A Survey of the Economics of Patent Systems and Procedures*

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Abstract:

The last several decades have seen increases in patenting activity worldwide, as well as growing issues related to patent quality. In response to these quality issues a recent patent literature has emerged that examines the behavior and incentives of patent examiners, applicants, and third parties. In this paper we provide a survey of this new economic literature on patent office systems. Both theoretical and empirical papers are considered. Policy implications coming from this literature are presented.

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1. Introduction

The last several decades have seen an explosion in patenting activity in many countries. This surge has been accompanied by increasing backlogs at many patent offices, increased time periods from patent applications to decisions, problems in retaining patent examination staff, and allegations of low quality patents being granted (van Pottelsberghe, 2010).

Several reasons for the surge in patent activity have been proposed, including higher research and development expenditures and increases in invention rates, an increased propensity to file for patents abroad, new patent strategies and management practices, and lower examination standards.[1] The increase in patenting activity has also been partly attributed to Information and Communication Technology (ICT) industries. Indeed, Hall and Ziedonis (2001) and Hall (2004) suggest that patenting activity growth in the U.S. has been focused primarily on "electrical, electronics, computing and scientific instruments" industries, and that patent growth may be the result of firms accumulating patents to defend against infringement claims and to bolster their positions in cross-licensing negotiations. The surge in patents in the U.S. has also been associated with important legal decisions which have allowed the granting of patents for software and business methods.

The problems of the U.S. have been experienced in other countries to a lesser degree, possibly as a result of more conservative approaches to software and business method patents.[2] However, a recent Canadian court decision may represent a shift towards granting such patents in Canada, at least in the area of business methods. On October 14, 2010, the Federal Court of Canada overturned a recent Canadian Intellectual Property Office (CIPO) decision denying a

[1] See, for instance, Kortum and Lerner (1999), Hall and Ziedonis (2001), Langinier (2005) and Bessen and Meurer (2008).
[2] Discussions of international differences in patent outcomes can be found, for example, in London Economics (2010) and van Pottelsberghe (2010).

patent to Amazon for its "one-click" technology for online shopping. This technology had already been granted patents elsewhere, including in the U.S. and Europe. The Court sent the case back to CIPO, instructing it to reconsider Amazon's application.

This decision represents a potential turning point in Canadian patent policy, with one observer writing that "overall, Amazon is a landmark decision that potentially heralds a new era of increasing acceptance for patents directed to computer-implemented inventions and business methods in Canada."[3] Furthermore, this decision could potentially lead to a surge in patent applications and examinations in ICT industries. On November 4, 2010 it was reported that "If the case isn't appealed, IP lawyers expect clients to instruct them to request examination for a pile of pending business method applications. The bottom line is that this decision will likely result in more patents being granted."[4]

As this decision might possibly result in increased pressure on CIPO in the form of increases in patent applications and examinations, it becomes important to consider responses in terms of procedure and process. In this paper, we review the recent growing economic literature on patent office systems, with a focus on whether it provides any lessons for policy recommendations. This literature, which has arisen in response to patent system problems in the U.S. and elsewhere, goes beyond the classic economics of patents to open the "black box" of patent office procedure and practice. Topics considered include the incentives and behavior of patent examiners and applicants, the role of fees and the fee structure, and the impact of policy changes. Both theoretical and empirical studies are considered.

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[3] Conneely, J., Macchione, A., Mason, S., Nakano, R., and Tanne, S. (2010), "With 'One-Click' Business Methods are Patentable in Canada," available online at http://www.barrysookman.com/2010/10/15/with-one-click-business-methods-are-patentable-in-canada/.

[4] Hasselback, D. (2010), "Businesses can patent their methods," *Calgary Herald* , Nov. 10, 2010, pp. C.8. An appeal of the *Amazon* decision was submitted by CIPO on November 15, 2010. The notice of appeal may be viewed at http://www.ippractice.ca/files/AmazonFCAAppeal.pdf (last accessed November 25, 2010).

Several conclusions emerge from our review. The identification of optimal policy is made difficult by the early stage of the literature, and a lack of data and empirical analysis. Economic theories of patent process and office procedure often yield no clear policy proposals, meaning that empirical analysis is required. However, patent research is rife with data measurement and availability issues. While headway has been made in this regard for the major patent offices such as the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO), it is unclear that results for these offices carry over to a smaller office such as CIPO. Even though most of the empirical patent literature focuses on the trilateral patent offices (USPTO, EPO and Japan Patent Office), our objective here is to gain some insights for a smaller patent office, CIPO, and to point out to major differences with the USPTO.

Patent office outcomes are the result of the interaction of several types of agents, with their own objectives, incentives and private information. Applicants may possess private information on the value of their innovations, and may act strategically in the revelation of that information, the speed with which they pursue applications, and in other decisions associated with the application. Patent process outcomes also may be influenced by the actions and abilities of individual patent examiners, who respond to incentives put in place by patent offices and possibly to other incentives such as mobility and career concerns. Third parties also have the ability to impact patent system outcomes, for example by revealing information on rival patents.

In considering policy options, policy makers should evaluate the impact a policy would have on the behavior of the different agents involved. Indeed, because of the complexity of the response of different agents to policy initiatives, new policies designed to expedite examinations or promote quality should be adopted with caution. While certain policies, such as increased international cooperation and harmonization of patents or strengthened incentives for examiners, have been considered, concerns have been raised in the literature that such changes could in fact reduce patent quality. This may be particularly relevant to ICT industries involving complex patent examinations with little available prior information.

The paper is organized as follows. Section 2 presents an overview of patent rules and patent system procedures. We focus on the U.S. and Canada, with some discussion of other patent offices. The economic literature on patent systems is reviewed in Section 3. Section 4 concludes and discusses policy implications.

2. Patents and the Functioning of Patent Systems

Absent patents, many inventions would exhibit public good attributes: even though the innovation cost is borne by inventors, competitors can benefit from the inventions. Because of the resulting free–riding problem, too few innovations would be developed. Patents address this problem by endowing innovators with property rights on their inventions. A patent confers its owner a temporary right to exclude others from exploiting the innovation. In exchange for the exclusionary right, the patent holder must disclose details about the innovation (for an overview of the economics of patents see, for instance, Langinier and Moschini, 2002).

Patent rights extend typically for a maximum of twenty years from the date of filing and in most jurisdictions the innovation must demonstrate similar attributes to be patentable: an innovation must be novel (not already in the public domain), non obvious (to a person with ordinary skills in the particular field), and useful (to have at least one application) as defined in the U.S. [5] Once a patent is granted, to maintain his rights a patent owner must pay renewal fees.

[5] In Canada, for example, the innovation must exhibit novelty, utility and ingenuity. See the Guide to Patents, http://www.cipo.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr01090.html#sec8 (last accessed October 7, 2010). General information on U.S. patents can be found at http://www.uspto.gov/web/offices/pac/doc/general/index.html#patent (last accessed November 30, 2010). Basic

Even though patents can be exploited by their owner, they can also be traded through license agreements or sold. Patents, along with copyrights and trademarks, are one of an array of available intellectual property rights.

Patent rules and procedures are broadly consistent across countries.[6] An innovator files an application for a patent with a patent office, typically at the national level. The application is, or may be, subject to an examination, including a consideration of "prior art" (related inventions or patents) to determine whether a patent should be granted. The application is made public, and others will be given the opportunity to protest it. If a negative result is received, the applicant has avenues for appeal (for details about the appeal procedure see Hall et al., 2004). If patent rights are violated, the patent holder has the opportunity for litigation.

The remainder of this section provides an overview of patent systems and their functioning in different jurisdictions, with a special focus on the U.S. and Canada.

2.1. Legislation, Patentable Material and Enforcement

A country's rules regarding patentable material and the patent process typically are contained in legislation. Patent office manuals provide further detail on the patent process. In addition, many countries participate in patent treaties or agreements which influence patent process and procedure.

There are 142 contracting countries (Canada and the U.S. among them) of the Patent Cooperation Treaty (PCT) under which an applicant can pursue protection simultaneously in many countries through the submission of an international patent application. The application is

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information on patenting at the European Patent Office (EPO) is available at http://www.epo.org/applying/basics.html (last accessed April 19, 2011).

[6] This review is based on the existing literature, resources available through the CIPO, USPTO and EPO websites, and interviews with members of CIPO and Industry Canada.

examined separately in the different countries, where different decisions may be reached.[7] Some countries also participate in accelerated examination. Since January 2008, CIPO and USPTO have been participating in a Patent Prosecution Highway Pilot Program, under which accelerated examination in one country can be requested for an application for which at least some claims have been allowed in the other country.[8] The European Patent Convention (EPC) establishes that the European Patent Office (EPO) coordinates patent grants within Europe.

Jurisdictions vary in terms of the material that is patentable. Maskus (2005) suggests, as do other authors, that the U.S. has a more liberal approach to patentable material than elsewhere. Differences across jurisdictions include the patentability of higher-order animals, the treatment of surgical and medical methods and the treatment of software and business methods.[9] In contrast, other jurisdictions, including Canada and Europe have been traditionally seen as more cautious in allowing patents in these areas.[10] However, in the case of Canada this may be changing with the recent Federal Court decision in *Amazon.com v. Attorney General of Canada and the Commissioner of Patents.*

In most patent offices, patents are awarded according to the first-to-file rule; the main exception is the U.S., which awards patents to the first to invent. The tradeoff seems to be between encouraging early communication of research results (e.g., through publications and conferences) under a first-to-invent rule, and the greater certainty and lower cost of a first-to-file rule (e.g., Maskus, 2005; van Pottelsberghe, 2010).

Patent systems generally offer the opportunity to oppose a patent application. In the U.S.

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[7] See http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/h_wr02598.html (last accessed October 8, 2010).
[8] Canada is also involved with other Patent Prosecution Highway agreements with other countries, including Japan.
[9] Business methods were opened up to patenting in State Street Bank and Trust Co., Inc. v. Signature Financial Group, inc., 149 F. 3d 1368 (Fed. Cir. 1998). The patenting of software has been associated with decisions in the early to mid 1990s. See Hall and MacGarvie (2010) for more details.
[10]Regarding Canada, see Stikeman Elliot, available at http://www.stikeman.com/SoftwareCopyright_Patent_Derenyi_07.pdf (last accessed October 12, 2010). A discussion of patentable materials in Europe can be found in XX.

and Canada, an application will be open to public inspection after 18 months, or sooner by request of the applicant. After an application is made public, anyone may file prior art, or protest the granting of a patent.[11] Recent policy changes may expand the role of third parties in the U.S. In October 2010, the USPTO launched a second peer to patent pilot program which is the continuation of a previous program but expanded to applications in biotechnology, bioinformatics, telecommunications, and speech recognition.[12] This program opens the patent examination process to public participation. In Europe, beside the existence of an opposition system during the examination of a patent, there exists a post-grant opposition system in which third parties can register opposition within nine months of the patent being granted (Hall and Harhoff, 2004).

As opposed to the European post-grant opposition system, in the U.S. enforcement occurs primarily through the court system. However, only a few patents are litigated, and among then very few go to trial. According to Lanjouw and Shankerman (2001), about 95% of litigated patents settle out of court. A single U.S. Federal Circuit Court is dedicated to intellectual property appeals; it has been suggested that this structure is favorable to patent holders (see Maskus 2005).

2.2. Patent Process, Examination and Fees

In the U.S. an examination is triggered with the application for a patent – an application enters the queue for examination as soon as it has been filed and fees are received. However, in other jurisdictions (including Canada and Europe),[13] after submitting a patent application and

[11] Substantial differences between the U.S. and European opposition systems have been discussed in, for example, Hall and Harhoff (2004).
[12] http://www.uspto.gov/news/pr/2010/10_50.jsp (last accessed November 25, 2010).
[13] See London Economics (2010), p. 8 for an international comparison.

associated fees, an applicant must submit a separate request for examination. This request must take place within five years of filing in Canada, and six months in Europe.[14]

In Canada, once an examination is requested and necessary fees are paid, it enters the queue of a specific examiner, chosen according to its assigned International Patent Classification (IPC). Classification and technical field are also used to direct applications to appropriate examiners at the USPTO and EPO. Applications are processed according to examination request date, although certain applications may be given priority if an extra fee has been paid for advanced examination. As well, proposed amendments to the Canadian *Patent Rules* would provide expedited examinations for patent applications concerning "green technology."[15]

The examination of an application begins with a review of legal formalities and an analysis of the claims. The examiner must judge the application against the relevant technical, legal and commercial information. This involves searching for prior art information to determine whether the innovation is sufficiently novel. In the U.S. and Canada, the applicant must disclose the entire prior art he is aware of, whereas in Europe disclosure of the prior art by the applicant is not obligatory. The effort required to search for prior art seems to differ across U.S. and Canada. As Canada is described as being a "country of second filing" -- meaning that inventors will typically apply for a patent in Canada after having filed elsewhere -- CIPO can have access to, and take advantage of, prior art searches conducted by other patent offices.[16]

In general the examination follows a report and response format. In the U.S., for instance, a first action letter is sent to the applicant, accepting or refuting the claims. The applicant must

[14] Note however that the U.S. permits provisional applications, with non-provisional applications that trigger examination being required within 12 months.
[15] See http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr02462.html (last accessed November 30, 2010).
[16] This point is also made on the CIPO website; see for example http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr02168.html (last accessed October 7, 2010).

respond during a certain time frame and must narrow the claims or explain changes made to the original application. The examiner then analyzes the answer and writes a second action letter. Most applications are allowed or not on the second or third action letter.

Patent applicants must pay several fees at various stages of their application, as well as after a patent is granted. Such fees are essential, since patent offices are typically self funded agencies. In general, fees include filing fees, examination fees, grant of patent fees and maintenance fees.[17] Fees to maintain the patent rights must be paid every year in Canada and Europe, but three times in the U.S. In some countries, lower fees are required of applicants who identify themselves as "small entities," although the definition differs.[18]

2.3. Patent Office Structure and Incentive Systems

Patent examiners are generally grouped according to technological categories. In the U.S. examiners are assigned to eight technological centers divided into three major categories: Chemical, Electrical and Mechanical. Each technological center is divided into Work Groups, which in turn are made up of Art. Examiners start as assistant examiners and advance to become primary examiners. Similarly, CIPO divides examiners into four divisions (Chemical, Electrical, Mechanical and Biotechnology), which are in turn divided into sections.

Patent offices differ in the incentives provided to examiners.[19] Historically, the USPTO has used a formal bonus and award system based primarily on the numbers of applications

[17] For Canada see http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/vwapj/TVDB-HYPAP-eng.pdf/$file/TVDB-HYPAP-eng.pdf (last accessed October 8, 2010). U.S. information on fees is available at http://www.uspto.gov/web/offices/ac/qs/ope/fee2009september15.htm (last accessed November 27, 2010).
[18] In the U.S. a small entity is a person, small business (500 or fewer employees including affiliates) or a non-profit organization. In Canada, a small entity is a university or a business with fewer than 50 employees.
[19] See for example Friebel, et al. (2006) for a discussion of examiner incentives within the EPO.

processed.[20] Examiner goals would vary according to technological field and experience. Promotion and bonuses are based on whether examiners exceed their production goals with few errors.[21] Quality is monitored through both random and routine checks. According to the USPTO, the error rate has been approximately constant and low over time.[22]

In contrast, CIPO does not use a formal bonus system.[23] As in the U.S., individual goals for time per application are established, and can vary by field and experience. Expectations need to be met to be promoted from trainee to line examiner. The implications of failing to meet individual goals vary, and can include the loss of discretionary privileges such as flexible hours, compressed hours, and the ability to work at home. Several quality control checks exist: all trainee work must be approved by a senior examiner, and random checks are performed. All work is submitted to the section head for either 100% or cross-section control checks. Similarly, examiners at the EPO are not subject to explicit monetary incentives (Friebel et al., 2006).

Examiner retention at the USPTO has been identified as an important area of concern (Friebel et al., 2006; Langinier and Marcoul, 2010b). While their 2010-2011 Business Plan highlights employee retention as a focus, CIPO indicated to us that retention rates of examiners are in line with other CIPO and Industry Canada branches. It seems that examinations required to become patent agents make it difficult for Canadian examiners to move into the private sector.[24]

2.4. Patent Statistics and their Limitations

A major difference between countries lies in the numbers of patent applications received

[20] This system which has been in place since 1976 has been recently updated. In February 2010, a new examiner count system was implemented. As well, "new, more comprehensive procedures for measuring the quality of patent examination" were adopted by the USPTO in October 2010.
[21] Because of the subjective nature of qualitative criteria, it is unclear what would be considered an error, and how many would be considered "few."
[22] The error rate was 6.6% in 2000 and 5.3% in 2004 (NAPA, 2005).
[23] Information on the Canadian system is based on interviews with CIPO staff.
[24] Friebel et al. (2006) report that this is also an important difference between the USPTO and the EPO.

and patents granted.[25] In the U.S., while applications have increased over the past decade (from 345,732 in 2000/01 to 482,871 in 2008/09), granted patents have been stable (at 183,970 in 00/01 and 191,927 in 08/09). In contrast, applications in Canada have been stable (increasing only from 39,657 in 2001 to 40,796 in 2009), while the number of granted patents has increased by 53 percent (from 11,888 to 18,251). London Economics (2010) reports that at the EPO both applications and grants have grown since 2000.

At patent offices in smaller countries, foreign applications may be more important. Indeed, statistics from CIPO indicate that applications of Canadian origin accounted for only 13% of CIPO applications and 10% of granted patents on average over the 2001/02 to 2008/09 period, compared to 47% and 49% coming from the U.S. In contrast, at the USPTO for the same period, only 49% of granted patents have been for foreign applications, with 2% of granted patents having Canadian origin.[26]According to CIPO annual reports, Patent Cooperation Treaty (PCT) applications represented 62% of all applications in 2000/2001 and 76% by 2008/2009. CIPO reports that from January 2008 to January 2009 it received 413 requests under the pilot program for the Canada-U.S. Patent Prosecution Highway program.

Patent applications and granted patents can be broken down by technological sector, even though sector definition differs across countries, which makes comparisons difficult to perform. Statistics on patent applications and grants in Information and Communication Technology (ICT) industries are difficult to obtain, although some are available under the Patent Cooperation Treaty. According to OECD data, ICT patent applications from the U.S. increased from 4,233 in 1994 to 17,049 in 2005. According to data provided to us by CIPO, over the 2000-2008 period,

[25] Annual statistics can be found in WIPO world reports; see WIPO, http://www.wipo.int/ipstats/en/statistics/patents/ (last accessed February 22, 2011).
[26] Foreign patenting activity can have an impact on the increase in Canadian applications (Gallini et al., 2005).

ICT applications accounted for approximately 21% of all patent applications.[27]

Surprisingly, there is no simple measure of grant rates, backlogs and delays in the patent examination process. Calculating the grant rate as being the number of patents issued divided by the number of applications in a given year does not account for the existing lag between filing and granting. Using a three year lag (corresponding roughly to average pendency time) will correct this measurement error, but stills provide only a rough estimate because of the variance due to technological fields. As well, differences in patent systems across countries complicate the interpretation of cross-country comparisons of grant rates. In many countries, applicants often apply for several patents with the same innovation (patent flooding), and in the U.S. continuing applications (divisional and continuation in parts applications) have to be accounted for (Quillan and Webster, 2001; van Pottelsberghe, 2010). As well, countries differ in terms of whether applicants apply for a small number of broad patents, or a large number of narrow patents (Japan being a standard example of the latter).

As a result, estimates of grant rates can vary widely. While U.S. grant rates estimated by the USPTO have ranged from 54% to 66% (as reported in Lemley and Sampat, 2008), Quillan and Webster (2001; 2006) find that 87 to 95% of U.S. applications are granted a patent. Further, the likelihood of being granted a patent has been found to depend on the technological field (Lemley and Sampat, 2008), and the number of citations (Popp et al., 2004).

Backlogs and pendency times are also difficult to measure in a way that permits comparisons across countries, although attempts have been made (e.g., van Pottelsberghe, 2010; London Economics, 2010). Because the duration of examination varies across offices, using the number of pending patents as a measure of the backlogs provides a biased proxy. As well, in some countries applicants may choose to delay the examination of the application, meaning that

[27] Based on an application's primary IPC, and using the OECD's definition of ICT (given by a list of IPCs).

longer pendency times may be attributed to applicants' behavior rather than patent office (Palangkaraya et al., 2008). In their recent international review of such backlogs and delays, London Economics (2010) report that "our research indicated that, not only is there no commonly accepted measure of backlogs across patent offices, in practice the publicly available data regarding either patent backlogs or (for many patent offices) the number of pending applications outstanding is scarce."

Bearing in mind these concerns, some statistics regarding backlogs and pendency times can be presented. London Economics (2010) reports that pendency time (measured as time between filing and granting) has increased in Canada from approximately 60 to over 90 months, in the U.S. from 20 to 40, over the 1996 to 2008 period; in contrast, pendency times at the EPO are reported to have fallen.[28] It should be noted, however, that pendency calculations include the time elapsed between filing and request for examination where those occur separately. A detailed analysis of pendency time in Canada can be found in Nikzad (2010a).

London Economics (2010) also provides an overview of trends in backlogs at different patent offices, with a discussion of competing measures. Their findings show no general trends in backlogs across patent offices over time, once examiner counts or the number of disposals per year are controlled for. Indeed, while according to these measures backlogs have in general been increasing since 2001 at the trilateral patent offices, CIPO workloads appear to have fallen. Finally, it would be desirable to make cross-country comparisons of patent quality. However, given the difficulties in constructing measures of basic statistics such as grant rates and pendency times, it is not surprising that patent quality is subject to multiple interpretations and difficult to measure (Hall and Harhoff, 2004; Lemley and Sampat, 2008; van Pottelsberghe, 2010).

[28] Pendency statistics were computed using PATSTAT, an international data base of patent applications. London Economics (2010) also report that based on pendency data reported to them from CIPO, over the March 2003 to May 2009 period, pendency times from request for examination increased from 45 months to 52 months.

3. The Economics of Patents and Patent systems

In response to questions regarding backlogs, pendency times and concerns over the quality of granted patents, a recent patent economic literature has emerged that focuses on the patent process and procedure. This literature, which is both theoretical and empirical, addresses questions about how patent rules affect the decision to apply for a patent and the preparation of the application, the examination of the patent, and the subsequent litigation process.[29]

In this section we discuss how the economic literature has contributed to the debate over patents. We first provide a brief discussion of the traditional patent literature before briefly examining how patent data have been handled in empirical work. Third, we review the economic literature on patent prosecution, organization and incentives within patent offices.

3.1. Traditional Patent Literature

Traditionally, patents have been seen as a necessary evil, involving a tradeoff between providing incentives for innovation and disclosure on the one hand, and the creation of a temporary monopoly on the other hand. The main advantages of patents are that they (i) promote new discovery, (ii) assist in the dissemination of knowledge, (iii) encourage technological transfer and commercialization, and (iv) may facilitate entry of new small firms, and allow the trading of knowledge. Disadvantages of patents include: (i) the social inefficiency of monopoly, (ii) a duplication of spending, (iii) increased transaction costs that may delay new inventions, and (iv) imperfect protection since monitoring to detect infringement must be done by the patent holder (Hall, 2007; Langinier and Moschini, 2002). Beyond the regular patenting costs (registration and renewal costs), monitoring and litigation costs can make patenting extremely

[29] A review of patent system differences across the three major patent offices (USPTO, EPO and JPO) and their possible effects on patent quality, along with a discussion of relevant economic literature, can be found in van Pottelsberghe (2010).

costly (Crampes and Langinier, 2002).

Private and public benefits from patents differ. Firm level surveys find that many firms report that they do not rely on patents to appropriate a return on their innovation (Levin et al., 1987; Cohen et al., 2002) and that patents provide weak incentives to innovate (Graham et al., 2009). The main reported reasons for patenting are keeping competitive advantage, securing financing, preventing technology copying and enhancing reputation (Graham et al., 2009). Patenting activity may also be motivated by strategic concerns, including blocking competitors and strengthening a firm's bargaining position in the negotiation of licensing agreements (Blind et al., 2006; Langinier, 2005; Hall and Ziedonis, 2001).

The focus of the traditional patent literature has been on the role of patents in encouraging invention and the disclosure of technology, and on the optimal design of patent rights (Mazzoleni and Nelson, 1998; Gallini, 2002). This literature has largely ignored the internal working of patent offices, and its impact on examiners, applicants and third parties.

According to Nordhaus (1969)'s seminal paper, a patent protection too short tends to discourage innovation, whereas a protection too long gives excessive monopoly power to the patent holder and reduces the number of further improvements. In order to reduce the monopoly distortion, depending on the industrial sector, patent duration must be finite (Nordhaus, 1969; Scherer, 1972) and should depend on the type of innovation (Denicolò, 1999).

Attention has also been paid to the optimal determination of patent scope, which refers to patent protection against imitation (called breadth in the patent jargon) and improvements (sometimes referred to as height or leading breadth). In general, broader protection increases the social cost from monopoly, but may increase R&D incentives as well. Depending upon model assumptions and the nature of competition and technology (Denicolò, 1996), optimal patents may be narrow and long (Gilbert and Shapiro, 1990; Klemperer, 1990) or broad and short (Klemperer, 1990; Gallini, 1992).

In many industries innovation is cumulative, with new inventions building upon and making use of past inventions (Scotchmer, 1991). In such a context, an optimal patent system must provide the appropriate incentives for the development of initial invention but also of follow-up innovations. However, it seems difficult to set appropriate incentives for both first and second generations of innovators (Scotchmer and Green, 1990; Green and Scotchmer, 1995). Furthermore, if too many patents are required to develop a subsequent innovation, as is the case for complex new products (e.g., a computer chip) the new innovator becomes susceptible to *hold-up* by the patentees (Shapiro, 2001). In the context of biotechnology, this problem has been characterized as the "tragedy of the anticommons" (Heller and Eisenberg, 1998). Therefore, in a model of sequential and complementary innovations, patent protection might not fulfill its goal of encouraging innovation (Bessen and Maskin, 2009).

Unfortunately, the concepts of patent scope developed in the theoretical patent literature seem to be too abstract, are difficult to relate to the reality of patent examination and are difficult to be empirically tested. The patent literature does not provide clear guidance as to how stringent patentable requirement should be, and seem to have limited concrete policy implications.

3.2. Data Sources and Related Issues

Empirical studies of patenting and the patent process have made use of data from multiple sources. Studies focusing on the impact of policy changes on patenting decisions and innovations have used aggregate data on patent counts by country and industry. Such data are typically available from patent offices. In some cases, researchers have made use of data from surveys (at the firms or patent examiners' level) conducted by the researchers or government agencies (e.g., Friebel et al., 2006).

Data on individual patents have also been widely used in studies of innovation. Detailed information provided in patents is freely accessible on the web sites of patent offices. In the U.S., about 6 millions patents are online and detailed information for each of them can be consulted. Taking advantage of this data availability, Hall et al. (2001) have put together the biggest and most comprehensive U.S. patent data set that is freely available with almost 5 millions patents granted from 1976 to 2006. The data set contains basic information for each patent such as filing and granting dates, name of inventor (and geographical location), name of assignee, number of claims. They have also added constructed variables such as citations (self-citations, backward citations --citation from the patent to prior patents, and forward citations --citation to the patent made by other patents), technological field, and indices of generality and originality. This dataset, which is constantly updated by its creators, has been widely used in empirical analyses concerned with measuring the private value of innovations and patents.

For instance, weighted patent counts have been used to analyze the impact of innovation and patents on firm value or performance (e.g., Hall et al., 2005; Trajtenberg, 1990; Jaffe et al., 1993; Trajtenberg et al., 1997; Lanjouw and Schankerman, 1998; 2001; 2004); Schankerman and Pakes (1986) have used European patent renewal data to analyze the value of patents; Patent citations are also widely used as an indicator of spillovers (Trajtenberg, 1990; Jaffe, and al., 1993). It should be noted, however, that several concerns arise in making use of available patent information. All inventions are not patented, so patents concern only a fraction of all inventions, which can create a biased indicator of the innovative activity. As well, patent office changes can make it hard to gather consistent data.

Furthermore, many technical problems plague the use of patent data. For instance, the lack of unique identification numbers for applicants means that we must rely on innovator names, which can be misspelled or change over time.[30] It is also not always easy to link the patent to a particular technological field as patent offices constantly update their classification system with new classes for new fields. Until recently, many countries (including the U.S.) made available only information on granted patents, as opposed to all patent applications.

To analyze the examiner's behavior, data at the level of examiner should be available. However, before 2000, it was impossible to identify which one of the applicant or the examiner had added the citations in a U.S. patent. Starting in 2000, the USPTO had added this information in the detail of the patents. In the U.S. it is possible to gather examiners data from the website of the USPTO and to link the patents per examiner with Hall's dataset, for instance. This has been done at a small scale by several studies (Cockburn et al, 2003; Lemley and Sampat, 2008; Langinier and Lluis, 2010). Unfortunately, even in the U.S. it is impossible to estimate the acceptance rate of any given patent examiner as there is no information concerning examiners and patent applications. In most other countries, there is no easily accessible information regarding patent examiners.

3.3. Economic Literature on Patent Prosecution, Organization and Incentives Within Patent Offices

The economic literature of the patent system considers (at least) four different types of agents: patent applicants, patent examiners, patent office management, and third parties, including rival firms. These agents are expected to differ in their objectives, and also in the information they possess. Applicants may know more about the quality of their innovation than examiners, and examiners may have a better knowledge of their own skills and efforts than the

[30] In the past, CIPO used an identifier for applicants but its use was discontinued as there was duplication of numbers and the same company was attributed different identifiers.

patent office. Such information asymmetries can lead to strategic behavior on the part of the more informed party. Patent offices are large organizations that employ many patent examiners, and it seems unlikely that patent offices and examiners have congruent objectives. Importantly, the actions of one type of agent may "feed back" into the behavior of other agents interacting with the patent system. Changes to examiner incentives that result in a more stringent examination process may impact the number and type of applications being submitted. Policy changes that encourage patent applications by certain groups may increase demand for examiner services and reduce examination quality. Policies that encourage third party participation may have an impact on the quality of applications.

In the remaining of this section we focus in turn on the behavior of patent examiners, patent applicants and third parties.

3.3.1. Patent Examiner Behavior

While the patent prosecution process is partially standardized by office manuals and legislation, the behavior of individual examiners will likely influence the patent examination outcome. When processing a patent application, an examiner must analyze the information submitted by the applicant, search for relevant (complementary) information, and determine whether the innovation is sufficiently novel to be granted a patent. The outcome of this process may depend upon the availability of relevant information, the examiner's experience, skill and familiarity with the field, and his incentives to complete examinations thoroughly. Several questions, therefore, arise. How dependent is the outcome of the patent process on the skills and talents of examiners? To what extent are examiners influenced by the incentives developed for them by patent offices, as well as external incentives such as the possibility of new employment?

How effective are policies designed to encourage examination quantity and/or quality?

Empirical evidence suggests that the abilities of individual examiners do have a measurable impact on patent system outcomes. Cockburn et al. (2003), using U.S. data from a survey of 187 examiners of patents invalidated by the Court of appeals over the period from 1997 to 2000, find evidence of significant heterogeneity among examiners, particularly in the search stage of the examination process. For instance, they find that the distribution of the average number of citations per patent per examiner is highly skewed. There exist also examiner-specific effects when the editorial "style" is analyzed (Lichtman, 2004). Using U.S. data, Lemley and Sampat (2010) show that there exist differences across examiners in their experience and in the depth of their prior art search. In contrast, however, evidence exists that, despite an increased workload, examiners do spend on average the same amount of time on each application, even though the pendency time (between filing to granting) has increased (King, 2003).

Since it appears that individual examiners can influence patent system outcomes, it is important to understand how examiners respond to different incentives (Friebel et al., 2006). The establishment of incentives for examiners involves a tradeoff between examination quality and quantity; an examiner may devote more effort, for example, into searching for invalidating information, thus increasing examination quality, but at the expense of processing fewer applications. Furthermore, setting up the appropriate incentives for quality versus quantity is complicated by the fact that while quantity is easily contractible (see for example the U.S. quota system), measuring and verifying quality is problematic.

Because quality is hard to measure, it is difficult to write into a contract, as it relies on a subjective assessment of a more senior examiner. In this case, only an implicit contract can be offered in which the patent office promises a reward to examiners when and if they reach the quality goal, without any formal written contract. However, because it is not formal, this type of contract relies on trust: if the patent office honors its promise and pays the reward accordingly examiners will trust the patent office to respect its engagement. Instead of relying on implicit contracts, the patent office could potentially use proxies for quality (such as the number of disputed patents or the number of citations made by the examiner), which will allow explicit contracts to be written (Langinier and Marcoul, 2010c).[31] In evaluating the relevance of incentives, it is important to provide an appropriate balance between a system of implicit and explicit incentives.

The effectiveness of the incentive system within EPO has been analyzed in Friebel et al. (2006), who provide a survey of EPO examiners and a detailed overview of the literature on incentives. The authors apply this literature to the behavior of examiners within the EPO, and provide a list of "tests" to be considered in determining whether explicit incentives should be adopted. They warn against the risk of putting too much emphasis upon rewarding examiners according to quantitative measures. In particular, their survey of the EPO staff shows that examiners perceive their work as being highly interdependent. Therefore, incentives to improve individual performance (through quantity measurement for instance) may be detrimental to team work. The literature on organizational incentive theory shows that when there is asymmetric information between managers and workers, explicit incentive mechanisms can be a powerful tool. However, if the work is complex and subject to uncertainty, these mechanisms can induce workers to behave in a detrimental way (Friebel et al., 2006). Explicit incentives based on quantity will likely reduce quality and, therefore, the introduction of implicit incentive mechanisms should be considered (Langinier and Marcoul, 2010c).

[31] Imprecise quality standards not tied to quantitative proxies may however allow the patent office more flexibility in evaluating examiners.

Examination quality may also be driven by incentives coming from outside of the patent office. It has been observed that the high attrition rate of examiners at the USPTO[32] has resulted in a lower overall level of patent examiner experience (van Pottelsberghe, 2010). One possible explanation for the high turnover at the USPTO is career concerns; patent examiners may be leaving the patent office to take up employment at firms on the other side of the patent process that might value their experience and their understanding of the patent system.

Indeed, examiners might behave strategically in order to enhance their ability to move to the private sector, which is not necessarily detrimental to the patenting process (Langinier and Marcoul, 2010b). In managerial career contexts, Holmstrom (1999) shows that career motives can be either beneficial or detrimental to organizations depending on the context. While Fama (1980) argues that career concerns will induce efficient behavior and discipline manager's behavior, Holmstrom (1999) shows that labor market forces may induce suboptimal behavior. More precisely, a manager will, in equilibrium, make decisions in order to manipulate labor market inference about his talent rather than to maximizing profit. In the context of the patenting process, examiners might send signals (such as systematically granting patents with many claims) through their patenting decisions to potential employers in order to accelerate their career track. However, it is unclear whether career motives of patent examiners will negatively impact the patenting process (Langinier and Marcoul, 2010b), even though examiners seems to be more careful about making the right decision when they stay longer at the USPTO (Schuett, 2010).

To date, mobility motives of patent examiners have received only limited empirical attention. Langinier and Lluis (2010) use data on U.S. patent examiners over the period 1976-2006 to analyze the determinants of examiners' mobility (e.g., experience, technological field

[32] During the period 1992-2004, even though the attrition rate at the USPTO was only 7 percent (which is just above the average attrition rate at federal agencies), for every 10 examiners hired during that period, five left (NAPA, 2005).

and patent characteristics) at the USPTO. In particular, they examine the factors that may impact mobility outcomes within the institution (promotion or lateral move) or outside of the institution (when examiners leave the USPTO).

The main findings of this preliminary empirical analysis are that the determinants of mobility have different effects on mobility. For instance, the technological field and the tenure as assistant examiner seem to have significant effects on promotion within the institution. By using longitudinal data, the authors show that switching Art Units has a positive impact on the mobility, and that the longer an examiner stays at the USPTO, the lower his chances to leave the USPTO. These findings are consistent with those in the labor economics literature where it has been established that long-term employment relationships are common and the probability of job changes in the U.S. declines with tenure (Farber, 1999), and individuals hold on average seven jobs over the first ten years of their career (Topel and Ward, 1992).

Beyond influencing examiner incentives, other policies have been considered or adopted by patent offices to address issues about patent quality. For example, it has been suggested that quality could be enhanced by having more examiners processing the same patent application. In Europe, each patent application is evaluated by three examiners whereas in the U.S. examination is done by one examiner. If three pairs of eyes are better than one, the screening in Europe should be higher than in U.S. In fact, the quality standards seem to be higher in Europe (van Pottelsberghe, 2010).

In 2000, the USPTO implemented a Second Pair of Eyes Review (SPER) in the class of business method innovations. The expected effect of this initiative is ambiguous. If patent applications are more thoroughly examined in a particular field, the average patent quality in this field should increase, but possibly at the expense of other fields. As well, if applicants expect their applications to be reviewed more thoroughly, bad patent applicants may be less likely to apply. As a result, patents in the field in which the SPER is implemented will be expected to be of higher quality, on average, while quality in other fields may fall (Allison and Hunter, 2006; Langinier and Marcoul, 2010a). In addition, increasing the number of patent examiners would also increase the cost of the patent office. As a matter of fact EPO is the costlier system (van Pottelsberghe, 2010).

Recent policy attention has been paid to possible gains in patent quality and reductions in backlogs and pendency times through increased international co-operation on examinations and increased harmonization of patent rules. London Economics (2010, p. ix) concludes that a system of "mutual recognition" that reduced by 25% the time spent on duplicate applications could reduce backlogs by 19% within five years. In contrast, van Pottelsberghe (2010, p. 38) warns of the impact of increased harmonization on patent quality: "As long as the quality of the examination process is not harmonized among major patent offices and as long as their operational designs diverge, moves towards several bilateral work sharing and mutual recognition agreements might actually drive global patent quality down towards the lowest quality level possible." However, to date, there is no theoretical or empirical evidence to support these facts. The transmission of patent quality from country to country, and the impact of such transmission, remains an area of research that could benefit from further study.

3.3.2. Patent Applicant Behavior

Applicants make decisions that impact the outcomes of the patent system, including whether to apply for a patent, whether to have the application examined, whether to withdraw it, the speed at which to advance the application, and what information to include in the application.

Hence, it is important to understand the behavior of applicants during the patenting process.[33] One avenue for strategic behavior by the applicant is through the identification of “prior art.” Several theoretical papers consider the incentives of applicants in identifying prior art, with some theoretical studies finding that applicants have an incentive to behave strategically in their effort to search for information and reveal it. If applicants always disclose the prior art information they possess (as stipulated by the duty to disclose in the U.S.), Atal and Bar (2010a) show that they might have an incentive not to search for prior art. If they do search, their search intensity increases with R&D cost, and with the examiners' expected search effort.

Furthermore, since it is difficult for a patent office to prove that an applicant did not disclose all relevant information, applicants have an incentive to conceal information on prior art. In a theoretical contribution, Langinier and Marcoul (2010a) show that applicants endowed with innovations that should not be issued a patent have an incentive not to reveal all prior art information. Another finding is that because of strategic non revelation of information from applicants, patent examiners should undertake identical scrutiny effort, irrespective of the amount of information provided by the applicant. Caillaud and Duchêne (2010) examine the impact of the overload problem on the innovator’s incentive to invest in research and then to apply for a patent. They show that given the imperfection in the examination process, it will be impossible to have only good patent applications, and some bad applications are inevitable. As examiners make mistakes it is easier to obtain a patent, therefore more applications are filed, which increases the workload of examiners, and more mistakes are made.

Empirical studies have begun to consider the information provided by patent applicants, exploiting the recent availability of data sets that distinguish between citations provided by

[33] The more traditional patent literature has already dealt with issues on whether to patent or keep the innovation secret (see, for instance, Hortstman, et al., 1985; Gallini, 1992).

applicants and examiners. Empirical evidence suggests that examiners are less informed than applicant (Sampat, 2010) even though many citations are added by examiners. Indeed, using U.S. patent data from January 2001 to August 2003, Alcacer and Gittelman (2006) show that two thirds of citations are added by the examiner. Schneider (2007), using data on patents applied for by Danish firms at the EPO during the period 1978-1998, finds behavioral differences between experienced and inexperienced patent applicants; applicants with large patents portfolio tend to apply for more patents and do not withdraw their application when the expected probability of grant is high. In a study of U.S. patents over the period 2001-2003, Alcacer et al., (2009) find that firm-level effects (e.g., experience of applicants, nationality) seem to explain most of the variance of examiner citation shares. Indeed, it seems that more experienced applicants (with a high number of patents) received higher shares of examiner citations than less experienced ones. Empirical evidence that innovators conceal information about prior art is also presented in an analysis of applicant citations of U.S. patents (Lampe, 2010).

Attention has also been paid to the incentives of applicants to strategically delay the examination and decision of an application. As discussed in Regibeau and Rockett (2010), since examination follows a back-and-forth process between examiner and applicant, both parties contribute to delay in the examination process. Delaying the granting of a patent may be attractive to an applicant for several reasons, including delaying fees, allowing time to improve the patent right, and inflicting uncertainty on competitors. Harhoff and Wagner (2009), in a study of applications at the EPO over the 1982-1998 period, find that more valuable patents are granted earlier than those of lower quality, and that patent examination duration communicates information on the patent to rivals. Regibeau and Rockett (2010), using data on U.S. patents for genetically modified crops over the period from 1983 to 1999, find that once the filing date is controlled for, delay is shorter for more important patents. The authors suggest (p. 244) that "more important patents are pushed through the approval process more eagerly…" but cannot distinguish between delays caused by examiners and those caused by applicants. As well, they note that their study does not consider delay of examinations for patents ultimately rejected.[34]

Several patent policies could influence the decision of whether to apply for a patent, some of which have been subject to theoretical and empirical attention. A switch from first-to-invent to first-to-file has been under consideration in the U.S. for many years now, while the change has been done in Canada in 1987. A switch of system might impact examiners behavior as they might have to search for more evidence in a first-to-file system. According to Green and Scotchmer (1994), novelty requirement and the existence of a "first-to-file" or "first-to-invent" system affect the speed of innovation. One of their findings is that that first-to-file accelerates discovery of the final innovation relative to first-to-invent. This finding does not seem to be consistent with those of the empirical analysis of Lo and Sutthiphisal (2009) in which they study the impact of the 1987 Canadian Patent Reforms. They find that the switch did not change R&D efforts by Canadian inventors and had a small negative impact on patenting of Canadian industries in Canada, U.S. and Europe, and that the first-to-file system seems unfavorable to individual inventors and small businesses. Overall, they suggest that a switch from first-to-invent to first-to-file may harm the inventive activity of a country.

A change in the patenting fees will likely change the behavior of applicants, which in turn will affect the examination process. Theoretical and empirical work on patent fees is surveyed by de Rassenfosse and van Pottelsberghe (2010). The economic literature attempting to understand the impact of fees on applicant's behavior dates back at least to Federico (1954). The earliest

[34] Further evidence for the U.S. is given by Popp, et al. (2004), who document that examination duration is associated with technological field, and suggest that duration is greater in complex areas that require frequent communications between examiner and applicant.

work on fees was first mostly descriptive in nature, and analyzed the various fees across patent offices worldwide (Helfgott, 1993).

Recently, it has been empirically shown that there exists a negative relationship between patent cost per claim per capita and the number of claims filed in the office (van Pottelsberghe and François, 2009). This supports the idea that differences in fees might partly explain difference in patenting rates in different countries. Surveys have also emphasized the importance of fees for patent applicants (Cohen and al., 2000; Graham et al., 2009). It has been argued that lower fees in Europe have contributed to the increase propensity to patent (de Rassenfosse and van Pottelsberghe, 2009). A few theoretical contributions have studied the optimal fee schemes. When there is *ex ante* uncertainty on the R&D effort, and the inventor has more information about the *ex post* value of the innovation, it might be optimal for the patent office to offer a menu of patent durations and associated lump-sum fees. In fact, the current renewal fee system rises at too slow a path (Cornelli and Schankerman, 1999).

Other theoretical contributions have considered the efficiency impact of increased patent fees. Atal and Bar (2010a) show that increasing patenting fees will lower the net expected benefit of bad patents and will likely increase the prior art search intensity of applicant, which might also be welfare enhancing. On the other hand, Caillaud and Duchêne (2010) show that the impact of patent fees on R&D investment and on incentive to apply for a patent might be very limited. Implementing a policy based on patent fees cannot by itself solve the problem of patent quality.

Another way of altering the fee structure could be to make the applicant choose between two types of examinations (quick and more expensive or normal and cheaper). The introduction of a two speed system (or gold-plate system), which will affect the quality of patent examination through the behavior of the applicant, is under consideration at the USPTO (Lemley and al., 2005). Such a policy could reduce the total number of applications as, in equilibrium, only good applicants will apply for the gold-plate whereas those who apply in the regular system will signal that it is more likely they have bad applications (Atal and Bar, 2010b).

In several countries (e.g., Europe, Japan, Canada), patent applicants must request an examination after they filed for a patent, which is not the case in the U.S. The primary reasons given for a request for examination are that it reduces the number of examinations since many applications never request examination, and that it allows applicants additional time to assess the marketability of the innovation (see Nikzad and Collette, 2008; van Pottelsberghe, 2010). Shortening the period of examination request (as has been done in Canada or in Japan) may have an impact on the quality of examination as it will affect the behavior of patent applicants. The lag between the patent filing and the examination request seems to be mainly due to strategic behavior from patent applicants (Palangkaraya et al., 2008). Indeed, applicants with innovations that are more likely to deserve a patent have strong incentives to get a fast decision whereas those with low quality invention might prefer to delay. However, according to Yamauchi and Nagaoka (2009), the impact of reducing the period of request for examination in Japan has increased the workload of examiners with low quality patents. Because applicants have now less time to assess the quality of their inventions, the average quality of applications for which examinations are requested reduces, which raises the rate of examination request as well as the number of patent grants.

3.3.3. Third Party Behavior

Patent offices might also be interested in involving third parties or competitors as in the European opposition system. A post grant review mechanism can provide incentives for third parties to supply information at a relatively low cost (Hall and Harhoff, 2004). In the U.S. the adoption of an opposition system has been considered for years, mainly because litigation is the only mechanism to challenge patent quality *ex post*. The perceived benefits of an opposition system are less uncertainty and a reduction in the social costs of litigation. Opponents to the opposition system claim that it might increase transaction costs and its overall impact is not clear. Indeed, a system that requires the participation of third parties can be subject to free riding because of weak incentives for third parties to challenge the patent (Lemley and Shapiro, 2005).

By using European and U.S. data for equivalent patents on a period 1963-2003, Graham and Harhoff (2006) show that a low cost post-grant review mechanism could increase welfare. Similar conclusions are reached by Hall and Harhoff (2004) using European data on patents that were opposed between 1980 and 1995. Using survey data, Harhoff, et al., (2003) find that the European opposition system is effective in identifying important patents. However, according to Chiou (2008) in a theoretical contribution, in an opposition system, weak patents will likely be settled out of court and therefore strong patents will be challenged.

4. Concluding Remarks and Policy Implications

Increases over the last several decades in patenting activity in many countries, and the recognition that further increases may be realized in certain jurisdictions, motivate an overview of the recent economic literature aimed at opening the “black box” of the patent process. This literature has made advances in developing the economic theory of patent systems, and in assembling data sets that may be used to answer questions about examiner and applicant behavior. Recent developments of patent data have permitted new studies of patenting behavior. Furthermore, some patent offices have recently begun to actively encourage research into these areas by increasing data access and commissioning new studies. However, much remains to be done, and many interesting questions are currently unresolved.

In general, the outcomes of the patent system are affected by the behavior of several different types of agents who are likely to have their own objectives, incentives and information. Empirical work confirms the importance of individual examiner conduct to the output of patent offices, and economic theory outlines how examiners are expected to respond to different managerial incentives that may be set by a patent office. Likewise, applicants can be seen as behaving strategically along multiple dimensions, including decisions regarding whether to reveal private information on the value of their innovations. Empirical evidence highlights the strategic motives of applicants, the importance of individual applicant behavior, and the role of asymmetric information. Strategic motives can also influence the behavior of third parties when providing information during the patenting process.

Much of the focus of the recent literature on patent systems has been on policy issues of patent quality and patent backlogs, and on whether differences in patent systems across countries may contribute to differences in the observed outcomes. However, as has been emphasized, cross-country differences in these outcomes can be difficult to interpret. Several policies might be considered by a patent office anticipating a surge in applications in a particular field. In order to maintain patent quality and to minimize the increase of backlogs, a patent office may revisit its examiner incentive system to place more direct incentives on quality or, at least, on measurable proxies for quality. The economic literature to date urges caution in this regard, since quality is difficult to measure, and the work of a patent examiner is complicated and involves teamwork. This is particularly relevant for the ICT sector.

Other policies aimed at promoting examination quality and reducing pendency times may target certain technical areas or firms. Applications in certain fields could be given faster examinations, or could be subject to consideration by multiple examiners. Indeed, such targeted policies have already been adopted or considered; both Canada and the U.S., for example, offer reduced fees to small entities, and both have considered expedited examinations for applications regarding "green technology." Likewise, there is some experience in the U.S. with patent examination policies (such as the Second Pair of Eyes review) that treat examinations of applications in certain technical areas differently. However, it is important with any such policy to consider its impact on agent behavior. Subjecting a particular field to increased examination scrutiny, for example, may provide incentives for applicants to misreport the field of the innovation, increasing backlogs and complicating quality judgments in other technical areas.

The suggestion has also been made that increased international harmonization of patent systems, through shared examination effort and mutual recognition, can reduce examiner workloads and backlogs. Indeed, many countries, including Canada, are already engaged in some form of cooperation through the Patent Co-operation Treaty and participation in Patent Prosecution Highway projects. Again, some caution has been urged within the literature, as it has been suggested that by participating in such projects, countries run the risk of importing lower quality from elsewhere (particularly the U.S.).

Several important directions for future research remain. The focus of existing research has been on the major patent offices (USPTO, EPO and JPO). However, because of differences in patent systems, findings from one patent office may be difficult to apply to another. In particular, important lessons could be learned from research on patenting at smaller offices. Basic descriptive work could verify claims made about smaller offices, such as their roles as offices of second filing. Furthermore, smaller offices may face unique policy questions that could be addressed with empirical research. The claim that harmonization of examination procedure could harm countries by importing lower standards is particularly important to smaller offices, but at the moment is an untested hypothesis. Policy changes in smaller countries, such as the 1996 change to the Canadian request for examination deadline, present the opportunity for useful research.[35]

More work also remains to be done to understand the interaction between examiners and applicants. Data sets that allow research into the role of individual examiners and the strategic behavior of applicants have only recently been developed and face continued technical challenges. Little empirical evidence currently exists, for example, regarding how examiners respond to patent office incentives and the relative roles of examiners and applicants in affecting pendency time and overall patent quality. However, because both applicants and examiners play a key role in the patenting process it is important to explore their behavior and their interactions. In evaluating the effectiveness of any policy aimed at improving patent quality the impact the main actors of the patenting process should be considered.

[35] Indeed, CIPO economists indicated to us that they are already considering research on this question.

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