D4.2 SEARCH DERIVERABLE

Technological activities and innovation diffusion in the EU and interactions with the neighbouring regions

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Deliverable 4.2: TECHNOLOGICAL ACTIVITIES AND INNOVATION DIFFUSION IN THE EU AND INTERACTIONS WITH THE NEIGHBOURING REGIONS

Raffaele Paci (CRENoS), Nadine Massard (UJM-GATE), Stefano Usai (CRENoS), Rosina Moreno (UB-AQR), Anna Pikalova (HSE) and Marta Foddi (CRENoS)

Coordinators

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2. Introduction

2.1. General framework

The general objective of this Work Package is to investigate on the innovative performance of countries and regions of the EU27 and NC16 in order to understand to what extent this performance depends on the one hand on the endogenous ability in knowledge creation and on the other hand on the absorptive capacity to adopt and imitate other regions’ innovations.

An important aspect analysed is the innovation diffusion stage and the increasing importance of technological networks in the innovation diffusion process which implies interactions among agents located in different geographical areas. This is likely to modify the spatial diffusion of knowledge and, thus, it is important to investigate more precisely into the spatial implications of such transformation. The objective of this analysis is to facilitate a better understanding on how groups of scientists, investors or companies form research alliances and collaborate to create and diffuse knowledge, and what is the specific role played by geography in these processes. The theoretical literature analyses the characteristics of the network structure and their consequences on knowledge diffusion (Jackson and Wolinski, 1996, Cowan and Jonard, 2003). It has also been noticed that previously separated regions and countries are not easily penetrated by knowledge flows or by the diffusion of innovative impulses, primarily because their flow depends heavily upon trust among the participants. The high-value attached to tacit exchanges is a reflection of their exploitation potential in commercialized goods and services, but tacit diffusion requires sufficient periods of prior engagement and integration before building a cross-border innovation system. This raises the question of how newly engaged agents in previously separated territorial units (for instance in the NCs) eventually become able to exchange and exploit innovative ideas and opportunities together (Lundquist and Tripl, 2009; Tripl, 2009). From all these considerations it is clear why in the last years the analysis of innovative activities (such as R&D expenditure and patents) has been integrated with a detailed investigation into the different types of interactions (such as patent citations, patent co-inventorships FP partnerships; R&D collaborations, firms' technological alliances) among firms and other institutional actors.

In this framework, the gap in the empirical research on knowledge diffusion processes is addressed by focusing on the empirical analysis of innovation adoption, on research collaborations funded by the EU Framework Programmes (FPs), on co-inventors network based on patents and on firms research alliances, with an emphasis on the geographical, structural and temporal dimension of the collaborative activities. Workpackage 4 focuses on the understanding on how innovation diffusion and research networks work, their main determinants and how institutional factors may affect them. This kind of analysis would provide policy-makers with a quantitative assessment of possible future impact of strengthening innovation diffusion and knowledge flows within EU territories and their wider neighbourhood.

Another important issue is related to the effects of internationalization on innovation, technological upgrade and productivity of manufacturing firms. This question is crucial to shed light on the policy debate over the nature of structural weaknesses that prevent European transition economies from generating competitive advantage out of their own research and innovation efforts. Only a small portion of manufacturing in transition economies is innovative; few companies develop technologies internally, most follow technology acquisition strategy. This strategy, however, is easy to imitate and employ in much lower cost locations. Thus the long term prospects for the moderate and low innovation-intensive manufacturing in the region are pretty poor.
2.2. Partners involved

In this workpackage, 7 project partners’ are involved:

CRENoS: from February 2012 to November 2013;
UB-AQR: from April 2012 to May 2013;
WU: from April 2012 to November 2013;
UJM-GATE: from February 2012 to September 2013;
GKK: from April 2012 to September 2013;
HSE: from February 2012 to September 2013;
ICBSS: from February 2012 to November 2012.

2.3. Executive summary

The general objective of this Work Package is to investigate on the innovative performance of countries and regions in the European Union (EU27) and in the 16 European Neighbouring Countries (ENC). We aim at understanding to what extent this performance depends on the one hand on the endogenous ability in knowledge creation and on the other hand on the absorptive capacity to adopt and imitate other regions’ innovations taking advantages of various form of research and technological networks.

In particular we analyse how internal and external factors (such as human capital, social capital, institutions, public policies, spatial spillovers) affect the innovation activities and, consequently, the regional economic performances. Moreover, we focus on the process of innovation diffusion and research networking in order to assess to what extent the EU and EN countries have established valuable collaboration procedures. Throughout the analysis we devote specific attention to the economic dynamics of those countries (and regions) which have recently entered the EU (EU12) in order to conjecture on the evolution process which may involve in the near future the neighboring countries due to the reinforcement of the integration process. In all the research activities we have tried to derive useful policy recommendations at both the European and the EN countries level.

In order to widely explore all the issues presented above, researchers make use of several methodologies. Descriptive analysis is accompanied by parametric and non-parametric methods. Among the parametric methods a large set of econometric tools have been employed (i.e. econometric estimation methods, spatial analysis, etc) while among the non-parametric methods, Data Envelopment Analysis. Moreover some results are obtained through qualitative analysis of empirical data collected through interviews. Finally, in order to clearly observe the relationships among people involved in the innovation process, some analysis takes advantage of Social Network Analysis (SNA) tools.

Main results highlight the important role of knowledge diffusion and research networks by enhancing the innovation endowment of regions for both EU countries and EN countries. All indicators confirm the large gap between EU countries and ENC and the great heterogeneity among ENC with the only exception of Israel. The low levels of literacy and schooling rates have been one of the most crucial obstacles in these countries. Also when we look at the productive structure, we observe a great heterogeneity among countries and such a gap is even greater in terms of technological activity and
performance. The great diversity of regions and nations doesn’t only result from their development level or endowment in resources for innovation; it also results from their highly heterogeneous efficiency in exploiting these resources.

Great attention has been devoted to the determinants of innovation. Among them, the potential of manufacturing activities and formal R&D expenditure remain determining factors of the capacity of regions/nations to innovate. Moreover, our results confirm the widespread consensus that the transfer of knowledge is significantly favoured not only by spatial closeness among agents involved in the innovation process, but also by the intentional relations they develop within a-spatial networks, such as those shaped by institutional, technological, social and organizational links. In the case of innovation adoption, its main determinant is cooperation and a key role seems to be played by the level of trust among people within each country, by the improvement of communications and simplification procedures, as well as by high educational levels. Ccompetition has been identified as another factor that affects, although to a much lesser extent, product innovation adoption directly acquired from external firms.

The presence of a-spatial relationships like institutional, historical, cultural, cognitive, social and organizational links has been proved to facilitate also the exchange of knowledge fostering innovation diffusion and the creation of research networks. Results from the CIS suggest that developing countries (the EU12) generate innovation and may contribute to the overall knowledge space but they need to increase their export exposure and their internal level of knowledge to foster the ability to generate innovation and adopt existing technologies at the same time. Looking at the cross border knowledge flows, it appears that the degree of internationalization of innovative activities is extremely limited among countries which have a very different economic background and level of development. Nonetheless the relationships are increasing along time and especially the largest countries, are becoming important partners for the European countries. Results show also that firms’ agreements represent an important channel of knowledge exchanges generated along the variety of activities carried out before, during and after the deal. If we focus on cross-border innovation cooperation of the Russian firms, a detailed study survey indicates that the economic interactions among Russian and EU firms are still predominantly determined by traditional channels of export and import. Despite certain improvements in terms of international trade and technology transfer since the beginning of transition to market economy in Russia, there are still relevant improvements which can be made to reinforce the collaboration among EU and Russia in terms of science, technology and innovation activities.

Regarding the impact of R&D collaboration on regional innovation performances, the results point to positive and significant impact, but this impact is not systematic. The results related to the knowledge production function including both spatial and relational neighbourhoods suggest that external knowledge matters for innovation and additionally they show that two different types of neighbourhoods play an equally important role as a source of external knowledge. In addition, results show that the EU policy implemented through the Framework Programme appears as an effective way to diffuse knowledge among European regions. The study also reveals that although the effect of contemporaneous flows from neighbours is small in magnitude, they are in play in time because evidence is found on the effect of past inventive activity on the current inventive activity. This highlights the necessity of considering dynamic effects for a more a proper assessment of the importance of knowledge flows from neighbourhoods. But the positive impact of inter-regional flows of knowledge is not systematic. Peripheral regions (in geographical terms as well as in relational terms) remain weakly integrated into these global networks and thus suffer from a difficulty to access external knowledge.
In conclusion, for the neighbouring countries the prospective of cross border knowledge flows due to inter firms agreements, innovation networks and research program cooperation is very important and potentially rewarding. However the ENC still face some difficulties and impediments in getting engaged with appropriate knowledge bases and to thus take a full advantage of these potential benefits due to the presence of large differences in terms of institutional, cultural, social and economic risk factors.

2.4. Tasks

Workpackage 4 is organized into six tasks:

**Task 4.1 - Technological activities of countries and regions** (participants CRENOS, UJM-GATE, HSE,ICBSS), deals with a descriptive analysis of technological activities providing a comprehensive picture of the key trends in innovative performance. It includes 7 research papers.

**Task 4.2 - Descriptive analysis of knowledge diffusion and research network** (participants UB-AQR, CRENOS, UJM-GATE, GKK, WU, HSE) is devoted to a descriptive analysis of knowledge diffusion and research networks that is carried out by taking into account that innovation diffusion is a very complex phenomenon. It includes 10 research papers.

**Task 4.3 - The effects of Internal Market and Intangible Assets on innovation diffusion** (participants UB-AQR, UJM-GATE) aims at analysing the effects of the policies aimed to reinforced the Internal Market on innovation diffusion/ adoption, with the aim of characterising this innovation diffusion/ adoption in European countries stressing the different nature of innovations and also their geographical and temporal dimensions. It includes 3 research papers.

**Task 4.4 - The effects of firms networks in the process of cross-border technological diffusion** (participants CRENOS, WU, HSE) has the objective to investigate the role and effects of firms networks in the process of cross-border technological diffusion, to better investigate and describe firms networks. This procedure allows investigating the presence of structural differences among relational networks, their dynamics across time and their sectoral heterogeneity. It includes 5 research papers.

In the case of **Task 4.5 - The effects of research networks within the EU Framework Program** (participants HSE, UJMGATE, GKK, WU), the main aim is the investigation of the temporal and spatial evolution of European R&D collaborations within the research Framework Programs. The research employs spatial econometric techniques to make a systematic assessment of the effectiveness of EU FP programs in influencing the change in the position of the lagging regions in international inventor networks. It includes research 3 papers.

**Task 4.6 - Policy implications** (participants CRENOS, UJM-GATE, UB-AQR, GKK, WU, HSE, ICBSS), presents policy implications extracted from the research carried out in the workpackage in order to support the policy guidelines with a particular focus on the importance of technological activities and innovation diffusion and interactions with the neighbouring regions.

All the papers, distinguished by task, are listed below in Annex 1 and Annex 2.
3. Scientific Issues

3.1. Measures of innovative performance and common patterns of innovative activities in EU and NCs. (Coordinator: CRENoS. Task 4.1A)

Innovation is a key factor for the economic growth process but there is a large heterogeneity across territories in their capacity to create knowledge and innovation, and, as a result, in their abilities to exploit available ideas and technologies. This task presents the main characteristics related to technology and innovation based on indicators on R&D expenditures and patents for the EU and ENC. Remarkably, ENC countries are almost always below the ten thousand dollar per capita threshold and, as a result, rank in the bottom position in terms of Human Development Index. The only exception is Israel, ranked 17 out of 187 countries, which falls into the category of highly human developed countries. Moreover, the low levels of literacy and schooling rates have been one of the most crucial obstacle in these countries. As far as the productive structure is concerned, we observe a great heterogeneity among countries and a large divide between Europe and ENC. Such a gap is even greater in terms of technological activity and performance. There is a marked difference in the R&D expenditure and in the production of innovation which are transformed to patent applications. On the one hand, we find that EU15, with almost 220 millions, invest a relatively high share (close to 2%) of their income in R&D. On the other hand, the 16 ENC as a whole spend about 13 million, which implies an R&D intensity slightly less than 1% of their GDP. A share which is, nevertheless, slightly higher than that of new EU member states. Larger disparities are also observed in patenting activity. The EU27 is in general very active in patenting, especially EU15 countries which have an average of 30 thousand patents per country. On the contrary ENC’s, Israel excluded, register very low levels of patenting activity. In general, all indicators confirm the large gap between EU and ENC and the great heterogeneity among ENC.

3.2. Analysis of the determinants of innovative activities at regional level and on the impacts on the NCs (Coordinator: UJM-GATE; other partners: CRENoS, HSE, ICBSS. Task4.1B-F)

This section is devoted to the determinants of innovative activities and the analysis of the factors affecting the innovative capacity of a region in terms of knowledge creation and diffusion. It consists of five research papers listed in the Appendix.

On the whole original results have been obtained through the different studies. Among the traditional recognized determinants of innovation, manufacturing activities and formal R&D expenditures remain determining factors of the capacity of regions/nations to innovate. However, the attention must focus on two other factors because of their strong and pervasive role in the capacity of an economy to articulate internal capacities to create knowledge and capacities to absorb external knowledge: these are human capital (measured by well-educated labor force) and international openness of firms. Moreover, our results confirm the widespread consensus among scholars that the transfer of knowledge is significantly favoured not only by spatial closeness among agents involved in the innovation process, but also by the intentional relations they develop within a-spatial networks, such as those shaped by institutional, technological, social and organizational links. Comparing the strength of regional association captured by the different “closeness” dimensions, the technological one ranks first, followed by the geographical one; the weakest relations are found for the social and organizational networks. Moreover, evidence of important complementarities among the different proximities is found.
The great diversity of regions and nations doesn’t only result from their development level or endowment in resources for innovation; it also results from their highly heterogeneous efficiency in exploiting these resources. Important differences are found between the core (rich and industrialized countries) and periphery (relatively poorer new accession countries and ENCs) of Europe at the regional as well as the national level. Moreover, results show that there has been a process of catching-up between regions, albeit slow, and that such a convergence is mostly attributable to a closing up of the technology gap and to a significant enhancement in pure efficiency. On the contrary, the efficiency component due to the scale dimension has been decreasing for all regions in Europe and in particular in new entrant countries.

Concerning the role of internationalisation, interesting results have been obtained from the survey data on Russian manufacturing firms. Once taken into account the selection process which shows that more productive and larger manufacturing firms are more likely to start exporting and importing, results indicate a significantly higher impact of the learning effects for continuous exporters than for new export entrants and non-exporting firms. Learning effects for importing firms appear also higher than for exporters and seem to be higher for those firms which import technological machinery than for importers of raw materials.

A common result from the two papers on public policies is that different countries place emphasis at different instruments. Technoparks, which are the focus of Northern European countries, require a richer background as regards knowledge creation and the institutional environment to support the generation, diffusion and commercialization of knowledge. On the other hand, Eastern and Southern European countries seem to reasonably place increased emphasis on the development of business incubators which foster a different type of entrepreneurship and require fewer endowments compared to technoparks. Concerning public financial support to R&D investment, there exists an even greater variety of country’s profile in terms of instruments used, their intensity and their dynamic. Globally, core EU countries tend to increasingly privilege indirect support detrimental to direct subsidies while no real trend can be found for New European countries and other developing countries.

Overall, these results have some interesting and potentially useful implications for the current and future design of cohesion policies within EU and between EU and ENC.

3.3. Analysis of the indicators of innovation diffusion and research networks (Coordinator: CRENoS; other partners: UB-AQR, UJIM-GATE, GKK, WU, HSE. Task 4.2)

This section, devoted to innovation diffusion and research networks, consists of ten research papers which are based either on the direct study of the recent experience of ENC or on the indirect evidence based on the economic dynamics of the new member states (EU12) which have recently entered the EU. The research studies employ micro data based on the Community Innovation Survey (CIS) and indicators of knowledge transfer like patents, citations, co-inventorships, applicant-inventors links and inter-firms agreements, which are used to build different matrices of flows across countries between EU and ENC and across regions within EU (since data on regions are not available for ENC).

A first general consideration remarked in several studies concerns the lack of adequate information on innovation creation, diffusion and adoption in the ENC which partly prevents a complete analysis of the phenomenon. Thus more effort should be devoted by the Community Statistical Offices to interact with ENC in providing homogeneous and comparable data on technological activities.

Results from the CIS suggest that developing countries (the NMS12) do generate innovation and may contribute to the overall knowledge space but they need to increase their export exposure and their
internal level of knowledge to foster the ability to generate innovation and adopt existing technologies at the same time. These results are also useful in relation to the future process of development of ENC. Looking at the cross border knowledge flows, it appears that the degree of internationalization of innovative activities is extremely limited among countries which have a very different economic background and level of development. Nonetheless the relationships are increasing along time and especially the largest countries, are becoming important partners for the European countries. More specifically, a weak connectivity is observed 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 arises in the Framework Programme network and lower heterogeneity among ENC. These connectivity links build upon historical and commercial linkages, and are favoured sometime by common languages too. The analysis of EU-ENC research networks through the specific scientific international cooperation activity (INCO) highlights that international collaboration ensure knowledge diffusion and research networking between the EU and ENC thus promoting innovation diffusion.

In general, knowledge flows are clearly influenced by several dimensions of proximities across countries. Geographical distance and proximity clearly still plays a role, but also cultural and historical linkages may impact on the probability to have an exchange, either market mediated or as a result of an externality.

The key element emerged from all the contributions is that the capacity of a territory to innovate does not depend only on the internal creation of new knowledge but it is also affected by its capacity to absorb and efficiently exploit the knowledge available outside. Indeed, countries with strong R&D and human resources and high innovation output exhibit the highest adoption rates. This supports the idea that innovation adoption requires an absorption capability and thus innovation creation and adoption have been proved to be concurrent phenomena.

Another common conclusion of the research papers concerns the evidence that firms and territories are more able to develop technological competences (by creating them internally of absorbing from outside) when they can exploit a wide range of transmission channels which go beyond the usual geographical proximity. The presence of a-spatial relationships like institutional, historical, cultural, cognitive, social and organizational links has been proved to facilitate the exchange of knowledge.

3.4. Analysis of the effects of the Internal Market and Intangible Assets on innovation diffusion. (Coordinator: UB-AQR; other partner: UJM-GATE. Task 4.3)

This section, devoted to the effects of the Internal Market (IM) and Intangible Assets on innovation diffusion, consists of three research papers.

The impact of the IM policies on the diffusion of innovation has been studied by using Instrumental Variables estimators considering the direct effect of the IM on the transmission channels (Cooperation, Competition and Trade) and the indirect one on the degree of innovation adoption. The study stresses that the main determinant of innovation adoption is cooperation and a key role seems to be played by the level of trust among people within each country, by the improvement of communications and simplification procedures, as well as by high educational levels. Competition has been identified as another factor that affect, although to a much lesser extent, product innovation adoption directly acquired from external firms. Competition is negatively affected by the level of public ownership within each country, by the level of transfer and subsidies, as well as by the administrative burdens. Considering the relationship between innovation diffusion and productivity change at the country level results show a general positive relationship. This is mostly due by those countries (Estonia, Bulgaria, Latvia, Spain, Portugal, Luxembourg and Hungary) which experience a lower decreases of productivity
as innovation adoption grows. Moreover, disaggregating for product and process innovation adoption, the relationship seems more clearly positive than in the general case, being even more straightforward in the case of the adoption of process innovations. This could be due to the fact that introducing a new production process makes firms to be more efficient, reducing costs and therefore each worker being more productive.

Additionally, through the estimation of a growth equation, it can be observed that those countries that increase their rates of innovation adoption tend to present higher productivity growth rates. Therefore, it seems that an effort in incentivizing enterprises increasing innovation adoption, either in the form of cooperating with other enterprises of incorporating innovations made by other enterprises has a positive and clear impact on productivity growth. On the other hand, the impact of increasing R&D expenditures is not as clear, but depends on the type of innovation carried out. In this sense, we can conclude that the countries making efforts to increase the number of their firms engaged in extramural R&D or the number of firms engaged in training tend to have higher increases in productivity. On the contrary, the result is not as clear if the type of innovation that is encouraged is R&D intramural, in acquisition of machinery or market introduction of innovation.

3.5. Analysis of the effects of firms networks in the process of cross-border technological diffusion. (Coordinator: CRENoS; other partner: WU, HSE. Task 4.4)

There is a large consensus among researchers and policy makers on the idea that technological innovation is one of the key driver for a successful economic performance at the national and regional level. A large body of the literature has also highlighted that the stock of knowledge available in an economy can be the result of an internal effort to produce new technology but it may also take place from a process of technological diffusion of external knowledge. This process of absorption of external knowledge can be generated from several types of interactions carried out by the economic agents: participation in research programs, co-patenting, co-publications, patent citations, inventors mobility, firms agreements. All these interactions give rise to social links and networks among firms, inventors and researchers which facilitate the exchange of knowledge and the diffusion of technological innovation. In this task we have analysed these issues in six scientific papers (see Annex 2 for a detailed analysis of each contribution) looking in particular at the role of firms agreements, research cooperation and patent citations in the EU and ENC.

The analysis of firms agreements over the period 2000-2012 (Task 4.4B) is based on the SDC Platinum database which covers Merger and Acquisition (M&A), Joint Ventures and Strategic Alliances. Results show that firms’ agreements represent an important channel of knowledge exchanges generated along the variety of activities carried out before, during and after the deal. The ENC market is still immature in terms of numbers of transactions, with a significant share of transactions announced but not completed. Moreover firms in ENC are definitely more active in M&A than in alliances, and more often act in the deals as a target rather than as a bidder. In some countries (Libya, Syria, Egypt, Azerbaijan and Belarus) the share of announced transactions which are actually completed is quite low signalling a situation of uncertainty linked to the political situation, high corruption and low indexes in easiness of doing business, which makes more difficult the completion of the acquisitions, especially for the international deals. In some countries there is a resistance to international integration due to political and institutional factors and also for the fear of giving too much control to foreign multinationals. Focusing on the international M&A and alliance we observe that cross-border transactions and thus technological flows are affected by the historical, cultural, political, economic and geographical links. In general, firms entering in markets characterized by cultural and political differences come across an increase in the costs and risks associated with the transactions. A regression analysis based on zero-
inflated negative binomial (ZINB) models indicates that the probability of observing a deal among EU and ENC is positively related to the relative masses (population) and the economic development level (GDP per capita) of the acquirer and target countries, while it is negatively related the distance measures. In essence, if two countries are very distant in terms of spatial, cultural, and institutional dimensions, thus it is very high the probability that they will not conclude a bilateral deal and thus that they do not benefit from a knowledge flows.

A more specific analysis of knowledge flows among EU and ENC based on patent citations is carried out in Task 4.4A. Results show the limitations of ENC in relying on innovative knowledge flows from FDI. While EU accession countries quickly established important links to patent knowledge bases in the EU15, the ENC regions appear to have steadily lost such linkages over a 30 year period with the EU15, with North America, with Japan, and even within ENC regions. The sole exception is a very slow growth of knowledge linkage with the EU accession countries from an extremely small base. Much more effort will be required to enable ENCs to adopt and incorporate external patent knowledge into the design and production of important goods and services. ENCs appear to have steadily withdrawn from the orbit of advancing innovations just as the EU hopes to implement its ENP.

A detailed study survey on cross-border innovation cooperation of the Russian firms (Task 4.4C) indicates that the economic interactions among Russian and EU firms are still predominantly determined by traditional channels of export and import. Despite a certain improvements in terms of international trade and technology transfer since the beginning of transition to market economy in Russia, there are still relevant improvements which can be made to reinforce the collaboration among EU and Russia in terms of science, technology and innovation activities. The main specificity of international cooperation compared to the domestic networking is the concentration on process and organizational innovations as the main objective of co-development. In the joint activities Russian companies tend to bring in production capacities and technological skills while their partners are expected to bring in technology capital (machinery and equipment) and knowledge of the international markets.

In conclusion, for the neighboring countries the prospective of cross border knowledge flows due to inter firms agreements and innovation networks is very important and potentially rewarding. However the ENC still face some difficulties and impediments in getting engaged with appropriate knowledge bases and to thus take a full advantage of these potential benefits due to the presence of large differences in terms of institutional, cultural, social and economic risk factors.

3.6. Analysis of European R&D collaborations in EU research Framework Programs.

(Coordinator: HSE; other partner: UJM-GATE; GKK. Task 4.5)

The fundamental role played by research networks on innovation diffusion has been confirmed by previous results yet. In this section, which includes 3 papers, researchers have analysed the spatial and temporal evolution of R&D collaborations in EU Framework Programs in order to evaluate a potential policy option for the EU to promote the involvement of EU neighbour regions in research networks. In this sense, the results are important for EU policy in the perspective of creating a Knowledge Space and favouring regional convergence.

Regarding the impact of R&D collaboration on regional innovation performances, our results point to positive and significant impact, but this impact is not systematic. The results of the knowledge production function including both spatial and relational neighbourhoods suggest that external knowledge matters for innovation and additionally it shows that two different types of neighbourhoods play an equally important role as a source of external knowledge. To this regard, our results corroborate past studies on the role played by space in knowledge diffusion. In addition, it
shows that the EU policy implemented through the Framework Programmes appears as an effective way to diffuse knowledge among European regions. The study also reveals that although the effect of contemporaneous flows from neighbours is small in magnitude, they are in play in time because evidence is found on the effect of past inventive activity on the current inventive activity. This highlights the necessity of considering dynamic effects for a more a proper assessment of the importance of knowledge flows from neighbourhoods. This means that the weak cross-sectional dependence may prove to have important impacts on the long run, due to the temporal dependence. This can therefore explain the existence of regional clusters with persistently different levels of innovative activity.

But the positive impact of inter-regional flows of knowledge is not systematic. First of all, some regions remain weakly integrated into these global networks. Peripheral regions (in geographical terms as well as in relational terms) may thus suffer from a difficulty to access external knowledge. Secondly, among connected regions, clear and marked differences exist between CEE-Obj 1 and non-CEE regions. While knowledge transferred from FP networks acts as an additional input of patenting in CEE-Obj 1 regions, network knowledge has no any role in patenting in regions of the old member states. On the other hand it is clear that localized learning is extremely important for regions located in EU 15 for patenting while knowledge flows from neighbouring regions play no role in CEE Obj 1 regions’ innovation. Thus it was concluded that since they can rely more on local knowledge inputs participating in FP programs does not appear relevant for patenting in regions of old member states (at least not in IST). On the other hand, since local sources are not supportive enough for innovation in CEE Obj 1 regions, they tend to rely more on external knowledge transferred from research networks in innovation. Our findings are important as they suggest that strengthening research excellence and international scientific networking in relatively lagging regions (such as regions in CEE and ENP countries) could be a viable option to increase regional innovativeness, which in combination with other policies could form a base for a systematic support of regional development.

In order to include ENC and to study all the fields covered by the EU Framework Programs, other contributions have shift the focus from regional to national data. They provide deep scrutiny of the structure of the R&D collaborations looking specifically at the EU-EECA and EU-Russia project cooperation under FP5-7 in the period 1998 –2012. The overall number of joint S&T projects jointly implemented by EU and EECA countries has increased from FP5 to FP7 indicating a growing mutual interest in the S&T cooperation as well as in joint participation in the EU RTD Framework Programmes. The analysis showed intensive development of the cooperation in such priority scientific areas as Information and Communication Technologies (ICT), Environment, Health and Social Sciences and the Humanities, as well as in the area of International Cooperation (INCO). The analysis of types of EU and EECA organisations involved into joint FP5-7 projects showed that the most intensive S&T collaboration has been between Research and Higher Educational Institutions of the EU and EECA countries. It should be noted that the number of firms involved increased during the implementation of FP-7. More close cooperation between EU and EECA Research, Higher Educational and Industrial Organisations could lead to further improvement of the EU-EECA cooperation in the sphere of innovation. At present time Russia is the most successful and international S&T cooperation 3rd partner country in terms of the total number of participations in the programme, the total amount of EU financial contribution received and the number of collaborative actions launched. Russia cooperated with nearly all the EU MS within FP5-7 but the major three partners of Russia were Germany, France and the UK in the areas of ICT, Nanotechnology and INCO areas. Case-studies on the functioning of EU-EECA research networks allows to identify the added value and the barriers to EU-EECA collaboration. Among the main three categories of added value generated within the research networks partners indicate: a) establishment of EU-EECA research networks; b) promotion of EU
Framework RTD Programme in EECA countries; c) relevance of the project research area to the country S&T priority. Among barriers hampering to setting-up and implementation of international research: a) lack of financial support for international cooperation, b) lack of personal contacts in international research networks, c) difficult to access international networks and platforms for researchers. The results of the case-study will be used to shape recommendations on how to overcome the barriers and improve S&T cooperation among countries involved into international research.

4. Final Remarks

The general objective of this Work Package is to investigate on the innovative performance of countries and regions in the European Union (EU27) and in the European Neighbouring Countries (ENC). We aim at understanding to what extent this performance depends on the one hand on the endogenous ability in knowledge creation and on the other hand on the absorptive capacity to adopt and imitate other regions’ innovations taking advantages of various form of research and technological networks.

In particular we analyse how internal and external factors (such as human capital, social capital, institutions, public policies, spatial spillovers) affect the innovation activities and, consequently, the regional economic performances. Moreover, we focus on the process of innovations diffusion and research networking in order to assess to what extent the EU and EN countries have established valuable collaboration procedures. Throughout the analysis we have devoted specific attention to the economic dynamics of those countries (and regions) which have recently entered the EU in order to conjecture on the evolution process which may involve in the near future the neighboring countries due to the reinforcement of the integration process. In all the contributions the ultimate purpose of the research activities has been to derive useful policy recommendations at both the European and the EN countries level.

Main results highlight the important role of knowledge diffusion and research networks by enhancing the regional innovation endowment in both EU countries and EN countries although with a high degree of heterogeneity.

Considering the determinants of innovation, our results confirm the widespread consensus that the transfer of knowledge is significantly favoured not only by spatial closeness among agents involved in the innovation process, but also by the intentional relations they develop within a-spatial networks, such as those shaped by institutional, technological, social and organizational links. Cooperation among firms turns out to be the main determinant of innovation adoption and a key role seems to be played by the level of trust among people within each country, by the simplification procedures, as well as by high educational levels. The presence of a-spatial relationships like institutional, historical, cultural, cognitive, social and organizational links has been proved to facilitate also the exchange of knowledge fostering innovation diffusion and the creation of research networks.

Looking at the cross border knowledge flows, it appears that the degree of internationalization of innovative activities is extremely limited among countries which have a very different economic background and level of development. Nonetheless the relationships are increasing along time and especially the largest countries are becoming important partners for the European countries. Results show also that firms’ agreements represent an important channel of knowledge exchanges generated along the variety of activities carried out before, during and after the deal.

Regarding the impact of R&D collaboration on regional innovation performances, the results point to positive and significant impact, but this impact is not systematic. More specifically, the analysis of EU-EECA and EU-Russia project cooperation under FP5-7 shows that the overall number of joint S&T projects jointly implemented by EU and EECA countries has increased over time. It indicates also
growing mutual interest of the EU and EECA in the S&T cooperation as well as in joint participation in the EU RTD Framework Programmes.

In conclusion, for the neighboring countries the prospective of cross border knowledge flows due to inter firms agreements and innovation and research networks is very important and potentially rewarding. However the ENC still face some difficulties and impediments in getting engaged with appropriate knowledge bases and to thus take a full advantage of these potential benefits due to the presence of large differences in terms of institutional, cultural, social and economic risk factors.

5. Potential impact

In order to achieve all the objectives of WP4, the effort made by the researchers involved has been twofold. First, the scientific contribute has been highly significant with the production of 28 scientific contributions. Moreover, taking into account one of the main objective of the SEARCH project, for each scientific contribution we have derived a policy note in order to give policy suggestions to policy makers and social stakeholders, such as NGOs, associations and networks working in fields closely related with neighbouring countries.

For what concerns the scientific contribute, the starting point has been the description of innovation endowment in ENC and research networks looking at the existing relationships among EU countries and ENC. The database built with this aim, freely available and distributed under the Search Open Data tool, and the results discussed in the previous sections are a chance to deeply develop research on this issue. Then, this Work Package has made possible opening a round table where researchers belonging to seven different institutions and seven different countries, highly specialized on the issue of innovation, were able to compare and to give their contribution with the aim of involving other researchers and policy makers from other institutions in order to extend the current research but also to replicate and validate our policy analysis.

It is worth remarking that scientific results are the tools to derive policy implications which are one of the main goals of the SEARCH project. In this sense, the WP4 research activity has been aimed to formulate policy suggestions for EU and its Neighbourhood policy about the determinants of innovation and its diffusion process. Moreover these results could be the basis to evaluate which could be the future impact related to the possible EU enlargement.

Among the traditional determinants of innovation, widely accepted in the literature, we have been able to classify them on the basis of their efficiency in enhancing innovation in ENC. This result is of great importance because, in terms of EU Neighbourhood policy, it could help policy makers to choose the most efficient tool to support the easiest growth path.

Results about the diffusion of innovation and research networks, have shed light on the importance of past relationships among countries. The presence of a-spatial relationships like institutional, historical, cultural, cognitive, social and organizational links has been proved to facilitate also the exchange of knowledge fostering innovation diffusion and the creation of research networks. Also in this case this result should be taken into account if the goal is to make easier the innovation diffusion process. As a matter of fact, such a diffusion can be enhanced when economic agents in different context can communicate more easily and reduce knowledge barriers, either tangible or intangible. In other words, proximity among agents and firms can lessen transaction costs and facilitate knowledge transmission.

Another result, among many others, which could have an important policy impact is the one related to the EU policy implemented through the Framework Programme. Results show that it appears as an effective way to diffuse knowledge among European regions. But our results also suggest that the positive impact of inter-regional flows of knowledge is not systematic. Peripheral regions (in
geographical terms as well as in relational terms) remain weakly integrated into these global networks and thus suffer from a difficulty to access external knowledge. Thus, if we consider ENC regions close to the peripheral ones, we should take this result into account by considering and organising the participation of extra-EU institution into Framework Programme as a mean to diffuse knowledge.

6. Further research

Overall the extensive research carried out in WP4 with 28 research papers produced has allowed to reach relevant achievements with respect to the existing literature improving the understanding of the key mechanisms behind the production and exchanges of knowledge among EU and ENC. Given the importance of external cooperation and knowledge transfer to enhance the internal technological capacity of ENC, future research has to be devoted to deeper analyse at the micro level how the potential interconnections among economic agents (workers, firms, research centres, institutions) are affected by the external environment in terms of economic, institutional and social conditions.

7. Deviations from initial proposal

With respect to the initial proposal, we have been able to follow the planned research project. However, in some parts of the research we had to change the territorial unit of analysis due to the lack of data for the ENC at the sub-national level. Moreover, the innovation activity, for most EN countries, is quite negligible and thus a regional breakdown would have been of limited significance.
Annex 1: List of working papers by tasks

Task 4.1: Technological activities of countries and regions
Usai S., Dettori B., Gagliardini E. The technological activity of neighbouring countries: a preliminary overview. WP4.0
Marrocu E., Paci R. and Usai S. Knowledge production function and proximities. Evidence from spatial regression models for the European regions. WP4.1
Fodzi M., Usai S. Technological catching up among European regions. Lessons from Data Envelopment Analysis. WP4.2
Usai S., Dettori B., Gagliardini E. A country-level knowledge production analysis with parametric and non parametric methods. WP4.3
Golikova V., Gonchar K., Kuznetsov B. The effect of internationalization on innovation in the manufacturing sector. WP4.4
Liargovas P. Do Business Incubators and Technoparks affect regional development? A comparative study in the EU27 and the NC16 countries. WP4.5
Montmartin B. Business-funded R&D intensity: impact and complementarity of public financial support. WP4.6

Task 4.2: Descriptive analysis of knowledge diffusion and research network
Moreno R., Autant-Bernard C., Chalaye S., Manca F., Suriñach J. Design and construction of a set of indicators for innovation production and adoption in EU countries. WP4.7
Moreno R., Suriñach J. Characterisation of innovation adoption in Europe. WP4.8
Autant-Bernard C., Guironnet J. and Massard N. Determinants of innovation diffusion in the EU: A microeconometric analysis of firms’ innovation adoption choices. WP4.9
Dettori B., Gagliardini E., Usai S. Knowledge networks and internationalization of innovative activity across European and Neighboring countries. WP4.10
Ondos S., Bergman E. European Integration as Policy Metaphor for future EU-EN Knowledge Sharing. WP4.11
Sebestyén T., Varga A. Interregional Knowledge Network Quality and Research Performance: Do Objective 1 and EU 12 Border Regions Follow Different Patterns than the Rest of Europe? WP4.12
Autant-Bernard C., Chalaye S. Knowledge diffusion between European Neighboring Countries and the European Union. WP4.13
Mazurin A., Pikalova A. Analysis of knowledge diffusion and EU-Neighbouring Countries research networks based on the outcomes of interviews with INCO projects’ consortium members. WP4.14
López-Bazo E., Motellón E. Firm exports, innovation, ... and regions. Lessons from Spain. WP4.19
Di Guardo M. C. and Paci R. Firms’ alliances in the European Neighboring Countries. WP4.15

Task 4.3: The effects of Internal Market and Intangible Assets on innovation diffusion
Manca F., Moreno R. and Suriñach J. The role of the EU Internal Market on the adoption of innovation. WP4.16
Moreno R. and Suriñach J. Study of the impact of the IM and the diffusion of knowledge on productivity change and economic growth. WP4.17
Miguélez E. and Moreno R. Do labour mobility and technological collaborations foster geographical knowledge diffusion? The case of European regions. WP4.18

Task 4.4: The effects of firms networks in the process of cross-border technological diffusion
Ondos S., Bergman E. Emerging Knowledge Networks: EU-ENC Patent Citation Links WP4.20
Usai S., Marrocu E., Paci R. Networks, proximities and inter-firm knowledge exchanges WP4.21
Di Guardo M. C., Marrocu E., Paci R. The Concurrent Impact of Cultural, Political, and Spatial Distances on International Mergers and Acquisitions WP4.22
Di Guardo M. C, Paci R. Firms’ transactions and knowledge flows in the European Union’s Neighboring Countries WP4.23
Kuznetsova T., Roud V., Bredikhin S. The collaboration activities in the innovation system of Russia WP4.24

Task 4.5: The effects of research networks within the EU Framework Program
Varga A., Sebestyén T. Does EU Framework Program participation contribute to regional development? A comparative spatial analysis of FP network quality and patenting in CEE Objective 1 regions WP4.26
Pikalova A., Korobeynikova M. Assessment of EU-EECA and EU-Russia research cooperation under the EU Framework Programmes for Research & Development WP4.27
Annex 2. Working paper title and abstract by tasks

Task 4.1: **Technological activities of countries and regions**

Usai S., Dettori B., Gagliardini E. *The technological activity of neighbouring countries: a preliminary overview.* **WP4.0**

The purpose of this paper is to offer a preliminary descriptive overview of the technological activity of the European Neighbourhood Countries (ENC) based on the few available information. Furthermore, we aim at making a comparison between EU and EN countries but also among EN countries and two geographical areas: South and East. The idea is to start developing a set of information to illustrate, even though partially and incompletely, the national innovation systems of each ENC (Lundvall, 1992, Pavit, 1994). Technological indicators are usually divided into two main groups: input and output indicators. As the main input variable, we employ R&D expenditure (million of dollars and as a percentage of GDP) and as output indicators we use patents applications. R&D is considered to be the most important innovative input indicator and it is defined as the creative work undertaken systematically with a view to increase the stock of knowledge, and, thanks to its use, to devise new applications. As for output indicators, patents are expected to measure the return resulting from the technological activity of individuals and firms and are used as a proxy for R&D effectiveness. We consider both patent applications at the European Patent Office (EPO) and international applications under the Patent Cooperation Treaty (PCT) for each country. Patent statistics include breakdowns by applicants and inventors and by some selected sectors.

Marroc E., Paci R. and Usai S. *Knowledge production function and proximities. Evidence from spatial regression models for the European regions.* **WP4.1**

This paper aims at investigating the connections among regional innovation systems along several proximity dimensions. In particular, we assess if, and how much, the creation of new ideas in a certain region is the result of internal efforts as much as of knowledge flows coming from other regions which may be considered neighbors not only in the geographical space but also in the institutional, technological, social and organizational one. The analysis, based on spatial econometric techniques, is implemented for an ample dataset referring to 276 regions in 29 European countries (EU27 plus Norway, Switzerland) for the last decade. Results attest the importance of exploiting relationships with spatially close-by regions but also with technologically proximate regions which may prove geographically very distant. This implies that, no matter whether the knowledge flow is due to collaborations, imitation or workers mobility, there is a global perspective which goes beyond the regional and the national systems of innovation. Global networks connecting regions which share a similar specialization pattern and therefore the same cognitive and technological base may be as crucial as local cluster of regions in enhancing technological advance. On the whole, regional system of innovations have to be effective not only in exploiting their internal production of ideas based on R&D investments and human capital but also in creating synergies with other regions to absorb part of their knowledge and expertise. This interpretative scenario is crucial for regions in the European Neighboring Countries since it enlarges the potential basin of knowledge externalities which may help their technological catching up with respect to advanced regions in the European Union.
Foddì M., Usai S. *Technological catching up among European regions. Lessons from Data Envelopment Analysis*. WP4.2

Europe’s 2020 strategy and the initiative “Innovation Union” call for a particular attention to the territorial dimension of innovation and knowledge creation. To this end, this paper investigates the nature of knowledge production and diffusion among regions in 29 EU countries and tries to assess its effectiveness. Data Envelopment Analysis is thus applied to assess how efficiently European regions use internal and external inputs for the production of new knowledge and ideas. The analysis produces a ranking of the innovative performance of EU regions for two points in time: the beginning of the current century and the second part of this decade. This ranking is then evaluated through the Malmquist productivity index in order to assess the relative importance of its main components. The Data Envelopment Analysis provides further evidence of a dualistic (centre vs. periphery) pattern in the regional innovation activities, with the most efficient territories located in the most central or economically strategic areas of the continent. The application of the Malmquist productivity index shows that both the magnitude and intrinsic features of the productivity dynamics are extremely differentiated across regions. Again, we observe important differences between the core and periphery of Europe and, more specifically, between the rich and industrialized countries which form the so called “Old Europe” and the relatively poorer ones which have entered the European Union quite recently. This scenario provides some interesting lessons for European neighbouring countries and regions which are going to play the role of the New Europe in the foreseeable future.

Usai S., Dettori B., Gagliardini E. *A country-level knowledge production analysis with parametric and non parametric methods*. WP4.3

Economic growth, according to both applied and theoretical economists, is not entirely dependent on traditional production factors endowment, such as physical capital and labour, but more and more related to the stock of intangible resources such as culture, competence, innovative capacity, knowledge. Our main aim is, consequently, to provide an exploratory analysis on the phenomena of knowledge creation and diffusion in Europe and its neighbours at the country level. We firstly describe the innovative activity across countries in order to make available a comprehensive picture of this phenomenon across and beyond Europe. We analyse both input (R&D expenditure) and output indicators (patent applications) for the 27 European countries and the 16 European Neighbouring Countries. Moreover, we analyse the main factors influencing the innovation process. We pursue this aim by adopting both parametric and non-parametric methods to investigate about the knowledge production function at the country level. The analysis is mainly speculative because the absence of information about some potentially important phenomena, such as human capital, may hinder our results and conclusions. Nevertheless, main results are robust and confirm previous analysis at the country and regional level. Moreover, they add some original finding about the potential for catching up of European Neighbouring Countries.

Golikova V., Gonchar K., Kuznetsov B. *The effect of internationalization on innovation in the manufacturing sector*. WP4.4

This paper examines how Russian manufacturing firms respond to international trade with product innovations, R&D expenditures and technologies’ upgrade. The discussion is guided by the theoretical models for heterogeneous firms engaged in international trade which predict that as more productive firms generate higher profit gains, therefore they are able to afford high entry costs, while trade
liberalization encourages the use of more progressive technologies and brings higher returns from R&D investments. We test the theory using a panel of manufacturing Russian firms surveyed in 2004 and 2009, and use export and import entry indicators to identify the causal effects on various direct measures of technologies’ upgrade. We found that probability of the firm to invest in R&D depends on the prior experience in international trade – both export and import. Importing tends to have stronger learning effects than exporting. Imported input stimulates R&D less than machinery import. Continuous traders are more likely to introduce all three types of innovation. However, we cannot identify any impact of government or foreign ownership on learning-by-exporting or importing effects. Firm location in the border region is irrelevant for the power of links between trade and innovation behavior.

Liargovas P. Do Business Incubators and Technoparks affect regional development? A comparative study in the EU27 and the NC16 countries. WP4.5

This working paper deals with the incubation phenomenon (i.e. business incubators and technoparks in the EU27 and NC16. The indisputable importance of incubators has been the focus of much research since the mid 1980s placing emphasis on a number of main topics and research questions. One of the most important questions regarding the role of incubators and the incubation process relates to their effectiveness as a regional and local development strategy that might achieve economic growth and social cohesion among the peripheries of developed countries. This is important as regional development and cohesion is the umbrella concept used by the EU and member states to support the increasing amount of funds directed towards the development of incubators. It is widely acknowledged that incubators are a technology transfer mechanism and a means of promoting entrepreneurship and the commercialization of new knowledge and innovations. The associational positive impacts of business incubators are usually measured by their contribution to job and wealth creation, outcomes resulting from accelerating the value-added process inherent in supporting small and medium sized enterprises (SMEs) which are the vehicle of an economy’s growth potential. Recent research findings bring the spatial context into the analysis of the critical determinants for incubators’ success, suggesting that it is favourable environments that will benefit most from the presence of business incubators. In line with this view, we argue that incubators might contribute to regional performance, subject to the existing regional endowments base. In other words, the operation of business incubators might enhance regional performance through the generation of multiplier effects but we might anticipate that these multiplier effects will be higher the more endowed a region is. This study analyzes empirically the incubation activity in EU27 and NC16 countries by bringing into the analysis three dimensions, namely the type of incubators, the intensity of their activity and the spatial context within which incubators are embedded. We estimate three intensity indicators for business incubators and technoparks activity and use both a uniform and a weighted rank order of the EU27 and NC16 member countries to illustrate regional differences in the intensity of incubation activity within the EU. Exploratory analysis reveals that a region’s endowments base differentiates its ability to benefit from additive effects generated by the presence and operation of business incubators.

Montmartin B. Business-funded R&D intensity: impact and complementarity of public financial support. WP4.6

There are relatively few studies that measure the macroeconomic effect of financial support policies on private investment in R&D. By distinguishing direct and indirect measures, the objective of this
paper is to analyse the individual effect and the complementarity of these policies. The complementarity is studied in two ways: the complementarity between instruments and the complementarity between jurisdictions. Using a database covering 25 countries of OECD over the period 1990-2007, our dynamic panel data results show that only indirect support (tax incentives) affect directly and significantly the business-funded R&D intensity. Even though direct support (subsidies, loans) do not have any significant individual effect on business R&D, it seems that their strengthening would be detrimental to the effectiveness of indirect support. Indeed, our results show that direct and indirect support are substitutes for stimulating private investment in R&D. Finally, the fact that foreign policies for R&D do not influence the level of private investment in R&D in a country supports the idea of a jurisdiction’s complementarity at the national level.

Task 4.2: **Descriptive analysis of knowledge diffusion and research network**

Moreno R., Autant-Bernard C., Chalaye S., Manca F., Suriñach J. *Design and construction of a set of indicators for innovation production and adoption in EU countries.* WP4.7

Based on the Community Innovation Survey, this paper suggests new indicators of innovation adoption. The magnitude of innovation adoption is assessed for 22 EU countries and different industries (none of the ENCs are present in the CIS). The most striking feature is the correlation between the innovation activities and the adoption rate. Countries with strong R&D and human resources and high innovation output exhibit the highest adoption rates. This supports the idea that innovation adoption requires an absorption capability. In addition, the specificities of each country regarding the prevailing types of innovation and adoption (product or process, cooperation-based adoption or internal adoption) allow us to draw a typology of the EU countries, for which a specific geographical pattern is observed. Finally, based on our experience working with CIS, we offer some recommendations for improvements in the design of the questionnaire that would allow better coping with the construction of innovation adoption rates for a bigger group of countries.

Moreno R., Suriñach J. *Characterisation of innovation adoption in Europe.* WP4.8

The main aim of the present study is to provide a descriptive statistical analysis of the diffusion process at the EU level using indicators of innovation adoption that can be obtained from the information available in the Community Innovation Survey (CIS). In particular, we examine innovation adoption at the country level using the information contained in the CIS3, CIS4, CIS2006 and CIS2008. This way, we will highlight the dynamics of innovation adoption across EU member states for the different time spans of the CIS. Although we are also interested in knowing which is the innovation adoption process in the European Neighbouring Countries (ENCs) compared to that of the EU countries, the statistical information in CIS does not cover any of the ENCs. Therefore, since this task can not be tackled with the statistical information available, we will try to proxy for it doing a comparison between the innovation adoption processes followed in the core countries compared to that of the new member states.

Autant-Bernard C., Guironnet J. and Massard N. *Determinants of innovation diffusion in the EU: A microeconometric analysis of firms’ innovation adoption choices.* WP4.9

Using a sample of 45 674 EU firms from the Community Innovation Survey, this paper analyses the drivers of innovation adoption. In contrast to most empirical studies on innovation diffusion in which a
specific technology is analyzed, this study covers several countries and industries in the European Union. Following Van de Ven and Van Praag (1981), Heckman’s method is applied in a context of binary endogenous variable to explain the choices made by firms regarding innovation. Distinctions are made between the internal generation of innovation and the adoption of innovation produced by others, as well as between different types of adoption (cooperation-based adoption vs. isolated adoption). The study focuses on the impact of users’ features and their cooperation with suppliers on the adoption choices. The results point out that cooperation is a key driver of adoption choices. Usual determinants such as firm size, absorptive capability or exports would foster generation of innovation instead of adoption. In addition, the distinction between Old and New EU countries show that the innovation gap between these two groups of countries would rely more on the lack of absorptive capacity and export exposure of the former than on a division of the innovation process in which Old EU countries would generate innovation and New EU countries would adopt them.

Dettori B., Gagliardini E., Usai S. Knowledge networks and internationalization of innovative activity across European and Neighboring countries. WP4.10

The recent resurgence of growth studies has clearly established that technological progress and knowledge accumulation are among the most important factors in determining the performance of regional and national economic systems. In particular, it is clear that the success of lagging poor countries is strongly influenced by the capacity to absorb knowledge and technologies from rich industrialised countries. Nonetheless, few empirical studies have tried to analyse directly knowledge flows between the group of advanced and the group of developing economies, mainly because of the lack of adequate indicators.

In this paper we propose original, exploratory evidence on the characteristics of knowledge flows of European Neighbouring Countries (ENC) based on a statistical databank, set up by CRENoS, on patenting and citations at the European Patent Office and at the Patent Cooperation Treaty according to the place of residence of either the inventors or the applicant. We consider the 16 European Neighbouring Countries and their relationships with European Union, with the United States, with Japan and with other ENC’s. We also use data provided by WIPO, which distinguish patents at National Patent Offices according to the residence of applicant. We, therefore, use four proxies for knowledge flows across countries, the former three are based on patent at PCT and EPO whilst the latter refer to National Patent Offices: a) in- and out-flows of patent citations; b) cooperation links due to partnerships in the inventive activity; c) relationships between applicants and inventors; d) non resident patents at National Patent Offices. The analysis is mainly descriptive and aims at unfolding the main characteristics of this phenomenon.

Ondos S., Bergman E. European Integration as Policy Metaphor for future EU-EN Knowledge Sharing. WP4.11

This paper focuses tightly on how EU post-accession countries and regions evolved in their reliance upon and growing participation in beneficial knowledge flows that result from the information embedded in patent citations from advanced countries. In this paper we illustrate one aspect of the cross-border knowledge flow process more fully in situations structurally similar to future ENP circumstances. Relying upon OECD’s patent data base and network analytics, we note patent citation in Europe included more than 200,000 citation links between 1999 and 2008, about 48% occurring in the first 5 years and 52% in the second 5 year period, an increase of about 7%, of which 10,500 patent citations crossed the East-West border and grew more rapidly (23%) between the periods.
Communities of reciprocal patent citation observed in Europe are likely to evolve over time, eventually to include ENP countries, particularly the advantageously favored regions and those closest to borders. These are also the places most likely to cite patents in different patent classes as novel circumstances generate new innovations. The effects of other closely-related ENP initiatives will influence which ENC regions can take fullest advantage of potential knowledge flows within relevant citation exchange communities. Developing ENC regions are expected to be citationknowledge consumers in early rounds, similar to accession country experience, a dependence which may continue indefinitely for all but the most advanced or technically-specialized ENC regions, although more standardized industrial process and business practice technologies could benefit ENC border regions initially from physical proximity. The possibility that cross-border agents may be better positioned to take advantage of new innovative possibilities by cross-citing patent classes should be exploited with absorptive capacity measures in ENCs.

Sebestyén T., Varga A. Interregional Knowledge Network Quality and Research Performance: Do Objective 1 and EU 12 Border Regions Follow Different Patterns than the Rest of Europe? WP4.12

This paper estimates the impact of interregional knowledge flows on the productivity of research at the regional level with a particular attention given to Objective 1 and EU 12 border regions in this respect. The highlight of this latter aspect is related to the neighboring country focus of the SEARCH project. We apply the novel index of ‘ego network quality’ in order to measure the contribution of knowledge accessed from the interregional network to the production of new knowledge inside the region. Quality of interregional knowledge networks is related to the level of knowledge accumulated by the partners, the extent of collaboration among partners and the position of partners in the entire knowledge network. Ego network quality impacts on the productivity of research in scientific publications and patenting at the regional level are tested with co-patenting and EU Framework Program collaboration data for 189 European NUTS 2 regions. Though it is not possible to directly test the effects of co-patenting and FP network quality on EU neighboring countries we were able to get some estimates by testing the impacts of co-patenting and FP network quality on research productivity of NUTS 2 regions which possess the characteristics of EU neighboring countries in two respects: first, their GDP per capita is below the 75% or EU average (Objective 1 regions) and second, they are located at the border of the old EU 12 territory (border regions).

Autant-Bernard C., Chalaye S. Knowledge diffusion between European Neighboring Countries and the European Union. WP4.13

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.

Mazurin A., Pikalova A. *Analysis of knowledge diffusion and EU-Neighbouring Countries research networks based on the outcomes of interviews with INCO projects’ consortium members.* WP4.14

Strengthening of regional and multilateral co-operation between the European Union (EU) and neighbouring countries (NC) and shaping of a framework for its further development is a core task of the European Neighbourhood Policy (ENP). Analysis of knowledge diffusion and EU-NCs research networks helps to find out how the cross-border knowledge transfer activities affect innovation activities and thus regional economic performances, and how they should be improved to develop mutually profitable relationships among EU and neighbouring countries. The analysis of barriers hampering to knowledge spread and research networking allows to formulate policy recommendations for strengthening knowledge flows within EU territories and their wider neighbourhood regions. A specially designed questionnaire (Annex III) was addressed to consortium members of INCO projects implemented under the EU Framework RTD Programmes. Collected data was analysed and used for development of recommendations for both the EU and the NC policymakers adequately to the SEARCH project’s objective of identifying policies that will strengthen the relationship between the EU and the NCs. The presented report contributes to implementation of Task 4.2 “Descriptive analysis of knowledge diffusion and research network” of SEARCH project and introduces results of the interviews conducted with INCO projects’ consortium members. International collaboration networks initiated under EU Framework RTD Programmes ensure knowledge diffusion and research networking between the EU and NCs thus promoting innovation diffusion that is considered as a very complex phenomenon.

Di Guardo M. C. and Paci R. *Firms’ alliances in the European Neighboring Countries.* WP4.15

In the last two decades Merger & Acquisition (M&A) activities worldwide rose to an unprecedented level mainly due to two factors: globalization and technological progress. M&A transactions, whatever is their motivation, generate potential knowledge flows between bidder and target firms that happen before, during and after the deal in the form of: information exchange in the due diligence phase and among managers; access to new technologies and organizational competencies; task and human integration; interaction of different organizational cultures; transfers of capabilities and resource sharing. Consequently, M&A transactions represent a valuable proxy for the exchange of knowledge across the geographical areas where companies are located offering therefore the opportunity to investigate into the knowledge flows between the European Union and its neighboring countries. The aim of the paper is to analyse in details the M&A deals in the European Neighboring Countries (ENC) in order to explore the knowledge flows between firms in those areas and external firms. More specifically, we will examine the geographical directions of M&As and their sectoral scope. Data on M&A deals are retrieved from the SDC Platinum database (Thomson Financial) considering the period 2000-2011. Taken together, M&A data provide interesting evidence on the overall market-level impact of M&A on ENC and thus on the knowledge links that have been generated.

López-Bazo E., Motellón E. *Firm exports, innovation, … and regions. Lessons from Spain.* WP4.19
This paper uses firm-level data for each of the Spanish NUTS2 regions to estimate the effect of product and process innovations on firm’s export performance. It shows that the firm’s propensity to innovate and its export activity vary substantially across regions. Remarkably, results prove that the effect of innovation on exports is far from regionally uniform. The gap in the propensity to export between innovative and non-innovative firms, conditional to other sources of firm heterogeneity, is shown to be particularly wide in regions with high extensive margin of exports. However, differences in the propensity to innovate do not originate regional disparities in the share of sales abroad by exporting firms. The evidence from Spanish firms allows us to derive some implications for the ENC. For instance, the effectiveness of the stimulus of firm’s innovation to increase the share of exporting firms in these countries, and the emergence of regional polarisation due to the concentration of exporting firms in the best-endowed areas of each ENC.

Task 4.3: The effects of Internal Market and Intangible Assets on innovation diffusion

Manca F., Moreno R. and Suriñach J. *The role of the EU Internal Market on the adoption of innovation.* WP4.16

In this paper we analyse the impact that the Internal Market (IM) may have had on the diffusion of innovation at the European level thanks to the adoption of (i) less restrictive trade policies, (ii) increase in cooperation in science and technology and (iii) increased competition. The idea is simple. By pursuing some general goals such as increasing trade integration, cooperation and competition, the IM reforms have also likely reshaped the incentives for innovation creation and its adoption across European member states. Therefore, as an important "side effect", the IM reforms may have indirectly led to an increase in the rate by which innovation has been adopted in the EU member states due to the better institutional framework provided by these reforms.

Moreno R. and Suriñach J. *Study of the impact of the IM and the diffusion of knowledge on productivity change and economic growth.* WP4.17

The idea in this research is to provide an empirical verification of the relationship between innovation adoption and productivity growth. Initially, we are going to provide evidence of the above-mentioned relationship through means of descriptive statistics and subsequently, we will study the real impact that innovation adoption may have on productivity growth through a regression analysis. The analysis is made with the statistical information provided by the Community Innovation Survey in its third and fourth waves.

Miguélez E. and Moreno R. *Do labour mobility and technological collaborations foster geographical knowledge diffusion? The case of European regions.* WP4.18

The goal of this paper is twofold: first, we aim to assess the role played by inventors’ cross-regional mobility and collaborations in fostering knowledge diffusion across regions and subsequent innovation. Second, we intend to evaluate the feasibility of using mobility and co-patenting information to build cross-regional interaction matrices to be used within the spatial econometrics toolbox. The present inquiry is a first step in this direction and estimates a knowledge production function (KPF) where geographical interactions occurring across regions in the production of knowledge are introduced. Specifically, a more meaningful modelling of these interactions through
inventors’ mobility and co-patenting data has been considered when building weights matrices to describe the strength of bilateral knowledge relations across European regions.

Task 4.4: The effects of firms networks in the process of cross-border technological diffusion

Ondos S., Bergman E. Emerging Knowledge Networks: EU-ENC Patent Citation Links WP4.20

Do patent citations in European Neighboring Countries (ENCs) constitute elemental links in knowledge networks that provide access to sources of innovation in EU15 and EU12 countries? We use OECD patent citation data to trace the implicit networks that originate in several categories of ENCs to the principal citation communities in the EU and to other ENC countries. ENCs are found to establish fewer and fewer links with patent knowledge bases everywhere in the last 3 decades—except for EU12 countries—and the latter linkages were gained very slowly from a small base. Patent citation links were, however, being rapidly established with advanced centers of patenting and innovation. This network topology was first explored in search for scale-free property, the power-law behavior of degree distribution indicating possible similarity with the Barabási-Albert model. Second, the evolution of a growing spatial network is focused in search for a mechanism of interplay between preferential attachment, technological and spatial structure.

Usai S., Marrocu E., Paci R. Networks, proximities and inter-firm knowledge exchanges WP4.21

Building on previous literature providing extensive evidence on flows of knowledge generated by inter-firm agreements, in this paper we aim to analyse how the occurrence of such collaborations is driven by the multi-dimensional proximity among participants and by their position within firms’ network. More specifically, we assess how the likelihood that two firms set up a partnership is influenced by their bilateral geographical, technological, organizational, institutional and social proximity and by their position within networks in terms of centrality and closeness. Our analysis is based on agreements in the form of joint ventures or strategic alliances, announced over the period 2005-2012, in which at least one partner is localised in Italy. We consider the full range of economic activities and this allow us to offer a general scenario and to specifically investigate the role of technological relatedness across different sectors. The econometric analysis, based on the logistic framework for rare events, yielded three noteworthy results. First, all the five dimensions of proximity jointly exert a positive and relevant effect in determining the probability of inter-firm knowledge exchanges, signalling that they are complementary rather than substitute channels. Second, the higher impact on probability is due to the technological proximity, followed by the geographical one, while the other proximities (social, institutional and organizational) have a limited effect. Third, we find evidence on the positive role played by networks, through preferential attachment and transitivity effects, in enhancing the probability of inter-firm agreements.

Di Guardo M. C., Marrocu E., Paci R. The Concurrent Impact of Cultural, Political, and Spatial Distances on International Mergers and Acquisitions WP4.22
The paper explores the concurrent effects of cultural, political, and spatial distances on M&A flows occurring between any two countries belonging to the whole European Union (27 States) or to the European Neighbors group (16 States) over the period 2000-2011. By employing zero-inflated negative binomial specifications, entailing both a binary and count process, we adequately model the two different mechanisms which may generate zero observations in the cross-border bilateral deals. Zeros may be due to either the lack of any transactions or unsuccessful negotiations. We find robust evidence that the multi-dimensional distance between two countries negatively affects the probability that they will engage in M&A deals, while the recurrence rate of these deals is positively related to population, gross domestic product, and technological capital and negatively related to geographical distance.

Di Guardo M. C, Paci R. *Firms’ transactions and knowledge flows in the European Union’s Neighboring Countries* WP4.23

The globalization process of production and technological activities has generated an unprecedented increase in the number of international transactions among firms which take the forms of Strategic Alliances, Joint Ventures and Mergers and Acquisitions. These transactions, whatever their nature and motivation are, generate knowledge flow among the companies involved that occur before, during and after the deal. Consequently, firms’ transactions represent a valuable proxy for the exchange of knowledge across the geographical areas where companies are located. The aim of the paper is to analyze in details the companies transactions and agreements in the European Neighboring Countries (ENC) over the period 2000-2011 in order to explore the geographical directions and sectoral characteristics of the knowledge flows among firms in those areas and external firms.

Kuznetsova T., Roud V., Bredikhin S. *The collaboration activities in the innovation system of Russia* WP4.24

Cross-border flows of knowledge are crucial factors determining the efficiency of national innovation systems. Under the conditions of global economy by no means can the countries rely on the sole in-house development and utilization of innovations. In case of Russian socio-economic environment, the practice of cross-border collaboration remains lagging behind the high demand one could expect due to a number of reasons. Some of them relate to geographical disconnection which is still significant although eased by the advancement in telecommunications and transportation. Others imply the unequal macroeconomic conditions as well as heterogeneity of innovation performance and potential of the regions and sectors.

This study employs an extended set of statistical indicators in order to characterize the heterogeneity of Russian innovation landscape at the regions adjacent to the EU. Patterns of cross-border collaboration of Russian enterprises are explored using the specialized survey covering innovation activities of 760 manufacturing companies. Several case studies act as illustrations for the empirical findings. This study contributes to the T4.4 “Analysis of the effects of firms networks in the process of cross-border technological diffusion and on the impact of the creation and diffusion of knowledge and innovation across regions” of the Sharing KnowledgE Assets: InteRregionally Cohesive NeigHborhoods (SEARCH) Project.

Task 4.5: *The effects of research networks within the EU Framework Program*

In this study, we focus on the effects of external knowledge on regional innovation performance by considering that the neighborhood that supply a region with external knowledge might be relational as well as geographical, and it may evolve in time. Following Autant Bernard and LeSage (2011), and Lee and Yu (2012) we worked on a Spatial Durbin model, which includes time varying weight matrices, and space and time lagged variables. Our empirical application bases on European data in the field of ICT and aims at quantifying the effect of spatial, temporal and spatio-temporal flows on the inventive activity of 226 regions during 2003-2009. The results suggest that external knowledge emanating from geographical and relational neighbors play an equally important role on the regional inventive activity. The magnitude of contemporaneous flows from neighbors is small but they are in play in time because past inventive activity affects current inventive activity.

Varga A., Sebestyén T. Does EU Framework Program participation contribute to regional development? A comparative spatial analysis of FP network quality and patenting in CEE Objective 1 regions WP4.26

ENP countries already have the opportunity to join EU Framework projects as scientific partners. The research question this paper raises is whether joining EU Framework programs exerts a spillover effect on the innovativeness of participating regions. The connecting question is whether ENP countries might later be in a position to utilize the knowledge they learn through FP participation for the advantage of their regions’ well being. To this aim we closely study the case of Central and Eastern European (CEE) Objective 1 regions. More concretely within the frame of a Romerian knowledge production function we test if the quality of regions’ individual FP networks has any relationship with regional patenting. We carry out the analysis with three samples covering the years 1998-2009: the whole EU (262 regions), CEE-Obj 1 regions (51 regions) and non-CEE regions (211 regions). The selected research area of study is information science and technology (IST). While analyzing the FP network impact we control for localized knowledge flows via a systematic panel spatial econometric methodology. We found that with respect to the role of localized knowledge flows and FP network learning in patenting clear and marked differences exist between CEE-Obj 1 and non-CEE regions. While knowledge transferred from FP networks acts as an additional input of patenting in CEE-Obj 1 regions, network knowledge has no any role in patenting in regions of the old member states. On the other hand it is clear that localized learning is extremely important for regions located in EU 15 for patenting while knowledge flows from neighboring regions play no role in CEE Obj 1 regions’ innovation. Thus we conclude that since they can relay more on local knowledge inputs participating in FP programs does not appear relevant for patenting in regions of old member states (at least not in IST). On the other hand, since local sources are not supportive enough for innovation in CEE Obj 1 regions they tend to rely more on external knowledge transferred from research networks in innovation. Our findings are important as they suggest that strengthening research excellence and international scientific networking in relatively lagging regions (such as regions in CEE and ENP countries) could be a viable option to increase regional innovativeness, which in combination with other policies could form a base for a systematic support of regional development.

Pikalova A., Korobeynikova M. Assessment of EU-EECA and EU-Russia research cooperation under the EU Framework Programmes for Research & Development WP4.27

The European Neighbourhood Policy (ENP) remains the basis on which the EU works with its neighbours to achieve the closest possible political association and the greatest possible degree of economic integration.
Knowledge creation precisely research and technological development (RTD) is a shaping basis of up-to-date economy and measures focused on responding to the global challenges. International RTD cooperation and transfer of knowledge is essential to reinforce research capacity of involved parties, to share respective resources and risks as well as to lay the foundation for joint innovative activities. EU RTD programmes are open for participation of scientists from any countries world-wide including the EECA countries and Russia in cooperation with the European researchers. The EU policy actively promotes integration of the EECA and Russian scientists into the European Research Area. The present paper offers assessment of EU-EECA and EU-Russia cooperation within FP5-7 (1998-2012) classified by country, by discipline and by type of organisation. The conducted assessment is based on the collection and systematisation of data on joint EU-EECA and EU-Russia projects extracted from the EU CORDIS Project database. The synergy with the FP7 IncoNet EECA and FP6 SCOPE-EAST projects has been used. The part on Russian participation in projects within FP7 includes data presented by the European Commission at the workshops. The Case-study of 5 functioning EU-EECA thematic research networks was carried out via a specially elaborated questionnaire addressed to EU and EECA partners of ongoing research projects under the 7th EU Framework RTD Programme. The Case-study contributed to analysis of the effects of EU-EECA thematic research networks, formed in the course of FP7 projects including identification of added value, success stories and barriers to EU-EECA collaboration. It helped to understand what barriers scientists face implementing joint research projects under EU Framework RTD Programme. The results of the assessment of EU-EECA and EU-Russia cooperation within FP5-7 and of Case-study used to shape recommendations on how to overcome the barriers and improve S&T cooperation among countries involved into international research.