes' size depends on the degree of country that is to say the number of countries the country is related to.

Red nodes: neighboring countries; blue nodes: European countries.

To sum up, we can observe:

- Different network structures according to the indicator under study

- A weak connectivity between ENC countries in co-invention and co-authorship networks. France, Germany and UK play a central role in these knowledge networks linking EU with ENC.
- A stronger ENC connectivity in the FP network and lower heterogeneity among ENC.
- One common feature: Central position of Israel, Turkey, Ukraine, and to a lesser extent, Egypt.

## **5. EVOLUTION OF COLLABORATIONS BETWEEN EU AND ENC**

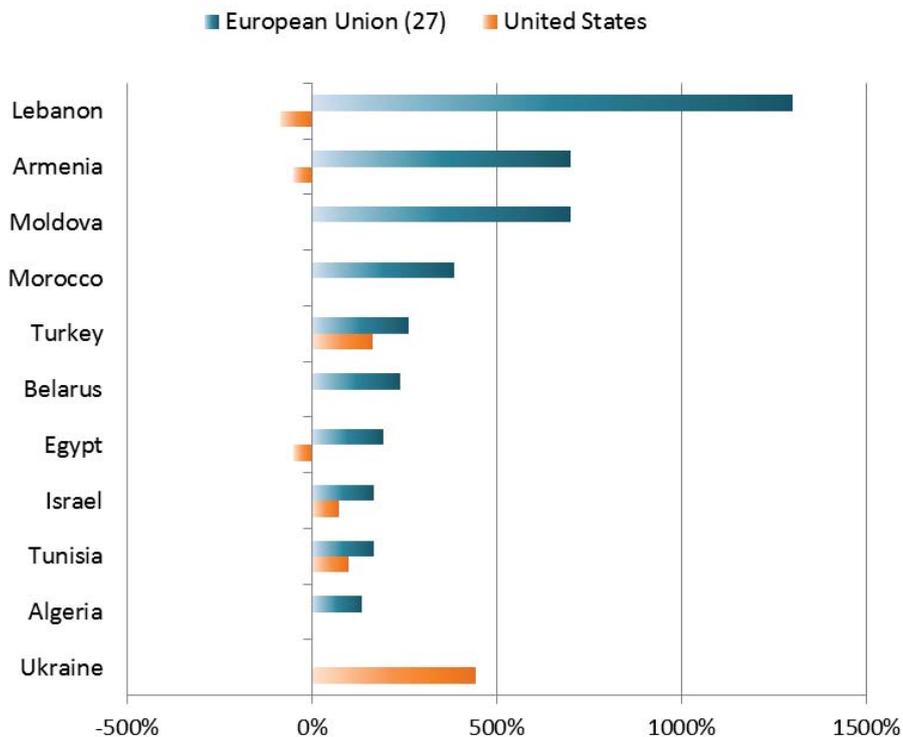
The aim of this part is to observe if there is a rise in knowledge diffusion between EU and ENC. Indeed, knowledge creation and diffusion is less and less the result of individual actions. Knowledge sharing and co-production of knowledge is rising dramatically in most countries as well as between countries (see Hagedoorn, 1996, Wagner and Leydersdorff, 2005). It is therefore very likely that collaboration of ENC intensifies over time. Is this increase also more oriented towards Europe? And is this increase homogenously distributed over ENC countries or do we observe a significant change in the knowledge network structure?

### **5.1 The evolution of collaboration intensity over time**

#### ***5.1.1 Co-inventorship with European Union on a steep growth in most neighboring countries***

For almost all neighboring countries, the growth of cooperation with European Union is very high and more important than the growth of cooperation with the US (figure 14). Cooperation with the US even tends to decrease in some countries like Lebanon, Armenia and Egypt. Only Ukraine records a higher growth rate towards the US than towards the EU.

**Figure 14.** Patent cooperation growth between 1994-98 and 2004-08 with European Union (27) and United States



*Growth rates for cooperation with USA have not been calculated for Morocco and Algeria (because of zero values for the 2 periods), for Moldova (because of zero values for the first period). For Georgia, there was 0 cooperation with USA and European Union for the first period. that's why this country doesn't appear on the figure.*

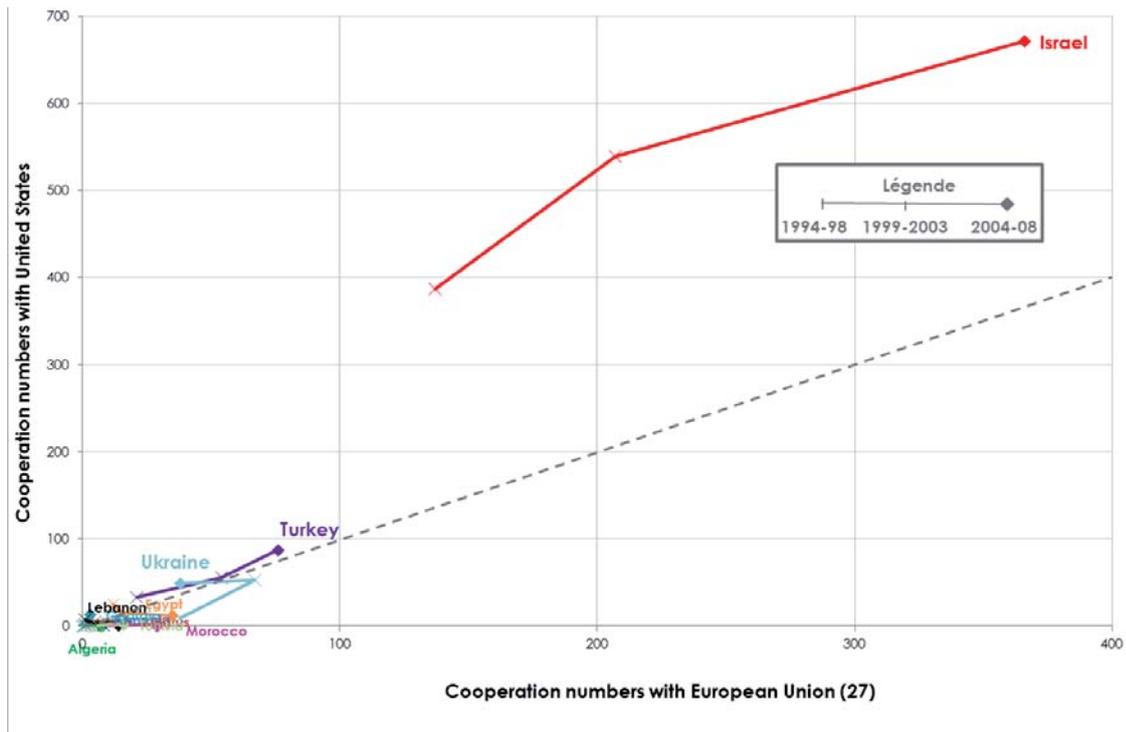
Source: OCDE.StatExtracts

Even though for Israel, the European Union growth rate is higher than the US one, this country is always much more US-oriented compared to other countries (figure 4). This observation is the same for Turkey but the gap between the share of US cooperation and the share of EU one is far less important.

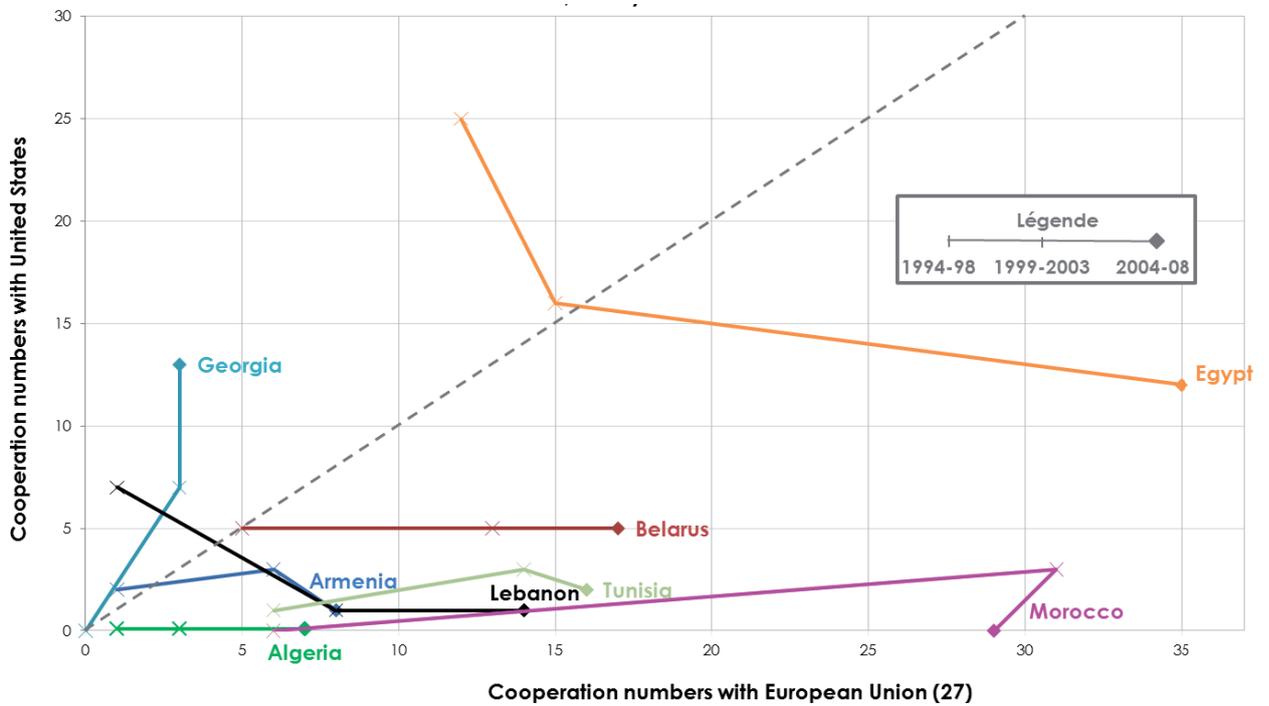
For almost all other countries, the level of cooperation with the European Union increases a lot and the US cooperation remains relatively stable or decrease. This is the case for Algeria, Armenia, Lebanon, Tunisia, Belarus, Morocco and Egypt.

Cooperation with the European Union has decreased between the two last periods for Ukraine only. For Georgia, cooperation with the European Union has increased but less rapidly than with the US.

**Figure 15.** Evolution of cooperation in EPO patents with the European Union and the United States



**Figure 16.** Evolution of cooperation in EPO patents with the European Union and the United States in EPO patents (without Israel, Turkey and Ukraine)

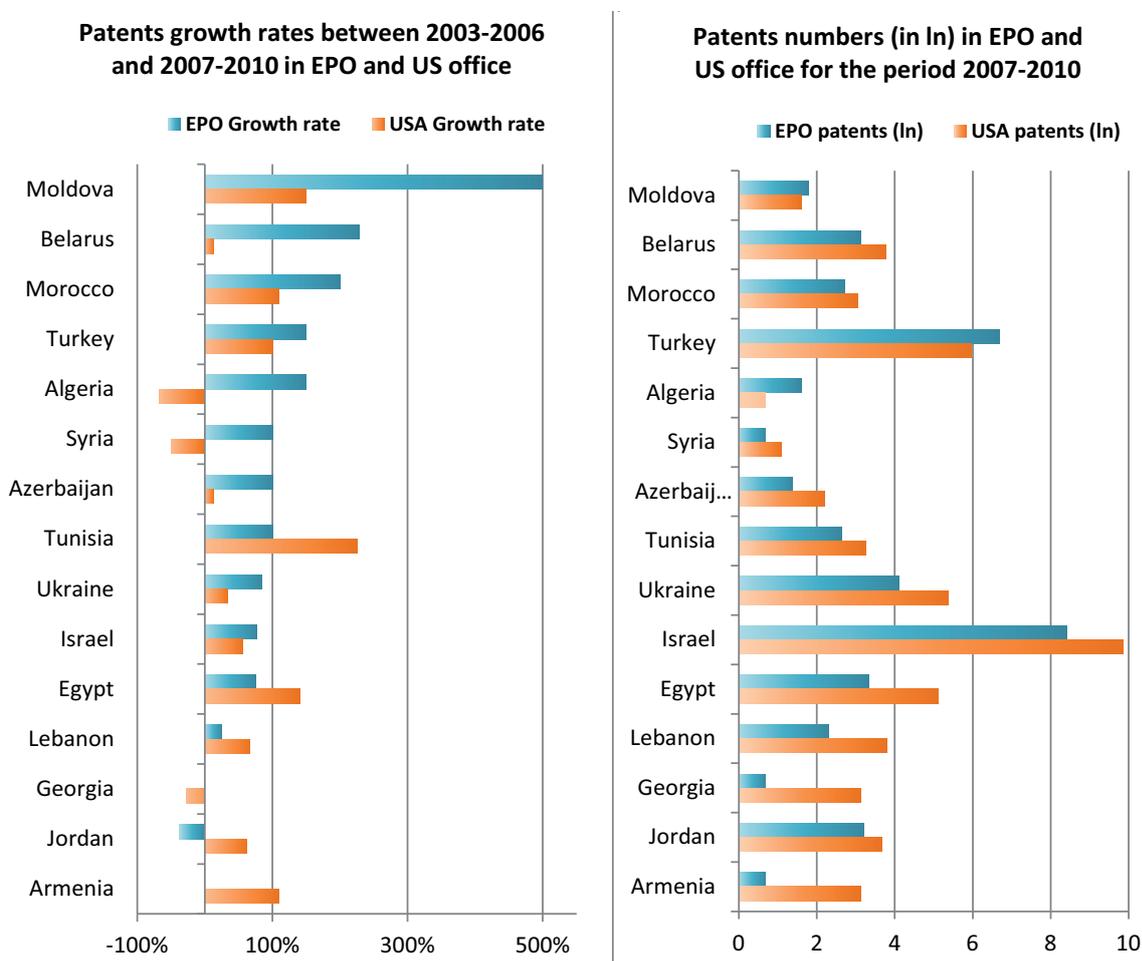


Source: OCDE.StatExtracts

### 5.1.2 Patents filed at EPO on a steep growth in most of neighboring countries

For a lot of neighboring countries, the growth rate of EPO patents between the period 2003-2006 and the period 2007-2010 is very high (more of 50%). For Moldova, Belarus, Morocco, Turkey, Algeria, Syria, Azerbaijan and Ukraine, it is clearly superior to growth rate recorded for patents filed at the USPTO. Nevertheless, for most of countries, the number of patents filed at EPO is lower than the number of patents filed at the USPTO (except for Moldova, Turkey and Algeria). These high rates of growth towards Europe therefore point to a “catch-up” effect reducing the gap between EPO and USA offices.

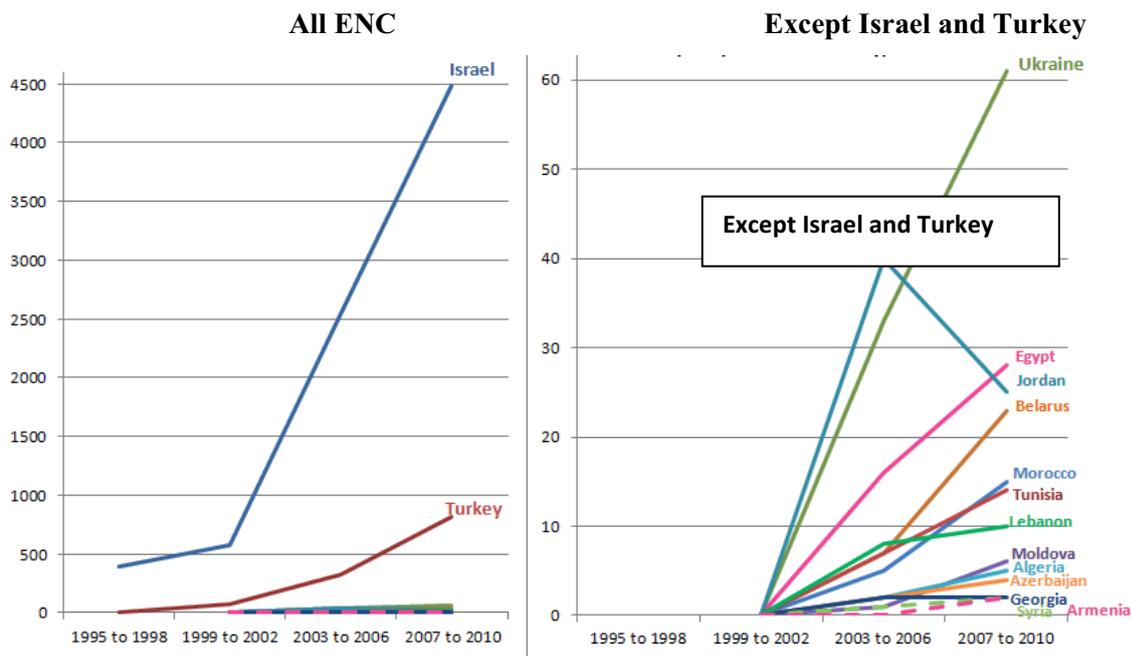
Figure 17. Patents growth rates and patents numbers in EPO and US offices



Source : WIPO Statistics Database, december 2011. Note: Counts are based on the patent filing date. Country of origin is the residence of the first-named applicant (or assignee). Data by origin might be incomplete.

Growth rates have not been calculated for a longer period because the number of EPO patents is null before 2003 for all ENC except Israel and turkey (see graphs below).

**Figure 18.** Evolution of the number of patents filed at EPO by European Neighboring Countries

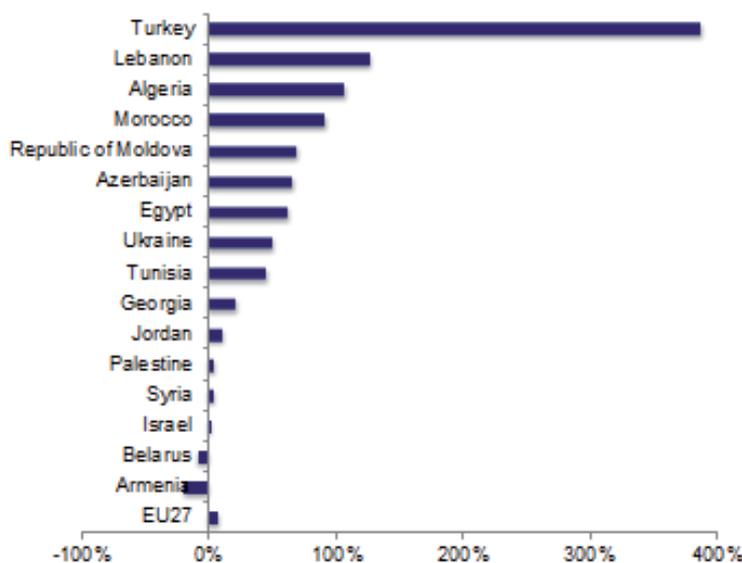


Source: WIPO Statistics Database, december 2011.

### 5.1.3 Evolution in FP project participations: a noticeable increase for Turkey

The growth rate of FP participations is also very high for a lot of neighboring countries. Turkey records the highest rate with 400%. Lebanon, Algeria, Morocco, Moldova, Azerbaijan, Egypt, Ukraine and Tunisia, also record a drastic increase of their participation. For Israel, the number of participations remains stable probably due its strong participation already observed in FP5. The participation has decreased in Belarus and Armenia.

**Figure 19.** Evolution of FP project participations (growth rate between FP5 and FP6).



Source: PCRDT French Research Ministry - EuroLIO

## 5.2 The evolution of the network structures over time

The strong increase of the scientific and technologic relationships observed above between EU and ENC is not homogenous among ENC countries. In addition, this increase is not necessarily homogeneously oriented towards all the EU countries. This may change the overall pattern of knowledge network as detailed in the next paragraphs.

### 5.2.1 *Co-inventorship network: a slight increase of cooperation between ENC. France, Germany and United-Kingdom are becoming more and more central in co-patents including ENC.*

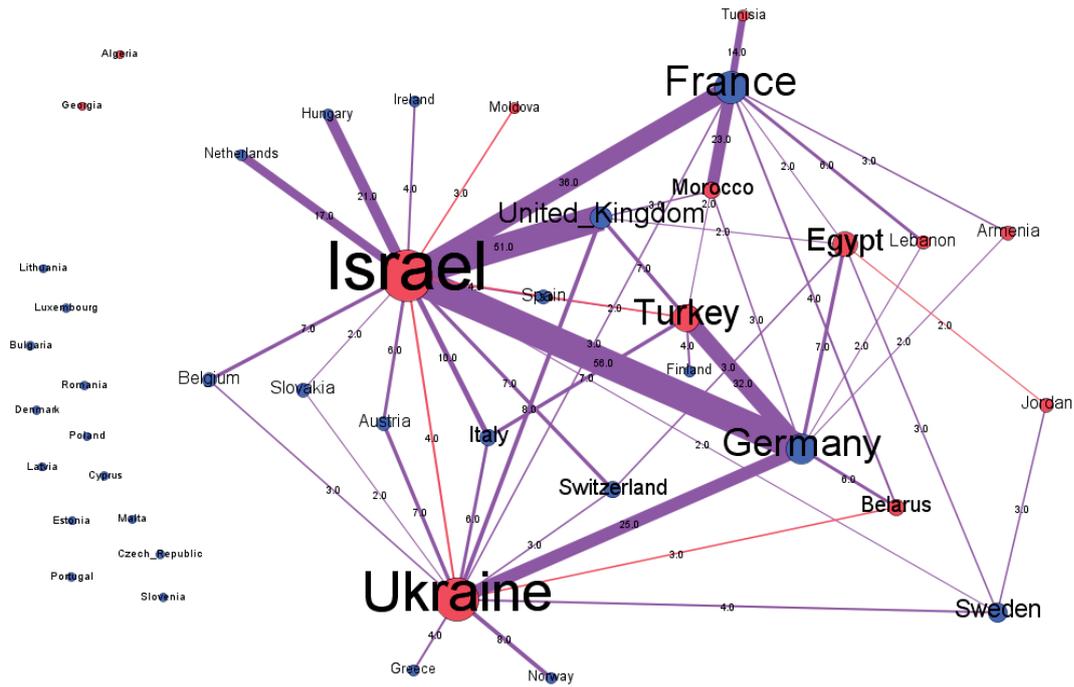
The patent network structure has significantly evolved during three periods: 1994 to 1998, 1999 to 2003 and 2004 to 2008 (Figures 20, 21 and 22).

The network is not dense for the first period from 1994 to 1998 (figure 20). Israel and Ukraine and to a smaller extent Turkey are the more cooperative countries. Technological relationships mainly take place between neighboring and European countries (mainly France, Germany, United Kingdom, Italy and Switzerland) and not directly between neighboring countries. Only one relationship between neighboring countries is recorded concerning Ukraine and Israel. Other ties exist but they are inferior to 2.

For the second period from 1999 to 2003, Israel, Ukraine and Turkey confirm their place as most cooperative neighboring countries. Egypt and to a lesser extent Belarus and Morocco carry weight



**Figure 21.** Patent cooperation with European Countries involving neighboring countries from 1999 to 2003 (relation numbers >1)



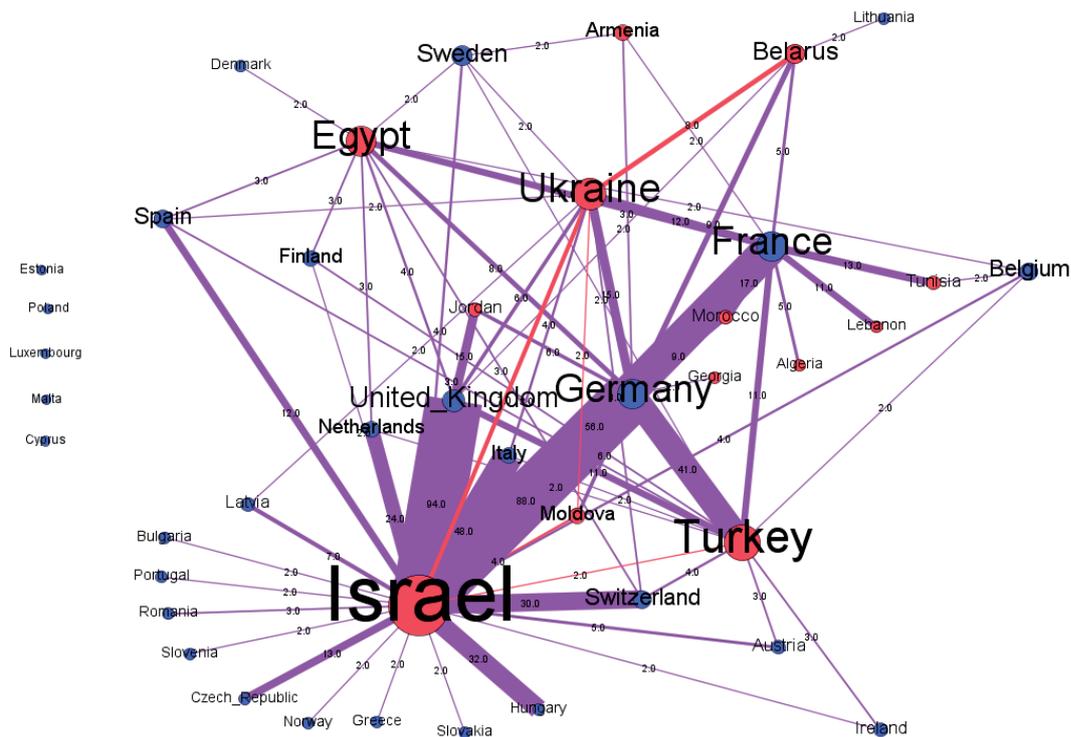
Source: OCDE.StatExtracts

Legend:

The node size depends on the degree of countries that is to say the number of countries the country is related to.

Red nodes: neighboring countries; blue nodes: European countries.

**Figure 22.** Patent cooperation with European Countries involving neighboring countries from 2004 to 2008 (relation numbers >1)



Source: OCDE.StatExtracts

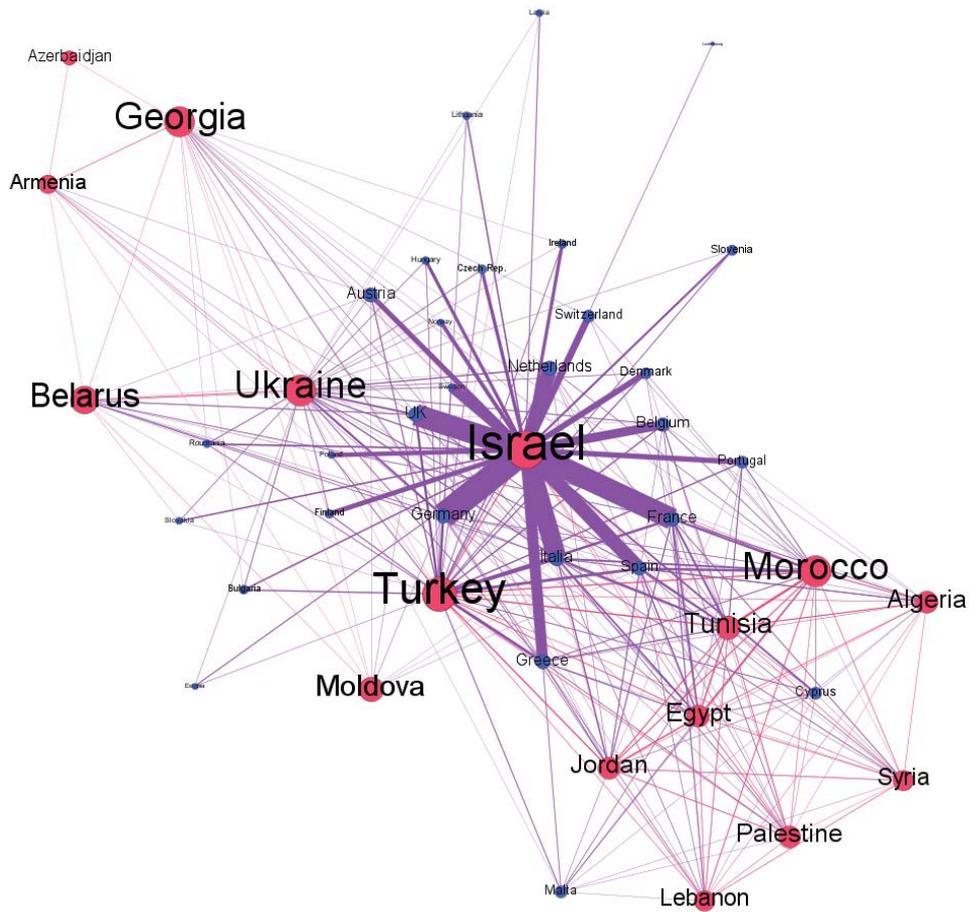
Legend:

The node size depends on the degree of countries that is to say the number of countries the country is related to.  
 Red nodes: neighboring countries; blue nodes: European countries.

**5.2.2 FP participation evolution: towards less heterogeneity among ENC in terms of the number of EU partner countries**

Israel is the most important neighboring countries in terms of cooperation with neighboring and European countries in both FP5 and FP6. But, the degree (that is to say the number of partner countries) is less and less heterogeneous among neighboring countries due to a strong increase of FP participations for a lot of ENC.

**Figure 23.** FP5 Cooperation with European Countries involving neighboring countries (relation numbers >2)



Source: PCRDT French Research Ministry - EuroLIO

Legend:

The node size depends on the degree of countries that is to say the number of countries the country is related to.

Red nodes: neighboring countries; blue nodes: European countries.



## 6. SYNTHESIS AND CONCLUSIONS

Based on five indicators of knowledge diffusion, this study investigates to what extent ENC and EU exchange their knowledge, how these knowledge flows are structured and how this knowledge diffusion evolves over time. The results provide original insights in the analysis of the different mechanisms of knowledge diffusion between EU and ENC.

The channels for knowledge diffusion appear as weakly developed. This is especially the case for IPR collaboration and student mobility, whereas co-authorship and co-inventorship are stronger channels for knowledge flows between the two areas. R&D cooperation taking place in FPs program is important for only one ENC. The ability to diffuse and to access knowledge are also heterogeneously distributed over EU and ENC countries giving rise to hierarchical networks in which some countries play a central role.

But the Neighbouring Knowledge Space is changing. Collaborations between EU and ENC are becoming more intense and the influence of the EU is increasing relatively to the one of the US. Moreover, even if most collaboration networks remain strongly centered on few countries, the network structures tend to some extent to be more homogenous.

This descriptive analysis opens new research perspectives in order to explore the impact of this knowledge diffusion between countries. Further research is thus required to assess the role played by the absorption and innovation capacity at two different levels. On the one hand, the intensity of collaboration is likely to impact on both EU and ENC economies. On the other hand, the network structure may influence the ability of knowledge to diffuse between EU and ENC and this may impact on both areas' performances. The next steps of the WP4 are therefore going to investigate these complementary issues.

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## **8. APPENDIX**

**Table 1. Patents distribution according to main partner countries – Period from 2004 to 2008**

Classification	Country	EU (27)	United States	Germany	France	Switzerland	United Kingdom	Netherlands	Austria	Sweden	Italy	Japan	Spain	Canada	China	Denmark	Australia	Norway	India	Russian Fed.	Israel	Total coop. with abroad	
More Europe specially France-oriented	Algeria	100%	0%	14%	71%																	7	
	Tunisia	89%	11%	6%	72%	6%																18	
	Lebanon	88%	6%	6%	89%				6%													16	
More Europe-oriented - specially France and Germany	Morocco	94%	0%	29%	53%	3%				3%												31	
	Armenia	89%	11%	33%	22%	11%				22%												9	
	Switzerland	84%	18%	30%	24%	1%	6%	1%	2%	2%	4%	1%	1%	1%	1%	0.4%	1%	0.4%	1%	0.5%	0.4%	7290	
	Bulgaria	80%	15%	45%	15%	2%	4%	5%	4%	4%	5%	2%	4%			4%		2%	2%		4%	55	
	Luxembourg	87%	17%	30%	39%	2%	3%	27%	0.3%	1%	1%	2%	0.3%	2%	1%			1%	1%	0.3%		380	
	Belgium	77%	24%	23%	25%	3%	3%	8%	17%	1%	2%	3%	2%	3%	1%	1%	1%	1%	1%	1%	0.1%	3596	
More Europe specially Germany-oriented	Malta	100%	0%	33%	10%		14%	24%			14%		10%									21	
	Slovakia	90%	3%	39%	4%	11%	1%	1%	14%		6%			2%		2%		1%	1%	2%	1%	135	
	Slovenia	77%	5%	38%	8%	11%	2%	4%	2%	15%	1%	7%	1%	3%	1%	2%		3%	0.3%	2%	2%	103	
	Austria	77%	8%	40%	3%	16%	4%	2%	2%	3%	2%	2%	1%	2%	1%	0%	3%	0.3%	1%	2%	0.2%	0%	2382
More Germany and Russia-oriented	Moldova	62%	8%	46%		8%	8%													38%	31%	13	
	Belarus	53%	16%	28%	16%	3%	6%				3%									31%	0%	32	
More North Europe-oriented (UK, Sweden, Finland, Denmark)	Estonia	84%	25%	2%			45%	6%		20%	4%		2%	8%		14%						51	
	Norway	77%	21%	15%	6%	5%	17%	3%	7%	24%	1%	1%	2%	2%	2%	6%		0.3%	1%	0.3%	0%	676	
	Finland	68%	20%	20%	3%	2%	11%	2%	2%	5%	18%	2%	5%	1%	1%	6%		3%	1%	1%	0%	1295	
	Sweden	65%	22%	18%	5%	4%	9%	3%	5%	2%	4%	1%	3%	3%	3%	9%		2%	6%	1%	0.1%	0%	2739
	Denmark	66%	29%	17%	3%	5%	10%	2%	4%	1%	21%	2%	2%	2%	1%	3%		2%	1%	0.5%	0%	1274	
	Hungary	75%	16%	31%	4%	2%	5%	2%	2%	6%	16%	7%	4%	1%	2%	1%	8%		1%		8%	395	
More Germany, Sweden & Finland-oriented	Latvia	74%	2%	33%		3%	3%			30%	2%					5%				13%	11%	61	
	Portugal	78%	20%	32%	8%	7%	17%	5%	2%	4%	2%	2%	1%	8%		2%		1%	1%		1%	192	
More Europe-oriented (Germany, France and United Kingdom)	Spain	78%	22%	32%	17%	5%	10%	5%	2%	5%	6%	2%	2%	1%	1%	1%		1%	1%	0.2%	1%	1650	
	Czech Rep.	67%	21%	36%	4%	13%	6%	1%	3%	1%	5%	2%	0.3%	2%	2%	2%		1%	1%	2%	3%	372	
	Egypt	67%	23%	15%	21%	6%	8%	4%	6%	4%	4%	2%	6%	4%	2%	6%		4%	1%	1%	2%	52	
	France	58%	24%	28%		20%	8%	10%	3%	1%	1%	4%	3%	3%	3%	0.4%		1%	0.4%	1%	1%	8718	
	Germany	51%	25%		14%	21%	7%	5%	6%	8%	3%	3%	4%	3%	2%	3%		1%	1%	1%	0.5%	17723	
	Italy	61%	26%	22%	14%	12%	9%	4%	3%	2%	4%		1%	4%	2%	1%		0.5%	1%	1%	2%	2609	
More Europe-oriented with USA relatively well represented.	Romania	74%	38%	20%	16%	1%	5%	4%	2%	2%	5%			3%		3%			1%	1%	3%	119	
	Poland	72%	29%	35%	10%	5%	7%	6%	3%	7%	3%	2%	1%	2%	1%	5%		0.5%	2%	0.3%	1%	321	
	Greece	66%	34%	24%	11%	2%	17%	7%	3%	2%	1%	3%	3%	5%	3%	1%		2%	1%	1%	1%	152	
	Netherlands	66%	29%	28%	7%	4%	10%	16%	1%	1%	4%	2%	2%	3%	1%	2%		1%	1%	1%	2%	3767	

Classification	Country	European Union (27)	United States	Germany	France	Switzerland	United Kingdom	Belgium	Netherlands	Austria	Sweden	Italy	Japan	Spain	Canada	China	Finland	Denmark	Australia	Norway	India	Russian Fed.	Israel	Total co-operation with abroad	
Balanced profile (Europe and US-oriented)	Lithuania	52%	48%	18%	6%	3%	6%	3%	3%	0.2%	3%	1%	0%	3%	3%	1%	3%	1.1%	2%		0.8%	3%	0.0%	33	
	Ireland	51%	51%	10%	3%	5%	23%	1%	5%	0.2%	4%	1%	0%	3%	3%	3%	0%	1.1%	2%		0.8%	0.3%	0.3%	635	
	United Kingdom	44%	45%	15%	9%	3%	6%	3%	5%	1%	3%	3%	3%	3%	2%	4%	2%	1.6%	2%	1.4%	1.3%	0.4%	1.2%	8110	
Much more US-oriented	Turkey	47%	54%	25%	7%	2%	7%	1%	1%	2%	1%	1%	1%	1%	3%	3%	1%	2%	0.6%		3%		1.2%	162	
	Israel	33%	50%	8%	5%	3%	8%	0.4%	2%	0%	0.4%	4%	1%	1%	3%	1%	1%	0.1%	0.7%	0.2%	3%	2%		1117	
	Ukraine	32%	41%	13%	10%	3%	5%	1%	1%	1%	2%	3%	2%	2%	3%	2%	3%		2%			21%	6%	120	
	Cyprus	28%	50%	6%	17%											28%				6%			6%		18
	Georgia	16%	68%	11%	5%				5%							5%			5%			5%		5%	19

Source: OCDE.StatExtracts

Legend :

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In orange : the share of the country is well represented (specialization index higher than 1)

In bleu : the share of the country is not well represented (specialization index less than 1)

The sum for each line can exceed 100% because in a same patent, there can be co-inventors located in different countries.

**Table 2.** Copublications distribution according to partner countries from 2004 to 2008

	United-States	Germany	United Kingdom	France	Italy	Netherlands	Spain	Switzerland	Canada	Belgium	Sweden	Denmark	Finland	Norway	Russia	Austria	Poland	Japan	Australia	China	External copublication numbers
Much more France-oriented	5%	4%	4%	74%	4%	4%	1%	4%	3%	3%	0%	0%	0%	0%	1%	0%	1%	1%	0%	0%	1 881
Tunisia	5%	2%	3%	74%	5%	1%	4%	1%	5%	4%	1%	0%	0%	0%	0%	1%	1%	1%	1%	0%	2 450
Morocco	6%	3%	2%	66%	5%	1%	12%	2%	5%	4%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	1 895
France & US-oriented	29%	5%	9%	44%	6%	4%	4%	2%	11%	4%	1%	0%	1%	1%	1%	1%	0%	2%	3%	2%	889
United-Kingdom oriented	10%	14%	5%	16%	21%	13%	15%	4%	4%	9%	9%	4%	2%	4%	2%	1%	1%	2%	8%	2%	127
Ireland	27%	15%	37%	11%	9%	8%	7%	4%	5%	5%	5%	4%	4%	3%	3%	2%	2%	3%	5%	3%	5 717
Libya	6%	7%	24%	7%	11%	1%	3%	3%	6%	4%	3%	6%	6%	2%	2%	5%	2%	2%	2%	6%	107
Germany and Russia oriented	10%	27%	9%	10%	6%	3%	4%	3%	2%	2%	2%	1%	2%	1%	26%	1%	14%	3%	1%	1%	969
Moldova	24%	22%	4%	8%	7%	2%	14%	14%	3%	4%	4%	2%	7%	7%	15%	2%	3%	0%	1%	1%	276
Bulgaria	14%	26%	11%	14%	12%	4%	9%	4%	3%	9%	4%	2%	3%	1%	7%	4%	7%	5%	2%	1%	2 291
Ukraine	19%	22%	9%	12%	6%	3%	5%	3%	3%	2%	3%	1%	2%	1%	14%	3%	15%	6%	1%	1%	3 959
Slovakia	17%	22%	12%	12%	10%	5%	6%	4%	5%	4%	4%	2%	3%	2%	7%	10%	10%	5%	3%	1%	2 375
Slovenia	18%	16%	14%	11%	14%	7%	6%	5%	4%	5%	6%	4%	5%	2%	3%	9%	5%	4%	5%	2%	1 867
Czech Rep.	20%	23%	13%	17%	11%	6%	6%	5%	4%	6%	5%	3%	3%	2%	6%	6%	8%	5%	3%	2%	6 647
Hungary	27%	24%	14%	13%	10%	7%	6%	4%	4%	7%	6%	3%	5%	2%	4%	8%	6%	4%	3%	2%	5 366
Luxembourg	9%	23%	16%	35%	9%	9%	7%	7%	1%	23%	7%	4%	4%	2%	1%	5%	3%	1%	2%	1%	485
Roumania	15%	18%	10%	25%	12%	4%	7%	3%	3%	6%	3%	1%	2%	2%	2%	2%	6%	6%	2%	1%	3 164
Syrie	19%	14%	14%	20%	6%	3%	4%	2%	3%	5%	0%	2%	0%	0%	1%	0%	0%	4%	6%	2%	266
Portugal	19%	13%	20%	17%	9%	7%	21%	5%	3%	5%	4%	4%	3%	2%	3%	3%	2%	2%	2%	2%	7 536
Austria	22%	38%	13%	12%	13%	8%	7%	9%	5%	5%	5%	3%	3%	2%	3%	0%	4%	3%	4%	2%	12 112
Belgium	23%	15%	18%	24%	11%	18%	8%	7%	5%	5%	3%	3%	2%	2%	2%	3%	3%	3%	4%	2%	20 613
France	23%	15%	15%	0%	12%	6%	8%	7%	7%	7%	5%	2%	2%	2%	3%	2%	3%	4%	3%	3%	68 002
Poland	25%	23%	13%	16%	10%	5%	7%	4%	5%	6%	5%	3%	3%	2%	6%	4%	4%	5%	3%	1%	12 014
Spain	26%	15%	18%	18%	15%	8%	8%	5%	5%	5%	4%	3%	2%	2%	2%	3%	3%	2%	3%	1%	31 781

	United-States	Germany	United Kingdom	France	Italy	Nether-lands	Spain	Switzer-land	Canada	Belgium	Sweden	Denmark	Finland	Norway	Russia	Austria	Poland	Japan	Austra-ilia	China	External copubli-cation numbers
Latvia	12%	28%	9%	10%	8%	4%	4%	5%	1%	3%	15%	6%	10%	2%	14%	5%	6%	4%	1%	1%	526
Germany and North Europe (Sweden, Finland, Denmark, Norway)	27%	17%	20%	10%	9%	9%	7%	5%	6%	5%	5%	20%	8%	0%	7%	3%	3%	4%	4%	2%	10 451
Denmark	28%	18%	22%	11%	10%	11%	8%	6%	6%	5%	17%	17%	7%	9%	2%	3%	3%	3%	6%	2%	12 794
Sweden	28%	17%	19%	11%	9%	8%	6%	5%	6%	5%	5%	10%	9%	8%	3%	3%	3%	4%	4%	4%	21 617
Norway	30%	14%	21%	12%	8%	9%	6%	4%	7%	4%	19%	12%	8%	4%	4%	3%	3%	3%	4%	3%	8 990
Estonia	17%	16%	16%	11%	10%	7%	7%	5%	3%	4%	20%	6%	25%	6%	8%	3%	5%	3%	3%	1%	1 074
Lithuania	16%	22%	11%	16%	10%	5%	6%	3%	2%	6%	16%	6%	9%	4%	6%	4%	10%	2%	2%	2%	1 033
Switzerland	29%	28%	17%	19%	12%	8%	6%	6%	6%	6%	4%	3%	3%	2%	2%	4%	2%	3%	4%	2%	24 924
Cyprus	29%	10%	25%	7%	8%	3%	6%	3%	4%	2%	2%	3%	2%	1%	1%	1%	2%	1%	4%	0%	607
Germany	30%	30%	16%	13%	9%	9%	6%	9%	5%	4%	5%	3%	3%	2%	2%	5%	3%	4%	4%	4%	79 583
USA and Europe-oriented	30%	22%	23%	13%	11%	11%	8%	6%	6%	12%	6%	4%	3%	3%	2%	3%	2%	3%	5%	2%	31 507
Greece	31%	17%	24%	13%	12%	7%	8%	4%	4%	5%	4%	3%	2%	2%	2%	2%	3%	2%	2%	1%	8 085
United Kingdom	31%	15%	12%	12%	9%	8%	7%	5%	7%	4%	5%	3%	3%	2%	2%	2%	2%	4%	7%	4%	84 655
Italy	33%	18%	19%	19%	11%	8%	11%	7%	5%	5%	5%	3%	2%	2%	3%	4%	3%	4%	3%	2%	42 006
Jordan	34%	12%	16%	3%	5%	3%	1%	1%	6%	1%	1%	0%	1%	0%	1%	0%	1%	3%	2%	0%	752
Armenia	36%	34%	15%	26%	18%	4%	11%	13%	4%	2%	2%	0%	4%	0%	14%	1%	12%	5%	1%	2%	396
Russia-oriented	40%	21%	10%	6%	12%	1%	6%	5%	3%	4%	3%	1%	2%	1%	14%	1%	4%	6%	1%	2%	434
Turkey* & Russia oriented	15%	13%	7%	3%	4%	1%	1%	4%	2%	2%	0%	0%	0%	0%	24%		1%	4%	1%	0%	210
Egypt	31%	12%	9%	5%	4%	3%	4%	2%	7%	1%	2%	0%	1%	0%	1%	2%	1%	8%	1%	2%	2 624
Turkey	45%	13%	13%	7%	7%	4%	3%	2%	5%	3%	2%	1%	2%	1%	2%	2%	2%	4%	2%	1%	6 051
Israel	53%	15%	11%	11%	8%	6%	4%	4%	6%	3%	2%	2%	1%	1%	3%	2%	2%	3%	4%	2%	10 171

\* Turkey is not represented in columns given the too low copublication numbers with other countries.

Source : Base Pascal (INIST-CNRS)

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**Table 3.** Patents distribution according to offices from 2007 to 2010 (Files in national offices are excluded)

Classifications	Country	European Patent Office	USA	Several countries of Asia*	Eurasian Patent Organization	Russian Federation	Canada, Mexico	South America	Australia, New Zealand	Germany	United Kingdom	France	Ukraine	Israel	Norway	Autre	Patent numbers (National Offices excluded)	Sum of Germany, UK, France and Norway
<b>More europe oriented</b>	Turkey	42%	20%	16%	3%	3%	3%	2%	2%	2%	1%	1%	1%	0.4%	0.2%	5%	1934	4%
	Algeria	38%	15%	15%			8%				8%	15%					13	23%
	Latvia	33%	9%	14%	6%	5%	5%	3%	4%	1%	0.2%		5%			13%	443	1%
	Slovenia	36%	22%	14%	4%	2%	6%	2%	3%	3%	0.3%	0.1%	3%	0.1%	2%	3%	1399	5%
	Poland	37%	30%	12%	1%	4%	3%	1%	2%	2%	2%	0.2%	4%	1%	0.3%	2%	1776	5%
<b>More Asia and Europe-oriented</b>	Netherlands	27%	17%	37%	1%	3%	5%	4%	3%	0%	1%	0.1%	0.3%	0.2%	1%	1%	98441	2%
	Switzerland	22%	13%	31%	1%	3%	9%	5%	5%	4%	1%	1%	1%	0.1%	1%	3%	110007	6%
	Cyprus	20%	5%	16%	1%	10%	10%	3%	6%	1%	6%	2%	1%	0.2%	1%	8%	897	10%
	Luxembourg	28%	8%	28%	1%	2%	7%	3%	4%	4%	2%	2%	1%	0.02%	1%	7%	4253	9%
	Malta	29%	7%	22%	0.2%	3%	7%	5%	4%	4%	10%	6%	1%		0.4%	4%	498	16%
<b>Balanced profile</b>	Portugal	21%	21%	20%	1%	3%	9%	7%	6%	2%	3%	1%	1%	1%	1%	4%	1632	6%
	Spain	27%	25%	17%	0.3%	3%	9%	5%	4%	1%	1%	1%	0.5%	1%	1%	5%	19340	3%
	Italy	30%	27%	22%	1%	3%	6%	4%	3%	1%	0.4%	0.3%	1%	0.3%	0.4%	2%	55855	2%
	Austria	26%	26%	18%	1%	3%	5%	2%	3%	14%	0.2%	0.4%	1%	0.3%	1%	2%	23732	15%
	Belgium	24%	24%	24%	2%	2%	7%	4%	5%	1%	3%	1%	1%	0.1%	1%	3%	30985	6%
	Denmark	24%	24%	27%	1%	2%	7%	3%	6%	1%	1%	0.1%	1%	1%	1%	2%	26179	3%
	France	25%	25%	28%	0.4%	2%	2%	4%	3%	3%	1%	0.4%	0.5%	0.5%	0.5%	3%	142925	1%
	Germany	29%	28%	16%	0.4%	2%	2%	5%	3%	2%	0.4%	0.4%	1%	1%	0.3%	2%	359073	1%
	Armenia	3%	37%	5%	22%	32%	32%									2%	63	0%
	Belarus	2%	4%	3%	46%	39%	39%	0.3%	0.2%	0.1%	0.3%			4%		0.3%	1024	0%
<b>More Asia and Russia-oriented</b>	Moldova	10%	8%	2%	48%	16%		2%		3%			5%			7%	61	3%
	Azerbaijan	4%	8%	5%	47%	9%	3%		2%	4%	1%		3%			14%	106	5%
<b>Much more Russia-oriented</b>	Ukraine	3%	12%	2%	3%	74%	1%	0.2%	1%	1%	0.2%	0.1%		0.1%		2%	1801	1%

\*China, Hong Kong SAR, India, Singapore, Viet Nam, Malaisie, Republic of Korea, Japan

Source : WIPO Statistics Database, december 2011. Note: Counts are based on the patent filing date. Country of origin is the residence of the first-named applicant (or assignee). Data by origin might be incomplete. Calculations: EuroLIO.

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	Tunisia	16%	31%	11%	0%	2%	9%	2%	4%	15%				9%	85	19%
	Morocco	17%	24%	18%	5%	6%	13%	1%	1%	11%				5%	88	13%
	Jordan	20%	32%	11%	2%	1%	15%	2%	2%				2%	123	4%	
	Lithuania	29%	37%	5%	1%	3%	3%	1%	2%	4%	1%	1%		13%	147	7%
	Slovakia	21%	28%	13%	0.4%	2%	2%	2%	6%	0.4%	3%	0.2%	0.2%	15%	447	9%
	Greece	26%	34%	13%	1%	2%	6%	3%	5%	0.4%	1%	0.1%	0.1%	5%	1376	5%
	Estonia	21%	39%	12%	4%	4%	6%	4%	1%	1%	1%	1%	1%	4%	379	3%
	Czech Republic	22%	36%	14%	3%	3%	4%	3%	3%	1%	3%	0.2%	0.2%	7%	2355	4%
	Ireland	17%	26%	24%	1%	2%	8%	7%	0%	0.4%	10%	0.2%	0.2%	2%	10972	11%
	Sweden	20%	22%	33%	0.2%	4%	6%	4%	2%	0.2%	1%	1%	1%	2%	61785	4%
	Finland	20%	30%	30%	1%	3%	5%	3%	1%	0.1%	1%	0.2%	0.2%	2%	34275	3%
	Hungary	15%	32%	21%	4%	2%	6%	4%	1%	0.3%	3%	2%	1%	7%	2778	3%
	Norway	16%	28%	20%	2%	5%	9%	6%	1%	0.4%	7%	0.4%	0.4%	3%	12125	8%
	United Kingdom	19%	38%	22%	1%	2%	6%	6%	0%	0.2%	0%	0.4%	1%	2%	107904	1%
	Egypt	9%	56%	14%	1%	0.3%	4%	3%	0.3%		3%	1%	1%	7%	302	4%
	Georgia	5%	58%		3%	8%	3%	3%	3%		8%	10%		3%	40	10%
	Israel	13%	54%	18%	0.4%	1%	6%	4%	0.2%	0.05%	1%	0.2%	0.2%	1%	34667	2%
	Lebanon	11%	50%	1%		3%	3%	3%	3%	2%	1%			12%	90	17%
	Romania	15%	60%	9%	1%	1%	4%	2%	1%	1%	1%	1%	1%	4%	394	3%
	Bulgaria	11%	67%	7%	1%	2%	2%	2%	2%	1%	2%	0.2%	0.2%	2%	520	4%
	Libya		17%					17%	33%					17%	6	50%
	Syrian Arab Rep.	10%	15%	5%				5%	5%					55%	20	15%

\*China, Hong Kong SAR, India, Singapore, Viet Nam, Malaysia, Republic of Korea, Japan

Source : WIPO Statistics Database, december 2011. Note: Counts are based on the patent filing date. Country of origin is the residence of the first-named applicant (or assignee). Data by origin might be incomplete. Calculations: EuroLIO.

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In green : no specialization index calculated.

