D5-1 | Literature Review and Data Collection

Deliverable: D5-1 Literature Review and Data Collection
WP 5 Promoting Openness and Capitalizing on Europe’s Creative Potential

Author(s): Ivan-Damir Anic, EIZ; Michele Cincera, ULB; Maja Jokić, Institute for Social Research Zagreb; Martin Hud, ZEW; Maikel Pellens, ZEW; Bettina Peters, ZEW; Anabela Santos (ULB)

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Coordinator: Bart Verspagen, UN-MERIT
E-mail: b.verspagen@maastrichtuniversity.nl

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Note: Originally, the structure of deliverables of WP5 was different than for the other WPs. In order for WP5 to be coherent with the other WPs and the inputs needed for WP9 and WP10, we suggested in the inception report (Deliverable D11.3) to rearrange the content of deliverables and changing the list of deliverables. This Deliverable D5-1 follows the new structure of the inception report.
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1 Introduction

One aim of the Innovation Union is to promote Openness and Europe’s Creative Potential. In order to achieve this goal 5 different commitments have been implemented within the Innovation Union:

- C19: Creative Industries
- C20: Open Access to Research Results / Research Information Services
- C21: Facilitating Effective Collaborative Research and Knowledge Transfer
- C22: Develop a European knowledge market for patents and licensing
- C23: Safeguard against the use of IPRs for anti-competitive purposes

The following chapters will present for each of these commitments the relevant literature which is the basis for the impact assessment in the next step of this project.
2 Creative Industries (Commitment 19)

Michele Cincera and Anabela Santos (ULB)

2.1 Introduction

Creative Industries are regarded as one of the most promising fields of economic activity in highly developed economies, having a great potential to contribute to wealth and job creation. According to Müller et al. (2009), "Creative Industries are defined as those economic activities that strongly rest on individual creativity, skill and talent and predominantly produce intellectual property (in contrast to material goods or immediately consumable services)".

The Department for Culture, Media and Sport (DCMS) in the UK proposes a list of six sectors to define creative industries:

- Content: film, (computer) games, journalism, authors, music, performing arts, photography, sound studios;
- Design: arts and crafts, design and fashion, graphic design, engineering design, web design;
- Architecture: architecture including landscaping and urban planning;
- Advertising: planning, creating and putting in place advertising campaigns, public relations management, market research, advertising services;
- Software: programming and computer services (excluding web design and computer games);
- Publishing: publishing of books, newspapers and other printed matter, including printing services.

This note is structured as follow. Section 2 provides a short overview of the recent literature on creative industries. Section 3 discusses data and indicators available to describe these activities.

2.2 Literature Review on Creative Industries

Several studies investigating creative industries have been identified in the academic literature (Müller et al., 2009). These studies can be classified into three groups according to whether they i) assess the contribution of creative industries to the economy, particularly in terms of employment, regional development and urban dynamics; ii) analyze the role of innovation in the creative industries, i.e. "Creative Industries may develop and introduce innovations as part of their business activities, thus directly contributing to an economy's innovative output" (Müller, 2009); and, iii) the role of creative industries in contributing to innovation in the wider economy, particularly with regard to inputs from the creative industries that may be used in innovation processes in other...
industries. As emphasized by Müller et al. (2009) and as we can see in Figure 1 “these inputs can either be upstream, i.e. creativity produced in the Creative Industries is used by customers in their innovative efforts, or downstream, i.e. the Creative Industries demand innovative inputs from their suppliers (e.g. technology producers).”

**Figure 1 Contribution of innovation activities in creative industries in the economy**

![Diagram showing the contribution of innovation activities in creative industries in the economy]

<table>
<thead>
<tr>
<th>Input</th>
<th>Innovative process</th>
<th>Output</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>Supply by C.I. of innovative inputs to their clients</td>
<td>Creative industries (C.I.)</td>
<td>Development of (product &amp; process) innovations</td>
</tr>
<tr>
<td>Downstream</td>
<td>Demand by C.I. of innovative inputs to their suppliers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: authors’ own elaboration based on Müller et al. (2009).

The special issue of Innovation: Management, Policy and Practice explores some empirical and analytical connections between creative industries and innovation policy (Potts, 2009).

The paper by Müller et al. (2009) reports analysis of a commissioned telephone survey of over 2000 commercial creative industries businesses in Austria. They use this large but targeted sample on the creative characteristics and innovation performance of creative industries firms to examine the effect they have on industrial innovation in the wider Austrian economy. This is a key question – it goes to the heart of the nature of the connection between creative industries and the innovation process – namely do creative industries businesses interact with the innovation process, and if so how? The authors found that creative industries are among the most innovative sectors in the Austrian economy, and also that they supported innovation as lead users of new technologies. Müller et al. (2009) construct an econometric model to explain the determinants of innovative activities in creative firms. They find that the creative industries contribute innovative goods and services into the wider economy, as well as functioning as a lead sector in demanding and experimentally using new technologies.

Bakhshi and McVittie (2009) also examine the mechanisms by which the creative industries may support innovation in the wider economy. They do so first through use of input–output analysis to explore the contribution of creative industries enterprises to knowledge transfer over forward and backward supply-chain linkages. They then examine this effect using data from the Fourth
Community Innovation Survey. They too find significant evidence of an important role played by creative industries business in B2B knowledge transfer and innovation processes.

2.3 Data and Indicators

Data on creative industries and firms are not very developed. At the micro level, financial information can be retrieved from the AMADEUS database. EUROSTAT contains statistics on cultural employment (by age, education level and NACE activity) as well as on international trade in cultural goods (by products and partner). Several macro aggregates (value added, employment, R&D is also available for the different creative industries and EU Member states from EUROSTAT.

The 4th edition of the Community Innovation Survey also contains some questions on firms’ innovative and creative activities. Figure 2 shows that for a wide range of innovation measures reported in the Community Innovation Survey, industries with greater links to the creative industries have stronger innovation performance.

The DCMS (2007) estimates that creative industries accounted in 2005 for 7.3 % of total Gross Value Added in the UK and grew at 6 per cent per year on average between the years 1997 and 2005 compared with the whole economy growth of 3 per cent over the same period. In Scotland, the creative industries account for around 4 % of GDP while in Northern Ireland, creative industries accounted for 5 % of the local economy in 2003 and employed 33500 people (compared with 32500 agricultural workers).

According to a study conducted by TERA Consultants (2014), the core creative industries in the 27 countries of the European Union were estimated to generate €558 billion in value added to GDP in 2008, approximately 4.5% of total European GDP. The value added by the total creative industries (core creative industries plus non-core creative industries) was approximately €862 billion in 2008, representing an estimated 6.9% share of GDP. The creative industries also account for a significant number of jobs throughout Europe. Employment in the core creative industries in the 27 countries of the EU was approximately 8.5 million in 2008, or 3.8% of total European workforce. Employment in the total creative industries (core creative industries plus non-core creative industries) was approximately 14.4 million, or 6.5% of the total EU workforce.

Figure 2 shows that the innovation performance is strongest for industries with highest spending on creative industry products as a percentage of their output.
Figure 2: Spending on creative industry products as a percentage of their output

2.4 Conclusions

The economic contribution of the creative industries is now widely recognized. In the UK, policymakers have sought to support the development of the creative industries, mostly through programmes targeting particular sectors (Frontier Economics Ltd, 2007). The Creative Economy Programme for instance was designed to explore seven issues with the industries themselves, namely Education and skills; Competition and intellectual property; Technology; Business support and access to finance; Diversity; Infrastructure; and Evidence and analysis. In the UK, Public agencies provide business support to small and medium-sized enterprises (SMEs) in the creative industries, including business skills development and access to finance. Business Link operators act as brokers between creative businesses and a wide range of business support schemes.

In recent years, a large number of studies increased our knowledge of creative industries and also highlight the process of innovation and impact of innovation in creative industries (see e.g. Potts 2009). However, creative industries are a quite heterogeneous group of industries where each industry demands special treatment to arrive at meaningful policy implications. The next steps in our analysis will highlight the innovative core of creative industries. We will also focus on design-based innovation. We will discuss the report and the recommendations of the European Design Leadership Board (see Thomson and Koskinen 2009) and will focus on the policy recommendations for the Board and critically assess whether at all and which government intervention will spur the European Design industries.
2.5 References


Handke CW (2004) Measuring Innovation in Media Industries: Insights from a Survey of German Record Companies, Humboldt-University, Berlin; Erasmus University, Rotterdam.

Handke CW (2006) Surveying innovation in the creative industries, Humboldt-University, Berlin; Erasmus University, Rotterdam


TERA Consultants (2014), The economic contribution of the creative industries to EU GDP and employment -Evolution 2008-2011, study conducted by TERA Consultants.

3 Open Access to Research Results / Research Information Services (Commitment 20)

Maja Jokić, Institute for Social Research Zagreb

Literature review on Commitment 20 has been carried out by the Institute for Social Research in Zagreb (Institute of Economics Zagreb (EIZ) subcontract), with a long-standing experience in the specific area of open access and information services.

3.1 Economic Rationale

The European Commission as a policymaker, funding agency and capacity builder defines rules of dissemination of results of EU-funded research projects. These rules are determined in strategic documents that promote open access to the results of publicly funded research (EC, 2010; 2012a; 2012b; 2012c; 2012d). In addition to promoting open access to publicly funded research, commitment 20 of the Innovation Union Flagship Initiative (EC, 2010: 19) states that Commission will aim to make open access to publications the general principle for projects funded by the EU research Framework Programmes. Furthermore, Commission will also support the development of smart research information services that are fully searchable and allow the results from research projects to be easily accessed.

What is the rationale behind commitment 20? Progressive journal subscription expenditures and budgetary constraints disable libraries of various organizations to purchase licenses for relevant journal content. Therefore, scientists, especially in less endowed institutions, have increasing problems to access scientific knowledge. It in particular applies to SMEs. According to a UK research report (Publishing Research Consortium, 2009) based on an online survey combined with qualitative interviews, a significant share of SMEs (55%) had experienced difficulty accessing a research article (against 34% in the case of large companies), with cost reported as the key obstacle. This prevents incorporating recent developments in their research or innovation agenda, affecting the scientific quality and the economic outcome of these entities.

The commitment 20 implies that results of publicly funded research, whether it takes place at the level of EC or national funds in the EU Member States, is made publicly available both to the research community and the academia, as well as to policymakers, and particularly to the industry, including the SME sector. In reality, the situation is somewhat different. Despite strong efforts in most EU countries to promote open access, research results are still predominantly published in professional and commercial scientific journals. These are usually available to their audiences in form of “packages” e.g. as collections of large number of various journals. The availability of the journals’ content usually calls for extraordinary generous funding. SMEs can hardly afford such packages, particularly in post-transition countries. The paradox is that while the content of
commercial scientific journals is created by researchers presenting the results of research either financed by the EC or national funds, these same researchers still need to pay for access to that content.

The solution to the problem of availability of relevant scientific and professional information can be reached by putting into practice a system of open access portals and repositories, which should then be accessible to their audience. Most Member States in the EU have, at least to some extent, developed open access programs for national journals and institutional repositories which contain integral texts of research papers and expert papers, different reports and software solutions. However, the problem still lies in the fact that such sources of scientific information are dispersed, insufficiently promoted and hard to find. In addition to repositories with open access to project results, scientific articles and other scientific information, attention should in the future be spread to other impact channels such as repositories with open access to research data as well as e-infrastructures to access and preserve scientific information in digital age.

The implementation of commitment 20 besides its economic should also have some important social impacts. While the former include expected increase in productivity of research as well as increased visibility and usage of the existing research results, the latter relates to increased transparency of research, improved science-literacy of citizens as well as opportunity for policymakers to make more evidence-based decisions (see Figure 1).
3.2 Review of the Literature on Open Access Journals

By definition, Open Access (OA) means online access to scientific publications, at no charge on access and free of many restrictions for the users. As journals constitute over 90% of scholars' information sources (King et al., 2009), by this commitment in the project, under the notion of OA we will primarily consider articles published in scientific journals.

Although open access should, by the definition, be free of charge, in reality we have two forms: "gratis" and "libre" open access. In this project we are interested in "gratis" open access which could be realized in two ways: "green" and "gold". In "green" open access authors are responsible for free access to their published research results, by self-archiving process, usually via institutional repositories, project websites, national portals or central repositories (PubMed Central, ArXiv etc.). In "green" open access self-archiving process, creation and maintaining institutional repositories, portals, usually is paid by institutional or national funding bodies. "Gold" open access is a way in which publishers allow everyone to read published articles for free. Publishers provide "gold" open access services because the article publishing charge (APC) - that authors, their institutions or funding bodies pay - covers all expenses needed to support the publication process.
Several EU initiatives have addressed the issue of open access to scientific knowledge and of knowledge transfer. In 2007 Council Council of EU (2007, p. 40) in its conclusion invited the European Commission to experiment with open access in the Framework Programme and Member States to reinforce national strategies on access to scientific information, thus building on the Commission Communication on scientific information in the digital age. Since then, funding and soft measures have been adopted at the EU level to support the development of open access. As a result of FP7, scientific publications resulting from a set of EU-funded projects are now increasingly available in open access. Despite their relevance, FP-funded measures concern only a very limited share of EU’s overall R&D expenditure and their impact thus remains limited. Member States have not equally advanced in the way they address and support the issue of open access (EC, 2011).

In addition to open access, effective implementation of ERA for research excellence requires a strategic approach to promoting the development and take-up of digital research services and the transformation of traditional ways of undertaking research into new data-intensive and collaborative research paradigms. Currently, Member States have different usage policies for publicly funded research e-infrastructures. In some cases high-speed connection networks or super computers are offered only to universities, in others to schools and hospitals, and yet in others linkages with commercial service providers and industrial research are allowed. Different national policies create obstacles for multi-national research collaborations, if research consortia have partners of different types. For instance, Europe lacks a common Authentication (identification) and Authorization (rights to access services) Infrastructure (AAI) which provides researchers with seamless access to research services in digital ERA. Effective implementation of digital ERA requires strategic action in all Member States, with active involvement of all research-related stakeholders.

According to ERA Progress Report and (EC, 2014), open access for publications resulting from publicly-funded research is becoming the standard. In Horizon 2020 open access to peer-reviewed publications is a default setting. Open access to data may require more frequent financial support from funders – as well as more proactive action by research performers – to increase their importance. Particular attention has been given by Member States to the re-use of research data, where a number of real and perceived barriers still exist, including those of a legal, technical, financial, trust-related and sociocultural nature. However, national policies, initiatives and practices are still fragmented and some of them do not properly reflect the EU definition of Open Access.

The main bottlenecks that have prevented OA from gaining greater acceptance among stakeholders include: lack of awareness among researchers, concerns about the quality and prestige of OA journals, concerns and confusion regarding copyright, the dissuasive influence of author-side fees, difficulties moving beyond the current system of subscription-based journals, the lack of useful data on OA’s evolution, a perceived lack of profitability surrounding OA business models, and a lack of infrastructure to support OA in developing countries. Open access to research data is rapidly evolving in an environment where citizens, institutions, governments, non-profits and private companies loosely cooperate to develop infrastructure, standards, prototypes and business models (Caruso et al., 2013).
The key factor which directly affects the issue of OA and the increased usage of its potentials is the lack of adequate legislation, not only at the level of individual EU Member States, but also at the level of EU as a whole. This refers to the lack of legislation which would include minimum set of common provisions to ensure a single system of availability of OA content. “Most national governments have not proposed or implemented direct legislation on OA. Instead, OA is often addressed through less formal means, such as the production of guidelines for research funding agencies. Related legislation often includes laws on copyright and licensing. ... Legislation directly addressing OA has been implemented in the US, Spain and Germany. Italy and Lithuania have also recently passed laws that have direct implications for OA in those countries” (Archambault et al., 2014: 1). However, it should be noted that Europe has some examples of good practice such as the UK. Namely, the UK is the leader in the development of OA to peer-reviewed publications thanks to its Higher Education Funding Council for England (HEFCE) and the Research Councils UK (RCUK). To reach the stage of defining legislative documents on OA, it is necessary to envisage how OA infrastructure would look like and how it would operate at the level of Member States and the EU itself. The issue of OA is a complex one, involving producers of scientific and professional information (researchers, research institutions and universities), funding organizations (the EC, national funds for science and research, the R&D sector and SMEs), users (researchers, scientists, policymakers, R&D, SMEs and the public), as well as the OA system itself along with its infrastructure (technical infrastructure, financial infrastructure, the management and the experts developing and upgrading the system). Within the framework of the current commitment in the project’s initial stage, the plan is to restrict activities to the current state of play in OA with special emphasis on OA scientific journals in EU countries and to provide a review of relevant literature dealing with OA journals.

The term “open access” was first set out in February 2002, in the document known as the Budapest Open Access Initiative. Although discussion on OA has intensified in the past 10 years or so, the idea of OA actually stems from a much longer tradition. Namely by 2002 some higher education institutions had already come across solutions that had allowed them to make the results of their research as widely available as possible, primarily after the emergence of the world wide web in the 1990s but also by virtue of the development of Information and Communications Technologies (ICT). Considering that the initiative for OA has developed in a relatively short time span and within a scientific system which has entailed a centuries-old paradigm of scientific communication, one can hardly expect that there would be consensus on certain aspects of OA. Because of a relatively poor promotion policy, which has stemmed from a lack of balanced OA policy and OA infrastructure in individual countries and at the EU level, scientists as the most frequent users of scientific literature do not have sufficient information on the OA system and the quality of the publications available, while there is also often confusion regarding the definition of OA publications.

In this brief introduction related to the literature review on open access journals, we will give just a few starting points. A more complete analysis and interpretation of the results will be presented in
the later stages of the project.

For the purpose of this project, Scopus bibliographic and citation database was selected as the most relevant secondary source of scientific and professional literature. Its relevance is based on clearly defined criteria for journal selection and indexing, as well as on comprehensive coverage of different document types. Scopus is a multidisciplinary source which covers more than 30,000 journals from all scientific fields. By retrieving Scopus database, we got a set of 439 publications, with the exact term “open access journal” in the title of the paper. The dynamics of publications on this topic through time can be seen in Figure 3.

**Figure 3 Publishing dynamics of papers concerning the subject “open access journal”**

Analysis of bibliography (N=439) indicates a dispersion of papers in a large number of journals from all scientific fields and disciplines. As expected, journals with the largest number of papers dealing with the open access topic are coming from the field of information and communication science. Journals with the most papers on open access topic are (in descending order): *Learned Publishing, American Society for Information Science and Technology, Serials Librarian, Scientometrics, Current Science, European Science Editing, Electronic Library, Information Research, Serials Review*, etc. Interestingly, among them only journal *Current Science* is an open access journal. Additionally, it is interesting to note that less than one quarter of the articles dealing with the issues related to OA (N=439) are actually available through OA.

Regarding geographic distribution of papers’, authors from EU member states are represented in 31.2% publications. These authors come from 16 out of 28 EU member states.
Analysis by publication type shows that article and review papers have a slight majority, with 50.1% share. Journals which have published those papers are predominantly (63.2%) coming from the social science fields. In those social science journals, authors from EU member states are represented with 33.2% articles.

Editorial papers, as opposed to articles and review papers are predominant (81%) in the fields of medicine, biochemistry, genetics and molecular biology, agricultural and biological sciences, and chemistry. However, out of the whole set of 439 publications, editorial papers make up 30% which indicates that journal editors perceive OA as a contemporary challenge. Analysis of the content of editorial papers on OA shows positive attitude towards OA, with most of the editors expecting their journals to be more widely available, visible, read and quoted should their journals be available through OA. Other publication types, such as conference papers, book chapters, short surveys, notes, letters and errata, have a share of approximately 20%.

The significance of published papers dealing with issues related to OA journals (N=439) can be measured by the number of citations. On average, each paper has been cited five times. However, citation analyses indicate that 70% of all citations come from only 10% of all papers, which represents a Pareto-like distribution. The range of citations spans from 0 to 190 (Harnad and Brody, 2004) and the largest share of publications – 49% percent of them – had not been cited at all, including self-citations. Among the most cited papers with over 50 citations, besides Harnad and Brody (2004), who have been among the initiators of the OA idea, one can find papers by Björk et al. (2010), Laakso et al. (2011), Björk et al. (2009) and Davis (2011).

Harnad and Brody (2004) have analysed citation rate of individual OA articles and non-OA articles appearing in the same (non-OA) journals. Such comparison reveals dramatic citation advantages.
for OA articles. Björk et al. (2010) have analysed how OA journals are represented across different scientific fields. The results imply that OA already has positive impact on the availability of scientific journal literature and that there are significant differences between disciplines. Due to the lack of awareness of OA-publishing among scientists in most fields outside physics, these results are important to scholars as well as academic publishers, who need to take into account OA in their business strategies and copyright policies. They should be of interest to funding organization as well as they increasingly require OA availability of results when they financially support research projects. Laakso et al. (2011) undertook a longitudinal study on the development of OA journals from their beginnings in the early 1990s until 2009. They recognise three distinct periods: pioneering years (1993-1999), the innovation years (2000-2004) and the consolidation years (2005-2009). The analysis indicates rapid growth of OA publishing during the 1993-2009 period. In 2009 an estimated 191,000 articles were published in 4769 journals. Since 2000, the average annual growth rate has amounted to 18% for the number of journals and 30% for the number of articles. This can be contrasted with the reported 3.5% annual volume increase in journal publishing in general. In 2009, the share of articles published in OA journals in the total number of all peer-reviewed journal articles reached 7.7%. Overall, the results document rapid growth in OA journal publishing over the last fifteen years.

Misunderstanding and mistrust on the part of the research community concerning the value of OA journals has most frequently pertained to the quality of the peer-review process (Suber, 2003; Bornmann et al., 2010). However, Eysenbach (2004: 1) argues that “because of their electronic form, openness for readers and the author-pays business model, they are better suited than traditional journals to ensure the sustainability and quality of protocol reviews and publications.”

One of the important aspects of promoting OA journals are studies dealing with the attitudes of scientists or users towards OA journals (Xia, 2010). Schroter et al. (2005) have investigated the authors’ attitudes towards open access publishing and author’s charges, their perceptions of journals which charge authors, and whether they would be willing to submit manuscripts to these journals. They conducted an analysis via semi-structured telephone interviews. Results indicate that authors are more aware of the concepts of open access publishing and author-pays models than had previously been reported. Authors disliked the idea of author charges without institutional support and were concerned about implications of such model for authors from developing countries and those without research funding. However, many said they would probably continue to submit to journals they perceived as being of high quality, even if they charge authors. Authors consider perceived journal quality as more important than open access when deciding to which journal to submit their papers. New journals with open access may need to do more to reassure authors of the quality of their journals. Nicholas et al. (2006) performed one of the most extensive studies of the attitudes of the world’s senior authors on OA journals and on publishing in those journals. The results of their research, which included more than 4000 authors, highlight the knowledge gap that exists between authors and publishers.
the research community while McCabe and Snyder (2013) argued that the wider availability of OA journals causes a statistically significant reduction in the number of citations to the bottom-ranked journals in sample, leading to conjecture that open access may intensify competition among articles for the readers' attention, generating losers as well as winners.

Out of the list of 439 publications extracted from Scopus, substantial part relates to case studies of individual journals or group of journals from a specific field (Sills et al., 2005; Drenth, 2005). They mostly promote OA and emphasize the advantages OA brings to given journals.

Considering the fact that this project is about innovations and its economic aspects, it is interesting to see how many papers were published in journals from the fields of economics, econometrics, finance, management, business and accounting. The result is somewhat surprising: we have compiled a list of 13 articles (total N=439). These articles were published in the journals such as Economic Inquiry, American Economic Review, Economic Analysis and Policy etc. Most often cited authors include McCabe and Snyder (2005) and Migheli and Ramello (2013). The fields of engineering, technology, the chemical industry, material sciences and energy have been concerned with the issues surrounding OA journals somewhat more intensively. A total of 38 papers had been published (N=439). The average citation count for these papers equals 1.4 citations per paper, while the number of citations ranges from 0 to 13. Those papers which had no citations make up for 63.1%.

Finally, we have been interested in the research investigating the relation between the SME sector and OA journals. By this we principally have in mind research on the level of usage of OA journals by the SME sector and research on the SME community's attitude towards the mentioned sources of scientific literature, as well as towards the issue of whether they had been introduced to the possibilities and advantages of OA journals. Although the results of searches connected to economics, management, technology, industry and OA journals have yielded relatively poor results, we had still not expected that the multidisciplinary Scopus database contains no papers concerned with these issues.

3.3 Data Collection – Portals/Databases

In order to obtain a more comprehensive picture about the role of open access journals in the EU member states, we will use available reliable international open access portals/databases: BASE, OpenAIR, OAIster, DOAJ, SERPA/RoMEO. These portals cover and index national portals of EU member states. Additionally, for bibliometric, scientometric and altmetric analysis of open access journals, professional Scopus database will be used.

- BASE is one of the world’s most voluminous search engines especially for academic open access web resources. It is operated by Bielefeld University Library http://www.base-search.net/. BASE is a registered OAI service provider and contributed to the European...
Union FP7 project "Digital Repository Infrastructure Vision for European Research" (DRIVER). BASE provides more than 70 million documents from more than 3,900 sources. You can access the full texts of about 70% of the indexed documents. The index is continuously enhanced by integrating further OAI sources as well as local sources.

- **OpenAIRE (DRIVER and OpenAIRE)** is an OA publications infrastructure, making visible funded research outcomes. They currently aggregate more than 13,333,000 publications and 16,730 datasets from 697 data providers, including many institutional repositories. OpenAIRE supports a wide range of scholarly resources (see content acquisition policy). To this extent, OpenAIRE now additionally to literature repositories harvest CRIS systems and repositories for research data sets, www.openaire.eu.

- **OAIster** is a union catalog of millions of records representing open access digital resources that was built by harvesting from open access collections worldwide using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). Today, OAIster includes more than 30 million records representing digital resources from more than 1,500 contributors. Additionally, the OAIster records are included in search results for those libraries with WorldCat Local and WorldCat Local "quick start." http://www.oclc.org/oaister/about.en.html

- **DOAJ - The Directory of Open Access Journals** was launched in 2003 at Lund University, Sweden, with 300 open access journals and today contains more than 10,000 open access journals covering all areas of science, technology, medicine, social science and humanities. The aim of the DOAJ is to increase the visibility and ease of use of open access scientific and scholarly journals, thereby promoting their increased usage and impact. The DOAJ aims to be comprehensive and cover all open access scientific and scholarly journals that use a quality control system to guarantee the content. In short, the DOAJ aims to be the one-stop shop for users of open access journals, https://doaj.org/.

- **SHERPA/RoMEO - RoMEO** is part of SHERPA Services based at the University of Nottingham. RoMEO has collaborative relationships with many international partners, who contribute time and effort to developing and maintaining the service. Current RoMEO development is funded by JISC. Past funders have included JISC, the Wellcome Trust and RLUK. Journal information is provided by the British Library’s Zetoc service hosted by JISC, the Directory of Open Access Journals (DOAJ) and the Entrez journal list hosted by the NCBI.

- **Scopus** is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings. Delivering a comprehensive overview of the world’s research output in the fields of science, technology, medicine, social sciences, and arts and humanities, https://www.elsevier.com/solutions/scopus.
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4 Facilitating Effective Collaborative Research and Knowledge Transfer (Commitment 21)

Ivan Damir Anic (EIZ)

4.1 Introduction

In a knowledge economy it is widely accepted that public research organizations - universities and institutes (hereafter Public Research Organisations - PRO) have an important role in the creation and diffusion of knowledge, and thus increasing the transfer of knowledge from PRO to business community is a primary policy aim in most developed economies (Bozeman 2000; Muscio, 2010; Arvanitis, Kubli and Woerter, 2011; Arza and López, 2011). Industry - science relationships (hereafter I-PRO collaboration) is considered to be a major factor contributing to high innovation performance, either at the firm, industry or country level (OECD, 2002; Arvanitis, Kubli and Woerter, 2011). I-PRO collaboration can be a powerful source of innovation and a factor that contributes to company’s success and economic growth (Azagra-Caro, Carat and Pontikakis, 2009; Ankrah, et. al., 2013). Collaborative research is expected to have positive impacts on a company’s innovation capabilities, research productivity, patenting activity and company sales as well (Fontana, Geuna and Matt, 2006). Firms may benefit from I-PRO collaboration by acquiring competitive advantage and improving their financial performance (Ankrah, et. al., 2013).

Past research shows that there is a gap between EU and US, and large differences exist across European countries in terms of I-PRO cooperation and technological competencies. In general, patenting activity in the South is lower than in the North (Maurseth, and Verspagen, 1998), while the cooperation between industry and science is much weaker in less developed and developing countries (Švarc, Grubišić and Sokol, 1996; Radas, 2005; Veugelers and Cassiman, 2005). Although a number of public policy initiatives have been introduced in EU (Kalar and Antončič, 2015), the potential I-PRO collaboration is not fully realised. This can be explained by significant fragmentation of activities, and insufficient PRO links with business community (Azagra-Caro et. al., 2009). In the literature exists a consensus that the cooperation between firms and science institutions has to be improved and knowledge and technology transfer activities (hereafter KTT) have to be intensified (Arvanitis, Kubli and Woerter, 2011).

Existing studies on I-PRO collaboration focus on the following issues: motivational factors for firms to get involved in collaborative research projects; the benefits of collaborative relations; the patterns of firms’ behaviour, perceptions and firms' characteristics decisive for cooperation, and obstacles for cooperation. Another stream of literature focuses on motivational factors for academics, the involvement of Technology transfer offices (thereafter TTOs) at PROs on transfer of new knowledge and technologies. The establishment of technology transfer offices (hereafter TTOs) has become a routine for supporting the commercialization of academic research at PROs.
However, as the literature indicates the potential of TTOs is not exploited due to various factors that affect the efficiency and effectiveness of these offices (Muscio, 2010).

Furthermore, various conceptual frameworks emerged in the literature aiming at understanding the way scientific and technological knowledge should be produced and supported (Arza and López, 2011). A number of variables have been identified to be important for the analysis of I-PRO collaboration and knowledge transfer, and various measures of those variables have been used in the literature. Most of the existing literature on PRO–industry linkages was produced in developed countries (Arza and López, 2011), and cover single country analysis, and fewer papers have focused on the analysis of EU collaborative research projects (Bach, Matt and Wolff, 2014). As structural characteristics of I-PRO relationships in developing countries are different from those in developed countries, policymakers have gone through frustrating experiences when trying to imitate successful examples from developed countries (Arza and López, 2011).

The purpose of this study is to gain a deeper insight into issues related to I-PRO collaborative research and knowledge transfer. More specifically, the study is focused on the following research questions:

1. What factors determine companies to get involved in I-PRO collaborative research?
2. What issues determine the lack of I-PRO collaborative research?
3. What issues face technology transfer offices?
4. How identified obstacles can be translated into the recommendation for public policy?

This research contributes to a better understanding of the quality and the extent of I-PRO collaborative research by examining the collaboration patterns and characteristics of companies that are involved in collaborative research projects and identifying the issues that affect a lack of collaborative research. Moreover, this study explores the drivers and barriers, the extent and quality of involvement of TTOs at PROs in the transfer of new knowledge and technologies. The research results might be useful for policy makers in the area.

The study is divided in four sections. In the second section the literature dealing with collaboration patterns and characteristics of companies is discussed. Third section includes the literature on the extent and quality of involvement of TTOs at PRO on transfer of new knowledge and technologies. Last section presents the conclusions and the main implications for policy making.

4.2 Collaboration Patterns and Characteristics of Companies

4.2.1 Collaboration Patterns of Companies

Studies on knowledge and technology transfer indicate that joint research activities are the most important channel for conveying scientific knowledge to industry, especially in Europe (Roessner, 1993; Schartinger, Schibany and Gassler, 2001; Raesfeld, et. al., 2012). Past research has examined...
motivational factors for I-PRO collaboration, and several motivational factors have been identified. Previous studies suggest that companies collaborate with PROs in order to achieve synergies in the research programme, to keep track of technological developments more easily and in order to split research costs and share risk (Radas, 2005; Decter, Bennett and Leseure, 2007). According to Lee (1996) major firms’ motives to collaborate with research organisations are obtaining access to new research and new technical knowledge, the development of new products, maintaining a relationship with the university, obtaining new patents and solving technical problems (Fontana, Geuna and Matt, 2006; Decter, Bennett and Leseure, 2007). Other motives include conducting research leading to new patents, improving product quality, reorienting R&D agenda (Lee, 2000). Similar motives, although different in their rankings, were found in other studies too. Besides accessing complementary knowledge, firms participate in FP projects to keep up with the state of the art of technological development and to explore new technological opportunities (Bach, Matt and Wolff, 2014). There are differences among countries in ranking of firms’ motivational factors for collaboration with PROs (Decter, Bennett and Leseure, 2007).

Motives for collaboration are regarded very often as being similar to anticipated benefits obtained from collaboration (Ankrah, et. al., 2013). The most cited benefits derived by industry are the following: participating in collaborative research is more cost-effective than conducting similar in-house research; obtaining public grants and funding; improved innovative ability and capacity that is aimed to strengthen research capacity; access to new knowledge; keeping up to date with technological developments in PRO; solving specific technical problems; having opportunity to access a wider network of research expertise (Ankrah, et. al., 2013). Other studies report that firms benefit from collaboration with PRO in a way that they enhance the knowledge base, which might help them improve production processes and develop new products (Caloghirou, Tsakanikas and Vonortas, 2001; Radas, 2005).

There are several studies that analyzed factors that determine firms’ decisions to get involved in I-PRO collaboration. Some of those studies were done at EU level taking into consideration the characteristics, behavior and perceptions of companies in several EU countries (Mohnen and Hoareau, 2003; Fontana, Geuna and Matt, 2006; Abramovsky, et. al., 2009), while the majority of studies were conducted at a single country level (e.g. Belgium - Capron and Cincera, 2003; Veugelers and Cassiman, 2005, Germany - Schmidt, 2005; UK - Laursen and Salter, 2004; Switzerland - Arvanitis, Kubli and Woerter, 2011; Argentina - Arza and López, 2011; US and UK - Decter, Bennett and Leseure, 2007; Croatia - Radas, 2005; Bozic, 2007).

The determinants the most often investigated in the literature can be observed as firm-related characteristics, R&D activities, firms' strategic orientation, innovation-related factors, geographical proximity and various environmental factors. Major firms' characteristics found in the literature are presented in table 1.
### Table 1 Literature review on firms’ characteristics decisive for I-PRO collaboration

<table>
<thead>
<tr>
<th>Factors</th>
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<tbody>
<tr>
<td>Firm size</td>
<td>Positive relationship: Caloghirou, Vonortas and Tsakanikas (2000); Schartinger, Schibany and Gassler, (2001); Fritsch (2003); Mohnen and Hoareau (2003); Capron and Cincera (2003); Laursen and Salter (2004); Veugeler and Cassiman (2005); Schmidt (2005); Fontana, Geuna and Matt (2006); Božić (2007); Arvanitis, Kubli and Woerter (2011).</td>
</tr>
<tr>
<td>Company activity</td>
<td>Positive for companies operating in sectors like biotechnology, information technology and new materials firms in the chemical and pharmaceutical industry (Fontana, Geuna and Matt, 2006).</td>
</tr>
<tr>
<td>Type of innovation</td>
<td>No relationship: Fontana, Geuna and Matt (2006).</td>
</tr>
<tr>
<td>The existence of R&amp;D activities in a company</td>
<td>Positive relationship: Cincera and Capron (2004); Fontana, Geuna and Matt (2006); Božić (2007); Arvanitis, Kubli and Woerter (2011).</td>
</tr>
<tr>
<td>Degree of openness of firms to</td>
<td>Positive relationship: Schmidt (2005); Fontana, Geuna and Matt (2006).</td>
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A number of studies have used **firm’s size** variable (measured for example as the number of employees or R&D employment) to explain firms’ characteristics decisive for I-PRO collaboration. Those studies show that firm size is positively related to I-PRO cooperation (Schmidt, 2005; Capron and Cincera, 2003; Mohnen and Hoareau, 2003; Fritsch, 2003; Veugelers and Cassiman, 2005; Fontana, Geuna and Matt, 2006; Božić, 2007; Arvanitis, Kubli and Woerter, 2011). As compared to small firms, large firms have more financial and human resources available to develop relationships with PROs. They have technological capabilities to optimally benefit from cooperation, and are more able to invest in competitive research (Radas, 2005; McKelvey, Zaring and Ljungberg, 2015). Usually larger firms have also a higher probability of benefiting from academic research (Fontana, Geuna and Matt, 2006). A study by Ljungberg and McKelvey (2012) showed that large multinational firms have high investments into R&D and high human competencies in terms of personnel including numerous Ph.Ds. They have the capacity to take the more general knowledge from PRO, bring it in-house and apply it to their specific technologies. On the other hand, small firms primarily see the university as “problem-solvers” for their technologies. The cooperation should be short-term and market oriented and focused on specific projects (McKelvey, Zaring and Ljungberg, 2015). The study of Arza and López (2011) show that in Argentina most I-PRO interactions (69%) lasted less than 5 years, while large firms managed to establish longer-term interactions than small firms.

The relationship between **firms’ age** (measured as e.g. firm age in number of years of operation) and I-PRO collaboration is not quite clear. While several studies show that firms age is positively related to cooperation (Arvanitis, Kubli and Woerter, 2011). Older firms are stronger inclined to get involved in KTT activities than younger companies, because they have a greater experience in cooperating with science institutions than younger ones (Arvanitis, Kubli and Woerter, 2011). Other studies show that older firms tend to have no KTT activities (Schartinger, Schibany and Gassler, 2001), while the study of Fontana, Geuna and Matt (2006) indicates that start-ups have a higher probability of benefiting from academic research.

Previous studies indicate that the firms’ propensity to cooperate with PRO varies across **industrial sectors**. The collaboration is especially important for firms operating in innovative sectors with fast developing technologies, like biotechnology, information technology and new materials. The study of Arvanitis, Kubli and Woerter (2011) shows that KTT-active firms are concentrated in the above-average innovative industries, like chemical industry, machinery, electronics and instrument industry, computer and business services (Arvanitis, Kubli and Woerter, 2011). Belgium case also supports the view that firms in the chemical and pharmaceutical industries are more likely to be
actively involved in I-PRO collaboration (Veugelers and Cassiman, 2005). This can be explained by the fact that in more innovative industries firms' research is complementary with their own research, and I-PRO collaboration leads to higher research productivity.

I-PRO collaboration may be influenced by the firm’s legal status. In a recent paper, Mohnen and Hoareau (2003) found that independent firms rely more on collaborations with PROs than firms that are part of large organisations. R&D activities are usually concentrated at a firm’s headquarter.

Previous research also indicates that foreign ownership (measured in terms whether a firm has foreign headquarter in observed country) has a negative effect on cooperation with universities. Foreign subsidiaries located in Belgium are less likely to be involved I-PRO collaboration. A high share of foreign-owned enterprises in the economy may be a restricting factor to I-PRO collaboration, as the local affiliates of multinational enterprises may not carry out the type of basic research which strongly relies on new scientific knowledge. This basic R&D is typically done centrally at headquarter level, leaving industry–science cooperation more headquarter than a subsidiary level (Veugelers and Cassiman, 2005).

Several studies have investigated various factors related to R&D activities as a driver for I-PRO collaboration. They show that that firm’s own R&D capacity and its R&D activities positively affects the decision to cooperate with universities (Veugelers and Cassiman, 2005; Fontana, Geuna and Matt, 2006; Arvanitis, Kubli and Woerter, 2011). Firms with the largest innovation propensity, which invest heavily in R&D, are likely to possess a high technological capability that allows them to absorb the knowledge developed outside the firm (Fontana, Geuna and Matt, 2006). Linked firms invest more intensively in both, in-house innovative activities and technology embodied in machinery (Arza and López, 2011). They have more incentives to invest in R&D and have greater ability to produce innovative output than non-collaborating firms.

Past research suggests that R&D intensity (measured for examples as the share of R&D employees) is positively related to I-PRO collaboration (Fritsch, 2003; Schmidt, 2005). Companies with a stronger innovation and technology orientation have more intensive collaboration with scientists (Radas, 2005).

The study of Arvanitis, Kubli and Woerter (2011) showed that long-term R&D orientation shows a positive impact on KTT activities (Arvanitis, Kubli and Woerter, 2011). Enterprises that significantly invest in R&D of new products place greater importance on innovations and to improve the quality of their businesses. Božić (2007) suggests that the number of radical innovations and the amount of investment in R&D are the variables most contributing to the establishment of collaboration on product innovation in Croatia. However, there are also papers that suggest that R&D intensity (measured for example as gross investment per employee or R&D expenditures/sales) is not significantly related to cooperation with universities (Mohnen and Hoareau, 2003).
Past research indicates that the propensity to KTT activities is significantly positively correlated with human capital intensity (measured for examples as the share of employees with tertiary-level education) (Arvanitis, Kubli and Woerter, 2011). Radas (2005) has shown that Croatian enterprises with experienced and capable employees develop a more intense collaboration with other enterprises and scientific institutions. The more a firm is staffed with this type of personnel, the more it is likely that it will be involved in collaboration with PROs (Arvanitis, Kubli and Woerter, 2011). On the other hand, a lack of qualified personnel was shown to be big problem for Croatian companies in establishing collaboration (Božić, 2007).

Mohnen and Hoareau (2003) showed that patenting (i.e. firm having patents applied for) also contributes positively towards explaining I-PRO collaborations (Veugelers and Cassiman, 2005). Linked firms are more prone to patenting (Arza and López, 2011).

When costs are seen as an important obstacle to conduct innovation activities in a company, firms have a significant higher probability of engaging in cooperative agreements with PRO. This is because the collaboration with PRO offer the opportunity of applying for and receiving government subsidies and decrease costs of innovation activities in such way (Veugelers and Cassiman, 2005). While cost-sharing seems to be an important driver, risk-sharing (i.e. the importance of high risks as an obstacle to innovation) was not shown to be important for I-PRO collaboration. Risk is actually a barrier for I-PRO collaboration. Firms for which risk is an important barrier to innovate are actually less likely to cooperate with PRO (Veugelers and Cassiman, 2005).

Government support is the most important driver for I-PRO collaboration. It enhances the probability of R&D cooperations to a great extent (Mohnen and Hoareau, 2003; Capron and Cincera, 2003; Abramovsky, et. al., 2009).

The theory of localized knowledge spillovers suggests that profits will be greater in agglomerations and spatial clusters, since there access to tacit knowledge is easier. The study of Rosa and Mohnen (2008) indicates that the distance matters. It is found that a 10% increase in distance decreases the proportion of total R&D paid to a university by 1.4% for enterprises. Linked firms tend to value more than unlinked firms PRO research outputs that require geographically close collaboration (Arza and López, 2011).

Past research also indicates that firms’ openness to environment (measured for example as the use of external sources of information or by market orientation index) increases their propensity to collaborate (Fontana, Geuna and Matt, 2006). Enterprises demonstrating a high level of market orientation are more open to their customers and buyers, as well as to other partners, and are more ready to collaborate with other partners on innovation development (Božić, 2007). The study of Schmidt (2005) indicates that German firms are more likely to be engaged in any type of R&D cooperation if incoming spillovers measured by firms’ evaluation on the importance of external information sources were high.
Further firm characteristics which are related to I-PRO collaboration is the degree of firm’s exposure to international competition. The study of Arvanitis, Kubli and Woerter (2011) shows that international competition positively affects I-PRO collaboration. Higher know-how and innovations are necessity for companies to increase their competitiveness in the market.

Quick review of past research shows that almost all above mentioned factors affect I-PRO collaboration, while the relationship is less clear with respect to firm’s age and R&D intensity. There are some differences in characteristics and the behavior of firms operating in developing as compared to developed countries.

- In Argentina, e.g., there is a high incidence of unpaid interactions. Firms that do not connect to PRO argue that they did not need so because their own R&D was enough to innovate; there is no clear effect of firms’ knowledge bases on the probability to interact (Arza and López, 2011).
- Croatian case indicates that collaboration does not result in products, services or processes that can be commercialized. Small companies in Croatia face much greater difficulties in obtaining funding and are in worst position with respect to investments in own development and staff qualifications (Radas, 2005).

4.2.2 Factors that Affect Negatively I-PRO Collaborative Research

Past research indicates that I-PRO collaboration and knowledge transfer to industry might not be successful and there is no guarantee that the companies participating in EU programs will exploit the FP instruments in accordance with their objectives and will produce wanted results (Bach, Matt and Wolff, 2014). This is due to various barriers that significantly and negatively affect I-PRO collaboration. Some of those barriers are presented in table 2.

<table>
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<th>Factors</th>
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<tr>
<td>Orientation-related barriers:</td>
<td>Fontana, Geuna and Matt (2006); Bruneel,</td>
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<tr>
<td></td>
<td>D’Este and Salter (2010).</td>
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<td></td>
<td>Time constraints</td>
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<tr>
<td>Administrative procedures</td>
<td>Bruneel, D’Este and Salter (2010).</td>
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<tr>
<td>Transaction-related barriers</td>
<td>Bruneel, D’Este and Salter (2010).</td>
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<tr>
<td>A lack of trust</td>
<td>Bruneel, D’Este and Salter (2010).</td>
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<tr>
<td>A lack of effective communication</td>
<td>Liu and Jiang (2001).</td>
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<tr>
<td>Diminished control of leakage of</td>
<td>Liu and Jiang (2001); Ankrah, Burgess,</td>
</tr>
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<td>proprietary information</td>
<td>Grimshaw and Shaw (2013).</td>
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Classic barriers to I-PRO collaboration are the university’s long-term orientation, discrepancies between the objectives and mutual lack of understanding about expectations (Fontana, Geuna and Matt, 2006; Bruneel, D’Este and Salter, 2010). Companies perceive that PROs do not fully understand their business (Arza and López, 2011). Companies stress more economic benefit in collaborative research, while PROs (especially universities) are orientated towards pure science and pay more attention to academic value. Many universities are mainly interested in conducting academic-orientated research programmes, which are not necessarily linked to market demand (Liu and Jiang, 2001). High academic value might not lead to excellent economic performance, while R&D results with significant economic benefits might be considered as having lower scientific value. High expectations are also very often stressed as a barrier for I-PRO collaboration (Ankrah, et. al., 2013).

Among the reasons for not collaborating with universities is the length of time involved in university research (Fontana, Geuna and Matt, 2006). Firms operate under a very significant time constraint, as they must produce value for the market. Companies can allocate rather limited resources in creating knowledge in the future, and are interested in short-term market-oriented results. The study of Arza and López (2011) found that the most important reason why firms do not collaborate with PRO in Argentina is that firms believe they do not need it because their in-house R&D is enough to obtain innovative results.

The share of benefits is also often unbalanced between PRO and companies. In pursuing technology transfer, many PRO are greatly concerned about gaining research funds and researchers’ financial rewards, and thus pay close attention to the financial benefits generated from the transfer (Liu and Jiang, 2001).

Organizational and institutional obstacles (such as problems with property rights; lack of support of commercialization of outcomes; management problems of the science partner) are often considered as a main source of mismatching between enterprises and science institutions (Arvanitis, Kubli and Woerter, 2011). Past research indicates that partners involved in EU research programs to a great extent pay attention to rules and procedures, imposed by universities or government funding agencies (Bach, Matt and Wolff, 2014), which is often cited as a barrier to successful I-PRO collaboration (Bruneel, D’Este and Salter, 2010; Bruneel, D’Este and Salter, 2010).

Barriers to I-PRO collaboration are also related to a lack of resources. A lack of or reduced government support for R&D collaborative projects is a major obstacle for collaboration. Moreover, next obstacle is technology involved. In general, R&D activities are at universities are

<table>
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<tr>
<th>A lack of R&amp;D capabilities at PRO</th>
<th>Liu and Jiang (2001).</th>
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<tr>
<td>A lack of financial resources</td>
<td>Liu and Jiang (2001); Božić (2007).</td>
</tr>
<tr>
<td>A lack of qualified personnel</td>
<td>Božić (2007).</td>
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</table>
completed in laboratories, and most of them only involve core technology. To apply these to production or markets, it is necessary to carry out a great deal of research on relevant auxiliary technology (Liu and Jiang, 2001). A lack of qualified personnel is the next factor that significantly contributes to the absence of collaboration between enterprises and other partners (Božić, 2007).

**Trust** has an important role in establishing I-PRO collaboration. High trust in university partners is associated with lower barriers, and low trust is related to high barriers. The dimension of trust was shown to be the strongest mechanism lowering both orientation and transaction-related barriers (Bruneel, D’Este and Salter, 2010).

R&D cooperation between universities and industry is characterized by **high uncertainty**, high information asymmetries between partners, high transaction costs for knowledge exchange requiring the presence of absorptive capacity, high spillovers to other market actors (i.e. a low level of appropriation of benefits out of the knowledge acquired), and, restrictions for financing knowledge production and exchange activities due to risk-averse and short-term oriented financial markets.

High risk with respect to innovation and **strategic protection** methods (like secrecy) exert a negative influence on a firm’s propensity to cooperate with research institutions (Schmidt, 2005; Arvanitis, Kubli and Woerter, 2011). Firms for which risk is an important barrier to innovate are less likely to cooperate with universities (Veugelers and Cassiman, 2005). The difficulty in establishing contractual agreements with PRO is also a barrier for I-PRO collaboration (Arza and López, 2011). When companies perceive that they have diminished control of leakage of proprietary information, which might allow competitors to imitate the innovation quickly, the likelihood of their involvement in I-PRO is lower (Ankrah, et. al., 2013). Other risks included in I-PRO collaboration are financial and market risks, mainly arising from uncertainty in the success of new products or technologies in the market, risk of incompetent academics in the technology transfer process, risk of incomplete transfer, and risk of non-performance of the technology (Lee and Win, 2004; Ankrah, et. al., 2013).

The study of Maurseth, and Verspagen (1998) shows that there are four main factors that limit technology flows across Europe. Firstly, spillovers are more extensive between regions with similar or complementary specialization patterns. Secondly, distance matters a lot for inter-regional citations. The data reveal that knowledge flows more freely within than across national borders. Intra-country spillovers are more extensive than inter-country spillovers.

Overall results also suggest that the structure of the industry might inhibit I-PRO collaboration. Factors that negatively affect collaboration are the following:

- a high percentage of small firms,
- industry with less technology-intensive companies,
- a high percentage of foreign subsidiaries operating in the country,
- a high percentage of firms with low R&D activities,
• a high percentage of firms with low human capital intensity,
• a high percentage of firms with low level of market orientation,
• low level of market competition,
• low level of government support for R&D activities.

If companies with such characteristics dominate in the industry, the level of I-PRO collaboration will be lower.

4.3 Extent and Quality of Involvement of TTOs at PRO on Transfer of New Knowledge and Technologies

Previous studies pointed out various motives for academics and public institutes to collaborate with business sector. Major benefits derived from I-PRO collaboration for PROs are the following: source of funding, created business opportunities, exposed researchers to practical problems, new ideas and state-of-the-art technology, stimulated technological advancement, access to wider network and greater links with industry, test the practical application of one’s own research and theory and gain knowledge about practical problems useful for teaching (Lee, 2000; Ankrah, Burgess, Grimshaw and Shaw, 2013). Government support (obtaining extra funding) is one of the most important motives for collaboration with industry.

Previous studies show that researchers do benefit from collaborating with industry, although the benefits derived in terms of publications are less clear. Past research shows that researchers with no industry involvement publish less than those with a small degree of collaboration. The presence of industry partners is associated with a higher degree of academic research output, but the intensity of industry collaboration decreases academic productivity. The publication rate of an academic with an average level of collaboration is higher than that of an academic with no collaborative funding. But for higher level of collaboration, the predicted number of publications is lower (Banal-Estano, Jofre-Bonet and Meissne, 2008).

In order to adjust to dynamic market environment, a number of PROs have transformed themselves from a traditional research organization to an entrepreneurial university with strong ties with industry, thereby encouraging the entrepreneurial activities of their academics (Krabel and Mueller, 2009). The role of the entrepreneurial university is not simply producing new knowledge, but also disseminating this new knowledge to industry and society (Guerrero et al., 2012). It seems that academics in the natural sciences perceive their university department as being more entrepreneurially oriented than their counterparts in the social sciences (Kalar and Antončič, 2015).

Nowadays, many universities and public research institutes establish TTOs (Muscio, 2010), that are responsible for managing the knowledge and technology transfer. The TTO’s responsibility includes helping PROs secure the human and financial resources (O'Shea, et al., 2005); negotiating with industry, providing mediation between academics, commercial organizations and university
administrators and mitigating conflicts, informing companies about inventions and expertise in the academic community, and they guard the university’s intellectual property (Siegel, Waldman and Link, 2003; Weckowska, 2015). Universities’ commercialization performance depends partly on the abilities of their respective TTOs to facilitate exploitation of academic inventions in commercial applications.

TTOs can assist in creating an environment more conducive to the establishment of new biotechnology companies by: (1) facilitating linkages between researchers with different competencies, as well as between research institutions, industry and government; (2) communicating their understanding of needs and conditions within research institutions to potential investors and business partners, and their knowledge of business prerequisites to researchers and management in their organisations; (3) raising awareness amongst researchers of opportunities to exploit their research; (4) pro-actively assisting researchers to secure funding for the next phase of their research; (5) lobbying management to provide incentives to entrepreneurial researchers and to develop an enabling environment that does not put such researchers at a disadvantage in respect of promotion prospects (Wolson, 2007). Italian case shows that the primary objectives of TTOs are to diffuse an entrepreneurial culture of research, support university spin-offs and promote economic valorisation of research output and academic competencies. TTOs are mainly focused on supporting spin-offs, managing intellectual property and licensing, and administering research contracts and university–industry collaborations (Muscio, 2010).

Italian case shows that most universities manage their own TT operations, but very few have sufficiently strong research bases to allow the establishment of high-quality offices. Research collaboration agreements are established mainly between departments or professors and firms directly and rarely involve TTOs. These offices intervene in the “transfer” of research output outside academic institutions. The departments with good research output, those that collaborate more frequently with industry and those directed by younger academics that have more trust in TTO activities are more likely to contact TTOs to transfer their results to market. On the other hand, companies are more likely to contact those TTOs located in universities that have good research rankings (Muscio, 2010).

Research performance drives PROs to use TTOs. TTO activities compensate for lower applicability of research outcomes, possibly by helping to find business partners interested in technologies based on more basic research or in turning those technologies into commercial products. The departments access TTOs when they have good research to transfer. Universities make greater use of TTOs that are run by non-academic managers (Muscio, 2010). Friedman and Silberman (2003) find evidence that universities with TTOs that have a clear mission and well defined objectives for generating licenses and license income are generally more productive in these areas. If the department director has a good opinion of the TTO, the office he or she will be more likely to involve it in collaboration.

The study of Muscio (2010) also showed that factors that do not affect the frequency of
collaboration are the size of department and university or location of the department size, the proximity of the university to science-based firms, the presence of a TTO at the university and TTO’s age. Age of TTO was not found to be an important determinant. Longer established TTOs appear to be just as efficient as newer ones, suggesting an absence of learning effects (Chapple et al. 2005; Friedman and Silberman 2003).

In the case of Italy, TTOs’ contributions to university–industry collaborations are marginal (Muscio, 2010). There are, however, several factors that affect the quality of involvement of TTOs at PRO on transfer of new knowledge and technologies (Figure 1), and might explain why even apparently well-staffed and -equipped TTOs may struggle to operate successfully (Wolson, 2007).

**Figure 4 Issues that TTOs Face: Barriers to Interactions with Industry**

Barriers for academics to interact with industry affect TTOs performance. The study of Decter, Bennett, and Leseure (2007) showed that major barriers to university to business technology transfer in US and UK sample were differing financial expectations, communications problems, need for more technical support, cultural differences between university and company, funding for further development, lack of entrepreneurs in universities. The study by Muscio (2010) shows that barriers for collaboration are financial reasons, expected delays in research, previously established contact of company with PRO, a lack of TTOs competencies. The involvement of a TTO in collaborations largely depends on faculty perceptions of the benefits that the TTO brings to the university (Muscio, 2010).

Academics and business communities have often different research orientation, objectives and

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expectations, which negatively affects TTOs performance (Wolson, 2007). Companies’ short-term orientation, the digression from PROs’ core objective, mutual lack of understanding on expectations and working priorities, the nature of PROs’ research that is not suited to industry interests have been often identified in several papers as a drawback for collaboration for academics (Muscio, 2010; Ankrah, Burgess, Grimshaw and Shaw, 2013). Scientists are more concerned about their academic output. Companies’ problems are often not interesting in the research sense for academics. Namely, it is difficult to publish results of research collaboration with industry.

Academics also perceive that most firms lack long-term vision and educated employees, and that they do not have information to understand what scientists can do (Radas and Vehovec, 2006). Academics also often have problem with the fact that in collaborative research projects PROs have to engage staff and resources away from their core business and research (Ankrah, Burgess, Grimshaw and Shaw, 2013). On the other hand, firms do not value enough the results of scientists’ work. Applicability of research has a positive impact on frequency of collaborations. What really matters for frequency of collaborations is not how much research is conducted or how good the research is, but how applicable it is to the industry context (Muscio, 2010). Image of PRO can affect I-PRO collaboration, and difficulties in finding appropriate partners were shown to be an important problem for collaboration too (Muscio, 2010).

Lack of suitable government funding programmes for I-PRO collaboration is also one of the major problems. The shortages of financial resources due to the shrinking government support affect negatively collaborative projects (Caloghirou, Vonortas and Tsakanikas, 2000). On the other hand, executive management often has unrealistic expectations about the financial returns which are likely to be generated by the TTO (Wolson, 2007).

Other studies show that I-PRO collaboration can negatively influence companies due to absence of established procedures for collaboration with industry, slow, academic bureaucracies, which may stifle technology commercialization and depress the firm’s performance (George, Zahra and Wood, 2002). Several studies pointed out that the effectiveness of TTOs depends to a great extent on their management as much as on university regulations and scientists’ incentives (O’Gorman, Byrne and Pandya, 2008; Muscio, 2010). The absence of established procedures for collaboration with industry might limit to a great extent the university departments’ abilities to cooperate (Muscio, 2010).

TTOs might lack the resources and competencies necessary to search a wide range of laboratories and research groups for commercially viable technologies (Muscio, 2010). Several studies pointed out those TTOs even were they prepared to provide services to valorise the research efforts of departments; they would not be able to respond successfully in most cases to the broad spectrum of universities’ TT needs. They are inadequately staffed, with employees with backgrounds in administration rather than technology. Local training opportunities at PROs are often limited with few experienced technology transfer practitioners to act as mentors and share
good practice (Wolson, 2007; Muscio, 2010).

A lack of **experienced managers** is another problem for TTOs. Managing a TTO requires special skills to facilitate the matching of academic knowledge, competencies and resources to business needs, and provide assistance in the commercialization and pricing of technology. The study of Muscio (2010) shows that experienced directors at TTOs is likely to sign more agreements than inexperienced ones.

Another issue that TTOs face is related to difficulties associated with **intellectual property** management. Companies are often worried about protecting sensitive information about their R&D and innovation activities from competitors (Radas and Vehovec, 2006). The intellectual property landscape has become increasingly complex, and available expertise to deal with this is limited (Wolson, 2007). In contrast, commercial secrecy, which industry relies on, is often associated with a narrowly-framed and result-oriented enquiry, with profit as its main goal, and restricted disclosure of information.

**Licensing** opportunities to existing companies are also often lacking. Domestic firms, especially in developing countries often not have the markets or distribution channels for exploitation, and marketing of new products can be difficult (Wolson, 2007).

**Location** of universities in southern Italy does not reduce use of TTOs, while location in an area that has several science-based firms negatively affects the probability of accessing the TTO. In some regions, due to lower levels of R&D and economic activity, universities are less efficient at the commercialization of technology (Muscio, 2010).

### 4.4 Conclusions

The purpose of this research was to enhance the understanding of issues related to I-PRO collaborative research and knowledge transfer. This study examined factors that determine companies to get involved in I-PRO collaborative research and identified major issues that determine the lack of I-PRO collaborative research.

Past research indicates that factors that positively and significantly affect I-PRO collaboration are the following: firm size, the existence of R&D activities in a company, long-term orientation, human capital intensity, patenting, high innovation costs, a degree of openness of firms to the external environment, government support and firm’s exposure to international competition. The relationship between I-PRO collaboration, firm’s age and R&D intensity is less clear.

I-PRO collaboration is still rather weak due to a number of barriers. Factors that negatively affect I-PRO collaboration are the following: orientation-related barriers, time constraints, administrative procedures, transaction-related barriers, a lack of trust, lack of effective communication,
unbalanced distribution of benefits, diminished control of leakage of proprietary information, lack of R&D capabilities at PRO, a lack of financial resources, a lack of qualified personnel and geographical distance. The structure of the industry might also inhibit I-PRO collaboration.

This study also examined the extent of TTOs involvement in I-PRO collaboration and transfer of technology. Although many universities and public research institutes have established TTOs, the contribution of TTOs to I-PRO collaborations is still marginal due to several barriers, while its contribution to TT processes is still being debated in literature. Past research indicates that TTOs can be the ‘bottlenecks’ to or “facilitators of innovation dissemination”.

There are several factors that negatively affect the quality of involvement of TTOs at PRO on transfer of new knowledge and technologies: limited financial resources, limited capacity, unclear expectations and objectives, intellectual property management, commercialization of research results, lack of suitable government funding programmes, absence of established procedures, and difficulties in finding appropriate partners.

From above mentioned evidence some implications for public policy might be derived. These empirical conclusions might be useful for policy design for the promotion of I-PRO linkages and collaboration. Knowing the company characteristics, TTOs’ issues and barriers might help policymakers in better plan incentives in their knowledge transfer initiatives.

Some of possible improvements for making TTOs more effective are the following: greater availability of financial resources, lower financial expectations, greater availability of experienced personnel, better rewards for investors, minimizing bureaucracy, better communication, stronger relationships with business, greater autonomy of TTOs. A crucial first step in TT is to persuade academic staff to disclose their potentially valuable innovations to the TTO. Special attention must be placed on issues of intellectual property rights.

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5 Develop a European Knowledge Market for Patents and Licensing (Commitment 22)

Maikel Pellens (ZEW)

5.1 Introduction

Commitment 22: “By the end of 2011, working closely with Member States and stakeholders, the Commission will make proposals to develop a European knowledge market for patents and licensing. This should build on Member State experience in trading platforms that match supply and demand, market places to enable financial investments in intangible assets, and other ideas to breathing new life into neglected intellectual property, such as patent pools and innovation brokering.” (European Commission, 2013a).

As the description above shows, the goal of commitment 22 is to enhance the valuation of intellectual property (IP). To achieve this, the European Commission has created expert groups (European Commission, 2014) that assessed opportunities for financial market placed for IP (European Commission, 2011), and potential instruments for patent valorization in Europe (European Commission, 2012a). The findings and conclusions of these expert groups were used as inputs to the Staff Working Document “Towards enhanced patent valorization for growth and jobs” (European Commission, 2012b). This document lays out the largest barriers faced by European companies, and especially SMEs, to enhance IP valorization. A third study tackled the specific issue of the valuation of IP (European Commission, 2013b).

In this document, we summarize the relevant literature on the topic of markets for technology, with special attention to current developments in technology trading platforms.

5.2 Literature Review

This section reviews the economic and business literature on the valorization of technology through the marketplace. A first section highlights the currently under realized usage of knowledge stocks. A second section reviews current thinking about markets for technologies and ideas, including supply and demand factors, opportunities, and identified issues.

5.2.1 State of the Art

This section reviews the main findings of the expert groups created by the European Commission in the context of commitment 22, as well as the results of the study on IP valuation. We pay special attention to the policy recommendations.
First, the expert group on patent valorization (European Commission, 2012b) identified the main factors that prohibit owners from licensing or otherwise utilizing their intellectual property. The main cause was pinned down as transaction costs: the costs of finding buyers and sellers, negotiating costs, information cost of agreeing on a valuation, and the cost of obtaining freedom to operate on all patents which form a technology. The expert group noted that this is especially an issue for SMEs. Keeping in mind the need to avoid short-term forms of valorization such as patent right enforcement, the group then considered IP exchange platforms, services for valorization, and patent funds as potential policy instruments. The first refers to (mostly online) platforms that aim to match potential buyers with potential sellers through the provision of information on patents and / or demand for technologies. There have been privately as well as publicly organized platforms. As this is a very recent phenomenon with limited results as of yet, and as the most successful platforms tend to be commercial initiatives that combine the offering of information with side services, the expert group concluded that it was at the moment not necessary to create an IPR exchange platform at the European level. However, as SMEs face special needs, it recommended to raise awareness about these platforms among SMEs, and to provide SMEs with consultancy services to maximize the effectiveness of their use of these platforms. Further, the Patent Register of the European Patent Office could be a key instrument for providing companies with easier access to patent information.

The second policy lever investigated in the report consisted of services to promote the valorization of patents through commercialization. While many public institutes have taken initiatives to promote the use of IPR in public research organizations and SMEs, services that focus on encouraging valorization through commercialization are much rarer. The group recommends that member states should encourage patent valorization by SMEs through consulting and financial support or technology development, supported by the Enterprise European Network (EEN) in order to recognize and spread best practice. The group also recommends tightening coordination between the EEN, Patent Information (PATLIB) centers, and national IP offices.

Lastly, the report considers patent funds which obtain patents in order to sell, license, or litigate them. They can focus on short-term litigation returns, or longer-term returns from technology development and commercialization. The expert group believes that there is too much risk in finding buyers for technology to guarantee that such funds will not opt for the short-term returns option. The group recommends that the creation of a European Licensing fund, which would aim to acquire a large patent portfolio in a short term, is not warranted. It does have some hope for the option of offering limited and targeted financial support in the creation of patent pools for selected technologies, which could reduce transaction costs in high potential technology fields. However, it recommends further investigation first.

Second, we consider the policy recommendations concerning the creation of a financial market for

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2 See section three for an overview of trading platforms mentioned in European Commission (2012b)
IPR described in European Commission (2011). The report highlights the need for well-functioning IPR asset markets as a prerequisite for IP financial markets. Regarding the market for IPRs, the report recommends that the EC should foster to create a single market for IPR assets in Europe, in order to stimulate within-Europe technology licensing and to defragment the European IP market. It recommends the EC to call for proposals for IPR asset market business models through. Additionally, the report recognizes a need for awareness among European research institutions and SMEs regarding opportunities for valorization, and recommends industry-specific valorization services are created to assist them. The EC should also increase confidence in the market for IP by ensuring high common patent quality and enforceability, and support European companies trying to move to non-EU IPR markets by moving toward the global harmonization of IPR systems. IP transactions should be supported through promoting licensing as preferred mode of transaction. IP circulation should be encouraged by the further professionalization of technology transfer offices. Lastly, the EC is recommended to facilitate IP transactions by encouraging the dissemination of patent valuation methods.

Regarding the financial market for IPR, the report recommends the EC to not establish it before the IPR asset market has been substantially improved. It further recommends launching a network of excellence on the topic, including the appropriate members of the financial community, patent offices, companies, research institutions, and researchers. After three years, this network should propose policy actions regarding the establishment of an IPR financial market as well as actions for the correction functioning of said market.

Lastly, the expert group on intellectual property valuation identified the main barriers for IP valuation (European Commission, 2013b). These are lack of data on IP transactions, lack of trust in IP value assessments, lack of annual reporting of company-owned IP, and hesitation to accept intangibles as collateral by banks. Against his background, it made the following policy recommendations. First, credibility of value assessments of intellectual property should be boosted by establishing a data source for valuation professionals and by creating an overseer for IP valuation. Third, IP-secured lending should be eased by introducing risk-sharing schemes for banks. Lastly, standardized inclusion of intangible assets in annual reports should increase the transparency of IP towards lenders, investors, and stakeholders.

5.2.2 Relevant Initiatives

European Commission (2012b) provides an overview of existing initiatives that are aimed at encouraging patent valorization. These include increasing transparency in the market for technologies (such as the unitary patent and information repositories) and measures that encourage SMEs to take part in commercialization (including awareness and training initiatives, information sources, and financial support for commercialization).

Especially relevant for this report, European Commission (2012a) includes on overview of exchange
platforms for technology. The list includes public and commercial initiatives. Public initiatives have been launched in Denmark, the United Kingdom, Spain, and Germany. In Denmark this took the form of the IP Marketplace, launched in 2007, where patents, trademarks, designs, and utility models could be listed anonymously. In August of 2015, 669 patents were listed on the site.³ In Germany the Federal Ministry of Education and Research has launched the Innovation Market in 1998.⁴ This served as a repository of inventions available for sale or licensing as well as enterprises that are looking for inventions to acquire or innovative capital. Entries were examined by a panel of experts to assure the value of that which was offered. In the UK, Spain and Germany there further exist License of Right systems that allow patent holders to signal that they are available for licensing through online databases. Patent holders can enjoy a 50 % reduction of renewal fees if they are willing to license non-exclusively to any person. Information on licenses is public. In France, the technology transfer office of CNRS achieve likewise through a database of CNRS-research related inventions, established in 2001. On the European scale, the European Commission provides information about transferable inventions stemming from European R&D programmes through the Community Research and Development Information Service (CORDIS).

The report lists several commercial knowledge exchange platforms have come into play since the late 1990s. They are mainly situated in the US, and usually work on anonymous basis. They can be grouped into platforms which provide access to technology suppliers for their clients, and into those which provide online repositories of patent portfolios of anonymous sellers. Examples of the first kind include Innovaro/UTEK, NineSigma, YourEncore, Innovation Exchange, and Flintbox. Examples of the second kind are Yet2, Tynax, and ICAP Ocean Tomo.⁵ These platforms typically offer significant side services to buyers and sellers, including assistance in negotiations and offers, or assessment of IP portfolios. A recent noncommercial initiative is that of Oropo,⁶ a non-profit organization which aims to build an open register of patent ownership. Launched in June 2015, the organization has received support from companies such as Microsoft, IBM, and ARM. In February 2016, the website listed patent ownership data of 11 companies.

European Commission (2012a) argues that these platforms have had limited impact on the matching process, citing interim survey results which find that the top 1000 applicants at the EPO consider electronic platforms to be never or rarely effective intermediaries (p.29). Another survey of European innovative SMEs found that only 12 % of them use electronic platforms to find partners, while much more (respectively 43 % and 30 %) use personal networks or prior partners (p.29). Only a fifth of those who used electronic platforms found a partner. The expert group therefore concludes that current platforms are immature. Public platforms tend to be small or limited in scope, while commercial platforms are still in their infancy, with many different business models

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⁴ This project has been suspended due to low participation.
⁵ Business models can still vary: Yet2 and Tynax, for instance, also offers a database of prospective sellers. Ocean Tomo actions patents or titles to patents.
⁶ Oropo.net
and high failure rate.

The expert group also reached conclusions regarding the key factors for good practice. First, listing patents is not sufficient to inform potential buyers as there remains significant information asymmetry between buyers and sellers. Platforms need to provide additional information regarding related knowhow and the commercial value of technologies. Second, it seems to be easier to offer solutions for problems then to do the reverse. Therefore, a demand-driven business model seems more viable one than a technology-driven one. Third, side services could play a crucial role for further reducing transaction costs. Fourth, a critical mass of potential buyers will be needed for the long-term success of exchange platforms, as they need to show potential in order to attract buyers. Fifth, the lack of awareness of these platforms, especially among SMEs and PROs, seems to be an important limiting factor for patent valorization through technology exchange platforms.

5.2.3 Potential Usage of Knowledge Stocks

There is ample evidence that there is room for improvement in the utilization of knowledge stocks. The expert group on patent valorization (European Commission, 2012b) estimates that an additional 8 to 24 % of granted European patents could be valorized. The PatVal survey reports that 36 % of European patents are not used for commercial or industrial purpose (Gambardella et al., 2005). Almost half of Japanese patents remain unused (Japan Patent Office, 2010). A survey of 150 technology-intense patentees in Europe, Japan, and the US by Kamiyama et al. (2006) found that only 15 % of these had no unused patents. 25 % have more than 100, and 12 % have more than 1000 unused patents.

Concerning licensing, the PatVal survey finds that European patent holders fail to license 38 % of the patents they would be willing to license out: only 14 % of the average respondents’ portfolio was licensed out while they would be willing to license another 9 %. A survey conducted in the US and Canada (Razgaitis, 2004) found that firms find a potential licensee for only a quarter of the inventions they want to license. Negotiations are started for 7 % of inventions, and 4 % of potentially licensable inventions are eventually licensed. Kani and Motohashi (2012) surveyed Japanese firms, and report that many firms do not license out their technologies while they would be open to it. Nevertheless, licensing revenue is a very important reason for 19 to 29 % of firms in Europe, North America and Asia, depending on the sector (Sheehan et al., 2004). A survey of European and Japanese patenting firms finds that 20 % of European patenting firms license patents to non-affiliated entities, as do 25 % of Japanese.

At the same time, the market for licensing and royalties is large and growing: Athreye and Cantwell (2007) report that the global market has increased from 55-60 billion USD in the mid ‘90s to 100 billion USD in 2000. Arora and Gambardella (2010) note that these data show significantly higher

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7 Approximately half of these serve some strategic purpose, while the others are truly ‘dormant’.
growth rates than world GDP. Based on confidential tax data, Robbins (2006) estimates the market of US licensing of industrial processes at 66 billion USD. An OECD survey of firms in Europe, North America and Asia confirms that licensing revenue is increasing (Sheehan et al., 2004).

5.2.4 Markets for Technology

This section reviews work, focusing on what constitutes a market for technology, then moving to the main dynamics regarding the buyers and sellers for technology, and closing with known issues in technology markets. The literature on the economics of the market for technology is fairly new, and many aspects remain to be investigated (Natalicchio et al., 2014). Nevertheless, below we summarize main findings. First we describe what is meant with a market for technology, then moving on to the main dynamics for buyers and sellers of technology, and closing with known issues.

From the firm’s perspective, the starting point for a ‘market for technology’ is the notion that innovation depends on external knowledge as well as firm-specific knowledge (Chesbrough, 2003; Christensen et al. 2005; Vanhaverbeke, 2006). Thus, firms need, and search for, external knowledge to enhance their own innovation and development. This is often codified in patents, but can also be generalized to ideas, methods, and capabilities. Scholars tend to refer to the market for technology when writing about patents and licensing and the market for ideas in a broader sense. However, the economics are similar in both cases. In the following, we refer to the market for technology.

In the most general case, a market for technology can be defined as a virtual marketplace where companies, individuals, universities, governments, and research institutes can buy and sell ideas, inventions, skills, or more generally knowledge assets (Arora and Gambardella, 2010; Natalicchio et al. 2014, Bakos, 1998; Enkel et al. 2009; Verona et al. 2006; Tapscott and Williams, 2006). What sets the market for ideas apart is that the goods being exchanged are strictly intangible in nature, and that implementations of the marketplace are usually online (Dushnitsky and Klueter, 2011). The market brings strangers together, whereas usually knowledge searches are strongly limited by geographic factors (Giuri and Mariani, 2008) and social circles (Shane and Cable, 2002; Arino et al. 2005; Kirsch et al. 2009). If the platform provides standardized information, search costs for potential buyers and sellers can be severely reduced (Teece, 2000; Dushnitsky and Klueter, 2011). This has the obvious benefit of greatly increasing exposure (Zahra et al., 2005, Hall et al., 2009), but also has the downside of increasing the risk of imitation and other issues related to appropriation (Winter, 1987; Rivkin, 2001; Dushnitsky and Klueter, 2011).

But is the market for technology is a functional one? Roth (2008) defines three key factors: in order to function well, a market must be thick – with many buyers and sellers -, uncongested – deals must be achievable in a timely fashion -, and safe – not allowing for transactions outside of the market and strategic behavior. As is more discussed in the ‘issues’ section below, markets for
technology fail the Roth test (see further Gans and Stern, 2010).

5.2.4.1 Supply for technology

Selling technology is one of two options firms have for commercialization, the other being to incorporate technology into products (Teece, 1986). Engaging in the market for technology thus presents an opportunity to increase revenue (Arora and Fosfuri, 2003). There are also other reasons for taking part: Arora and Gambardella (2010b) point out that firms can also be motivated through strategic considerations, and factors such as simpler IP portfolio management (Tapscott and Williams, 2006) and identification of potential market applications (Nambisan and Sawhney, 2007) can also be relevant.

Teece (1986) identified two factors that affect the choice of selling vs. incorporating technology: appropriability regime and control of downstream assets. The first factor helps reduce transaction cost for technology sales, since fear about loss of property rights is reduced. The second factor related to incorporation: firms are more likely to produce technologies that fit the type of downstream assets owned by the firm. Arora and Fosfuri (2003) argue that firms with downstream assets weigh additional licensing revenues to the additional competition created in the downstream market by licensing. Their empirical analysis shows that the decision to license correlates negatively with the size of downstream operations owned by the firm, the degree of differentiation in the downstream market, and the weakness of intellectual property rights. This is corroborate by Kani and Motohashi (2012), who find that licensing is more likely under strong patent protection, more competition in the technology market, and when the firm owns less complementary assets. The importance of patent protection makes licensing also highly sector-dependent, as appropriation regimes differ severely among industries. This makes technology licensing an especially viable option in sectors such as pharmaceuticals (Anand and Khanna, 2000) and electronics (Grindley and Teece, 1997). Arora and Giarratana (2009) further expanded this by showing that licensing is more likely when the produce market is differentiated and the technology in question is more general. This is because a fragmented market hinders the own exploitation of all potential applications, and generality allows the firm to license out to distant players, where any competition effects will be smaller.

5.2.4.2 Demand for technology

As external knowledge gains importance for innovation (Chesbrough, 2003; Chen et al., 2011; Tapscott and Williams; 2006; Bianchi et al. 2011), the demand for technology is naturally increasing. Arora and Gambardella (2010a) highlight three factors that relate to the demand for external technology. First the Not Invented Here syndrome: many organizations have a preference for internally developed technology over external technology (see also Chesbrough, 2003). Second is absorptive capacity: firms do better in the market for technology if they have strong internal R&D capabilities, which help to identify and use external knowledge (see also Cohen and Levinthal, 1989; Rosenberg, 1990, and Arora and Gambardella, 1994). The third is the nature of the relation between internal and external R&D. Firms view R&D and licensing of technology as complements
(Cassiman and Veugelers, 2006), and internal R&D can generate additional demand when it is not successful (as illustrated in Higgins and Rodriguez (2006) for the case of pharmaceuticals). However, internal R&D can also reduce the demand for external technology (Arora and Gambardella, 2010a).

5.2.4.3 Issues

The literature on markets for technology concludes that there are major issues in the market for technology. The three requirements for good market functioning mentioned above, are often lacking (Arora and Gambardella, 2010a, Gans and Stern, 2010). More specifically, issues in the market for technology relate to information asymmetry, transaction costs, market safety, and strategic considerations (Agarwal et al. 2014; Gans and Stern, 2010; Arora and Gambardella, 2010a, Pénin, 2012; Dushnitski and Klueter, 2011; Fosuri and Giarratana, 2010; Fosfuri, 2006; Pisano, 2006). Because of these issues, the market for technology is currently only well-developed in a limited number of sectors, such as biotechnology, chemicals, pharmaceuticals, software, and semiconductors (Fosfuri and Giarratana, 2010).

Agarwal et al. (2014) investigate which market failures are most prohibitive for U.S. and Canadian technology holders. They consider three stages in the licensing process: identifying buyers or sellers, initiating negotiations, and reaching an agreement. The first stage is mostly hindered by a lack of relevant buyers or sellers. Market safety, such as strong IPR, mainly matters for reaching an agreement.

Concerning market safety, Pénin (2012) notes that markets for technology can play a significant role facilitating patent trolls, and calls for legislation to limit their opportunities. If left alone, these can cause markets for technology to be not necessarily welfare-increasing (Reitzig et al. 2010).

Concerning information asymmetry, Agarwal et al. (2014) highlight that the market for technology suffers from Arrow’s paradox: it is impossible for a potential buyer to assess the true value of technology before he has acquired it, at which point the information has been transferred (Arrow, 1962). This is especially salient in the case of technology, as it is difficult to protect ownership of intellectual property, and intellectual property rights typically do not offer complete protection (Levin et al. 1987; Arora, 1995; Cohen et al., 2000). The value distribution of technologies is especially skewed (Gambardella et al., 2008; Sherer and Harhoff, 2002), escalating the issue. Thus, licensed technology runs the risk of being worse than technology developed in-house (Zeckhauser, 1996; Pisano, 1997; 2006). The advantage is not always with the seller, however. Technology buyers can have more market knowledge regarding potential applications (Arora and Gambardella, 2010a).

Technology licensing agreements also suffer from moral hazard (Arora, 1996) and hold-up issues,
especially when many patents constitute one technology (Pisano, 1991). In a more general sense, the market for technology is characterized by a tension between technology owners who need to protect information, and buyers who need to access said information in order to assess the technology at hand (Dushnitsky and Klueter, 2011; Silveira and Wright, 2010). Technology platforms need to address this issue in order to create a functional marketplace. If not addressed, adverse selection can lead to market failure (Akerlof, 1970).

Gans et al. (2008) show that uncertainty is also an issue in licensing by showing that licensing of US patents occurs mainly around the grant date. Before granting, there is significant knowledge asymmetry regarding the validity of the patent, for which buyer might demand a discount. The asymmetry is resolved once the patent has been granted. It is interesting that Gans et al. found this effect to be less pronounced when technology producers interact, indicating that in this case the asymmetry is less even before granting.

The value of technology is another problem. Not only is the value of technology skewed (Scherer and Harhoff, 2002; Gambardella et al., 2008), there is no ‘one’ model of patent valuation (Van Zeebroeck and Van Pottelsberghe de la Potterie, 2011). The final report of the expert group on intellectual property valuation (2013) concluded in that regard that, even though multiple valid methods for property valuation exist, they suffer from low credibility, and knowledge of valuation methods is low. Even if a valuation method is agreed on and used, there is still remaining uncertainty regarding the ‘fair’ price of a given technology, as clear communication of value risks imitation and the transfer of too much knowledge (Morgan and Wang, 2010). Lemley and Myhrvold (2008) describe the market for patents as in that sense blind.

It is clear that markets for technology offer an opportunity to decrease transaction costs. Without these platforms, extending searches to unknown alternatives is highly costly (Sorenson and Stuart, 2001). Silveira and Amit (2006) show in this regard that search cost play an important role in the venture capital market. Search costs are among the most highly cited reasons for not licensing technology along with fear of opportunities in negotiations and weak intellectual property enforcement (Razgaitis, 2004; Arora and Gambardella, 2010a). A survey of UK public research organizations shows that transaction costs are the main reason for underutilizing patents (Andersen and Rossi, 2012). Transaction costs are moderated by the degree of licensing is easier when technological outcomes can be identified through e.g. compounds or algorithms (Arora and Gambardella, 2010a), and the strength of IP regimes (Hall and Ziedonis, 2001; Cockburn and McGarvie, 2006; Arora and Ceccagnoli, 2006). Nevertheless, technology negotiation is a highly complex process, potentially involving concordant negotiations with many partners. Arora and Gambardella describe a ‘winner’s curse’ in the market for technology: the firm that manages to license the technology is likely to overpay, as the licensor can negotiate with many potential buyers, who each have different valuation of the value of the technology (Arora and Gambardella, 2010a).

Even though there clearly is potential, at this moment markets for technology seem to do little to...
help reduce transaction cost: European Commission (2012a) cites a survey of top patent applicants which shows that personal ties are still the most effective intermediary for patent valorization. Another survey of innovative European SMEs showed that personal networks and prior business partners are the most effective channels to find potential partners for buying or selling technologies, with success rates of 35 % and 36 %. The next most effective possibility was to use a patent attorney with a success rate of 24 %. Some authors have made recommendations to help improved the issues inherent in technology markets. One option would be to codify the knowledge exchange, thus reducing information technology (Kani and Motohashi, 2012). Another common proposition is to dissuade fears regarding the quality of the technology solved, and information by employing contingent payment requirements for knowledge owners, or common knowledge disclosure requirements (Dushnitsky and Klueter, 2011; Silveira and Wright, 2010; Zott and Huy, 2007).

5.3 Conclusions

In conclusion, studies by the Commission as well as the academic literature point to the current undervalorization of European technology. While technology trading platforms offer an opportunity to improve this by reducing transaction costs and facilitating search, the expert groups instated by the Commission as well as the academic literature on the market for technology agree that there exist real practical barriers that need to be resolved before there can be an European technology exchange. Hagiu and Yoffie (2013), in an overview of patent intermediaries, go so far as to describe two sided patent platforms as a failed solution, arguing that even if a platform brings together buyers and sellers, deals are still concluded face-to-face. This indicates that platforms can reduce search costs, but as of yet do not successfully reduce transaction costs.

Therefore, we preliminarily conclude that while commitment 22 can lead to a drastic reduction in transaction costs in the future, especially for SMEs and public research organizations, and to drastically lower technology / license search costs, as well as potentially lower patent portfolio management costs, these benefits are yet to be realized.

5.4 References


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6 Safeguard Against the Use of IPRs for Anti-competitive Purposes (Commitment 23)

Martin Hud (ZEW)

6.1 Introduction

Competition policy and intellectual property rights (IPRs) fundamentally contribute to the success of modern economies. Each mechanism by itself can foster innovation and has two primary objectives: (i) achieving allocative efficiency and (ii) maximizing consumer welfare. While competition policy protects rivalry to achieve optimum prices and product/service variety, IPRs promote the development of new products/services by rewarding innovators, which is supposed to stimulate competition and market dynamics (Torti, 2012). From this perspective, the relation between competition policy and IPRs can be understood as complementary. The intersection of IP and competition law, however, has been termed as paradoxical (Carrier, 2002). This is due to the monopolistic nature of IPRs granting a right to exclude, which can impair competition. Since IPRs become more and more important in a modern economy, the significance of the conflict between both policies increases. Policymakers and legal authorities who misinterpret or systematically distort one policy in favour of the other can significantly harm the other policy's effectiveness, thus compromising consumer welfare (FTC, 2003). For that reason, the legal frameworks and the interpretations of IP and competition law have to be in a proper balance (FTC, 2011). If IPRs were granted, for instance, to “obvious” inventions, it could hamper market competition that may have developed otherwise (FTC, 2003). In contrast, competition policymakers should keep in mind that IPRs are an important incentive mechanism for (potential) inventors to appropriate the returns of their inventions (Arrow, 1962). Therefore, if competition authorities intervene to the disadvantage of IPR-based market power they should take into account that market power is the legitimate price that rewards previous innovative investment (Farrell et al., 2007; Mariniello, 2013).

From a competition authority's point of view, market power based on IPRs is nothing special per se. It should be legally treated as any other source of market power (or market dominance) (EC, 2011a). The intersection of IP law and competition law, however, gives rise to some types of potentially strategically anti-competitive misconduct of firms (Von Graevenitz et al., 2007). What is special is that these types of abusive conduct are more likely to arise under market power based on

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9 This review uses the terms IPRs and patents interchangeably. Although IPRs include e.g. copyrights and trademarks, most of the issues and literature discussed in this section directly refer to patents and patent law.
10 See EC (2014a), paragraph 7.
12 Note that IPRs do not necessarily create monopolies because either consumers may be able to substitute the protected technology/product/service or the invention does not materialize on a profitable market (DOJ, 2007; Gürel, 2010).
IPRs than under market power based on other exclusive assets (Regibeau and Rockett, 2004).

This overview focuses on these types of anti-competitive misconduct of IPR-related practices and the role of safeguards proposed to alleviate and prevent that abusive conduct, respectively. In the following, section 6.2 describes the general problem. Section 6.3 presents an overview on solution mechanisms in a standard-setting context, while section 6.4 concludes. The last section is a short notice on possible databases.

6.2 General Problem: Patent Thickets and Hold-up

In the traditional paradigm of the patent system, the ownership over a single patent is sufficient to have the legal control of a newly invented product, process or technology. The traditional view on patents was a reasonable representation of the typical patent until the late 1980s in the US and the mid-1990s in Europe (Allison and Lemley, 2002). From then on, the number of patent applications and patents granted has exploded in both economic areas. This rather recent development has largely arisen in complex technology industries such as the biotechnology, telecommunication and semiconductor industries (Grindley and Teece, 1997; Kortum and Lerner, 1999; Hall and Ziedonis, 2001, Ziedonis, 2004; Hall, 2005; Aoki and Schiff, 2008; Von Graevenitz et al., 2013; Noel and Schankerman, 2013).

Products in complex technology sectors usually incorporate not only a single invention but many separate components, each of which may be subject to one or more patents (Von Graevenitz et al., 2007). These patents are complementary: if a firm wants to use a patented technology, e.g. for development and production purposes, it needs access to a bulk of patents to not get sued for patent infringement. The ownership of patents in complex technology sectors is often fragmented and – in order to get access to those patents – firms may have to negotiate with a large number of IP owners on licensing terms (Gilbert, 2010). This is what Shapiro (2001, p.120) calls a patent thicket: ”[…] a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology”.13 Patent thickets are a typical example of the complements problem (Kiley, 1992; Heller and Eisenberg, 1998; Geradin et al., 2008).14 That is, due to the fragmented ownership of a patented technology the aggregated licensing costs the technology user faces exceeds the licensing costs the user would have to bear if the ownership were only in the hands of one entity. Each patent owner does not take into account the negative externalities of her independent price-setting she exerts on the demand of the (other) complementary patents and on the final product price, respectively. The emerging aggregated burden of multiple royalties is known as “royalty stacking” (Geradin et al, 2008; Gilbert, 2010; Kobayashi and Wright, 2010). Overall, patent thickets potentially lead to higher prices and to an underuse of the protected technology, thus to a level of innovation that is not optimal.

13 What Shapiro (2001) calls “overlapping” corresponds to the term “complementary”.
14 The complements problem has been first discussed by Cournot in 1838.
A problem closely linked to patent thickets is hold-up (Shapiro, 2001). Lemley and Shapiro (2007) coined that term and describe it as a threat of a patentee to assert her patent right against an alleged infringer’s use of the patent. For instance, it could be that a firm develops and produces a product that is potentially or allegedly infringing one or more patents. In this situation, the patentee can credibly demand a royalty that is excessively high as the accused infringer may have made irreversible investments and may face significant switching costs (Lemley, 2007; Sidak, 2009; EC, 2014b). This royalty premium acts as a tax on new products incorporating the patented technology, which stifles rather than stimulates innovation (Lemley and Shapiro, 2007). Due to the premium-induced price increase, the consumers lose the benefits of competing technologies (FTC, 2011). The hold-up problem increases in the number of patents granted, in the duration of patent examination, in the degree of ownership fragmentation and patent complexity and in the spread between the value of the patented technology and the value of the actual product (Von Graevenitz et al., 2007).

Although patent thickets and the related hold-up problem have potentially disadvantageous effects for an economy, it is not their existence per se that can be described as anti-competitive patent behaviour. It becomes a matter for competition law when firms strategically act to raise their rivals’ costs to gain competitive advantages in the market (Rubinfeld and Maness, 2005). In a similar line of reasoning, Von Graevenitz et al. (2007) state that a firm’s action raises anti-competitive concerns if the firm not only intends to but also causes rivals’ production efficiency to decrease. However, the authors limit their case to firms that hold and exploit large patent portfolios.

Despite their relevance, there is only limited econometric evidence on measuring patent thickets. Cohen et al. (2000) find that firms in complex industries expand their patent portfolio for defensive purposes and not for appropriating the returns to R&D investment. Accordingly, a large patent portfolio prevents hold-ups and strengthens the firms’ bargaining power in negotiations for access to rivals’ technology. By combining field interviews with IP managers and executives from semiconductor firms with quantitative analyses, Hall and Ziedonis (2001) find that the patent explosion observed in the US has been a strategic response to an increased threat of hold-up. Ziedonis (2004) uses a sample of 67 US semiconductor firms to study the determinants of patenting. She finds that more fragmented patent rights directly increase a firm’s patenting activities. With a focus on US software firms, Noel and Schankerman (2013) find that greater fragmentation of patent rights is not only associated with increased patenting activities but also with lower market value of a firm. Von Graevenitz et al. (2013) show for a sample of 2074 European firms – for the first time – that greater fragmentation of patent ownership increases patenting in complex technologies.

Due to the widespread concern as to the anti-competitive risk related to patent thickets it would be important to measure the prevalence and the effects of them. However, measuring the prevalence of patent thickets is difficult and the size of inefficiencies caused by patent thickets is currently still
unknown (EC, 2011a). Von Graevenitz et al. (2013) define an ideal measure for patent thickets but cannot construct it due to lack of sufficient information. Instead, they apply an “unideal” measure they have developed in Von Graevenitz et al. (2011). In contrast to previous measures that construct fragmentation indices relying on the pattern of patent citations, Von Graevenitz et al.’s (2011) measure is fairly close to that ideal.\(^\text{15}\) They develop a measure that allows them to identify and count mutually blocking firm relationships, so called “triples” within a technology class. Von Graevenitz et al. (2013) find that patent thickets exist in nine out of thirty technology classes at the EPO. Accordingly, thickets most frequently occur in audio-visual technology, telecommunications, semiconductors, optics and information technology, i.e. complex technology industries.

### 6.3 Coordination Among Patent Holders

As discussed in section 6.2, patent thickets and the closely linked problem of hold-up poses a significant threat to the ultimate goal of IP and competition law: maximizing consumer welfare (Gürel, 2010). One solution to the issues discussed can be a patent reform (Gallini, 2002; Lemley et al., 2005; Shapiro, 2010). This approach would take into account that the perceived increase in the number of patent thickets is due to great leniency regarding the interpretation of patentability criteria such as non-obviousness (Jaffe, 2000; Geradin et al., 2008; EC, 2011a). Accordingly, it has been criticized that many patented inventions lack the necessary inventive step (Jaffe and Lerner, 2006). The implementation of such a reform, however, would likely take a lot of time. Hence, a solution mechanism based on competition law seems to be more attractive. The underlying idea is that policymakers should establish general framework conditions to promote licensing agreements that do not restrict competition (EC, 2011a). This means, a second approach requires (voluntary) coordination among patent owners to efficiently cut through patent thickets (Shapiro, 2001; Regibeau and Rockett, 2004). The set of coordination mechanisms includes cross-licensing and patent pools as well as standardization processes under the umbrella of standard-setting organizations (Bekkers and West, 2006; EC, 2011a; Gallini, 2011).

While potentially giving rise to significant efficiency gains, each mechanism is eventually subject to potential anti-competitive misconduct such as collusion or deception. Being aware of potential abusive behavior, for instance, the European competition law provides guidelines that ensure firms adhering to them to not infringe competition law, at least not within the meaning of Article 101 of the Treaty on the Functioning of the European Union (TFEU). The following sections discuss the coordination mechanisms and safeguards that have been proposed in the literature. Although cross-licensing and patent pools also appear outside the framework of standardization they are very relevant in the context of standard-setting (Geradin et al., 2008; Kobayashi and Wright, 2010; Blind et al., 2011; Kühn et al., 2013; EC, 2014b; EC, 2015). In particular, patent pools and standardization are closely interlinked (Lerner et al., 2007; WIPO, 2014). Furthermore, paragraph 245 of the Guidelines on the application of Article 101 of the Treaty on the Functioning of the

\(^{15}\) See EC (2011a) for a more detailed discussion on the measurement of patent thickets.
European Union to technology transfer agreements issued by the EC in 2014 states: “There is no inherent link between technology pools and standards, but the technologies in the pool often support, in whole or in part, a de facto or de jure industry standard.” EC (2014b, p. 54) finds that: “most contemporary pools are based around technical standards.” For these reasons, cross-licensing and patent pools will also be discussed in the standard-setting context.

6.3.1 Standardization

In the EU, standardization agreements have the primary goal of defining technical or quality requirements firms’ products, processes or methods may comply with (EC, 2011b). Standardization is a voluntary and cooperative process that involves participants to agree upon and to commit to common technical specifications (Simcoe, 2012a). Once set, standards make it possible to produce interoperable products among complementary and competing products (Sidak, 2009). Standard-setting processes are usually coordinated by independent standard-setting organizations (SSOs) (Mariniello, 2013).

It is well known that standardization has considerable effects for economic development (Chiao et al., 2007; Blind et al., 2011; Cary et al., 2011). Only recently, a communication from the European Commission on standardization has stated that the “[...] benefits of standards for the European industry are tremendous.” For instance, standards can foster economic growth by facilitating market integration and trade, which can lead to increased consumer choice and decreased product prices (Blind and Jungmittag, 2008; EC, 2010). Standards can ensure technological interoperability and often significantly reduce transaction and production costs (Geradin, 2009; Mariniello, 2011). They can encourage competition that makes market entry easier (Mariniello, 2013). Standard-setting also substantially increases innovation activities by encouraging a faster uptake and diffusion of new technologies and by reducing the uncertainty inherent to the success of R&D activities (EC, 2010; Mariniello, 2013).

It is important to know that standardization is not a recent development. Positive effects related to standardization have already been recognized by the European Union in the 1950s (EC, 2010). Initially, technical specifications were implemented in the legislation to harmonize European product and service markets. The implementation of standards did originally not require patented technology (Bekkers and Updegrove, 2012; EC, 2014b). During the last two decades, however, standards have very frequently been relying on patented technologies. This quite recent and policy charged phenomenon is tightly linked to the increasing importance of complex technology industries, thus to the patent explosion mentioned earlier in section 6.2 (Layne Farrar et al., 2014). Standard-setting is particularly pronounced in ICT sectors and sectors where ICT plays a large or increasing role as, for instance, in the automotive industry (Bekkers et al., 2012; EC, 2014b).

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16 EC (2011c, p.6).
17 Some standards in the US even go back to the 19th century, see Tsai and Wright (2015).
6.3.1.1 Main Competitive Concerns: Hold-up, Reverse Hold-up, Patent Ambush and Royalty Stacking

Standard-setting per se is not really concerning for competition authorities but the involvement of patents gives rise to anti-competitive misconduct (Besen and Levinson, 2012). In order to implement a new standard, market and institutional players taking part in standard-setting processes usually choose a technology the standard should be based on. If that technology is protected by patents firms cannot make their products compliant with a newly adopted standard without having access to those standard essential patents (SEPs). If being actively involved in a standardization process, the holder of such SEPs can (intentionally) withhold the information of owning the required patents. After the adoption of the standard, the SEP owner can exploit her position by claiming that her patent is infringed. This deceptive practice is called “patent ambush” (EC, 2014b). In extreme cases, firms not being part of a SSO wait for the adoption of a standard just to enforce their patent right afterwards (Reitzig et al., 2007). A similar type of deception particularly pronounced in the standardization context is “hold-up” (Shapiro, 2001; Farrell et al., 2007; Lemley, 2007; Sidak, 2009). That is, after the standard has been adopted, SEP owners may not keep their ex ante promise on agreed licensing terms.\(^\text{18}\) In either situation, once a standard has been put in place, firms are “locked-in” to that standard giving SEP owners market power that allows them to charge excessive licensing fees (Farrell et al., 2007; Kühn et al., 2013; EC, 2014b). The situation of being locked-in can eventually lead to royalty stacking when a standard is covered by complementary patents held by multiple owners (Kobayashi and Wright, 2010).\(^\text{19}\) The literature usually argues that the aggregate royalty burden is inefficiently high due to price externalities inherent to the complements problem. The royalty burden could even become so large that it is not reasonable anymore to produce the final product (Kattan and Wood, 2013).

While hold-up abuses of SEP owners are more intuitive, another problem identified in the hold-up literature challenges the view that only the standard adopters suffer from being locked-in (Mariniello, 2013). According to that view, SEP owners face the problem of “reverse hold-up”, which implies that holding SEPs guarantees the inventor neither to regain the R&D investment nor to have bargaining power during licensing negotiations (Geradin, 2010). Reverse hold-ups can arise because standard adopters can threaten the inventor to sue her for not abiding to licensing terms ex post that have been negotiated ex ante. Since SEP owners rather refrain from costly lawsuits they may rather accept lower royalties from the licensee. This means, instead of being overcompensated (hold-up), SEP owners run the risk of being forced to accept royalties that are below the actual value of the contribution of their technology to the standard (Geradin, 2010).

\(^{18}\) The licensing terms SSO members usually commit to are the so called “FRAND terms”. They will be explained below.

\(^{19}\) As in the case for hold-up, royalty stacking is especially problematic in a standard-setting context (Lemley and Shapiro, 2007). However, being locked-in is not a necessary condition for royalty stacking to appear in a standard-setting process.
Anticipating such behavior of the licensees, SEP owners may not innovate in the first place (Mariniello, 2013).

There is a large amount of literature that is concerned with the problem of hold-up (Farrell et al., 2007; Lemley and Shapiro, 2007; Schmalensee, 2009; Sidak, 2009; Kobayashi and Wright, 2010; Shapiro, 2010; FTC, 2011; Ganglmair et al., 2012; EC, 2014b; Layne-Farrar, 2014). Digging through the literature, it becomes obvious that hold-up has a tremendous theoretical relevance due to its potential to harm competition and consumer welfare. In contrast to its theoretical relevance, there is only very limited empirical evidence on patent hold-up, let alone on reverse hold-up or patent ambush (Geradin and Rato, 2007). Empirical studies on patent hold-up usually focus on patent litigation (Bessen and Meurer, 2013). Lerner (1995) examines the patenting behavior of biotechnology firms and finds that firms with higher litigation costs tend to patent less. Including different industries in their analysis, Bessen and Meurer (2013) find a positive relationship between the risk of getting sued for patent infringement and firms’ R&D investment. Their result implies a reduced incentive for innovative firms to conduct R&D activities. Furthermore, they find that the litigation risk is higher for small firms. Similar results have been found by Lanjouw and Schankerman (2001, 2004). Their study from 2001 finds that individuals or small firms owning few patents have to face higher litigation risks than firms with larger patent portfolios. According to Lanjouw and Schankerman (2004), small firms are handicapped in protecting their IPRs as they face higher litigation risks and higher litigation costs. While patent litigation risk and patent litigation rates seem to be the only measures applied for examining hold-up, it is questionable whether these are valid. According to Simcoe (2012b, p.64): “[…] high litigation rates do not necessarily imply widespread hold-up, but are strong indication that the market for standards-related intellectual property is not functioning well.”

Recently, the European Commission has investigated main antitrust cases where Rambus, Qualcomm, IPcom, Microsoft, Samsung and Motorola were alleged of conducting hold-up or patent ambush (Geradin, 2009; Culley et al., 2012; Mariniello, 2013; EC, 2014c). While the Qualcomm and IPcom cases have been closed due to complainants’ withdrawal, the alleged firms Rambus, Microsoft, Samsung and Motorola were found to infringe EU competition law (Geradin, 2009; Mariniello, 2013; EC, 2014c). Furthermore, the decisions of the Samsung and Motorola cases even set precedents that provide “[…] a path to patent peace in the telecommunications industry.” Apart from some firms found to be guilty in the US and Europe, it is very controversial whether the problems of hold-up and patent ambush constitute a problem in reality at all (Besen and Levinson, 2012). SEP holders usually take repeatedly part in standardization processes while hoping to license their technology in subsequent standards (Geradin et al., 2008). However, when conducting hold-up or patent ambush, SEP holders put their reputation at risk. This means, SEP holders significantly impede their future involvement in standardization processes (Kobayashi and

20 Main antitrust cases investigated in the USA can be found in Kobayashi and Wright (2010) and Besen and Levinson (2012).
21 EC (2014c, p.1).
Brooks’ (2011) article presents an overview on comments of companies, organizations and individuals regarding the actual problem of hold-up. The broad consensus of all the commentators is that the risk of hold-up is not only overstated but that there is no systematic risk of hold-up. There are three basic reasons for that, (i) standards implementers have sufficient information to prevent being held-up by ex-ante negotiations, (ii) reputational constraints and (iii) FRAND terms (Brooks, 2011).

A similar attention the hold-up threat arises also attracts the potential problem of royalty stacking. For instance, Kattan and Wood (2013, p. 15) say that: “The potential impact of royalty stacking on contemporary high-tech products can hardly be overstated.” However, there is hardly any convincing real world evidence on royalty stacking. The existing studies examining royalty stacking either do not use a viable measure or do not directly address royalty stacking (Geradin and Rato, 2007; Kobayashi and Wright, 2010). Lemley and Shapiro (2007) present two case studies as empirical evidence and state that “[...] empirical evidence has mounted that royalty stacking is far more than a theoretical possibility.” In contrast, Geradin et al. (2008) present an overview on studies that examine royalty stacking and conclude on page 5: “We find little evidence of systematic problems of royalty stacking within standard-setting that are not already adequately dealt with through existing mechanisms, including cross licensing, patent pools, and repeat play reputation.” Furthermore, Layne-Farrar (2014, p.9) concludes: “[...] there is no evidence that either hold-up or royalty stacking emerges in practice in anything more than isolated instances” and that “[...] it is not unreasonable to expect several solid, concrete examples of hold-up and stacking for interoperability standards.”

6.3.1.2 Proposed Safeguards to Prevent Anti-competitive Conduct

The majority of SSOs have adopted a variety of rules whose primary objective is to facilitate ex ante competition in order to prevent ex post opportunism that may result from selecting a standard (Geradin and Layne-Farrar, 2007; Geradin, 2009). Those kinds of rules are typically articulated in the SSO’s bylaws and can be divided into two main categories: (i) disclosure rules and (ii) licensing rules (Lemley, 2002; Farrell et al., 2007). These kinds of rules also entail weaknesses. For that reason, alternative propositions have been made in the literature. They basically rely on ex ante price-setting mechanisms discussed in the following.

6.3.1.2.1 Ex ante Disclosure of Patent Ownership

Patent ambush often arises when participants of standardization processes learn too late about the existence and ownership of SEPs (EC, 2010; Kobayashi and Wright, 2010; EC, 2014b). Therefore, most SSOs require SEP owners involved in standard-setting processes to disclose ex ante those patents they consider as potentially essential to a proposed standard (Geradin and Rato, 2007). Ex ante disclosure of all relevant patents and pending patents consequently allows the SSO members to make an informed decision on the choice of technology the standard should be based on (Mueller, 2002). Facing reduced asymmetric information, the members can more precisely evaluate the true contribution of the technology to the standard’s technical performance and cost-
effectiveness (Bekkers et al., 2011). The disclosure rules should basically lead to a “best-match” between technologies available and the standard to be implemented in an efficient way (Tsai and Wright, 2015). However, there are some drawbacks associated with ex ante disclosures. One problem is that SSOs rarely require their members to search for or disclose all patents they hold that may be essential to a standard (Geradin and Rato, 2007). This “specific disclosure” is costly for each firm having a patent portfolio as a search is complex and not really practicable. Finding out which patents may be essential for a standard can be a cumbersome procedure as it requires a patent-by-patent evaluation (Geradin and Laye-Farrar, 2007). Furthermore, the scope of the standard may evolve over time so that it becomes difficult to actually determine which patents are essential (Geradin and Rato, 2007). Constraining firms to explicitly searching and disclosing potentially essential patents could incentivize firms to claim that nearly all of their patents may be essential (Simcoe, 2012b). For these reasons, SSOs rarely require the members to thoroughly search their patents (Simcoe, 2012b). As a consequence, many participating firms use “blanket disclosures” indicating that a participant may holds essential patents, but does not provide a list of any patents or pending patents (Bekkers et al., 2012). Blanket disclosures can be efficient as it takes less time and effort for firms to provide information on their ownership of potentially essential patents. Hence, patent holders are more willing to contribute to standard-setting processes (EC, 2014b). However, it is important to note that blanket disclosures do not reduce the search costs but rather shift these costs form patent holders onto prospective licensees and other standard developers (Bekkers et al., 2012).

Another problem is the timing of patent disclosure (Farrell et al., 2007). In general, SSOs stress “early disclosure” of the patents or pending patents that may be essential to a standard. Since agreeing upon a particular standard may take some years, opportunistic patent holders may hesitate with their disclosure until the standard is sophisticated enough to vote on it (Bekkers and Updegrove, 2012; Simcoe, 2012b). In this stage, the (other) participants’ investments may already be sunk and the switching costs may be significant (Farrell et al., 2007). Then, the opportunistic SEP holders have an incentive to leave the SSO in order to demand high licensing fees afterwards (Simcoe, 2012b). In general, such opportunistic behaviour does not violate any SSO bylaws since (i) only a few SSOs have explicit disclosure deadlines and (ii) disclosure policies are only enforceable on members (Bekkers et al., 2012; Simcoe, 2012b).

6.3.1.2.2 FRAND Terms

Having disclosure rules is not sufficient for SSOs to eventually prevent patent ambush and hold-up because SEP holders can still charge excessive licensing fees ex post (Lemley, 2002, 2007). Therefore, the literature suggests SSOs to require from their members commitments to provide access to SEPs on non-prohibitive licensing terms (EC, 2010). By now, the most common condition actually imposed by SSOs on the participating SEP holders is a commitment from them to license on fair, reasonable and non-discriminatory (FRAND) terms prior to the adoption of the standard (Lemley, 2002, 2007; Dewatripont and Legros, 2013). If the participants refuse to make such a commitment, SSOs may circumvent the technology in question and find another technology or do
not adopt a standard after all (Cary et al., 2011).

Without any doubt, requiring licenses on FRAND terms can be a very important SSO rule as to the prevention of patent-related anti-competitive misconduct (Lemley, 2002, 2007; Geradin and Rato, 2007; Tsai and Wright, 2015). The concept of FRAND is designed to “[...] prevent the exploitation of unearned market power that patentees may gain from the incorporation of their patents into industry standards.”\(^{22}\) FRAND terms are an important mechanism for the efficient distribution of standards as each technology user should face a reasonable price and nobody should be excluded from technology access (Geradin and Rato, 2007; Cary et al., 2011). Furthermore, FRAND terms ensure the SEP holders to be properly compensated for their innovations (Geradin and Layne-Farrar, 2007). Accordingly, it leaves a sufficient incentive for technology developers and owners to take part in standardization processes ensuring that a new standard can be based on the best technology available. Licensing on FRAND terms is a very flexible mechanism that does not impose unduly restrictions on SEP holders, thus providing incentives to innovate (Geradin and Rato, 2007). However, the main obstacles for the FRAND concept to actually realize the benefits it’s linked with are its ex ante nature and its vagueness (Shapiro, 2001; Simcoe, 2012b). In fact, it is just an ex ante promise – not an obligation – of the SEP holders to potential standard implementers to negotiate fair, reasonable and non-discriminatory licensing terms. SSOs typically refrain from specifying any explicit licensing results but each negotiation between the licensor and the licensees is conducted individually and outside of the SSO bodies (Geradin and Rato, 2007). But what does FRAND actually mean?\(^{23}\) According to the literature, the “non-discriminatory” element is straightforward. It refers to licensing guaranteed on the same terms to firms that are similarly situated and competing with the SEP holders in products incorporating the technology (Miller, 2007; Geradin, 2009; Cary et al., 2011, Simcoe 2012b). This would ensure competitive neutrality and would not offer any particular benefits to any competitor, including the SEP holders (Swanson and Baumol, 2005). In contrast to the “non-discriminatory” element, the meanings of “fair” and “reasonable” remain fuzzier (Patterson, 2002).\(^{24}\) A “reasonable” licensing fee should reflect the benefits the SEP holders could have obtained by voluntary negotiations before users became committed to use a specific patented technology (Geradin and Rato, 2007). Farrell et al. (2007) argue that FRAND rates should be calculated according to the marginal contribution of the technology to the standard and not according to the additional hold-up value. Hence, FRAND rates should not exceed the intrinsic value of the technology (Lemley and Shapiro, 2007; Kattan and Wood, 2013). In contrast, Layne-Farrar et al. (2014) show in a theoretical model that an incremental rule implemented by SSOs reduce firms’ incentives to invest in R&D and their SSO participation propensity. Furthermore, it is often argued that if the SSO members had known ex ante that the chosen standard will be only

\(^{22}\) Kattan and Wood (2013, p.1).

\(^{23}\) Literature reviews on the meaning of FRAND can be found in Farrell et al. (2007) and Miller (2007).

\(^{24}\) The literature tends to not separate between “fair” and “reasonable”, in part because “fair” is Europe-specific. In the USA the concept of RAND is more common (Geradin and Rato, 2007). A “fair” royalty follows the “principle of proportionality” (Dewatripont and Legros, 2013) and properly rewards the SEP holder for its innovation (Cary et al., 2011).
accessible to non-FRAND conditions, they may have chosen an alternative technology (Geradin, 2009). However, in many instances of standard-setting no suitable alternative technology exists either before or after the adoption of a standard (Geradin and Layne-Farrar, 2007; Geradin, 2009). In those cases, it cannot be argued that standardization processes confer market power to the SEP holders beyond the market power conferred by the patent itself (Geradin, 2009).

Despite its flaws, it is not even clear whether and how the concept of FRAND terms should be stated more clearly and be more binding, respectively (EC, 2014b). As mentioned earlier, FRAND terms are broadly and flexibly designed not without purpose. According to Geradin and Rato (2007, p. 11): “The specific meaning of FRAND can only be established in concrete situations, in particular taking into account the positions of the licensor and the licensee.” In a similar line of reasoning, Mariniello (2013) states that FRAND rates are not supposed to be clearly defined ex ante as the available information on the value of the technology is often low. The actual value of the technology materializes only after the standard has been adopted by the market players and the products comply with the standard. Therefore, FRAND commitments should the SEP holders leave enough space to allow the technology’s price to adapt to its value revealed ex post (Mariniello, 2013).

6.3.1.2.3 Other Ex-Ante Propositions

Since the implemented FRAND commitments may only effectively prevent patent hold up and patent ambush in part, alternative rules and mechanisms have been proposed in the literature. Those propositions basically oblige the SSO members to negotiate (or set) licensing terms ex ante, i.e. before investment costs are sunk and the costs for switching to an alternative standard become significant (Layne-Farrar et al., 2009; Kobayashi and Wright, 2010). The discussion in the literature on ex ante licensing terms is rather a theoretical one as SSOs usually don’t have those kinds of rules implemented (Farrell et al., 2007). The ex-ante framework is based on the perception that the benefits of ex ante competition can be preserved and that the negotiated (or set) licensing fees can eventually reflect the incremental value of the technology and not the economic value of the standard itself (Kattan and Wood, 2013).

The question is how such policies can be put into practice. Three main proposals have been made. One famous approach for an ex ante mechanism is Swanson and Baumol’s (2005) regime of ex ante auctions. Accordingly, SSOs would hold auctions between different technologies during the standard-setting process. Patent owners that want to have their technology incorporated in the standard would make an offer to license their technology to downstream firms. Then, the downstream standard implementers would decide which technology wins the auction. Swanson and Baumol’s approach provides a benchmark for the meanings of what is a “fair” and “reasonable” licensing fee, thus solving the valuation problem (Geradin and Layne-Farrar, 2007). The fundamental problem the authors’ ex ante auction mechanism suffers from is its simplicity. Indeed, if their assumptions held in reality the mechanism could lead to efficiency-maximizing outcomes.

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25 However, there are two SSOs, VITA and IEEE that experiment with ex ante disclosure rules (Layne-Farrer et al., 2009).
Nonetheless, it is rather unrealistic that there are no vertically integrated firms among the SEP holders and that there are competing technologies available for every relevant portion of the standard (Geradin et al., 2007). If such a mechanism was implemented in reality, it would, for instance, under-compensate patent holders and reduce incentives for innovation.26

A second possibility that has been suggested by some SSOs and the literature requires a unilateral disclosure of licensing terms. This means, the SSO members are obliged to disclose ex ante (i) the maximum rate they would charge if their patents were to be incorporated in an industry standard and (ii) the most restrictive licensing terms (EC, 2010). A third option refers to a regime that relies on collective negotiations before a standard has been selected for adoption (Farrell et al., 2007). According to that, potential licensors and licensees would determine the licensing fees by negotiating as a group.

While the second and the third approach incentivize the SSO members to select the best technology with the best licensing terms, they also entail several drawbacks.27 One major problem is that the potential licensees have maximum negotiating leverage over the SEP holders (Kattan and Wood, 2013). That is, both approaches distort the incentives systematically towards the disadvantage of the SEP holders. The concern is that the potential licensees can cooperate and act as an oligopsony that would confer them the power to depress the licensing fees (Geradin and Rato, 2007). The licensor(s) would eventually be caught in a situation of reverse hold-up resulting in diminished competition and lower levels of R&D investment and innovation. A second problem refers to collusion on the downstream market that exclusively involves vertically-integrated licensors. These firms have an explicit incentive to set high licensing fees as higher fees could reduce competition in the downstream market by increasing the downstream competitors’ costs. In this sense, ex ante disclosure or bargaining of the licensing fees could be an effective mechanism for an integrated firm to signal the other integrated licensors its willingness to collude (Geradin and Layne-Farrar, 2007). This would eventually lead to higher product prices and also diminished competition (Sidak, 2009). Another concern is that mandatory disclosures and joint negotiations lead to a “flat solution”, i.e. all prospective licensees will face the same licensing conditions (Geradin and Rato, 2007; Kobayashi and Wright, 2010). This would remove the desired flexibility of individual licensing deals that usually account for the fact that not all competitors are similarly situated. However, it is difficult to say whether the pro-competitive effects would outweigh the anti-competitive effects of these kinds of ex ante policies or vice versa.28 If they were implemented in reality, it would be necessary to assess the policies on a case-by-case basis (Geradin and Rato, 2007). According to Geradin and Layne-Farrar (2007, p.106): “ex ante solutions would likely cause

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26 An extensive discussion on the auction mechanism can be found in Geradin et al. (2007).
27 However, the drawbacks are more pronounced for the joint negotiations than for the mandatory disclosure rule (Geradin and Rato, 2007). Farrell et al. (2007) state that the potential damages done to innovation incentives from group negotiations are not larger than when one innovator negotiates with a large user.
28 More detailed discussions on that can be found in Kobayashi and Wright (2010), Simcoe (2012b) and Kattan and Wood (2013).
more difficulties and unintended consequences than they could correct – even assuming the solutions could be implemented in practice.”

While patent disclosures, FRAND commitments and the discussed ex ante policies can prevent patent hold up and patent ambush, Lemley (2007) proposes an alternative policy able to directly deal with royalty stacking. What he calls a “step-down royalty rate procedure” imposes a declining cap on the licensing fees charged by the individual SEP holder. For instance, the first SEP holder who discloses can charge 5%, the second 3% and so on, conditioned that the cap will always be larger than zero. The main drawback of his suggestion is that the caps do not reflect the intrinsic value of the respective technology but rather the value of “first come first served” (Lemley, 2007). Nevertheless, the step-down procedure allows the SSO members to make a better informed decision on which technology to incorporate as it would incentivize early disclosure (Simcoe, 2012b).

In total, Lemley and Shapiro (2007) conclude that SSOs can only make an informed decision on the technology to be incorporated in the standard if it is aware of the costs and benefits. The problem is that not all firms and individuals that own a patent covering a particular technology take part in a standard-setting process. Even royalty caps or other forms of ex ante price-setting do not give a true picture of all the licensing costs necessary to access the technology and making products compliant with the standard.

6.3.1.3 Cross-Licensing

The origin of the standardization debate in this review was that coordination mechanisms among patent holders can be an efficient way to solve the problem of royalty stacking inherent to patent thickets and the hold-up problem. Cross-licensing is a form of bilateral exchange between firms holding complementary patents on a particular technology. This implies that the firms need to get access to the other party’s patents if they want to incorporate that technology into their own products (Miller, 2007). Agreeing on an exchange of patent rights is supposed to be beneficiary to consumers as it guarantees an efficient use and distribution of the particular technology (Shapiro, 2001; Giuri and Torrisi, 2010; Gallini, 2011). New products can be produced and new or old products can be produced with a higher quality, respectively.

The main problem of cross-licensing agreements is that they entail the risk of restricting competition (Shapiro, 2001; Kultti et al., 2006; Lefouili and Jeon, 2015). This may be the case if a small number of firms hold patents on key technologies and do not cross-license it to other firms (Geradin et al., 2008; EC, 2011a). Anti-competitive concerns also arise if the firms agree to charge running royalties to each other (Shapiro, 2001; Regibeau and Rockett, 2004; EC, 2011a). Accordingly, an aggressive strategy (e.g. competition on product prices) would increase one party’s costs due to royalty payment to the other party. However, it would also lead to lower royalty income as the other party is likely to sell fewer products. As both parties face the same problem they may end up producing the monopoly outcome (Fershtman and Kamien, 1992). This tacit
collusion would eventually lead to a slower pace of innovation (EC, 2011a).

This danger seems to be not that strong anymore for modern cross-licensing agreements as they have been frequently relying on a royalty-free base, on lump-sum payments or on balanced royalty payments (Grindley and Teece, 1997; Shapiro, 2001). Royalty-free licensing and lump-sum payments are generally preferred from a competition authority’s perspective as they are not linked to the performance of the licensee (Regibeau and Rockett, 2004). In contrast, balanced royalty payments are usually related to the annual sales amount of the licensee. However, they also incorporate the relative market value of both firms’ patent portfolios. Balanced payments are calculated according to the quality-weighted contribution one party’s patent portfolio makes to the other party’s products. The firm whose weighted portfolio is less valuable has to pay an annual sales share that reflects the difference in the portfolios’ values (Grindley and Teece, 1997). That is, the net contributor receives net payments from the firm having the less valuable portfolio. Although balanced payments are still linked to the performance, they seem to be a fair measure for firms to get access to complementary patents needed to use a particular technology. They moderate the danger of royalty stacking and additionally spur innovation as the firms have an incentive to build their own large patent portfolio (Grindley and Teece, 1997). The drawback of the valuation approach is that it may increase the transaction costs (Bekkers and West, 2006; Geradin et al., 2008). It can be difficult to identify all the patents that are particularly relevant for the prospective licensee and that approach entails rather complex issues of valuation of the weighted patent portfolio (Bekkers and West, 2006).

Modern cross-licensing agreements are usually quite broad, i.e. they cover not only the recent but also the future patents (Grindley and Teece, 1997; Shapiro, 2001). It is too cumbersome and costly to cross-license individual patents. This broad nature of modern cross-licensing agreements leaves the firms enough freedom to develop and produce goods without running the risk of unintentionally infringing the other firm’s patent rights (Shapiro, 2001). In total, despite its potential for anti-competitive misconduct, cross-licensing agreements seem to be an efficient way to circumvent royalty stacking and hold-up (Geradin et al., 2008).

6.3.1.4 Patent Pools

A patent pool is an organization established for the purpose to aggregate many complementary patents held by many voluntarily participating firms on a particular technology (Kobayashi and Wright, 2010). The patents are usually available for licensing in form of a bundled package to all pool contributors as well as to all non-members (Geradin et al., 2008). Whereas some pools do not charge any royalties, some rely on elaborate royalty schemes (Regibeau and Rockett, 2004). In the latter case, the collected licensing fees are typically allocated to the pool’s contributors in two different ways: (i) according to the share of patents each member contributes to the pool or (ii) according to the relative value of each member’s patents (Layne-Farrar and Lerner, 2011).

29 Kultti et al. (2006) also show that cross-licensing does not cause collusive concerns – and even if, it spurs innovation.
There is large consensus about the pro-competitive benefits inherent to the organized pooling of patents (Shapiro, 2001; Baron and Delcamp, 2010; Uijl et al., 2013). In fact, patent pools can be considered as the most efficient way to eliminate royalty stacking as the many patent rights (= complements) are controlled by one single entity (Farrell et al., 2007; WIPO, 2014). Furthermore, patent pools are a very efficient instrument to prevent potential patent infringement and the litigation costs involved. That is because the patent rights required to incorporate a particular technology into products are bundled in one licensing agreement. Overall, patent pools allow for a widespread distribution and efficient use of technologies (Gallini, 2011).

However, patent pools are potentially subject to anti-competitive misconduct (Aoki and Nagaoka, 2004; Gilbert, 2004; Lerner and Tirole, 2004; Gallini, 2011). One concern is that patent pooling can lead to the exclusion of non-members from product markets that incorporate the technology covered by the pool (Lerner and Tirole, 2004; Regibeau and Rockett, 2004). This is the case when the members have sufficient market power and do not grant access at all to non-members or only license to them to more prohibitive terms. However, patent owners will also face that incentive if they license on their own. Therefore, patent pools only exacerbate the risk of exclusion if it increases the individual incentives (Regibeau and Rockett, 2004). Another concern is the foreclosure of competition in a related market (Whinston, 1990; EC, 2014c). It arises when pool members have sufficient market power and the license bundle also includes patents of a different but related market. In this situation, the members can use the market power of their pooled technology as a leverage to “automatically” enhance their position in the related market (Regibeau and Rockett, 2004; EC, 2014c). A similar anti-competitive concern is raised by pools that include not only complementary but also substitutable patents (Lerner and Tirole, 2004; DOJ, 2007; EC, 2014c). Those patents cover an alternative, i.e. competing, technology. This means that the pool members would be practically able to control the distribution of the product incorporating either technology. The inclusion of substitutes would eventually lead to a price fixing cartel as the control over two competing technologies restricts inter-technology competition (Kobayashi and Wright, 2010; EC, 2014c; EC, 2015). In the context of standardization, a patent pool will raise the same anti-competitive concerns as just explained if the pool does not only include standard-essential patents but also non-essential patents (Lerner and Tirole, 2004; Gilbert, 2010). The terminology may be different but standard-essential patents are necessarily complementary whereas non-essential patents are substitutes (WIPO, 2014; EC, 2015). The literature also considers an anti-competitive risk of pools that do not allow individual licensing of patents outside of the pool (Lerner et al., 2007; WIPO, 2014). This would incentivize the pool members to charge licensing fees above the competitive rate (Lerner et al., 2004; WIPO, 2014). Furthermore, establishing a patent pool requires different firms to coordinate. They have to necessarily exchange sensitive information to find a consensus on the pricing, on the selection of the patents and other strategic information. That kind

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30 Think of, for instance, Bayer would license patents for Aspirin and for remedies against hypertension in one bundle.

31 Think of, for instance, Bayer would license patents for Aspirin and Paracetamol in one bundle.
of coordination has the potential to encourage collusive behavior among the pool members (Flamm, 2013; WIPO, 2014).

There are four main propositions that can be deduced from the literature to reduce the risk of anti-competitive misconduct of patent pools (EC, 2011a). The first is that patent pools should allow their members to license their own patent rights to any party, independent of the pool. The second is that each firm should be granted access to the pooled patents and that the access should be on FRAND terms. The third proposition relates to a control mechanism that should restrict the exchange of sensitive information. Probably the most important proposition is the essentiality condition of inclusion. Pool members should only include complementary or standard-essential patents in the pool. However, this is very tricky since there does not exist a clear-cut general definition of which patents are complementary or standard-essential (Baron and Delcamp, 2010; Gilbert, 2010). For instance, Lerner et al. (2007) use patent litigation as a proxy to distinguish between complementary and substitutable patents. EC (2011a) argue that this is not a suitable approach from a competition policy perspective since it uses competition policy itself to identify the two types of patent pools. A similar critic refers to the underlying dynamics of technology (WIPO, 2014). Once a patent has been identified as essential, does not necessarily mean that it will be essential forever. Rapid developments of markets may turn an essential patent to an inessential one. In light of competition law, patent pools require ongoing review of their patents (WIPO, 2014).

6.4 Conclusion

Since the rise of complex technology industries there has been a large amount of research on the intersection of IP and competition law. Complex industries are prone to patent thickets and the related patent hold-up. Both problems raise significant welfare concerns as they have the potential to eliminate market competition and to stifle innovation. There are different coordination mechanisms that can be regarded as the most efficient solutions – these are standardization agreements, cross-licensing and patent pools. Since standardization agreements are subject to large anti-competitive misconduct, SSOs usually controlling the standard-setting processes implement rules to prevent ex post opportunism such as hold-up. There are two widely implemented rules: (i) the licensing on FRAND terms and (ii) the ex-ante disclosure of potentially standard-essential patents. The drawback is that they may not be binding and explicit enough to efficiently prevent anti-competitive misconduct. However, there is hardly any convincing empirical evidence that the anti-competitive misconduct is a problem in reality. Actual anti-competitive misconduct could only be legally proven in the case of a few large firms. The other two coordination mechanisms, cross-licensing and patent pools, are rather supposed to prevent royalty stacking, a problem inherent to patent thickets. While cross-licensing is a bilateral licensing agreement, patent pools usually involve more than two licensing parties. Both mechanisms are subject to similar anti-competitive misconduct, i.e. collusion and foreclosure of competitors. In case of patent pools, there have been some safeguards proposed in the literature. The most important one is that only complementary or standard-essential patents should be included in patent pools.
6.5 Data

One would need to identify standard-setting organizations and the rules implemented. In particular, information is needed which standards are based upon FRAND commitments and information on ex-ante disclosure rules. There is a publicly available data set on that. Researchers have linked SSOs (and their policies) to the PATSTAT database and identified which PATSTAT patents can be claimed as essential for the covered standards. Similar datasets exist but they usually comprise standards and are not linked to patent information. Rysman and Simcoe (2008) and Chiao et al. (2007) use those datasets but only to measure the flow of citations related to SSO policies and the relationship between different SSO rules, respectively. Dewatripont and Legros (2013) examine the effect of SSO rules on R&D only theoretically. They argue that it is not only difficult to determine essentiality but that there is also a lot of uncertainty as to the legal validity of those patents. Furthermore, Goodman and Myers (2005) find that about 80% of the patents firms claimed to be essential were in fact not. Similar problems arise for patent pools and cross-licenses. In addition, collecting data is even more cumbersome since there does not exist a public database for patent pools and cross-licenses. However, to examine effects on R&D/innovation, all those databases have to be linked to firm data.

6.6 References


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