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Knowledge Networks and Markets

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FOREWORD

This report on Knowledge Networks and Markets (KNMs) provides a synthesis of the findings from work carried out across the Directorate for Science, Technology and Industry over the 2011-2012 biennium. The KNM activity was incorporated in the Committee for Scientific and Technological Policy (CSTP)'s *Programme of Work and Budget 2011-2012*, as intermediate output result "*2.7. Empirical and policy analysis of knowledge transfers through networks and markets*", under the joint formal direction of the National Experts on Science and Technology Indicators (NESTI) and Innovation and Technology Policy (TIP) working parties. This decision followed the October 2010 meeting of the CSTP on the importance of knowledge networks and markets for science, technology and innovation, as a follow on priority from the 2010 *OECD Innovation Strategy*. The outputs contained within this report have been partly funded via a voluntary contribution by the European Commission through its 7th Framework Programme, under the "Making the most of knowledge – KNOWINNO" project grant number 257078.

This report brings together a number of contributions from various OECD working parties. The Committee on Industry, Innovation and Entrepreneurship's Working Party on Industry Analysis (WPIA) has contributed analysis on the patenting behaviour of firms and secured the participation of IP experts at the various project's workshops. The CSTP's Working Party of National Experts on Science and Technology Indicators (NESTI) has worked on the development of indicators and analysis of linkages and knowledge flows. This report also draws upon results from the Working Party of Innovation and Technology Policy's (TIP) project on financing, transferring and commercialising knowledge from public research organisations and initial scoping phase of new work on "open science"; the Working Party on Biotechnology's (WPB) project on knowledge networks and markets and collaborative mechanisms for enabling technologies in the life sciences; and the Working Party on Research Institutions and Human Resources (RIHR) study of university-industry knowledge transfer.

The work on KNMs has benefited from the input of policy officials and experts and participants at three dedicated workshops in June 2011 (Paris), November 2011 (Alexandria, United States) and May 2012 (Paris), a final conference held in Paris on 26-27 November 2012, as well as discussions held at the meetings of CSTP, TIP, WPIA, NESTI, WPB and RIHR held over the last two years. Further information on project events and outputs are available on the dedicated project's website: www.oecd.org/sti/knowledge.

The report is further intended to contribute to the first phase of the OECD Horizontal Project on "New Sources of Growth (NSG): Knowledge Based Capital (KBC)" which has been led and co-ordinated by the OECD Committee for Industry Innovation and Entrepreneurship (CIIE).

The Committee for Scientific and Technological Policy (CSTP) agreed to declassify the document at its March 2013 meeting, subject to written comments from delegates. This process was completed in May 2013.

ABSTRACT

This report aims to shed light on the role of markets and networks for knowledge-based assets. Knowledge Networks and Markets (KNMs) comprise the wide array of mechanisms and institutions facilitating the creation, exchange, dissemination and utilisation of knowledge in its multiple forms. This document provides new evidence on the knowledge-sourcing strategies of firms and their role in shaping innovation activities, according to different characteristics, and their impact on performance. It proposes a conceptual framework for understanding how KNMs support knowledge flows and the transfer of intellectual property (IP) rights, supported by a number of novel examples. It considers more specifically some developments in the market for IP rights, looking in the first instance at the evidence on the size of the market and the role of intermediaries. The role of public policies in the IP marketplace is also considered, with particular emphasis on some new forms of policy interventions such as government-sponsored patent funds. This document briefly reviews some key features of the markets and networks for knowledge originating in public research organisations, as well as the role of intermediaries such as technology transfer offices, whose role has been changing rapidly in recent years. Finally, the analysis of knowledge markets is extended to the market for knowledge embodied in highly skilled employees. The mixed impact of mobility on innovation is noted, considering in particular the use of agreements to restrict the movement of human capital and the potential implications of their enforcement. Some proposals for inclusion in a future measurement agenda are outlined.

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SELECTED KEY FINDINGS AND MESSAGES

1. Unprecedented levels of investment in knowledge based capital, information and intellectual property rights have driven a widespread search for mechanisms to help individuals, business and organisations navigate an increasingly complex innovation ecosystem. Agents need to identify relevant sources and providers of knowledge beyond their immediate network of contacts, clear and exchange intellectual property (IP) rights with minimal transaction costs, and earn a return on their investments in knowledge creation through socially productive uses.
2. Knowledge networks and markets (KNMs) are defined as the set of systems, institutions, procedures, social relations, networks and infrastructures allowing firms, organisations and individuals to engage in the exchange of knowledge and associated IP rights. KNMs are expected to provide a number of critical services to actors in the innovation system, throughout the various phases of the knowledge exchange process. These services range from facilitating the search for and matching to relevant counterparties and their knowledge, through to evaluating, executing and enforcing agreements.
3. Broad categories of KNMs can be defined on the basis of whether they focus on facilitating the transfer of disembodied knowledge, as in the case of searchable registers and repositories of already-existing data and information; or instead constitute platforms for sourcing solutions to ad-hoc problems and challenges. The latter includes platforms for implementing inducement prize incentives or identifying consultants to assist with new R&D projects. The transfer of knowledge, even through the most “open” and “free” mechanisms, is critically dependent on the existence of enforceable IP rights, because they mitigate the creator’s risk that knowledge will be misused. The (constrained) ability to exclude third parties is a key enabler of knowledge disclosure and exchange. As a result, the primary aim of a broad class of KNMs is to facilitate the arms-length use and transfer of IP rights on disembodied knowledge. IP brokers, pools and funds primarily deal with the allocation of IP rights, which may frequently be but are not necessarily driven by a knowledge transfer motivation, and the creation and management of financial assets and liabilities attached to them. As a further category, it is important to emphasise the role of institutions and actors that specialise in ensuring the transfer of knowledge embodied in goods or people, such as standard setting organisations.
4. KNMs respond to the challenges and opportunities arising from open innovation strategies adopted by firms. Analysis of detailed business innovation survey data reveals that business innovation strategies are typically linked to specific approaches for sourcing knowledge and collaborating. Open sourcing strategies are not exclusive to R&D-active firms, but these firms do exhibit a different pattern of collaboration with other actors in the innovation system. A more complete and balanced description of business innovation strategies still requires collecting evidence on “inside-out” activities, i.e. how internally developed knowledge is used by other parties, which are currently absent from most official surveys, and a more extensive use of currently available R&D data.
5. Markets for intellectual property rights are particularly complex for policy analysis purposes and, based on the evidence available, it is not possible to conclude that promoting larger IPR markets is necessarily a sensible policy objective to pursue. The absence of a healthy market for IP rights may be a symptom rather than a cause of weakness in the innovation system. Policy makers should concentrate on identifying the original causes of market failure and evaluating the appropriate mechanisms for dealing with them. Among these, measures that improve the ability of markets to address the fundamental asymmetries that limit their effectiveness could feature quite prominently, but due care should be given to potential unintended impacts.
6. Patent assertion entities (sometimes known as “patent trolls”) are a relatively new species in the IP marketplace. They have been described by experts in the field as a path-breaking, (so far) legal disruptive “technology” for monetising patents that eliminates traditional obstacles to enforcement.

Like many other operators in this space, they exploit some weaknesses in the system to their advantage and that of their customers and investors. Their controversial business model is not universally successful, indicating that patent system features appear to have an impact on their viability.

7. Government-sponsored IP funds, typically involving patents, are another new addition both to the range of intermediaries operating in the IP market place and to the portfolio of policy instruments considered by governments and public authorities. Their stated rationale differs across countries, but shares the common objective to improve the valorisation of IP, address patent thickets and provide innovation actors with a defence against disruptive litigation. The case for this type of instrument is by no means uncontested. The use of public funds to invest in IP titles and the alignment of this practice with international treaties should be thoroughly scrutinised if implemented at all.
8. This project highlights the importance of knowledge flowing through people for the mobility of knowledge and the incentives by companies to restrict such flows. Our understanding of the impact of institutions and regulations on job mobility, knowledge transfer and business innovation is still very incomplete. Less conventional data sources will likely need to be combined with traditional measures and tools to gain real insights on policy relevant aspects of knowledge transfer through people. This is particularly important for graduates and researchers who can take their knowledge from one workplace to another and interact in many different ways.
9. Limited evidence exists for example with respect to the legal enforcement of contractual practices restricting a former employee's ability to work for a competitor or set up a new business. Evidence collected throughout this project suggests that enforcement practices vary significantly across OECD countries and partner economies. A number of countries share some of California's statutory restrictions on the enforcement of non-compete agreements and among those, some share some entrepreneurship dynamics in specific sectors although the correlation is by no means perfect. The impact of these agreements is likely to vary across economies with distinct types of labour market institutions and across different types of innovation systems.
10. Standard economic statistics are only beginning to account for the full implications of the market for ideas. In some countries, corporation tax data on licensing incomes provide additional evidence on the growth of knowledge markets which complements the picture emerging from a wide range of ad hoc studies and available data on international transactions on IP. The incorporation of R&D as a capital formation in the System of National Accounts will likely result in improved information sources on intellectual asset creation and trade across and within national boundaries.
11. New statistical data on IP specialist firms and intermediaries are now becoming available across many countries, resulting from the implementation of a new international statistical classification of economic activities. Data show that the value of their services is relatively small in comparison with the investment made in knowledge-based capital but appears to be increasing over time. The current comparison between the United States and European countries indicates that European markets appear to be significantly less developed.
12. Matched IP and business data provide some first insights into the relationship between IP strategies and business performance. The experimental matching of patent and business data on a global basis carried out under this project provides some evidence on the likelihood that firms based in different countries, of different size and in different industries would patent. The data matching exercise also reveals the limitations of commercially available business registers – which are often limited in scope – and suggests an avenue for further data infrastructure development, bringing together IP-based administrative data and statistical business registers and other linked information, such as R&D and innovation data.
13. In conclusion, the concept of KNMs is probably too broad to be considered as a single, all-encompassing element for analytical purposes, particularly those of a quantitative nature. A wide range of approaches, from data sources to multi-disciplinary strategies, are needed to fully grasp the implications of policies in this area.

EXECUTIVE SUMMARY

Over the last two decades, there has been a major surge in the amount of information, knowledge and associated intellectual property (IP) rights generated on a global basis across all domains of innovation and economic activity. Investment in knowledge-based capital has experienced a sustained increase, while increased competition from emerging economies moving towards more knowledge-intensive activities are challenging traditional assumptions about the way firms and countries specialise along innovation and value chains. New digital technologies have brought about large reductions in the cost of copying, storage and distribution of data and information. As information has become more abundant, easy to access and copy, IP rights have become more important to allow knowledge creators to exclude third parties from using an idea or the expression of an idea to extract value from knowledge-based assets. The rapid and sustained growth in volumes of IP rights may have been accompanied by a decline in quality, as well as an increased complexity and uncertainty regarding their scope and validity. Furthermore, IP transaction costs appear to have risen as owners and users navigate an ever more densely populated landscape of increasingly subdivided rights.

This unprecedented availability of information and growing volumes of overlapping rights have led to a continued search for mechanisms that help individuals, business and organisations navigate this complex ecosystem, identify relevant sources or providers of knowledge beyond their immediate network of contacts, enabling them to clear IP rights, and transact upon them with minimal transaction costs. Efficient knowledge markets encourage specialisation through the division of innovative efforts. They can thus encourage the exploration of knowledge development avenues which might otherwise be left unexploited. Enforceable IPRs help address the threat of misappropriation in downstream markets which could otherwise lead firms to adopt less efficient, internal development strategies.

The proliferation in the number of promising sources of knowledge has led large and small corporations to adapt their innovation models and to search across the globe for the best solutions to their individual needs. Data from innovation surveys shows that sourcing knowledge, collaborating and investing in external knowledge matter not only for R&D performing companies in so called high-tech sectors, but provide the basis for most other types of companies to introduce new products, including services, and improve the efficiency of their processes, drawing on knowledge generated elsewhere and through partnerships. Preliminary results suggest that innovative companies in different sectors and countries tend to favour specific sources of external knowledge.

Data on business extramural R&D expenditures can be used to gauge the importance that companies attach to procuring R&D services from outside their organisation. Notwithstanding the difficulties in comparing such data on an international basis, new evidence from selected countries suggests an increasing propensity to procure externally-provided R&D services as implied by the growing ratio of extramural to intramural R&D expenditures in business. Furthermore, there appears to be some evidence of a slowdown in the relative increase of extramural R&D, coinciding with the timing of the onset of the global financial crisis and the ensuing economic downturn.

While sources such as innovation surveys illustrate the varied set of sources for inbound knowledge flows, there is less evidence available on how companies deploy their knowledge outside their organisational boundaries. Open innovation at the firm level has been the object of considerable analysis but official statistics still have the potential to document on a more systematic basis which factors influence their strategies and external engagement.

The concept of knowledge networks and markets (KNMs) was introduced by the OECD in its 2010 Innovation Strategy as "arrangements which govern the transfer of various types of knowledge, such as intellectual property, know-how, software code or databases, between independent parties". This term has grown in popularity and can be applied to describe a very diverse set of knowledge sharing agreements, institutions, social relations, networks and infrastructures that aim to allow companies, organisations and individuals to safely engage in the meaningful exchange of knowledge and associated rights. The common defining feature of these mechanisms is the fact that they provide a number of critical services to actors in the innovation system throughout the various phases in the process of exchanging knowledge and associated rights. These services range from searching and matching to relevant counterparties and knowledge objects, through to evaluating, executing and enforcing agreements. In order to be effective, KNMs must succeed at conveying relevant information to market and network participants whilst ensuring participation and encouraging parties to contribute high quality knowledge objects and applications. When dealing with agreements on the co-creation of future knowledge, KNMs must also deal with the additional challenge of incentivising and verifying effort by the participating parties.

Broad categories of KNMs can be defined on the basis of whether they focus on facilitating the transfer of disembodied knowledge, as in the case of searchable registers and repositories of pre-existing data and information; or rather represent platforms for sourcing solutions to ad-hoc problems and challenges. The latter include platforms for implementing inducement prize incentives or identifying consultants to assist with new R&D projects. The primary aim of a broad class of KNMs is to facilitate the arms-length use and transfer of IP rights on disembodied knowledge. IP brokers, pools and funds primarily deal with the allocation of IP rights, which may frequently, but not necessarily, be driven by a knowledge transfer motivation, and the creation and management of financial assets and liabilities attached to them. As a further category, it is important to emphasize the role of institutions and actors that specialise in ensuring the transfer of knowledge embodied in goods or people. Standard setting organisations, for example, codify existing know-how and best practices collectively embodied into a community of practice into more widely replicable guidelines.

Engagement in KNMs requires a significant investment in absorptive – both outside-in and inside-out – capacity on the side of organisations trying to make sense of the wide amount of information and actors around them. KNMs rely on a range of newly available tools. ICT-based tools are providing new mechanisms for facilitating not only the mechanical transmission of data, information and knowledge, but also providing the infrastructure necessary to put such mechanisms in place supported by sustainable business models. New technologies can help reduce transaction costs in the market for knowledge by allowing the standardised representation of information about the knowledge being procured and the knowledge being offered. IT-enabled communication tools support the exchange of disembodied knowledge.

In the absence of government funding – which is common for several types of networks and collaborative infrastructures – or voluntary contributions from participants, the sustainability of KNMs depends on their ability to finance their operations in return for the services provided. This may occur through the charging of prices, membership fees, or bundling free services with proprietary ones - as in the case of advertising. To be efficient, they need to exploit economies of scope and scale, which can be particularly difficult in some narrowly-defined knowledge domains in which the information about knowledge can be difficult to standardise and communicate.

Platforms facilitating the use of inducement prize contests represent an interesting example of KNMs. Contests have driven a number of innovations throughout history and have recently experienced a significant revival, as inducement prize contests and other crowd-sourcing tools have been enabled by a new wave of Internet-based platforms. These are being increasingly used by firms and governments worldwide to use prizes and challenges to promote innovation, by having one party ("seeker") challenge a third party or parties ("solver") to accomplish a particular goal. Contests appear to be particularly useful means for tackling high-uncertainty problems which can be defined in an abstract, standardised format and addressed by a relatively wide range of experts endowed with the fundamental solution tools. These platforms often deliver solutions of a quality level which is orders of magnitude larger than state-of-the-art solutions, at a fraction of the cost. However, there appear to be some limits to the applicability of contests to a wider range of problems than currently applied to. Contests are less likely to be effective and efficient solutions than other incentive regimes in circumstances where considerable effort is required to formulate the challenge, and validate, test and implement the solution into a viable innovation. Some forms of risk are not suitable to be borne by solution developers, and some projects may require greater negotiation about the ownership and licensing of IP. Overall, their use is likely to increase in future years in some specific areas, which may disrupt some traditional, established expert communities.

The collaborative process of standard setting requires significant co-ordination among interested parties, in which standards setting organisations (SSOs) play a major role. The broad class of SSOs comprise both "traditional" standards development organisations as well as the consortia, alliances, special interest groups and other organisations which have emerged in recent years. SSOs also differ in their geographic membership and technology and sectoral focus. SSOs are network-based collaboration mechanisms that underpin the process of knowledge co-creation by which the dispersed and often tacit knowledge residing on a limited number of experts can be easily communicated and codified for wider usage and adoption. By developing a common language and definitions, the use of standards further facilitates the exchange of information and knowledge. Given the wide range of standards available, it is not possible to estimate the contribution of SSOs to knowledge flows. However, surveys of innovating firms find many enterprises say that standards are a source of information that helps their innovation activities.

SSOs are also impacted by the development of markets for IP rights and further shape their development. IPR policies are a major aspect of SSO practices because the implementation of a standard may require the use of products or processes that draw on protected IPR. For instance, a standard-essential patent (SEP) allows the owner to control the use of an invention required to practice a given industry standard. SSOs must strike a fine balance between securing participation by owners of relevant technology ("the supply side") and encouraging adoption of the standard ("the demand side"). So while SSOs may require that SEPs are made freely available to standard users, the usual response by SSOs to the "hold-up" problem – i.e. the demand for excessive royalty payments once the standard has been adopted and investments have been sunk into it by producers – is to require IP holders to make their essential technology available on "fair, reasonable and non-discriminatory" (FRAND) terms on an *ex ante* basis in return for having the technology selected as a standard.

FRAND pledges have become the recent focus of contention in technology markets –particularly in ICT standards– because FRAND terms can be ambiguous, leaving considerable room for disagreement between parties regarding the transferability of those pledges and the determination of an appropriate royalty rate in thicketed markets. The recourse to injunctions by SEP-holders has been evaluated by courts and authorities alike concerned about the potential implications for competition and innovation. There is an ongoing debate as to whether SSOs should determine IP terms more precisely at the standard setting phase, although this is a practice which is seen by many observers as a potential unwelcome distraction from their core remit.

It is important for policy makers to consider how the knowledge market supports the growth of promising new technologies, drawing lessons from past experiences in other technology domains. For example, the emerging field of synthetic biology operates at the intersection of biotechnology and information technology. Observers have noted that it has the potential to raise the intellectual property problems that exist in both fields. Foundational patents and patent thickets are likely to be particularly problematic to the extent they draw upon standards that synthetic biologists would like to establish. A number of KNM mechanisms have been created with standards setting in synthetic biology as an important goal.

Among the standards-setting groups that have formed within the synthetic biology community, most have expressed a preference for standards to remain open and accessible to the community as a whole. In this early development stage, academics play an important role and the public ethos is quite visible. This preference, however, has not yet been incorporated into formal policies requiring the disclosure and licensing of intellectual property rights covering technical standards, which frequently draw on outputs of publicly funded research. Whether such policies could be made mandatory or would ultimately be beneficial to the field of synthetic biology remain open questions. Synthetic biology also illustrates a potentially symbiotic relationship between open and proprietary innovation models. For example, if and when synthetic biology "parts" begin to be disseminated as openly pure information, such dissemination will likely increase demand for various proprietary DNA-synthesis platforms.

Traditionally, relatively small sums of money were actually exchanged in the market for patent rights, as companies typically developed their inventions in house and implemented cross-licensing agreements in order to attain freedom to operate within their markets. Patent pools have been used to circumvent the patent thicket problem by allowing firms to combine their patents, sharing them with other patent holders and, in some cases, licensing to other firms as a package. Their resurgence matches the rapid growth in number of patents discussed above, and is subject to close scrutiny by competition authorities to ensure that they do not hinder access to the market by hindering competition, a socially undesirable outcome that is more likely when the IP are substitutes, rather than complements.

In the view of several experts, the build-up of patent portfolios within companies and pools has become a defensive strategic response against competitors building equally large portfolios, with the view to secure better cross-licensing terms. Very recently, unprecedented sums of money have been paid in auctions for patents and in the acquisition of "patent-rich" companies. These deals have brought the market for patents to the attention of the wider public. Available statistics, while providing only a partial picture, appear to confirm a trend towards increasing transaction volumes for patents and other IP rights, although these only apply to a minority of companies and patents. IP markets appear to be providing investors with an additional avenue for value realisation independently of the commercial success of their venture.

Exact estimates of the size of the IP marketplace are difficult to produce because most transactions are based on confidential agreements and therefore go unreported in open sources of information and registers. Furthermore, statistical agencies have had limited incentives to collect the information on a confidential basis to produce aggregate statistics, because a majority of IP rights were not considered as produced assets but as the outcome of administrative decisions, and therefore did not count as new capital formation by firms, organisations or individuals. OECD evidence from trade statistics suggests an upward trend in the value of disembodied technology royalty payments and receipts across countries well above the growth rate of GDP. This should be interpreted with caution, as transactions between affiliated parties appear to account for approximately two thirds of the overall value of international transactions. Specific information on royalty and licensing income for the entire economy, including both international and domestic transactions, is notoriously more difficult to come by for the aforementioned reasons. According to US tax data on "gross royalties", the returns of active corporations reported gross royalty receipts increasing from USD 115.8 billion dollars in 2002 to USD 171 billion in 2008, reaching nearly 1% of total revenue. Over 5 % of US receipts in the computer manufacturing industries now derives from royalties and licence fees.

The increasing importance of markets for technology and other intellectual property has given rise to the appearance of companies whose main activity is the monetisation of IP, principally through licensing. A possible indicator of the relative importance of IP intermediaries in the innovation system can now be derived from detailed service sector statistics corresponding to IP "leasing" sector. US data for this sector indicate total revenues worth USD 20 billion in 2010, a significant increase (4% nominal) with respect to 2009 at a time of widespread economic contraction. Comparing US and EU totals for 2009, the last year for which a full EU figure is available, estimates suggest that US licensing industry revenues (at ca EUR 13 bn) were nearly 90% larger than in the European Union (EUR 6.7 bn), potentially indicating a higher degree of specialisation within the market for IP rights. More up-to-date figures for individual EU countries indicate this is a fast growing sector. It must be noted, though, that many companies operating in this sector simply manage the IP portfolios of their parent and affiliated companies. Their formal separation may be linked to corporate tax and reporting arrangements. There is also some evidence that companies that specialise in IP transactions may be actually allocated to sectors other than the licensing sector. Further work needs to be done to evaluate the coverage of official sources and their international comparability as the new ISIC classification becomes mainstreamed and official registers and fully updated.

In contrast with companies which license their IP for new products, a category that includes many universities and R&D specialist companies, patent assertion entities (PAEs) are companies that assert patents on existing products as a business model. PAEs have a number of unique common features: PAEs have relatively low assertion costs as they cannot be countersued or disrupted in their activities, since by not operating in the market they cannot infringe on other parties' intellectual property. Furthermore, they often use contingent fee lawyers and assert the same patents in the same venues to capture economies of scale. While courts are currently less willing to grant injunctions to such companies, thus reducing their scope for asking for high license payments and damages, the cost of litigation for the alleged infringer is such that it can be economical for the defendant to settle, regardless of the merits.

PAEs have been described by experts in the field as a path-breaking, legal disruptive technology for monetising patents that eliminates traditional obstacles to enforcement. The PAE model provides inventors with the opportunity to sell their IP at favourable prices, because PAEs are likely to outbid an uncoordinated set of operating companies from which they can subsequently extract considerable rents. This can in turn create incentives for invention, as the exit value increases. From the perspective of market operators, the activities of PAEs can be particularly damaging and impinge on the commercialisation of promising inventions. Recent US evidence suggests that cases brought forward by PAEs represent the majority of new patent infringement suits. However, this may represent only a small fraction of cases. Public cases and private demands are often resolved under non-disclosure agreements, implying that very little is known about their overall impact. It is not clear either to what extent the PAE phenomenon applies in other jurisdictions and what are the prospects that may occur in the future.

One potential ongoing development is the possibility that PAEs may be used by practicing companies seeking to shield themselves from the retaliatory and reputational costs of asserting patents themselves. In this scenario, practicing companies could retain a licence on the IP and sell the ownership rights, thus transferring to the new buyer the ability to sue potential infringers. Such an escalation scenario may distort the already fragile balance of "mutually assured destruction" strategies that has led many companies to build up large IP portfolios. Such a development could have particularly damaging implications for the credibility of the IP marketplace and the future conduct of innovation in some technology domains. Public authorities may need to consider whether increased transparency in the market for patents could help mitigate this risk and where the public interest may take precedence above the legitimate right for companies to maintain a basis degree of confidentiality in their innovation strategies.

Markets for disembodied knowledge can also enable companies to leverage a fair share of their knowledge-based capital. Rights to intellectual assets can be used to secure funding for their activities and enable investors to manage their risk exposure by selling and buying IP in liquid markets where prices reflect the underlying value of the assets. The ability to identify and transfer the rights to these flows provides in cases a much needed source of collateral, particularly for firms with limited track record and limited tangible assets. New valuation methods and products are increasingly used to demonstrate the cash flow-generating capacity of knowledge assets, but progress has been limited so far. Although knowledge assets and other intangibles account for a large proportion of the market value of companies, not all are suitable to be used as collateral and traded independently.

Governments and public sector organisations play an important role in facilitating, shaping and regulating KNMs. Providing quality assurance through the granting process and communicating accurate information on the ownership of IP rights rank among the key services provided by public authorities in the market for knowledge. A number of studies have pointed out the responsiveness of IP markets to various types of public policies. Tax policies for example can have profound impacts. As noted earlier, statistics on IP trade may be partly explained by the relative advantages of setting up separate companies and vehicles for managing revenues arising from the use of IP. Recent academic research has for example demonstrated that differences in capital gains taxes that apply to patent sales can drive incentives for individual inventors to sell their patents.

Competition policies and enforcement practices also play a major role in determining what types of collaborative arrangements, from joint ventures to patent pool agreements, can be detrimental to competition. Over time, knowledge owners and seekers have developed a variety of strategies to mitigate the recurrent problems found in the market for technology. One such mechanism has been the elaboration of licensing arrangements to govern the transfer of codified knowledge, know-how and IPR. These include direct or indirect obligations on the licensee not to challenge the validity of intellectual property rights which the licensor holds in the relevant market, "Non-assertion clauses", "Grant-back" and "Reach-through" licensing agreements. Although they provide private benefits to some or all of the contracting parties, these can, under certain circumstances, limit competition in product and/or technology markets, discourage innovation and reduce public welfare. Consequently, policy-makers, in particular IPR-granting institutions and competition agencies, play a crucial role in designing and implementing a sound regulatory framework to ensure that licensing arrangements maximise the economic benefits that are associated with knowledge transfer, while minimising harmful effects on competition and innovation.

Many governments have become increasingly concerned about the ability of domestic firms and organisations, in particular SMEs, universities and PROs, to access and operate effectively in the growing and complex IP marketplace. Policy makers have also been concerned about the efficiency with which the move to a digital economy has rendered obsolete many of the traditional arrangements and infrastructures for clearing rights to art, music and other copyrightable items. This is also perceived as a factor potentially stifling the development of new business and ideas that draw upon such material, leading some governments to consider the creation of marketplaces for owners and purchasers of rights.

One recent policy response to the IP marketplace challenge has been the sponsorship of patent funds, namely entities that invest in the acquisition of titles to patents from third parties, with a view to achieve a return by monetising these patents through sale, use of security interest, licensing or litigation. Some governments have recently contributed financially to the creation of private-public entities, either directly or through state-owned banks, which fund the acquisition of rights to existing among other possible activities. This type of intervention is often based on the perception that the IP aggregation and defensive services are under supplied in the market, requiring some degree of public co-ordination and support. Advocates of public support for patent funds further argue that publicly controlled funds can more credibly steer away from pursuing aggressive patent assertion behaviours. A number of objections have equally been raised against publicly-backed funds. Constraints on IP assertion strategies may be difficult to define and implement in practice, especially if the fund is operated at arms' length. These funds may in the short term raise prices without necessarily increasing the levels of inventive activity, especially if the intervention is perceived to be transitory. The likely competition effects of public patent funds are difficult to predict as they will depend on the precise implementation of the fund and the interrelationship between the various components of the patent rights portfolio. Adverse selection and moral hazard are common problems to private and public patent funds, however in the case of the latter the acquisition criteria need to be much clearer for accountability purposes.

The international dimension of government-backed patent funds is particularly important. The coordination across these mechanisms could be costly and challenging to implement, especially if funds' strategies give some form of preferential treatment to domestic companies. The inappropriate use of these funds could potentially result in escalating "patent wars" and "patent arms races" at the level of sovereign states. Underlying the debate on the case for publicly-sponsored patent funds there is a strong sense of what some countries perceive to be the main domestic challenges in the face of increasingly fierce international competition, global value chains and patent-related initiatives adopted elsewhere. There is a risk that the often stated objective of achieving an international level-playing field might potentially run counter to international agreements that constrain the scope for giving preferential treatment to national champions. One element in common across the literature on public patent funds is the need to continue to explore the potential role of targeted interventions in the areas where the market failure rationale is strongest. The implementation of policy experiments such as patent funds needs to be accompanied by a conscious investment in gathering evidence on the expected and actual impact of these interventions.

There has been a continued trend towards an increasing share of basic research being carried out within publicly funded research organisations. At the same time, a number of policy reforms have been designed to incentivise the exploitation and commercialisation of knowledge created by these institutions. The multitude of missions, one of them being the commercialisation of research, may lead to a "mission creep" or the overburdening of PROs. Indeed, the transfer of knowledge generated by public research takes place through a variety of channels. These include the movement of graduates and staff from universities to business; the publication of research results; people-based interactions between creators and users of new knowledge; industry sponsored contract research; individual faculty consulting arrangements; IPR-based activities such as patenting and licensing; and entrepreneurial activities of faculty, graduates and students. These channels often operate simultaneously or in a complementary fashion, underscoring the interaction between tacit and codified flows of knowledge as well as the multi-directional nature of flows. Knowledge does not only flow from university to industry but also the other way around. University inventions are embryonic and their commercialisation often requires additional input from faculty and students and entrepreneurs.

Changes in incentives for "third-stream" activities and increasing resources for technology transfer activities appear to have been associated with increasing levels of licensing and related income by universities and other public research organisations worldwide. As PROs have become more involved in commercialization activities, they have built up an extensive infrastructure in the form of technology licensing and transfer offices (TTOs). However, these initiatives have not been met with uniform success, often due to lack of expertise, incentives and critical mass. In this environment, many universities and governments have sought to reform or replace the functions of TTOs. They have crated regional TTOs ("hub-and- spoke" models) that service several universities at once, thus pooling resources. They have also used online IP marketplaces, partnered with patent funds, engaged with for-profit TTOs or developed approaches to vest some rights with inventors, while maintaining institutional ownership over inventions (e.g. free agency model).

Policy instruments will need to further differentiate the types of commercialisation paths used by various types of PROs. Considering the heterogeneity of universities and the different local and regional contexts, there is a need to make sure commercialisation strategies are aligned with the regional and global research environment. Incentive mechanisms play a fundamental role in the effectiveness of knowledge transfer strategies by PROs. Research funding agencies do play a major role in defining key policies concerning access to scientific results, data and instruments, as well as policies regarding knowledge and invention disclosures.

The institutions and infrastructures that support networks and markets for creating and disseminating scientific knowledge are being reviewed across many OECD countries, as traditional models are facing considerable limitations and may be restraining further scientific advance and broader innovation. New models will have to demonstrate – possibly through pilot experiences – their ability to ensure quality, participation and adequate rewards to those who contribute to the research, peer review and dissemination effort. Indicators of impact at the level of individuals and institutions are likely to grow in importance. This will create a significant challenge for decision makers, as the impacts of science take a long time to materialise and the mechanisms for these impacts to materialise can be highly dispersed and uncertain, therefore making it difficult to capture through available metrics and data infrastructures. A relatively unexplored domain of analysis is the role of graduates as key actors in the exploitation and possible commercialisation of knowledge generated in universities. Acknowledging this role and understanding what are its drivers and main barriers could prove a particularly fruitful area of future analysis.

Employee mobility is essential to what is arguably the most important market for knowledge, i.e. the market for highly-skilled workers. Various sources of empirical evidence confirm the importance of new personnel as a key source of information for innovation and as a vehicle for knowledge spillovers. However, a high degree of employee mobility also entails a fast obsolescence for firms' investments in knowledge embodied in employees, as well as a potential loss of competitiveness *vis à vis* competitors who might recruit former employees. Employers have developed strategies to protect business interests challenged by the risk of employee turnover. One of these is to place restrictions requiring employees to agree not to compete with the employer upon departure. These covenants are typically described as non-compete agreements (NCAs) and their use is widespread although not universally enforced. The existence of rules preventing their enforcement has been anecdotally linked to the entrepreneurial success of some states and industries, as in the outset of California's Silicon Valley when key inventors were allowed to set up their own companies after leaving large incumbent firms.

The potential impact of NCAs has been raised in the OECD Innovation Strategy alongside other labour market policies that may impact on the mobility of highly skilled personnel contributing to research and innovation activities. From an international comparative perspective there has been little attention given to NCAs and its impacts. Most of the policy debate and empirical evidence have been US-centred. To address this evidence gap, an initial investigation of legal sources was carried out to identify how countries' regulations and judicial practices differ in their enforcement of NCAs, examining a broad range of factors that characterise whether and, if so, how authorities consider NCAs to be "reasonable".

In addition to the renowned case of California (and a few other US states), countries such as India, Israel, Mexico, Luxembourg and the Russian Federation appear to rarely enforce NCAs. Most European countries and a majority of other OECD countries have a more permissive approach towards NCAs, although their statutes often require payment of compensation for affected employees, which in some cases can be large. The enforcement of NCAs is evolving through legislative reform and case law arising from decisions by courts. Policy and court decisions on NCAs can have broad ramifications. For instance, less enforcement of NCAs can potentially increase litigation around trade secrets, or encourage firms to adopt other anti-competitive practices to limit the flow of employees. In smaller countries, NCAs may have relatively little independent impact because of the limited scope for employee mobility across highly specialised posts.

There are concerns that companies may use NCAs strategically, for purposes other than preserving trade secrets and valuable knowledge. For example, NCAs are often presented to employees after they have signed their contracts or on their first day at work, when their bargaining power is limited. The evidence shows that NCAs often lead employees to take career detours away from their field of expertise, which may be socially wasteful and discourage specialisation and moves from academic into industry. NCA enforcement appears to reduce inventor mobility across firms in the relevant jurisdiction, while encouraging key knowledge workers such as inventors to take jobs in areas where NCAs are not enforced. However, the evidence on the impact on entrepreneurship and innovation is not clear-cut: if NCAs are enforced, employees might be less willing to leave an enterprise to work for start-ups. But, in the absence of NCAs, incumbent firms might also poach key staff from young innovating competitors.

Policy makers can focus their future monitoring of existing practices by identifying how trade secret legislation and NCA rules interest, and exploring how they can best address the strategic use of NCAs for purposes other than protecting legitimate business interests, e.g. by precluding firms from proposing NCAs after the terms of employment have been agreed. An improved evidence base would be an essential step for identifying which are the features of the labour market for inventors and other key knowledge workers that prevent flows from academia into research occupations in the business sectors.

Mapping the innovation system and knowledge flows within it has been a long-standing ambition of the OECD as its committees and working parties have developed conceptual, analytical and measurement frameworks that support policy decision-making across OECD countries and beyond. Identifying knowledge networks and markets, the flows of knowledge within and across them, all require an appropriate infrastructure. Some countries have developed worthwhile strategies to trace some of the flows of knowledge and funds as relevant to their national systems. In a highly integrated world economy, these approaches need to consider their implementation on a truly global scale in order for them to be useful. Administrative and informal sources can prove increasingly valuable, although particular attention needs to be paid to their informational content which results from the actual administrative or alternative purpose served. Linking these data to survey data generates evidence that is more valuable than the sum of the parts and has the potential to enhance their mutual quality.

The risk that measurement systems fail to keep up with the rapid changes in the system may lead to the policy debate focusing on few, easier-to measure indicators which do not reflect the rich variety of mechanisms for exchanging and using knowledge. Building a system capable of capturing differences between knowledge production and use, capturing partnerships and their financial dimension, monitoring the combined outward and inward dimension of knowledge flows, and going beyond IP indicators as measures of third mission output of public research organisations are amongst the most important evidence gaps at present and lay down priorities for future development.

1. INTRODUCTION

Since the dawn of the industrial revolution, the achievement of a strong, integrated system of innovation is and has been inevitably linked to its key actors engaging in productive knowledge exchanges and collaboration. Over many years, successful innovation systems have developed a complex and continuously evolving layer of institutions, networks and markets which underpin specialisation in innovation efforts, the financing of research and commercialisation, provide basic knowledge infrastructure and workforce and enable the entry of new companies alongside or in competition with established incumbents.

Over the last two decades, there has been a major surge in the amount of information, knowledge and associated intellectual property (IP) rights that have been generated on a global basis across all domains of innovation and economic activity. Investment in various forms of knowledge-based capital has experienced a sustained increase (Corrado et al, 2012). Increased competition from emerging economies, which are moving towards more knowledge-intensive activities, is also challenging traditional assumptions about the way firms and countries specialise along innovation and value chains. New digital technologies have brought about large reductions in the cost of copying, storage and distribution of data and information. In this environment, the knowledge that is relevant for companies' innovation activities is nowadays less likely to reside within their internal boundaries (Chesbrough. 2003; Dahlander and Gann, 2010).

In this environment in which information has become more abundant, easy to access and copy, IP rights have become more important as the tool that allows knowledge creators to exclude third parties from using an idea or the expression of an idea to extract value from knowledge-based assets. Patent applications worldwide are estimated to have doubled from approximately one million in 1995 to over two million by 2011 (WIPO, 2012). This growth has been fuelled by the applications in the information and communications technologies (ICT) domain and, on a country basis, they have been mostly due to rapid growth in applications filed in China and the United States. Due to legislative changes and policy incentives, publicly funded research organisations such as universities have emerged as particularly active players. Other IP rights such as trademarks and designs have experienced similar trends. The rapid and sustained growth in volumes of IP rights might have been accompanied by a decline in quality and increased complexity and uncertainty regarding their scope and validity. Experimental synthetic indicators recently developed by the OECD suggest that average patent quality – a combination of proxies for the technological and economic value of patents – might have steadily declined over the last decade (OECD, 2011). Furthermore, IP transaction costs appear to have risen as generators and users of rights navigate an ever more densely populated landscape of increasingly subdivided rights. In complex technology areas, single products draw upon a remarkably large number of IP rights, such as patents and designs. For example, patent thickets, namely "an overlapping set of patent rights", require innovators to reach licensing deals for multiple patents from multiple sources in order to commercialise their innovations. There is an increasing concern that thicketed markets might prevent new and innovative firms from entering the market, thereby inhibiting growth (von Graevenitz et al, 2011).

This unprecedented availability of information and volume of overlapping rights has led to a continued search for mechanisms that help individuals, business and organisations navigate this complex ecosystem, identifying relevant sources or providers of knowledge beyond their immediate network of contacts, enabling them to clear IP rights and transact upon them with minimal transaction costs. There has been a major surge in the number of mechanisms that attempt to help individuals, business and organisations navigate a complex system in which unprecedented amounts of information and knowledge – as well as associated intellectual property rights– are being created across all domains of innovation and economic activity. These mechanisms deal with a wide variety of knowledge-based products, from know-how and data arising from R&D activities in firms, universities or public sector labs, through to the recording of supermarket purchases in loyalty cards or the browsing histories by individual Internet users. All of these forms of knowledge have the potential to become economically relevant assets and are susceptible of being exchanged and shared, to meet the needs of their owners and society at large.

This report considers the role of markets and networks for knowledge-based assets as the mechanisms and institutions facilitating the creation, exchange, dissemination and utilisation of knowledge and associated rights in the innovation system. The report examines a concept previously introduced by the OECD in its Innovation Strategy (OECD, 2010), which defined “Knowledge, Networks and Markets” as “arrangements which govern the transfer of various types of knowledge, such as intellectual property, know-how, software code or databases, between independent parties”.

In this rapidly changing environment, ICT-based tools are providing a new wave of mechanisms for facilitating not only the mechanical transmission of data, information and knowledge, but also providing the infrastructure necessary to put such mechanisms in place with sustainable business models. New technologies help process unstructured text content and extract the names, dates, organisations and events within a text to tease out trends and correlations. These tools can help reduce transaction costs in the market for knowledge by allowing the standardised representation of information about the knowledge being procured and the knowledge being offered.

Efficient knowledge markets make it possible to separate various components in the production and use of knowledge across firms, thus encouraging specialisation through the division of innovative labour (Arora et al, 2010). Within knowledge markets, enforceable IP rights help address the threat of misappropriation in downstream markets which could otherwise lead firms to adopt less efficient, internal development strategies. Knowledge markets can thus contribute to encouraging the exploration of knowledge development avenues which might otherwise be left unexploited. Markets for disembodied knowledge can also enable companies to leverage a fair share of their knowledge-based capital. Rights to intellectual assets can be used to secure funding for their activities and enable investors to manage their risk exposure by selling and buying IP in liquid markets where prices reflect the underlying value of the assets. While the financing of innovation from invention through to commercialisation requires long-term capital commitments, the economic and financial crisis has accentuated the difficulties for firms to finance their innovation activities. The crisis has also reduced confidence in the ability of markets for complex products to address information asymmetries and align risks and rewards.

As this report highlights, the challenges to the emergence and sustainability of markets and networks for knowledge assets are several. Knowledge is no ordinary commodity and associated markets are likely to be missing owing to the absence of standard valuation approaches, its context dependency, the stickiness of information and the opportunistic behaviour of actors (Arora *et al.,* 2001a). For similar reasons, when markets for knowledge exist, their net contribution to innovation and social wellbeing can be ambiguous, depending on whether their design and the conditions under which they operate incentivise rent-seeking, as opposed to socially efficient behaviours and outcomes.

The recent evolution of knowledge markets raises a number of questions about the nature of knowledge markets, their impact and the appropriate role for policy.

- How marked has been the increase in business use of open innovation strategies? Is the use of markets for exchanging, sourcing and co-creating knowledge on the increase? What is the role of IP rights in driving this trend?

- What are the key defining and novel dimensions of the recent surge in knowledge networks and markets?

- What are the business models being adopted by new knowledge markets and networks and are they sustainable responses to the challenges that drove their emergence?

- Why, despite the appearance of new mechanisms for accelerating knowledge flows, is it often perceived that open innovation and knowledge networks have not resulted in a greater rate of commercialisation and innovation, particularly in some domains?

- What is the appropriate role of government in this rapidly changing landscape and is it possible to reconcile its various different roles?

This report attempts to shed some light on these questions and lay out a possible research agenda. It is structured as follows:

- Section 2 investigates the **knowledge sourcing strategies** used by firms, investigating their role in innovation strategies, and their link to business characteristics and actual performance.

- Section 3 introduces the concepts of **knowledge networks and markets** and proposes a conceptual framework for understanding the purposes they serve in relation to knowledge flows and the transfer of IP rights. A number of novel examples of KNMS are considered.

- Section 4 considers more specifically some developments in the **market for IP rights**, looking in the first instance at the evidence on the size of the market and the role of intermediaries. The various features of the market for IP rights are considered, as well as the implications of a number of strategies in this highly complex marketplace.

- Section 5 briefly examines the role of **public policies in the IP marketplace**, with particular emphasis on the new forms of policy interventions such as government-sponsored patent funds.

- Section 6 considers the dynamics of the markets and networks for **knowledge originating in public research organisations** such as universities, as well as the role of intermediaries such as technology transfer offices whose role has been rapidly changing in recent years.

- Section 7 extends the analysis of knowledge markets to the **market of knowledge embodied in highly skilled employees**. The ambiguous impact of mobility on innovation is considered, considering in particular the use of agreements to restrict the movement of human capital and the potential implications of their enforcement by authorities.

2. KNOWLEDGE FLOWS AND OPEN INNOVATION STRATEGIES

Previous OECD work has highlighted the importance of knowledge flows for the efficiency of national innovation systems (OECD, 1997). More recent OECD analysis has demonstrated the existence and importance of stylised open modes of innovation for business innovation strategies (OECD, 2009 and Frenz and Lambert, 2012). Data from innovation surveys shows that sourcing knowledge, collaborating and investing in external knowledge matter not only for R&D performing companies in so called high-tech sectors but provide the basis for most other types of companies to introduce new products, including services, and improve the efficiency of their processes, drawing on knowledge generated elsewhere and through partnerships. Preliminary results suggest that innovative companies in different sectors and countries tend to favour specific sources of external knowledge.

Mapping knowledge and innovation flows is a complex and demanding endeavour in which it is not possible to rely on a single source of evidence. It also requires a comprehensive data infrastructure comprising of very distinct elements that allows linkages to be drawn between actors, outputs and outcomes. Systems approaches to innovation have shifted the focus of innovation policy debate towards an emphasis on the interplay of institutions and the interactive processes at work in the creation of knowledge and in its diffusion and application. For example, the term “national innovation system” has been coined to represent this set of institutions and these knowledge flows (OECD, 1997). This theoretical perspective influences the choice of indicators and the sources used within various measurement frameworks, for example in the case of R&D and innovation surveys, and the need, for example, to aim for extensive coverage of linkages and knowledge sources.

How do organisations engage in open innovation?

The literature abounds with examples of a shifting culture and acceptance of more open innovation strategies that cut across organisational boundaries. Companies such as IBM, Intel, and Procter & Gamble all exemplify organisations that have adopted an open innovation model (Chesbrough et al., 2006).

Box 1. Defining "open"

Open innovation: This concept describes the “use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation”. This includes proprietary-based business models that make active use of licensing, collaborations joint ventures, etc… Here “open” is understood to denote the arms’ length flow of innovation knowledge across the boundaries of individual organisations.

Open source: This term is now applied to designate innovations, often jointly developed by different contributors, available royalty free to anyone and without significant restrictions on how they are to be used. A possible restriction is that derivative work also has to be provided on a same basis.

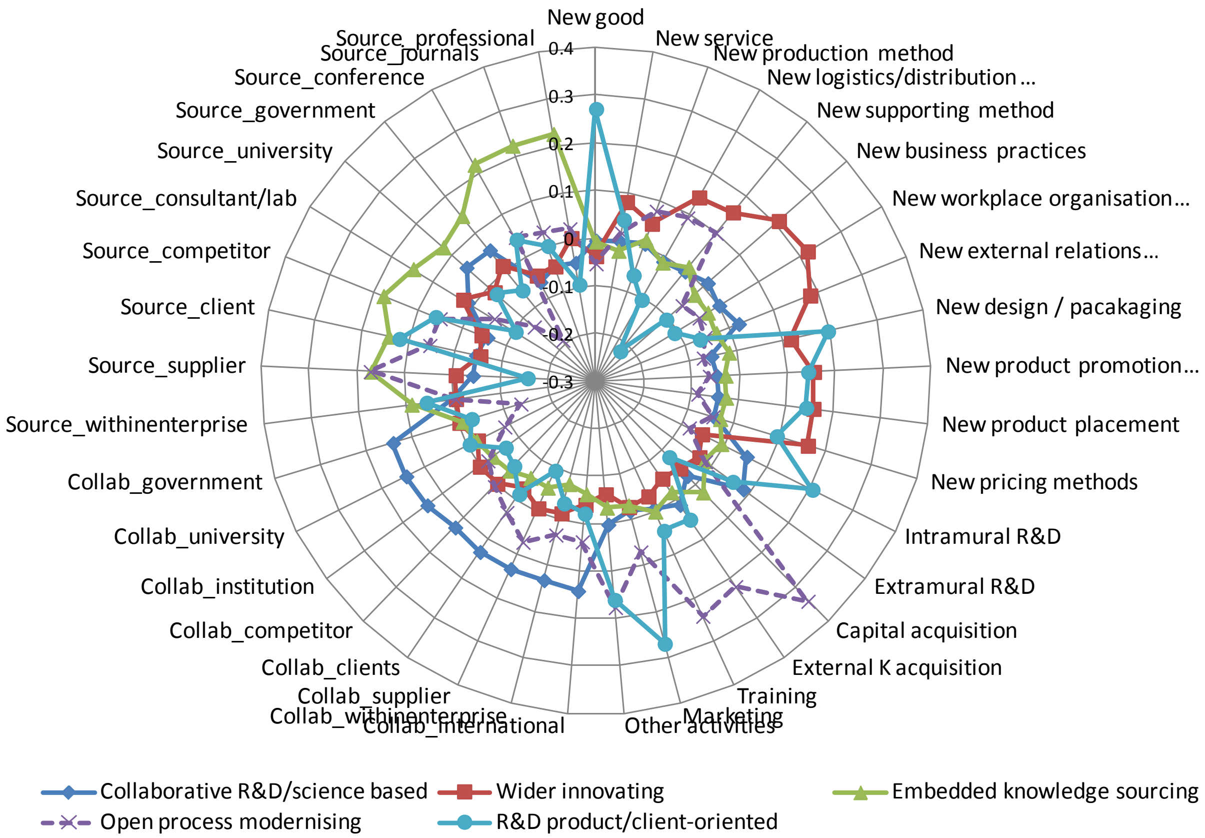
Open science: This term is often used to describe a movement that promotes greater transparency in the scientific methodology used and data collected, ensuring the public availability and reusability of data, tools and materials, arguing for broadly communicating research (particularly when publicly funded) and its results.

Open access: This term describes the possibility of accessing scientific literature and data “digital, online, free of charge, and free of most copyright and licensing restrictions”. This term also gets increasingly applied to data provided by profit-driven operators, who develop business models that enable them to obtain a source of revenue bundled alongside information provided on a free and open basis.

Source: OECD, based on OECD (2012) “Knowledge networks and markets in the life sciences.”

Despite the recurrent use of the open innovation term and the abundant anecdotal evidence, the size and nature of this phenomenon are relatively little-understood for official statistics. It has long been recognised that organisations, and firms in particular, do not rely exclusively on their in-house research or development resources to generate inventions and develop them into final new goods and services (OECD, 2008). Knowledge sourcing strategies in businesses can be highly complex and there are significant complementarities (Cassiman and Veugelers, 2006). It can therefore be useful to analyse instead a reduced set of synthetic measures that encapsulate various modes of sourcing knowledge among firms actively pursuing innovation. The study by Frenz and Lambert (2012), carried out in the framework of the OECD *Innovation Microdata Project*, uses exploratory data analysis techniques to develop typologies of innovation modes or strategies for groups of firms based on innovation survey data –collected under the guidelines in the OECD/Eurostat *Oslo Manual*- for 2006. This work has been recently extended to examine in more detail the different patterns of openness in business innovation strategies, considering the full breadth of information available on the sources of knowledge identified by companies as important to their innovation efforts, the partners engaged in collaborative innovation efforts and the use of company resources on innovation activities (including R&D). These possible approaches for sourcing innovation knowledge are combined with indicators of different types of innovation outcomes reported by firms, thus providing a complete characterisation of modes of innovation used by firms and their degree of openness.

Figure 1. Modes of innovation and knowledge sourcing for European innovation-active firms, 2008



Note: Rotated factor loadings for five main factors and business responses to official innovation survey questions on sources of information for innovation (e.g. internal, clients, suppliers, institutions…), collaboration (likewise), innovation activities (from intra and extramural R&D through to IP acquisition and marketing, training and other expenditures including design) and types of innovation (varieties of product, process, organisational and marketing innovation). Factors have been interpreted and named on the basis of their loading scores.

Source: OECD own calculations based on CIS 2008 microdata (Eurostat), 2012, The analysis of innovation survey data covering the 2006-2008 period that is reported in Figure 1 reveals the existence of five main factors describing innovation patterns in European firms that are "innovation active".[1] Two of these modes appear to describe the activities of R&D-active companies. One such factor appears to describe companies that carry out intramural R&D while introducing new product and marketing innovations. Clients, customers and internal sources are primary sources of information for this type of innovation-active firms. A second factor reveals companies that are R&D-active but particularly so in procuring extramural R&D while collaborating with and sourcing knowledge from organisations within the higher education and government sectors (the research base). For presentational convenience, we label the first factor as describing a cluster of "**R&D product/client-oriented**" innovative firms, and the second as "**Collaborative R&D/science-based**" innovative firms.

Two additional modes score relatively low on R&D activity but indicate a considerable degree of external engagement. The first of these two modes exhibits high "loading scores" for several sources of information, particularly professional associations and technical literature, while it only correlates positively with innovation outcomes and activities concerning the introduction of new production methods and the acquisition of new capital. One could describe this as companies whose approach to innovation involves the sourcing of external know-how embedded through capital and software purchases and describe these as "**embedded knowledge sourcing**" innovative firms. A further factor scores highly on suppliers and customers being reported both as collaborators and sources of knowledge, which tend to co-occur with process innovations and activities involving the acquisition of capital, external knowledge and training. Since companies that score highly on this factor appear to be introducing new processes in response to collaboration with market partners one could define these as "**open process modernising**".

Table 1. Modes of knowledge sourcing and innovation

Summary of factor analysis

Modes	Variance	R&D	Knowledge Sources	Collaboration	Innovation activities / investment	Innovation outcomes
R&D product/client-oriented	7 %	Yes	High on clients and competitors	Low, mainly clients and customers	Intramural R&D, other activities including design	Goods, marketing, partly services
Collaborative R&D/science-based	21%	Yes	High on labs, universities, government	High on all, including institutional	Intramural and extramural R&D	New products (goods and services)
Embedded knowledge sourcing	11 %	No	High, most sources	Low	Capital acquisition	Low, only production process
Open process modernising	7 %	No	Market sources, principally suppliers	Market sources, principally suppliers	Training and capital and knowledge acquisition	Process
Wider innovating	13%	No	Low, consultants	Low	No systematic activity	Services, marketing, organisation

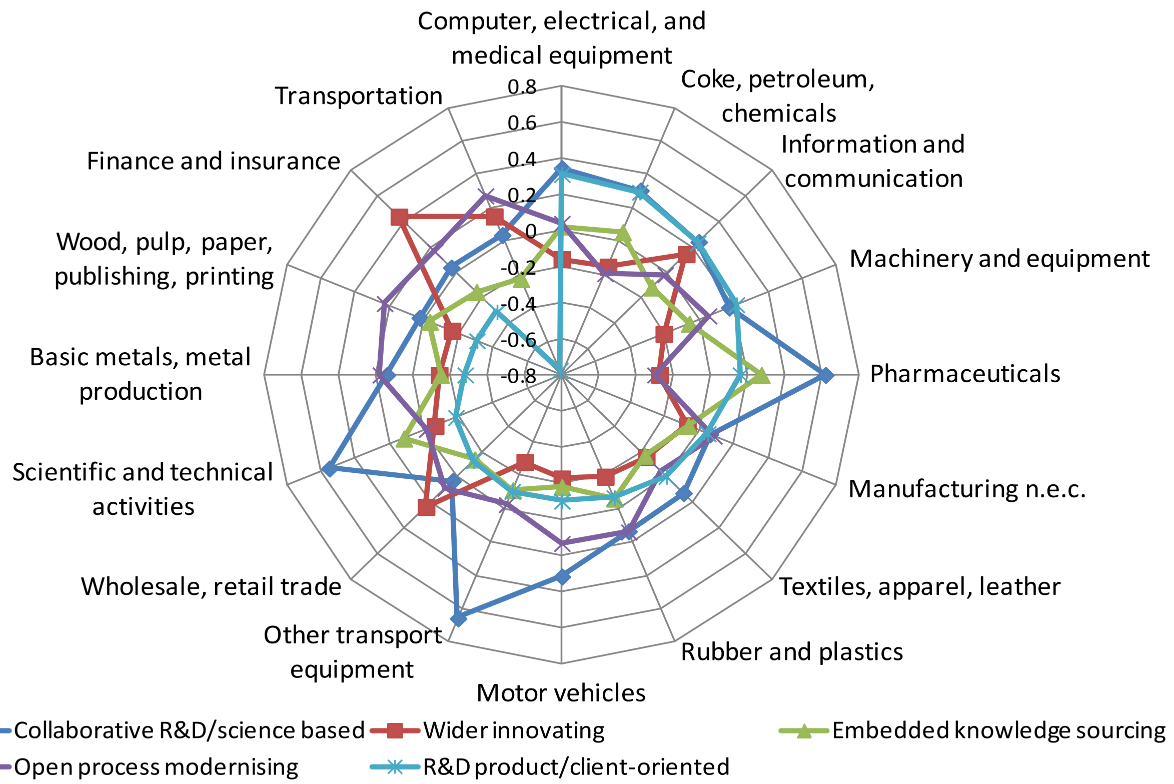
Note: % Variance denotes the proportion of the overall variation in the data accounted for by the relevant factor.

A fifth and final mode exhibits a relatively low degree of external engagement through reported knowledge sources, knowledge acquisition or collaboration. This factor characterises companies more likely to report the introduction of new services alongside some non production processes, marketing and organisational methods, without intervening R&D or related innovation investments. This mode is described as "**wider innovating**". These are companies which only appear to use consultants and professional/industry associations as main external sources of knowledge. It is important to note that the European Community Innovation Survey only asks companies to report activities, sources of knowledge and collaboration occurring in relation to the pursuit of product or process innovations. Therefore, it may not be appropriate to describe this mode as fundamentally less open than the other four.

The descriptive validity of these "implied" modes can be further assessed by studying how business characteristics correlate with the factors describing the innovation modes. The standardised factors have therefore been compared with business characteristics dummies, including sector, firm size and country. The summary results in Figure 2 display the resulting regression coefficients for sector affiliation indicators, using the food and beverages manufacturing sector as reference. These results show that firms in the "pharmaceutical", "other transport equipment" (comprising aerospace) and "scientific and technical activities" sectors are the most likely to display the "Collaborative R&D/science-based" mode, followed by motor vehicles. Within pharmaceuticals, firms also tend to score relatively high on the "R&D product/client oriented" mode. The ICT manufacturing and services sectors are amongst those scoring the highest on this particular mode. Firms in "Finance and insurance" and "Wholesale and retail trade" tend to score high on the "wider innovating" factor dimension. The open process modernising mode is particularly salient among transportation services and some of the less R&D intensive manufacturing sectors. Differences are less marked across sectors in terms of the "Embedded knowledge sourcing" factor. This factor appears to be particularly common among firms within the pharmaceutical and scientific and technical services sectors.

Figure 2. The incidence of innovation modes, by sector of activity

Regression coefficients of standardised scores for "innovation modes" on sector dummies



Source: OECD calculations based on CIS 2008 microdata (Eurostat), 2012. Based on data for 36 051 European companies from DEU, FIN, CZE, FRA, SVK, LUX, NLD, HUN, PRT, ITA and ESP.

The resulting taxonomy has similarities with the popular taxonomy developed by Pavitt (1984), but also exhibits some differences. Pavitt's "specialised supplier" and "science-based" match relatively well with the two R&D-related factors proposed above. His "scale-intensive" group of firms that import and build upon science developed elsewhere, particularly with regard to process improvements and "supplier-dominated" categories have somewhat close counterparts in the "open process modernising" and "embedded knowledge sourcing" categories developed here. Some sectors identified by Pavitt as belonging to this group appear to be nowadays more strongly R&D-oriented, as is the case of the motor vehicle industry. Furthermore, being based on a specific notion of technological innovation, most services with the exception of software industries are allocated to the so-called "supplier dominated" group, while innovation survey data makes a further distinction between firms in services embedding innovations through new equipment to improve their processes, and companies implementing broader types of so-called non technological innovation. Differences and similarities between Pavitt's technology-based classification and an innovation survey-based one are illustrated in Table 2.

Table 2. Comparing technology and innovation-based taxonomies: Analogies and differences with Pavitt's taxonomy

Pavitt's taxonomy	Pavitt's examples	Analogue Innovation Survey–based factors	Differences and similarities
Specialised supplier	*Computer hardware and software.* R&D intensive - product innovations, working with each other and users.	**R&D product/client-oriented**	Strong similarities of definition and examples
Science-based	*Pharmaceuticals, aero.* Access to basic research and PROs complements own research activities	**Collaborative R&D/science-based**	Strong similarities of definition and examples
Scale-intensive	*Food-processing, vehicles.* Import and build upon science developed elsewhere, particularly with regard to process improvements	**Open process modernising**	Innovation survey data shows that firms in the motor vehicle sector are far more active R&D based developers, with strong science-based traits.
Supplier-dominated	*Forestry, services.* Import technology mainly in the form of capital goods and intermediary products	**Embedded knowledge sourcing**	Not all services actually fit under this category using innovation data.
		Wider innovating	Pavitt's work focuses on technological innovation.

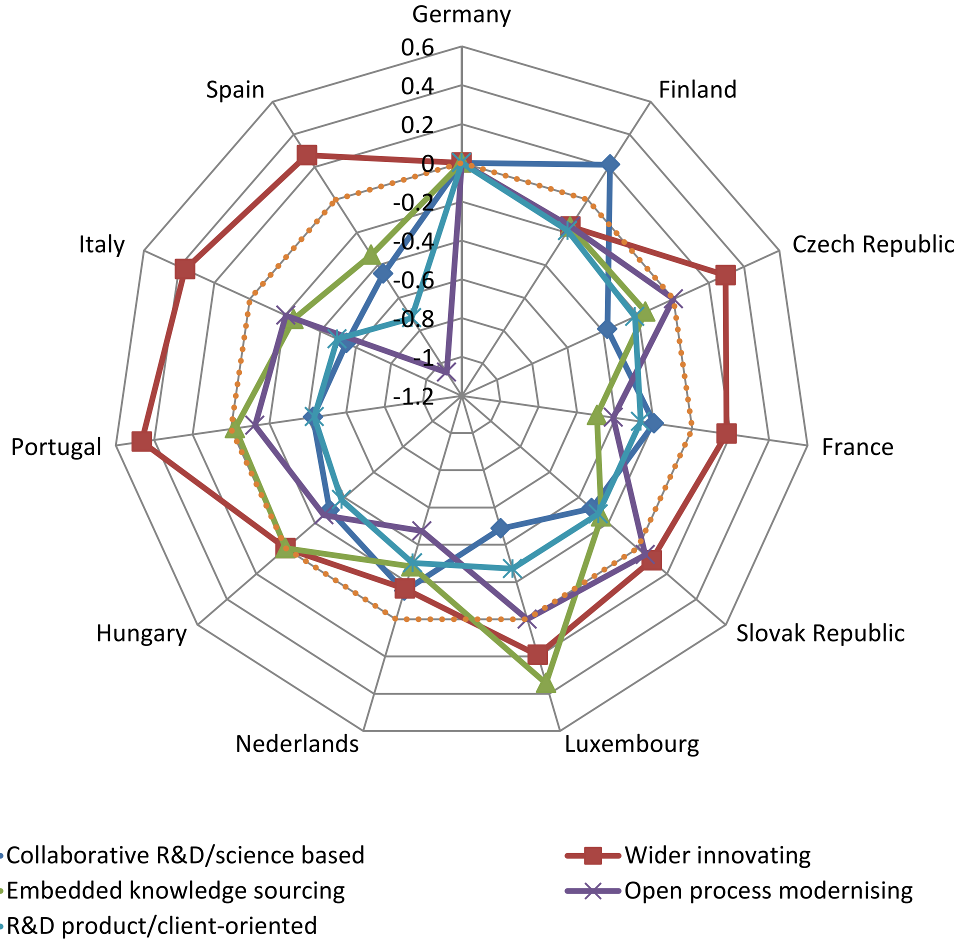
Source: OECD and Pavitt (1984)

Results not reported here also confirm that firm size is positively associated with all types of innovation. Size appears to be a particularly discriminating factor with regards to the adoption of the collaborative R&D science-based mode. This may reflect the need for scale in order to develop the internal capabilities that are required to engage in this type of relationships.

The regression results can also be used to study whether these implied modes are more prevalent amongst specific countries (Figure 3). Because sector dummies have been included, these estimates account to some degree for differences in sector composition. Taking Germany as the baseline, it is easy to note that scores on all factors but one, namely the one concerning the "wider innovating" mode are highest for this particular country. The wider innovating mode is particularly prevalent in Portugal, followed by Italy, Spain, Czech Republic, France and Luxembourg. Only Finland exhibits a higher score on the collaborative, science-based mode indicator.

Figure 3. Country-level patterns of modes of innovation and knowledge sourcing, European firms 2006-08

Estimated country-level "effects", controlling for business characteristics



Source: OECD calculations based on CIS 2008 microdata (Eurostat), 2012. Data for DEU (baseline), FIN, CZE, FRA, SVK, LUX, NLD, HUN, PRT, ITA and ESP. In this chart, statistically not significant estimates have been displayed as zeroes.

The analysis of innovation modes further allows examining to what extent the knowledge sourcing and innovation modes can predict specific features of innovation as well as economic outcomes within the firm. The results in Table 3 provide some further insights on the specific role of companies in developing innovations. R&D product/client-oriented innovators are the most likely to report higher shares of new to market products and turnover accounted for by new products, although all four other modes are positively correlated with this measure of innovativeness. Wider innovators and open process modernising firms are the most likely to report processes which are new-to-the-market. R&D Product/client oriented firms that introduced new products or processes are significantly less likely to report having co-developed these with other parties in any form, revealing a considerable degree of internal control over the development process, notwithstanding the external engagement with customers. Collaborative R&D/science based firms are more likely to have co-developed products or processes, but less likely to have let another party take responsibility for their development. Open process innovating firms are more likely to have co-developed their process innovations. Conditional on having introduced a new process, wider innovators are less likely to report that another firm mainly developed the innovation. All five modes are positively correlated with growth in turnover and employment over the reference period 2006-2008. While this is not necessarily evidence of a causal effect, the relationship is robust to the inclusion of controls for other firm characteristics including sector affiliation and size.

Table 3. The relationship between modes of innovation and business performance, European firms 2006-2008

OLS regression estimates

	Innovation novelty			External engagement				Business performance		
Dependent variable Independent variable (Standardised score)	**Share of turnover from new products**	**Whether product new to market**	**Whether process new to market**	**Whether co-dev 'd new product**	**Whether product mainly dev'd by other**	**Whether co-dev'd new process**	**Whether process mainly dev'd by other**	**Growth in turnover**	**Growth in employ-ment**	**Productivity level**
Collaborative, scientific R&D based	0.040*** 0.003	0.114*** 0.005	0.034*** 0.007	**0.079***** 0.006	-0.021*** 0.003	**0.076***** 0.006	-0.041*** 0.004	**0.029***** 0.005	**0.024***** 0.003	0.037*** 0.008
Wider innovating	0.044*** 0.003	0.083*** 0.005	**0.122***** 0.007	-0.004 0.006	-0.018*** 0.004	-0.006 0.007	-0.045*** 0.004	**0.028***** 0.004	**0.029***** 0.003	0.019 0.011
Embedded process sourcing	0.024*** 0.003	0.056*** 0.005	0.020** 0.007	**0.017**** 0.007	-0.009* 0.004	0.018** 0.006	-0.016*** 0.004	0.015*** 0.004	**0.015***** 0.003	0.040*** 0.009
Open process modernising	0.014*** 0.003	0.043*** 0.005	**0.062***** 0.007	0.018** 0.006	0.000 0.003	**0.050***** 0.007	0.002 0.004	0.012* 0.005	**0.009**** 0.003	0.007 0.01
Product / client oriented R&D	**0.095***** 0.003	**0.215***** 0.004	0.004 0.007	-0.053*** 0.007	-0.034*** 0.004	-0.070*** 0.006	-0.053*** 0.004	0.007 0.004	**0.010***** 0.003	0.017 0.009
Number of observations	35102	36051	16953	23991	23991	26620	26620	33497	33599	36031
Sample	Innovation active firms	Innovation active firms	Innovation active firms*	Product innovators	Product innovators	Process innovators	Process innov	Innovation active	Innovation active	Innovation active

* Variable not available for all countries.

How to read: One standard deviation increase in the "collaborative-science based" mode score raises the proportion of turnover from new products by 4 percentage points.

Note: Regression controls for firm size, country and sector affiliation. 3 asterisks denote statistical significance at 1%.

Source: OECD estimates based on CIS 2008 microdata (Eurostat), 2012.

One apparent limitation of existing innovation surveys is the lack of information on the outbound dimension of knowledge exchanges and its interaction with the knowledge sourcing strategies described above. Ad-hoc surveys carried out mainly by academics have identified three broad categories of open innovation typically used by companies:

Companies using **"outside-in"** strategies mainly assimilate ideas that originate externally, often by customers or suppliers, into their own innovative processes. Based on the evidence considered above, it may be possible to conclude that innovation surveys may not fully capture this group as there may be an implicit bias in the use of the innovation terms towards under-reporting innovation by companies that do not develop the innovations themselves.

The **"inside-out"** approach normally refers to the commercialisation or licensing of companies' existing technologies and the finding of new applications for these technologies in completely different markets. (Chesbrough, 2006a and Chesbrough et al, 2010). In this case, new knowledge becomes the "product innovation" of firms' profits by bringing ideas to market, selling IP, and multiplying technology by transferring ideas to the outside environment. Based on a sample of 1095 UK firms, Cosh and Zhang (2011) estimate that 29% of firms engage in transfer of technology and knowledge to external parties. This study also identified that, to protect their innovations, confidentiality agreements were the most widely used and most highly regarded method by firms. Although other legal methods were less frequently used, they were considered highly important for those firms that had used them. The authors point out that this may reflect not only the effectiveness of the intellectual property regime, but also the availability of certain legal protection methods for products and services.

Companies that **combine the "inside out" and "outside in"** approaches have been described in the literature as **"ambidextrous"** (Cosh and Zhang, 2011). Such companies engage in coupled or joint processes, which are typically performed with entities from outside the industry, and involve the search for new sources of knowledge and the recombination of knowledge from inside and outside the company.

Box 2. Measurement implications of open innovation for innovation surveys

Most official innovation and R&D surveys typically focus on the "outside-in" perspective of open innovation. While the analysis of knowledge sourcing and collaboration patterns is highly informative and reveals marked differences in business performance, the academic literature has highlighted the importance of considering the interaction at the firm level between inbound and outbound approaches to innovation. ***Outbound diffusion*** is recognised in the OECD/Eurostat *Oslo Manual* as being "relevant both for identifying the economic effects of innovation and for establishing the shape of an enterprise's network", although no guidelines or recommendations are made in this respect.

Additional insights on outbound innovation can also help improve the interpretation of existing indicators. For example, innovation implementers who do not develop the innovations themselves may under-report innovation if they think the definition requires them to have developed the innovation, for example by performing R&D. This may explain the relatively high shares of reported innovations entirely developed by companies. Conversely, those firms that develop innovations that are implemented by other firms may or may not identify themselves as innovators, given the potential ambiguity.

Statisticians in charge of official innovation surveys could consider how outbound approaches are currently depicted within business responses and aim to identify best practice in capturing "outbound" innovation activities –for example in the form of standard questions– in order to develop recommendations on whether and how outbound diffusion should be captured in order to meet user needs.

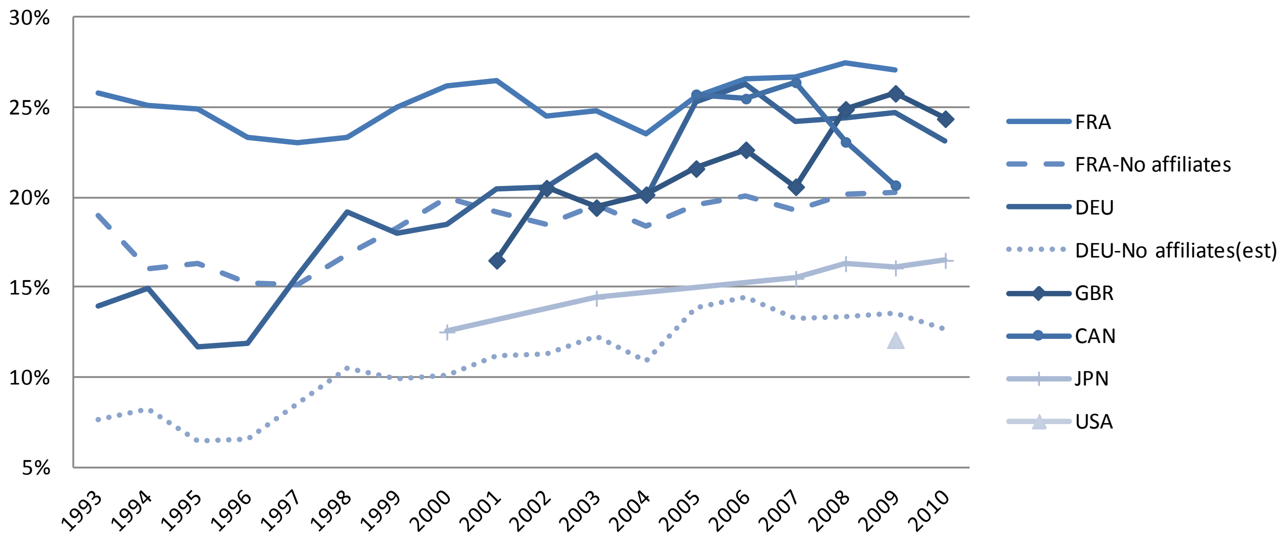
Inbound and outbound innovation processes differ in their practices and capability requirements. The extent to which different businesses are willing to engage in different types of open innovation strategies is driven by the assessment of their own optimal balance with regard to transaction costs between the degree of control over their knowledge assets and core competences which a close approach to innovation protects, and the benefits of specialization brought by open approaches. Gassmann et al. (2011) report in their study on 107 companies that risks such as loss of knowledge (48%), higher coordination costs (48%), as well as loss of control and higher complexity (both 41%) are mentioned as frequent risks connected to open innovation activities. In addition, they identify the existence of significant internal barriers, such as the difficulty in finding the right partner (43%), the imbalance between open innovation activities and daily business (36%), and lack of sufficient time and financial resources for open innovation activities.

Is there a trend towards increased openness in research and innovation?

Unlike R&D statistics, innovation statistics are less well suited for time series purposes. Estimates of flows of funds for R&D across different institutional sectors are among the most long-standing indicators of the extent of innovation-related, transactional flows across sectors.[2]

Figure 4. Trends in extramural R&D expenditures

As a ratio to business enterprise intramural R&D



Source: OECD, based on selected national sources.

Data on extramural R&D expenditures can be used in some cases to gauge the importance that companies attach to procuring R&D services from outside their organisation, not just their institutional sector. While these data on intra-sectoral flows do not yet feature in standard international reports by the OECD, evidence from selected countries suggests an increasing propensity to outsource R&D as implied by the growing ratio of extramural to intramural R&D expenditures incurred by businesses. For some countries, there is some evidence of a slowdown or even reversal in this trend coinciding with the onset of the global financial crisis and the ensuing economic downturn. On the one hand, financial stress episodes may accelerate a shift towards external approaches for sourcing and producing knowledge which transfer the risk to third parties. On the other hand, companies may prefer to reduce external R&D expenditures as opposed to internal activities if the latter correspond to core business competencies and there is an expectation that the research capability embodied in the personnel will be eventually re-utilised. Thus, external ties may be easier to severe rather than write off internal investments in building research capability. This could be a promising area for further research, identifying comparable data across OECD countries and testing how the economic downturn has impacted on the open innovation paradigm.

3. KNOWLEDGE NETWORKS AND MARKETS

The concept of knowledge, networks and markets (KNMs) was introduced by the OECD in its 2010 Innovation Strategy and defined as “arrangements which govern the transfer of various types of knowledge, such as intellectual property, know-how, software code or databases, between independent parties” (OECD, 2010). This term has grown in popularity and applied to a very diverse set of possible agreements, institutions, organisations, intermediaries and agreements in the innovation system. While knowledge does not resemble conventional commodities that are widely traded in markets, there is a continuous search for appropriate solutions which help support a more fluid exchange of knowledge, exploit the benefits of specialisation and division of labour, and encourage the continued creation of scientific, technical and other forms of knowledge.

The first known use of the term “knowledge market” can be traced to Hayek’s seminal 1945 work on the use of knowledge in society (Hayek, 1945), where he emphasized the uneven distribution of knowledge in society as a means to support the view that decentralised markets are most effective at aggregating highly distributed knowledge and establish accurate prices for resources that can guide economic decisions. Furthermore, Hayek underlined the economic importance of knowledge of particular circumstances, alongside the scientific and technical knowledge of universal rules. Nowadays, the mutually reinforcing role of both types of knowledge is better understood, yet there is still a tendency to identify R&D with innovation and conceptualised by policy makers as occurring linearly in discrete batches within the boundaries of organisations. The “open innovation” paradigm has increased awareness of the distributed nature of knowledge across actors (von Hippel, 1988), its increasing accessibility in specialised markets (Arora et al. 2001b) and the specialisation in the innovation process (e.g. Acha and Cusmano, 2005).

In order to describe the broad range of possible knowledge interactions for which KNMs can be relevant, it is possible to adopt the broad definition of “knowledge network” proposed by Phelps et al. (2012) as “a set of nodes – which can represent knowledge elements, repositories and/or agents that search for, transmit and create knowledge- that are interconnected by relationships that enable and constrain the acquisition, transfer and creation of knowledge”. There are two main types of nodes, namely knowledge objects and network subjects or actors, which correspond to the “What is exchanged?” and “Who exchanges” questions, respectively. Alongside knowledge objects, actors exchange others types of goods and services, as well as financial compensation and risk. Identifying and categorising the subjects, parties or actors in the exchange can be particularly important for understanding motivations and potential constraints faced.

Knowledge objects define the object of exchange and its different types. These may include databases, information, coded software routines, codified inventions, scientific results and know-how, to cite some examples. A classification system can include:

- The extent to which knowledge is **explicit or implicit** and therefore the ease with which it can be transferred to other parties (von Hippel 1988, Polanyi 1958).

- The degree to which it is possible to **exclude** other parties from using the knowledge and the **non-rivalry in the use** of many forms of information and knowledge influences the degree to which it can be efficiently produced and allocated through traditional market mechanisms. While knowledge is typically considered to be non-rival in use, some forms of knowledge embodied in people may not fit this description and will not have public good features (Breschi and Lissoni, 2001), e.g. a scientist cannot work full time for two different employees. Excludability can be inherent to in the nature of the knowledge but can also be based on laws, through IP right protection, and social norms. Non-excludability can paradoxically lead to sub-optimal levels of information disclosure and sharing.

- The **distinction between knowledge as such and legal rights to knowledge:** Intellectual property (IP) rights protect holders' interests in the information or knowledge they relate to. IP rights operate by allowing owners to exclude others from "using" those knowledge objects. A transfer of control over the IP rights does not necessarily entail a flow of knowledge from the seller to buyer of the rights.

- The extent to which **the knowledge object already exists or is prospective**, in the sense that knowledge is to be procured *ex-novo* or jointly produced. There is an analogy here between spot and futures markets. Joint production of *prospective knowledge* is invariably preceded by some pledge or exchange of *existing knowledge*.

Knowledge exchange subjects are the organisations, agents or individuals involved in knowledge flows. They can be classified according to:

- **Sectoral affiliation**. It is customary in science, technology and innovation (STI) measurement and policy analysis to classify actors, individuals or organisations by allocating them to a given institutional sector and sector of activity. Institutional affiliation reflects a combination of attributes that summarise information relating to ownership, independence and control, predominant sources of funding and general purpose of activities.
- **Supply / demand / intermediary roles**. Actors can also be characterised on the basis of their position with respect the knowledge object in the exchange, alongside the usual supply / demand distinctions. It is common to refer to knowledge providers and knowledge seekers. There are several possible contexts in which the same actor will adopt multiple roles as supplier and user of knowledge.
- **Size, experience, expertise and other capability-related attributes**. These help predict the "absorptive" (both outside-in and inside-out) capacity of individuals and organisations to engage in knowledge exchange with other parties.
- **The "relatedness" between parties**, such as ownership ties, geographic distance and common network membership. The use of criteria based on the existence of formal ties or commonalities between actors is often required in order to identify what is the relevant measure of "distance" for predicting the likelihood that an exchange of knowledge will take place.

The literature suggests that it is particularly important to distinguish between the *ex-ante* and *ex-post* dimension of knowledge exchange agreements. As pointed out by Arora and Gambardella (2010), contracts for existing knowledge are relatively more straightforward than contracts for knowledge "futures", as "ex-ante deals create greater potential contracting problems arising from the moral hazard". Ex-ante deals are necessarily more complex because they not only entail agreements on the use of existing knowledge by the parties, but also require an explicit or implicit agreement on the production and distribution of future knowledge. Based on the ex-ante/ex-post distinction, Table 4 provides a tentative classification for knowledge exchange agreements. Within the class of transactions involving existing knowledge, a distinction is made between those focusing on disembodied, IPR-based mechanisms, and those where knowledge flows are embedded into separate transactions. Amongst the latter group, one can consider the embedded transfer of knowledge through the transfer of company ownership, capital equipment or materials. Within the broad class of agreements involving the creation of prospective knowledge, a distinction is made between agreements to provide custom knowledge-based solutions, and agreements between parties to contribute in kind to the joint development of a knowledge product. It is easy to appreciate the choices a company can face at any given time, for example between contracting with an R&D provider, expanding the internal R&D unit to address the same problem, or crowd-sourcing the solution through a prize mechanism. The choice will be ultimately determined by the relative efficiency of the various knowledge markets to deliver a solution and the firm's own capacity to implement a solution that mitigates their specific limitations and risks.

Table 4. Different types of knowledge exchange agreements and examples

Existing knowledge	Prospective knowledge
Disembodied, IPR-based mechanisms • Confidentiality and non-disclosure agreements • IP licensing (exclusive, non-exclusive) • IP rights pooling agreement (may also involve commitments about future rights) • Sale or assignment of IP rights • Franchise agreements • Know-how contracts (transfer in tangible form through technical data)	***Sourcing solutions*** • Service and consultancy purchase agreement • Consultancy services • Research services • Crowd-source prize commitment
Embedded knowledge transactions • Transfer of rights to IP and other knowledge-based capital through M&A of holding companies • Acquisition of equipment; turn-key project agreements (delivery of facility with incorporated technology ready to use) • Material / data transfer agreements	***Co-development*** • Co-development programmes • Research joint ventures • Research / commercialisation alliances • Private-public partnerships • Secondments / release agreements • Hiring of R&D personnel (co-development between employee and hiring firm) • Network membership agreements (depending on the nature of exchanges within the network)

As a result, very subtle and context-dependent factors may drive organisations to opt for a particular form of agreement for sourcing or deploying knowledge outside their own boundaries. This is particularly relevant for any attempt to identify the relevant knowledge network or market, given what is *a priori* a potentially high degree of substitutability between possible options.

Types of knowledge networks and markets

On a functional basis, KNMs are the diverse set of systems, institutions, procedures, social relations/networks and infrastructures that aim to allow companies, organisations and individuals to safely engage in the meaningful exchange of knowledge and associated rights. Productive knowledge-based exchanges cannot occur in the absence of supporting systems, institutions, procedures and enabling social relations/networks.

While many of these are the outcome of policy decisions, a wide range of independent mechanisms, institutions, platforms and intermediaries also emerge out of the initiative of private parties. The common feature to these various mechanisms, institutions, platforms and intermediaries is their attempt to provide a number of critical services to market participants at various stages of the knowledge exchange process.

To understand the role of KNMs as service providers, it is important to examine the various phases or steps that parties typically go through as part of any given knowledge-based interaction. The stylized sequence proposed by Maass (2008) – originally designed for the purpose of describing electronic knowledge markets – is helpful for broader illustrative purposes.

Table 5. Services provided by knowledge markets along the knowledge contracting process

Steps in knowledge-based interactions	Potential role of KNMs
Search and evaluation of knowledge partners and offering	Knowledge object and/or partner search tools Information storage / repository platform Clearing of IP rights Rating, consulting, legal
Determination of terms (Negotiation, contracting…)	Platform for price determination Due diligence
Execution	Delivery/transmission of knowledge object Recording of transactions IP rights and payments clearing Rules enforcement Conflict resolution

Source: Adapted from Maass (2008).

Table 5 highlights some of the potential roles played by providers of knowledge exchange infrastructures and solutions, from the identification of a relevant counterparty or knowledge object, through to overseeing the enforcement of the agreement under possible future contingencies. These KNM enablers can specialise in:

- Providing specific services or bundles thereof, e.g. matching knowledge providers and seekers, providing quality assurance, enforcing agreements, etc;
- Facilitating access to or providing exchanges for specific types of knowledge objects, for example databases, patents or knowledge embodied in individuals;
- Serving the needs of specific types of actors, for example technology transfer offices specialise in supporting the needs of higher education institutions.[3]

In order to be effective, KNMs must succeed at conveying relevant information to market and network participants whilst ensuring participation and encouraging parties to contribute high quality knowledge objects/applications without which the market cannot be sustained. When dealing with agreements on the co-creation of future knowledge, KNMs must also deal with the additional challenge of incentivising and verifying effort incurred by the participating parties.

A tentative functional classification of KNMs is proposed in Table 6, which draws on the existing literature and in particular some elements of the taxonomy proposed by Dahlander et al (2012).

Table 6. A proposed typology for KNMs

Defining feature	*Knowledge object*	*Core/salient types of KNMs*
Sourcing / providing knowledge	Existing knowledge	(1) Searchable registers and data repositories
	Create and co-create new knowledge	(2) Platforms for sourcing solutions
Sourcing / providing rights to knowledge	Existing knowledge	(3) IP-based marketplaces and intermediaries (E.g. patent market intermediaries, digital rights collecting societies)
Making knowledge transferable	Create and co-create new knowledge	(4) Standard setting bodies and consortia, accreditation bodies, etc…
	All	(5) Infrastructures and intermediaries in the market for embodied knowledge

Broad categories of KNMs can be defined on the basis of whether their focus is on facilitating the transfer of disembodied knowledge, as in the case of (1) searchable registers and repositories of already-existing data and information; and (2) platforms for sourcing solutions to ad-hoc problems and challenges, which includes platforms for implementing inducement prize incentives or identifying consultants to assist with new R&D projects. Both have in common having the transfer of knowledge between firms or other parties, including individuals, as their main goal.

KNMs can directly focus on resolving ownership and transfer of intellectual rights on disembodied knowledge (3). IP brokers, pools and funds primarily deal with the allocation of IP rights – which may not be necessarily driven by a motivation to transfer knowledge – and the origination and management of financial assets and liabilities attached to these rights.

As a further category, it is worth emphasising the role of institutions and actors that specialise in facilitating the transfer of knowledge embodied in goods or people by transforming the actual nature of the knowledge. Standard setting organisations (4), for example, codify existing know-how and best practices collectively embodied into a community of practice into more widely replicable guidelines. Many of the services provided by OECD to its members fit under this category. Intermediaries that support the transfer of knowledge embodied in people may also fit under this category (5).

Objectives and challenges faced by KNMs: Examples

In its recent study of KNMs in the life sciences, the OECD put forward a number of theoretical advantages from KNMs which can apply to wider knowledge domains (OECD, 2012). These essentially boil down to the expectation that KNMs can contribute to accelerate the innovation cycle towards meeting user needs and delivering a more balanced distribution and lower volume of development costs. These “advantages”, which essentially shift the traditional trade-off between the specialisation benefits, transaction costs and risks of openness, can be in principle achieved through KNMs ability to achieve economies of scale and scope in their activities, providing new tools for managing complexity, risk-sharing, promoting specialisation and division of labour, facilitating collaboration, learning effects and development of organisational capabilities, and facilitating the emergence of prices and market-based signals which go on to generate liquidity in the marketplace. Potential downsides of knowledge markets can instead arise from the higher likelihood of agency risk, conflicts of interest, limited transparency, limited scope for standardisation and the risk of barriers to entry, lock-in effects and other anti-competitive behaviours.

In the absence of government funding – which is common for several types of networks and collaborative infrastructures – or voluntary contributions from participants, the sustainability of KNMs depends on their ability to finance their operations in return for the services provided. This may occur through the charging of prices, membership fees, bundling free services with proprietary ones - as in the case of advertising. Exploiting economies of scope and scale in providing services for knowledge exchange can be particularly difficult in some narrowly-defined knowledge domains and those in which the information about knowledge –for example estimating the value of knowledge assets– can be difficult to standardize and communicate.

Box 3. Policy rationale for supporting networks

The costs of setting up and running a market or network tend to fall primarily on the organisations actively promoting it. They stem from the process of finding the right partners, negotiating, creating behavioural rules for co-operation and building the necessary shared resources. However, the benefits of an efficient network tend to accrue to all of its members. This is also true for the costs of actually running a network. Partners might want to "free-ride" on the transaction costs borne by the co-ordinators or promoters of a network. Thus, networking obviously has a public good or externality dimension; the private benefits from network formation may not cover the private costs for some partners, although the social benefits may be substantial. Firms will only engage in networking if the perceived private benefits of setting up a network exceed its private costs. Therefore, there may be room for efficiency-enhancing government intervention to address the aforementioned awareness, information, search and transaction cost problems associated with networking.

These problems occur at different stages of the networking process; thus, the role to be played by public policy differs accordingly. The stages include: i) developing awareness of a networking possibility; ii) searching for partners; iii) building trust and a shared knowledge base; iv) organising the network; v) ensuring complementary resources; vi) active co-operation.

Market failures seem to be more prominent in the early stages of network formation and operation (search, setting-up, trust formation, etc.); in the final stages they can be solved by the network participants themselves. The role of policy must change accordingly: it should not continue to support networks once they are established and their benefits have become obvious to participants. At this stage, all participants should have found and put in place mechanisms for contributing fairly to the costs and sharing the benefits. Rather, the role of governments should shift to one of avoiding the "lock-in" phenomena of established networks and the detrimental effects that established networks can have on competition in product markets.

Source: OECD (2001)

Online knowledge marketplaces

Online knowledge marketplaces manage platforms -websites from a user perspective- that accommodate communication, matching, and transacting for innovative knowledge (Dushnitsky and Klueter, 2010). In general, online knowledge marketplaces are independent entities unaffiliated with either knowledge owners or seekers, in order to avoid potential conflicts of interest. Many are for-profit companies, while some are not-for-profit ventures which rely to different extent on member subscriptions, fees or external support, possibly from governments. Online knowledge markets (OKMs) share many similarities with more ubiquitous online marketplaces for goods and services, including their ambition to exploit economies of scale and scope.

While OKMs may attract owners of high-quality inventions, anonymity and speed may lead to them being dominated by low quality ideas, in what might be described as a "bad knowledge drives out good knowledge" variation on Gresham's law on money. This can in turn deter serious knowledge seekers from using the platform and thus impinge on their long term sustainability as vehicle for knowledge exchange. By bringing together strangers, unbound by pre-established trust links, their model marks a sharp departure from accepted practices wherein transactions tend to occur within an organisation's immediate (geographical or social) circle. Anonymity reduces disclosure risk and prevents competitors from gaining valuable information about a company's strategic interests, but also contributes to a dilution of the reputational ties which bound parties together and prevent them from deviating from established social norms that contribute to building trust and confidence.

Online marketplaces typically require a standardised representation of information about the knowledge being procured and the knowledge being offered. In its absence, the platforms would not deliver the services at a significantly lower cost than the sum of the individual, un-coordinated search efforts. The use of semantic technologies can be particularly important in the process of organising and communicating information about knowledge. These technologies help process unstructured text content and extract the names, dates, organisations, events, within a text, tease out trends and correlations within large sets of data, answer complex questions automatically through machine-learning algorithms, use heuristics and rules to tag data with categories to help with searching and with analysing information, as well as allow users to locate information by concept instead of by keyword or key phrase. In particular, semantic web technologies are a toolbox that can be used to implement a wide variety of algorithms, solutions, and applications. Online knowledge marketplaces typically use proprietary technologies and databases to provide value added services which are not openly available. Semantic Web technologies enable people to create data stores on the Web, build vocabularies, and write rules for handling data.[4] The collection, structuring and recovery of linked data are enabled by technologies that provide a formal description of concepts, terms, and relationships within a given knowledge domain.

Online knowledge marketplaces use a number of strategies to address the challenges of misappropriation and asymmetric information problems that challenge their own existence. For example, they have mechanisms that relate payments to the ultimate quality of the posted knowledge in order to attract knowledge seekers (Leland and Pyle, 1977). Non-disclosure agreements may not always be effective in reducing the likelihood that knowledge seekers will exploit disclosed information and imitate knowledge owners. Social norms within the network and reputational measures can be sometimes used to manage that risk. A marketplace may enforce disclosure requirements on knowledge-owners with the objective of enabling knowledge-seekers to accurately evaluate the knowledge, but may put off some knowledge providers from participating.

Dushnitsky and Klueter (2010) have studied 30 prominent websites that act as marketplaces where owners of knowledge (e.g., an inventor of a patent, or an entrepreneur with an innovative business idea), interact with knowledge seekers (e.g., potential licensees, or prospective investors). Their study thus distinguishes between online knowledge markets for business plans (venture capital marketplaces) and markets for intellectual assets. They find that IP-related OKMs[5] systematically require entrepreneurs and inventors (i.e., knowledge owners) to disclose their inventions and/or to make upfront fees as prerequisite for participation. Both mechanisms appear to alleviate adverse selection and thus attract prospective investors and licensees, but their effectiveness as an inducement to widespread market participation may still be limited.

Box 4. New online knowledge marketplaces: The case of platforms for inducement prize contests

Online platforms for inducement prize contests represent an interesting example of KNMs. Contests have driven many innovations throughout history, from the construction of the Duomo in Florence in 1418 to the invention of an accurate ship-board clock to win the Longitude Prize of 1714. They have recently experienced a significant revival, as inducement prize contests and other crowd-sourcing tools have been enabled by a new wave of Internet-based platforms. Inducement prize contests are being increasingly used by firms and governments worldwide to use prizes and challenges as a complementary, and sometimes alternative means to promote innovation, by having one party (a "seeker") challenge a third party or parties (a "solver") to identify a solution to a particular problem or reward contestants for accomplishing a particular goal. Challenges can range from fairly simple proofs of concept, designs, to finished products that solve grand societal challenges. Competitions such as the Ansari X Prize in 1996 and Netflix's 2006 contest to improve its film recommendation engine received considerable publicity.

In recent years, the number of websites making and facilitating open calls for solutions to tasks such as logo design, software development, and image labeling has grown tremendously. Examples include Amazon Mechanical Turk, Ninesigma, Taskcn, Topcoder, 99designs, Innocentive, CrowdCloud, and CrowdFlower, to name a few. A number of governments have been using challenges and competitions as a means of stimulating innovation. In the United States, for example, the Challenge.gov website is a centralised clearinghouse for information about such competitions. It lists hundreds of challenges ranging from multimillion dollar efforts to develop fuel-efficient automobiles and energy efficient lighting sources to smaller scale efforts to develop innovative applications of biomedical data available from the National Library of Medicine.

There are many types of competitions applied in different contexts, hence it is difficult to generalise. Evidence from the literature on contests implemented in the "TopCoder" and "Innocentive" platforms suggests that contests appear to be particularly useful to tackling high-uncertainty problems which can be defined in an abstract, standardised format and address by a relatively wide range of experts endowed with the fundamental solution tools. These platforms have been found to deliver solutions of a quality about an order of magnitude larger than state-of-the-art solutions, at a fraction of the cost (Jeppesen and Lakhani, 2010, Lakhani et al., 2013). These platforms and the award mechanisms they support can transform standard models of employment and innovation, as they transfer much of the risk and cost to the knowledge supplier. The literature also suggests the importance of considering participation incentives in detail (Boudreau et al., 2011).

Standards-setting organisations: Codifying knowledge networks

A standard is a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition. Standards are created by bringing together the experience and expertise of all interested parties such as the producers, sellers, buyers, users and regulators of a particular material, product, process or service.

The collaborative process of standard setting requires a significant co-ordination effort among interested parties in which standards setting organisations (SSOs) play a major role. The broad class of SSOs comprise both "traditional" standards development organisations as well as the consortia, alliances, special interest groups and other organisations which have emerged in recent years. SSOs also differ in their geographic membership and technology and sectoral focus.

Examples of SSOs include the International Organisation for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Telecommunication Union (ITU), the IEEE (originally the Institute of Electrical and Electronics Engineers), European Telecommunications Standards Institute (ETSI) and national organisations such as the American National Standards Institute (ANSI), the British Standards Institute, the "Association Française de Normalization" (AFNOR) and Germany's Deutsches Institut für Normung (DIN) – typically private non-profit organisations with varying degrees of public sector engagement. In addition to standard development, some organisations focus on activities intended to support and promote the development of standards, including provision of information, certification, accreditation and training services.

SSOs are network-based collaboration mechanisms that underpin the process of knowledge co-creation by which the dispersed and often tacit knowledge residing on a limited number of experts can be easily communicated and codified for wider usage and adoption. By developing a common language and definitions, the use of standards further facilitates the exchange of information and knowledge. Given the wide range of standards available, it is not possible to estimate what is the contribution of SSOs to knowledge flows. However, surveys of innovating firms find many enterprises that say that standards are a source of information that helps their innovation activities (Swan, 2010).

SSOs are also impacted by the development of markets for IP rights and further shape their development. A recent study by Bekkers and Updegrove (2012) provides a comprehensive assessment of the challenges arising from the interaction between standards and IP rights and the role played by SSOs. IPR policies are a major aspect of SSO practices because the implementation of a standard may require the use of products or processes that draw on protected IPR. This is the case of standards-essential patents (SEPs), which grant the owner the ability to control the use of an invention required to practice a given industry standard.

SSOs must strike a fine balance between securing participation by owners of relevant technology ("the supply side") and encouraging adoption of the standard ("the demand side"). So while SSOs may require that SEPs are made freely available to standard users, the most usual response by SSOs to the "hold-up" problem – i.e. the demand for excessive royalty payments once the standard has been adopted and investments have been sunk into it by producers – is to require IP holders on an *ex ante* basis to make their essential technology available on "fair, reasonable and non-discriminatory" (FRAND) terms in return for having the technology selected as a standard.

FRAND pledges have become the recent focus of contention in technology markets –particularly in ICT standards– because FRAND terms can be ambiguously specified, leaving considerable room for disagreement between parties regarding the transferability of those pledges and the determination of an appropriate royalty rate in thicketed markets. The recourse to injunctions by SEP-holders has been evaluated by courts and authorities alike, concerned about the potential implications for competition and innovation. There is an ongoing debate as to whether SSOs should determine more precisely IP terms at the standard setting phase, a practice which is seen by many observers as a potential unwelcome distraction from their core remit.

Box 5. Patent thickets and patent pools

The last two decades have witnessed an unprecedented growth in the number of patent applications filed and granted in all major intellectual property (IP) offices around the world. The scope of patentable subject matter has become wider across a broad number of jurisdictions, with the possibility of granting software and business method patents leading to difficulties in assessing the patentability (in particular the non-obviousness) of new inventions. Although this generalised increase in numbers is a potential source of inefficiency in the system, many observers have found that it is not the numbers but the structure and complexity of relationships between patents that might be more problematic. The existence of ‘patent thickets’, which can be defined as dense webs of overlapping patent rights (Shapiro, 2001), has become a growing problem for inventors who seek to commercialise their inventions. This is particularly true in ‘complex product’ industries, such as electronics and semiconductors, which are characterised by cumulative processes of innovation (Ziedonis, 2004). The high search and transaction costs which need to be incurred in order to hack through patent thickets and establish freedom to operate may discourage entry to market, depress competition and negatively impact future innovation (Hargreaves, 2011). The problem is all the more severe when the ownership of patent rights is fragmented among multiple entities – a situation which tends to considerably raise bargaining costs in licensing negotiations.

A recent study by von Graevenitz et al. (2011) proposes a measure of patent thickets using the classification of references in the search reports issued by the European Patent Office (EPO) which identifies instances in which three firms each own patents that block patent applications of the other two firms and is based on the notion that the likelihood of resolving a mutual blocking relationship between any two firms in a triple depends on the actions of the third party and therefore makes the resolution of blocking relationships more difficult and costly than in a bilateral relationship. Using a normalised estimate of the growth in the number of such “triples” -to account for the general increase in the number of patent applications over this period- and comparing the evolution of patent thickets over the period 1983-2003 in complex and discrete technologies, the authors show that the market for complex technological products (e.g. electronics and semiconductors) has become increasingly thicketed, while that of discrete technological products (e.g. pharmaceuticals) has only experienced a mild increase in thickets.

Highly thicketed markets tend to exacerbate two inter-twined problems – patent holdup and royalty-stacking. As explained in Lemley and Shapiro (2007), patent holdup refers to the threat by a patent holder to obtain an injunction that will force the downstream producer to pull its product from the market. Injunction threats often involve a strong element of holdup in circumstances where the defendant has already invested heavily in the design, manufacture, marketing and sale of the product with the allegedly infringing feature. In those cases, the threat of injunction enables the patent holder to negotiate royalties far in excess of their invention’s true economic contribution. These excessive royalties may act as a tax on new products incorporating the patented technology, thereby impeding, rather than promoting, innovation. Royalty stacking occurs when multiple patents read on a single product. Under many plausible circumstances, the royalty negotiated in the shadow of litigation and holdup can significantly exceed the intrinsic value of the invention itself.

The growth in complex, highly interlinked technology domains such as ICT has resulted in patent pools being used to circumvent the patent thicket problem by allowing firms to combine their patents, sharing them with other patent holders and, in some cases, licensing to other firms as a package. Examples include those devoted to the rights associated to standards for telephone or video compression. Their resurgence has been subject to close scrutiny by competition authorities to ensure that they do not hinder access to the market by hindering competition, a socially undesirable outcome that is more likely when the IP rights are close substitutes, rather than complements. As explained in Lerner and Tirole (2004) and in Regibeau and Rockett (2011), pools that include complementary patents are socially desirable because the profit-maximising prices of complements are lower when prices are set jointly. On the other hand, if pools include patents that are substitutes, then there is a risk that the pool is actually a device for jointly selling what would otherwise be competing technologies. These anticompetitive effects of pools are considered unlikely unless access to the pooled technology is necessary to compete in the downstream market, and the pool participants collectively have market power in the downstream market. In those circumstances, it would have to be examined whether the limitations on participation are reasonably related to the efficient development and exploitation of the pooled technology. The acquisition and build-up of patent portfolios within companies and pools has become an important defensive strategic response against competitors building equally large portfolios, with the view to secure better cross-licensing terms. A number of studies have examined the features of patent pool licensing agreements (Lerner, Tirole and Strojwas, 2007). members and characteristics (Layne Farrar and Lerner, 2008) and factors that drive the introduction of patents to a pool (Baron and Delcamp, 2010), *Knowledge markets and emerging technologies*

Emerging technology domains with potential “general purpose” features present challenging test cases for KNMs. It is important for policy makers to consider how the knowledge market supports the growth of promising new general purpose technologies, drawing lessons from past experiences in other technology domains.[6] For example, the emerging field of synthetic biology involves the synthesis of large DNA molecules of specified nucleotide sequence, giving rise to an industry synthesising made-to-order DNA molecules on a commercial scale, further facilitated by speed and cost improvements of DNA synthesis technology. Synthetic biology also involves the design and implementation of genetic circuits constructed from basic genetic components.

A distinct feature of synthetic biology is its conscious reliance on engineering approaches. As noted by Torrance and Kahl (2012) and several others, influences from engineering, as well as computer science, have led to more consideration of standards setting, interoperability, and interchangeability in synthetic biology than is usual in other areas of biology. By operating at the intersection of biotechnology and information technology, Rai and Kumar (2007) have noted that it has the potential to raise, in a particularly acute manner, the intellectual property problems that exist in both fields. The latter found, in a preliminary patent landscape, the existence of problematic foundational patents that could, if licensed and enforced inappropriately, impede the potential of the technology, as well as a proliferation of patents on basic synthetic biology "parts" that could create transaction cost heavy patent thickets. Both foundational patents and patent thickets are likely to be particularly problematic to the extent they read on standards that synthetic biologists would like to establish. Synthetic biologists have argued that strings of DNA bases are comparable to source code and that DNA strings could therefore also be covered by copyright. However, Rai and Boyle (2007) have questioned the ability to invoke copyright protection in this domain, for example owing to the wide room for expressive choice when constructing DNA sequences with base pairs that do not exist in nature.

Numerous institutions that have features of knowledge markets, networks and collaborative mechanisms have been created with standards setting in synthetic biology as an important goal. Probably the best known is the BioBricks Foundation (“BBF”), which has created a registry and repository of standard biological parts that are the building blocks of synthetic biology, effectively promoting the creation of a “commons” solution. A BioBrick™ standard biological part is a nucleic acidencoded molecular biological function […] along with the associated information defining and describing the part.” Scientists can browse the Biobricks catalogue and contribute new parts that conform to the Foundation’s specification. The BioBrick foundation also provides a model contract “that allows individuals, companies, and institutions to make their standardized biological parts free for others to use.” BioBricks has created a technical standard, an open technology platform, and a repository open to anyone interested in building new biological parts. An example of a patent-based commons is the one created by the group Biological Innovation for an Open Society (BIOS).

Among the standards-setting groups that have formed within the synthetic biology community, most have expressed a preference that standards remain open and accessible to the community as a whole. In this early development stage, academics play an important role and the public ethos is quite visible. This preference, however, has not yet been incorporated into formal policies requiring the disclosure and licensing of intellectual property rights covering technical standards, which frequently draw on outputs of publicly funded research. Whether such policies could be made mandatory or would ultimately be beneficial to the field of synthetic biology remain open questions. Synthetic biology also illustrates a potentially symbiotic relationship between open and proprietary innovation models. For example, the dissemination of synthetic biology “parts” as openly pure information would likely increase demand for various proprietary DNA-synthesis platforms.

An OECD symposium on the opportunities and challenges in the field of synthetic biology held in 2009 highlighted the intellectual property challenges, including the relevance of various forms of IP protection for the bundle of rights –covering patents, material transfer agreements, databases, trademark and copyright protectable material (OECD, 2010d). It was noted at the symposium that the community is built around trust because the output volume is still relatively small, which raises questions about the transition to a more contractual basis that may likely occur in the event of rapid growth. The symposium stressed the importance of user-driven, collaborative and community-driven approaches to drive forward progress in this field.

Box 6. Knowledge markets versus knowledge networks?

A stark distinction is regularly drawn between networks and markets as involving diametrically opposite types of arrangements intended to facilitate the search for knowledge and the matching of knowledge resources. Networks are often presented as connections between innovation actors in which monetary transactions are absent, while markets are presented as arrangements that permit discrete, predominately commercial transactions There is ample evidence that markets for highly sophisticated and complex products cannot exist –and serve their ultimate purpose– purely on the basis of self or externally-imposed rules.

Such markets rely to a varying extent on formal or informal networks of relations in order to be sustainable and promote the efficiency of the innovation system. When the cohesiveness and strength of relationships in networks becomes displaced by rules and one-off, anonymous interactions, there is a significant risk of market failure. Despite the gains in scale and scope, the incentives of parties and intermediaries may ultimately become misaligned, potentially diminishing a longer-term development perspective that is essential for the conduit of socially beneficial innovations.

4. MARKETS FOR INTELLECTUAL PROPERTY RIGHTS

Intellectual property rights

The creation and assignment of intellectual property rights conveys a monopoly right to exclude third parties from the economic exploitation of an idea (in the case of patent rights) or of a particular expression of an idea (in the case of copyright) that has been disclosed. These exclusion rights are provided for a defined period, apply in a given territory, and are theoretically underpinned by a social contract whereby legal protection against misappropriation is provided in return for disclosure of the idea.

Across most jurisdictions, IP rights include patents, copyrights, trademarks, designs, and in some cases trade secrets are also recognised as formal IP rights. Innovation surveys have and are being used as instruments to collect direct information on firms' use of IP strategies to protect their innovations. The work by Frenz and Lambert (2012) identifies a strong association between modes of innovation and IP protection strategies, based on 2006 data, the latest year in which the Community Innovation Survey common questionnaire included questions on IPRs. OECD analysis of CIS data indicates that trademarks are the most frequently and widely used across sectors forms of IP protection, with more than 10% of companies reporting their use. Use of trademarks is more likely in knowledge intensive services. A more recent wave of official survey results has become available reporting statistics on the use of IP in firms. For example, a recent survey carried out by Statistics Canada[7] shows that among the 5% of companies that held or used patents in a subset of selected industries, most have been applied for by the enterprise or originated within founders or predecessors. Non-disclosure agreements are the most often cited type of intellectual property used by Canadian firms, with nearly 26% of the total, followed by trademarks (20%), copyrights (18%), IP accessed through open sources (12%) and trade secrets (7%). In the United States, trademarks and trade secrets are identified by the largest number of businesses as important forms of IP protection, followed by copyrights, and then patents (Jankowski, 2012).

Statistical evidence on the IP strategies by business can also be gauged from the linking of registered IP data to business registers that contain information on companies, for example those based on public repositories where companies file their accounts as part of their corporate reporting activities. Initial results from OECD work linking patent and company data are provided in Box 6. These provide a consistent picture with previous available evidence, but highlight the challenges in ensuring a comprehensive description of patenting behaviour when the business register data is incomplete and coverage limited to certain types of firms. This type of exercise should be replicated on a country-by-country and confidential basis with more reliable, national statistical registers. These could be further linked to national innovation and R&D surveys in order to gain a more complete picture of the relationship between patenting behaviour, innovation activities and business performance.

The ability of IPRs to exclude third parties allows the organisation of markets for knowledge.[8] The availability of IP markets creates in turn economic incentives to generate new protectable ideas, as well as finding new applications for old ones. If IP markets succeed in allocating these rights to those who are prepared to pay the most for them, they can serve a socially useful purpose by preventing ideas from remaining in the exclusive and possibly secret possession of creators, discoverers and inventors, who can in turn be rewarded for their efforts and achievements.

Box 7. Using matched patent and business data to map the patenting behaviour of firms

Recent OECD work provides a preliminary description of firms' patenting behaviour across fifteen countries (Austria, Belgium, Canada, Switzerland, Germany, Spain, Finland, France, Ireland, Italy, Japan, Netherlands, Norway, Sweden and the United States) over the period 1999-2010; depicting the relationship between firms' characteristics and their patenting activities. Characterising the patenting behaviour of firms across sectors, age groups and size classes requires linking individual patent data to enterprise microdata. To this end, patent assignees' names available in the April 2012 PATSTAT database have been matched to the names of the firms included in the OECD-ORBIS 2011 database, a second-best solution to accessing and pooling country-specific business register data. A limitation of commercial data sources such as ORBIS concerns their limited coverage and representativeness. In this particular case, they appear to vary across age and size classes, as well as across countries and over time, rendering any comparative analysis hazardous. The linking has been carried out on a country-by-country basis using a series of algorithms contained in the Imalinker system (Idener Multi Algorithm Linker) developed for the OECD by IDENER, Seville, 2011. *:* Only countries for which the matching rate is above 80% of patents in the late 2000s have been considered in the final sample.

Patenting and non-patenting firms: Patenting firms represent a small part of the population of firms, i.e. between 1.6% in Ireland and 8.8% in Germany. This is broadly in line with evidence from survey data.

Firm size: With the exception of Austria and Germany, companies with less than 250 employees generally account for 75% or more of all matched patenting firms. Only a very small proportion of large firms – varying between 4% and 11% – do not have patents assigned to them. The relative proportion of small and medium enterprises applying for at least one patent over the period considered is low, with percentages ranging between 1% (Spain and Canada) and 4.9% (Finland) for firms of 20-49 employees, and between 1.8% (Ireland) and 12.5% (Switzerland) in the case of medium-sized firms. The majority of patent applications and families originate in large firms, with the exception of Ireland and Spain (48% and 50% respectively) in the case of patent counts, and of Spain and Italy (44% and 48% respectively) in the case of patent families. Moreover, with the exception of Ireland and Canada, a general pattern emerges: the proportion of patent families applied for by SMEs consistently exceeds the proportion of individual patent applications filed by small and medium enterprises.

Ownership: The analysis suggests that firms that belong to groups are more likely to patent than their independent counterparts, with the exception of the Netherlands and the United States, where the number of independent firms that patent is relatively higher.

Firm age: Simple country averages suggests that in the 43% of cases firms first file for a patent up to 5 years before being established. These filings are likely related to firms that are later established in order to exploit a certain innovative portfolio. 29% and 31% of firms instead appear to file the first time for a patent between 5-10 years and more than 10 years before being established, respectively.

Industry: The sectors typically accounting for the highest share of patent applications are sector "Computer, electronic and optical products (ISICRev4 26)" and "Machinery and equipment n.e.c." followed by the large sector of "Wholesale and retail trade, repair of motor vehicles and motorcycles" (45-47). The highest average shares of patenting firms can be observed in manufacturing sectors 20 to 35 such as chemicals, pharmaceuticals, transport equipment and the "Scientific Research and Development" sector (72), across all size classes considered. This is consistent with previous studies and with what is known about the innovative activity of these sectors. The evidence on which countries exhibit the highest patenting rates by sector also appear consistent with what is known about the innovation performance of such countries. For example, Netherlands leads in "Electrical equipment" (27), Finland in "Computer, electronic and optical equipment" (26) and France in "Transport equipment" (29-30).

Patent renewals: The renewal of a patent by a firm signals that the knowledge and R&D output described in the patent document is still useful for the firm, even if the patent is not being actively used. For the whole sample, we observe an average renewal value of 12.7 years, a median renewal value of 13 years, and 1st and 99th percentile values of 3 and 20 years respectively. It is not possible to identify a significant difference in renewal rates between SMEs and large firms, but this may be the results of the selected nature of SMEs included in ORBIS©.

These stylised facts should not be interpreted as causal estimates, but as initial indicators of the potential information that could be extracted by applying common linking protocols to national statistical registers. This could then provide a firm basis for evaluating the impact of patenting on business performance, paving the way for a more informed discussion on the role of country-specific framework conditions in explaining the observed differences in firm behaviours and outcomes. There would also be significant advantages from linking data from innovation surveys to patent publications and considering the results in the framework of an internationally coordinated exercise.

Source: OECD Working Party of Industry Analysis. **"**A cross-country characterisation of the patenting behaviour of firms based on matched firm and patent data" DSTI/EAS/IND/WPIA(2012)5. STI Working paper, forthcoming.

In order to understand the very specific features of IPRs as instruments in the market for knowledge and technology, it is equally important to understand the potential reasons that limit the use of IPRs as currency-like instrument for specialisation and knowledge exchange. The validity of an IP right can be often questioned and challenged, contributing to uncertainty about its value. The distribution of patent value is indeed highly skewed – a few patents are highly valuable and a majority have very limited individual value in their own – (InnoS&T, 2011). The knowledge contained in a disclosed invention may also be insufficient to enable its practical use. Additional agreements can be often required to access the know-how and additional information that are required to put an invention in use. IP rights are negative rights in the sense that they only confer the holder with the right to preclude third parties from using the protected knowledge. The owner only has the right to use provided the use does not infringe on other IP rights held by third parties. This is difficult to establish as there is no simple correspondence between an idea (e.g. a patented invention) and a self-standing innovation, which may draw on several rights of different forms. Finally, IP rights are not uniformly enforced and infringement can often be inadvertent.

Table 7. Map of value-generating options for leveraging patent portfolios

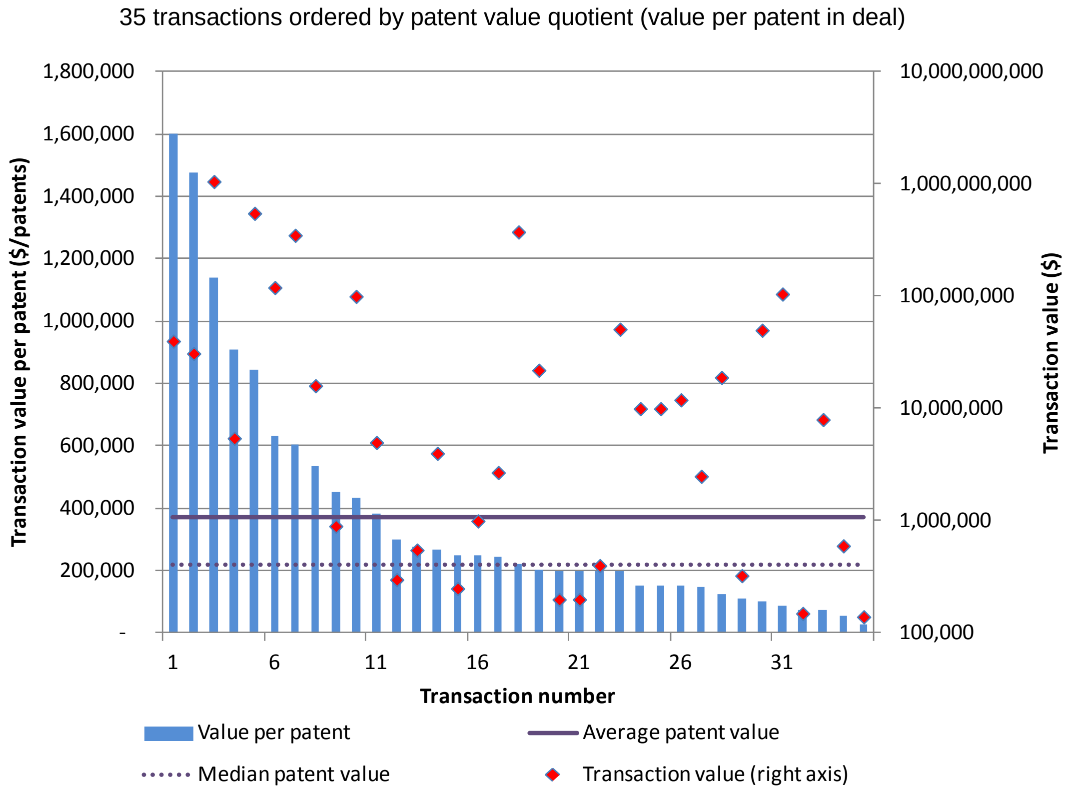
Type of value			
Financial value	• Collateralisation	• Selling with tech • Selling without tech • Spin off • Abandon	• Stick/enforcement licensing
Strategic value	• Erecting entry barriers • Blocking core tech • Blocking substitution tech • Protect innovation • Prevent circumvention	• Donation • Selling with tech	• Standardisation • Joint ventures • Carrot licensing for • selected applications
Defensive value	• Ensure freedom to operate	• Open source	• Cross licensing
	Internal exploitation	**External exploitation**	
Strategic needs of companies	Own use	Capture remaining value	Realise complementary value / multiplication
Decision	Keep	Assign	License

Source: Rüther (2012). Accessed from http://verdi.unisg.ch/www/edis.nsf/SysLkpByIdentifier/4039/$FILE/dis4039.pdf

For these reasons, the IP market is not necessarily driven by the transfer of technological knowledge. The market can also serve as a mechanism for procuring rights to sue potential infringers and for settling the outcome of litigation (through the payment of royalties, in addition to any damages awarded). Depending on the perspective adopted, the ability to trade IP rights provides buyers with a range of assertive and defensive[9] strategies that leverage the broad range of remedies offered by courts, such as injunctions, damages and royalties. Independently of these potential uses that underpin the value of a patent to a potential acquirer (technology transfer, offensive and defensive uses), IPRs can be also used as security as part of financing deals. Patent portfolios, as show in Table 7, can be leveraged externally in multiple ways, according to the strategy pursued by the organisation.

In the post-war period characterised by the dominance of large industrial corporations in the innovation landscape, relatively small sums of money were actually exchanged in the market for patent rights, as companies typically developed their inventions in-house and implemented cross-licensing agreements in order to attain freedom to operate within their markets. In the last couple of years, unprecedented sums of money have been paid in auctions for patents and in the acquisition of patent-rich companies. These deals have brought the market for patents to the attention of the wider public. For example, the Nortel patent portfolio reached USD 4.5bn in auction while IP-rich Motorola was sold to Google for more than USD 12bn. Kodak is selling its digital image patents to a consortium of technology companies led by two well-known companies in the patent fund marketplace (RPX and Intellectual Ventures) as part of ongoing bankruptcy proceedings. Using data from various sources, IP market intermediaries *IPOfferings LLC* analysed 35 transactions held 2012 and found a unit value per patent close to USD 373 k, and a median value just above USD 220 k (Figure 5).

Figure 5. Major patent transactions, United States 2012



Source: IPOfferings LLC. Accessed from www.ip-watch.org/weblog/wp-content/uploads/2013/02/Patient-Quotient.pdf

The size of the market for IP rights

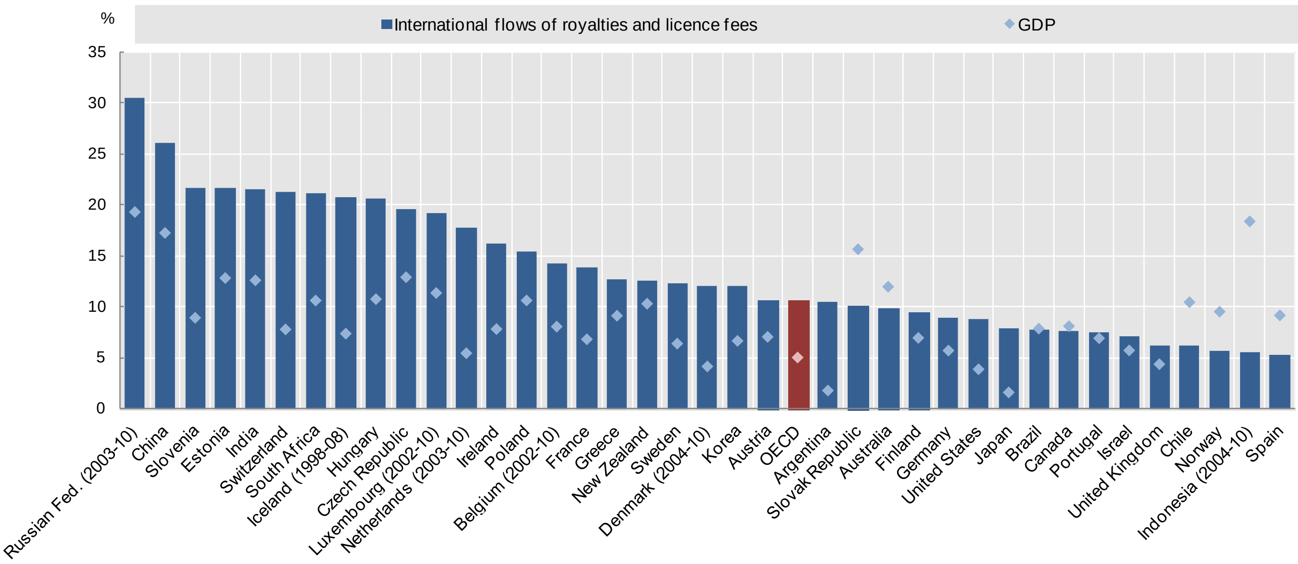
Available statistics, while providing only a partial picture, appear to confirm a trend towards increasing trading levels for patents and other IP rights, although these only apply to a minority of companies and patents. Managers are realising that even after a company loses its overall competitiveness in the product market it operates, its legacy IP can be a valuable asset which can be leveraged in a number of ways. IP markets have therefore provided investors with an additional avenue for value realisation independently of the commercial success of their venture.

Robust estimates of the size of the IP marketplace are difficult to produce because most transactions are based on confidential agreements and therefore key elements go unreported in open sources. Furthermore, statistical agencies have had limited incentives to collect related information on a confidential basis because a majority of IP rights were not considered as produced assets but the outcome of administrative decisions, and therefore did not count as the formation of new capital by firms, organisations or individuals. By implication, most IP related transactions did not impact on the estimation of key economic aggregates such as investment or GDP unless they involved cross-country transactions.

Evidence from trade-related statistics suggests an upward trend in transactions. Disembodied technology royalty payments and receipts across countries have increased by an average annual rate of 8.5%, well above the growth of the world GDP over the same period, reaching a total value of approximately USD 180 billion in 2009 (Athreye and Yang, 2011). These figures include transactions between affiliated parties, which have been estimated to account for approximately two thirds of the overall value of transactions. Similar results are obtained from more recent data from the OECD's Technology Balance of Payments Database (OECD, 2012b).

Figure 6. International IP flows through royalties and licence fees, 2000-2010

Average annual growth rate, based on USD, percentage



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Sources: OECD, Technology Balance of Payments Database, March 2012; OECD, Trade in Services Database, March 2012; World Bank, World Development Indicators, March 2012; OECD, Annual National Accounts Database, March 2012.

Statistics on trade in services, which for some countries contain information on payments and receipts for royalties and licensing fees, can also be examined in order to identify the effective network of disembodied IP trade across countries, thus contributing to the analysis of global value chains and the role played by intangibles and knowledge-based capital in particular.

Box 8. Knowledge products in the 2008 System of National Accounts

The System of National Accounts (2008) introduces two relevant statistical concepts for the study of markets for knowledge and IP rights:

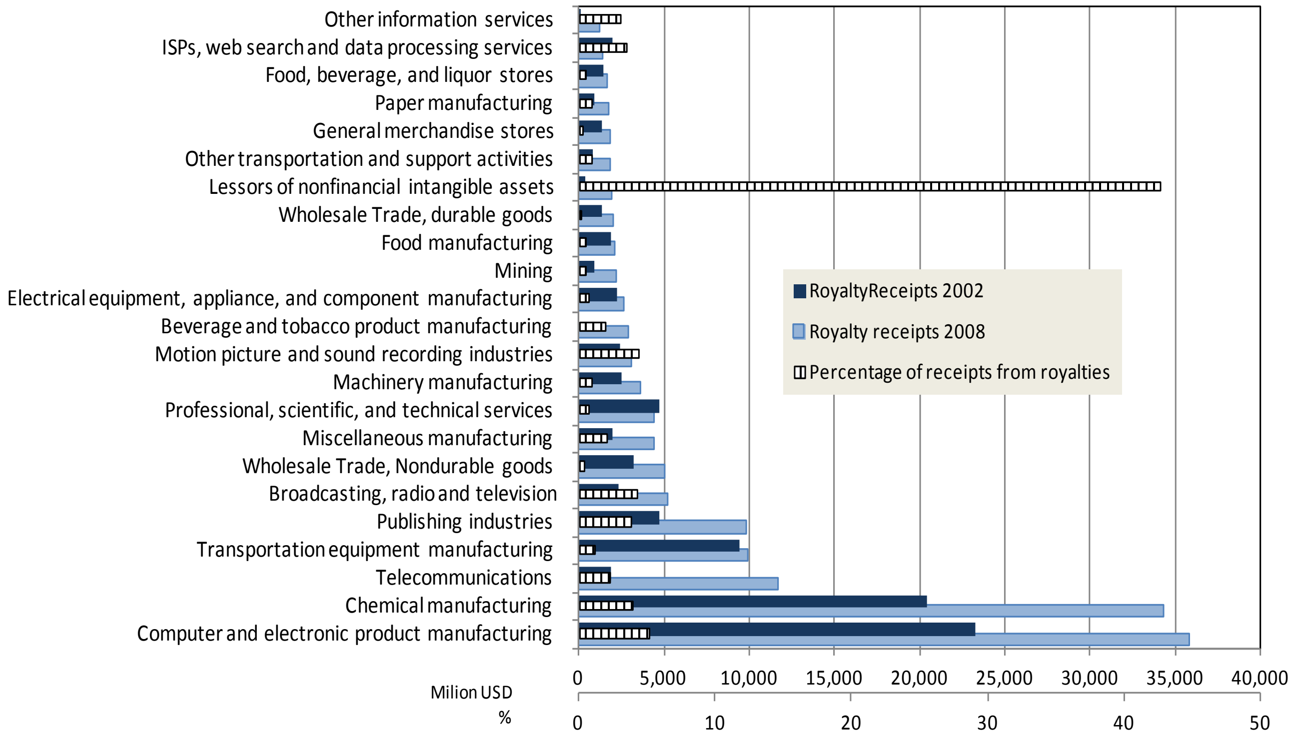
Knowledge-capturing products are defined as separate entities from goods and services, comprising the provision, storage, communication and dissemination of information, advice and entertainment in such a way that consuming units can access the knowledge repeatedly. The industries that produce such products are concerned with the provision, storage, communication and dissemination of information, advice and entertainment in the broadest sense of those terms including the production of general or specialised information, news, consultancy reports, computer programs, movies, music, etc. The outputs of these industries, over which ownership rights may be established, are often stored on physical objects (whether on paper or on electronic media) that can be traded like ordinary goods. They have many of the characteristics of goods in that ownership rights over these products can be established and they can be used repeatedly. Whether characterised as goods or services, these products possess the essential common characteristic that they can be produced by one unit and supplied to another, thus making possible the division of labour and the emergence of markets.

Intellectual property products are defined as the result of research, development, investigation or innovation leading to knowledge that the developers can market or use to their own benefit in production because use of the knowledge is restricted by means of legal or other protection. The knowledge may be embodied in a free-standing product or may be embodied in another. The knowledge remains an asset as long as its use can create some form of monopoly profits for its owner. When it is no longer protected or becomes outdated by later developments, it ceases to be an asset. While software and some other rights (e.g. mineral exploration rights or artistic originals) have long been treated as such, research and development products have only been recently included within the class of intellectual property products. As a result, patented entities are no longer treated in the economy's balance sheet as non-produced assets and are subsumed into research and development assets. The fixed asset boundary of the SNA has been expanded to include the output of research and experimental development (R&D) that meets the general definition of an asset, thus capturing part, but not all, of the knowledge assets created within the innovation process. For example, marketing assets including brand names, mastheads, trademarks, logos and domain names, are still treated for practical reasons as being "non-produced" and the expenditures incurred in their creation as intermediate consumption. They appear in the balance sheet only when they are acquired in the marketplace. Architectural and engineering designs are potentially within the scope of IPPs, although their inclusion as produced assets by national statistical agencies is not envisaged in the near term.

Source: OECD, based on SNA 2008.

Specific information on royalty and licensing income for the entire economy, including both domestic and international transactions, is notoriously more difficult to come by for the aforementioned reasons. According to United States Statistics of Income based on the "gross royalties" income line of the US Corporation Income Tax Return Form 1120, the returns of active corporations reported gross royalty receipts increasing from USD 115.8 billion dollars in 2002 to USD 171 billion in 2008, reaching nearly 1% of total business revenue.[10] Over 5 % of income in the US computer manufacturing industries derived in 2008 from royalties and licence fees, corresponding to more than USD 35 billion. This figure is likely to have increased since, judging by recent news coverage and reports such as those mentioned above.

Figure 7. US Royalties by Industry and royalty revenue shares, 2002-8



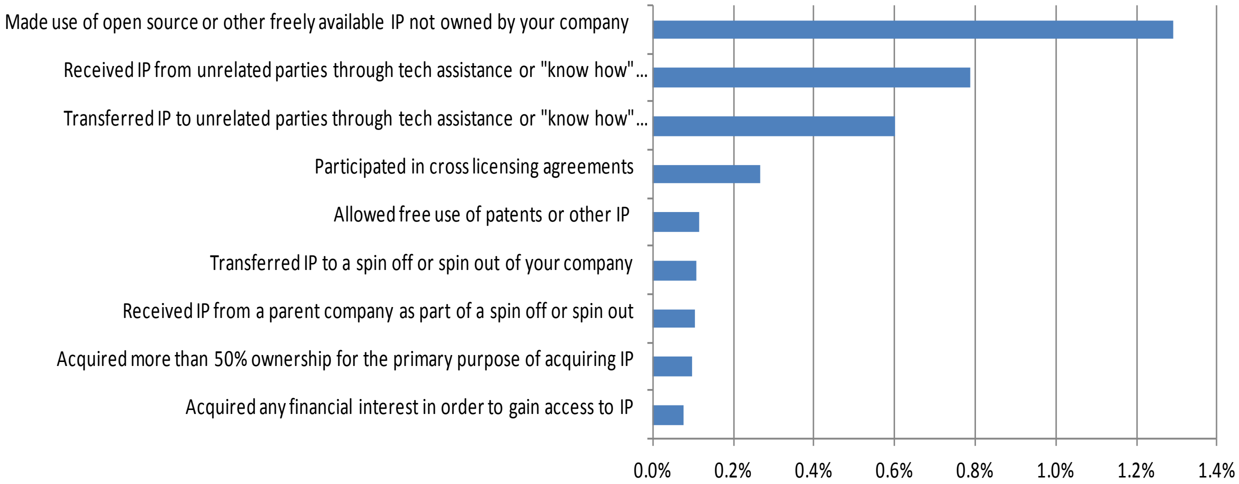
Source: OECD, based on Internal Revenue Service SOI Tax Stats - Table 16 - Returns of Active Corporations, Form 1120. **Error! Hyperlink reference not valid.** Accessed on September 2012.

IP transaction strategies

A number of business surveys provide some detailed, although not internationally comparable evidence, on the use of various forms of IP transaction strategies. In the case of the re-designed US Business R&D and Innovation Survey (BRDIS), a number of questions provide new insights into these questions. Preliminary results suggest that, for 2009, amongst the full population of companies, use of open source and freely available sources were the most common form of IP-related exchange (1.3 % of all firms). In second place, slightly less than 1 % of companies indicated having received IP from unrelated parties through assistance or “know-how” agreements, with a slightly smaller proportion of companies reporting the counterpart outward flow of know-how. Other forms of transaction, such as cross licensing, spin off/out activity and IP motivated M&A activity are much rarer among the general population of firms, although it could be qualitatively and quantitatively significant among the subset of R&D intensive companies, indicators which are at present not available.

Figure 8. IP-related transactions in US companies, 2009

As a percentage of all companies, by order of stated importance



Note: Experimental results, to be subject to confirmation and validation.

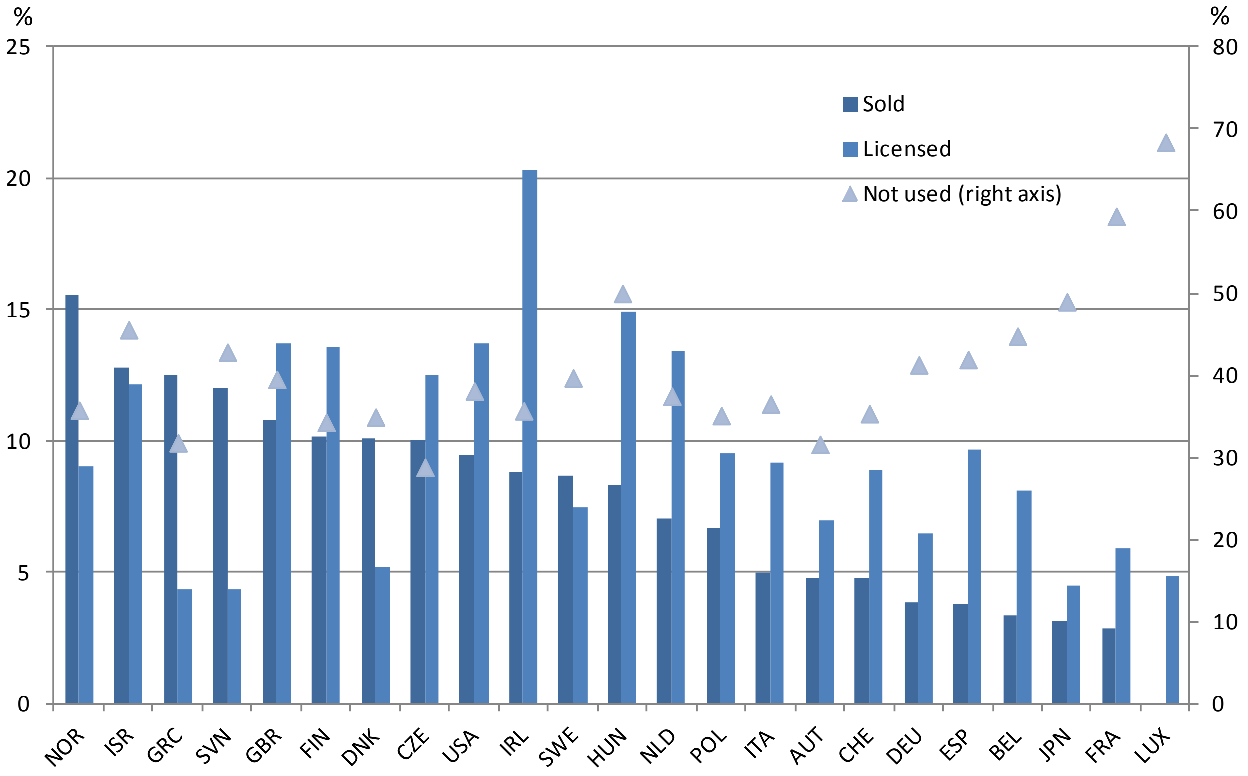
Source: Based on specially provided tables by the U.S. NCSES from the U.S. Business R&D and Innovation Survey (BRDIS).

In Canada, detailed information on sources on patent use reveal that 0.7% of all companies license patents, while the fraction of companies acquiring rights to patents stands at 0.4%. In contrast, the acquisition of patents via mergers and acquisitions stands at a slightly higher rate of 0.5%. It is important to bear in mind that these are not exclusive categories. 0.2% of firms engage in cross-licensing agreements while only 0.1% report to access patents through patent pools.

In contrast with representative sample surveys of the entire business population, public patent data repositories enable the retrieval of inventor and patent ownership information, which can provide in turn the basis for dedicated surveys which take the patent-inventor or patent-owner pair as key units of analysis. One such example is the PatVal/InnoS&T studies for patents filed at the European Patent Office (InnoS&T, 2011). Results from the InnoS&T survey show significant variations in the likelihood that patents are transacted upon or used internally by firms. Patents are in general more likely to be licensed than sold across the majority of countries. This may reflect the need to mitigate against the informational asymmetry problems that impinge on the economic valuation of intangible assets.[11] As a result, the most likely use for patents is often within the firm, although there is a large proportion of patents that are not used either way, their implicit value just arising from the option to use the knowledge and associated rights (using internally, licensing to third parties or in litigation) in the future. This in turn has been used to motivate a discussion on the desirability of policies to ensure the valorisation of patents.

Figure 9. Patents sold, licensed and not used internally

As a percentage of patents, by country



Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Source: INNOS&T (2011), based on inventors identified from patent applications to the European Patent Office with priority dates between 2003 and 2005. Data available from http://www.innost.unibocconi.it

The proportion of patenting companies who license their technologies to non-affiliated companies was estimated by Zúñiga and Guellec (2008) to be 13% in Europe and 24% in Japan, based on a sample of 600 European and 1 600 Japanese patent filing firms. A previous, smaller scale study of 105, mostly large, firms in Europe, North America and Asia-Pacific revealed that almost 60% of the firms interviewed reported increased inward and outward licensing during the 1990s (Sheehan *et al.*, 2004). Moreover, this was reported more frequently by North-American and Japanese than European firms.

Box 9. Data on patent re-assignments and knowledge markets

A series of academic papers have recently examined the possibility of identifying trade in patents by identifying changes in patent ownership records. Patent ownership data is noisy as not all transactions are necessarily recorded at all or in a timely fashion, as recordation in most jurisdictions is only required in order to protect rights owners against third parties acting on good faith. Confidential agreements and warrants can be alternatively used by parties to protect their rights against other trades which impinge on the value of the patent, particularly if there are strategic reasons for not publicising the existence of a deal. Furthermore, patent documents cannot for example provide up to date and detailed information on the ultimate ownership of patents, which ultimately requires parties willing to trade to conduct complex diligence exercises. In many cases, reassignments are only belatedly registered with no particular strategic motivation, as the administrative cost (direct and legal fees) can add up substantially if the transaction requires recordation for several patents and in many different jurisdictions. Notwithstanding these limitations, the analysis of ownership changes could be a promising avenue for future research and indicators provided differences in legal regimes and enforcement can be accounted for.

In the United States, Serrano (2011) found a re-assignment rate of 10 % over total granted patents by the USPTO (including reassignments owing to M&A activity). Traded patents were more likely to have higher number of citations and come from private inventors and small firms than their non-traded counterparts.

Ménière et al (2012) have also investigated ownership registration changes for French patents, distinguishing between those applied for through the national and EPO systems over the 1997-2009 period. They find that approximately 2.7% of patent applications were reassigned (5% of granted patents), of which nearly three-quarters correspond to transactions within the same group. This indicates a relatively low proportion of patents being genuinely sold as arms-length transactions. This marked difference with the United States is consistent with the result of the InnoS&T/Patval studies.

Results for Japan indicate comparable results (Chesbrough, 2006b). The overall reassignment rate stood at ca 3% in 2005, depending on the calculation method, with only 30% of such reassignments being accounted for by actual transfers (compared with 20% in 1997). The bulk of reassignment activity corresponds to name changes (nearly 50% of the total plus a further 18% for mergers). One pattern that is common to reassignment data across many countries is that it mainly occurs across affiliated enterprises within larger organisations, providing more evidence of dynamism and restructuring within companies than actual activity in the market for technology.

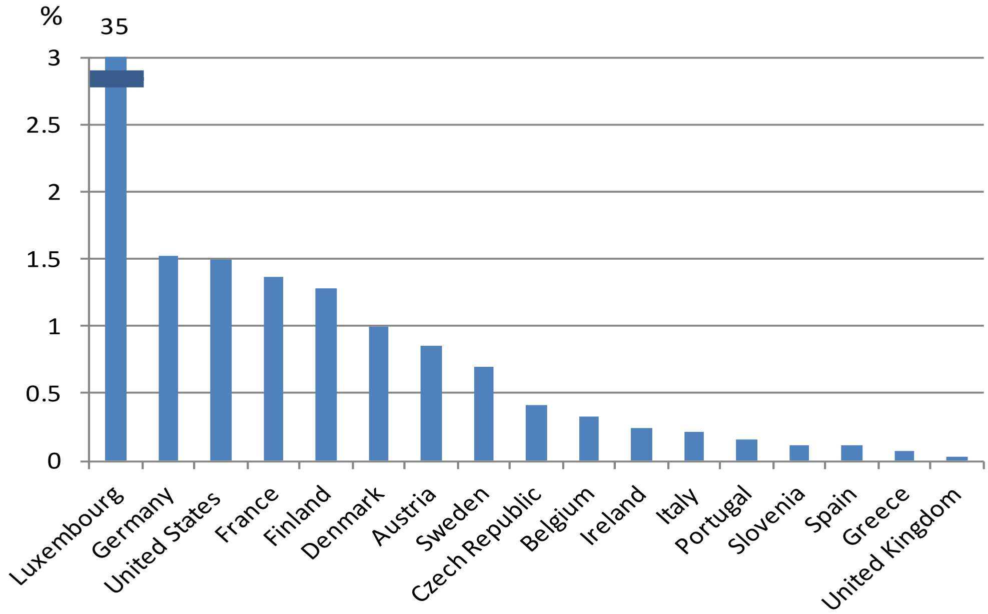
Intermediaries

The increasing importance of markets for technology and other intellectual property has given rise to the appearance of companies whose main activity is the monetisation of IP, principally through licensing. A possible indicator of the relative importance of IP intermediaries in the innovation system can now be derived from detailed service sector statistics corresponding to a recently identified sector in the standard international classification of economic activities ISIC774 - “Leasing of intellectual property and similar products, except copyrighted works” and its counterpart in the North-American Industrial Classification (NAICS) category “Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)” subsector NAICS533. This includes establishments that are primarily engaged in assigning rights to assets, such as patents, trademarks, brand names, and/or franchise agreements for which a royalty payment or licensing fee is paid to the asset holder. Establishments in this subsector own the patents, trademarks, and/or franchise agreements that allow others to use or reproduce for a fee and may or may not have created those assets. The revenue for companies in this industry sector comprises not only royalties and licence fees, but potentially also litigation compensation, fees for ancillary IP management and advisory services.

In the United States, data available from the Census Bureau of Statistics indicate total revenues worth USD 20 billion in 2010, a significant increase (4% nominal) with respect to 2009 at a time of widespread economic contraction. Comparing totals for the United States and the European Union in 2009, the last year for which a full EU figure is available, estimates suggest that US licensing industry revenues (at ca EUR13bn) were nearly 90% larger than in the European Union (EUR 6.7bn), potentially indicating a higher degree of specialisation within the market for IP rights. More up-to-date figures for individual EU countries indicate particularly high growth rates. For example, in the case of Germany, revenues increased in current price terms by nearly 25% in 2010. In the United Kingdom, turnover for this sector was estimated to be seven times as large in 2011 as it was in 2009, starting from an admittedly small value given the extent of investment in R&D and other intangibles.

Figure 10. Revenues of specialist licensing firms, 2009

As a percentage of business investment in R&D, other innovative property and economic competences



Notes: Turnover estimates of NACE Rev2 sector ("Leasing of intellectual property and similar products, except copyrighted works") and NAICS Sector "Lessors of nonfinancial intangible assets (excluding copyrights)", divided by "Intaninvest" estimates of business sector investment in Intangible Assets Currently not Included in pre-SNA 2008 National Accounts Asset Boundary (namely R&D, Design, New Financial Products, Advertising, Market Research, Training and Organisational Capital)

Source: Eurostat (2013) Annual detailed enterprise statistics for services; United Census Bureau 2010 Annual Services Report Data, and Intaninvest cross-country intangible investment data. www.intan-invest.net/

Box 10. An example of a marketplace for IP rights: the IPXI platform for "unit licence rights"

Intellectual Property Exchange International, Inc. (IPXI) is an exchange-based mechanism for the non-exclusive licensing and trading of intellectual property (IP) rights. The initial product traded on IPXI is a Unit License Right (ULR) contract, a non-exclusive license right, offered on a nondiscriminatory basis at a market-based price and with standardised terms. A ULR contract buyer is granted the right to use the underlying technology for a pre-established number of instances, defined on a case-by-case basis for the launch of each patented technology. Unused ULRs can be traded on the IPXI platform. Thus, once an Initial Offering has been priced, IPXI maintains a secondary market which provides ULR purchasers and sellers an opportunity to realise liquidity through resale and trading.

The IPXI Market Rulebook was made available in May 2012, aiming to address operational processes such as patent quality vetting, market eligibility, consumption reporting as well as the creation of a selection committee to evaluate proposed offerings.

Source : www.ipxi.com/

As official statistics begin to emerge about this sector on a wider international basis, it will become more important to understand what types of companies are effectively included in and excluded from this category. Casual inspection of public register data, such as information contained in proprietary aggregating databases such as Orbis® may provide some indication, although this information need not coincide with more detailed statistical registers and data collection methods. This particular data repository shows that the sector comprises subsidiaries of large companies tasked with managing the intellectual property generated and ultimately owned by parent companies, in some cases operating the legacy IP after they have stopped manufacturing and commercialising new products.[12] Companies assigned in this database to a main NAICS code 533, comprising mainly US and European based companies, account for a total USD 74 billion worth of turnover in 2010 or most recent year. This figure is notably larger than implied by official statistics. Patents do not appear to be the dominant type of IP right deployed by companies within this database, and there are only a limited number of clearly identifiable IP intermediaries that appear to be independent from operating companies. A search in this database for known IP intermediaries reveals that some significant, world renowned players are actually classified as belonging to other sectors, such as Internet or software services, confirming the difficulty in identifying this type of activity.[13]

Patent assertion entities

In contrast with companies which license their IP for new products, a category that includes many universities and R&D specialist companies, patent assertion entities (PAEs) are companies that assert patents on existing products as a business model (Chien, 2012b). PAEs –sometimes pejoratively described as patent trolls- have a number of unique common features: PAEs have relatively low assertion costs as they cannot be countersued or disrupted in their activities, since by not operating in the market they cannot infringe on other parties' intellectual property. Furthermore, they often use contingent fee lawyers and assert the same patents in the same venues to capture economies of scale. While courts are currently less willing to grant injunctions to such companies, thus reducing their scope for asking for high license payments and damages, the cost of litigation for the alleged infringer is such that it can be economical for the defendant to settle, regardless of the merits.

PAEs have been described by experts in the field as a "path-breaking, legal and disruptive technology for monetising patents that eliminates traditional obstacles to enforcement" (Chien, 2012b). From the perspective of inventors, this model allows them the opportunity to sell their IP at more favourable prices, because PAEs are likely to outbid an unco-ordinated set of operating companies from which they can subsequently extract considerable rents. This can in turn create incentives for invention, as the exit value increases. From the perspective of market operators, the PAEs irruption can be particularly damaging and impinge on the commercialisation of promising inventions.[14]

Recent US evidence suggests that cases brought forward by PAEs represent the majority of new patent infringement suits. However, this may represent only a small fraction of cases. Public cases and private demands are often resolved under non-disclosure agreements, implying that very little is known about their overall impact. It is not clear either to what extent the PAE phenomenon applies in other jurisdictions and what are the prospects this may occur in the future.

One potential ongoing development is the possibility that PAEs may be used by practicing companies seeking to shield themselves from the retaliatory and reputational costs brought about by attempts to assert patents. In this scenario, practicing companies could retain a licence on the IP and sell the ownership rights, thus transferring to the new buyer the ability to sue potential infringers. An escalation scenario may distort the already fragile balance of "mutually assured destruction" strategies that has led many companies to build up large IP portfolios. Such a development could have particularly damaging implications for the credibility of the IP marketplace and the future conduct of innovation in some technology domains. Public authorities may need to consider whether increased transparency in the market for patents could help mitigate this risk and where the public interest may take precedence above the legitimate right for companies to maintain a basis degree of confidentiality in their innovation strategies.

Box 11. Crowd-sourcing and the IP marketplace

Many companies subject to litigation threats are increasingly discovering the power of crowds to carry out tasks that previously required expensive efforts by in-house legal specialists. These firms are turning to crowd-sourcing patent research sites including Article One, Patexia, and Ask Patents to help combat infringement claims, check for existing patents on products they want to develop, and scrutinize rivals' patents before licensing them. For example, when Philips Electronics faced a potential legal challenge on its LED lighting products it turned to one of these services for evidence.

From the policy side, a number of patent offices are increasingly using crowd-sourcing methods for identifying prior art. The European Patent Office has launched a Third Party Observation service (epo.org/searching/free/observations.html) and peer to peer patent systems have been developed by USPTO (www.peertopatent.org/) and Australia (www.peertopatent.org.au/), among others. In the United States, the 2011 Leahy-Smith America Invents Act designed to reduce litigation and streamline the patent filing process, attempts to improve patent quality by allowing researchers and patent attorneys to electronically file evidence related to pending applications at the US Patent and Trademark Office.

Source: Bloomberg Businessweek www.businessweek.com/articles/2013-01-17/crowdsourcing-the-fight-against-tech-patent-trolls

The market for IP rights for financing purposes

Markets for disembodied knowledge can also enable companies to leverage a fair share of their knowledge-based capital. To the extent that they can be transferred independently and provide their owners with economic value that does not automatically dissipate, rights to intellectual assets can be used, at least in principle, to secure funding for business activities and enable investors to manage their risk exposure by selling and buying IP in liquid markets where prices reflect the underlying value of the assets. While the financing of innovation from invention through to commercialisation requires long-term capital commitments, the economic and financial crisis has accentuated the difficulties for firms to finance their innovation activities. The crisis has also reduced confidence in the ability of markets for complex products to address information asymmetries and align risks and rewards.

New valuation methods and products are increasingly used to demonstrate the independent (direct or indirect) cash flow-generating capacity of knowledge assets, but progress has been limited so far due to the lack of widely applicable standards and methods across highly idiosyncratic intellectual assets. Furthermore, although knowledge assets and other intangibles account for a large proportion of the market value of companies, not all are suitable to be used as collateral and traded independently. The existence of a well functioning market for IPRs critically depends on the ability to identify and transfer the rights to these flows. This could provide in some cases a much needed source of collateral, particularly for firms with a limited track record and with a limited pool of tangible assets to pledge against finance.

Companies are increasingly implementing strategies and business models to use knowledge-based capital assets as a mechanism for raising finance in multiple forms. Yanagisawa and Guellec (2009) discuss different types of companies that provide IP-based financial instruments. These have also been examined by Ellis (2009) and Nikolic (2009).

IP equity funds: Entities (the funds) invest money raised from the capital market in promising inventions, especially in inventions related to future-oriented developing technologies. These entities acquire rights to a number of invention sources with cutting-edge technologies, such as universities, research institutes, individual inventors and small start-ups. Large investment banks and boutique private equity (PE) firms alike have been involved in these activities targeted at intellectual property and other intangible assets. Investors in the fund themselves may not have specific strategies interests with regards to the use of the IP rights, but it is certainly in their interest that the IP rights are fully utilised to maximise revenues for the fund. Patent trading funds collect investments from private equity, institutional investors, high net worth individuals, or other private investors.

IP-backed debt-financing: Intellectual property owners seeking debt-financing may find that their most valuable property for use as collateral is their trademarks, copyrights, or patents. In fact, a bank that provides capital or credit to an IP owner will most likely require that the latter's intellectual property assets be pledged as collateral. For example, a EUR 1.6bn loan financing deal was recently secured by Alcatel-Lucent using its extensive patent portfolio as collateral. Some firms specialising in IA-backed lending structures provide additional services as a credit enhancement agent to a larger bank or firm that ultimately lends the funds, for example by agreeing to buy the intangibles of a firm undergoing bankruptcy proceedings at a given price. This helps the lender reduce exposure to the vagaries of distress sales, i.e. auctions in bankruptcy proceedings.[15]

IP-related revenue stream securitisation is a variant of IP-backed lending, allowing a seller to use future cash flows from an asset or group of assets to receive upfront payments from investors in exchange for an interest in the revenue associated to the underlying asset. The basis for the work of royalty monetisation companies are existing licensing agreements between the original patent owner (licensor) and another company (licensee) that generate somewhat predictable cash flows to enable investors to accept the exchange. Leading firms in this field include the likes of Capital Royalty LP, Cowen Healthcare Royalty Partners, DRI Capital Inc., Paul Capital Healthcare, and Royalty Pharma. Music copyright owners (e.g. the famous “David Bowie bonds”) and companies in the pharmaceutical sector are known to have used such instruments. The underlying intellectual assets are used as security in order to reduce the risk borne by investors and increase their willingness to anticipate future proceeds. In a royalty purchase transaction, the capital seeking company receives an upfront payment and assigns all or a portion of their future royalty inflows to the royalty monetisation company. The upfront payment is typically structured through a royalty bond issuance, whereby royalty interests are bundled, securitised, and sold to the capital market. As security, the royalty monetisation company acquires the IP and concomitant licences through a special purpose vehicle (SPV) in a true sale transaction.

5. PUBLIC POLICIES AND THE MARKET FOR IP RIGHTS

There are several mechanisms through which public policies impact on the IP marketplace. These can be highly complex and have relatively unpredictable consequences. This section provides a summary overview of some of the main instruments and their possible impacts.

IP regime features and enforcement

Providing quality assurance through the application and granting process and communicating information on the ownership of IP rights such as patents rank among the key services provided by public authorities in the market for knowledge. This is just one example among the many roles that governments and public sector organisations play in facilitating, shaping and regulating KNMs. Regimes that grant and enforce high quality and distinctive rights help reduce the threat of misappropriation and indirectly encourage the transfer of knowledge through IP rights. Strict IP award decisions contribute to higher quality and help reduce uncertainty on the validity of the granted IP rights. The systematic requirement to pay renewal fees is thought to encourage the search for potential licensors if the company is not intending to develop the technology itself, as it increases the opportunity cost of holding patents active without being used. Rules regarding responsibility for litigation costs linked to its final outcome can impact on litigation costs and potentially deter assertion-based IP market models.[16]

Patent offices worldwide are looking at how they balance the social contract and the role of the IP marketplace (Graham and Vishnubhakat, 2013). The USPTO and the EPO have recently overhauled their fee structures and rules in order to discourage excessive patent filing. Both institutions have also expressed the need for better screening of patent applications in order to increase patent quality.[17] Transparency in the patent market, concerning information on IP rights ownership has become an area of increasing policy interest. Lack of knowledge on who owns a patent may undermine risk management and decision-making about patents, creating arbitrage and hold up opportunities, and forms a major component of patent notice failure.[18] Patent ownership is a critical component of patent notice. If patents provide the right to exclude, the public is entitled to know who might do the excluding. While there are significant legal and economic benefits from accurate recordation of IP ownership (e.g., legally, when asserting IP against bona-fide acquirers, and economically, demonstrating the value of IP assets such as inventions to potential investors), there are many reasons why records do not accurately represent the real owner.

Chien (2012a) notes different factors for patent recordation failure. These can include: a) cost (attorney time and fees, for a privately owned start-up small company); b) poor record-keeping practices once the company has dissolved or gone bankrupt, tax reasons for assigning to one entity rather than another; c) large companies failing to keep up their assignment records post-issuance; d) the patent is the subject to a “whole company” transfer and no individual assignment is necessary or where the ownership issues are not straightforward; and e) companies inconsistently referring to themselves in their interactions before the relevant IP office. Companies also deliberately withhold patent ownership information in order to gain strategic advantage.

The US Patent and Trademark Office (USPTO) has been considering changes in practice designed to encourage a more complete record at the USPTO of patent assignments. Late in 2011, the USPTO invited the public to provide comments on methods the USPTO can employ to collect more timely and accurate patent assignment information both during prosecution and after issuance. In contrast, Japan’s patent law has been recently amended to remove the requirement to register licensing agreements as a condition for licensees to be allowed assert their rights against third parties, as this was seen to be a too onerous reporting requirement. In Europe, a recent 2012 EC Working document (EU, 2012) noted that information about valid patents is highly fragmented in Europe. While applications can be filed centrally to the EPO, maintenance is managed by national offices. The availability of data on the maintenance, ownership or licensing of European patents in the EPO Patent Register depends on the discretion of national patent offices' reporting and transmission to EPO. The implementation of the Unitary Patent system will have impacts on the recordation system.

The provision of information on ownership and rights is not only important for assertion and defence purposes, but also for enabling a financial market for IP. Investors need reliable sources of information on the IP offered as security. For a lender to obtain priority over other parties who might have interests in the IP owner's trademarks, copyrights, and patents, lenders across OECD jurisdictions must "perfect" - complete a series of legal steps- their interests in the intellectual property. This means that they have priority over other creditors for the collateral in the event that the debtor cannot repay its debts. In the United States, for example, security lenders are required to file financing documents identifying the security in compliance with either Article 9 of the Uniform Commercial Code (UCC) or an appropriate federal government entity as required by statute. For example, the USPTO allows the recordation of security interests on patents. In France, no notarisation is required but a pledge of IP rights needs registration with the national register for intellectual property rights ("INPI"). A recent WIPO questionnaire indicated that IP registers recordation was the prevalent requirement for security interest in IP to become effective against third parties upon its creation. (Chile, China, Colombia, Czech Republic, Estonia, Greece, Israel, Japan, Korea, Luxembourg, The Russian Federation, Slovakia, Sweden, Switzerland, The Netherlands, United States of America as well as Austria, Brazil, Estonia and Mexico, except for copyright). In Australia, Austria, Brazil, Czech Republic, Germany, New Zealand, Slovenia and the United Kingdom an interest becomes effective upon creation, while other registers can be used in Denmark, Israel, South Africa and Spain.[19] Information from these registers could be a potential useful source of information for policy analysis.

Tax policies can have profound impacts on the IP marketplace dynamics. Current statistics on international and domestic IP trade may be partly explained by the relative advantages of setting up separate companies and vehicles for managing revenues arising from the use of IP.[20] Recent academic research has for example demonstrated that differences in capital gains taxes that apply to patent sales can drive incentives for individual inventors to sell their patents (Galasso et al, 2011). This allows the researchers to infer that markets in which patents are more likely to be traded will benefit from reduced litigation due to comparative advantage among sellers in patent enforcement. In other words, in otherwise comparable circumstances, the reallocation of patent rights reduces litigation risk because buyers will deal more effectively with litigation challenges. Competition policies and enforcement practices, as hinted at earlier and as per Box 11, also play a major role in determining what types of collaborative arrangements, from joint ventures to patent pool agreements, can be detrimental to competition.

Box 12. Licensing agreements generating policy scrutiny

Over time, knowledge owners and seekers have developed a variety of strategies to mitigate the recurrent problems found in the market for technology. One such mechanism has been the elaboration of more sophisticated licensing arrangements to govern the transfer of codified knowledge, know-how and IPR. These include:

- "***No challenge obligations***", direct or indirect obligations on the licensee not to challenge the validity of intellectual property rights which the licensor holds in the relevant market. These are often inserted into cross-licensing agreements which settle conflicts relating to the infringement or invalidity of patents (Ahn 2008). These can potentially f*acilitate information sharing (t*he licensor may be encouraged to transmit additional information to the licensee) and reduce the threat of expensive litigation as a bargaining tool. However, this may weakens the ability to rid the economy of invalid patents, which "impede efficient licensing, hinder competition and undermine incentive for innovation". (DoJ and FTC, 2007)
- "***Non-assertion clauses***", providing that a contracting party will not assert patents or other IP rights against the other party. These clauses may help reduce the extent *of the patent hold-up problem*, namely the threat by a patent holder to obtain an injunction that will force the downstream producer to pull its product from the market (Lemley and Shapiro 2007). By obliging each licensee not to assert its patents against the licensors' other licensees, this can prevent patent hold up for multiple users of the technology. One downside of such clauses is that, particularly when unlimited in scope and duration, they may limit the ability of licensees to collect rents on their own IP, thereby discouraging independent R&D and innovation. The approach typically adopted in the United States and the European Union is to examine the enforceability of such clauses on a case-by-case basis, as they are not regarded as necessarily restricting competition, while the Japanese competition authorities, on the other hand, have taken a more negative view of Non-Assertion Provisions (NAP).
- "***Grant-back agreements***", whereby a licensee agrees to extend to the licensor of intellectual property the right to use – on an exclusive or non-exclusive basis – the licensee's improvements to the licensed technology. Grant-backs are very common in licensing agreements, with 43% of all licenses encompassing such clauses (Cockburn, 2007; Razgaitis, 2006). According to Laursen et al. (2012), grant-back clauses are more likely to be used when the licensing agreement occurs between actual or at least potential competitors in both products and technology markets. Non-exclusive grant-back agreements may be an alternative to higher upfront royalty rates where the nature and value of future improvements is uncertain. These clauses can have adverse effects on incentives to engage in R&D and innovation, particularly in the case of exclusive grant-back to the original licensor, which prevent the licensee from benefitting from its own innovation. Grant-backs can also raise competition concerns because they can improperly extend the original licensor's market power, by enabling it to benefit from numerous improvements made by multiple licensees.
- "***Reach-through licensing agreements***", granting the owner of a patent on an upstream [patented] research tool rights on the sales or usage of a subsequent downstream product created with that tool. In the biotechnology sector, for example, reach through licenses provide downstream companies with access to patented research platforms in exchange for royalties on future products that would not have infringed the upstream patent (OECD, 2004).

Although they provide private benefits to some or all of the contracting parties, these agreements can, under certain circumstances, limit competition in product and/or technology markets, discourage innovation and reduce public welfare. Consequently, policy-makers, in particular IPR-granting institutions and competition agencies, play a crucial role in designing and implementing a sound regulatory framework to ensure that licensing arrangements maximise the economic benefits that are associated with knowledge transfer, while minimising harmful effects on competition and innovation.

A number of factors may impact on the desirability of such restrictive practices:

- The power imbalance between the negotiating parties and whether they are practicing or non-practicing entities. When the alleged infringer is liquidity-constrained, the threat of a lengthy and costly litigation might lead it to voluntarily accept a licensing agreement it would have otherwise refused. In some cases, the licensor might be a Patent Assertion Entity (PAE), whose business model consists solely of monetising its IP portfolio by actively asserting it against alleged infringers. Such obligations would reduce the ability of alleged infringers to contest the validity of the IPR while the licensing agreement would not be facilitating any real knowledge transfer. Although there is much debate on whether the patents asserted by these companies are of higher or lower quality, agencies might under some circumstances choose to adopt a more prohibitive approach towards no-challenge obligations imposed by such licensors.
- Whether the licensing agreement took place before or after infringement litigation proceedings began. If proceedings for examining the case for infringement have already begun, then the patent would have undergone some scrutiny of its validity. In that case, an obligation not to challenge the validity of the patent is less likely to decrease the ability of the economy to rid itself of invalid patents.
- The degree of IPR ownership fragmentation in the relevant technology market. Problems of royalty-stacking and patent hold-up are exacerbated in heavily thicketed technological sectors. Agencies and courts might therefore consider a more lenient approach towards non-assertion provisions and grant-backs in licensing agreements governing the transfer of IPR which protect inventions in these areas.
- The balance of risks and rewards associated with research, development and commercialisation in different technological domains. For example, licensors who are small enterprises operating in emerging technological markets might be in a worse position to bear risk than large licensees. Licensing agreements, such as reach-throughs, that induce more risk-sharing between the firms developing the research-tools and those that develop downstream pharmaceutical products, may encourage research-tool developers to enter the market.
- The degree of scrutiny of patent applications and the use of procedures available for challenging the validity of patent applications before they are granted by patent-offices. Higher degree of scrutiny might help reduce the number of patents with too broad a scope or unclear claims and mitigate risks of post-licensing patent invalidation. This could also assist in the valuation of IP and overall help reduce the uncertainty associated with licensing for the contracting parties, enabling both licensors and licensees to better “quantify” the opportunity costs of adhering to certain restrictive licensing terms.
- The extent to which IP rights owned by different parties entering agreements are substitutes or complements. This is a key factor in shaping the desirability of enforcing grant-back or non-assertion provisions. If these provisions are imposed in the context of substitutes, they might assist the parties in foreclosing the market. If, on the other hand, they apply to complements, then they can prevent patent hold-up problems.

Many governments have become increasingly concerned about the ability of domestic firms and organisations, in particular liquidity-constrained ones such as SMEs, universities and PROs, to access and operate effectively in the growing and complex IP marketplace. Policy makers have also been concerned about the efficiency with which the move to a digital economy has rendered obsolete many of the traditional arrangements and infrastructures for clearing rights to art, music and other copyrightable items. This is also perceived as a factor potentially stifling the development of new business and ideas that draw upon such material. In the latter case, for example, the UK government has been considering the creation of a Digital Copyright Exchange to offer a more efficient market-place for owners and purchasers of rights, as well as opening up new markets to creators who may not have previously been able to access them (Hargreaves, 2011).

Other cases that exemplify governments and public sector organisations' engagement as actors in knowledge markets which are perceived to be deficient include Denmark's web-based portal *IP-Handelsportal* to facilitate co-operation and trade in IP; The *World Intellectual Property Organisation's WIPO Green*, a hub aimed at enabling environmental technology owners to make IP and know-how available to users through a searchable, public database of available intellectual property assets and resources; and *Re:Search*, a WIPO-led consortium, plays a similar role in the domain of research on treatments for neglected tropical diseases.

Government-sponsored patent fund initiatives

Sponsoring the creation of patent funds, whose business models share some features with private-sector private patent funds, has been considered by a number of governments and organisations as a possible policy instrument to promote the economic use of IP rights. The business models of government-sponsored patent funds share some features with private-sector funds. Patent funds can be defined as entities that invest in the acquisition of titles to patents from third parties, with a view to achieve a return by monetising these patents through sale, use of security interest, licensing or litigation. Some governments have recently contributed financially to the creation of private-public entities and consortia, either directly or through state-owned banks, which fund the acquisition of rights to existing among other possible activities. Initiatives have been implemented for example in Korea (Intellectual Discovery and IP Cube Partners funds), France (France Brevets) and Japan (Life Sciences IP Platform Fund) among others (Table 8). There are also abundant examples of public support for a range of patent security pledge and IP-based mechanisms in China (Table 9).

Many of these interventions are based on the perception that the IP aggregation and defensive services are undersupplied in the marketplace, requiring some degree of public coordination and support. This perception appears to be stronger outside the United States, where most private funds operate from and where IP markets appear to be most developed. Advocates in favour of public support for patent funds further argue that publicly controlled funds can more credibly steer away from pursuing aggressive patent assertion behaviours than their privately-owned counterparts.

A number of objections have been raised against publicly-backed funds. Constraints on the IP assertion strategies may be difficult to define and implement in practice, especially if the fund is operated at arms' length from public authorities. The acquisition strategies of funds may in the short term raise prices without necessarily increasing the levels of inventive activity, especially if the intervention is considered by actors to be transitory. The likely competition effects of public patent funds are difficult to predict as they will depend on the precise implementation of the fund and the interrelationship between the various components of the patent rights portfolio. For example, bundles of unrelated IP assets contribute to a more diversified portfolio and its financial exploitation, while complementary assets will be more suited for providing protective services around a set of technologies as a pool. Adverse selection and moral hazard are common problems to private and public patent funds, however in the case of the latter the acquisition criteria need to be much clearer for accountability purposes. By focusing their activities on specific technology domains, government-backed patent funds may unintentionally trigger technology lock-in.

The international perspective dimension of government-backed patent funds is particularly important, as there is a clear risk that these become instruments of support for national champions. The coordination across these mechanisms could be costly and challenging to implement, especially if funds' strategies give some form of preferential treatment to domestic companies. The inappropriate use of these funds could potentially result in escalating "patent wars" and "patent arms races" at the level of sovereign states.

Table 8. Examples of publicly-backed patent fund initiatives

Korea - Intellectual Discovery (2010)
Funding: This public-private partnership has an initial endowment of over KWN 500 bn (about EUR 314 million) from both public (government) and private investors (several household names). **Services provided:** A range of IP-related functions. The fund invests since 2011 in R&D activities both in Korea and abroad and purchases the IP to create a portfolio (IP incubation), which is then licensed based on demand. Provides IP-based banking services by investing in IP-owning companies who can use their IP as collateral. **Objectives:** Increase liquidity of innovating firms, defensive role against lawsuits, prevent acquisition of domestic patents by foreign funds. (See www.i-discovery.com/about/company.asp for more details).
Korea- IP Cube Partners (2010)
Funding: Funding from the state-owned Korea Development Bank (USD 15 million) and membership fees from its members, which also include universities and some Korean enterprises. **Services provided:** IPC is organised into three different business areas: Invention development (long-term) of inventions principally from Korean universities and R&D labs, developing a strategic portfolio in selected technologies based on customer requirements; IP incubation and brokerage (short-term) –focused on technology transfer, collaboration with academia and government and providing IP intelligence and patent database mining services; and current activity focused on patent acquisition and assistance to partners. **Objectives:** Incubate, harvest and protect inventions by "Filing the best inventions in selected global countries and ensure adequate compensation of IP owners and inventors, promoting valuable IP through global marketing channels, acquiring patents and connecting with the potential buyers and helping Korean patents into the global market for IP sale and licensing".
France - France Brevets (2010)
Funding: EUR100 million investment fund (split between the State, EUR 50 million and the *Caisse des Dépôts et Consignations*, a public-sector investment corporation, EUR 50 million. **Services provided:** The Fund is focused on patent monetisation and matching SMEs and PROs that hold patents with potential licensees. In some cases it also funds patent generation, finances the maintenance of the patents and covers the costs that are associated with litigation. The three main services provided cover: aggregation (reducing transaction costs in licensing agreements), mutualisation (finding potential licensees and preparing the negotiations); financing the time gap to market. Since 2011, the fund has been active in the areas of ICT, life-sciences and space. **Objectives:** Its stated aim is to enable universities, schools of engineering and research bodies, as well as private companies, to exploit their patents more effectively on an international scale, primarily through the operation of patent clusters for licensing purposes, and also by promoting cross-fertilisation in the management of public and private-sector patents. See www.francebrevets.com and www.caissedesdepots.fr/activites/investissements-davenir/france-brevets-50-meur.html for more details.
Japan - Life Sciences IP Platform Fund (LSIP) (2010)
Funding: The fund was set up by the Japanese Intellectual Property Strategy Network, Inc. (IPSN) and the Innovation Network Corporation of Japan (INCJ) and it is managed by the former. INCJ is a public-private partnership that provides financial, technological and management support for next-generation businesses and invested JPN 600 million (EUR 6 million) yen in the LSIP when the fund was established, and may make additional investments over the following years up to a maximum of JPN one billion (EUR 10 million). A number of private companies, mainly large-scale pharmaceutical companies, are also investing in the LSIP. **Services:** The LSIP is a fund that invests in life-science-related intellectual property. The fund focuses on four areas: biomarkers, ES/stem cells, cancer and Alzheimer's disease and works with universities, public research and other institutions to bundle together their intellectual property, add value to it, and then license it so that the life-science sector may develop through the application of new technologies and the creation of venture businesses. **Objectives:** The LSIP stated missions are: (a) increasing the value of IP in universities and ventures; (b) raising the probability of success by universities and ventures in commercialising their advanced technology; (c) developing IP human resources in Japan; (d) promoting a two-way technology transfer in the world, especially in Asia, through the construction of networks; and (e) achieving a "creative IP industry". See www.incj.co.jp/english/ for more details.

Source: OECD, various online sources and presentations made at OECD, TIP June Meeting, 2012.

Underlying the debate on the case for publicly-sponsored patent funds there is a recurring reference to countries' perception of national innovation systems weaknesses in the face of increasingly fierce international competition, rapidly changing global value chains and patent-related initiatives adopted elsewhere. Some of the rhetoric used in advertising new measures indicates there is a risk that the stated objective of achieving a level-playing field may unwittingly result in practice in patent funds being used to give preferential treatment to national champions. To manage the risk of supporting the implementation legally questionable and economically counterproductive practices, a basic set of rules may be necessary at the international level, which for example, differentiate between defensive and aggressive behaviours and recognise the eligibility of patent owners who genuinely invest locally in the patent's exploitation, including engineering, research and development or licensing. Policy makers should not lose sight of the overarching need to draw coherent strategies aimed at reducing the number of overlapping patent rights in complex product industries.

When considering the specific added value of patent funds, the features and implications of patent aggregation need to be considered in some detail. It is important to draw a clear distinction with the traditional rationale for pooling financial assets and pooling patents within a fund. Diversification of risk is the dominant factor in the former case, in which case a mix of uncorrelated assets will reduce the portfolio risk. However, there are very strong factors that, from the perspective of the investors, recommend the pooling of closely related and complementary inventions in order to gain control on a particular technology. This can result in the opposite effect by concentrating risk. Only sufficiently large funds will be able to cope simultaneously with concentration and diversification.

One element in common across the literature on public patent funds is the need to continue to explore the potential role of targeted interventions in the areas where the market failure rationale is strongest. The implementation of policy experiments such as patent funds needs to be consciously matched by a conscious investment in gathering evidence on the impact of these interventions. Given the relatively limited amount of public funds that have been devoted so far to these policies, it is particularly important to use this limitation to the advantage of evidence-based policy making, bearing in mind that without strong support evidence these efforts are very likely to be discontinued independently of their actual merits.

Recent proposals for government-backed patent funds clearly recognise the importance of complementary measures to improve the functioning of the IP ecosystem. It is recognised that the absence of operators and intermediaries in certain key market segments could hinder or thwart the offer of certain functions essential to promoting strong growth in the knowledge-based and inventive economy (such as database services, a rating system, portfolio management, etc.). It may be noted that this absence of intermediaries might be a symptom rather than the cause of limited commercialisation activity but it is possible that both effects reinforce each other. There is still insufficient evidence available upon which to make any firm recommendations on which are the key design features for public patent funds that can be considered to be best practice, as their own rationale is still subject to questions. A demand-driven screening and acquisition process is highlighted by the EU expert panel as an element of success in IP markets (see also Arora and Gambardella, 2010); a licensing policy consistent with the accepted practice in specific technology areas and co-ordinated provision of ancillary services to patent valorisation may potentially contribute to improving outcomes.

Table 9. Other related examples

Chinese Taipei – IP Bank (2011)
Funding: By October 2011, Chinese Taipei's Industrial Technology Research Institute (ITRI, a quasi-government agency) had raised TWD 50 million (EUR 1.3 million) for the preliminary operation of the new company and another TWD 200 million (EUR 5.1 million) to be used as a guidance fund to draw more investment from the industry. According to ITRI, within six months of its establishment, the IP bank is expected to raise its first counterclaim fund, on a scale of TWD 500 million (EUR 12.75 million). Meanwhile, another fund of roughly TWD 1 billion (EUR 25.6 million), will be used to devise better international IP strategies for Chinese Taipei technology firms. The IP bank is intended to assist local manufacturers with the creation of patent portfolios and patenting strategies in the R&D phases, while defending them from suits as they seek to expand their market share. Furthermore, in cases where a domestic firm will face a patent-infringement lawsuit filed by its competitors or a patent assertion entity, the IP bank will provide patents in support of defensive actions among facilitating other strategies. In addition, the company, via the ITRI, can use other funds to tap into the intellectual property of Chinese Taipei universities and research institutes as the industry's backup. The IP bank will be apparently fully funded by corporations. Note: For more information, see www.itri.org.tw/eng/econtent/business/business03.aspx
Italy, Innovation National Fund (2010)
Funding: The fund, set up by the Italian Ministry of Economic Development, is endowed with Euro 80 million derived from patent renewal fees and assigned to the Ministry with the aim of reinforcing the competitiveness of SMEs within the IP system. **Services:** The fund has two strands, one dedicated to equity investments (solely for patents) and another dedicated to debt financing (for patents and designs). The venture/risk capital strand will support tranches of up to EUR 1.5 million over 12 months for SMEs with high growth potential, aimed at supporting a project intended to commercialise the patent towards the introduction of new products or services in the market or towards further developing the innovation, with the aim of securing a return over an 8-year period. In addition to this, the state provides a loan guarantee to similarly eligible companies and valorisation projects based on patents and designs, intended to facilitate the provision of credits by selected banks (Deutsche Bank, Intesa Sanpaolo and Unicredit). The guarantees are expected to facilitate the granting of up to EUR 75 million worth of credit, with loans of up to EUR 3 million over a 10 year term.
China
There are abundant examples of public support for a range patent pledge and IP-based mechanisms in China. The exact nature of public security, involving provision of ancillary services, loan subsidy and risk bearing on guarantees cannot be determined from the available information, as it is understood that public sector banks are also involved in facilitating these measures. Schemes appear to be provided on a regional or municipality basis: • The State Intellectual Property Office (SIPO) has piloted schemes in cities such as Beijing - For example, the Beijing IP Office joined forces with a subsidiary of Bank of Communications to provide USD 58 million to 37 SMEs for IP- collateralized loans -, Shanghai and Guangzhou, with the latest addition being an agreement between the Bank of Communications and the IP administration in the city of Zhangzhou, Fujian province, in which the bank will offer patent-collateralized loans to help small sized companies raise capital. (See www.chinaipmagazine.com/en/news-show.asp?id=4735). • Chongqing: The State Intellectual Property Office (SIPO) recently approved the Two Rivers Area as an IP pledge financing pilot area - the total amount of IP pledge financing in the city is thought to have reached CNY 250 million and is expected to reach CNY 1 billion (ca USD 250 million). • Shenzen in the Guandong Province announced measures aimed at promoting IP Pledge loans, covering "mechanism, platforms, evaluation, lending, guarantee, transaction, ancillary services and guarantee promotion". (See www.chinaipr.gov.cn/newsarticle/news/local/201205/1294473_1.html) . • The Tianjin Binhai International Intellectual Property Exchange, created in 2011, is sponsored by Tianjin municipal government, State Intellectual Property Office, Torch Centre of MOST, and Tianjin's Steering Panel for Intellectual Property Rights. Total investment is expected to reach USD 1.2 million. The IP Exchange collects tradable IP projects and companies in key industries, and provides IP financing and transaction service. The exchange is expected to focus on providing facilities, technical support and related services for Chinese and foreign IP rights transactions, derivatives trading related to intellectual property rights and equity transaction of the limited liability companies or un-listed corporations with IP as the main carrier, information dissemination and settlement services for IP evaluation, auction, pledge, custody, training, certification, authentication, and trading.

6. MARKETS AND NETWORKS FOR KNOWLEDGE ORIGINATING IN PUBLIC SECTOR RESEARCH ORGANISATIONS [21]

Across the world, government authorities and public sector organisations produce, collect and hold vast amounts of data and information as part of their mandate. The generation of knowledge for the benefit of society is at the very core of their research remit, as in the case of public universities, geographic or meteorological services. Public research organisations (PROs) are therefore in possession of vast amounts of information, knowledge and associated IP rights that can be used to meet a wide number of economic and societal objectives. Knowledge networks and markets can assist in increasing the utilisation of this knowledge and associated rights, as well as promoting the co-creating of new knowledge. The transfer, exploitation and commercialisation of public research results remain a critical focus area for science, technology and innovation policymakers in OECD and non-member economies alike. Efforts to ring-fence public research in a context of fiscal austerity in many OECD countries – as well as competition from new players – have increased pressure on universities, PROs and governments to increase the economic outputs from, and impact of, investments in public research and knowledge building strategies. This challenge also extends to researchers and broader society's access to the research outputs produced in the research and science base. Policy reforms have been designed to incentivise and accelerate the transfer, exploitation and commercialisation of knowledge created by these institutions.

In the case of universities and many PROs, a range of relatively recent developments can be thought of as sustaining this policy trend, including:

- Greater autonomy granted to universities in many OECD countries, combined with the widespread, yet not universal, adoption of "Bayh-Dole"-like policies that grant universities ownership over the rights on academic inventions and provide them with incentives to patent and enter licensing agreements.
- Increasing demand from the business sector to collaborate or to contract research to universities and PROs, which may result from the use of open innovation strategies by companies to de-risk their own activities, access research excellence and possibly improve their leverage of public support which is often provided on more generous terms when involving partnerships with PROs.
- The rising costs of scientific research and budgetary pressures on universities and public research institutions, which creates incentives to search for new sources of revenue and engage in public-private partnerships to share risks and costs.
- The rise of the entrepreneurial universities in the context of global competition among higher education institutions for funding and talent and regional government efforts to foster economic development around knowledge-based clusters.
- Growing recognition of the value of data and information produced by universities and PROs and the development of ICT infrastructure to make it more readily accessible to entrepreneurs and other potential innovators.

Modes of knowledge transfer

The transfer of knowledge generated by public research takes place through a wide variety of channels, many of which are difficult to monitor with statistically robust information, including the movement of highly skilled students and faculty staff from universities to industry; the publication of research results; people-based interactions between creators and users of new knowledge; industry sponsored contract research projects; individual faculty consulting arrangements; IPR activities such as patenting; and entrepreneurial activities and people-based interactions involving not only faculty and graduates but also students (Hughes et al., 2011). These channels often operate simultaneously or in a complementary fashion, underscoring the interaction between tacit and codified flows of knowledge as well as the multi-directional nature of flows. Knowledge does not only flow from university to industry but also the other way around. University inventions are embryonic and their commercialisation often requires additional input from faculty and students and entrepreneurs.

Table 10. Summary of *selected* knowledge transfer channels and modes

Knowledge transfer channels	Features/Characteristics	Characteristics			
		Degree of formalisation	Degree of finalisation	Relational intensity	Significance for industry
Publishing	Most traditional and widespread mode of transmission of knowledge; made available in the public domain	Low	High	Low	High
Conferencing, Networking	Professional conferences, informal relations, casual contact, conversations are among the channels ranked as most important by industry; important across sectors	Low	Low	Medium	High
Collaborative research and research partnerships	Situations where scientists and private companies jointly commit resources and research efforts to projects; research carried out co-jointly and may be cofounded (vis-a-vis contract research); large variations (individual level or institutional level); range from small-scale projects to strategic partnerships with multiple members and stakeholders (i.e. P/PPs)	Medium	Low	High	High
Contract research	Commissioned by a private firm to pursue a solution to a problem of interest; distinction with most types of consulting involves creating new knowledge per the specifications or goals of client; usually more applied than collaborative research	High	High	High	High
Academic consulting	Research or advisory services provided by researchers to industry clients; most widespread activities – yet least institutionalised - in which industry and academics engage.; three different types: research-, opportunity and commercialisation driven consulting; important to industry, which usually do not compromise university missions.	Medium	High	High	High
Industry hiring, student placement	Major motivations for firms to engage in industry-science linkages and main benefit for universities; occurs through e.g. joint supervision of theses, internships, or collaborative research	Medium	Low	Medium	Medium
IPR based channels	IPR commercialisation (patenting, licensing, creation of spin-offs) ranked among the least important channels by both industry and researchers; substantial attention in the literature and by policy makers.	High	High	Low	Low
	Patenting: ranked among the least important channels	High	High	Low	Low
	Licensing: most popular form of IPR commercialisation; little transfer of tacit knowledge	High	High	Low	Low
	Spin-offs: received substantial attention, although rare a rare form of "entrepreneurship" compared to alumni and student start-ups	High	High	Low	Low
Personnel exchanges / inter-sectoral mobility	May take many forms; usually university or industry researchers spending time in the alternate settings; most important form of "personnel mobility" is the employment by industry.	High	Low	Medium	Low

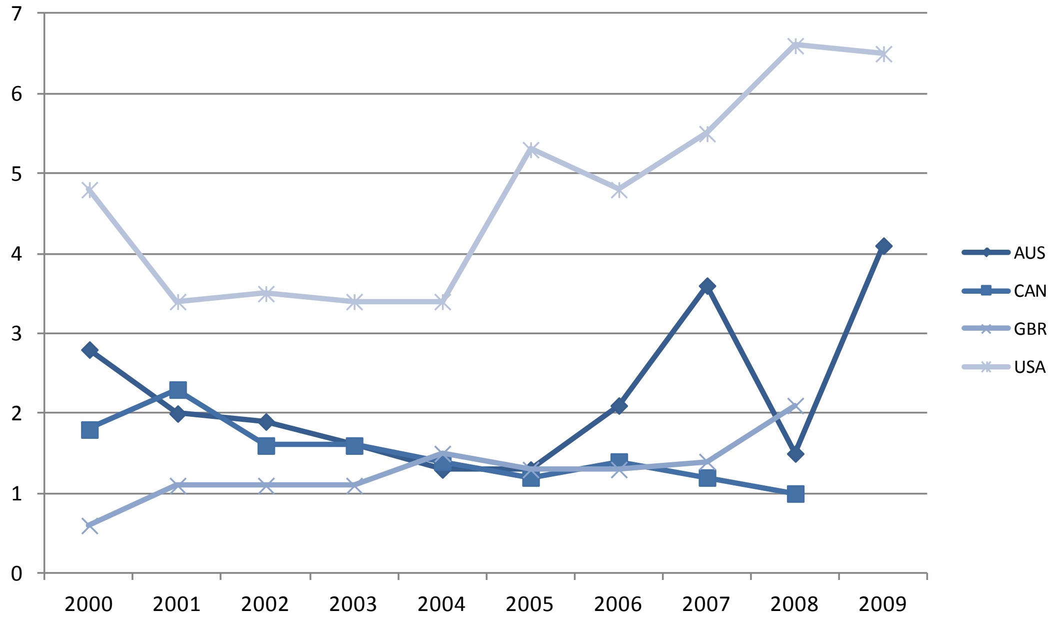
Source: OECD Working Party on Innovation and Technology Policy.

Mechanisms of university-industry knowledge transfer (U-I KT) have been shown to vary in their "relational intensity" (i.e. the degree of interaction between knowledge creators and receivers), their significance to industry, the type of knowledge involved, and their degree of formality (OECD, 2012). Traditional measures of U-I KT activities are limited as they miss on aspects of the process of U-I KT (e.g. discovery) or its indirect impacts (e.g. learning). Human resource management strategies can influence U-I KT channels, although the impact will vary according to channel characteristics. The analysis of informal contacts, conferences and professional meetings, consulting and collaborative research has the potential to become a fruitful avenue of research, as these channels are important to industry and have high relational intensity. Understanding researchers' involvement in these activities further requires enquiring about their mindset, motivations and competences, and the institutional culture and leadership in their workplace. A potential approach for doing this could draw upon features of the framework for measuring business innovation, with its emphasis on linkages, inputs and outputs.

There has been a significant drive towards public research organisations and other publicly funded bodies' participation in IP-related transactions. Such organisations have invested considerably in increasing their technology transfer capabilities, as demonstrated by a number of surveys carried by statistical offices and associations of technology transfer and licensing offices. Changes in incentives for "third-stream" activities and increasing resources for technology transfer activities appear to have been associated with increasing levels of licensing and related income by universities and other public research organisations worldwide. International comparisons provided by Australia's Department of Innovation, Industry, Science and Research suggest that licensing incomes are not only increasing but also doing so faster than R&D expenditures, although not in the case of Canada where R&D expenditure in the higher education is reported to have been strong in recent years. Licensing income in US universities is higher, reflecting not only the composition of the US survey implemented by the Association of University Technology Managers (AUTM), but also the research leadership of its institutions across many S&T fields and its accumulated experience in patenting and licensing activity, compared to other countries.

Figure 11. Licensing and option agreement income in PROs

As a ratio of income to total R&D expenditure



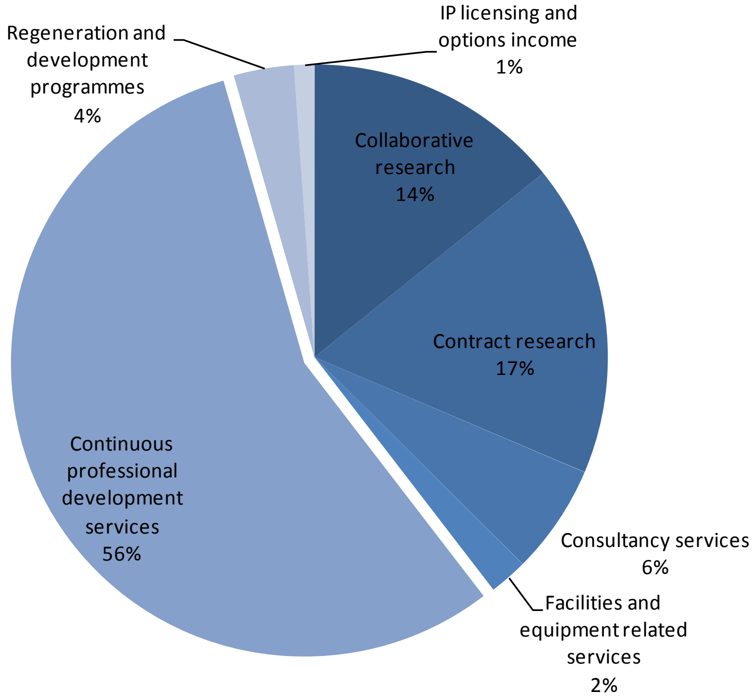
Source: Australia's Department of Innovation, Industry, Science and Research (2011) "Australian National Survey Of Research Commercialisation: 2008 and 2009". Based on a number of different sources. Results need not represent national averages, but averages of institutions covered by respective studies in each year.

However, the adoption of licensing income or spin off rates as indicators of technology transfer in universities risks oversimplifying what should be a much broader perspective about the nature of their third mission task and the many vehicles it can use. Even from a simple transactional perspective, there is ample evidence that licensing income can be relative minor compared to other activities, such as contract R&D

and consultancy services For example, data for the United Kingdom indicates that licensing activities, despite attracting most of the policy discussion, only account for 1% of "third stream/mission" income, while in contrast contract and collaborative research account for 17 and 14% respectively, with the provision of continuous professional development services accounting for more than half of total income in that category (HESA, 2012). Data for the United States shows a marked increase in the share of research funds that are passed-through to other organisations, highlighting an increase in the importance of collaborative arrangements (Hale, 2012).

Figure 12. "Third stream" sources of income for higher education institutions in the United Kingdom, 2010-2011

Percentages of total "third-stream" income



Source: UK HESA Business and Community Interaction survey data.

Policy developments

Resolution of ownership over IP rights generated in PROs: Most OECD countries, with the notable exception of Sweden and Italy, have removed the so-called "professor's privilege" which exempts professors from employment or research funding rules that grant universities rights over patented inventions. Some models vest a range of rights with inventors, while maintaining institutional ownership ("Free Agency Model"). The resolution of ownership is an essential requirement for encouraging the utilisation of IP rights arising from publicly funding research.

Intermediary role of technology licensing and transfer offices: Changes in incentives for "third-stream" activities and increasing resources for technology transfer activities appear to have been associated with increasing levels of licensing and related income by universities and other public research organisations worldwide. As PROs have become more involved in commercialization activities, they have built up an extensive infrastructure in the form of technology licensing and transfer offices (TTOs), which play a key intermediary role in the market for knowledge generated in PROs. However, these initiatives have not been met with uniform success, often due to lack of expertise, incentives and critical mass. In this environment, many universities and governments have sought to reform or replace the functions of TTOs. They have created regional TTOs (“hub-and- spoke" models) that service several universities at once, thus pooling resources. They have also used alternative online IP marketplaces, partnered with patent funds, engaged with for-profit TTOs or developed approaches to vest some rights with inventors, while maintaining institutional ownership over inventions (e.g. free agency model). The business model of TTOs has also been changing beyond the administration of narrowly defined tech transfer within PROs towards providing a wide range of IP related services, combining free access with proprietary models and developing internal innovation capabilities.

A broader range of intermediary and bridging organisations: Governments, sub-national governments and universities/PROs have attempted to stimulate the formation of a range of bridging institutions to meet specific needs. The relative importance of disembodied IP rights exhibits considerable variation across these organisations/infrastructures.

Table 3 Typology of intermediary and bridging organisations

Typologies	Mission statement/Aim	Centrality of IPR
Technology transfer office (TTO)	Supporting the academic staff to identify and manage the organisation’s intellectual assets, including protecting intellectual property and transferring or licensing rights to other parties to enhance prospects for further development	HIGH
Business incubator	Accelerating the growth and success of entrepreneurial companies through an array of business support resources and services that could include physical space, capital, coaching, common services, and networking connections (National Business Incubation Association).	LOW
Business innovation centre	Offering a range of integrated guidance and support services for projects carried out by innovative SMEs, thereby contributing to regional and local development (European Business and Innovation Centre Network).	LOW
Science park and technology hub	Promoting the economic development and competitiveness of regions and cities by creating new business opportunities and adding value to mature companies; fostering entrepreneurship and incubating new innovative companies; generating knowledge-based jobs; building attractive spaces for the emerging knowledge workers; enhancing the synergy between universities and companies (International Association of Science Parks)	MEDIUM
Chamber of commerce special agency and laboratory	Furthering the development and expansion of technological innovation through the offer of services that meet the requirements of the firms associated with the Chamber of Commerce	LOW
Territorial development enterprise	Gathering and coordinating scientific, organisational and financial resources in the region in order to transfer acquired information into new production processes and research results to the entrepreneurial context.	LOW
Topic centre	Promoting a specific industry or a specific technological area inside a geographical context	LOW
Multi-sector centre	Supplying diversified services to firms operating in several sectors	LOW
Industry Liaison Offices (ILO)	Although ILOs may share large functional similarities with technology transfer offices (TTOs) in a sense that they also manage patenting and licensing activities, but the ILOs perform a broader scope of activities, including serving as a central contact point for industrial partners, conducting external/internal marketing and creating networks and partnerships	MEDIUM
Proof of concept centres (PoC)	A PoC Center is an organisation working within or in association with the university, to provide funding, mentoring, and education, in a customizable support to PoC activities in TC, i.e., the development and verification of a commercial concept, the identification of an appropriate target market, and the development of additional required protectable IP.	LOW

Note: PROs and broader institutes (e.g. centre of excellence) have been excluded.

Source: OECD Working Party on Innovation and Technology Policy

Diffusion of standard licensing agreements: These are aimed at reducing transaction costs, recent examples can be found in the development of the Carolina Express License Agreement, a standard licensing agreement to commercialise academic inventions, allowing potential startups to select an appropriate standardized licensing agreement rather than undertake a customised negotiation with the university that can take considerable time with unpredictable results (Kaufmann Foundation, 2012).[22]

Internet-based mechanisms: Advances in ICTs have also permitted mechanisms that complement existing internal TTO structures through Internet-based platforms. These platforms have been developed in response to the need of technology transfer professionals as well as application-oriented researchers of having easier access to knowledge and information in their working environment. One example is the "iBridge network", aimed at researchers, universities and companies and entrepreneurs.[23] The online-enabled network allows the posting, search and retrieval of information on university inventions. Some inventions are available for online licensing.

Public access to the results of publicly funded research: Another trend with several implications for the market for knowledge created in PROs and universities is the range of open science initiatives and the adoption of requirements by funding organisations concerning the access to the outputs of research. The exploitation of research through new open science channels (e.g. publicly accessible databases) is intended to promote their use for research purposes and the downstream exploitation of new commercial opportunities associated to the resulting findings and data. Research policies that encourage greater access to public research results may potentially allow for greater participation in public research and greater exploitation of the results. These policies need to be considered in the wider context that shapes the incentives for various parties to undertake new research and communicate and utilise its direct results. This will be the subject of future, more detailed OECD work in 2013-2014.

Box 13. Examples of public initiatives to improve access to outputs of publicly funded research

Examples of recent initiatives in this area include the recent directive by the US Office of Science and Technology Policy to Federal agencies with more than UDS 100 million in R&D expenditures to develop plans to make the published results of federally funded research freely available to the public within one year of publication and requiring researchers to better account for and manage the digital data resulting from federally funded scientific research. In the European Union, the European Commission strategy is to develop and implement open access to research results from projects funded by the EU Research Framework Programmes, namely FP7 and Horizon 2020, based on support to both 'Green open access' (immediate or delayed open access that is provided through self-archiving) and 'Gold open access' (immediate open access that is provided by a publisher, typically for a fee). The Commission strategy is also to encourage national initiatives at a member state level and contribute to their co-ordination within the European Research Area, providing funds for research and supporting activities in the area of open access. In the United Kingdom, the Government announced on July 2012 that it has accepted the recommendations of the Working Group on Expanding Access to Published Research Findings, chaired by Dame Janet Finch, which recommended steps toward supporting 'Gold' open access publishing, extensions to current licensing arrangements in the higher education, health and other sectors; improvements to the infrastructure of repositories, and support for the moves by publishers to provide access to the great majority of journals in public libraries.

Source: Office of Science and Technology Policy, February 2013; European Commission, 2012; UK Department for Business, Innovation and Skills, July 2012.

Potential implications

Policy instruments in the market for knowledge generated in PROs will need to further differentiate the types of commercialisation paths used by various types of PROs. This will require additional evidence on the extent to which different activities complement each other as they all compete for limited resources. Recent OECD work on PROs has found evidence among some countries that the multitudes of missions, one of them being the commercialisation of research, may lead to a "mission creep" or the overburdening of PROs (OECD, 2011). Considering the heterogeneity of organisations and universities and the different local and regional contexts, there is a need to ensure that knowledge exploitation and commercialisation strategies are consistent with the local and global research environment.

Incentive mechanisms play a fundamental role in the effectiveness of knowledge transfer strategies by PROs. Research funding agencies do have a major role to play in defining key policies concerning access to scientific results, data and instruments, as well as policies regarding knowledge and invention disclosures. It is of particular importance to ensure that those who generate ideas and inventions, from professors to students, have relevant incentives and assistance to share and disclose their findings so that a relevant validation, development and exploitation strategy can be identified and implemented.

The institutions and infrastructures that support the networks and markets for creating and disseminating scientific knowledge are being reviewed across many OECD countries, as traditional models are facing considerable limitations and may be restraining further scientific advance and broader innovation. New models will have to demonstrate – possibly through pilot experiences – their ability to ensure quality, participation and adequate rewards to those who contribute to the research, peer review and dissemination effort.

Indicators of impact at the level of individuals and institutions are likely to grow in importance. This will create a significant challenge for decision makers, as the impacts of science can take a long time to materialise and the mechanisms can be several and disperse, as well as not necessarily captured by available metrics and data infrastructures. Future developments in indicators are bound to draw attention to economically and socially important uses of research outputs, recognising that the information and knowledge they produce can be used by actors beyond the traditional research community (e.g. not just other academic scientists). Users include business, large and small, entrepreneurs, and the general public. Our current understanding of the pattern of scientific knowledge flows and their impact relies rather heavily on traditional bibliometric sources which focus on the use of information by the research community, including scientists and inventors. While the linking of scientific and patent data can capture some use of information by inventors, there are health practitioners, policy decision makers who do not publish in scholarly journals who rely on a regular basis on the knowledge contained in scientific publications. Emerging Internet-based indicators of use and reuse of publications and data may provide additional insight into the scope and intensity of the impact of scientific knowledge on society and the economy.

A relatively unexplored domain of analysis is the role of current and former students as key actors in the exploitation and possible commercialisation of knowledge generated in universities in particular. Acknowledging this role and understanding what drives it and what are the main barriers could prove a particularly fruitful area of future analysis, comparing the level of support and training that PROs provide to promote research-based entrepreneurship among students.

7. KNOWLEDGE FLOWS THROUGH MOBILE KNOWLEDGE WORKERS: POTENTIAL BARRIERS

Knowledge flows and job mobility

There is widespread consensus about the importance of knowledge diffusion as an enabler of innovation and the key role played by networked and mobile highly-skilled employees in facilitating such flows. Employee mobility is widely held to be important not only for enhancing labour market efficiency and productivity, allowing human resources to flow the posts that value them most, but also as a major conduit for knowledge flows across firms and organisations.

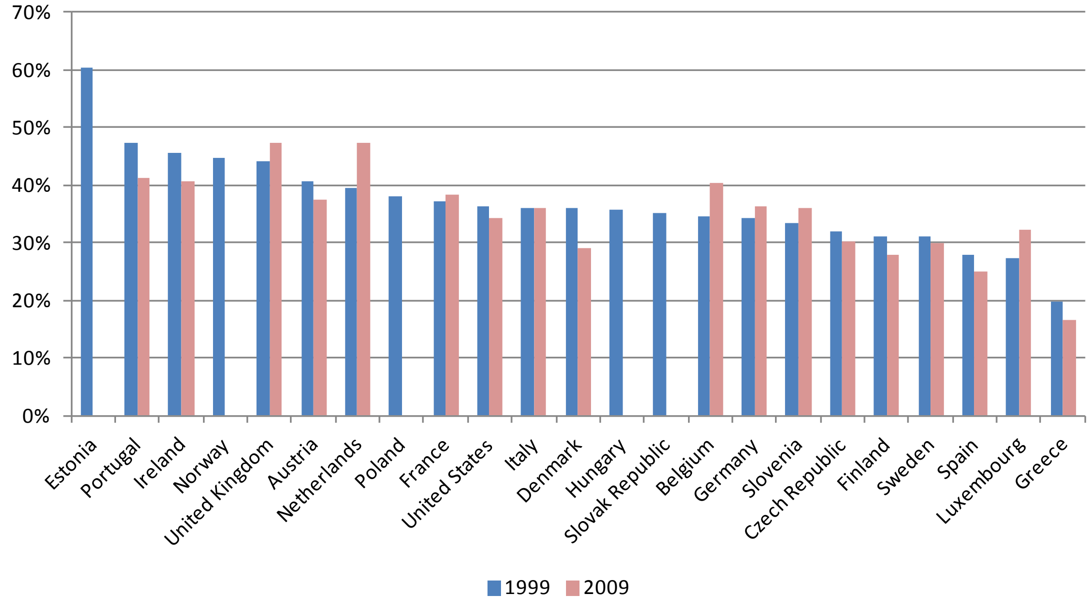
Human capital plays an essential role facilitating knowledge flows, as knowledge cannot always be commoditised and transferred without the intervening know-how and knowledge embedded in people that facilitate its absorption and usage. For example, Levin et al. (1987) highlighted, in their influential study of flows of technological knowledge, the role of the movement of personnel – specifically, the hiring of R&D employees away from innovating firms – as a key element within a wider range of potential channels of information flows such as licensing, patent disclosures, reverse engineering. This contribution also noted the very close link between the movement of skilled personnel with other forms of information flows involving inter-personal communication (technical meetings, informal conversations, etc.). Hyde (2011) went on to argue that “mobile employees are the best source for spreading lawful, public domain information”. In particular, he argues that rather than trying to learn from scientific and trade journals, conferences and the like, it is easier for firms to hire someone with the relevant expertise. The labour market for the services of highly skilled individuals and knowledge workers can thus be described as one, if not the most, important markets for knowledge.

While business innovation surveys carried out worldwide under the guidelines set out in the *Oslo Manual* (OECD/Eurostat 2005) consistently find the main source of information for innovation typically lies within the business itself or an affiliated company with shared ownership links, this may hide the fact that resources that are internal to the company at the time of reporting might have been sourced from external organisations. Unfortunately there is no widespread information across OECD countries on the extent to which internal sources of innovation are linked to the hiring of new staff. One exception is the Australian Innovation Survey which asks business how they “sourced labour for the development or introduction of new goods, services, process or methods” and prompts them for different approaches. Twenty-two percent of firms report the employment of new persons (18% for non graduates) as one of the approaches, compared with 81% for persons within the company, 18% for consultants, and 11% for persons employed by the business’s collaboration partners (Australian Bureau of Statistics, 2010). The New Zealand innovation survey shows that the three most important sources of information for innovating businesses were “existing staff” (70%), customers (56%) and new staff (48%). Existing and new staff are internal sources of knowledge that businesses can draw upon to support their innovation efforts.

Recent cross-country macroeconomic estimates of the size of business investment in intangible assets confirm the significance of knowledge-based assets, in particular economic competences which are embodied in employees and as a result can be highly mobile and difficult to retain. Estimates based on the methodology developed by Corrado et al. (2006) indicate that on average, one third of intangible investments (including R&D, design, marketing and software investment) appear to be accounted for by internal and external expenditures on training and organisational capital (Figure 13). Only by maintaining a continued employment relationship with employees can firms secure exclusive access to and use of the organisation’s stock of human capital and the knowledge assets embodied in its staff. Employees bring their previous education and talent to their job, own these skills, and are free to decide if and when and where they will contribute this capital to the firm. However, the human capital embodied in employees contains a great deal more than what the employee brought from previous experience, and includes newly acquired knowledge through training or qualifications sponsored by the employer that may be applicable, to a greater or lesser extent, in other companies in the same or different sectors.

Figure 13. Estimates of investment in training and organisational capital

As a percentage of total investment in intangibles



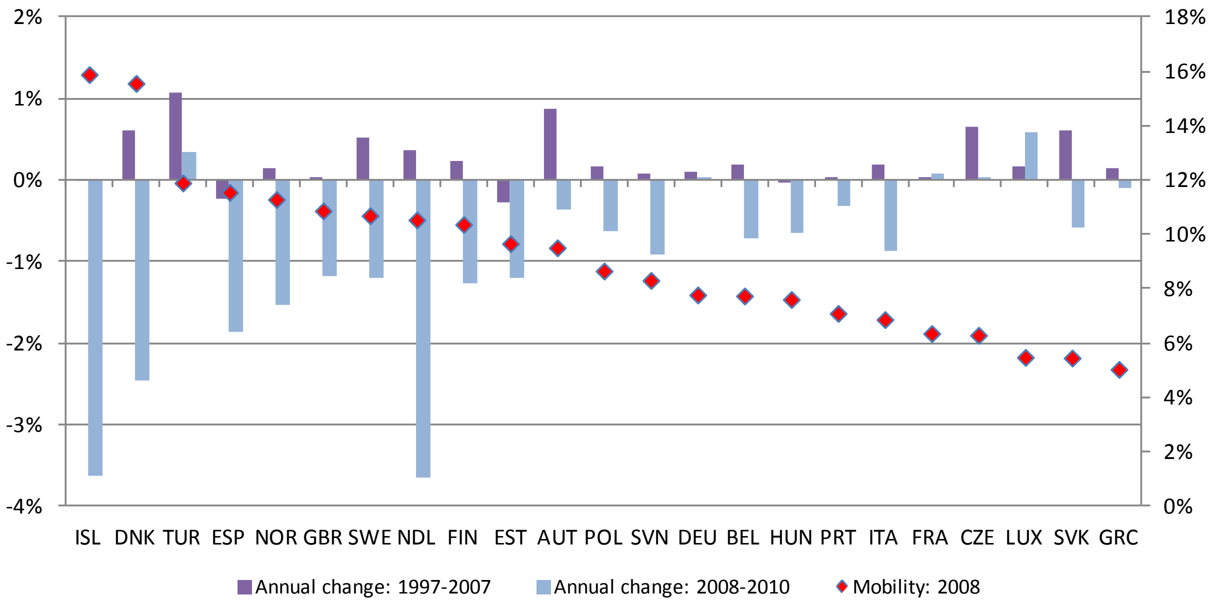
Source: OECD, based on INTAN Invest data. See Corrado, Carol, Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi (2012). "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results" available at www.INTAN-Invest.net

There are significant differences in general job mobility rates and average tenure across OECD countries. With few exceptions, job mobility is by and large lower in most European countries compared to non-EU OECD countries, reflecting differences in labour market regulations but also general institutions and practices. Within Europe, it is possible to use comparable microdata from the EU Labour Force Surveys (EU-LFS) to obtain more detailed estimates of job mobility patterns as well as recent trends and changes. The EU-LFS makes it possible to identify whether an individual has changed employer within the past 12 months. Figure 14 shows that most European countries experienced increases in job mobility rates during the 2003-2007 pre-crisis period. This may reflect an increasing employee ability and willingness to change jobs in situations closer to full employment and of economic growth. In contrast, mobility appears to have declined with the onset of the economic downturn in 2008, potentially revealing a reduction in the number of vacancies in addition to a reduced willingness to move jobs in more unstable times.

Further analysis shows that there is no clearcut relationship between level of skill and the likelihood of job mobility, reflecting the dual nature of mobility episodes. It is interesting to note that employees in the computer services sector exhibit the highest mobility rates, followed by those in professional services other than R&D and those working in retail as well as hotels and restaurants. Skilled workers in Ireland, Sweden, the Netherlands and Slovenia are on average 20% more mobile than their unskilled counterparts, while in Spain, Czech Republic, Turkey and Hungary, mobility is largest amongst the workforce without tertiary education qualifications or professional occupations.

Figure 14. Average annual changes in job mobility, EU countries

As a percentage of employees and annual average change, with respect to previous year



Source: OECD, based on especially micro-aggregated data from EU Labour Force Surveys.

The empirical literature has found evidence of positive knowledge spillover effects arising from mobility. However, the range of possible mechanisms and impacts is particularly wide and the net impacts on innovation and economic performance can be ambiguous. A high degree of employee mobility implies the obsolescence of investments made by firms in knowledge that is embodied in employees, as well as a potential loss of competitiveness *vis à vis* competitors who might recruit former employees. Free riding on other individuals' and firms' investments in training is a well known and important economic problem that a number of contractual arrangements and practices attempt to address.

Non compete agreements

Over time, employers have developed strategies to protect business interests challenged by the risk of employee turnover, including the financial reward of loyalty by linking wages to tenure. One of these strategies is to place contractual restrictions on employees, requiring them to agree not to compete with the employer upon departure from the firm. These covenants are typically described as non-compete agreements (NCAs) and their use is widespread although not universally enforced.

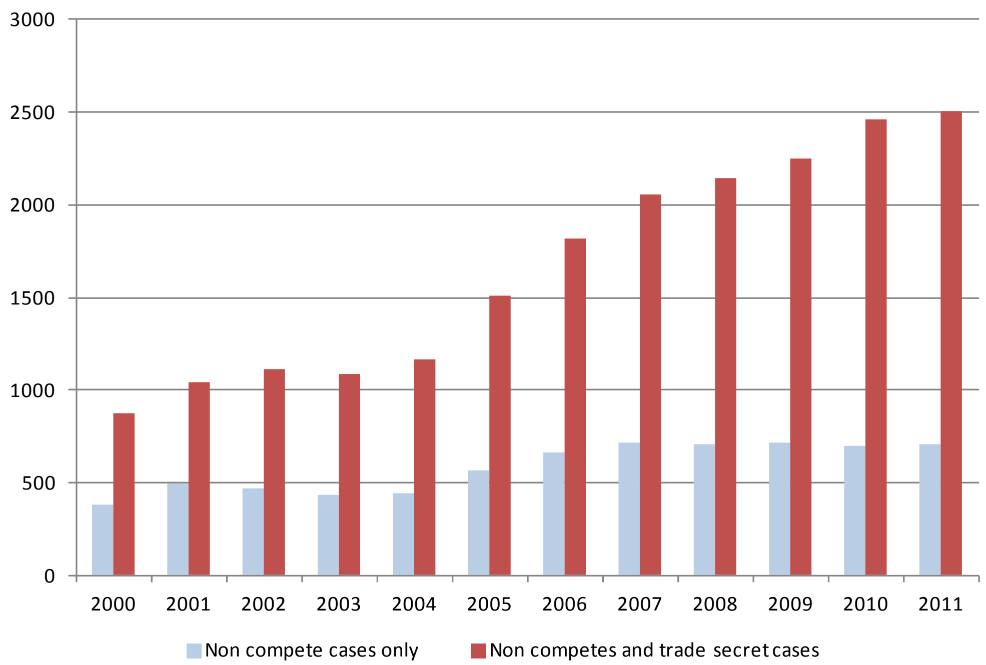
Non-compete agreements have been described as amongst the most sophisticated contractual instruments used in employment law today. By accepting non-compete clauses, which can be either included within the employment contract or agreed upon separately, the employee promises not to carry out a set of pre-defined activities for competing firms if a number of conditions are met. Such terms typically entail activities that are prescribed (e.g. an outright ban on working for a competitor), starting up her own business, field of services, and geographic and time limitations after the termination of the employment relationship with the current employer. NCAs can also include specific provisions regarding protection of confidential information, such as former client and colleague solicitation, and some cases, the NCA may include additional provisions which oblige the employer to compensate the employee for such restrictions (e.g. by granting gardening leave or paying a fraction of her average salary).

The existence of rules preventing their enforcement has been anecdotally linked to the entrepreneurial success of some states and industries, as in the outset of California's Silicon Valley when key inventors were allowed to set up their own companies after leaving large incumbent firms. Saxenian (1994) examined key differences between Silicon Valley and Boston's Route 128 as part of an investigation into the role of decentralised industrial and innovation systems with comparable technological capabilities. She famously concluded that Silicon Valley's success at various stages had been related to the tendency of skilled employees to move from company to company, and to more easily apply the knowledge they developed along the way. Gilson (1999) went further by arguing that jurisprudential differences between the state of California, which has banned non-competition agreements by statute since 1872, and Massachusetts, which permits non competition agreements, could have had the probably unintended consequence of making it relatively easier to move jobs ("job-hopping") in California, thus promoting an entrepreneurial community of technology-based start-up companies. While most observers are willing to agree with the general statement that "knowledge spillovers" provide economic benefits, some authors have counter-argued (Wood, 2000) that venture financing and start-up success has also been prevalent in regions where non-competition clauses are legal, suggesting that regions that enforce these agreements might have developed alternative mechanisms for ensuring labour mobility and the associated knowledge spillovers.

The potential impact of NCAs has been raised in the OECD Innovation Strategy (OECD, 2010a) alongside other labour market policies that may impact on the mobility of highly skilled personnel contributing to research and innovation activities. The use of NCAs appears to be more prevalent than commonly thought, judging by evidence from *ad hoc* surveys and litigation statistics from the United States. Litigation on non-competes appears to be increasingly associated with disputes regarding trade secrets (Figure 15).

Figure 15. Litigation trends for non compete agreements

United States, total numbers



Note: Red bars represent search counts of cases including non competes, trade secrets or both of them. Blue bars represent counts of non compete cases, regardless of whether they simultaneously involve trade secret cases.

Source: Beck (2012), based on Westlaw information on litigation cases. Accessed from http://faircompetitionlaw.com/

From an international comparative perspective, attention to legislation on NCAs in employment contracts and its impact has been limited and often restricted to analysis by legal practitioners. Most of the policy debate and available empirical evidence have been, to this date, largely US-centred, likely due to the combined effect of employee mobility being significantly higher than in many other OECD countries and, from a research perspective, the possibility of studying variation across states, thus enabling comparisons which are more difficult to support across countries with very different labour regulations and systems.

Table 11. Codification of legal restrictions on NCA enforcement

	High score	Medium score	Low score
Statute and enforceability			
Is there a state statute of general application that governs the enforceability of covenants not to compete?	Statutes are in place that favour strong enforcement of NCAs	There is no statute or when there is, it is neutral in its stance towards NCAs	There are statutes that significantly disfavour or ban enforcement
Breadth of protectable interest			
What is an employer's protectable interest and how is that defined? To what extent does it differ from trade secret and related protections?	The protectable interest is very broadly defined	Balanced approach to defining the protectable interest	The protectable interest is very narrowly defined
Time limitations			
Do statutes/courts enforce NCAs with terms longer than one year?	Typically they do accept such terms	Terms >1 year sometimes allowed	Term >1 year generally precluded
Functional limitations			
Are certain occupations, workers or groups exempt from NCAs?	Enforced for all types of workers	Some occupations exempted, earnings thresholds	Applicable to very limited set of occupations and types of workers
Compensation			
Is compensation formally required to support NCA or a factor considered in assessing reasonableness?	Compensation is not required and not taken into account	Some compensation required	Not accepted or very generous compensation required
Burden of proof			
What must the employer be able to show to prove the existence / reasonableness of an enforceable covenant not to compete?	Weak burden of proof on employer – burden on employee to waive NCA	Balanced approach to the burden of proof	Very strict burden of proof on the employer
Formal requirement for consideration			
Is a written agreement required and does the signing at inception provide sufficient consideration to support the NCA?	Written agreement not required. Start of employment sufficient	Sometimes sufficient to support NCA.	Independent consideration needed
Changes in circumstances			
Are NCAs still enforceable if employment circumstances change?	Valid if circumstances change?	Beneficial changes sufficient to support NCA.	The NCA is void if circumstances change
Termination			
Does the reason for contract termination define the enforceability of NCAs?	Always enforceable if employer terminates	Sometimes enforceable	Never enforceable if employer terminates
Modification by courts			
Do courts have the power to modify NCAs to ensure their enforceability?	Judicial modification allows - limited restrictions on maximum enforcement	Blue pencil: modifications were allowed to reform the contract instead of disallowing it outright	NCA deemed void if it does not to meet full legal requirements
Remedies			
Do courts grant preliminary injunctions and/or damages?	Courts grant preliminary injunctions	Limited damages, no preliminary injunction	No injunctions – very limited / no damages
International			
Are foreign NCAs enforced in the territory?	Always	As long as consistent with local rules	Apply domestic rules not to enforce

Source: OECD, principally based on Bishara (2011).

To address this evidence gap, the OECD undertook an initial investigation of legal sources to identify how countries regulations and judicial practices differ in their enforcement of NCAs, examining a broad range of factors that characterise whether and, if so, how authorities consider NCAs to be “reasonable”. Among other parameters considered (see Table 11), the analysis of enforcement practices captures information on the breadth of employers’ protectable interest (e.g. whether these interests go beyond trade secrets), the use of time and regional limitations, the special treatment of certain “knowledge workers”, the required compensation for employees prevented from competing, the ability of courts to modify NCAs, and the possibility of awarding injunctions.

The results from an initial examination of legal sources indicates that, in addition to the better known examples of certain US States such as California, countries such as India, Israel, Mexico, Luxembourg and the Russian Federation rarely enforce NCAs (Table 12). Chile and a number of “common law” countries such as United Kingdom, Australia and New Zealand have regimes in which the enforcement of NCAs is permitted but only under restrictive circumstances.

In contrast, most European continental countries and a majority of US states have a more permissive approach towards NCAs, although their statutes often require payment of compensation for affected employees, which in some cases can be particularly large. The enforcement of NCAs is evolving through legislative reform and case law arising from decisions by courts. For instance, the Slovak Republic reformed its system late in 2011 to allow the use of NCAs as part of a wider range of labour market reforms.

Policy and court decisions on NCAs can have broad ramifications. A reduced level of enforcement for NCAs can potentially increase litigation around trade secrets, or encourage firms to adopt other anti-competitive practices to limit the flow of employees across firms. For example, US authorities have been looking at the alleged use of agreements between major IT companies not to poach each others' employees. In small countries, NCAs may have relatively little independent impact because of the limited scope for employee mobility, particularly in highly specialised jobs.

There are concerns, and some evidence that companies often use NCAs strategically, for purposes other than preserving trade secrets and other valuable knowledge. For example, NCAs are often presented to employees after they have signed their contracts or on their first day at work, when their bargaining power is limited (Marx, 2011)[24]. The available evidence suggests that NCAs often lead employees to take career detours away from their field of expertise, which may be socially wasteful and discourage specialisation and moves from academia (where NCAs do not apply) into industry (Marx and Fleming, 2012).

Research shows that NCA enforcement does reduce skilled labour mobility across firms in the relevant jurisdiction (Marx, Strumsky and Fleming, 2009), while encouraging key knowledge workers such as inventors to take jobs in areas where NCAs are not enforced (Marx, Singh and Fleming, 2010). However, the evidence on the impact on entrepreneurship and innovation is ambiguous. For example, if NCAs are enforced, employees might be less willing to leave an enterprise to work for start-ups. But, in the absence of NCAs, incumbent firms might also poach key staff from young innovating competitors. The impact on R&D efforts and patenting can also have uncertain impacts.

Table 12. Country observations and comments – NCAs not or lightly enforced

Country	General comments and key features
Australia	Common law declares restraint of trade clauses as prima facie void as considered against public policy. Restraint clauses must be proved reasonable. No formal requirement on compensation. New south Wales allows contracts to be modified.
Chile	Non-compete clauses made after termination of the employment contract are only accepted to a limited extent as they are deemed to be in conflict with the constitutional rights established in Article 19 Nos 16 and 21 of the Constitution, namely freedom to contract in labour matters and the right to develop any economic activity. The "Dirección del Trabajo" has rejected non-compete clauses having effect after termination of the employment contract by Ruling 4,392/187 dated 6 August 1992 and Ruling 5,620/300 dated 22 September 1997.
Czech Republic	The employer is obliged to compensate its employee with his or her **full average salary** during the effective period of non-competition. The maximum period is 12 months.
Slovak Republic (until September 2011)	Non-compete clauses which apply after termination of employment were not permitted under Slovak law prior to 2011. Work Inspectorates were able to impose a **fine** of up to EUR 100K if the employer had concluded a non-compete clause with its employee. However, from September 2011, an amendment to the Act 311/2001 Coll. Labour Code introduces the possibility of using NCAs that apply after the conclusion of the employment relationship.
Israel	Recent case law (see main text) has led some authors to conclude that Israel's National Labor Court's interpretation of the Basic Law of Freedom of Occupation effectively coincides with the California approach to NCAs.
India	Agreements in 'restraint of trade' are governed by Section 27 of the Indian Contract Act 1872. Generally speaking, the validity and enforceability of a non-compete clause usually depends on whether or not such a clause constitutes or amounts to 'restraint of trade', which apart from a few exceptions, is barred by law. All restrictions which operate after the term of the contract are void except in cases of the sale of goodwill, where protection may be given to the buyer. An employer would only be entitled to protect his proprietary interest, namely his trade secrets, confidential information, intellectual property, etc. and can in no way restrict an employee from working with anyone after termination of the contract.
Luxembourg	It is not possible to prevent an employee from working in competition with the former employer if this is done through a new employer, as the Luxembourg labour code only serves to prevent former employees from running their **own businesses** and does not stop employees from working for competitors within the framework of new employment contracts. Annual gross salary of the employee concerned must be at least EUR 47,875.60. It cannot be extended outside the Grand-Duchy of Luxembourg. A non-compete clause must also to be restricted to a specific professional sector as well as to professional activities which are similar to those performed by the employer, limited to a maximum 12 month period.
Mexico	Under Mexico's Constitution (Article 5), nobody can be impeded from dedicating to the profession, industry, business activity or type of work that she/he so elects. In the context of an employment agreement, provisions can only deviate from labour law principles if such deviation is more favourable to the employee and the employee's Constitutional guarantees are not violated. An employer may not specifically enforce a covenant not to compete, but any breach of such covenant may give rise to an action of money damages.
Russian Federation	Russian law does not allow for an employee to be restricted from working for another employer (a competitor of the company) during the employment or for some time after its termination. If a non-compete clause is included in an employment contract, it cannot be legally applied and will not be enforceable in the Russian courts. In practice, many employers (especially companies with foreign management) often include non-compete provisions in their employment contracts and other labour related documents as a 'moral' obligation on the employee. The provisions of Russian law on the protection of information comprising commercial secrets (including production secrets) of the company are reported to be in turn rather strict.
United States (California)	Under California law, covenants not to compete are generally void and unenforceable: "Except as provided in this chapter, every contract by which anyone is restrained from engaging in a lawful profession, trade, or business of any kind is to that extent void." Cal. Bus. & Prof. Code § 16000.
United Kingdom	Covenants not to compete after the end of the employment are unenforceable unless the employer can show that they are reasonable. Courts favourable to preventing restraints on trade. Less than one year in practice. Trade secrets and confidential information are automatically protected even without a covenant.

Source: OECD, based on multiple sources.

Initial OECD analysis has exploited data by Bishara (2011) on changes in enforceability of NCAs across US states for the period 1991-2009 to investigate the statistical relationship, not necessarily causal, between enforcement and two typically-used proxies for innovation, namely R&D expenditures and patents granted. A simple difference-in-differences approach is used comparing states that increased (decreased) their relative degree of NCA enforcement *vis à vis* changes in the variables of interest. The regression results reported in Table 13 correspond to very simple specifications in which only a limited number of controls are accounted for and no real instrument are used for identifying the causal impact of policy changes on the innovation measures. To the extent that those changes may have been driven by groups with significant interests in the outcomes, the results would be biased in either direction.

Table 13. Changes in NCA enforcement rankings, R&D and patenting

US states, 1991-2008/9

	Change Log R&D	*Change Log R&D*	*Change Log R&D*	*Change Log R&D*	*Change Log Patents*	*Change Log Patents*	*Change Log Patents*	*Change Log Patents*	*Change Log Patents*	*Change Log Patents*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
NCA enforcement ranking change	0.002 (0.002)	0.005 (0.002)*	0.005 (0.002)**	0.006 (0.003)*	0.002 (0.005)	0.001 (0.005)	0.001 (0.005)	-0.020 (0.003)**	-0.020 (0.004)**	-0.023 (0.004)**
ChRank MidPat91*				-0.001 (0.004)				0.028 (0.005)**	0.027 (0.005)**	0.028 (0.005)**
ChRank HighPat91*				-0.001 (0.006)				0.031 (0.007)**	0.031 (0.006)**	0.035 (0.006)**
Log R&D91		-0.059 (0.019)**	-0.524 (0.290)	-0.528 (0.294)						0.264 (0.097)**
LogR&D91^2			0.065 (0.049)	0.065 (0.049)						
LogPat91						0.023 (0.055)	0.044 (0.517)	0.236 (0.520)	0.093 (0.414)	-0.181 (0.097)
LogPat91^2							-0.004 (0.095)	-0.036 (0.098)	-0.006 (0.079)	
Change LogR&D									0.326 (0.109)**	0.507 (0.114)**
Intercept	0.457 (0.032)**	0.869 (0.141)**	1.425 (0.411)**	1.433 (0.419)**	0.254 (0.031)**	0.193 (0.153)	0.167 (0.675)	-0.135 (0.671)	-0.126 (0.518)	-0.334 (0.169)
R^2	0.00	0.13	0.15	0.15	0.01	0.01	0.01	0.28	0.39	0.47
N	51	51	51	51	51	51	51	51	51	51

Note: Ordinary least squares regression results resported. * p<0.05; ** p<0.01 Robust standard errors within parentheses. In the final specification, the net coefficient for "ChangeRank" for the high patent group is 0.012 (=ChRank+Interaction) (SE=0.004**)

Source: OECD. Analysis based on enforcement ranking change data in Bishara (2011), USPTO state-level patent data for 1991 and 2009 www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utlh.htm and NSF National Patterns of R&D Resources 2012 (2004) for 2008 (2001) R&D data. www.nsf.gov/statistics/natlpatterns/.

The "Change Rank" variable (positive if a state's enforcement strength ranking declines) is on its own positively related to both changes in R&D and patents, although the effect is not statistically significant (cols 1 and 5). In the case of R&D, accounting for the fact that R&D grows proportionally more in states with lower R&D levels at the beginning of the period leads to more precise estimates of the impact of NCA enforcement rank (cols 2-4). It is not possible to identify to what extent this is driven by R&D conducted by either existing or firms newly set-up, possibly moving from another region. In the case of patents, we do not observe any sort of convergence in performance as observed for R&D, as the growth rate in patents between 1991 and 2009 is unrelated to the 1991 level. What we do see is that the changes in enforcement intensity appear to have a different impact among regions with initially high or low numbers of patents. Thus a relaxation in NCA enforcement in states with initially high number of patents is observed to be linked with faster growth in patents granted, while a similar shift for initially low patenting states appears to be associated with a lower growth in patents. This result is too broad to be interpreted as evidence of any particular mechanism through which NCA enforcement impacts on innovation in a given region or state.[25] Patents provide an indicator of the outcome of innovation efforts but patenting intensity can also increase in response to a perceived need to protect the company's inventions. Thus an increase in the patenting rate may be due to an increasing difficulty in protecting secrets as a result of reduced enforceability. Further checks are needed to assess to what extent this applies to patents in different technology classes.

The heightened potential for employee departure may introduce uncertainty into an acquirer's expectations about the return potential of the acquisition: if a target firm's employees are more likely to leave after an acquisition, the firm will be less attractive to acquirers and acquirers will be less likely to bid for the firm. Younge, Tong, and Fleming (2011) show a significant increase in the likelihood of Michigan firms becoming an acquisition target after non-compete enforcement was strengthened by legislative changes in 1985. They also provided evidence that the effect was stronger when the firm was exposed to greater risks of employee mobility, such as when the firm employs more knowledge workers in its work force and when it faces greater in-state competition. By contrast, the effect is weaker when the firm is protected by a stronger intellectual property regime that can mitigate knowledge loss due to employee mobility. Younge and Marx (2012) found that enforceable non-compete agreements boosted companies' Tobin's q by 26-30% in the short run, a result that was found to be robust to a number of alternative specifications and placebo tests.

The study of NCAs and their economic impact highlights the importance of assessing the systemic nature of the innovation system. While investment in innovation by any given firm may be encouraged through the strict enforcement of NCAs, this may not be necessarily optimal from the perspective of the system as a whole if the circumstances are such that the benefits arising from higher human resource mobility and knowledge flows outweigh the impact on the specific incumbent. The regulation and enforcement of non-compete agreements lie at the complex intersection of employment, IP, contract and competition law. These various strands of law need to be considered as an interlinked set of rules that shape the relationships within the innovation system and the investment decisions of firms and individuals.

Policy makers can focus their future monitoring of existing practices by identifying how trade secret legislation and NCA rules interest, and exploring how they can best address the strategic use of NCAs for purposes other than protecting legitimate business interests. For example, the US state of Oregon recently passed legislation requiring firms to make clear in offer letters whether employees will be expected to sign non-compete agreements, thus precluding the abuse of dominant position to impose NCAs after the terms of employment have been discussed. An improved evidence base would be an essential step for identifying which are the features of the labour market for inventors and other key knowledge workers that prevent flows from academia into research occupations in the business sectors.

8. CONCLUDING REMARKS AND MEASUREMENT IMPLICATIONS

The project on knowledge, networks and markets has attempted to shed new light on the centrality of KNMs to the functioning of the innovation system. Evidence is emerging on how KNMs have a critical role as bridging mechanisms and catalysts. It is only by accumulating often disparate sources of evidence that is possible to demonstrate how these arrangements and institutions can play a part in helping countries tackle some of their most pressing challenges. Efforts to understand the role of knowledge networks and markets (KNMs) should be considered in the wider context of the OECD search for policy best practices that help improve the use of existing knowledge and increase the level and quality of innovation in the global economy in order to increase economic growth and societal wellbeing.

Knowledge networks and markets should be recognised as being context-specific and should therefore be regarded as relevant to part of a wider toolkit, and not indiscriminately prescribed across all possible domains. The promotion of knowledge markets should not be considered as a legitimate policy objective on its own right, but as one set of potential instruments for achieving a wide range of policy objectives. Policy makers should be mindful of the potential distortions that markets and the intermediaries that operate within them might cause to incentives to invest in innovation and its potential outcomes...

The interest in KNM is based on the notion that ideas and knowledge need to be put to work. While more knowledge is now susceptible to being disembodied and traded, which can result in reduced transaction costs, it is still true that information, as expressed in textbooks or patents, usually needs investing in and interpreting by experienced people, or teams of people, with rich supplies of tacit knowledge and relevant implementation skills. Such tacit knowledge may in turn become the scarcest and more valuable factor of production. It is possible to understand observed patterns of location and co-location in knowledge intensity industries from this perspective. This reality helps redefine KNMs more clearly, as proxies for the kind of people-centred knowledge-sharing that actually leads to innovation and economic growth.

The resources for innovation and growth within small and large companies are increasingly driven by their access to knowledge markets and networks, involving a combination of closed and open, proprietary and free approaches. The coexistence and potential synergies between these approaches is exemplified by practices being adopted in some newly emerging technology domains the OECD and the CSTP has been looking at in recent years.

Trust, commitment, reciprocity and openness are all vital to effective markets and networks in which knowledge effectively flows. For example, some industries with a pressure to deliver “winner-takes- all” blockbuster discoveries, may fall short from delivering sustained innovation through an over-emphasis on confidentiality and insufficient collaboration. This problem can be bridged in part through pre-competitive knowledge networks - which enable closed industries to experiment with greater openness. The use of trusted intermediaries to aggregate confidential knowledge, draw conclusions from it and then pass those conclusions back to consortium members may also be valuable. Promoting pre-competitive information sharing and research collaboration can expand the knowledge commons, delaying the point at which companies feel they must start protecting their competitive differentiation.

Markets for IP rights are particularly complex for policy analysis purposes and, on the evidence available, it is not possible to conclude that achieving larger markets is necessarily a sensible policy objective to pursue. The absence of a healthy market for IP rights may be a symptom rather than the cause of weakness in an innovation system. Policy makers should concentrate on identifying these ultimate causes and evaluating the appropriate mechanisms for dealing with them. Among these, measures that improve the ability of markets to address the fundamental asymmetries that limit their effectiveness could feature quite prominently, but due care should be given to potential unintended impacts.[26]

Box 14. Measurement implications

Mapping the innovation system and knowledge flows within it has been a long-standing ambition of the CSTP and its working parties as they have developed conceptual, analytical and measurement frameworks that support policy decision making across the OECD. This requires a modern infrastructure which cannot be built overnight. Some countries have developed comprehensive strategies to trace some of the flows of knowledge and funds as relevant to their national systems. In a highly globalised works, these approaches need to consider their implementation on a truly global scale.

Through the KNM work on indicators, four broad areas for measuring knowledge flows have been identified:

- **Skills mobility and knowledge flows through people**. The specificities of knowledge embodied in people and the very different types of data required for tracing these types of flows warrant special measurement efforts, highlighting a number of indicators on the allocation and mobility (sectoral and international) of highly skilled individuals, from general graduates through to very specific populations such as that of doctorate holders or patent inventors.

- **Disclosing and accessing knowledge**. Analysing the access to and use of knowledge sources found elsewhere in the innovation system, including repositories of disclosed information on science and technology, is of key importance. Citations of scholarly and patent publications provide a relevant source of knowledge connections, but are not the sole one. New approaches are emerging for tracing wider user communities and developing a more integrated measurement system that spans different, less traditional knowledge "communities".

- **Transacting on knowledge and knowledge rights**. Traditional and new evidence sources on how different actors transact with other parties to procure knowledge. Current data on R&D funding flows and disembodied technology trade have significant limitations but also offer considerable potential. Transactions can relate to payments for accessing existing knowledge or benefiting from rights over it, but can also involve agreements to provide custom knowledge solutions.

- **Co-creating new knowledge**. Moving beyond transactions, several sources of evidence point to indicators of collaboration efforts carried out in the pursuit of creating new knowledge. This includes the process of scientific creation, technological invention and introduction of new products and process. In contrast with transactions, collaborations involve shared efforts, risks and, obviously, the upside from any resulting knowledge.

The risk that measurement systems fail to keep up with the rapid changes in the system may lead to the policy debate focusing on few, easier-to measure indicators which do not reflect the rich variety of mechanisms for exchanging and using knowledge. Building a system capable of capturing differences between knowledge production and use (as in the case of R&D), capturing partnerships and their financial dimension, monitoring the combined outward and inward dimension of knowledge flows, and going beyond IP indicators as measures of third mission output of public research organisations rank amongst the most important evidence gaps at present.

Although knowledge is inherently connected, existing databases are not and there are considerable technical and institutional difficulties in linking across them (OECD, 2010b). For example, concerted efforts need to be made to disambiguate people and organisations engaged in knowledge creation. Raw data-sources have to be transformed into standardised databases on which matching functions can be used to obtain derived and cross-linked information which can be mined for various purposes. One example is research outcomes tracking, aggregating and analysing research, publications, patents and finally, products. Measurement standards need to adapt to improve the interoperability of STI data sources across different domains, such as R&D, patents, other forms of registered IP, scientific publications, innovation survey data and administrative sources, and develop solutions that address the impact of knowledge flows on the interpretation, relevance and international comparability of existing STI indicators.

NOTES

1. This work is being replicated across other non EU countries with similar data sources.
2. See OECD *R&D Statistics* database and *Main Science and Technology Indicators* (www.oecd.org/sti/msti).
3. In her presentation at the KNM workshop held in June 2011, Prof. Ellen Enkel highlighted the distinction between mechanisms aimed at securing knowledge from (a) within the organisation ("the people we have"), (b) within the communities of interest, e.g. key customers, investors, known experts ("the people we know") and (c) within the broader crowd, both lay and expert ("the people we don't know"). See also Enkel (2010).
4. See http://www.w3.org/standards/semanticweb/. The term "Semantic Web" refers to W3C's vision of the web of linked data. Semantic Web technologies enable people to create data stores on the Web, build vocabularies, and write rules for handling data. Linked data are empowered by technologies such as RDF, SPARQL, OWL, and SKOS.
5. Examples included Yet2, Flintbox, Ideaconnection, SparkIP, Techtransferonline, Patentcafe (2XFR), Ideaconnection and Taeus, some of which are described in Yanagisawa and Guellec (2009).
6. For a number of reasons, patenting activity in emerging fields such as nanotechnology, green materials, bioinformatics and synthetic biology has not reached comparable levels to those found in ICT, and some of these domains are heavily influenced by an open science ethos which is associated with public funding. IPRs other than patents have played a significant role, such as copyrights and trademarks.
7. Survey of Intellectual Property Management (2012).
8. According to Gans *et al.* (2008) analysis of the determinants of firm choice to sell the technology or to operate in the downstream final market, weak IP discourages technology sales. A number of studies also provide evidence that weak IP right protection discourages entry of technology specialists in the chemical engineering (Arora et al., 2001b), semiconductor (Hall and Ziedonis, 2001) and software industries (Cockburn and McGarvie, 2006).
9. In instances where complex, overlapping claims and rights apply to their products or processes, companies may be driven to acquire rights to patents to protect themselves against the risk of patent litigation. By stockpiling on rights which competitors may infringe upon, companies can retaliate against or neutralise threats of suits, securing better cross licensing terms and ultimately securing a freedom to operate.
10. Royalties account for approximately 40 % of the gross income reported by the NAICS533 Lessors of Nonfinancial Intangible Assets (except Copyrighted Works) sector (which accounts for approximately between 1 and 2% of the total).
11. With significant informational asymmetries, the signal that a firm is willing to sell may generate questions about the actual value of the patent (for otherwise the owner would have tried to retain some equity). This adds up to the winner's course problem, whereby the ultimate buyer (i.e. the auction winner) is the least informed party that has paid over the odds for the rights. This in turn is likely to be a deterrent for buyers when making bids and may result in mutually beneficial trades not taking place at all.
12. A number of factors, particularly related to tax rules regarding the treatment of licensing revenues and costs, may lie behind the strategy to consolidate IP assets in subsidiary companies.
13. It is important to note that official statistics will be not be necessarily based on the same classification criteria to give rise to the classifications applied for other registration purposes.

14. The business model pursued by PAEs has been criticised by some authors for penalising independent innovation (Bessen et al., 2011), while others have claimed that it facilitates technology markets and increases rents for small inventors (Hosie, 2008).

15. While intangibles have always been included in a blanket lien on all assets, it is becoming more commonplace for creditors to focus their analysis more directly on intangibles, either as a separate asset or as an integral part of overall company value. Most banks insist on obtaining a security interest in the IP owner's trademarks, copyrights, and patents using a security agreement that greatly favours the bank and may severely restrict the IP owner's ability to alienate any of its intellectual property assets in the normal course of business. Under international banking regulations, banks however cannot use intangibles as Tier 1 capital, which tends to reduce their attractiveness as an asset class.

16. In Europe, a "loser pays" principle applies and the use of contingency fees is also limited by law. These measures increase the expected cost of litigation and reduce the likelihood of settlements to avoid nuisance. Such settlements may have negative externalities on the system as a whole as they could encourage further rent seeking behaviour. In the United States, a 2012 legislative proposal entitled "Saving High-tech Innovators from Egregious Legal Disputes" (SHIELD) Act would require a non-practicing entity to pay the legal costs of the company it sued if a court determines the lawsuit didn't have a reasonable likelihood of succeeding. As proposed, the SHIELD Act would only apply to software and computer hardware patents.

17. See www.epo.org/news-issues/news/2012/20120124.html and www.uspto.gov/about/stratplan/ar/2011/mda_02_03.html

18. See for example Federal Trade Commission (2011).

19. WIPO Information Meeting on Intellectual Property (IP) Financing. WIPO/IP/FIN/GE/09/7 Geneva, 2009. Accessed from: www.wipo.int/meetings/en/2009/ip_fin_ge_09/

20 . For example, recent OECD work is looking at whether the current rules allow for the allocation of taxable profits to locations different from those where the actual business activity takes place, also known as Base Erosion and Profit Shifting (BEPS). www.oecd.org/tax/beps.htm

21. This section draws heavily on recent work carried out under the aegis of the OECD Working Party of Innovation and Technology Policy (TIP) as part of its project on financing, transferring and commercialising knowledge.

22. Previously in 2003, the Lambert toolkit was developed in the United Kingdom for universities and companies wishing to undertake collaborative research projects with each other or join broader consortia. See www.ipo.gov.uk/lambert

23. See www.ibridgenetwork.org/

24. In the sample of engineers studied by Marx (2011), 70% of non-compete requests were handed out for signing by the employee only after the job offer has been accepted, mainly on the first (or even after) the first day at the company

25. Furthermore, a complete analysis should focus on the R&D and patenting carried out in companies and organisations for which the enforcement of NCAs is applicable.

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ANNEX: OECD PUBLICATIONS ON INTELLECTUAL PROPERTY AND KNOWLEDGE NETWORKS AND MARKETS

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