# Knowledge Circulation between Universities, Public Research Organizations and Business in the EU 27. Drivers, Barriers, Actions to be put Forward

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**Abstract**

*The purpose of this study is to explore different patterns of knowledge circulation between universities, public research organizations (PROs) and businesses in the EU27. To this end, a Knowledge circulation index was created based on funding flows (business funded R&D in higher education and government sectors), co-operation-based innovation indicators, bibliometric data and patent statistics. The results have confirmed a leading position for Finland, Netherlands, Denmark, Belgium, the UK and Slovenia, countries with a long tradition in knowledge transfer, but with a sustainable base for networks and links between all innovation actors. The paper advances some future paths to action, such as rising up SMEs' profile in knowledge circulation, finding the best coordination matrix for already existent support network or finding solutions to reduce the strong dependence on public and EU funding.*

**Keywords**: knowledge circulation, EU27, composite indicator, Erawatch R&D profiles

**JEL Classification**: O3

## 1. Introduction

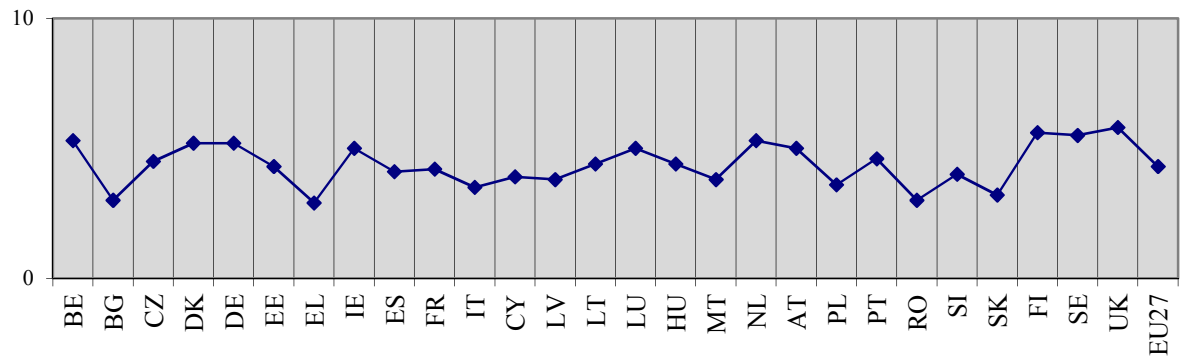
As producers of knowledge, universities and public research institutions have a key-role in driving the objectives of the cross – cutting strategy Europe 2020. To this end, through the *Innovation Union* flagship initiative, it is envisaged to enhance cooperation between the world of science and the world of business, to remove obstacles and put in place various incentives (EC COM(2010) 2020). Inter alia, EUROPE 2020 asks for knowledge partnerships and stronger links between education, research and innovation and enhancing the performance of education systems and facilitating the entry of young people to the labour market. To this end, the European Commission and the Member States aims to support „**knowledge alliances**" bringing together business and education/ training institutions, to develop new curricula addressing innovation skill gaps and matching labour market needs. The European Institute for Technology should set out a **Strategic Innovation Agenda** to expand its activities as a showcase for Innovation in Europe. This should map out its long term development within the Innovation Union, including the creation of new Knowledge and Innovation Communities, close links with the private sector and a stronger role in entrepreneurship. Moreover, assuming that too much funding is currently allocated to overlapping projects or to priorities where a region lacks relative strengths, a **smart specialisation** approach should be applied. Rather than being a strategy imposed from above, smart specialization involve business, research centres and universities working together to identify a region's most promising areas of specialization, but also the weaknesses that hamper innovation.

These desiderata are reiterated by *The Higher Education Modernization Agenda* issued by the European Commission in 2011 that identifies the need to strengthen the links between higher education, research and businesses for excellence and regional development as one of the five main priorities for higher education in Europe. Among the key policy issues, it is envisaged to stimulate the development of entrepreneurial, creative and innovation skills, strengthen the knowledge-transfer infrastructure of higher education institutions (HEIs) and enhance their capacity to engage in start-ups and spin-offs, promote the systematic involvement in the development of integrated local and regional development plans and encourage partnership and cooperation with business as a core activity of HEIs (EC COM(2011) 567). All these recommendations come together with the conclusion that *the capacity of higher education institutions to integrate research results and innovative practice into the educational offer and to exploit the potential for marketable products and services remains weak* (EC COM(2011) 567, EC C(2008) 1329).

In order to support knowledge circulation, the European Commission launched in 2008 the University-Business Forum as a European platform for dialogue between the two worlds (EC COM(2009) 158). Considering the situation and the needs identified, two general policy objectives were established for university – business cooperation at European level: to improve the relevance of tertiary education for the labour market and to improve Europe's innovation capacity, by speeding up the Higher Education Modernization Agenda (EC SEC (2009)/ 423). A significant output associated with the forum was the study 'The State of European University Business Cooperation' that captured experiences in cooperation from more than 6000 academics, HEI managers and university professional working with business. The key-conclusion of this exhaustive study is that *whilst there are some exceptions, cooperation between HEIs and business in Europe is still in the early stages of development*, as approximately 40% of academics are not engaged in cooperation at all, 20% of academics undertake only a low extent of cooperation whilst only 40% of academics undertake a medium or high extent (Davey et al., 2011, pp. 9 - 10). Finally, the *Trends report* synthesising the main finding of nine forums held between 2008 and 2011 (Allinson et al., 2012) highlights evident progresses in cooperation, but also some remaining challenges, such as ensuring that funds are available to encourage cooperation and simplifying the bureaucratic procedures.

The survey carried out for the *Global Competitiveness Report 2011-2012* provides valuable information on the potential for the research base to co-operate with industry for 142 world countries and allows comparisons in this respect (Schwab, 2011).

**Figure 1.** University – industry collaboration in R&D




Source: Schwab K. (2011): *World Economic Forum: Global Competitiveness Report 2011-2012*.

Figure 1 introduces EU27 countries' scores for university – industry collaboration in R&D and syntheses the responses of more than 13000 respondents to the question: *To what extent do business and universities collaborate on research and development in your country?,* on a scale from 1 to 7, where 1 means they *do not collaborate at all* and 7 means they *collaborate extensively*.

Even if EU27 countries' performances for university – industry cooperation for R&D seem very close to each other (given the disadvantages of scale measurement), their ranks at the global level differ significantly, with five countries on the world's top 10 positions: UK - the 2nd, Finland: the 4th, Sweden - the 5th, the Netherlands - the 6th and Belgium - the7th position and four countries at the end of the ranking: Slovakia – the 104th, Romania – the 115th, Bulgaria – 116th and Greece the 120th - in 142 participating countries. The UK is one of the most successful countries for university – industry cooperation, not only at the EU27 level, but also at the global level. The last data collected from the Higher Education Business and Community Interaction Survey in the UK highlights the increase in the overall exchange of knowledge between UK universities and the private, public and the third sectors with a growth rate of around 4%, despite the crisis and uncertainty in the economy (HEFCE, 2011).

Given these evidences, the purpose of this study is to explore different patterns of knowledge circulation between universities, public research organizations (PROs) and businesses in the EU27 and to compare countries' performances for available indicators.

## 2. Research Method

According to Polt et. al (2001) and OECD (2002), the linkages between science and industry and the effectiveness and efficiency of these linkages are many-facetted and difficult to measure and evaluate, as country-specific features cannot be captured accurately by a single set of quantitative indicators. Despite these constraints, the Benchmarking report commissioned by DG Enterprise, European Commission and the Austrian Federal Ministry of Economy and Labour in 2001 proposes a range of 'indicators for the performance of industry – science relations' referring to contract and collaborative research, cooperation in innovation projects, science as information source by for industrial innovation, mobility of researchers, continuous professional development, patent applications by public science, royalty incomes, start-ups, informal contacts, personal contacts etc. (Polt et al., 2001)

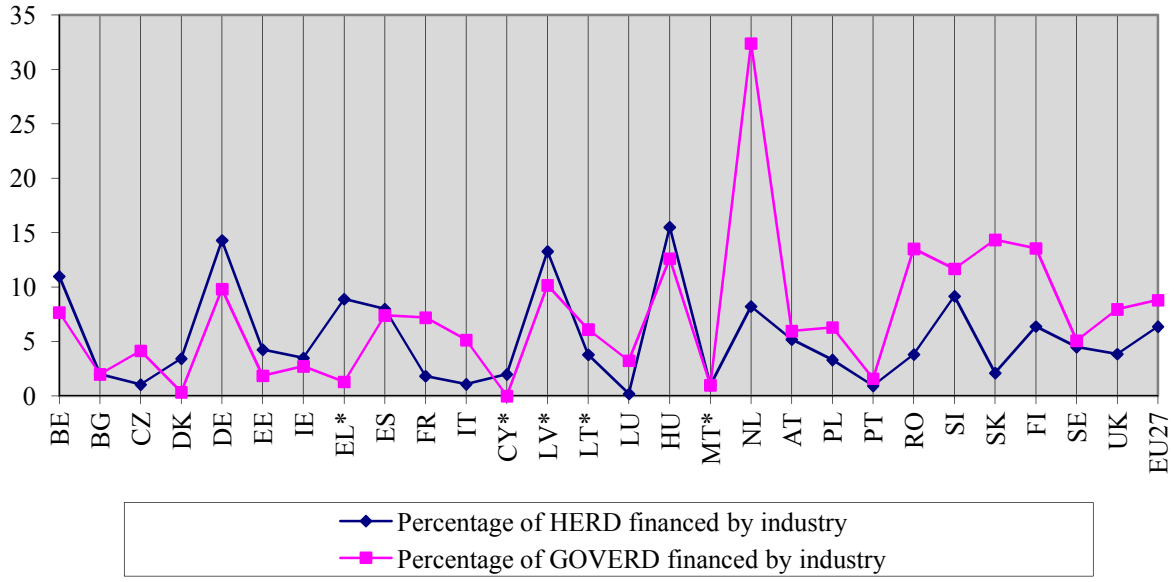
In order to meet our research purpose and to compare EU27 countries' performances in knowledge circulation between universities, public research organizations (PROs) and businesses, we only selected from the proposed list those indicators available from international R&D databases such as OECD and Eurostat and added qualitative evidences from (Erawatch) national R&D country profiles. To this end, a **Knowledge circulation index** was designed based on funding flows (business funded R&D in higher education and government sectors), co-operation-based innovation indicators, bibliometric data and patent statistics, to enable between countries comparisons.

## 3. Key Performance Indicators for Knowledge Circulation

### 3.1. Funding Flows

In OECD's definition, **business-funded R&D in the higher education and government sectors** (in the form of grants, donations and contracts) is the domestic business enterprise sector's contribution to intramural R&D expenditures in those sectors (OECD, 2011). Industry funding in Higher Education R&D Expenditure (HERD) and Government R&D Expenditure (GOVERD) can therefore serve as proxies for contractual agreements, giving relevant information over the extent of cooperation (See Figure 2).

**Figure 2.** Knowledge circulation by funding flows, 2009




Sources: OECD Science, *Technology and Industry Scoreboard 2011; Innovation Union Competitiveness Report 2011* & Erawatch country reports (2011) for *Greece (EL), Malta (MT) – 2005; Cyprus (CY), Latvia (LV), Lithuania (LT) – 2006.

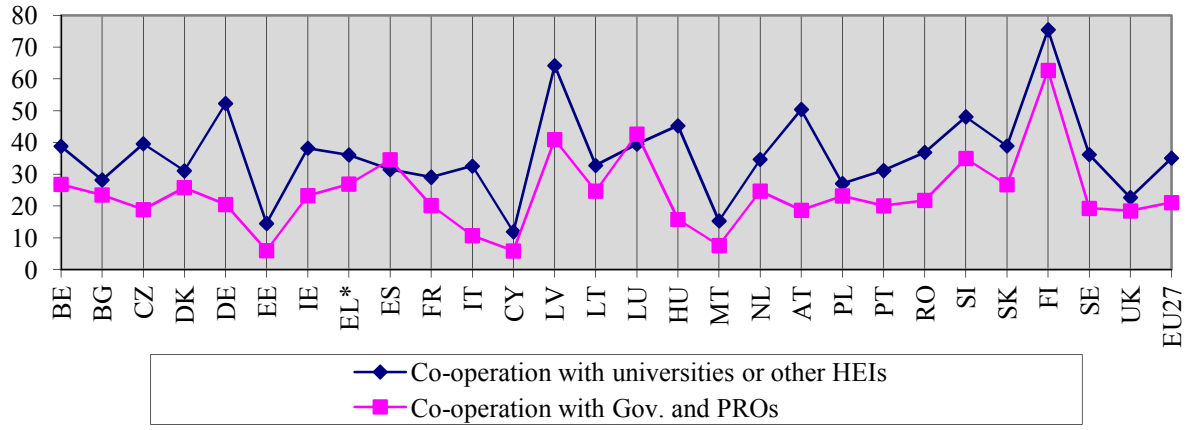
As depicted by Figure 2, the percentage of HERD and GOVERD financed by industry tend to go in the same direction, except from the Netherlands, where about one third of the GOVERD (32,4%) is business-funded, four times more than the EU27 avg. (8,81%). As regarding the % of HERD financed by industry, Hungary (15,12 %) and Germany (14,31 %) are top performers, while in countries such as the Czech Republic, Luxembourg, Italy and Portugal – the percent tends to zero. In their turn, Romania and Slovakia have significantly different performances for business-funded HERD and GERD, indicating a highest capacity for public research institutions to cooperate with business.

### 3.2. Cooperation-based Innovation Indicators

As one of the main sources for innovation dynamics, the Community Innovation Survey 2008 (Eurostat, 2012) gives important insights into European companies' cooperative behaviours. In CIS' terms, innovation co-operation measures the active partnership of the observed enterprise with other enterprises or non-commercial institutions such as

universities or public research institutes, at national or international level. Figure 3 summarizes the data regarding the % of enterprises with technological innovations (regardless of organizational or marketing innovations) having cooperated with higher education institutions and public research organizations between 2006 and 2008.

**Figure 3.** Percentage of enterprises with technological innovations cooperating with HEIs and PROs, 2006 - 2008



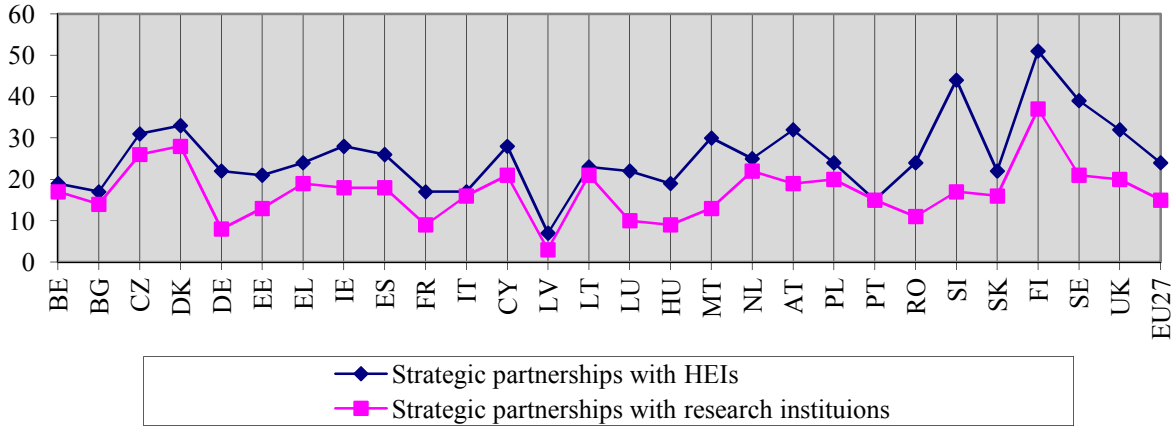

Source: EUROSTAT (2012): Community Innovation Survey 2008.

* Data for EL: 2004 - 2006

## 3.3. Strategic Partnerships between Enterprises, HEIs and PROs

Under the framework of the Flash Eurobarometer surveys (EC, 2009), Gallup's interviews with senior company managers responsible for strategic decision-making in 5,238 enterprises across Europe has revealed other cooperation patterns envisaged by the strategic partnerships with HEIs and PROs in support of innovation activities (Figure 4).

**Figure 4.** Strategic partnerships with HEIs and PROs, 2006 - 2008



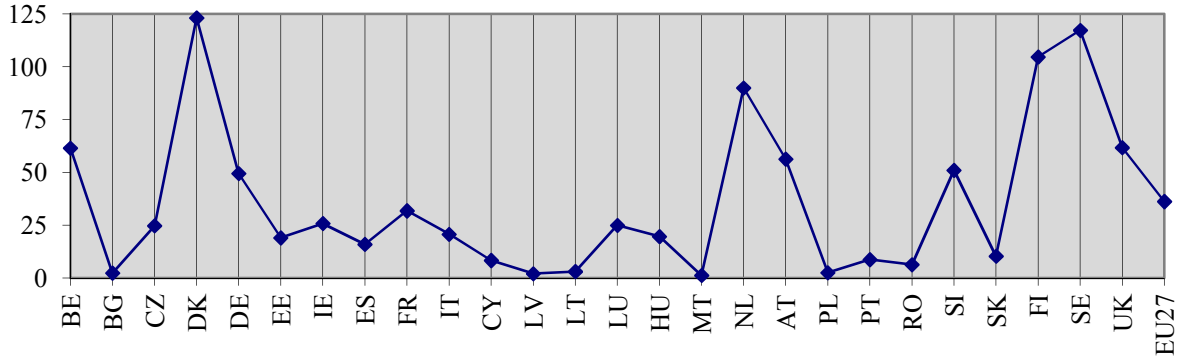

Source: EC (2009): *Innobarometer*.

Finnish enterprises were by far the most likely to have built relationships with both HEIs (51%) and research institutes (37%) to support innovation. Slovenian enterprises have a very good profile for cooperation with HEIs (44%), while the relationships with PROs stays close to the EU27 average (15%). On the contrary, Latvian enterprises were the least likely to confirm such strategic relationships for both HEIs (7%) and PROs (3%).

## 3.4. Bibliometric Data

Public – private co-publications per million population (Figure 5) are often considered as proxies for cooperation. In the Innovation Union Scoreboard's terms, this indicator captures public – private research linkages and active collaboration activities between business sector researchers and public sector researchers resulting in academic publications (EC, 2011). It should be also noted that publications are assigned to the country/ countries in which the business company is located.

**Figure 5.** Public – private co-publications per million population, 2008



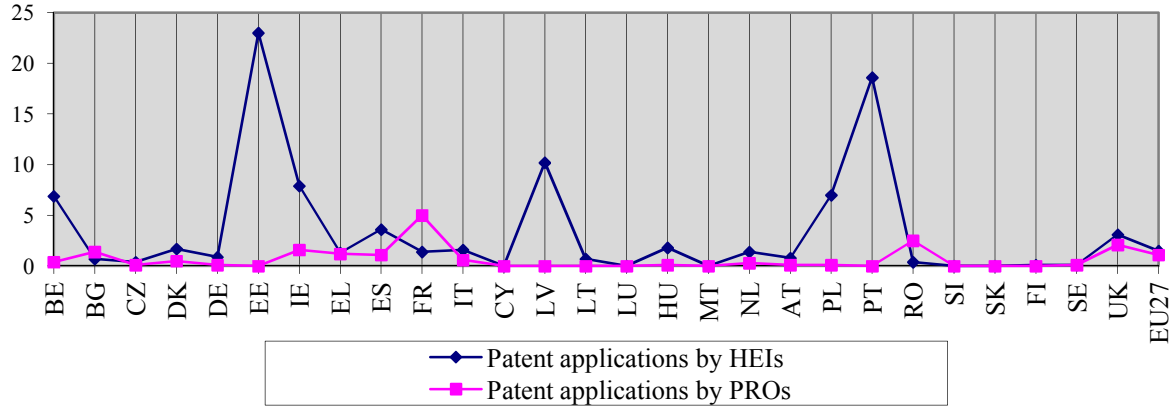

Source: EC (2011): Innovation Union Competitiveness Report

As evidenced by Figure 5, there are large differences in co-publication patterns between EU27 countries, with more than 100 co-publications for Denmark, Finland and Sweden and less than five co-publications in Bulgaria, Latvia, Lithuania, Malta and Poland. On average 36 co-publications are observed for the EU27, but if we exclude the three top performers, the average decreases to less than 25.

## 3.5. Patent Statistics

Patent applications are usually reported by universities and public research organizations as a leading indicator of technology transfer (Finne et al., 2011). Figure 6 presents the EU27 countries' EPO patent applications in 2006 - the last available data.

**Figure 6.** EPO patent applications by HEIs and PROs, 2006



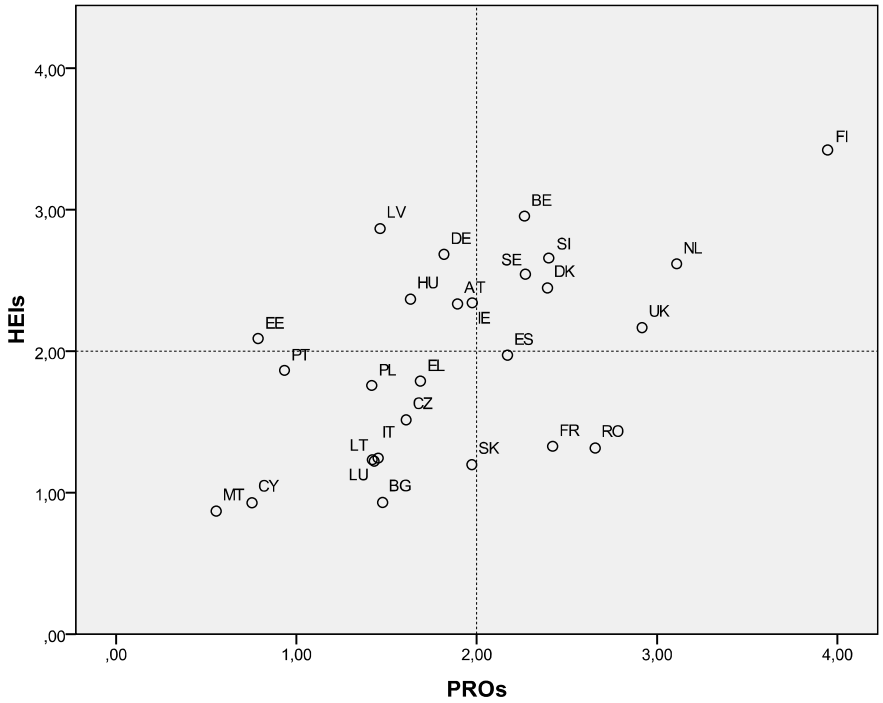

Source: EUROSTAT (2009): Science, technology and innovation in Europe

According to the EU Innovation Competitiveness Report (EC, 2011), although patents applied by for HEIs and PROs still represent a very small share of the total number of EPO patents (about 2%), this share is growing. Estonian, Latvian and Portuguese HEIs have the highest performances for EPO patent applications, while the number of patents applied by PROs is similar across the countries, with French PROs being the top performers.

## 4. Comparing EU27 Countries' Performances in Knowledge Circulation

In order to compare EU27 countries' performances for all selected indicators (funding flows, co-operation for innovation, strategic partnerships, bibliometric data and patent statistics), we have created a **Knowledge circulation index** (Figure 7), following the OECD methodology to provide builders of composite indicators (OECD, 2008). To avoid biases in data, we identified the outliers within each indicator using the Schweinle formula (2,5 standard deviation from mean) and transformed their values to the next highest non-outlier number. Therefore we standardized all the indicators with the min-max technique and computed countries' aggregated scores separately for HEIs and PROs, using an equal weights scenario.

**Figure 7.** The EU27 Knowledge Circulation Index




Source: Own computation based on funding flows, co-operation for innovation indicators, strategic partnerships, bibliometric data and patent statistics

As illustrated by Figure 7, Finland is by far the EU27 leader in knowledge circulation between HEIs, PROs and businesses. According to Finland's Erawatch country profile (Viljamaa, 2011), since the beginning of the 1980s, the Tekes programmes have provided

important venues for knowledge circulation between the universities, research institutes and business sector and they were complemented by special programmes dedicated to supporting commercialisation of research and academic spin-offs and the establishment of Strategic Centres for Science, Technology and Innovation. Moreover, supporting professorships in close collaboration with the business sector and encouraging universities to have their own collected capital that is 2.5 times multiplied by the government – are some of the policy measures that have fostered Finland's performances in knowledge circulation.

Beside Finland, the leaders' group includes other two Nordic countries - Denmark and Sweden, the Netherlands, Belgium, Slovenia, the UK and, at the crossroad with HEIs – driven group, Ireland. According to a number of evaluation studies for different funding instruments in both Denmark and Sweden, the majority of knowledge circulation policy initiatives (e.g. research consortia, Strategic Research Centres and Strategic Research Alliances, high technology projects/ platforms etc.) have resulted in new and stronger collaborations between (Klitkou A., 2011; Mattsson et al., 2011). In their turn, the Netherlands and Belgium have also stimulated inter-sector R&D cooperation through various incentives and dedicated support programs, while paying attention to regional strengths and characteristics in Belgium and giving the relatively large PRO sector an intermediating role between universities and companies - within the "open innovation" framework - in the Netherlands (Bruno and van Til, 2011; Deuten and Mostert, 2011). As regarding the UK, a huge system of support institutions, frameworks and resources have been devoted to improving knowledge transfer (Cunningham and Gök, 2011), while Slovenia has effectively succeeded to build a relatively extensive R&D, innovation and entrepreneurship support network and has introduced a new system of financing public research, requiring the public research organizations to increase the share of business funding (Bučar, 2011). Finally, in Ireland, knowledge circulation has become a popular policy issue as a result of the economic downturn and has been stimulated through the establishment of a National Intellectual Property Protocol and various funding schemes (Martin, 2011).

Besides the *Leaders'* group, Figure 7 reveals the presence of a *PROs–driven* group and of a *HEIs–driven group*, together with the existence of a *lagging – behind* group, which is the most numerous one.

France, Spain, Romania and Slovakia do cluster together in the PROs – driven group that exhibits high scores for PROs – mediated knowledge circulation, but also a low profile for the HEIs. France's Erawatch country profile (Zaparucha, 2011) identifies the relatively weak knowledge circulation and transfer as a long-standing barrier in the R&D system. As compared to the countries in the *Leaders'* group, France has been very active in reinforcing knowledge circulation only after 2005 and the mechanisms did not produce immediate results, so the effects are still expected. In what it concerns Spain, despite the growing importance of programmes that foster industrial and academic links, co-operation is biased towards polytechnic schools, while the mismatch between research results and the needs in innovation systems has negative effects on effective knowledge circulation (Heijs, 2011). Finally, Romania and Slovakia inherited a communist-specific R&D system, with an increased concentration of gross expenditures on R&D in public research institutions (Baláž, 2011). Despite visible progress, Romania still faces many gaps in the public – private cooperation legislation and universities' third mission is in its very incipient stage, with only few universities consolidating their technology transfer and commercial infrastructure and personnel (Ranga, 2011).

The *HEIs–driven* group is populated by Austria, Deutschland, Hungary and two Baltic countries – Latvia and Estonia. Similarly to the Leaders' group, these countries have rich portfolio of R&D programmes which are targeted at inter-sectoral R&D cooperation, with a special attention paid to fostering the human research base in Austria (Schuch, 2011), encouraging thematic R&D programmes and giving them intermediary support in Deutschland (Aschhoff and Rammer, 2011) or financing joint research centres, each located at a university in Hungary (Havas, 2011). Latvia and Estonia share the same major R&D challenge in the national R&D system: companies take almost no advantage of the research potential at universities and state research institutes, despite various policy measures aimed at knowledge transfer such as competence centers that have succeeded in improving technology absorption on the industrial side (Kristapsons et al. 2011, Rannala and Männik, 2011).

The forth group exhibits comparatively lower performances both in HEIs and PROs due to a number of common constraints: the lack of systemic integration between the research and innovation stakeholders, together with low concern with exploitability of knowledge in Portugal (Godinho and Simões, 2011), high dependence on public and structural funding in Poland (Jerzyniak, 2011) and the Czech Republic (Hebakova and Valenta, 2011), a fragmented technology transfer system, with TTOs being diffusely present in Lithuania and Italy (Paliokaitė, 2011; Potì and Reale, 2011), an outdated legal and institutional frameworks related to innovation and research (Damianova et al., 2011) or the severe crisis impacting high on R&D system (Maroulis and Mikroglou, 2011). In addition, the institutionalization of knowledge transfer and the from HEIs and PROs to the industry is still in its infancy in Cyprus (Tsipouri and Rublova, 2011), while small countries such as Malta or Luxemburg still have to foster their IPR regimes and fight resistance to cooperation (Pace, 2011; Alexander, 2011).

## 5. Conclusions. Actions to be put Forward

This study has been focused on knowledge circulation issues at the EU27 level and has advanced a composite indicator able to capture performances on different specific indicators, including business funded HERD and GOVERD, co-operation based innovation indicators, bibliometric data and patent statistics. The results have confirmed a leading position for Finland, Netherlands, Denmark, Belgium, the UK and Slovenia, countries with a long tradition in knowledge transfer, but with a sustainable base for networks and links between all innovation actors. Nevertheless, their success is still hampered by some constraints, especially by the low level of participation of SMEs. As resulted from these countries' R&D profiles, even though SMEs have been encouraged to participate in policy initiatives, the participation rate was moderate and it is expected that the situation would worsen because of the economic crisis. Besides rising up SMEs' profile, there are some other actions to be put forward, such as finding the best coordination matrix for the already existent support network or monitoring closely human resources in science and technology stocks, as they are on a decreasing slope.

As regarding the other countries, it becomes clear that countries such as France or Romania should boost their R&D potential, while Austria, Germany, Lithuania and Hungary have to deal more efficiently with PROs' involvement in knowledge circulation. The same recommendations are valid for Ireland and Spain, whose knowledge circulation efforts should be intensified in order to catch up with the Leaders' group.

The countries that stay in the low-performance quadrant seem to have a still long way towards reaching the efficiency level. On the one hand, the undefined IPR regimes and the insufficient stimuli for long-term cooperation represent a serious threat for knowledge circulation. On the other hand, for those countries that succeeded in implementing a range of support initiatives, there is a major risk generated by the strong dependence on public and EU funding. Finally, all the efforts meant to rising up each country's national profile should be complemented by specific actions to foster international knowledge circulation and support Europe 2020 ambitious targets.

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