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The role of patents and licenses in securing external finance for innovation

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ABSTRACT

Financing constraints have been discussed as a major obstacle to innovation. Small and medium-sized enterprises and start-ups are particularly concerned by such impediments. Venture capital has emerged as a partial solution in some countries, but is only available for start-up firms with major growth potential. Recently, new intermediaries have attempted to provide external finance to innovative firms based on the firms' patent portfolios. Patents have been used as collateral or as assets assembled in patent funds seeking to commercialize the patent rights. Patent auctions are indicative of a nascent market for patented technology. This paper presents an overview on the role of patents and licenses, both in the classical sense and as instruments for financing innovation. It also discusses implications of these developments for public policy and the design of patent systems.

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The role of patents and licenses in securing external finance for innovation

1. Introduction

The economic literature has analyzed a number of problems that stand in the way of an efficient allocation of resources to R&D and innovation in a market economy. Among them are the well-known externalities that emerge from knowledge having characteristics of public goods. Moreover, it has been suggested in theoretical and empirical studies that there are financing constraints for particular types of firms and activities, such as research and development. These constraints limit the extent to which firms engage in R&D and innovation, even if no knowledge externalities are present. A more recent literature has focused on a third problem and argues that the market for intermediate outputs of the innovation process (such as ideas, patents, licences, blue-prints, prototypes, etc.) is incomplete. The first two problems lead to inefficiently low investment in innovation. The third one leads to inefficiently low extent in the division of labour, since the market for technology (defined as the aforementioned intermediate outputs) is not transparent and does not function well at this point. Transactions have to be internalized, and gains from specialization are lost.



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This paper is mostly concerned with the latter two problems which are intricately linked.¹ At the root of them lies the same phenomenon – the idiosyncratic nature of technology, largely following firm-specific paths of development, coupled with asymmetric information on alternative uses, substitutes and values. If a market for intermediate results of innovation processes existed, then the financing constraints of innovative firms would probably be less pronounced. Intermediate results could be licensed, sold, leased or become part of other financial transactions, which would relax the financing constraints problem. The topic of this paper is the role that patent rights do or could play in the establishment of such markets for technology and as an instrument to support the financing of innovation.

The following sections develop these thoughts in some detail. First, a brief summary of the classical theoretical arguments pertaining to financing constraints, pecking orders and cost of capital is given. In Section 3, classical uses of patents and licenses are summarized and discussed. Section 4 discusses relatively novel uses of patents as instruments for securing external finance. Section 5 provides a discussion of how modern patent systems are or could be designed to support the financial functions of patents. Section 6 concludes.

2. Theoretical and empirical evidence on financing gaps

Hidden information, hidden action and incompleteness of contracts impact debt and equity finance. The following sections briefly review how these market imperfections lead to financing problems – in particular for small and young firms and for innovative enterprises.

2.1 Asymmetric information and pecking orders

The impact of asymmetric information on financing has been studied in particular detail for debt finance. Credit markets differ from standard commodity markets in that the lender delivers a loan on

¹ The material presented here builds on earlier work with Carolin Haeussler and Elisabeth Mueller, as well as work with Karin Hoisl, Georg von Graevenitz and Stefan Wagner.

the borrower's promise to pay back the loan and interest. The lender's evaluation of the borrower's capability to pay back is crucial for the lending decision. Equilibrium quantity rationing emerges endogenously due to asymmetric information (the lender knows less about the borrower than the borrower himself) and incompleteness of contracts (contractual agreements to control all aspects of borrower behaviour are infeasible). In the case of rationing, the lender will decide not to grant a loan to the borrower, even if the borrower offers a higher interest rate than is observed in the market for loans. Thus, the supply of loans does not equate the demand at the market interest rate.

The underlying cause for all credit rationing phenomena can be traced back to selection and incentive effects imposed by interest rates. Adverse selection occurs, since the average quality of borrowers will be a decreasing function of the interest rate charged by the lender. Moreover, as the interest rate increases a borrower will be tempted to undertake riskier projects unless the loan is fully collateralized. As a consequence, either some lenders are not able to obtain any loan, or the loan size will be below the one demanded by the borrower (Bester and Hellwig 1987). If collateral is in short supply for firms, then the firm may have projects that would be worth financing, but cannot be pursued because of the lack of debt finance. As we discuss later, this is particularly likely in innovation projects which largely produce intangible assets as intermediate output.

Firms prefer internal finance over debt and debt over new shares, reflecting capital costs.

In response to a lack of debt finance, firms may want to issue equity. But asymmetric information and moral hazard may prevent managers from doing so as Myers and Majluf (1984) show. They analyze the effects of asymmetric information if managers have privileged knowledge about the true value of investment projects and the firm's other assets while investors (or lenders) only know the joint distribution of these values until the *ex ante* random characteristics of the projects are revealed. Managers are assumed to act on behalf of "old" shareholders. Issuance of new shares will occur only if this is not to the disadvantage of old stockholders, i.e., if the market's evaluation of the new stock is above the respective value for the old stockholders. Thus, managers will only issue shares for investment with less than expected value. Consequently, issuing shares will be seen by the new investors as a bad signal. Anticipating this, the firm will not issue new shares even if the projects have positive net present value. Thus, in the Myers/Majluf model, financing constraints have negative welfare effects. Variations of the fundamental theme of the Myers and Majluf paper have been developed in large numbers, but the basic idea is the same in these extensions. Given that management acts in the interest of existing shareholders, firms will prefer internal finance over debt financing, and debt financing over the issuance of new shares. This prediction has found some empirical support (e.g. see the review in Thakor 1993, p. 461).

As a result of some of these arguments, Myers and Majluf (1984), *inter alia*, have postulated a financial "pecking order" model. In this model there is no well-defined optimal capital structure as it exists in the static Modigliani-Miller model with taxation, but a well-defined ranking of capital costs. Once slack resources are exhausted, the firm will have to borrow to satisfy its capital needs. The most expensive type of capital will be new equity. In some cases, the firm will rather forego an investment opportunity than to issue debt or equity. Exogenous variations in cash flow will lead to more or less investment in such a situation.

2.2 Different types of investment: Capital goods versus intangibles

Can financing constraints be particularly important for investment in research and development (R&D) or innovation projects? There are a number of reasons why investment in physical capital and investment in knowledge capital should be affected differentially by financing constraints, and why obtaining external finance for innovation and R&D projects may be more costly than obtaining such funding for capital investment. At the same time, fundamental technological differences with respect to the

adjustment costs of investment and R&D and differences in tax treatment may work against extensive sensitivity of R&D spending to transitory shocks in cash flow. Finally, the impact of uncertainty needs to be taken into account.

For the purpose of the present discussion, let us first assume that contrary to most capital investment goods (plant, property, and equipment), R&D results such as a new prototype, a design or a patent cannot be used as collateral. This is largely still the rule, but there are important exceptions which will be considered in Section 4 below. The reasoning behind this assumption is simple: The investment share of R&D expenditure is of the order of 10 percent of total R&D expenditure, and most inputs to the innovation process are likely to be firm-specific or specific to the new product or process to be developed. Under these conditions there is no liquid market where the collateral could be liquidated in the case of insolvency. Thus, external financiers cannot expect to recover a significant share of their funds from collateralized intangibles.

Second, for obvious reasons firms may be hesitant to reveal the content and objectives of their R&D efforts since this knowledge may leak out to competitors.² Strategic considerations of this kind will tend to maintain and reinforce informational asymmetries. But even without secrecy undermining the incentives to share information about R&D projects, the evaluation of long-term risky projects by external financiers may be more costly than the assessment of more short-term oriented ones. Thus, if providers of finance face greater uncertainty and longer planning horizons with respect to R&D than capital investment projects, they will require a higher “lemon’s” premium for the former type of investment. Hence, even without rationing behaviour on behalf of banks and other financial institutions, there will be a premium to be paid for obtaining external funding for R&D projects. If lenders cannot control which type of project will be financed by the loan, then the cost of capital will reflect the financiers’ assessment of average project risk. Taken together, these results suggest that R&D-intensive firms face a larger difference between capital costs for internal and for external funds than firms with few R&D projects.

R&D firms may be reluctant to reveal their R&D efforts – which adds to the cost of external funds.

The cost of capital for investment and for R&D projects may also be affected differentially due to the tax treatment of R&D and intangibles. Traditionally, R&D had to be expensed. This is a preferential treatment (full depreciation in the year of investment) when compared to capital investment but only so if the firm does have a tax debt which can be reduced by the expensed R&D. Young firms with extended periods in which no positive tax debt occurs will not profit from this treatment. Moreover, carrying the tax losses forward does not fully compensate this disadvantage, either because the value of the tax loss declines over time or because some taxation regimes limit the extent to which firms can off-set current profits with past losses. An example is the minimum taxation principle in the current German tax code which effectively limits the off-setting of profits against losses that have been carried forward. Hence, while a young firm may not be able to derive much benefit out of the classical tax treatment of R&D, there are actually dangers coming with it. Since the firm does not capitalize its intangibles, it runs an increased risk of ending up over-indebted. New taxation and accounting rules have therefore tried to address this issue. The US General Accounting Principles (GAP) have included a limited right to choose between capitalization and expensing for some time. Such an option is now available in most accounting and taxation systems, e.g. under the International Accounting Standards IAS 38 and IAS 39. To summarize, for most young firms the R&D expensing rule did not generate any advantages in the past, and the current trend towards explicitly listing some intangible assets (but only the development component) on the asset side of the balance sheet does not create a particular advantage for R&D.

² See Mansfield (1985) for some evidence on the speed of information dissemination. Theoretical models of knowledge dissemination are presented by Bhattacharya and Ritter (1985) and Bhattacharya and Chiesa (1994).

Taken together, these theoretical arguments suggest that finance for R&D and innovation will be more constrained and thus more susceptible to cash-flow variations than capital investment.

Despite heavy reliance on own cash flow, R&D is relatively smooth over time due to high adjustment costs.

However, there are other considerations that run counter to this conclusion. For one, adjustment costs are likely to be higher for R&D than for physical investment. Indeed, it is likely that the R&D process cannot be delayed or accelerated to the extent to which this may be possible for capital investment. Scientists cannot be fired and rehired without substantial loss of human capital to the firm (and potential gains to competitors), and resources employed in R&D cannot simply be used in production (or *vice versa*). This effect will actually dampen the long-term response of R&D to cash flow variation. But since the marginal cost of capital is increased – not reduced – by higher marginal adjustment costs, firms with high marginal adjustment costs are likely to show more stable R&D expenditure – albeit at a lower average level – than firms with low adjustment costs.

The recent economic crisis has triggered new studies on the relationship between uncertainty, the business cycle and R&D. Bloom (2007) develops a real-options model in which he analyzes the reaction of capital investment and/or R&D to changes in the level of uncertainty. He finds that there have been (and currently are) strong fluctuations in economic uncertainty. Higher uncertainty tends to reduce aggregate investment, hiring and productivity growth because decision-makers seek to delay important decisions. As to R&D, Bloom shows that higher uncertainty reduces the responsiveness of R&D to changes in demand conditions and increases the persistence of R&D over time. Nabar and Nicolas (2009) study R&D investment behaviour during the Great Depression. They develop a model in which firms differ with respect to the precision of their beliefs about the future development of demand. Firms with imprecise prior beliefs react more strongly to sector-specific signals than firms with more precise information. Their empirical investigation yields interesting insights as well. Their data suggest that learning and updating were important determinants of R&D decision making between 1930 and 1932, but not in the subsequent years till 1936. Access to liquidity was not sufficient to let firms engage in R&D – even financially unconstrained firms were apparently not willing to engage in countercyclical innovation. The results confirm that uncertainty may seriously undermine R&D and innovation – even if financial constraints are not a problem.

The arguments described in the previous sections (and in some cases countervailing ones) have by now been tested in a large number of empirical studies. I will not review this evidence in detail, but will largely point to survey results instead, in particular to the overview presented by Hall (2002).³ Summarizing a large number of empirical studies, she concludes that the empirical evidence regarding financing constraints or “funding gaps” is fairly clear by now. In particular, there is strong empirical evidence in favour of the view that relatively small and young firms (SMEs and start-ups) attempting to undertake innovation face relatively high costs of capital. Classical financing institutions are not well-prepared to support the financing of innovation in these firms. It is much harder to find convincing empirical evidence for the existence of financing constraints in large, established firms. While it may still be the case that R&D and innovation in these firms are subject to important externalities (such as knowledge spillovers), funding gaps appear to be limited to SMEs and young firms.

2.3 External equity and the emergence of the venture capitalist

The literature summarized above considered debt and public equity markets, but not private equity (PE). For the purpose of this study, the most interesting form of PE is venture capital which explicitly

³ See Hall (2009, in this issue) for an updated overview article.

addresses the financing needs of young firms with strong growth prospects, but no assets that could be collateralized. Venture capital (VC) is equity or equity-based investment in private companies with high potential for growth (see Gompers and Lerner 2000; Kaplan and Strömberg 2003). VC is typically organized as a limited partnership. The limited partners – wealthy individuals and institutional investors – enter a partnership with experienced venture capitalists (VCs) who act as general partners. The partnership typically lasts for about ten years. The funds are then invested in young firms in return for preferred stock. VCs also receive important special rights which allow them to influence the management of the start-up even if they hold a minority share. Venture capital emerged first at the end of WWII but gained in importance in the US during the 1980s when a clarification of the Employee Retirement Income Security Act's 'prudent-man' rule allowed pension funds to invest in high-risk assets, including VC. While VC has seen a dramatic development in the US, it has not been successful in a broad set of countries, with the UK, Israel, Canada and New Zealand being the exceptions. The lack of an initial-public-offering (IPO) exit channel is presumably one of the most important impediments for the emergence of a functioning VC market in Europe. The emergence of VC can be interpreted as evidence that other financing institutions – in particular banks and public markets – have not been able to address the financing problems of young firms. It is all the more sobering that the majority of European countries and the European Union have not been able to establish a strong VC financing channel for young firms.

Venture capital addresses financing constraints of young companies with little collateral – but only of very fast-growing ones.

The positive role of VC in supporting innovation is well established by now (Kortum and Lerner 2000). But one needs to point out that VC is restricted in scope – it addresses the financing need of a very important, yet small segment of start-ups with particularly high growth potential. Even with a working VC market in Europe, a much larger segment of innovative small and medium-sized enterprises (SMEs) would continue to experience financing problems.

2.4 A summary

To summarize, funding gaps exist, and they are particularly problematic for SMEs and young firms. The emergence of the venture capitalist, a new type of intermediary in the 1960s and 1970s and its subsequent success (at least in some countries and regions) can be taken as evidence that the financing needs of innovative SMEs and young firms in Europe are not being met by existing institutions and players. While these insights are relatively clear cut, many questions are still unresolved at this point. As Hall (2002) points out, little is known about the effectiveness of various government policies pertaining to institutions such as incubators, pre-seed and seed funding (as in the case of the German *Hightech Gründerfonds*) and other forms of subsidies for start-ups. There is also a lack of information as to how corporate-governance regimes and regulation interact with different types of information problems that lie at the root of financing constraints for innovation. It will be important to analyze how these factors affect innovation. Unfortunately, history has shown that policy discussions frequently neglect this aspect and focus on capital investment and issues of depreciation. That focus appears more and more outdated – the design of accounting and taxations systems should increasingly be concerned with its impact on innovation and training, rather than the installation of fixed capital.

Moreover, as the next sections will show, there is a host of relatively new financing arrangements that have not received detailed attention in the academic discussion while some innovative financial firms and investors are already betting considerable sums on these new arrangements. There is an open question if and how the emergence of these new institutions and players should be supported by governments. To delineate these novel financing instruments from more classical uses of patents and licenses, the next section first summarizes what is known about the “old world” of intellectual property.

3. Classical functions and uses of patents

Patents can be valuable assets to firms because they protect inventions and their transformation to innovative products (Cohen *et al.* 2000 and Dechenaux *et al.* 2008). Patents may protect the company's competitive position by virtue of their exclusion power. This is essentially saying that patents carry private value.⁴ The most convincing evidence in favour of this view comes from event studies analyzing the market response to critical events such as the loss of patent rights in litigation or attacks on patent rights in opposition proceedings. Given that litigation cases are usually surprising news, these studies come close to an experimental setting. For example, in a study by Marco (2001) the impact of patent litigation outcomes on stock prices is analyzed (413 patents of 158 US corporations). These events have a significant impact on stock prices. Whenever the validity of patents is confirmed in court rulings, stock prices increase by 1 percent on average. "Bad news" (a revocation or narrowing of claims) leads to a reduction of stock prices by 0.7 percent on average. More evidence on the contribution of patent rights to a corporation's market value comes from Hall *et al.* (2005 and 2007) for the US and Sandner (2009) for Europe. Haeussler *et al.* (2009) analyze the impact on share prices of opposition, *i.e.*, a formal request by a third party to have the patent revoked. They find that the stock market reacts to patent oppositions. Historically, such oppositions lead to a revocation in one third of all cases, and in another third of cases they lead to a restriction of the patent right. Hence, oppositions are a real threat to the patent-holder. Haeussler *et al.* (2009) find that stock market reactions are particularly strong in the case of oppositions against highly-cited (presumably valuable) European patents, but that stocks appreciate if the opposed patent was deemed to be "academic", *i.e.*, if the patent is associated with a large number of prior art references to the scientific literature. While patents can be valuable, there is considerable dispersion in the patent value distribution. As a rule of thumb, 90 percent of the value in a patent portfolio is accounted for by only 10 percent of the patents (Scherer and Harhoff 2000). Litigation and opposition are usually directed at the more valuable patents (Lanjouw and Schankerman 2001).

Patents convey survival advantages to firms and allow operating at higher margins.

The asset character of patents can be traced back to the fact that they provide protection against full competition. In markets with elastic demand, this allows firms to operate at higher margins. Moreover, patents convey survival advantages to firms. Cockburn and Wagner (2007) investigate the effect of patenting on the survival chances of 356 internet firms that went public at the peak of the stock market bubble of the late 1990s. They find that by March 2005, about 66 percent of these firms had delisted from the NASDAQ exchange. Fewer than half of the firms in the sample had obtained patent protection. Those firms that had done so had significantly longer survival spans than firms without patent protection. As the authors show in a detailed econometric analysis, patenting is positively associated with survival. Interestingly, this positive result does not appear to hold for business method patents, for which no survival advantage was apparent in the estimates.

Even if patents had no asset value (in the sense that they could be subject to transactions), they may serve an important purpose in supporting economic transactions such as co-operation on the development of an improved technology. Patents safeguard the right of the technology owner and allow parties to write contracts based on a well-defined ownership title. A sophisticated version of this argument has been put forth by Merges (2005). In Merges' view, property titles support pre-contractual liability and thus grant some protection for disclosure of sensitive information in the period leading up to contract formation. Moreover, property provides enforcement flexibility after a contract is signed since a property right grants its holder many important advantages in the course of enforcement. Property thus supports transactions and would support the emergence of a more transaction-rich economy populated with specialized firms.

⁴ That alone is not sufficient to justify patent systems from a normative perspective. But the lack of conclusive evidence on the welfare balance of the patent system continues to vex economists. See Section 5 for comments on this problem.

Licensing is a way of trading technology rights while cross-licensing mainly serves to avoid legal controversy.

While patents are not required to license technology, many technology-licensing contracts are based on patent rights. The exact extent of licensing is subject to some uncertainty, but most surveys arrive at the conclusion that up to 10 percent of patents are licensed. See Motohashi (2008), Nagaoka and Kwon (2006), and Gambardella *et al.* (2007) for further important studies. Thus a modest volume of transactions is taking place already. However, the conditions at which licensing takes place are difficult to assess. For example, patents may form complex “thickets” when individual patent rights have overlapping and uncertain scope. Patent owners and technology users cannot determine with precision which rights they may be infringing upon or if other parties infringe upon their own patents. Rather than carrying the legal conflicts to court, firms may choose to cross-license parts of their portfolios or even form a pool of patents. In such a situation, patents form the currency for coming to an agreement that substitutes for costly resolution in court. In some cases, the cross-licensing arrangement will be accompanied by compensatory payments to those parties who contribute a particularly large share of patent rights. Cross-licensing differs conceptually from licensing of specific patents since it is used to avoid legal controversy, not to trade technology rights.

Patents also serve other purposes, such as demonstrating the technological prowess of the applicant or as a visible sign of technical competence of the inventor named on the patent. These functions should not be belittled. Given that patent offices offer their search services at subsidized fee levels, some corporations even use the patent system as an evaluation device of their corporate R&D staff.

In the PatVal-EU survey, inventors named on EPO-granted patent rights were asked whether their patents were used for commercial or industrial purposes, or if they were licensed (Giuri *et al.* 2007). They were also asked to rate the importance of different motivations for patenting (on a 1-5 scale), including licensing, cross-licensing and strategic reasons like blocking competitors. The survey distinguishes between the following six uses of the patents:

- Internal use. The patent is exploited internally for commercial or industrial purposes, it can be used in a production process or incorporated in a product;
- Licensing. The patent is not used internally by the applicant, but it is licensed out to another party;
- Cross-licensing. The patent is licensed to another party in exchange for another patented innovation;
- Licensing & use. The patent is both licensed to another party and used internally by the applicant organisation;
- Blocking patent. The patent is used neither internally nor for licensing, and was applied for to block competitors; and
- Sleeping patents. The patent is not employed in any of the uses described above. It may still have option value to the holder as an asset protecting a completely different technical approach, but it unfolds no blocking effect with respect to competitors.

The analysis by Giuri *et al.* (2007) shows that slightly more than half of the patents were exploited by the applicant organisation for industrial and commercial purposes. About 36 percent were not used, with about half of them being blocking patents and the other half sleeping patents. Finally, 6.4 percent of the patents were licensed, 4 percent were both licensed and internally used, and 3 percent were used in cross-licensing agreements.

Of particular interest are differences between large firms and SMEs. Overall, the small firms licensed out 26 percent of their patents and left 18 percent unused. This is in contrast to large firms which

licensed out only 10 percent of the patents and left 40 percent of their patents unused. Hence, firm size and firm type explain a large part of the variation in the extent to which patents are used or licensed. As shown in earlier contributions (e.g. Mowery *et al.* 2001), public or private research organisations and universities license a large fraction of their technologies and do not use them internally.

Even if part of the results may be accounted for by the fact that large firms have lower marginal costs of patenting and thus maintain some share of patents in their portfolio for merely strategic reasons, these results are in line with the notion that SMEs will seek to license technology in order to open a source of financing for their enterprises, and that SMEs would profit more from a functioning market for licenses than larger firms. There is strong agreement on this point in the literature. More support for it has recently come from studies undertaken by the OECD (Zuniga and Guellec 2009) and by a team of US researchers (Graham *et al.* 2009).

4. Patents as financing tools

4.1 The market for technology

Market exchanges of non-embodied technology are still at a modest level but gathering pace.

Recent research following the work by Arora *et al.* (2004) has emphasized the importance of a market for technology. This notion refers to the market exchange of non-embodied technology. Most of the economics literature has followed the assumption that trading non-embodied technology, e.g. ideas, know-how and patents, is considerably more difficult than trading the embodiment of such knowledge, for example, in the form of machines and other artefacts. The classical argument points at the low rates of licensing and patent trade. As the above sections have shown, licensing is indeed relatively rare, although many patents are not utilized.

The overall monetary volume of licensing transactions has been the subject of some research and of speculation. It is important to note that licensing (in the sense of granting access to technology) occurs for a number of reasons, some of which have little to do with genuine market exchange. For example, within multi-national enterprises (MNEs) licensing can be used to shift profits towards a low-tariff tax jurisdiction. Given the intangible nature of intellectual property, the transfer of a patent right to a subsidiary in a low-tax country could be followed by high royalty payments from the high-tax to the low-tax location of the MNE. A large share of international trade occurs within MNEs (Maskus 2000). The use of intangibles for “tax optimization” purposes should therefore be an important aspect in the empirical picture, but its extent is unknown. Furthermore, licensing is difficult to separate from conceptually different activities, such as cross-licensing for the purpose of avoiding litigation. In this case, there is no genuine trade or transactions indicative of a market, but merely an avoidance of legal confrontation.

Arora *et al.* (2004) estimate that the world market for technology has had a volume of about USD 35-50 billion in the mid-1990s. The estimate includes licenses and the transfer of know-how as well as transfers based on other forms of collaboration such as production and marketing. Athreye and Cantwell (2007) employ data from the IMF balance of payments statistics and from the World Development Indicators database to compute global licensing revenues. Their time series indicates that worldwide royalty and licensing revenues amounted to about USD 10 billion in 1980, and about USD 80 billion in 1998 (Athreye and Cantwell 2007, Figure 2). It is unclear which share of this growth is accounted for by within-MNE transactions and to what extent transfer pricing issues have been relevant. A 2005 special issue of the *Economist* included an estimate for technology licensing revenues at around USD 100 billion in 2005. Slightly less than half of this figure (USD 45 billion) is estimated for licensing and royalties in the USA alone. Survey evidence (as in Zuniga and Guellec 2009, p. 16) points to increases in the frequency of

licensing and of licensing revenues. Their survey data are particularly telling since they restrict the analysis to licensing transactions with unaffiliated firms. Hence, while there is still a need for more precise figures, there is some evidence that the market for technology is growing. Despite this evidence, if less than one tenth of all patents are licensed (see Section 3 above) then this points to a rather incomplete market.

Another component of technology markets might be the outright sale of patent rights. However, the sparse evidence available on patent trade supports the argument that markets for technology are not liquid. Recent studies by Serrano (2008) and Burhop (2009) confirm that there is a moderate degree of patent trade, probably even larger than many economists had thought. Burhop (2009) finds that about 8.3 percent of all patents granted by the German Imperial Patent Office between 1884 and 1913 were transferred to other owners. Serrano (2008) finds that the rate of transfers in the US has been 13.5 percent between 1983 and 2002. In both contexts, the share of patents ever traded during their statutory lifetime is small, confirming that there may be a high degree of illiquidity in the market. One reason for the low degree of trade may lie in the idiosyncratic nature of technology. Many patents protect inventions that firms pursue on firm-specific development paths. At the same time, the lack of trade may simply reflect the high degree of asymmetric information which may lead to a market failure.

Establishing a market for technology would be equivalent to allowing firms to trade intermediate inputs and outputs of the innovation process. This would have advantageous effects. First, specialized firms may emerge that focus and specialize on particular stages of innovation, for example the design stage. Hall and Ziedonis (2001) study the relevance of patents for the emergence of specialized design firms in the semiconductor industry. Leaving aside economies of specialization, a liquid and transparent market for technology would also alleviate financing constraints by allowing firms to shorten the time period from first investment to arriving at an output that can be taken to a market. Financing needs for the intermediate steps would be smaller so that the likelihood of financing these steps internally would increase. Moreover, with a market at hand loans could possibly be collateralized, opening the path to more debt finance. Finally, the likelihood of obtaining private equity finance would also be enhanced since the start-up can be liquidated more quickly. The highly illiquid nature of private equity currently translates into high premia for the investor, and thus into high costs of finance.

A more liquid market for technology would enable firms to specialize on specific stages of innovation and open paths to debt finance.

Markets for technology are not a magical cure. As Gambardella (2002) points out, they may introduce new forms of market failures while alleviating others. In particular, they may generate externalities related to the complementarity of intermediate inputs to innovation processes. Much more needs to be learned about markets for technology, but for present purposes a focus on the positive properties seems appropriate.

Moreover, patents can contribute to the growth of markets for technology in manifold ways. They can safeguard the value of assets, lower the costs of transactions, facilitate licensing and technology trade, serve as collateral or provide important signals to investors. As Epstein and Pierantozzi (2009) point out, patents will also help to recover value in the case of distress or bankruptcy – which will again lower the *ex-ante* cost of capital. These aspects are discussed in the subsequent sections.

4.2 Hybrid business models and “financial bootstrapping”⁵

Growth-oriented firms are subject to highly cyclical financial environments. Venture capital supply and demand have seen strong fluctuations over time. It is not surprising that firms have tried to survive periods of scarce finance by somehow reverting to their own means. One strategy has been referred

⁵ This section builds on Haagen *et al.* (2007).

to as “bootstrapping” – the start-up seeks to slow its growth to the rate that can be supported with the financial means at hand. “Bootstrapping” can be supported by the performance of R&D services. This allows the firm to maintain a functioning R&D group which can switch back to working on own development targets once financial conditions have improved.

Slowing firm growth to a pace that is sustainable with own funds circumvents financing constraints but may not be optimal.

In this context, even the promise of the future delivery of know-how and patented inventions may serve to support the financing of start-ups. In the 1990s, biotechnology firms developed hybrid business models which allowed them to survive extended periods of under-financing by engaging in contract R&D for larger firms, mostly from the pharmaceuticals sector. Pharmaceuticals producers have been eager to replenish their product pipelines which were threatened by expiring patents and low incidence of new clinical entities (NCEs). Rather than internalizing the costly search for NCEs, large firms have increasingly sought co-operation with smaller biotechnology firms in the early phases of drug development.

Haagen *et al.* (2007), in a comparative assessment of British and German biotechnology firms, evaluate the extent to which firms make use of such approaches. They show that start-ups in a VC-poor country (Germany) engage more often in hybrid models, presumably because other means of finance are not available in sufficient volume. Firms with a hybrid business model offer contract research or services to third parties in order to finance the company's own research and development activities. In essence, the contractual relationship between firms is that of *ex-ante licensing*. 63 percent of the German firms as compared to 55 percent of British firms follow this ‘bootstrapping’ mode of finance. Focusing on the subgroup of firms that are younger than five years, Haagen *et al.* find that 66 percent of German firms compared to 60 percent of British firms pursue a hybrid business model. Nearly half of German firms’ personnel resources are devoted to conducting contract research or services to finance the company's own research. Somewhat unexpectedly, the proportion of British firms’ personnel committed to contract research or services is also relatively large at about 45 percent.

The bootstrapping approach may be in conflict with the rapid development of the firms’ own products and technologies. After all, firms pursuing a bootstrapping approach choose a form of finance that reduces external control, but may delay the growth of the start-up. This may not be optimal. In fact, there are often very large rewards for early entrants in large but immature markets. The dominance of US firms in emerging technology markets may be due to the fact that they have access to financial channels, which allows them to grow quickly. This is presumably not the only reason for the (relative) scarcity of fast-growing European high-technology firms, but it may contribute significantly to the phenomenon.

4.3 Patents as signals and attractors of external equity finance

The relevance of patents for companies attempting to obtain financial resources, especially in their early stages, has been noted repeatedly in the literature (Hayes 1999; Lemley 2000). An important source of finance for innovation in high-growth start-ups is external equity which is often supplied by venture capitalists (VCs). A product that is proprietary or can otherwise be protected is an important selection criterion for VCs (MacMillan 1985). Hence, companies in need of capital will try to obtain patents if the cost of doing so is not too high for them.

Patents increase appropriability and thus provide incentives for innovation. In addition, patents facilitate the licensing of technology (*e.g.* Gans *et al.* 2002). They increase the attractiveness of companies as acquisition targets (Cockburn and Wagner 2007) and enable VCs to recover a salvage value from failing companies. However, scholars have also documented that “patent strength” varies between industries

in that in most industries patents are less featured than other means of protecting innovations, such as first-mover advantages or secrecy (Levin *et al.* 1987). But on average, patents matter for VCs. Baum and Silverman (2004) examine selection criteria used by VCs and subsequent company performance. They find a positive association between patent applications at the US Patent Office (USPTO) and pre-IPO financing defined as VC financing and private placements. Interestingly, patent grants have a positive but smaller effect than patent applications.

While a large strand of literature has investigated the traditional view of patents as a means of protecting intellectual property, Long (2002, p. 625) notes that scholars have overlooked the informational function of patents which “may be more valuable to the rights holder than the substance of the rights”. Moreover, the information that is relevant to a financier may not just come from the grant event, but from other aspects of the patenting process. Recently, a few scholars have shed light on some aspects of the role of patents for VC financing. Hsu and Ziedonis (2008) find a positive effect of patents on investors’ estimates of company value for a sample of VC-financed semiconductor start-ups. They find larger effects for early funding rounds, where information asymmetry is at its largest. In addition, patents are particularly valued by more prominent VC investors. Lerner (1994) also documents a positive influence of patents on company valuation.

The signaling function might be more valuable to the patent holder than the substance of the rights.

VCs need to make their investment decisions under a high degree of uncertainty. Technology start-ups are difficult to evaluate since they do not have a track record which outsiders can use to evaluate their potential, they are often years away from first revenues, their assets are mostly intangible and they are plagued by a high failure rate. These perils have led VCs to spend a great deal of effort in seeking and assessing signals of ventures’ growth potential (Amit *et al.* 1990; Hall and Hofer 1993) and have driven entrepreneurs to undertake symbolic action to gain legitimacy (Zott and Huy 2007).

The value of signaling lies in the reduction of information asymmetries (Spence 1973) and of information costs (Long 2002). In general, the literature has identified three broad categories of signals that are relevant for technology-based start-ups. Signals of the first type include educational background as well as founder history (Eisenhardt and Schoonhoven 1990; Burton *et al.* 2002; Shane and Stuart 2002). The second group includes signals in the form of attributes of parties affiliated with a person or organization (*e.g.* Stuart *et al.* 1999). The third category includes previous accomplishments of the start-up company. Patent grants and even patent applications may be considered as such an accomplishment, signaling a company’s technical abilities.

The value of signals generated during the patenting process is that they reduce information asymmetries between VCs and the new and unproven company seeking capital, and that they minimize information costs for the financiers. Even a patent application which has not been approved yet by a patent office may constitute such a signal. The preparation of patent applications requires effort and time, since applicants have to follow strict guidelines and need to include technical information in a structured manner. This may allow individuals familiar with the patent application requirements to quickly assess the strengths and weaknesses of an invention and of the technology employed by the start-up.

The notion that patents facilitate the acquisition of VC is quite intuitive. From an investor’s perspective, a start-up with strong patent rights should be preferred since the patent protects the start-up’s market position by allowing it to exclude others from using its proprietary technology. Moreover, should the start-up fail the patent may allow VCs to obtain some salvage value. In this regard, patents may both serve as valuable assets that enhance the value of the investment in the case of success *and* in the case of failure, and also as signals which certify to some extent that the start-up has at its avail a novel and inventive technology. In the latter case, the patent’s function is mainly to act as a seal of quality, possibly

reducing the information problem on the investor's side. Both functions are complementary, but the second one could even work for industries in which patent protection is not effective, as long as the patent office's assessment contains new information for the venture capitalist.

Patenting activity is positively correlated with company value and other success measures.

Several contributions in the empirical literature suggest that patents can indeed work in the two ways just described. Mann and Sager (2007), building on a qualitative study by Mann (2005), investigate the relationship between patents and VC availability. They show that there is a significant positive correlation between various success measures (number of financing rounds, overall investment, exit status, acquisition of late-stage financing and survival span) and measures of patenting activity. They also demonstrate that in the software industry, only few start-ups ever have patents (hence, they are a relatively scarce asset), that patenting behaviour varies strongly, and that the size of the patent portfolio does not matter as much as a simple indicator of patenting activity. Mann and Sager (2007) do not have strong evidence in favour of a causal relationship; hence, the results could be caused by "good start-ups" being active in patenting and simultaneously being favoured by VC investments without a causal impact of patent rights on the financing decision.

Hsu and Ziedonis (2008) bring a new aspect into the discussion and treat patents as quality signals for entrepreneurial ventures which have to fight the liabilities of smallness and youth. They find that patent filings have a strong association with investor estimates of company value – a doubling of the stock of applications is associated with a 28-percent increase in value. Patents are particularly important in early financing rounds, valued more highly by prominent VCs, and positively correlated with the likelihood of an IPO. Theoretical considerations would predict that founders with more experience should profit less from the signalling effect than less experienced ones, but this expectation cannot be confirmed. While the authors also estimate panel models (over financing rounds, including an IPO round), the claim that the effects of patent filings are causal remains tentative (as in other studies as well). Moreover, it seems that the results could be reconciled with the notion that on average, the firms simply own valuable assets, and that the VC valuation reflects that.

Haeussler *et al.* (2008) accept the notion that patents might be signals, but point to a weakness in the argument. Usually, the VC investment decision precedes the patent grant considerably. Hence, the signal (if there is any) cannot lie in the grant decision of the patent office itself, but must reside in other information generated in the course of patent examination. In the US patent system, patents are usually taken to be patent grants, since the application used to be unknown to the public. Conversely, the European Patent Office (EPO) data used by Haeussler *et al.* (2008) can be employed to trace unsuccessful applications as well as successful ones. The European patent system thus affords a much more detailed view of the patenting process, since applications, search reports, grants, oppositions and communications between applicant and examiner are observable. This allows the authors to test if VCs react more strongly to patents that become – much later on – highly cited and to patent oppositions.

Using the timing of events to identify effects, Haeussler *et al.* (2008) find that in the presence of patent applications, VC financing occurs earlier. The results also show that VCs pay attention to patent quality, financing those ventures faster which later turn out to have high-quality patents. Patent oppositions increase the likelihood of receiving VC, but ultimate grant decisions do not spur VC financing, presumably because they are anticipated. The empirical results and additional interviews with VCs suggest that the process of patenting generates signals which help to overcome the liabilities of newness faced by new ventures. However, it is not the patent application or patent grant *per se* which certify the start-up's quality. It is a diverse set of events which taken together allow VCs sufficiently familiar with the patent system to assess the quality of the firm in their portfolio.

Taken together, these studies suggest that patents have an important but complex function for start-ups to secure external finance from VC channels. Patents may in part reflect enhanced appropriability, but they may also act as signals which would be hard to obtain in the absence of a patent system. Since these functions of patents have only been investigated in the recent literature, there is still no quantitative measure of how strongly the institution contributes to the financing of new firms.

4.4 Patents as collateral in debt finance

Researchers have studied the nexus of finance and innovation for more than thirty years now. The financing-gap problem has already been described. Venture capital provides a solution in some of the cases, but in all likelihood, there are a large number of firms which are subject to financing constraints for R&D and innovation, but most of them are unlikely to receive VC. Reasons could be that the growth prospects of the firm's projects – although substantial – are not as high as required from a VC's point of view. Moreover, the entrepreneur or owner may not wish to give up their independence.

In these cases, innovative firms typically tend to lack tangible capital that could be used as collateral to obtain external finance. Why can they not make use of their intangible assets to provide collateral? In the presence of liquid markets for intellectual property such as patent rights and with some certainty given their scope and value, managers could resort to using patents as collateral in debt financing transactions. The literature states that there are two reasons why the use of intangibles as collateral in debt finance has been limited (e.g. Lev 2001). The first one is that it is often exceedingly difficult to come up with an objective valuation of such assets, even from the proprietor's perspective. Even if a valuation existed, asymmetric information could make it hard to communicate the assessment to the financier. The second is that in the case of the loan going defunct, the bank will find it typically very difficult to sell the asset or commercialize it in some other way. Markets for intellectual property are still not well-developed. In other words, the collateral will not provide the intended function as an asset that can compensate the bank for the loss from the defunct loan.

Difficult valuation issues and the risk surrounding the liquidation values limit the use of patents as collateral.

Several authors have suggested that the classical view needs to be amended and that extending debt finance against intellectual-property (IP) collateral is becoming more common. The argument is in line with the "markets-for-technology" view which states that technology is increasingly being traded in some form of market transactions. While there is some systematic evidence of the latter, there is no comprehensive statistical data that would capture the extent to which loans are granted in exchange for IP collateral. As an upper bound, a recent KfW survey of 4,300 German SMEs yielded the result that in 2007, only 2.2 percent of the surveyed firms used intangible assets as collateral (KfW 2007). Given that these assets may include trademarks, copyright, patents and other IP rights, the share of firms using patents as collateral is likely to be less than one in a hundred.

The phenomenon should nonetheless not be belittled. It is true that only few specialist financiers offer such services today, and the use of patents for collateral is still largely experimental and non-standard. But this form of financing innovation has true potential and could make a major contribution in improving overall conditions for innovation. To get a flavour of such transactions consider the example of ESKA Implants GmbH & Co KG, a producer of joint replacements reported in Schlemvagt (2009). The company needed capital for expanding its product range and service network to complete a turn-around. The main bank was willing to accept patents as collateral. An external valuation specialist identified 320 relevant patent rights which were valued at EUR 3.5 to 5.0 million. The bank then accepted the respective portfolio (with a risk adjustment of 30 to 50 percent) as collateral. The company remained the owner of its patents in these transactions.

Better valuation techniques, greater IP-market liquidity and financial innovations would boost debt finance for innovative firms.

Several factors are currently counteracting the use of patents as collateral. Banks are still highly sceptical, and loan officers typically point to the lack of expertise in dealing with complex IP issues. The inclusion of IP specialists is likely to raise the costs of such transactions. Moreover, the high risk regarding the liquidation value of the collateralized IP also reduces the extent to which it can be used. It is not uncommon that the collateral value of IP in such debt finance transactions is below ten percent of its value to the proprietor. Nonetheless, even such a low valuation may provide the firm with sufficient credit to perform sizeable innovation activities. As a consequence, an increase in innovation activity would be the consequence of past inventive activities.

It is too early to assess the relevance of these developments and to give predictions about the future potential of IP-collateralized debt finance for innovation. With improvements and standardization in valuation techniques, with greater liquidity in markets for patents and licenses, and with greater openness towards innovative financing instruments on behalf of banks, a significant financing branch could emerge. Some banks could evolve into specialists handling such transactions and become lead debt-holders in syndicated transactions. Debt transactions of this type could be handled either by “house banks” with the support of patent valuation specialists or by specialist banks which offer valuation and extension of debt in one organization. Clearly, the new form of financing requires both relational as well as transactional competencies.

Offering this option as an additional source of finance would be welfare-improving since the extent of funding gaps (in particular for SMEs) could be reduced. Yet, there are important obstacles. A significant shift towards this form of financing would necessitate that loan officers in banks have technical expertise as well as legal and business training. Clearly, this would constitute a major change. Moreover, there is an open question if temporary support *via* public banks (*e.g.* the KfW in Germany), government support or coordinated EU-wide measures could accelerate the development of a new and stable private financing mechanism for innovation. These questions will be discussed below.

4.5 Patent funds

Patent funds are one of the most interesting types of commercialization vehicles. While IP funds are not a recent invention,⁶ they have been rising in importance recently. Some US patent funds have gained an ambivalent reputation for extorting license payments by making intensive use of legal threats or full-fledged litigation (*e.g.* see Business Week 2006). The European situation is different, presumably because the litigation system does not grant the kind of strategic opportunities available in the US system. There are other differences as well. While US commercialization of patents is usually undertaken by stock-listed firms, European patent funds are typically closed investment funds which require investors to hold on to their investments for a time period of four years or more. Investors are compensated for the illiquidity of the investment with relatively high returns – most patent funds announce return expectations between approximately 10 and 20 percent after taxes.

Two types of funds have been set up in recent years – “blind pools” and “asset pools”.⁷ In blind pools,

6 Less recent examples include the British Technology Group (BTG) which was founded in 1995. BTG seeks to commercialize patent rights in the field of pharmaceutical and medical inventions. BTG has been expanding its portfolio by several large-scale acquisitions, *e.g.* in 2000 when Siemens AG transferred a portfolio of about 1800 patents to BTG.

7 Deutsche Bank has set up three asset-pool funds, starting with Patent Select I in 2006, while Credit Suisse established a blind-pool fund in 2004/2005 already. Euram Bank has set up three blind-pool patent funds, starting in 2007. Little is known about fund performance to date; returns from the first fund are supposed to be distributed in 2009/10. Fund volume has been increasing, and minimum investments have been declining from 50,000 EUR in 2005 to 10,000 EUR in 2008. The total fund volume is currently of the order of 300 million EUR and is expected to grow further. For a practitioner's view on these funds, see Lipfert and Ostler (2008).

the patent portfolio to be commercialized has not been selected yet – the performance of the pool rides mostly on the fund managers' talent in detecting, acquiring and commercializing patents. In asset pools, the intermediary makes an up-front investment in selecting the patent portfolio and then invites investors to fund the subsequent commercialization process. Asset pools are considerably less risky for the investor than blind pools, but the intermediary will have to be compensated for the set-up costs and shifting of risk and returns are lower than in the case of blind-pool funds. While the first generation of European patent funds was privately placed, subsequent funds have been marketed as investments to a broader group of investors.

Patent funds come as 'blind pools' (portfolio yet to be chosen) and 'asset pools' (intermediary buys portfolio up-front).

From an analytical perspective, investments in patent funds are still largely unknown entities, and more research is needed to describe their characteristics reliably. Understandably, the information provided by fund managers themselves tends to veer to the optimistic side. The claim made by fund managers that patent fund investments are largely uncorrelated with investments in other asset classes (e.g. Lipfert and Ostler 2008, p. 265 and BIT 2008, p. 51 and p. 71) have not been substantiated in independent research. Moreover, the performance expectations appear to be relatively high at this point, and may be seriously affected by the current economic crisis. How patent funds will weather the current decline in IP activity and the trend towards a more restrictive granting of such rights remains to be seen. Despite these sceptical remarks, this new form of IP monetization can support the financing of innovative companies. It should therefore be welcome. The setup of funds whose commercialization strategy relies heavily on litigation and threat of litigation is likely to receive a more critical assessment. The discussion of these practices is taken up in the next section.

5. Patent systems and the financing of innovation

5.1 Parameters of patent system design

The rules of the patent system are important determinants of the new financing and exchange institutions that are currently springing up. Given the focus of this paper, the central question is how the patent system should be designed to facilitate the financing function of patents and licenses. If it is true that patents make it easier for innovative firms to obtain finance or to license their inventions, then a well-functioning patent system also has a positive effect on innovation through this channel. This is a welfare component of the patent system that has only recently found attention and that still needs further study.⁸ If patents facilitate the emergence of new markets or even the competitive entry of new firms into existing markets with innovative products, then the simple juxtaposition of welfare losses due to exclusion rights (market power) and of welfare gains due to innovation does not hold. To stretch the argument somewhat, absent the patent there would be no entry (i.e., competition) and no innovation.

Various questions need to be answered in this context. Is there a trade-off between what is good for financing innovation and social welfare maximisation of patent systems more broadly? Is a poorly designed patent system an impediment for innovation finance? And is the European Patent System conducive to allowing the use of patents to procure external finance?

The main aspect to be considered when answering these questions is the extent of uncertainty about patent rights. It should be recalled that patent rights can support the financing of innovative companies since they may help to reduce informational asymmetries. But if patent rights themselves are highly

⁸ To the best of my knowledge Bronwyn Hall has been the first to make this point. Hall (2007) contains a detailed discussion of the role of patents for start-up firms and for competition.

uncertain regarding the scope of the concomitant exclusion right, then their effect in reducing informational asymmetries is likely to be small. Moreover, with uncertain patent rights it will be difficult to establish liquid and transparent markets for patents and licenses. Hence, for a patent system to support the emergence of new financing channels, it needs to provide well-delineated patent rights. Finally, the granting and scope decision should come quickly in order to support firms in the initial stages of innovation, when financial constraints are particularly pronounced.

A full-fledged discussion of patent system design is well beyond the scope of this paper. Instead, I will focus on a limited number of parameters which are particularly important for achieving reasonable trade-offs. These are the timing of decisions, the quality and precision of the examination and the cost of patenting (as perceived by the applicant). Aspects of the patent-litigation system are discussed in the next sub-section. These characteristics are strongly related – higher quality and faster examination are likely to require more resources than low-quality, slow decision-making.

**Patent system policy
faces a trade-off
between duration/costs
and the precision of
granting decisions.**

From the perspective of any stakeholder, the optimal patent system would simply arrive at precise and reliable decisions almost immediately and at almost no cost to the applicant or society at large. Obviously, this ideal system does not exist due to trade-offs between precision, duration and costs. Consider the issue of precision first. To simplify somewhat, decisions by patent authorities are subject to two types of errors. An error of type I consists in not granting a patent to an applicant with a truly novel and inventive technology. Conversely, an error of type II occurs when a patent is granted to an undeserving application, *e.g.* when the technology already exists or the inventive step is too small to deserve patent protection. Clearly, minimizing the likelihood of any error will require resources. Moreover, it may require time – irrespective of resources. Some information is simply generated by time passing by and cannot be replicated easily by investing more private resources. Hence, an immediate examination would not be optimal, especially in new technical fields. This argument has been made by Regibeau and Rockett (2007).

Since efforts to avoid errors will tend to increase the duration and costs of patent examination, it is clear that a patent system supportive of the new financing functions will involve complex trade-offs. A look at the empirical literature supports this view. There is strong evidence that (i) longer time lags in patent examination create uncertainty (Schankerman and Galasso 2007; Gans *et al.* 2008); (ii) some applicants seek to increase uncertainty for their rivals and therefore delay examination proceedings (Harhoff and Wagner 2009); (iii) quick decisions are typically less precise than slower ones, in particular in new technical fields (Regibeau and Rockett 2009); (iv) systems which allow applicants to delay examination (deferred examination) lead to a significant reduction of the examination workload; and (v) systems with a large inflow of “marginal” applications create additional uncertainty for all players because the state of the art can no longer be determined reliably (McGinley 2008 and Opperman 2009).

The current situation of the European Patent Office (EPO) and of the national patent offices in Europe and beyond is not satisfactory. The EPO has accumulated a major backlog of applications. Moreover, applicants are increasingly resorting to tactics of delay and artificial complexity in their filings (McGinley 2009). After some time period in which the EPO had tried to accommodate the quantity objectives of its “clients”, the office has now switched to a quality-oriented approach. It has established practices towards “raising the bar” which will result in lower grant rates and sanctions (higher fees) for abusive practices. This approach needs to be supported by policy makers in Europe, and by the leadership of national patent offices. The reform measures undertaken at the EPO need further support. This conclusion is not new, and it is broadly supported in the academic literature – see Harhoff (2006) and Guellec and van Pottelsberghe (2007) for further comments and references. Yet some stakeholders such as legal representatives see private value in an ever-expanding patent system. Furthermore,

patent offices themselves may be “self-interested”. After all, these are organizations with legal and implicit commitments to their employees who would wish to see secure pension funds, high degrees of job security and comparatively high salary levels. Complex issues of fairness, labour market competition and long-term incentives in the patent office need to be considered. The political economy of patent systems may therefore be far more complex than the optimization of these systems in terms of welfare and efficiency. It is probably the most neglected aspect in the current academic discussion.

While it is clear that patent office operations should be as efficient as possible, there is no reason to believe that the price of patenting should necessarily be as low as the marginal costs of operating a patent office (which should be as low as possible in order to have patent offices work efficiently). The cost of patenting (as perceived from the applicant) is a screening device that will deter applicants with low-value, marginal applications. Thus, a low-price system is likely to invite a large number of marginal applications which would clog the patent system, with subsequent problems for examination quality. Even some US practitioners are now conceding that this has been the fate of the US patent system (Oppermann 2009). Fees and filing costs are an important determinant of actual applicant behaviour – they should therefore be considered appropriate instruments of patent policies. A policy of providing patent protection at the lowest possible cost to the applicant without considering the implications for filing volumes is seriously misguided.

Finally, the backlogs at the major patent offices create uncertainty with respect to the state of the art and the scope of protection. If granting decisions cannot be produced quickly, then the patent system should generate precise information that allows knowledgeable experts to arrive at reasonably precise estimates of subsequent decisions at later stages. In that regard, the European system does well since the written communication between applicant and examiner is made public in the EPO’s file inspection system.

5.2 Patent litigation

Despite the infrequent occurrence of patent litigation (in particular at appeal levels), the patent litigation framework has a particularly important impact on patenting practice, patent office behaviour and on emerging markets for technology. Patent-litigation cases occur in two basic forms: either as revocation proceedings challenging the validity of patents granted by the respective patent authority or as infringement proceedings seeking to enforce patent rights. The likelihood of a patent being involved in litigation at some point during its term is estimated at between 1 and 3 percent in most patent systems, with some variation across technical domains, industries and countries. It is particularly high in the US and still relatively low in Europe. Patent litigation is known to occur particularly frequently (i) for valuable patents; (ii) as assessments of case quality become more divergent; and (iii) as the distribution of information becomes increasingly asymmetric. Patent litigation is “the tail that wags the dog of the patent system” – litigated cases provide legal precedence and important signals to patent holders, potential infringers and third parties seeking to steer free of patent conflicts. A well-designed litigation system is therefore the capstone of any patent system. Conversely, a flawed litigation system may effectively counteract any welfare gains from the system or cause welfare losses of its own.

The “ascendancy of intangibles”, as Lev (2001) has termed recent developments, has led to the emergence of new types of players and intermediaries. The so-called “patent troll” has become the most notable one. Using the patent litigation system to extort license payments has been referred to in the literature as “trolling” which is not an illegal practice, but seeks to exploit structural and procedural weaknesses of the patent and judicial system to earn rents. See Reitzig *et al.* (2007) for a detailed analysis of the “troll” business model. Since these rents may not be compensated by welfare gains, trolling is likely to be welfare-reducing.

A low-price patent system invites many low-value applications that clog the patent system, affecting examination quality.

Various features of the US patent and litigation system may contribute to the widespread occurrence of trolling in the US. The following aspects have been named as supportive of patent trolling:

- High costs of legal proceedings;
- Cost allocation rules in court (both parties bear their own costs);
- Contingency fee payments for lawyers, creating incentives for lawsuits;
- High damage awards and risk of treble damages in the case of “wilful infringement”;
- Pro-patentee posture of US courts and juries;
- Low examination quality creating uncertainty about the scope of protection;
- General and broadly defined extension of patentable subject matter to software and business methods; and
- Quick and indiscriminate availability of injunctions⁹ which can be used to create economic pressure.

Patent trolls who exploit weaknesses of the litigation system to extort license payments are more widespread in the US than in Europe.

The exact extent of “trolling” in Europe is unknown. Certainly, the practice has not played the prominent role that it has in the US. On the other hand, several patent funds have purchased several thousands of patents, and the first court actions by “trolls” may already be pending in Europe. The weaker presence of “trolls” is presumably due to the fact that the patent system in Europe deviates from the US system in several crucial points. In Europe, (i) court proceedings are much less costly; (ii) cost allocation favours the winning party; (iii) damage awards are not excessive; (iv) most courts have sought a careful balance between the rights of the parties and have not followed a systematic pro-patent posture; (v) injunctions are not issued automatically; and (vi) the quality of patent examination has been considerably better than in the US, despite some weakening. However, one should not assume that the European system is “troll-proof”.

Current efforts to transform the fragmented European patent litigation system into a unified court need to take these and other considerations into account. A patent litigation system in which parties duplicate their controversies in national courts is no longer appropriate for the European economy. But the reform towards the unified system needs to assure that the current balance of power between parties is maintained. The Czech EU Presidency, in Working Document 5072/09 (Draft Agreement on the European and Community Patents Court and Draft Statute, dated January 8th, 2009) has put forth a new proposal for a unified Patent Court, to be named “European and Community Patents Court”. Essentially, the proposal foresees the establishment of a unified patent court which will cover both European patents and future Community patents. This proposal has revived the policy discussion. It describes a good starting point for creating a unified system without creating loopholes that could be exploited by patent trolls. A more detailed discussion is given in Harhoff (2009).

Most importantly, patent litigation should occur at relatively low cost for litigants. As a US judge once noted, high litigation costs distort patent trade and the patent system.¹⁰ They would be dangerous to an emerging market for technology and new financing channels.

9 In May 2006, the US Supreme Court decided to put an end to quasi-automatic injunctions in the US litigation system. These were one of the major instruments used by trolls to exert pressure on presumed infringers. See *eBay Inc v. MercExchange, L.L.C.*, 547 U.S. 388 (2006).

10 Ellis (2000): “(...) It is, simply put, that the escalating, indeed skyrocketing litigation costs of the 1970’s and 1980’s have distorted patent markets and patent economics.” This comment concerns the development in the United States.

6. Conclusions and policy implications

It has long been known that innovation activity may not only be impeded by classical knowledge externalities, but also by financing constraints. These arise due to informational asymmetries that are particularly pronounced in the early stages of innovative processes and technology creation. Traditional debt finance and public equity markets cannot close these funding gaps, and relatively new forms of private equity, such as venture capital, reach only the small portion of start-up firms which are likely to generate a particularly high rate of return.

New forms of innovation finance are emerging, however. While these do not play a major role at this point, policy makers and managers should pay attention to these new developments. Supported by changes in valuation techniques and accounting regulation, it seems likely that patent rights will increasingly be used as collateral in debt finance. Moreover, patent funds may become an important source of finance for owners of patents. When intermediate outputs of the innovation process become increasingly tradable for financing reasons, a more liquid and transparent market for technology will emerge.

The two developments – enhanced availability of finance and improved markets for technology – are complementary, but they depend crucially on the appropriate design of patent systems. The more uncertain patent rights are, the less likely is it that the new forms of finance will play a major role, and the more will markets for technology be impacted by information asymmetries that drive up the cost of innovation finance. Thus, the trend towards high quantities of low-quality patents needs to be stopped. The pro-quantity stance of some patent offices needs to give way to a strategy in favour of well-delineated and reasonably secure property rights. There is even the possibility of a virtuous cycle in which high-quality patent rights lead to an improvement of the financing situation for SMEs and young firms, and ultimately to more research, innovation and high-quality inventions. Paradoxically, the path towards the virtuous cycle will require cutting the number of patent grants from currently inflationary to much lower future levels, with a concomitant improvement of inventive step and value. Policy-makers need to learn that patent offices are not the modern analogue of the alchemist who promises the transmutation of common metals into gold. They are more like central banks – printing too much money may lead to inflation and uncertainty, and thus undermine growth.

These comments are of course partly speculative. To advise policy makers more objectively, there is a need for more reliable and objective data and sober analysis. In future research, a comprehensive annual survey of banks could help to measure the extent to which patents are already being employed as collateral in debt financing. More detailed data on licensing and patent transfers are required to study the development of markets for technology. Moreover, a Europe-wide listing or collection of information on patent funds would be helpful to describe the state of the emerging fund market more reliably. It is also clear that further policy interventions should support the emerging markets. The market for licenses is in dire need of more transparency. Such transparency might be achieved by changing the reporting requirements for licensing transactions as proposed by Lemley and Myhrvold (2007). But the issues are complex – in some cases the emergence of a market for technology will benefit from allowing for anonymous transactions in order to avoid situations in which a party showing interest in a license is immediately threatened with litigation in order to drive up prices.

Summing up, there are promising signs of a positive scenario of markets for technology and improved innovation financing, in particular when measures are taken to make these exchanges more transparent and less prone to opportunistic rent extortion. Such a development would reduce informational asymmetries and quasi-rents, yield lower prices for technology, allow for greater specialization and lower capital costs for innovative firms. All of this would be welcome news for European entrepreneurs, managers and policy makers alike.

Greater availability of finance and markets for technology are complementary and require appropriate design of patent systems.

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