5th IRIMA WORKSHOP
INDUSTRIAL RESEARCH AND INNOVATION MONITORING AND ANALYSIS

Top R&D investors: Productivity gains and technological profiles

11 June 2015

Background Paper

Based on company data collected from public accounts or obtained via dedicated surveys, the Commission has been analysing patterns and trends in corporate R&D and innovation activities for more than ten years[1]*. The EU Industrial R&D Investment Scoreboard*[2]*, published annually since 2004, monitors top EU based R&D investing companies benchmarking them with top investors located in other parts of the world, trying to understand their contribution to the competitiveness of the EU economy. The Scoreboard is complemented by an annual Survey*[3] *on these top EU R&D investors, providing a forward-looking perspective and direct insights from companies on important issues such as location strategies and perception on the effectiveness of policy interventions aiming at supporting firm's R&D and innovation activities. Results of further research (undertaken on Scoreboard data and on other sources available, such as Community Innovation Survey and commercial databases) are published in a series of working papers and policy briefs*[4]*.*

The objective of these activities is to support evidence-based policy development at European level and to accelerate innovation in the EU. The evidence collected has been exploited to provide insights on the global patterns and trends in corporate research and innovation activities and on their medium and long-term implications for the competitiveness of the EU.

During the fifth IRIMA Workshop that will take place in Brussels on 11 June 2015 we will aim at:

i) enhancing the understanding of the link between R&D investments and productivity at firm level;

ii) obtaining feed-back on the ongoing attempt to better define the location decision of Scoreboard companies by analysing the innovation and technological profiles of EU regions;

iii) discuss with policy makers, industry representatives and experts the elaboration of a policy relevant research agenda for the continuation of the IRIMA activities in 2016-2017.

[1] These activities have been carried-out in the context of a series of collaborative projects carried out by the European Commission's Joint Research Centre (JRC) - Institute for Prospective Technological Studies (IPTS) and the Directorate-General for Research and Innovation.
[2] http://iri.jrc.ec.europa.eu/reports.htm
[3] Ibidem.
[4] http://iri.jrc.ec.europa.eu/papers.htm

The objective of this background paper is to set the scene for the contributions expected from the workshop participants.

The workshop is organised in two thematic sessions and a final roundtable. In each of the two sessions, the main topic will be introduced by a high-profile academic expert, followed by a presentation of results obtained in the context of the IRIMA project and a discussion with participants. The final round table will be devoted to discuss future policy relevant research agendas for IRIMA.

Session 1. Productivity and R&D: evidence from top R&D investors

This session will focus on the empirical evidences obtained from company level data showing the relationship between R&D investments and productivity. Such evidence shows that the impact of investment in R&D on labour productivity, technical efficiency and ultimately on firm's overall performance is in general positive but that it varies among sectors and firms, which calls for the establishment of differentiated support policies.

Presentation: Do research and other sources of innovation drive productivity gains in European top R&D investors? (Sara Amoroso and Fernando Hervás JRC-IPTS)

Aim

This study provides an overview of the empirical evidence obtained from the analysis of the link between R&D investments and productivity at firm level, including also indirect links related to factor's such as the degree of firm's internationalisation, the level of cooperation and investments in other intangible assets. It also looks at differences in the R&D-productivity related to company location (e..g. EU versus US, Japan and rest of the world).

Data and Methods

Review of evidences emerging from scientific contributions investigating the R&D-productivity link, with particular emphasis on those obtained using data from the sample of the world's top R&D investors, representing more than 90% of the R&D financed and implemented by the business sector worldwide.

Main Results

- There is evidence of a positive direct link between R&D and labour productivity at firm level, with higher returns to R&D investments in high-tech sectors. In low R&D intensive sectors, investments in physical capital have higher impact on labour productivity.
- Returns to R&D investment in the form of productivity increases are non-linear: returns are positive only after a minimum critical mass is reached and the degree of impact increases as the R&D intensity of the firm increases.

- Efficiency (optimal use of resources) is the only channel for productivity improvements in low-tech sectors. In high-tech sectors, also shifts of the technological frontier (technological progress) matter.

- Knowledge capital (R&D) is the more important factor to explain output growth only for high-tech sectors and in this case returns to scale do not decrease even for the largest companies

- Much of the productivity gap of firm's located in the EU is attributable to lower R&D spending. In addition evidence shows that European firms are less able than US and Japanese firms to transform R&D into labour productivity.

- Likewise top R&D investors located in Southern Europe are less able to transform R&D into productivity than companies located in other EU countries, but seem to compensate it with other competitive factors.

- The degree of multinationality of top R&D investors increases firm's R&D investments and their capacity to transform it into productivity. The link between multinationality and productivity is negative particularly when it is based on higher geographical dispersion.

- Cooperation in R&D and investments in other intangible assets positively affects firm's innovative performance.

Session 2. Revealed technological advantages of EU regions and top R&D investors

In this session, preliminary results obtained from studies looking at the technological profiles of top R&D investors and of EU regions will be presented and discussed. One main motivation of this research is to exploit the data collected and the analysis recently performed on the world top R&D investor's patent portfolios in the direction of better understanding to what extent the technological endowment and relative specialisation of regions (now and in the future) operate as attraction factor's for the location of these companies' innovation investments.

Preliminary evidences obtained from a first IRIMA study that will be presented at the workshop suggest that the technological proximity to the host country in which these companies seek for new knowledge is a key determinant for their R&D location decision (up-coming Working Paper from Dosso and Vezzani).

In addition, there will be a presentation (entitled "*The technological specialization of EU regions: patterns, trends and economic effects*") based on two studies investigating in more detail the technological profile of EU regions using the Revealed Technological Advantage (RTA) framework. This framework allows depicting and comparing in a systematic manner the technological specializations of one or several territories (countries, regions, etc.) or organisations within a larger group of entities. The focus will be on drawing a typology of the EU regions based on their overall technological profiles and the specific technologies in which they specialise in.

One important objective during the discussion will be to identify how to bring forward this research activity, combining firm level data with territorial data on technological profiles and relative advantages. The aim is to provide robust empirical evidence to support Member States' and region's innovation and industrial policies.

Study 1: The Distribution of Technological Activities in Europe: A Regional Perspective (by Rinaldo Evangelista)

Aim of the study

This study deals with the broad theme of technological and economic convergence in Europe adopting a regional perspective. More specifically, the study aims at: analysing major trends in the spatial distribution of technological capacities in the EU area over the last 15 years; highlighting key changes occurred in the pattern of technological specialization of EU regions; identifying the regional technological trajectories that have been more effective, that is able to sustain long-term economic growth and facilitate catching-up processes of EU laggard regions.

Data and Methods

The technological activities and performances of EU regions will be analysed using REGPAT, a patent database developed by the OECD where patents are linked to regions according to the addresses of the applicants and inventors. In the present report we will focus on the inventor localization to analyse the technological capabilities of European regions.
Patent data allow identifying the technologies where a region is active in its inventive activities and can be used as a proxy for technological specialisation, and to identify the technological competences and characteristics at the base of economic performance. To this end, the concordance between International Patent Classification (IPC)3 and technologies, originally developed by Schmoch is used.

Main results

- In the EU area there is a very uneven distribution of technological capacities, with all indicators of technological concentration being much higher the ones referring to GDP or employment.

- Over the last 15 years some degree of technological convergence of the most peripheral and less innovative regions of Europe with respect to more advanced core EU regions has occurred.

- There is a high level heterogeneity - within the main EU countries and groups of regional innovation systems - in the long-term technological performance NUTS1 regions.
- The analysis of the Revealed Technological Advantage indicators (carried out using 5 - 1 digit -and 35 - 2 digits patent classes) has shown a rather complex picture of the regional distribution of technological strengths and weaknesses in the EU area.

- The dynamic analysis of RTA has shown a process of technological upgrading of the East-European area with most of the new member state regions increasing their relative strength in the ICT & Electrical Engineering technologies while showing a parallel de-specializing trend

in the areas of Chemicals and also in more technological mature fields related to consumer goods, furniture and games, civil engineering.

• The absolute level of technological specialization of European regions has decreased in the last fifteen years, that is regions have moved towards a more evenly distribution of innovative efforts across the different technological fields.

• There is a high degree of cumulativeness in the technological trajectories of EU regions, in particular among the most innovative regional groups.

Study 2: The specialisation of EU regions in emerging and high-opportunity technologies (by Valentina Meliciani)

Aim of the study

Despite the great emphasis on 'Key Enabling Technologies' (KETs) at EC level, there is only very limited evidence on the capability of EU regions to specialise in these fields and there are no studies directly investigating the actual impact of these technologies on regional innovation and economic growth.
This report aims at filling these gaps by: i) looking at the relationship between KETs and fast growing technologies (FGTs); ii) providing empirical evidence on EU regional specialisation in KETs and FGTs; iii) relating technological specialisation to regional innovation and economic growth.

Data and Methods

The empirical analysis is drawn on a sample of European Union regions at the NUTS 2 level over the period 1996-2011. Due to problems with variability of patents data over time, patents are aggregated over 4 years periods (1996-1999; 2000-2003; 2004-2007 and 2008-2011). Finally, in order to reduce problems of small numbers, regions with less than twenty patents in the first period are dropped from the sample. Thus, we end up with a sample of 227 European Union regions.
The technological strength of EU regions in KETs and FGTs is captured by the indicator of 'absolute technological advantage' measuring the share of each region i in the total number of patents in KET or FGT:

$$\mathrm{ATA_i} = \frac{\mathrm{KET_i}}{\sum_{i=1}^{N} \mathrm{KET_i}}$$

where KET is the number of patents in Key Enabling Technologies and N is the total number of regions. The technological specialisation is measured with the revealed technological advantage index:

$$\mathrm{RTA_i} = \frac{\mathrm{KET_i}}{\sum_{i=1}^{N} \mathrm{KET_i}} \Big/ \frac{\mathrm{PAT_i}}{\sum_{i=1}^{N} \mathrm{PAT_i}}$$

where PAT indicates the total number of patents. Values of RTA larger than one indicate relative specialisation (the share of region i in KETs is higher than its share in total patents). Analogous indicators are computed for FGT.

Main results

• A small share of KETs are also fast growing technologies, although the degree of overlapping between KETS and FGTs varies substantially across different KET fields.

• While KETs are concentrated in Central Europe, FGTs prevail in Scandinavian countries and the UK.

• while there is evidence of some regional convergence in KETs and, to a less extent, in FGTs, spatial correlation increases over time, showing that diffusion often occurs across contiguous regions.

• the results of the estimation of innovation (patents' growth) and economic growth (growth in per capita GDP) show that only specialisation in KETs directly affect economic growth, while specialisation in FGTs affects growth only indirectly through its impact on innovation.

• the results obtained in the analysis confirm the pervasive and enabling role of KETs pointing to the importance for European regions to target these technologies as part of their RIS3 strategy.

Round table: **IRIMA future research agenda**

The objective of the final roundtable will be to discuss how the IRIMA project could best support policymaking in the context of the new Commission priorities, identifying key research topics and priorities.

The company dataset on world top R&D investors constructed over the past 12 years by the IRIMA project is an extremely valuable data source, complementing official territorial statistics (such as BERD) and allowing the study of policy relevant topics such as: firm's performance and dynamics, including the benchmarking of individual companies against main competitors, the analysis of specific sectors of interest –focusing on the most knowledge intensive ones, the impact of companies' heterogeneity in their R&D and productivity performance, including location factors or the globalisation of R&D and innovation firm's activities. More recently, the project has started to look at the technological and innovation profiles of companies, using new data on patents and trademarks.

Possible developments for the next stage of IRIMA, would include:

- Exploitation of the panel dimension of the IRIMA history dataset, to dig into companies and industrial sectors dynamics, innovation patterns and companies' performance determinants and barriers. One important issue to investigate in this context could be the identification of specific firm characteristics which, coupled with particular institutional/policy frameworks, act as determinants of good performance, possibly with a focus on employment growth. Another interesting issue could also be the analysis of company balance sheet investment and asset data in order to gain better insight into their longer-term investment behaviour, which could be related to the Juncker Investment Plan.

- Analysis of the geographic distribution of value-added and jobs generated in key innovative industries. The objective will be to analyse the value chains of selected industries in order to assess the value-added and jobs generated and their geographic distribution across countries and regions and to assess the competitive position of the EU in the global value chains of the selected industries. This would be based on a bottom-up analysis of main industrial players and suppliers involved in the selected industries, relying on their economic, financial, R&D and patent data (and particularly on the on-going efforts to improve information about the location of their activities using e.g. subsidiaries structures and inventor's locations) and complemented with ad-hoc industry-specific expertise and interviews.

- Deepening of the investigation of the technological and innovation patterns of world top R&D investors, relying on the new patent and trademark data collected and eventually expanding it to other intangibles. This would include an analysis of the technical and technology flows shaping the long-term dynamics of corporate knowledge creation and innovation.

Questions to be addressed during the roundtable include:

- Do you consider the above outlined possible developments policy relevant in view of the new Commission priorities?

- Are there missing areas to which the IRIMA project could contribute in the future?

- What in your view are the main data and methodological challenges to successfully address these research questions in the context of IRIMA?

- Which from your point of view are the main strengths and opportunities of this project to bring added-value and impact on these issues?

- How to strengthen and improve interaction and involvement of main project stakeholders – policy makers, industrialists, academic community and experts?