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Knowledge spillovers from the patenting process

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Abstract:

This chapter highlights and investigates potential knowledge spillovers from a patent office. It furthermore discuss if such spillovers are localised within the nation. It is researched if the interaction between the applicant firms and the patent office, in this case the Danish Patent and Trademark Office (DKPTO), add to the general competence of both parties. In turn, this may have positive long-term effects on the ability of the firms to innovate and use the intellectual property rights (IPR)-system.

Patent offices are often regarded as performing relatively standardised processing of applications without much interaction with other parties in the innovation system. Contrary, the research reveals that the DKPTO not only grant patents and sell business services they also has a complementary role as a knowledge-diffusing organisation.

A survey was implemented to explore this role in the innovation system further. The general impact of the DKPTO on knowledge diffusion is, according to the survey, primarily increasing the awareness of IPR among firms and to bring together the IPR branch by constituting a central focus point for common interests. Additionally, the DKPTO serves a role in facilitating easy access to the patent system for firms by lowering the cultural and linguistic barriers of IPR protection. Moreover, the DKPTO educate patent engineers who after a period in the DKPTO are employed in other organisations. The role of the DKPTO in terms of stimulating innovation directly is modest, but the above-mentioned complementary functions are likely to produce considerable knowledge spillovers. On the basis of the results the organization of a European patent system is discussed, specifically whether a centralisation of the patenting process would deprive nation states of the knowledge spillovers from a national location of patent offices. The conclusion from the study is that although many Danish firms would be able to do without a national patent office with regard to the patenting process, then there is still a role for national IPR-institutions.

1. Introduction¹

The organisation of the patent system has been subject to discussions during many years both in policy circles and in academia. One of the issues in this discussion is an intense debate on the consequences of centralising patent casework in the European Patent Office (EPO). The present research may have valuable insight for this discussion. For many years, probably for the past 25 years, there has been a broad agreement that a common European patent system would be beneficial. While it were decided (Lisbon Council in 2000) that by the end of 2001 a community patent should be launched, there has (until recently, march 3th 2003 when many of the most severe barriers were removed) been little progress in the efforts to actually get the organisation of the system in place. In fact, the negotiations on this issue have proven immensely difficult. One of the obstacles were agreement on language, another the juridical question regarding, for example settling disputes and in harmonising procedures. A third issue in the debate is particularly relevant in the present context, that is whether the centralisation of patent casework, as prescribed by the European Patent Convention (EPC), would deprive national offices of knowledge and competencies concerning patenting. This knowledge, it is argued, may diffuse in the innovation system if a national patent casework is upheld.

The role of knowledge generation and diffusion in the economy is nowadays high on the agenda of innovation studies. In particular, a number of earlier and contemporary studies have looked into possible knowledge spillovers² from university-industry interaction, and other types of knowledge institutions are analysed as well. However, patent offices³ are most often regarded as different from other knowledge institutions. The actual operation of national patent offices is rarely discussed; mainly they are seen as part of the regulatory framework together with standard-setting agencies, they are thus often regarded as only performing the necessary tasks in relation to granting a patent. Reviews for improving the dynamics of a national patenting system disregard the technology diffusion potential of the institutions themselves and their activities. The contribution of this chapter lies in highlighting and investigating potential knowledge spillovers from a patent office. It furthermore discuss if such spillovers are localised within the nation. The latter may have implications for the rationale for the political decision with regard to harmonising and centralising the patent system in Europe.

¹ The author wishes to thank Benjamin Coriat, Birgitte Andersen, Lee Davis, Dominique Foray and colleagues in the Department of Business Studies, Aalborg University for comments on earlier drafts of this chapter. Thanks to Mia B. Rasmussen for valuable research assistance. Also thanks to ESST-student Joseph Stewart, Texas for language editing. I am grateful to Patent manager Dan Nissen of Sauer Danfoss for critical assessment of an earlier draft of the questionnaire used in the survey. Special thanks also to Ole Kirkelund and Steffen Rebien of the DKPTO for comments on preliminary findings and earlier drafts, as well as written notes on the content in section 3. Finally, thanks to all the people who helped with information and data during survey and interviews in the DKPTO. Full responsibility rests with the author.

² Knowledge spillovers are here defined in line with Griliches (1992) as flows of ideas and/or knowledge between agents at less original costs (“..working on similar things and hence benefiting much from each others research”).

³ Throughout the chapter the term “patent office” is used even if activities in these offices are broader on IPR, and not just confined to patents.

This aspect of the patent system is often overlooked and scarcely researched as an issue in itself. The study investigates in particular the competence building and knowledge diffusion resulting from a) the processing of the patent application and b) the provided services related to patenting. This analysis contends that the interaction between the applicant firms and the patent office, in this case the Danish Patent and Trademark Office (DKPTO), may add to the general competence of both parties. In turn, this may have positive long-term effects on the ability of the firms to innovate and to use the intellectual property rights (IPR)-system on the one hand, and on the other hand the competence of the patent office. The internal competencies resulting from processing applications are likely to spill over to other activities of the DKPTO, thus enhancing other departments' abilities to provide services, not only to firms directly (the main focus in this study), but also indirectly through various types of intermediaries such as patent agents and technological institutes. Additionally it is discussed if there are other channels of knowledge diffusion from the patent office. The chapter focuses upon the possible knowledge spillovers to firms, disregarding the possible internal knowledge building within the DKPTO. The latter is analysed specifically in Christensen (2004).

The research is not on patents per se or on the economics of patenting. Rather, it is on the institutional role of the patent office in innovation. Thus, the research question is *to which extent are there knowledge spillovers from patent offices?* In this analysis it is important to consider the spatial dimension, that is whether a *national* location of patent offices is of importance (as is implicit in the argument above about potential knowledge drain from centralised patent casework).

The chapter proceeds in section 2 with a more thorough theoretical discussion on the rationale for the research question. Section 3 presents key activities of the patent office in Denmark. This section discusses important complementary institutions in the innovation system and their place in the overall national innovation system. A survey was undertaken to determine if the services provided in relation to patenting contributed to a build-up of innovative capabilities in Danish firms. Results from this survey are reported in section 4. The concluding section 5 summarises the findings and points to perspectives based on the research findings.

2. Potential learning processes from the interaction between knowledge institutions and firms

It is widely believed that knowledge is a critical asset in the present mode of production. The move from production based mainly on land use and machinery to a mode of production heavily dependent on human skills has even been compared to the transformation occurred during the industrial revolution⁴. Terms like “information society,” “the knowledge-based economy” and even “the learning economy” are now part of the daily vocabulary of academics and policy-makers alike. Modern economic theory now emphasise strongly that knowledge is the most important asset and learning the most important process in production⁵. A policy strategy for promoting economic de-

⁴ Freeman and Perez (e.g. 1988) are among the early scholars arguing that especially the ICT-revolution represents a qualitative new paradigm in the production mode. Several more recent works have followed this line of argument, often with the U.S. development as case (see e.g. Thurow, 1997, who link this development to potential reforms of the IPR-system).

⁵ Of course, production has to some degree always been knowledge-based and the concept is not new in economics. For example, Marshall stated that “knowledge is our most powerful engine of production” (Principles, 1920). However, the importance of knowledge has greatly increased and has regained interest in eco-

velopment is consequently often said to be to increase the knowledge base of the economy and the speed of knowledge diffusion in the economy. One of the most prominent policy strategies in many countries is to stimulate the interplay between key actors in the innovation system. Specifically, a number of governments have now put the knowledge exchange between industry and knowledge institutions high on the agenda.

In spite of the general agreement on the importance of knowledge and learning our understanding of the process of knowledge creation and diffusion remains limited. Likewise, the indicators used to measure knowledge and knowledge flows are underdeveloped. With the case of DKPTO-firm interaction in mind, this section sets out to point to important advances in the theory of innovation and knowledge creation and –diffusion relevant for the research in this chapter. It discusses in sequence the transmission and transformation of knowledge. The spatial dimension of knowledge spillovers are then briefly discussed by considering if the national innovation system is a relevant geographical entity in the present research.

2.1. The transmission of knowledge

The development of situations beneficial for learning implies among other things trust and various kinds of proximity. The latter has several dimensions, spatial, cultural, and historical. Similar to the situations beneficial for generating knowledge, the transmission of knowledge may have several dimensions: spatial-, over time, between people.

To some extent a one-time/first-time exchange of knowledge is different from a situation where the parties know each other. The transmission of information is easier when relationships have been established and ways of communication, which are understandable by both parties, have been worked out. Once established through a process of learning, one is unwilling to invest in building up new relationships implying a new series of learning processes.

"A communication system has some cost of initial investment which is irreversible. In particular, a communication channel is used to greatest capacity when it has an optimal code for transmitting messages. This "code" need not be interpreted literally; the term refers to all patterns of communication and interaction within an organization, patterns that make use of conventional signals and forms that have to be learned. Once learned, however, it is cheaper to reuse the same system than to learn a new one; there is a payoff on the initial learning investment but no way of liquidating it by sale to others." (Arrow, 1974, p.19)

A prerequisite for efficient information exchange is common channels and codes of information, effectively distributed and understood. The specific channels and codes will reflect the cultural, geographical and organisational differences between the parties. Established relationships will be kept when satisfactory exchange of information (through interactive learning processes) has developed together with an establishment of competence on both sides. The establishment and maintenance of relationships between users of business services like the process of producing the final patent application and producers of these services is facilitated by a social and cultural coherence. However,

conomic theory. The latter renewal of interest in knowledge in economic theory is both carried by a group of non-neo-classical economist and a revisionist wave among more traditional economists, exemplified by, the work of e.g. Krugman and Romer.

there may be difficulties in the ability to process information. Therefore the interaction must lead to ways of pooling the information in a manner suited to the receivers' organisational structure and ability to process informational signals.

The recent upsurge of social network theory builds upon, and extends these insights (Podolny 1996, Shane and Cable 2002, Sorensen and Stuart 2001, Stuart and Sorensen 2003). Parts of this literature add a spatial dimension claiming that these processes are best facilitated in close geographical proximity. For example, Stuart & Sorensen explain spatial concentrations of start-ups by the social networks of potential entrepreneurs. The social capital to mobilize resources for start-ups is tied to the relationships of the entrepreneur. Both the potential entrepreneurs and the social and professional ties of these entrepreneurs tend to cluster in space, these authors claim. Debate prevails as to whether the social ties are more important or if the geographical proximity per se is the decisive factor. Breschi and Lissoni (2003) maintain that social ties rather than geographical proximity are important when analysing knowledge spillovers by mapping patent citations, thus contrasting the Jaffe, Trajtenberg and Henderson (1993) analysis. Later we shall return to this discussion about localised knowledge spillovers.

Implications of this understanding with respect to our case are not only confined to the alleviation of information problems related to the specific treatment of one patent application. The process is not only a development and accumulation of knowledge about a single patent application. As the one part, a firm or entrepreneur, becomes better at articulating requirements concerning the process, the other might be able to develop new procedures to meet these needs.

There are, however, limits to the benefits of such "relational" transactions. The primary disadvantage of such relational transactions is probably the costs such as the time invested in the relationship. In addition to time, it has been pointed to that these relationships or "strong ties" (Granovetter, 1973, Hansen, 1998), may produce inertia and lack of innovation because new, and perhaps better alternatives are not explored (Arrow, 1974). In the words of Hansen (1998) the search efforts and benefits are constrained by the strong ties. The parties in established relations adopt a satisfying behaviour with respect to maintaining the relationship. Weak ties, on the other hand, increases the possibilities of linking up to a larger array of different people and networks thus facilitating more opportunities and stimuli of ideas. Moreover, one may argue that whether close relationships are beneficial for the interaction or not, is highly depended upon the type of knowledge to be transferred. To explore this argument further we need to apply the distinction between tacit and codified knowledge, and we shall introduce the distinction between transactional and relational transfer of knowledge. Tacit knowledge is rarely transferred by means of the market mechanism, but is rather transferred in a mutual, and often repetitive exchange of knowledge. This is necessary as tacit knowledge is often inherent in individual or collective routines, which are not necessarily written down or explicit even to the members of the collective. This type of knowledge is most efficiently transferred relationally. On the contrary, standardised, codified information may be transferred by simple exchange without much interaction, sometimes through the market (Hansen, 1998)⁶. However, information and knowledge are not purely either codified or tacit. Even the processing of codified knowledge may require the use of tacit knowledge, and it may even be rational to codify procedures in order to learn about what is the tacit knowledge involved, for example in the

⁶ Grilliches, Z. (1992) likewise argues that pecuniary externalities flows through the market but the main body (tacit knowledge transmitted through interpersonal interaction) of spillovers are transmitted relational.

procedures involved in a novelty search. In other words, these two dimensions of knowledge may sometimes be interdependent.

The context of transactions and the partners exchanging the knowledge are highly influential on the specific mechanisms and media for exchange of knowledge. Likewise the media and the way knowledge is transferred may differ according to the absorptive capacity of the receptor (Kristensen & Vinding, 2001). Feldman (1999) contends that the empirical literature on localised knowledge spillovers identifies some mechanisms through which knowledge spillovers may be channelled. One branch of empirical studies has identified geographically mediated spillovers as explanations of the geography of innovation (although several studies only point out co-location of spillovers and economic activity rather than patterns of causality). Generally these types of studies do not identify the mechanisms by which spillovers are realized. Other empirical studies do, however, point to such mechanisms. First, Feldman points to 'paper trails' left by patent citations. That is, as Jaffe, Trajtenberg and Henderson (1993) find, there is higher frequency of patents citing another patent from the same city than citing other patents. Generally, the localized character of patent citations indicates geographic boundaries for knowledge spillovers. A second mechanism of knowledge spillovers is the skills and knowledge embodied in people. The degree to which such spillovers are geographically bounded depends on the mobility of highly skilled people, and therefore on the labour market. But empirical evidence suggests that there is some inertia in both the interfirm mobility of people as such and in the geographical mobility as well. Finally, knowledge spillovers may be channelled through knowledge embodied in goods. Although this may be thought of as highly mobile, then empirical studies do indicate that spillovers are primarily intranational (Branstetter, 1996).

In our case, the patent examiner may need a broad and deep technological knowledge in order to undertake efficient screening of potential infringements of other patents. In turn it benefits an efficient production of business services if the examiner is also conscious about what are the most efficient search methods. Moreover, other firms/entrepreneurs may use in the patent description. In order to assimilate the knowledge from such patent descriptions the entrepreneur needs abilities to not only understand the principles of the technology embodied in the patent. He also need creativity, as he must be able to apply this technology to other fields of use not covered by the patent, alternatively to see perspectives in the technology in terms of combining the technology with other existing technologies.

The argument above has a dual proposition: on the one hand it could be argued that knowledge spillovers are facilitated by different, complementary competencies of the parties. On the other hand there need to be some overlapping competencies to facilitate a mutual understanding (Arrow, 1974) and an ability to discuss and absorb the knowledge of the other party (Cohen & Levinthal, 1989). These two contrasting arguments are both based on the assertion that there is a monotonic relationship between the extent of knowledge spillovers and the internal knowledge resources of the firm. However, it may be argued that the intensity of the knowledge exchange instead follows an inverted u-shaped curve. Over time the firm may have disproportionately large learning effects from the interaction until a stage when returns from additional information diminishes as a result of internal build-up of internal capacity to produce this information. The interaction may prevail but may change character as it transforms into a learning-to-learn form (Stiglitz, 1987) rather than a learning-by-interaction (Lundvall, 1988). The now more knowledgeable firm may now know how to make a patent application, do novelty search, infringement search etc., perhaps even in a separate patent department, but will continuously need a mirror – the DKPTO – to check if the competencies that are build up are adequate compared to present and future requirements.

This proposition introduces a dynamic element in contrast to the normal theory that considers mainly a comparison between firms with high or low absorptive capacity. We may, however, also apply the just proposed theory to a static version: firms with a certain minimum of absorptive capacity may be the most inclined to interact with e.g. the DKPTO, but only to a threshold whereafter they are likely to be able to do without the competencies of the DKPTO. To be more specific, such firms could be medium-sized firms with only one or a few innovations and limited experience with patenting. On the other hand they may know about the IPR-system (and the patenting process) as well as they are perhaps able to adequately describe their technology/product.

Other studies (Kleinknecht et al, 2002) have suggested that the first patent is a threshold and that patenting thereafter increases substantially. An event, which will accentuate this inverted u-shaped form of interaction intensity, is if there is mobility of personnel between the parties, usually from the DKPTO to firms. In that case the interaction with the DKPTO will be upheld but as competencies regarding the patenting processes have been transferred to the firm, some of the previous interaction becomes unnessecary.

Innovation policies have largely focused upon the diffusion of knowledge (Christensen, 2003). Theories within the “innovation systems approach” have likewise emphasized the diffusion aspects. Some even argue that what has been denoted the “new economy” is a steep increase in what may be termed knowledge externalities. Such externalities are non-pecuniary in the sense that knowledge produced by one agent – or a set of agents – may benefit other agents without financial compensation (Foray, 2000, p.2). The externalities contribute to the build up of the general knowledge base of the society, which is, in turn, beneficial for future innovators. In relation to the DKPTO-case in this study, the knowledge spillovers from treating an application can be said to be two-fold. As the interaction between the parties produce useful knowledge both within the firm and within the DKPTO as well, the spillover effect may occur. Whereas the discussion on spillovers from the patent system previously has been focused upon the transfer of knowledge through the patent descriptions per se (Rivera-Batiz and Romer, 1991, see Feldman, 1999 and Andersen, 2004, p.435 for a discussion) this chapter introduce this knowledge spollover as the accumulation and subsequent diffusion of knowledge in the form of learning by patent case workers. However, one prerequisite for this spillover of knowledge to happen is that the knowledge produced is not sunk, that is, if the knowledge has a very specific character, and is not useable in other connections, then the knowledge spillover is likely to be close to nil⁷.

2.2. The dual nature and transformation of knowledge

It is obvious from the above discussion that tacit knowledge is not easily accessible for others. The tacit knowledge may therefore be the key to a competitive edge for some firms. Similarly, a patent may in some cases be essential for a firm. A paradox may arise here. On the one hand, protecting a new technology via a patent requires codification in order to specify in the application what is the technology. However, this process is exactly making the technology less excludable to others.

⁷ In practise, however, this is likely to be a special case. Even very special cases are most often generating some kind of knowledge or experience, which may be used elsewhere.

It may therefore be argued that a patent description is a way of transforming knowledge into codified knowledge. This makes it possible – or at least easier - for the market to estimate the value of such assets. Such a transformation of what is sometimes tacit knowledge into codified knowledge is, however, by no means a simple process. In addition, it is often not only difficult and costly but also only possible up to a limit. One of the limitations is that the transformation has to take into account the capacity of the receptor to understand the description.

The level of interactive learning may also depend on the complexity of knowledge. Innovations based upon several different knowledge bases may for example involve collaboration with a multitude of different partners. Moreover, innovations where knowledge inputs are tacit knowledge may require more intense interaction to understand and incorporate this knowledge in the innovation process. Thus, Meeus et al. (2001) contend that complex innovative activities implies a higher level of interactive learning. This argument is consistent with the present discussion on transfer of tacit and codified knowledge.

2.3. The national innovation system as a framework for learning processes between firms and the DKPTO

The discussions above have primarily referred to a non-specific context. However, the innovation process and learning processes are not only governed by inherent characteristics. They take place within external boundaries, which are of importance to the processes. As indicated above proximity in several dimensions may facilitate learning. The spatial dimension may be important to learning as close geographical proximity facilitates social networks, personal interaction and build-up of trust. In addition, proximity may stimulate mutual understanding and cultural coherence. This may in turn contribute to the development of a code of conduct or governance of interaction that may benefit spatially bounded interactions (Gertler, 2000, Storper, 1992). A number of studies have pointed out that indeed knowledge spillovers tend to be localized (cf. above). It is, however, rarely specified what is meant by ‘localised’ – how local are spillovers? One important boundary for learning processes is the nation-state. In the past 15 years there has been an increasing recognition of this fact, reflected in the amount of studies focused on and using the concept of "national systems of innovation and in the use of the concept by policy-makers. In the present context we shall be confined to regard the nation state as the relevant geographical entity.

In spite of generally increased internationalization there are arguments why national borders are still a co-determinant for the scope of the innovation process.⁸

- 1) Distance is, however, not a complete argument for the nation-state as a boundary for the innovation process. The argument could equally well be applied to regions or local areas. On the other hand, even if counter-examples are easily found, the general picture is that language, culture and business norms to a large extent coincide with national borders. Moreover, in the literature on localised knowledge spillovers (e.g. Jaffe, Trajtenberg and Henderson, 1993, Adams, 2002) there are arguments why spillovers may be restricted in space. In the present connection one can ask if spillovers from interaction between firms and the DKPTO are

⁸ For some time there has been a general debate on the “death of geography” between on the one hand scholars arguing that globalization has wiped out national differences, and on the other hand those who claim that the spatial dimension is still important (see e.g. writings by Krugman, (1991, 2001) and Morgan (1997, 2001).

confined to national borders, or if a European, centralised patent office would also produce spillovers to Denmark. At first sight one could argue that processing the patent application and informing the applicant about decisions involves limited interpersonal interaction and only codified knowledge. But at closer look there are several channels of such knowledge flows that are heavily dependent upon the spatial, national context. As explained in more detail later, patent offices do many things other than processing patent applications and other IPR like trademarks. For example, it is an important activity to arrange seminars, courses, increasing awareness of IPR issues generally. In addition, personnel mobility from the patent office to patent agents and patent intensive corporate firms is likely to be most intense within national borders. Thus, the channels of localised knowledge spillovers are indeed primarily national.

- 2) In spite of an increasing share of EU legislation relative to what is decided by national parliaments legislation, standards and other regulations, are primarily national, and this is important to firms when choosing their innovation strategy. Even if liberalized, public procurement is often directed towards domestic products, and the overall government technology-, industrial-, and economic policy has a national focus, this also affects the innovation process. In the present context we see a case of “pure monopoly”, which is confined to the nation state – it is not feasible to have several patent granting institutions within one nation. Thus, the minimum geographical entity relevant for our study is the nation state. There is, however, a trend towards expanding this regional focus to Europe as a whole, a key question in our study.
- 3) The paths for exploration are defined through a historical process of interplay between demand patterns and the domestic production structure. The existing range and specialization of products produced in a country largely reflects this process. The area of specialization of a country will in turn impact on which types of innovation will be predominant in a nation. This path-dependency of innovation may in turn have implications for the patent system in that patent engineers specialize in accordance with the volume and complexity of the applications received. This is also an issue in the debate on centralisation of the patent system in Europe in case a decentralized system is upheld: will small, European countries then be able to attract a sufficient critical mass of applications within a certain technological field to generate the specialist knowledge needed for processing the still more complex technologies in the applications⁹?
- 4) Some of the knowledge valuable to innovations is produced in public laboratories, universities and other parts of the education system, which is primarily national. This knowledge infrastructure has become much more important in the past decade or more (Smith, 2000). Telecommunication systems, libraries, databases, education and vocational training systems are important elements in this infrastructure. The institutional infrastructure in other areas is largely national in character. Among important institutional factors are the financial institutions, the technological service institutions, appropriability system as well as more traditional infrastructures.

It should also be noted that there is nothing normative in the discussion above on the role of the nation. Even if the nation-state, or even the region, may facilitate learning and innovation, the cross-border harmonisation may in some cases be beneficial, or even a pre-requisite, for utilising the diversity of nations in a manner promoting innovation (Johnson & Gregersen, 1997). Johnson & Gregersen (1997, p.55, 69) point to the patent system as one clear illustration of this argument, as is illustrated in the citations below:

⁹ There is currently an application under consideration in WIPO, which is 110.000 pages.

Compatibility between institutions at the national and the European level is a key issue in the whole integration process. The development of a European patent system is a clear illustration on this. From its origins, the registration of a patent took place within a national legal system reflecting national specific regulations on intellectual property rights. Spurred by the ongoing European economic integration and the creation of the “Single Market” the European Patent Office (EPO) was established under the Munich Convention of 1973 in order to facilitate industrial protection based on a unified system of registration, which ensures the protection of inventions simultaneously in several European countries.” (p.55)

“ A diversity of innovation systems may be a prerequisite for safeguarding innovation potentials in Europe. Every attempt to build a European system of innovation should take this into account. However, convergence between national innovation systems in some respects, for example in terms of intellectual property rights, communication channels, administrative routines and technical standards may be a prerequisite for utilising other aspects of the diversity.” (p.69)

Even if a firm conclusion should not be derived solely from these statements, one may learn from this that harmonisation should not necessarily be an end in itself. It may be so in some areas, but it should be considered carefully which areas should be harmonised and which should not¹⁰.

The discussion on the nation-state as a framework for innovation processes and learning thus pointed to the need to explore in more detail what are the pros and cons of the physical location of national institutions such as the patent offices. As was mentioned, the location could be decentralised or centralised, as patent applications are largely codified knowledge. This was also one of the main points in the tie-strength discussion: in case of transfer of pure codified knowledge there may be no need for strong ties. In that case, in principle the patent granting authorities could be physically located anywhere in the world. Even if some of the potential learning between the parties is no doubt possible to mediate by way of simple transfer of codified knowledge, we need to investigate whether the tacit element in the knowledge transfer is substantial and whether possible knowledge spillovers are localised.

3. The DKPTO in the Danish innovation system

It was argued in section 2 that the environment in which the learning processes take place is important for the outcome. Earlier research has shown that the national boundaries, and how the learning processes are institutional embedded, matter for the interaction between the parties, in this case firms and the DKPTO. Therefore, defining the role of the DKPTO in the overall innovation system is not trivial; rather it is important to the understanding of the functioning of the DKPTO.

¹⁰ The implementation of the European Currency Unit (later developed into The European Monetary Union) is probably the best known example. Not all joined every step of the ECU-project. Even if this issue is well researched it is still subject to controversies.

3.1. The functions of the DKPTO – what do patent offices (also) do?

The key task of the DKPTO is to offer protection for inventions, trademarks, copyrights and design¹¹. The Patent Office issue patents to individual firms, the technological institutes, Technology Incubators and Science Parks. Furthermore, the office offers consultancy services such as information services, guidance and training within the area of industrial property rights. In addition to handling patent applications and granting patents the DKPTO sell business services. These services consist of a number of different products. The most important products include novelty searches, infringement inquiries, state of the art inquiries, and analyses of competitors / profile analyses. Educational activities, information meetings, library and information services and courses are also offered. These business services constitute the other main part of DKPTO activities¹².

The relationship to the patent agents is particular important as the agents constitute a major group of customers to the DKPTO and because around two-thirds of all the applications filed at the DKPTO are filed via a patent agent. The patent agents' main job is to help companies to write patent applications and specify a patent strategy. This means that most communication goes through the agents, and it means that they are the main customers to a range of the services offered by the DKPTO. At the same time the patent agents are competitors of the patent office on some of the patent-based services. They do not have the right to issue patents and trademarks but they operate within the same business service areas such as courses, market analysis, searches on prior art etc. as the patent office. Even if the patent agents are competitors they are at the same time customers and collaborators, such as when the DKPTO co-operates with patent agents to establish different courses on technical and legal issues concerning patenting.

The DKPTO also influence the innovation system in general indirectly because patent engineers trained within the DKPTO often move to industry. The knowledge embodied in people and the mobility of skilled people is an important channel of knowledge diffusion. In the case of this study the industry may be able to enhance its capabilities within the field of IPR by way of using these mobile patent engineers. The fact that experience from employment in the DKPTO is often mentioned as an asset in job advertisements from companies advertising for patent engineers supports the notion of the DKPTO as a supplier to the industry of these competencies.

Furthermore, the DKPTO contributes to technical / professional literature on IPR, and the DKPTO store patent descriptions for open disclosure. This is also a direct channel through which knowledge is diffused in the innovation system in general in the words of Feldmann (1999) they are "paper trails". Initiatives have also been taken to reinforce co-operation with universities in order to incorporate IPR education into existing curricula of especially technical and natural sciences education. (Ministry of Industry and DKPTO, 2001).

¹¹ In 1999 the DKPTO received 1674 Danish patent applications and 221 foreign (DKPTO, Annual report 1999). In the same year the EPO received 34.932 patent applications applying for patent in Denmark and 592 of the applications were from Denmark (EPO, annual report 1999).

¹² Earlier in DKPTO history business services have shown a potential for growth. Interviews in both the Sales and Marketing section and in the Patent section suggest that the DKPTO could potentially increase the revenue of business services significantly. The revenue of business services has in recent years become stagnant. (EUR 511.000 for technical services in 1998, 619.000 in 1999, and 592.000 in 2000). By contrast, rapid expansion was experienced in the mid 1990s (based on interviews, no statistical data available).

The patent system as such may play an important role for innovation. One policy objective of the patent system is to create incentives for investments in inventions by way of IPR protection. Another policy objective is that patents are a means of establishing a market for knowledge in that patents are traded as well as used for inspiration to technological development. The knowledge from the published patents and the patent descriptions can for instance be used for research purposes and other companies have the chance to use such knowledge as a foundation for new innovations. Thus the system both helps protecting knowledge (thus giving an incentive to develop new knowledge), and it may help to diffuse knowledge in the economy. The companies' possibilities of protecting new knowledge and the publishing of patents are the two main arguments for why governments support the system of intellectual property rights¹³¹⁴.

3.2. Conclusions

The role of the DKPTO in the national system of innovation thus includes the incentive system described above to develop inventions, trademarks, design and information services, guidance and training in the area of industrial property rights. Moreover, the DKPTO participate in the policy process within the field of IPR. Thus, the review above on 'what do patent offices do' showed that the DKPTO might happen to fulfil a knowledge diffusing function as well, especially through delivering of services.

In addition to business services the DKPTO is engaged in a number of activities, which entail interaction with other important actors in the Danish innovation system such as patent agents, science parks, incubators and the policy system. Although the DKPTO, and patent institutions generally, are most often classified in the literature on innovation system as regulatory institutions the interactions with other institutions and the role as "educating" staff competent in patenting who are subsequently being employed in industry, points to a possible diffusion role as well.

¹³ The Danish government supports international harmonisation of patent standards and procedures. The Danish government also supports the EPO and a EU patent system. However, at the same time it is believed that fully qualified national patent offices play an important role in the environment for innovation and that is why the government support the idea of the national patent offices as subsuppliers to the EPO. This has been a Danish policy for several years. For example it was stated in the yearly publication on Danish Industrial development and policy from 1995 that a Danish patent authority would still be needed in order to ensure that Danish firms have easy access to the IPR services they need. This is particularly important for small firms, who experience geographical, cultural and language differences as major barriers to the use of the central, European patent authorities in Munich (Ministry of Industry, 1995 pp. 187, Patent- og Varemærkestyrelsen, 2000).

¹⁴ Nevertheless, there are drawbacks of a patent system as well. It may be argued that the patent system distorts the allocation of resources as certain types of production are stimulated. Other traditional arguments why the patent system has drawbacks is that the monopoly position of the patenting firm render consumer welfare reduction, and that patents block further development of a product or technology. It may be worth emphasizing that assessing pros and cons against each other is extremely difficult. In a literature review Riis (2001) concludes that since Machlup in 1958 claimed that we do not know if the patent system as such is economically beneficial for society, the economic theory have still not reached a conclusion as to this question (see also Mazzoleni and Nelson (1998)).

4. Empirical assessment of knowledge diffusion from the patenting process

This section explores quantitatively the learning effects discussed in section 2. This research is pursued by analysing data from a survey designed for this special purpose. Quantitative methods to reveal a complex phenomenon like knowledge and competencies may only take us some of the way in understanding the way the DKPTO operate and its role in innovation. One complication is that IPR is many other things than patents. Firms value different measures of appropriating returns from innovation differently (Arundel, 2001), even within the firm different products may require different strategies for protection. This is supported by an earlier survey of Danish manufacturing firms and their means of appropriation (DKPTO, 2000). In that survey it was found that patenting firms are also those who use other appropriability measures to a larger degree than the average firm (ibid., p.14). That survey also confirmed other studies on what are the most frequently used measures for protecting product innovations. 61% of 451 responding firms used lead time advantages, 54% secrecy. Patenting ranked fifth out of eight with 38% of the sample having used patenting.

Our own survey was conducted among all Danish firms who either applied for a patent or who used business services from the DKPTO within a three-year period. The questionnaire was developed through several iterations and then tested on a patent director in one of the largest firms in Denmark. It was inspired by the theoretical considerations developed in section 2. The survey was implemented by telephone interviews. The overall response rate showed to be $290/501 = 57.9\%$, which is satisfactory and is sufficient to make a breakdown by various variables. Moreover, the sample reflects the actual population. In other words, there is no way of increasing the number of respondents beyond what has been obtained, e.g. by using more resources on interviews.

More details about the implementation of the survey may be obtained from appendix 1.

The presentation of results from the survey is organised in three sections. Firstly, structural characteristics of the firms in the database are highlighted. This section is kept relatively short, as most of this information can be obtained from the tables and needs few comments. Secondly, knowledge flows from the DKPTO and potential effects of these knowledge flows is analysed. Thirdly, the survey showed the opinions of firms on the importance of having a nationally localised patent institution.

In the tables N denotes the total number of firms relevant to each variable and the percentages denote the share of each category of the total. It should be added that we here only present a selection of the results. A number of other issues were covered in the survey but left out here.

4.1. The characteristics of the realised sample.

Basic characteristics of the realised sample are presented below in five tables. The realised sample is broken down on size, number of patents applied for, year of establishment, year of first contact with the DKPTO, innovations.

One of the often-used background variables of data on innovation and innovation related issues are the size of firms. Many surveys have found substantial differences across categories of firm size.

Table 1 shows our realised sample in the survey by firm size.

Table 1: Survey realised sample by firm size in full time employees.

Number of employees	N	%
0	3	2
1-9	52	27
10-99	52	27
100-499	47	24
>500	38	19
Do not know	3	2
Total	254	100

The average firm size was 280 with a median of 30. This, together with the fact that 43% of firms in the survey have 100 or more employees, makes our realised sample relatively large-firm dominated by Danish standards.

Even if intellectual property rights is indeed many other things than patents it is often the patent activity of firms, which is in focus in the literature and empirical investigations of IPR. In our sample several of the organisations interviewed should not be expected to have patents as they are natural buyers of services from the DKPTO but are not themselves developing new products or processes. One such example is research parks, which inform their companies about intellectual property rights and therefore need information and courses from the DKPTO, but they do not necessarily (although they could) have patents themselves. In the sample, patenting is nevertheless widespread. Thirty percent of the firms had no patent applications.

Table 2: Number of patent applications through the DKPTO within the past 5 years

Number of patent applications	N	%
0	59	30
1-2	51	26
3-5	33	17
6-20	23	12
>20	23	12
Do not know	6	3
Total	195	100

Survey question: How many patents did you apply for through the DKPTO during the past 5 years?

The average number of patent applications was 18 with a median of 3¹⁵.

The year of establishment is an important parameter for understanding the interaction between the firms and the DKPTO, because it may be the case that young, or even new firms/single entrepreneurs, are less aware of the opportunities of interplay with the DKPTO. In somewhat the same vein the year of first contact with the DKPTO may be important information, because for example a large, old firm who have had a long-term, frequent contact with the DKPTO may not learn much

¹⁵ In a survey by the DKPTO (2000) the median of patents granted was also 3. The two surveys are not directly comparable because the DKPTO-survey focused upon SMEs within the manufacturing industry, whereas this survey covers all industries and all size categories. The medians will, though, tend to be fairly equal.

from the DKPTO any longer, whereas the same firm may have benefited substantially from the first years of contact¹⁶. Table 3 and 4 below show these two features.

Table 3: Year of establishment.

	N	%
1960 or before	71	36
1961-1990	64	33
1991 or later	49	25
Do not know	11	6
Total	195	100

Survey question: When was your company established?

There were 69 percent of firms established before 1991, indicating a sample of relatively large, old firms. On average firms are established in 1963 with a median of 1978.

Table 4: Year of first contact with DKPTO.

	N	%
1980 or before	43	15
1981-1990	34	12
1991-1997	50	17
1998 or later	54	19
Do not know	14	5
Had no direct contact	95	33
total	290	100

Survey question: When did you get in contact with the DKPTO for the first time?

On average firms had their first contact with DKPTO in 1987, with a median of 1995.

It may be worth noting in Table 5 below that the firms in the realised sample are also relatively innovative. Thus, at least 60% have introduced an innovation within the past year. It is likely that a large share of respondents answering, “do not know” is highly innovative, but just do not know the exact number of new products and processes¹⁷.

Table 5: Number of innovations within the past year.

	N	%
0	26	13
1-2	37	19
3-9	45	23
10 or more	36	18
Do not know	51	26
Total	195	100

Survey question: How many innovations did your company introduce within the past year?

The average number of innovations was 13 with a median of 4. Innovation intensity, calculated as the number of innovations divided by number of full time employees in the firm, is 0.86 and 0.1

¹⁶ In a pilot test of the questionnaire a large Danish firm emphasized this point.

¹⁷ This was the case in the pilot test of the questionnaire. The test respondent would answer that question with “many”, as he was not able to have a sense of the correct figure.

mean and median, respectively. On average 16 persons in the firm are occupied with innovative activity (median 4 persons).

4.2. Potential effects of knowledge flows from the DKPTO

A first step towards accessing the question in the headline is to make clear to what extent is knowledge flows actually taking place. Asking the firms directly on this issue, both in relation to a specific task and more generally, we find that according to the firms in our survey the assessment of this vary from not at all (6% and 11% in relation to a specific task and general knowledge on IPR respectively) to Very large extent (14% and 9%). A majority characterise the knowledge generated through the interplay with the DKPTO to be to “some degree” or more. It is to be expected, that at least some learning effects would be reflected in the responses. It is, however, uncertain what level one should expect, as we do not have any good measures for comparison. The results in Table 6 and 7 are consequently difficult to access.

Table 6: The degree of learning in the firm from interacting with the DKPTO on a specific task %.

Not at all	To a small extent	To some degree	much	Very much	Do not know	No. of obs
6	18	33	27	14	2	195

Survey question: To which degree do you think that your contact to the DKPTO has increased the knowledge of the firm in relation to a specific task?

Table 7: The degree of learning from interacting with the DKPTO re knowledge on IPR generally. %.

Not at all	To a small extent	To some degree	much	Very much	Do not know	No. of obs
11	22	29	25	9	4	195

Survey question: To which degree do you think that your contact to the DKPTO has increased the knowledge of the firm on IPR in general?

It is to be expected that knowledge flows are more productive in terms of learning when it is on a specific task. This seems indeed to be the case, although differences are not big.

There were no differences between groups of firms like firms of different size, number of innovations, year of establishment or first contact. This could be said to be somewhat surprising. One should perhaps expect small, new firms to learn more. This is not the case. In fact, if anything should be concluded on this issue it would be the opposite as there is a tendency among firms who claim to have learned nothing or only little on IPR generally from the DKPTO contact to be established in 1998 or later. The discussion in section 2 pointed to the fact that absorptive capacity of the receptor may promote learning. It may be that highly innovative or large firms are more prone to learn. Later we shall investigate further on this issue.

When focusing upon firms who attach importance to the learning in the DKPTO interplay we can assess what is more precisely learnt in the interaction. As displayed in Table 6 and 7 above 41% of the firms attach either great or very large effects to the DKPTO interplay on specific tasks, whereas 57% think the impact has been some, small or none, so-called “high scores” (a 5-point Likert scale has been used in the questionnaire). Table 6 shows a considerable polarisation of answers and a corresponding disagreement concerning the degree of learning from interacting with the DKPTO. Regardless, a substantial part of the respondents scored “high” on this question. The “high scoring” firms give the following priorities, when asked to specify what are the most important things learnt.

Table 8: Contributions of DKPTO interplay. High scores. $N=191$

Contribution	%
Increase knowledge on and use of intellectual PR generally	29
Guidance re applications	24
Increase knowledge on the competitors	15
Increase the general level of competence within the firm	11
Increase the technical know-how of the firm	9
Increase the ability to develop new products or processes	8
Increase the R&D activities of the firm	7
Strategy	6
Increase knowledge on the market	6
Relations to other knowledge institutions	5
Provide Contacts and networks	5
Increase collaboration with other firms	3
Other contributions (share who list one or more)	23

Survey question: Please assess effects of the services from the DKPTO on (several possibilities)?

High scores are calculated as the share of respondents answering ‘Very large effect’ + ‘large effect’ compared to all responding.

The results show that firms primarily see the contribution of the DKPTO as increasing their general knowledge on IPR. Secondary, the DKPTO plays a role in the application phase. These two are by far the most important contributions from the DKPTO. Calculating what could be patterns with respect to firm size, number of innovations etc., we find only unclear relationships.

It is evident from the results that the direct stimulation of innovative capabilities is not seen as a major contribution from the DKPTO. This is ranked low in table 8, and 45% of firms see the contribution in this respect as zero. Compared to previous research on information sources for innovation, such as the results from the Community Innovation Surveys, this is not very surprising. Patent disclosures and institutions are generally assessed as having a minor importance in stimulating information to innovation activities.

In section 2, the transfer of knowledge was discussed. It was pointed out that tacit knowledge may be best transferred by means of what we labelled relational transfer, whereas codified knowledge may efficiently be transferred through transactional transfer. The channels of knowledge transfer are only partly indicated in the results above. One specific channel, which we have better knowledge on, is the mobility of personnel between the DKPTO and the firms interviewed. Answering the question “Has your enterprise, now or previously, employed people previously employed with DKPTO”, it showed out that 12% confirmed that this has been the case. In other words, every 8th firm in the sample has one or more former DKPTO-worker in the staff. This is even a minimum figure as it is likely that some respondents are not fully aware of all the previous jobs of the staff.¹⁸

¹⁸ The estimation of the number of former DKPTO-employees is likely to be under-estimated for other reasons: once the employee is working for some time in the new firm, the respondents do not think of that colleague as having benefited from external knowledge upgrading. Moreover, the need to interact with the DKPTO may be reduced when DKPTO employees are hired. The formerly DKPTO-employees primarily are

One of the hypotheses generated from this could be that previous DKPTO employees would stimulate the knowledge of the firm and the specific use of IPR. However, when answers of previous DKPTO employees are combined with answers on the question if DKPTO services have resulted in more knowledge and use of IPR there are no clear patterns. This is somewhat surprising as the implications of the theoretical considerations in section 2 are that absorptive capacity should increase.

Another plausible hypothesis is that firms who employ DKPTO-staff are more patent-active. It shows that patent intensity – calculated as the number of patents per employee - is 2.01 and 0.64 respectively in firms with/without former DKPTO-staff (after cleaning for two extremes). This is a significant difference. One should, though, be careful about the interpretation of these figures, as the causality is not clear. On the one hand one may presume that firms with former DKPTO-staff will increase their patenting as they have the expertise in-house and as they are presumably more aware of the possibilities and necessities in patenting. On the other hand, one may think that firms are inclined to hire DKPTO-staff because they increased their patenting and therefore need, or cost-efficiently benefit from, having in-house expertise.

As mentioned, it was emphasized in section 2 that an absorptive capacity is important in order to make knowledge useful and to facilitate knowledge diffusion in the economy. Although it may only be an approximation then the innovation intensity of firms may in some respects indicate an absorptive capacity, at least in the present connection where IPR is in question. Table 9 shows the average innovation intensity in two groups of firms with high or some learning effects from DKPTO and firms with low/no learning effects. In the survey firms were asked to list how many innovations they introduced. The innovation intensity is then calculated as the number of innovations per employee in the firm in 2001. Statistical tests shows that the averages are not significantly different within a 5% level.

Table 9. Innovation intensities in ‘learning’ and ‘non-learning’ firms

	Mean	Median	N
High/some learning effect of DKPTO	1.10	0.10	60
Small/no learning effect of DKPTO	0.53	0.10	43

Survey question: see table 5 and 7.

Similar calculations have been done on number of patents, number of innovations, size of firm, number of personnel in innovation. However, these analyses did not render statistically significant differences, although both the number of innovations and the number of patents did show some differences in favour of firms who had large learning effects from the DKPTO.

It could be that learning effects are related to the age of the firm. It is however, not totally clear what is the most appropriate hypothesis. On the one hand, one should expect old firms to have greater absorptive capacity and to have needs that are more specific and therefore perhaps more

hired by large, innovative firms with a long record of DKPTO-contact.

readily identification of the learning effects. On the other hand, it may be that firms over time generate their own expertise and consequently will have less need for the DKPTO services. Table 10 indicates that none of these hypotheses is valid. In fact, the two groups are remarkable alike.

Table 10. Years of establishment in 'learning' and 'non-learning' firms

	Learning			None learning		
	Mean	Median	N	Mean	Median	N
Years of age	1964	1975	98	1964	1980	67

Survey question: see table 2 and 7.

Similarly, one may propose that the DKPTO are more likely to learn from firms the more innovative they are, measured by innovation intensities and number of patents. These two innovation indicators confirm our hypothesis that firms who provide knowledge to the DKPTO are innovative. However, the number of innovation personnel does not show that pattern.

With respect to learning in the DKPTO-firm interaction it seems fair to conclude that results are not that strong. The main contribution from the DKPTO is apparently raising IPR awareness, and analysing characteristics of firms who do learn render a somewhat blurred picture.¹⁹

4.3. The importance of being domestically located

In section 2 we put forward arguments from the innovation systems literature and the literature on localised knowledge spillovers as to why the innovation system prevails as a national system and why knowledge spillovers may be spatially bounded. This includes the specific, national endowment of institutions in the innovation system. With respect to national patent offices, it has been explored whether such offices should be upheld or harmonisation should entail not only legislation but also the organisation (centralisation) of patenting procedures²⁰.

One of the important issues in the interviews was the opinion of firms as to how important it is to have a national patent office. Table 11 show the overall distribution of answers on that question.

Table 11: Perceived importance on use of services of the DKPTO being a domestic patent office, %.

None/negative	Small	Some	Large	Very large	Do not know	No. of obs
38	10	20	20	11	2	195

Survey question: To which degree was it important to your purchase of services from the DKPTO that the DKPTO is a national authority rather than e.g. an European authority?

Again, the assessment of the level of the percentages is difficult since there is no "expected level of importance" against which to compare the answers of the firms. If anything, the answers indicate considerable disagreement concerning the importance of the DKPTO being a domestic institution. Half of the respondents attach none or small importance to the national location, but one third sees it as having large or very large importance. Differences across size categories are small. Only in the very large firm segment, there is a significant tendency of attaching less importance to the domestic location of the patent office.

¹⁹ However, the analyses have so far assumed linear relationships between learning and our independent variables. As suggested in section 2 there might be inverted u-shaped learning effects.

²⁰ See e.g. Koper (2001) for an account of the discussion seen from the perspective of the EPO.

The share of respondents who attach any importance (even if only small) to the location, were then asked to specify this importance (if any) on the following possibilities:

- avoid language barriers,
- higher competences in treatment of applications,
- avoid cultural barriers,
- better possibility for dialogue,
- speed of treatment and
- price.

More than one option was open to the respondents. As mentioned, in this question it was a precondition that the respondent attached importance to the fact that the DKPTO is located nationally, as it would not make sense to ask about specific effects if no importance is attached at all. Consequently, the number of respondents was reduced from 195 to 120.

Table 12: Advantages of being nationally located, pct. listing a reason.

Advantages	%
better possibility for dialogue	84
avoid language barriers	73
Speedy treatment	63
avoid cultural barriers	56
higher competences in treatment of applications	24
Price	21
Other contributions (share who list one or more)	29

Survey question: To which degree was it important to your purchase of services from the DKPTO that the DKPTO is a national authority rather than e.g. an European authority? If confirmed – Why was this important (various options)?

The respondents think the main advantages of dealing with a domestic patent office is related to better possibilities of dialogue and direct contact on Danish language. This corresponds with previous discussions in section 2. The competencies do not seem to be an important parameter.

An important aspect in this connection is the potential difference between small and large firms, as one could presume that especially small firms could be inclined to prefer a national office. Therefore, the 120 firms are sub-divided into two groups, one with an above median number of employees, another with below the median number of employees. The share of firms within these two groups listing reasons for the advantages of being domestically located are then listed in Table 13.

Table 13: Advantages of being nationally located, pct. listing a reason by two size groups.

Advantages	Large firms	Small firms
	%	%
better possibility for dialogue	83	88
avoid language barriers	72	75
Speedy treatment	60	67
avoid cultural barriers	57	57
higher competences in treatment of applications	19	30
Price	26	17

Survey question: See table 12.

From Table 13, we may conclude that the tendency of small firms being more in favour of a domestic location of the patent office is only very small and statistically insignificant.

Two other indicators of the issue of location of the patent office should be emphasized. First, it was asked if firms within the past 5 years submitted one or more patent applications directly to the European Patent Office in Munich. The responses to this question were naturally conditioned on two other questions, namely if they had a patent application within the past 5 years and secondly if they were aware that a European Patent Office exists (78% knew this). Out of the remaining 153 respondents after these conditions, 27% answered that they did so. There is a tendency that large, old firms have submitted directly to the EPO.

Secondly, the firms were asked if the patent application were in any respect made easier because a domestic patent office exists. Again, answers are valid only if respondents had one or more patent applications. 70% out of 89 relevant firms (those who applied for at least one patent at the DKPTO) confirmed that indeed it has been easier to apply for patent due to the domestic location of the patent office. No significant differences across firm size appeared.

4.4. Conclusion

The results from the survey showed a broader picture of the role of the DKPTO in innovation²¹. We have found that firms disagree concerning the question of learning from interacting with the DKPTO. There are 41% of firms who attach 'large' or 'very large' effects when seen in connection with a specific task, and 34% see 'large' learning effects on IPR issues generally. Approximately 60% of the respondent perceive, however, learning from interacting with the DKPTO to be relatively modest.

This, in combination with other results from the survey, made us conclude that the effects on innovation of the DKPTO are primarily confined to increasing general awareness of IPR. Firms did not see the role of the DKPTO as neither improving directly the capability of the firms to develop new products/processes nor to improve the R&D-activities of the firm.

There were 12% of firms that stated their organisation had hired people previously employed with the DKPTO. This is a source of knowledge diffusion alongside the role of the DKPTO as arranging seminars, courses, policy formulation etc. Thus, although the learning effects with respect to innovation at first sight seem modest then the indirect effects in terms of stimulating knowledge valuable for the innovation process should not be overlooked.

Of the firms who did learn from the DKPTO, the innovation intensity is higher. Likewise, those who transfer knowledge from the firm to the DKPTO are more innovative and more patent intensive. This is an indication that they also have more absorptive capacity with respect to learning.

A third of the companies see the domestic location of the DKPTO of having large or very large importance. In particular, firms see advantages as more easy dialogue, and the advantage of being able to communicate in Danish. Thus, at least the communicative processes are likely to benefit from the availability of national entries to the patent system. This is partly confirmed by the responses con-

²¹ In order to further verify and go deeper into the issues in the survey a number (7) of in-depth case studies were undertaken. They are reported in Christensen, J. L. (2004). These case studies rendered roughly the same picture as that of the survey.

cerning the advantages of nationally located patent authorities (Table 12). There are only minor indications that small firms are more prone to prefer a domestic location of the patent office.

5. Conclusions – the general effects of DKPTO on knowledge transfer and competence building

It was contended in section 1 that the interaction between firms or individuals applying for patents and the patent office would add to the competencies with both parties. In the end, this may have positive effects on the innovative abilities of the firms and their awareness on and actual use of the IPR-system. Moreover, the competencies in the patent office may increase as a result of this interplay.

Many tend to think of patent offices as performing relatively standardised procedures ending up in a ‘stamp’ saying yes or no to an application for a patent. A closer examination of the question ‘what do patent offices actually do?’ showed that the relationships of the DKPTO with external organisations are not only confined to industrial firms and to a simple granting of a patent. A wide array of other relations and activities are important in the overall picture of the role of the DKPTO in the innovation system. Although the DKPTO has direct contact with many firms, its indirect role as a provider of information and knowledge to other organisations should not be underestimated. It also says that the traditional classification of patent offices, as exclusively regulatory institutions, may be too narrow. The research reveals that the DKPTO not only grant patents, they also have a complementary role as a knowledge-diffusing organisation.

The DKPTO contribute to diffusion of knowledge in the economy, primarily by way of increasing the awareness of IPR among firms, according to the survey. For example, the increase in the knowledge of firms on the awareness and use of IPR generally, was ranked in top of possible contributions from interacting with the DKPTO. In addition, there is a transfer of knowledge through a flow of qualified patent caseworkers from the DKPTO to the patent agents and to large industrial firms.

With respect to the knowledge spillover in the innovation system as a whole, we thus found that interaction with the DKPTO does not seem to render much spillover of *technological* knowledge. We have seen clearly that firms do not attach great importance to the direct help of the DKPTO in Danish firms’ innovation activities. This does not rule out that the DKPTO is an important part of the innovation system in Denmark. The offices role is, however, of an indirect character. As described earlier, the DKPTO is, particularly important in raising awareness on IPR.

In conclusion, the results of this analysis concerning the general role of the DKPTO in the Danish national innovation system is that the DKPTO seems to contribute to general IPR awareness and to bring together the IPR branch by constituting a central focus point for common interests. There are some indications that the DKPTO serves a role in facilitating easy access to the patent system for firms by lowering the (cultural and linguistic) barriers of IPR protection. Moreover, there are indications that the DKPTO serves a function as training patent engineers who, after a period in the DKPTO, are employed in other organisations. The role of the DKPTO in terms of stimulating innovation directly seems to be modest²², but knowledge spillovers may nevertheless be considerable.

²² This is after all is no big surprise considering the results of innovation research in general and the ranking

Perspective: A harmonised patent system: the role of the national location for knowledge spillovers

As mentioned in the introduction, the debate on the future European structure of the patent system has been long and intense. In particular, the debate has evolved arguments similar to the statement below:

“If the community patent system does go ahead, it will inevitably rely on the existing EPO structure in Munich to examine and grant the new single patent. Some governments and national patent offices fear for their small and medium-sized enterprises, which rely on national offices for advice and support on patent issues. ... Governments and national patent offices have thus argued that a centralised system would deprive them of skills and revenues for which they should be compensated.” (Financial Times, Oct. 8th 2001).

Arguments against the above perspective have claimed that the alternative approach – a decentralised system, perhaps with a sub-contracting organisation where European patents are granted by national patent offices on behalf of the EPO – is against the purpose of simplifying. Moreover, it is feared that quality will become too different and cannot be upheld in national patent offices without a critical mass of patent cases.²³ This may distort the harmonisation, as it will urge firms to “shop around” between offices²⁴.

One may question if the above-mentioned functions could effectively be taken care of by the EPO, patent agents, or some other institution. After many years of negotiations the EU countries agreed march 3th 2003 on basic principles for an EU patent. According to the compromise reached the EPO will in the future be the only legal institution granting EU-patents. The role of national patent offices will take the role of disseminating information and awareness of IPR issues and provide guidelines for how to fill in application forms. Under certain conditions and quality assurance standards the national organisations may also do novelty search after agreement with the EPO.

This issue of centralising or decentralising the patent system was in fact part of our questions to respondents in the survey. Drawing upon section 2 and the results from the survey our answer on whether it would be an appropriate policy development to centralise the system is somewhat ambiguous. Certainly many firms, especially the large firms, would not mind if the functions mentioned were fulfilled by the EPO. On the other hand, we saw in the survey that firms may feel more confident with a national patent office in the proximity, with its familiar and national language. This was discussed in section 2, where knowledge flows were seen as depending on common codes of understanding and cultural, and geographical proximity. These reasons for preferring a national location of the patent office were confirmed in our survey by the firms who preferred a domestic location. Our survey revealed that about half (48%) of the respondents attached small or no importance to having a national office while, on the other hand, about one third (31%) saw it as being of large or very large importance.

of information sources for innovation as has been displayed in numerous studies on innovation, for example studies using CIS-data.

²³ It is highly uncertain, and subject to further research, to determine what is more precisely a critical mass in a world of rapidly changing technologies.

²⁴ See in particular Koper (2001).

From a general European perspective, the question of the future role of national patent offices (NPOs) is highly relevant in this connection. The empirical evidence of this analysis does provide some knowledge on this, but does not allow a *general* conclusion concerning the possible obsolescence or indispensability of these institutions on a European level as this may differ from country to country²⁵. The role of individual NPOs should therefore be carefully considered and balanced against the benefits of a pure centralisation.

If the role of national patent offices only concerned the *granting* of patents per se rather than the full processing of applications, this may pose a problem, if other activities of the national patent offices such as business services and general information and awareness raising depend on these competencies. It may thus be argued that the possibility of preserving competencies at a national level (e.g., by carrying out casework as a subcontractor to the EPO) perhaps is a prerequisite for the possibilities of the national patent offices of playing an important role in the innovation system. If the system is fully centralised an alternative role for national patent authorities could be to increase the awareness among firms of IPR, especially in the small firm segment, and to continue the activities already pursued such as selling business services, courses and other information services, interaction with the policy system and to act as a nodal point for the actors in the innovation system who work with IPR²⁶.

A further perspective may generalise the present case to the current political interest in Europe in stimulating interplay between knowledge institutions and industry. Although the DKPTO is not a higher education institutions as is often thought of when this policy issue is discussed, then it may resemble that type of institution. Often the U.S. is referred to as a role model in this connection. It should be emphasized, though, that the close university-industry interaction in the U.S. has not come about by coincidence. On the contrary, it may better be described as a cooperative movement, which stems from long-run, deliberate policies. Adams (2002, p. 275) points to the Morrill Act from 1862 and the Hatch Act from 1887 as laying the foundation for the subsequent policies on this university-industry interaction that is nowadays clearly reflected in data.

Adams also finds that knowledge spillovers are localised, especially those stemming from university research. In light of this finding one may speculate whether there is a limit to how far away patent examination can be located if such spillovers should be preserved. The present study points to a differentiated picture of what knowledge produce spillovers within the nation state, the geographical entity relevant for the policy question in the introduction. It should be remembered that there are important differences between the patent offices and universities in this respect. University research may be characterised as open science with elements of tacit, interpersonal knowledge²⁷, whereas patent offices are characterised by codified, closed knowledge.

²⁵ Of course this would not affect all members of the EPO equally. The role of national patent offices in national innovation systems differs from one country to another. These differences could be subject to further research through comparative analyses, which might give an overview of the effect of centralisation at a cross-European level. In particular, it would be interesting to study whether it actually has been the case that patent expertise are indispensable and if they have in fact vanished in those countries who gave up to have a national examination procedure.

²⁶ Today the DKPTO is regarded as such a 'community creating' organisation by way of their arranging meetings for 'the branch' and their network to the other parties dealing with IPR related issues.

²⁷ This may explain why Adams (2002) finds that university spillovers are more significant than industry spillovers and that spillovers from consulting etc are more localised.

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Appendix: The design and implementation of the survey

The questionnaire was designed to render clear answers and to keep the interview within limited time. The average time spent on the interviews was 12 minutes.

The sampling was done using two sources. Our primary interests were firms who had both applied for patent and had experience with services from the DKPTO. From the DKPTO, we obtained two databases, one of firms who applied for a patent within the past 3 years, and one of customers who bought services. These bases were 1865 and 625 firms respectively. The common share made up 143 firms. As our target was 200 interviews, the 143 firms were interviewed first, then supplemented with the base of services customers. The former list was reduced to 140 after cleaning for double registration of observations closed down firms etc., and the latter list made up 361 firms. Re-dials were set to 25 before giving up reaching the relevant respondent. Three trained and carefully instructed interviewers undertook interviews in the period 11th – 27th September 2001. Neither respondents nor the interviewers had problems with any of the formulations of the questions.

As the resulting sample therefore seemed realistic or even perhaps too small compared to the target of 200 interviews, it was during the process decided to go for emptying the entire sample. This resulted in 290 interviews of which 77 stems from the 140-group, that is firms that applied for at least one patent. In this group, the response rate is thus 54%. The overall response rate showed to be $290/501 = 57.9\%$, which is satisfactory, especially considering that pure abstaining from participation happened in only 49 cases, and 30 interviews were terminated before completion. The remaining 132 non-responding cases showed to be either non-existing, or for other reasons not able to get in contact. As mentioned 77 interviews were performed with firms who were in the 140-group. Out of the remaining 213 firms interviewed a surprisingly 95 firms claimed to have had no contact with DKPTO. This relatively large share is surprising considering that the firms are listed in the customer base of the DKPTO Sales and Marketing department. The interviews with these 95 firms were consequently terminated after only a few questions (3 minutes). Our realised sample thus consists of 195 useful interviews.

Non-responses were unsystematically distributed. We can therefore regard the data, as reflecting the total population and no weighting of the data is necessary.

There are large differences in who are the relevant respondents in the firms. In large firms there may be a special department dealing exclusively with intellectual property rights, whereas in small firms it may be the owner. There were a large number of the firms that had the head of production/products handling these matters. Consequently, the interviews started with a filter process, identifying the relevant person to be interviewed. In order to make clear that the interview is not solely on patenting but rather a broader range of services from the DKPTO it was mentioned explicitly in the introduction what is the subject of the interview, and examples were given on what are services more precisely. Many firms use patent agents to handle matters regarding their intellectual property rights. As we were particularly interested in the effect of the DKPTO, respondents were asked to state if they used patent agents alongside the DKPTO (60% of the group of firms in the sample with a priori assumption on patent applications claimed to have used patent agents for services). They were subsequently asked to disregard the cases where only patent agents handled their case.