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FINANCING TECHNOLOGY TRANSFER

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Abstract

Global policy discussions increasingly focus on innovation and the knowledge economy as a driver of long-term growth. In parallel new forms of innovation processes are emerging, notably open innovation and innovation networks stressing the importance of connections between various stakeholders. Links between universities and the business sector are of particular importance as many inventions come out of universities but have to be further developed to become economically relevant innovations.

New financing instruments and attracting private investors to Technology Transfer (TT) are necessary but difficult as the pattern of risk and information in this 'in-between area' is complex: Technology is not basic anymore and it requires large amounts of capital to be scaled up – with uncertain market prospects. This paper addresses new financial instruments for TT, building on European Investment Fund's experience in this field.

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Executive Summary

This paper addresses new financial instruments for Technology Transfer (TT) against the background of the EU´s support of innovation. Global policy discussions in the context of the current crisis increasingly focus on innovation and the knowledge economy as a driver of long term growth[1]. In parallel new forms of innovation process are emerging notably open innovation and innovation networks stressing the importance of links and connections between the various stakeholders. Links between universities and the business sector are of particular importance as many inventions come out of universities but have to be further developed in order to become socially and economically relevant innovations. Attracting private investors to TT operations is necessary, but difficult as the pattern of risk and information in this 'in-between area' is complex: the technology is not basic anymore, it requires large amounts of capital to be scaled up notably in biotech and lifescience, but its markets prospects remain too uncertain to attract standard financial instruments.

Hence the need to design specific financial instruments which will allocate appropriately the risk and provide the right incentives for all parties is a prerequisite for attracting more private capital in TT. This paper presents some of these possible instruments, putting them in the context of the European Investment Fund activities. Direct support to Technology Transfer, Pre-seed and Seed, Business Angels, and incubators are important instruments; notably through a more active commercialisation of intellectual property (IP). IP management has to be integrated in these strategies from the outset, as IP is a major instrument for transferring knowledge and generating revenue.

[1] See Policy Responses to the Economic Crisis, OECD June 2009
http://www.oecd.org/dataoecd/59/45/42983414.pdf

1. Innovation and the Knowledge Economy

1.1 Where is Lisbon?

According to the European Commission, "Europe's research and industrial base suffers from a series of weaknesses. The greatest perceived weakness, however, is Europe's comparatively limited capacity to convert scientific breakthroughs and technological achievements into industrial and commercial successes" (e.g. European Commission 1994). This assessment has served as major catalyst for making innovation policy a strategic priority for the EC. In its broad-based innovation strategy for the EU, the importance of improving knowledge transfer between public research institutions and third parties, including industry, has been identified by the EC as one of the key areas for action (European Commission 2007b) and reiterated in its recent review of the EU innovation policy (European Commission 2009).

There is the well-known Lisbon-objective that the EU shall become in 2010 "the most competitive knowledge-based economy of the world" (Lisbon Summit 2000) with expenditures of 3% of GDP for R&D. However, with only a few months left in 2009 and despite increased financial efforts and structural reforms implemented in several countries during the past years, Europe has not significantly improved its competitive position (Guellec and Sachwald 2008). Europe will not be able to meet the target in 2010, so what is necessary to improve the situation in the future?

Strengthening EU invention capacity is a necessary but not sufficient condition as already stressed by Schumpeter (1951) "Economic leadership must be distinguished from invention. As long as they are not carried out into practice, inventions are economically irrelevant". Future growth will be determined by the Schumpeterian entrepreneur being able to transform the invention and new knowledge into practice through innovation. In this context, the term "marriage of new knowledge with its successful introduction into the marketplace" is often used (*e.g.* Baumol *et al.* 2007, p. 5).

1.2 Innovation is key

Hence, stronger innovation is the key element. The Oslo manual (OECD, Eurostat 2005) defines Innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relation. The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm".[2] It is – to say it with Peter Drucker's words – the change that creates a new dimension of performance.

The sources and conditions for innovation are variegated. Many innovations, notably non-technological ones (marketing, organisation, distribution *etc.*) come directly from the effort of firms and specialised in-house departments implementing their own ingenuity. However, many other innovations proceed from inventions, often based on R&D performed by high-tech firms or universities. They are more intensive in scientific knowledge, they are often more radical or disruptive (transformative of market conditions). This demonstrates the importance of a high-quality, vibrant university sector which performs the best basic research.

The issue in those cases is how to bring the invention from the lab to the market, gathering both the funding and the knowledge transfer which are required. This is all the less trivial when the invention is made in a university (as opposed to a corporate) laboratory, which usually does not have the skills and incentives to transform the invention into an innovation. The two issues, raising capital and transferring knowledge, cannot be addressed separately: designing the right incentives and sharing risk optimally between the parties requires the two aspects to be solved simultaneously, using then appropriate intellectual-property (IP) and financial instruments. This is the focus of the rest of this paper.

1.3 Small is beautiful – but so is large

Innovation is important for SMEs and corporates – and SMEs and corporates are essential for innovation. Empirical studies show that innovative small and medium-sized enterprises (SMEs) grow faster and create more jobs than non-innovative SMEs. They are the so-called Gazelles. Empirical studies (see *e.g.* KfW 2006) show as well that innovative start-ups (where the creation of the start-up was based on an innovation) create more new jobs than non-innovative start-ups.

2 Source: http://ec.europa.eu/enterprise/policies/innovation/glossary/index_en.htm

However, policy measures should not only focus on SMEs. The share of innovative SMEs increases gradually with the size of the companies. As early as 1942, Schumpeter describes the innovative power of bigger enterprises – they have the necessary resources to finance substantial R&D project. These ideas have also been discussed by Galbraith (1952) and Arrow (1962). Policy measures should recognise that large firms are essential for the innovation system. The recent trend of concentrating resources on SMEs ignores the natural ecology of industry. An often neglected target group is the medium-sized firm above the SME threshold. This category probably has the greatest potential for increasing R&D spending but has also been struggling to do so in recent years (Aho 2006).

The contribution of small and medium-sized innovative firms is also key for large firms: many of the smaller firms are acquired at some stage by large ones, which use them as a source of radical innovations that the more closed and stratified context of large firms does not facilitate. At the same time, access to the funding, manufacturing and distribution capacities of a large firm allows in many cases to leverage the innovative performance of small firms. In the information technology or biotechnology sectors this dynamic has been essential to industrial development.

The reasons why Europe is currently not able to meet the Lisbon goals have been discussed extensively in various reports (see *e.g.* Guellec and Sachwald 2008; Aho, 2006). The connection between academia, which generates new inventions, and the business sector, which can transform them into innovations is too weak. Innovative businesses face difficulties to access capital and markets; reasons are risks, external benefits associated to R&D programmes, and the cost structure (high fixed costs, low marginal costs). Hence the need for new financial instruments as part of public policies to boost technology transfers between universities and businesses and to ease the setting-up of new businesses exploiting university inventions.

1.4 Knowledge exploitation

Knowledge creation and diffusion are more and more integrated into the notion of open innovation (see OECD 2008), corresponding to the increased organisation of innovative activities across firm boundaries to optimise the use of internal and external sources of innovation. The sourcing of external knowledge and the commercialisation of in-house innovations leads to the emergence of new networks to share and exchange knowledge. In turn, the development of innovation networks helps create new markets for ideas and technologies to facilitate the exchange of Intellectual Property (IP) between parties, the signing of research contracts or the creation of spin-outs. New forms of knowledge exploitation and the creation of technology markets require the design of appropriate financial instruments to support the circulation and commercialisation of knowledge.

Such an evolution should be connected to Europe's own ability to turn new ideas and inventions into products and services responding to client needs. In addition, the European technological landscape is still mainly supply-side oriented partially due to the lack of adequate matching interfaces between the supply and demand for scientific knowledge.

Dissemination of created knowledge and commercialisation of IP rights are closely connected to the different phases of growth of technology start-ups. They broadly evolve through the following phases of development from downstream to upstream investment:

- "Technology transfer" phase: from invention and IP generation to business concept, proof-of-concept phase and first customers;
- "Venture" phase: developing a product line, broadening the customer base and establishing a full-fledged business;
- "Expansion" phase: Once the business opportunity is proven, the business needs to expand, distribution channels need to be set up, marketing efforts need to be developed and large-scale production capabilities need to be put in place.

Across Europe, it is often the first and third phases that are most difficult to finance.[3]

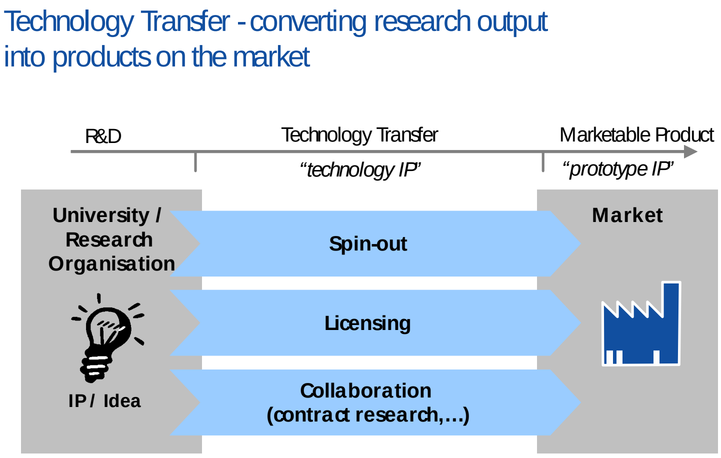
[3] Other related market segments like pre-seed and seed investments, Business Angel investing and clusters/incubators face similar challenges.

2. Converting research into products

Technology transfer (TT) can be broadly defined as the process of converting scientific findings from research organisations into useful products by the commercial sector. TT is also known as "knowledge transfer or knowledge sharing". This is the process whereby an enterprise converts scientific findings from research laboratories and universities into products and services in the marketplace.[4] TT can take three main channels (Figure 1):

- The creation of new companies (spin-outs), which often involves some transfer of personnel (mobility of researchers);
- Collaboration between universities, research organisations and industry notably via research contracts; and/or
- Licensing of IP.

Figure 1: The idea of TT from universities/research centres to the market



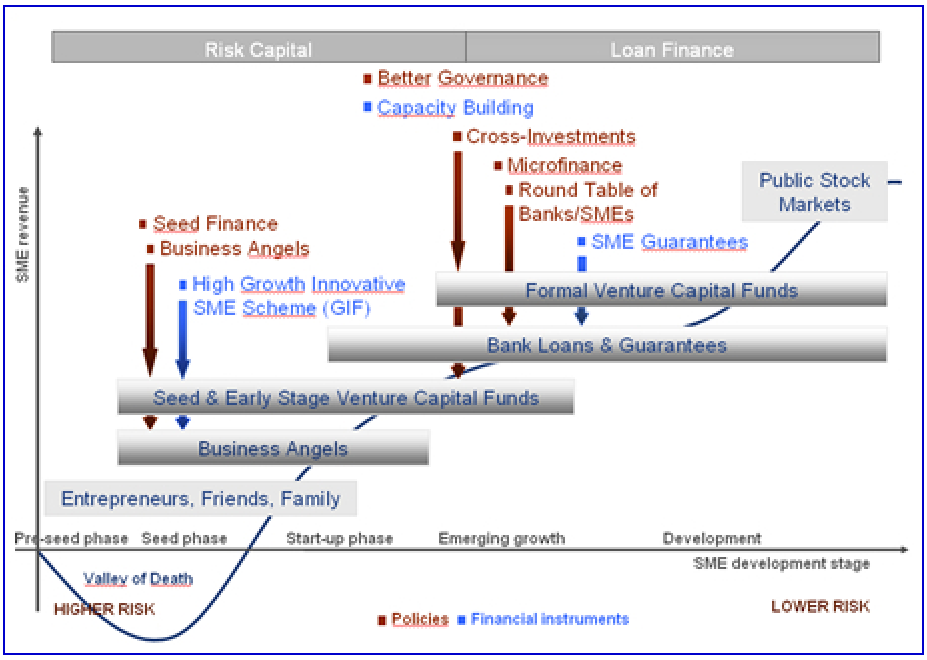
Source: EIF

TT presents specific features discussed in this paper. Many such features are also found in other areas of "upstream investing" (Business Angels, Clusters, pre-seed, seed investments).

Figure 2 below summarises the SME life cycle and the related financing needs. TT is to be seen on the left hand side of the graph. But this only captures technology transfer incompletely. TT or the commercialisation of research also takes many other forms than the SME life cycle (licensing, corporate venture *etc.*). Box 1 provides a more elaborate presentation of the importance of licensing.

4 See also: http://ec.europa.eu/enterprise/policies/finance/index_en.htm

Figure 2: Positioning of TT in the company/spin-off market segment



Source: European Commission (2009a)

Box 1: Exploiting patents through licensing[5]

Various types of licensing are practiced, including unilateral licensing, cross-licensing and patent pools, all of which involve an agreement by the owner of a patent (licensor) to allow another party (licensee) to make, sell and use the patented invention on an exclusive or non-exclusive basis, without transferring ownership of the patent. Usually, a licensor receives financial rewards in exchange for the licence, typically in the form of royalty payments. Licensing is therefore one suitable mechanism for transferring technology between licensors who want to leverage their technological assets and licensees who want to complement their internal technological capabilities.

The advantages and disadvantages of licensing can vary from one case to another. In some cases, a patent licence itself is not sufficient to enable a licensee to bring a new product or service to the market because additional know-how is needed, in the form of documentation, software, samples, training and consulting services.

Table B1. Advantages and disadvantages of patent licensing

Inward-licensing	
Advantages	• Licence payments tend to be less costly than in-house R&D • Payment can be used to control risks by prudent design of payment scheme • Shortens the time required for R&D and bringing new products into markets • Lower risks when an invention has already been commercialised
Disadvantages	• Some restrictions in licensing agreements may raise antitrust concerns
Outward-licensing	
Advantages	• High profitability, although revenue streams are uncertain • Allows multiple licensees at the same time • Less risky than Foreign Direct Investment (FDI) • Simplicity if licensee does not need technical advice (only contract drafting needed) • Especially for SMEs, lowers risk by eliminating need for downstream production facilities
Disadvantages	• Potentially creates rivals in downstream markets who could erode future profits • Total profit is usually smaller than with successful internal development • Returns depend on capability of licensees to develop and market the invention

[5] This box is based on Kamiyama *et al*. (2006).

As will be explained in Section 3, the size and evolution of technology licensing markets is difficult to measure. Accounting rules do not require firms to disclose patent licensing revenues as a separate item in corporate reports, and although most OECD countries have regulatory requirements for reporting licensing contracts, these are mostly related to cross-border transactions, and data are published only at an aggregate level. As a result, disclosure of patent licensing activity depends largely on firm policy. Even though disclosure of information on licensing revenues has been shown to have a positive effect on investors, most firms choose not to make such information public. Hence, available data on patent licensing is limited, scattered, and lacking in uniformity in spite of demand for more systematic data by policy makers, investors and academics.

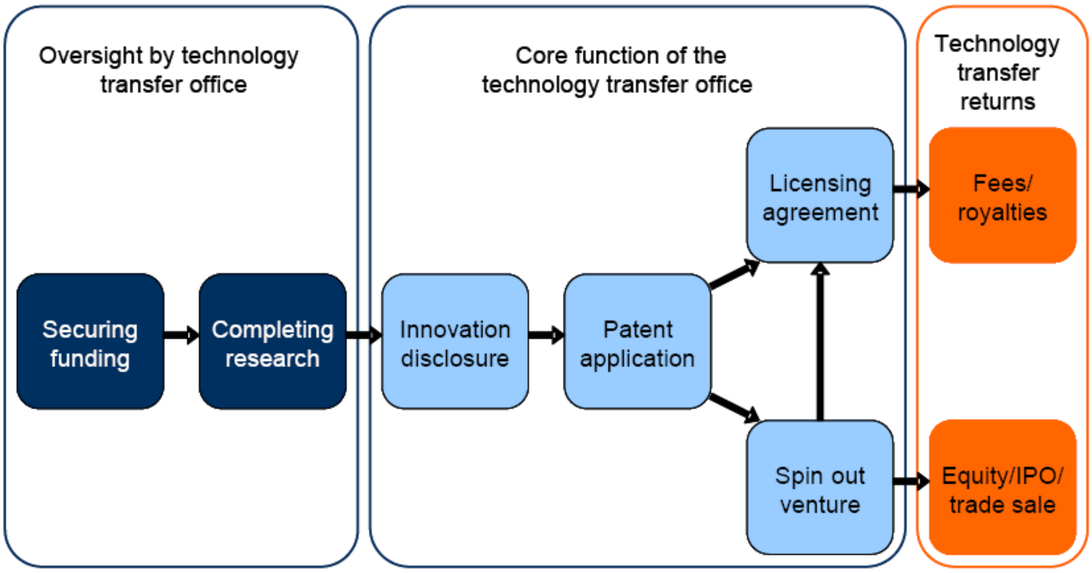
One of the most direct benefits of patent licensing is generating revenue for the patent holder. In recent years, a number of firms have been able to generate considerable royalties from outward licensing of technology. IBM Corp., which started to more actively manage its IP rights in the late 1990s and obtained more than 3,000 US patent grants per year on average between 2000 and 2004, received more than USD 1bn in annual revenues from licensing royalties and sales of IP rights; about half of these revenues came from licensing. Other technology-intensive firms also report significant amounts from patent licensing.

Licensing appears to be concentrated in high-technology sectors. In an OECD survey, respondents from the ICT sector were the most likely to report increases in outward licensing (about 80 percent of respondents), suggesting that outward-licensing has become an important source of revenue for ICT firms. In contrast, respondents from the pharmaceutical industry were most likely to report increases in inward-licensing (about 80 percent of respondents), reflecting the trend of licensing-in from small biotechnology firms. International licensing also appears to be on the rise and accounts for a significant share of total patent licensing. Receipts from world-wide licensing appear to have grown steadily since the mid-1980s. While receipts remain considerably higher in the United States than in the EU or Japan, growth rates in the latter have been equal or faster over the past 20 years.

At the national level, indicators of technology licensing also show significant increases. In European countries, OECD data on receipts from international licensing and transfers of patents show steep increases in France and Germany during the 1990s. In France receipts increased by more than a factor of seven between 1990 and 2003 from EUR 330m to EUR 2.4bn (not taking into account inflation), while in Germany they doubled from EUR 1.3bn to EUR 2.7bn. In contrast, receipts remained relatively flat in Italy at roughly EUR 200m to EUR 300m per year.

Technology Transfer often involves a formal transfer of rights to use and commercialise new discoveries and innovations resulting from scientific research to another party. The TT process also covers funded research, innovation disclosure, patents, licensing and sometimes new start-up ventures. Returns on TT are primarily in the form of licensing royalties, but also include sponsored research, one-off transactional fees and new venture equity. Figure 3 summarises the TT process from the securing of funding to the generation of TT returns, considering the core functions of a Technology Transfer Office (TTO).

Figure 3: Technology Transfer Process



Source: Seget, S. (2008)

The TT "funding gap" describes a situation in the life-cycle of a start-up/project whereby typical sources of early-stage funding dry up while late-stage sources of funding are not yet available. The TT "funding gap" thus generates a disconnection between early basic research and downstream development. Typically basic research and early target discovery are mainly funded by government grants (sometimes also through philanthropic research funds). Once a technology has reached the proof-of-concept stage, in late preclinical testing in the case of biotech for instance, venture capital (VC) and licensing funds become available and are supplemented by private equity, public offerings and late stage licensing as the technology progresses towards commercialisation. The "funding gap" arises in between, the point where government and philanthropic funds begin to run out but the technology's risk profile still discourages VC and licensing investments.

The TT funding gap has been around for some time, but was magnified after the stock market and VC downturn in 2001 and also in the current crisis. Generating a successful initial public offering (IPO) or trade-sale exit for a venture capitalist has become more difficult, which in turn has put increased pressure on associated royalty rates and spin-out terms. As venture capitalists have become more conservative, moving new technologies from public funding to proof of concept has become more challenging.

With regard to the financial gap between the R&D patenting stages and the development (of prototypes, test series *etc.*) and the stage of commercialisation, the difficulty to assess the value of patents limits the advance toward the production stage. To adequately quantify the value of patents and patent portfolios, the licensing potential needs to be analysed. However, selling and buying technology is not costless; for example, initial investment is frequently needed to screen and identify a licensee, an outlay which patent holders are rarely willing to make due to uncertainty on their licensing potential. Patent Value Funds attempt to uncover both the financial gaps faced by the IP holders and their licensing potential. These are institutional funds that invest in patent portfolios, acting as intermediaries, making IP sellers and buyers meet and pulling off contracting easier to both parties.[6]

Therefore, TT can be envisaged as an intermediary institution for technologies and innovations aimed at facilitating the commercialisation and use of IP generated mainly in the research sector. The development of innovation networks linked to major companies and of technology markets, notably around IP exchange platforms creates new opportunities for adequate intermediary structures for innovation. New forms of commercialisation of IPs should be supported by appropriate financial instruments.

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[6] IP can also be securitised. Names mentioned in the literature in relation to monetisation and securitisation are, for example, Intellectual Ventures, ThinkFire, Capital Value Partners, Ocean Tomo Capital Fund, Microsoft Intellectual Property Ventures. IP can also be transferred *via* public auctions; a company offering a marketplace is *e.g.* Ocean Tomo Intellectual Capital Equity.

3. A review of the technology transfer market

Data for Europe on the commercialisation of public science have not been available until recently. Information about patenting and licensing is opaque. The size and evolution of technology licensing markets – in general and not only with regard to commercialisation of public science – is difficult to measure because of a lack of robust statistics. This has been confirmed in discussions with leading experts. Most patent licensing is based on private contracts that are subject to confidentiality agreements, meaning that comprehensive time-series data on patent licensing are not available. The TT market is sizeable, also against the background of the EU's innovation strategy. Despite the funding gap TT is a fast growing market. One proxy for the growth in the TT market is to track EU patent applications at the European Patent Office, which experienced a growth of 40 percent between 1997 and 2007 overall, and more than 70 percent for patents owned by universities (OECD 2008).

The number of university start-ups has started being used as an indicator of TT success, particularly in Europe. However, such a measure ignores the eventual success of such activity and whether or not it is preferable to other forms of TT. This criticism, that undue focus on spin-out companies has negatively affected other transfer mechanisms such as technology licensing, is discussed in the literature but there is little empirical evidence. From various surveys it appears that in comparison with licensing, spin-outs play a more important role in Europe than in the US. But there is no evidence of an optimal spin-out level or an optimal licensing level. According to another line of argument, it is difficult for European Technology Transfer Offices (TTOs) to find licensing partners for their technologies and they are instead progressing via spin-outs. In a way, European TT offices might be constrained to create the institutional partners (companies) that they do not find readily on the market.

Only a few studies have analysed the success of TT and TTOs. The recent literature analyzing the efficiency and determinants of university TT focuses on studying American universities (*e.g.* Jensen and Thursby 2001; Lach and Schankerman 2008). This is mainly because of their longer history in the commercialisation of academic research and the availability of university-level datasets containing rich information on universities' TT activities. The main findings from recent empirical studies (*e.g.* Proton 2008; ASTP 2008; Business Insights 2008 and Milken Institute 2006) may be summarized as follows:

- **Technology Transfer policies and strategies matter.** Studies have underlined the importance of adopting an institutionalized and strategic approach towards the commercialisation of research activities by universities. Such institutional strategies may cover institutional procedures, organizational structures or management processes that allow universities to exploit their R&D portfolio without hampering the fundamental university mission of teaching and research. Maximising TT to industry is not necessarily in conflict with the mission of universities to perform basic research – indeed the opposite can be argued. Several studies (notably by van Looy *et al.* 2006) have shown that researchers who patent more are also those who publish more in scientific journals, controlling for their seniority, field of research *etc*. Survey evidence for the US shows that researchers often lack the interest to participate in TT (Siegel *et al.* 2003; Thursby *et al.* 2001). Theoretical work by Jensen and Thursby (2001) and Macho-Stadler *et al.* (1996) shows that well-defined licensing contracts can help in this respect by providing the right incentive mechanisms to ensure inventors' cooperation in the disclosure of an invention and its later commercialisation. Lach and Schankerman (2008) find strong empirical support for this intuition and show the importance of well-devised inventor royalty sharing rules for university performance in terms of licensing.[7] Based on a panel of US universities they find that universities giving a higher share of royalties to the inventor generate more inventions and higher licensing income. This incentive effect appears to work both by inducing the sorting of scientists across universities and by increasing scientists' efforts. TT outcomes are also a function of commercialisation strategies. Licensing provides the most common mechanism for TT but spin-out companies have become increasingly popular. Licensing agreements tend to work best in established TT offices with access to well-funded research projects. By contrast, spin-out ventures tend to be more prevalent in markets where research funds are more limited and where commercial licensing partners are less willing to share risk on academic research discoveries. However, licensing statistics have to be read carefully – survey results of higher licensing income can be attributed to the higher average age of (US-) university license portfolios. In addition, in the US, licensing income is highly concentrated, with a small number of universities, both private (Harvard, Stanford) and public (the University of California system) making the bulk of the market.

[7] But university patents are not only about creating financial or market value. For example, university patents play an important role in creating knowledge spillovers, building networks with other academics and venture capitalists and catalysing university-industry recognition (Striukova 2009b).

- **The key role of the intermediary structure.** Successful technology transfer not only depends on the quality of the research and the involvement of the inventor, but crucially also on the size and the experience of the TTO. Among others, Siegel *et al.* (2003) find that larger TTOs generate more technology transfer outcomes. TTO experience in the transfer of technology is also important. Friedman and Silberman (2003) and Lach and Schankerman (2004) find that older TTOs execute more licenses, and suggest that efficiency gains arise as TTOs gain experience in the management of university technology transfer. Friedman and Silberman (2003) further suggest that the TTO's age matters because to be successful TTOs need to build a qualitative portfolio of inventions, which takes time. On average, TTOs in the US benefit from larger research endowments and have had more time to develop than their European, Canadian and Australian counterparts. The TT function involves significant time-lags. It is only as TT offices are given the time to develop and mature that they begin to generate sustainable income streams and as a result are able to justify further investment. The ability to build strong relationships with both university faculty and external commercial partners also benefits from time and experience. According to a study by UNU-Merit (Arundel and Bordoy 2006) the key differences between TT practices across countries can be explained by the size of the respective research budgets and the maturity (experience) of the TT function. Moreover, geographical differences in regulations[8] and location contexts have a significant impact on TT practices and results.

- **The characteristics of public research institutions.** A number of recent empirical studies have found that the size of the university, as measured by the number of academic staff is positively related with the amount of technology transfer (*e.g.* Belenzon and Schankerman 2008). Besides size, previous research finds that the research quality of the university also matters. Universities producing higher-quality research, as measured by the quality of their doctoral programmes, generate more licenses and higher licensing income as shown by Chukumba and Jensen (2005). Thursby and Kemp (2002) further suggest that the portfolio of disciplines present at the university could also play a distinctive role as some sciences are more likely than others to produce research that can be transferred to industry. Recent empirical studies find support for this hypothesis and show that the presence of biomedical and engineering faculties appear to be associated with higher levels of patenting and licensing activity (*e.g.* Lach and Schankerman 2008). Moreover, a number of studies have shown that private universities are more efficient, as measured in terms of scientific publications and various

[8] An interesting tool to compare various national IP regimes can be found here: http://www.eutechnologytransfer.eu/compare.php

outcomes of TT activity (Adams and Griliches 1998; Siegel *et al*. 2003). Beyond these differences in the level of efficiency Lach and Schankerman (2008) show that scientists at private institutions are more responsive to royalty incentives. The wealth of private universities (endowment) and different criteria for the selection of researchers could explain this difference in responsiveness.

- Clusters, proximity and openness still matter. Existing research suggests the importance of geographic concentration for successful university-industry relations (Agrawal and Cokburn 2003) and the relevance of spillovers of academic research (Jaffe 1989; Jaffe *et al*. 1993; Henderson *et al*. 1998). For instance, Mansfield (1998) who explores the relationship between academic and industrial R&D suggests that universities are more likely to license technology to firms located nearby as the further development of the technology often requires further collaborative efforts: TT is often a proximity activity, requiring much face-to-face interaction. The development of open innovation set-ups is expected to strengthen the role of proximity notably to deal with commercialisation of IPs based on tacit knowledge and requiring trust between partners. That said, new communication technologies also enable collaboration among individuals or entities based in different locations.

- Is Europe so different from the US? US TTOs are more effective in generating invention disclosures, patent applications and grants than their European peers. However, European TTOs appear to require a smaller level of research expenditure to generate licensing agreements and start-ups than their US peers. The share of licensing revenue for university TT as a percentage of research expenditure is around 1% in Europe but closer to 3% in the US. One explanation for the lower licensing returns is a greater reliance on start-ups in Europe.[9] Higher start-up activity and relatively low licensing activity in Europe is also to be put in relation with the lower royalties available for academic inventors in Europe compared with the US. A second explanation could be the advanced market-readiness of projects in the US:

[9] The Lambert Review criticises too little licensing and too many unsustainable spin-outs (for the UK): "(…) there are signs that the pendulum has swung too far and that too many spin-outs are now being created, some of low quality (…). Despite a fall in 2002, many more spin-outs are created as a proportion of research expenditure than in the US and Canada. (…) but these spin-out rates come at a cost to licensing. (…) nine new university technologies are licensed for every spin-out that is formed in US, compared to only four in the UK." (Lambert Review of Business 2003, p. 58f.) However, the Lambert Review's criticism, that undue focus on spin-out companies has negatively affected technology licensing, has been addressed in an article by Ederyn Williams (Warwick Ventures). He shows that the poorer performance of UK universities in generating licensing income can be entirely attributed to the higher average age of US university license portfolios (Library House, 2007).

- Projects at US universities are better financed and further developed towards their relevant markets than in Europe.

Improving the commercialisation of IP and filling the gap with the US, notably in terms of shifting from research and proof-of-concept grants towards commercial funding, will require access to adequate financial instruments. Financial instruments in the TT segment are not well developed to date. Discussions with market participants in different industry sectors make it clear that a very significant potential exists for specialized investment vehicles focusing on the TT segment.

The change in the innovation process has led to the emergence of new collaborative mechanisms such as patent pools[10] or innovation platforms requiring appropriate intermediate mechanisms for the commercialisation of IP. Knowledge exploitation appears as a key issue in open innovation strategies especially in the upstream phase. New forms of joint IP or IP sharing require adequate management tools and alignment of incentives not always developed in research organisations.

The notion of "Technology market" encompasses a range of different mechanisms by which buyers and sellers trade various forms of knowledge: Buyers and sellers can pool or trade IP, data, information, contacts and know-how. Intellectual property exchanges and patent pools, consortia, networking, matching or brokering services, clearing houses, knowledge warehouses and auctions enter into this broadly defined concept. The current market situation (market needs, unused high-tech potential, funding gap between basic research and commercialisation, funding gap of exploiting the whole range of technology) leads to many opportunities to develop innovative funding, both SME-related and project-related instruments.

The financial instruments in these markets – and these are not the standard VC tools – are not yet fully developed. However, discussions over the last years with market players from different sectors have made it clear that a sizeable potential for specialized investment companies exists. This is true for the seed stage, but also for the full exploitation of IP.

The financial crisis has further intensified the "traditional" funding issues for the exploitation of R&D. In general, there has been (and still is) a sharp decline in private-equity fundraising activities; early-stage VC is currently more stable than other phases, but also at a much lower level than before. Reasons for the sharp slowdown of fundraising activities are mainly uncertainty due

[10] A patent pool can provide an incentive for further innovation by enabling its members to share the risks associated to R&D. Patent pools can also increase the likelihood that a company will recover some, if not all, of its investment in R&D (Striukova, 2009).

to the ongoing crisis, the strong level of activity in previous years (2005 to 2007), and also uncertainty about the impact on valuations. According to private-equity statistics (*e.g.* Deloitte, EVCA 2009) many VCs are optimistic about their future funds – however, VCs are looking to governments as their financial partners because they see their traditional investor base – commercial banks, investment banks, corporate operating funds, insurance companies and public pension funds – to be drying up.

4. Key lessons learnt from the EIF experience

As outlined above, TT can take various routes which sometimes differ in substantial ways from better-known financial instruments such as debt/guarantees and equity investments. This section summarises key lessons from EIF's experience in TT investing. An overview of EIF's operational activities is given in the Annex:

4.1 Financial design: Privileged access to deal flow and "Bears' hugs"

TT operations are often organised in partnership with research centres, universities or other structures. In this context, successful operations often benefit from privileged access to spin-outs originating from such innovation centres. Fostering and maintaining privileged relationships with those centres does not always make it possible (let alone desirable) to press for the typical governance/structuring features of VC, such as arms' length principles, conflict of interest parameters etc. This is a departure from standard structuring features and requires a specific approach and skills for successful implementation. In fact, the further upstream the project in the investment spectrum, the less certain standard features of equity investing are applicable – they can even become outright damaging, much like debt standards when applied to equity. The issue is about risk: At this intermediate stage, technology is more developed than basic knowledge but it is not developed enough yet for its market applications to have the degree of certainty that standard capital providers require. Appropriate solutions must be found which address the specifics of this market segment rather than trying to superimpose solutions which work in other environments.

4.2 Implementation issues - private co-investors

TT investing is an emerging area within finance. Consequently, it is not an established asset class among "market-oriented investors" – to an even more significant extent than technology VC which itself is increasingly shunned by the private sector. As regards structuring, limits in the level of public investment at first closings of funds are often an obstacle. Typically this specific rule is a legacy of VC or other private-equity investment guidelines, which is ceteris paribus applied to TT as if it was the same market segment. At the time of writing, market conditions are such that EIF and similar investors are often led to take up to 50 percent of first closings in their VC and private-equity investments. Therefore, an emerging area such as TT could greatly benefit from a similar approach.

4.3 Business development effort and lead-time

This is an emerging market, which lacks existing teams periodically submitting well-structured investment proposals. This mirrors the funding gap at this stage. EIF's role is to partner with leading research and innovation organisations in order to develop products and approaches resulting in "investable" operations by EIF and other investors. This resource-intensive, "tailor-made" approach entails a high attrition rate, which is counterbalanced by the fact that it positions EIF as the partner of choice with leading innovation centres.

4.4 Longer time horizons: Average size currently smaller than other areas

Successful TT investing requires a long-term approach, with fifteen, twenty year (and beyond) horizons being sometimes necessary. Also, the average size of investments in this area can be significantly smaller than in the typical private-equity operations.

5. Potential activities to meet market needs

Investing in support of knowledge transfer from universities to industry calls for new financing models which could address both the information and risk patterns of this activity (in-between public and market research). The availability of such instruments is a necessary condition for attracting larger amounts of private capital without which inventions cannot be transformed into innovations. In order to meet the markets' needs, public support should be provided through a flexible tool set, adapted to a variety of situations and needs. The remainder of the section explains potential future options for the EIF.

5.1 Extension of current Technology Transfer activities

EIF, like other investors, has so far focused on leading European universities/research institutions, ruling out smaller operations. However, public-sector investors like EIF could also address smaller or less prominent universities and research centres. Indeed Europe has a significant number of universities/research centres producing numerous spin-outs. Given the growing number of teams that have professionalised their TT approach over time, this could open up a new market segment for investors if addressed with the right instruments and approach. Another growing trend is the emergence of trans-national operations, creating a critical mass in terms of deal flow, network and competencies.

5.2 Licensing operations

In TT through licensing, the IP developed within a research organisation is "licensed" by the research organisation to a production company. This license can be exclusive or not, is often limited to certain market segments or countries as well as in time. The IP can potentially also be acquired by the company.

Licensing operations can take various forms. Often the IP developed at research organisations is not mature enough to be licensed or sold directly to companies but requires further validation of the technology (e.g. by building a prototype or carrying out pre-clinical testing) before it is in a position to attract industrial buyers. Funding for such activities is mostly not in place within research organisations. Licensing TT operations can address precisely this funding gap. What is needed is an investor who could fund the further development of the technology by paying for the activities required to make the IP more mature. In return, the TT Operation receives a share of the IP and the associated revenue streams in case the IP is licensed out or sold. Financing of this kind is of great value as it ensures that valuable technologies are not left unused within academia. This type of operation is complementary to that of seed and early-stage funds, which invest in companies (not in projects or IP assets) and which only partially address the TT process.

Licensing operations can take other forms such as Project Funds, IP Funds, Royalty Funds, IP Line Extension and IP Live Extension Projects, IP carve out projects etc. A more detailed description can be found in Table 1.

Because of the portfolio aspects as well as long lead times, “licensing” or “royalty” market segments lend themselves to complex financial engineering encompassing securitisation techniques and secondary approaches, which can be a more efficient form of funding than equity.

Table 1: Different types of licensing operations

Profile	Comments
"Licensing" operations	The IP developed within a research organisation is "licensed" to a(n industrial) company. License is exclusive or not, with often limited coverage (market segments, countries, and time). See the discussion in Section 5.2 of the main text. Note that existing or planned initiatives in this area are often either supported by non-EU private groups (*e.g.* Royaltypharma 2009 using a securitisation angle; Paul Capital 2009 following a secondaries strategy; and Intellectual Ventures 2009 with a translational lab focus), or by national public groups without a European remit (*e.g.* the initiative by CDC to establish an organisation to commercialise patents from public-sector research).
Projects funds	Shares some features with upstream VC. However, investments are made not in a company but in projects. Overhead costs are initially low because it can be decided at a later stage whether to commercialise the IP through licensing or through a spin-out. The ownership of the IP developed within these projects needs to be contractually agreed upfront. Similar to some existing university proof-of-concept funds.
IP funds	Investments are made into individual IP assets (e.g. patents), which have a potential to be commercialised. Different investment strategies can be applied. One strategy consists in buying portfolios of existing but (nearly) unused patents, often in batches at reduced prices. Grouping individual patents into "patent families" (or bundles) can be valuable to potential buyers (or licensors) of the technology by allowing them to fully protect their use of key technologies. Another strategy consists in selectively acquiring clusters of patents and building project teams around these technologies to further develop them to the point where they are attractive to commercial buyers. Such funds contribute to transferring existing IP assets into the commercial world.
Royalty funds	Fund buys the rights to the future royalty streams linked to a specific patent of or pools of patens. This is applicable for patents that are already commercialised (or close to commercialisation). By doing so, the fund increases the liquidity of the markets for patents.
IP line extension projects	Project financing is needed to develop further products on existing and already commercialised IP. The commercial use of existing IP-protected technologies can be extended with the development of tailored products for specific markets and customer profiles. Example: Schwarz Pharma asked for the financing of a clinical study in order to get market approval of a molecule already on the market for another indication. As a result, Schwarz would have been able to double revenues on their existing IP with only some minor IP extensions. An investor such as EIF could finance (part of) these developments in the form of project finance (also on a portfolio basis).
IP carve out projects	Spin-off or licensing-out of specific IP families that protect a potential new product from existing companies. Main driver is the lack of financing for second-line products which often bear higher potential than the first line but have more onerous product development. The cost of product development could then be addressed through TT financing, *e.g.* in the form of an SME or a special-purpose vehicle (SPV).
Secondary use of IP	Most (major) innovative companies manage their IP portfolio actively, often maintaining IP portfolios which are not in the (new) focus of the company. Also, stressed (tech) companies struggling for survival try to sell their IP when the underlying product development is at a too early stage but IP, know-how, skilled staff and results are in place. Acquiring the necessary IP and creating a new appropriate structure is a potential target of a TT transaction.

5.3 Corporate venturing and larger commercial Technology Transfer operations

Corporate venturing or corporate VC can be defined as the practice whereby a large firm takes an equity stake in a small innovative or specialist firm to which it may also provide management and marketing expertise. The objective of corporate VC is to gain a specific competitive advantage as well as to achieve a return. Corporate funds focusing on early-stage investments can be used as a tool to gain access to new technologies, often developed in the research organisations relevant to the industries on which the corporate venture fund focuses. In some cases the fund may also invest in companies spun out of the parent organisation, for instance to commercialise IP in an industry segment not relevant to the parent organisation. Corporate venture funds can be managed by teams which are still strongly linked to the parent company or by teams held at arms length. Some corporate funds attract third-party investors at fund level. The individual ticket size of this type of transaction is larger than for the other TT activities described in this section.

5.4 University seed funds

Another area of development consists in supporting numerous university (pre)-seed funds. These funds are often in collaboration with a single university and managed by a small local team. In this area, the return expectations are very limited. However, these funds play an important role in the creation of numerous technology spin-outs and, hence, significantly contribute to the commercialisation of academic research. This approach could be taken to a higher level, through operations bringing together several universities in order to create more sizeable spin-out funds – such funds could operate in physical or virtual clusters possibly extending across different EU countries.

6. Conclusion

Global policy discussions[11] increasingly focus on innovation and the knowledge economy as a driver of long-term growth. In parallel, new forms of innovation processes are emerging, notably open innovation and innovation networks, stressing the importance of links and connections between the various stakeholders. Older business and innovation models do not hold anymore, and likewise new financing models have to emerge. Investment in supporting innovation calls for new financing models, particularly in knowledge commercialisation and diffusion. Direct support to TT, Pre-seed and Seed, Business Angels, and incubators are important instruments, notably through a more active commercialisation of intellectual property. IP management has to be integrated in these strategies from the outset, as IP is a major instrument for transferring knowledge and generating revenue.

Scaling up TT as a policy measure to support the commercialisation of research is a separate area within the financing arena, with its own characteristics requiring a targeted approach and dedicated financial products and approaches. Financial engineering in this market segment must be flexible and blend financial products as needed (certainly equity but also guarantees, lending *etc.*) to share the risk between universities, inventors, entrepreneurs and investors appropriately and to maximise the potential value of IP so as to make this IP a powerful attractor for further capital.

[11] See *e.g.* Executive Office of the President (2009) and European Commission (2009b).

Annex

EIF's Technology Transfer activities so far

Profile	Examples	Comments
Spin-off portfolio	IP Venture Fund	A GBP 32m co-investment fund in which EIF invested GBP 14m and which reached its first close in September 2006. The fund systematically co-invests 25 percent of the financing round of spin-outs originating from the 10 universities with which IP group has commercialisation agreements. These include Oxford Chemistry, Oxford Engineering, Queen Mary College, King's College London, Southampton, Bath, Bristol, Leeds, Glasgow, York, and Surrey universities.
Next-generation licensing	Leuven/CD3	CD3, the Centre for Drug Design and Discovery financed jointly by EIF (EUR 4m) and the University of Leuven (EUR 4m) in 2006, finances early-stage drug development projects, bridging the gap between academic research and the point where large pharma companies are willing to get involved. A successor fund is under consideration.
University seed fund	UMIP Premier Fund	The UMIP Premier Fund is a GBP 32m fund, closed in April 2008, corner-stoned by EIF with a GBP 9m investment. The fund is dedicated to spin-out companies originating from the University of Manchester and performs investments ranging from proof-of-concept, seed and A/B rounds. The fund is managed by MTI partners, a technology VC.
University / Incubator fund	University X (name deleted) Innovation	The University X (name deleted) Innovation Seed Fund is a EUR 10.5m fund, sponsored by EIF with EUR 5.25 m. EIF worked together with the University and the incubator in the structuring and set-up of the fund. The fund reached its first close in July 2008 and has since already performed five investments in promising start-up companies. The fund invests in start-up companies originating from the university and other innovative centres in the Gothenburg region.
Two-step spin-off portfolio	University Y (name deleted), under completion	EIF envisages an investment in partnership with the University Y (name deleted) Institute in the life sciences sector to finance spin-outs in Sweden and the Nordic region. EIF would invest into a dedicated structure, the University Y Co-Investment Fund, in which it would be the main or a major investor and which would systematically co-invest alongside University Y Development at a fixed ratio. The fund would provide seed financing to newly created spin-out companies as well as follow-on financing to the existing portfolio of approximately 40 companies created by University Y Development since 2003.

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