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What are the costs and benefits of patent systems?

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ABSTRACT

There do not appear to be any cost-benefit assessments of the impact of patent systems, nor any data that can be used to directly assess the economic impact of patent systems. Discussions of patent policy therefore tend to be theoretical, and any evidence used is anecdotal rather than scientifically based. A wider search shows, however, that there is substantial empirical material on the costs and benefits of patent systems published in a very diverse range of journals and working papers. While these do not allow a full assessment of the economic impact of patent systems, they do provide useful evidence on many aspects of the impact of patent systems. This evidence is drawn together in this summary overview. The objective is to assist in a move towards an evidence-based discussion of patents as a central issue in innovation policy.

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This paper has been accepted as a chapter in a forthcoming book to be published by Edward Elgar. The book is edited by William van Caenegem and Christopher Arup, and is likely to be called Intellectual Property Policy Reform.

What *are* the costs and benefits of patent systems?

Patent systems are one of the oldest policies to promote innovation. So it is surprising how little factual information is available about their economic costs and benefits. The data that are available seem to be regularly ignored in patent policy discussions (Mazzoleni and Nelson 1998). Macdonald (2004) suggests this imperviousness to fact shows that the idea that innovation will not occur without patents has achieved the status of myth.

The objective of this chapter is to set out the range of benefits and costs of a patent system,[1] identify those elements most critical to sound patent policy, and review the evidence available so far, so as to set an agenda to establish an evidence basis for sound patent policy. A sound patent system is defined as one where social benefits exceed social costs, and the system therefore improves a nation's economic well-being.

Patent policy is based on a conundrum: designed to increase innovation, it operates by initially suppressing the dissemination of new patented technologies. Balance is therefore central to patent policy. Benefits deriving from any induced higher level of innovation must offset, at least at societal level, the costs due to the grant of monopoly privileges.

As yet, no country appears to have undertaken a cost-benefit analysis of their patent system. The earliest complete approach still remains Machlup's 1958 report to the US Congress, but needed data were missing.[2] The sole economist on the 1984 Australian patent review tabled a dissenting statement saying that there was nothing economic about the supposedly economic review (IPAC 1984: 79-80). Since then a significant body of empirical research on the role of patents in protecting returns to industrial innovation has been undertaken (detailed below), and this clearly shows that the innovation benefits of patents have been greatly over-stated. While the Bureau of Industry Economics (BIE) referred to the earlier of this evidence, it put greater weight on econometric estimates of high social returns to R&D (BIE 1994b). The IPCRC review referred only briefly to the empirical evidence, and

[1] The range of possible economic impacts identified here draws on a wide range of readings, not all of which are identified here, for which I apologise. Doubtless there are other economic impacts which I have missed, and which ought to be added to this accounting.

[2] In this comprehensive review of economic impacts, Machlup presented an assessment of the probable economic impact of a 1-year extension in patent life. One of the few economic assessments of any aspect of the impact of the 1994 TRIPS Treaty was of the costs and benefits of extending the Australian patent term by 4 years (Gruen et al. 1996).

maintained a strong faith in the absolute need for patents to encourage innovation (IPCRC 2000). Neither presented any evidence to support this presumption. Both also assumed a high inventiveness standard in the patent system.

To the extent that costs and benefits have been measured, the major focus has been on private benefits and private costs. The most recent study on this shows that if pharmaceutical companies are excluded, the net private return from patents to publicly listed US firms is substantially negative (Bessen and Meurer 2008).

This paper is concerned with social costs and social benefits. Private costs and benefits form part of this.[3] But patent systems involve significant positive and negative externalities and these need to be added to private costs and benefits to estimate the net return to society. Anticipated positive externalities are the underlying rationale for the patent intervention. Patents are expected to induce more innovation, generating increased consumer surplus, spillovers of knowledge, enhanced productivity, and higher economic growth. The negative externalities are the losses due to the exercise of monopoly power (lower output, less competition, and reduced consumer surplus). Because knowledge develops in a cumulative fashion, there may also be negative externalities in the form of lower levels of subsequent innovation. Finally, any form of market regulation gives rise to direct transaction and rent-seeking costs, and indirect costs due to misallocation of resources.

Measuring economic costs and benefits

A starting point for identifying the costs and benefits of patent systems is those areas of economic activity to which the system is directed, or through which it works. Thus impacts on *innovation*, *competition*, and *resource allocation* are priority categories within which benefits and costs should be identified. Innovation impacts need to include any benefit from improved technology information dissemination. Naturally any regulatory system also has associated *transaction costs*. Public choice theory directs us to pay attention to lobbying costs as an important element of the costs associated with regulatory intervention.

But these headings do not form a clear framework which can be used as a classification system. For example if a patent system induces more innovation, this affects resource allocation, and, through the grant of the patent monopoly, competition. Under which

[3] But are not the direct subject of this paper.

category should induced innovation then be included? The "headings" are useful in ensuring as complete as possible an accounting of the full range of economic impacts, but do not provide a good classification system.

Implicit in any measurement of costs or benefits is the question, relative to what? Given the substantial evidence that in most industries market mechanisms provide an adequate return to innovation investment, the comparison chosen here is compared to a situation where there is no patent system.[4] This could be modified to a comparison with patent system variants where, for example, patents were restricted to technology-based inventions, where there was a genuine inventive step of a reasonable height, where clear boundaries to claims were a condition for grant, and/or where scope was limited to the knowledge actually contributed. Where it is clear that such changes to patent policy would impact on a particular cost or benefit, this is noted.

Naturally any effort to measure as complex a phenomenon as innovation is fraught with hazards. A full discussion of these measurement problems would leave room for little else. Carter (1996) and Griliches (1990) provide useful discussions of some specific measurement difficulties.

Induced patents and used patents

From a policy perspective there are two key absolutely critical measures. Firstly, any policy is effective if it induces the desired change: here, more innovation. Do patents induce innovation which would not otherwise occur? It is only from induced innovations that the potential benefits of a patent system flow. Where innovation would have taken place, absent patents, no benefits from that innovation can be attributed to patent policy. This remarkably central policy issue has received little comment since Machlup (1958). Innovations that are patented, but not induced by the patent system, create no benefits attributable to patent policy, but they do create costs attributable to patent policy. It is not possible to quantify the economic impact of a patent system without first estimating the proportion of patents induced by it.

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[4] That is, that only the wide range of direct and indirect government supports and subsidies to innovation exist.

The second key policy measure is the proportion of patents used. Some analysts assert that because of close substitutes, the monopoly losses from patent policy are small (e.g. Gans et al. 2004). This seems counter-intuitive—if a monopoly is needed to gain a return to innovation investment, then it will not deliver a return unless it is used. Certainly the *degree* of monopoly power exercised in the use of any individual patent can vary widely. Some authors assert that only a very small proportion of patents are actually used, but provide no supporting evidence (Lemley 2001; Blonder 2005). The one major empirical study on patent use found that 50 percent of Canadian patents were worked in at least one country. Firestone also reported on the proportion of patents worked in the UK (30 percent) and the USA (49 percent for large companies and 71 percent for small companies) (Firestone 1971: 148 - 149).[5]

This issue is complicated by the question of what manner of use. Use was once simply thought of as local working, but with the massive growth in the volume of patents and strategic uses of patents, other uses need to be considered. Each type of use may confer different types of cost on other parties, including intermediate firms. Even patents which are renewed but not used can increase costs of boundary search for other firms (Bessen and Meurer 2008). Because of defensive patenting, patents may have value even where they are used only as insurance. Patent renewal data thus reveal more about private value than about use. Information on the proportions of patents used in different ways is also central to measuring the economic impact of patent systems.

There are some known facts relevant to patent use. Firstly, the proportion of non-use is likely to be higher among domestic than foreign patentees. The majority of patentees first patent domestically (lower patent costs and a more familiar system).[6] For some domestic applicants, the very grant of the patent might fulfil the innovator's prestige or marketing objectives and the patent may not be used or renewed (Bartow 2000). Secondly, certain

[5] And these figures are consistent with an earlier US study reported by Griliches (1990:1679) that 41-55 percent of patents were used commercially, with up to 71 percent used among small firms.

[6] Evidence from recent EPO market research on companies receiving EPO patents in 2002 and 2003 indicates that 74 percent of companies initially filed in their country of domicile (Roland Berger Market Research 2004). This sample is biased towards more frequent patentees and larger companies. It is probable that smaller companies would be even more likely to make their initial filing domestically. For an unknown share of applications one could reasonably argue that some non-US firms might choose to first patent in the USA, because of the wider subject matter scope and low novelty standards in US patent law, and because of the size and importance of the US market.

patentees are known to take out very large numbers of patents for strategic reasons. These include (particularly large) firms in the industries well-known for strategic patenting – particularly the electrical and computing industries (Bessen and Hunt 2004).[7] A small number of firms obtain the bulk of patents: one-third of grants to organisations in each of the USA and Australia go to just 100 firms (Moir 2008). Many of the patents owned by such firms may not be used in the sense of being 'worked'. They are however used for strategic purposes, including misleading competitors about the key directions of research, making significant patents harder to find, challenging other firms in cross-licensing negotiations, and preventing entry to a market.

There is now substantial evidence that the proportion of patented innovations induced by the patent system is low. This possibility was first documented by Scherer et al (1959), confirmed by Taylor and Silberston (1973), and further documented by Mansfield (1986). The large-scale Yale survey in the early 1980s and the 1994 Carnegie-Mellon survey (CMS) confirmed that in most industries imitation time and cost were substantial, patents were poorly regarded as a mechanism for obtaining a return to R&D investment, and most innovations would occur absent patents (Levin et al. 1987; Cohen et al. 2000).[8] The principal findings, particularly the low frequency with which patents are used as a means of ensuring a return to R&D investment, have since been replicated in national innovation surveys in many European countries (Mairesse and Mohnen 2003; Crowley 2004; Larsson 2004; Robson and Ortmans 2006), in Canada (Hanel 2008) and in Australia (Australian Bureau of Statistics 2007). These very large surveys include many small R&D performing firms. Their results confirm that there is no general failure in the market for innovation. First mover advantages, market segmentation (including product differentiation, branding and reputation), speed of technological change, complementary sales, service and manufacturing capabilities, knowledge imperfections, transaction costs, learning and switching costs and network effects all operate to ensure that firms are both motivated to innovate and gain good returns from their R&D investments.

7 Hall also identifies a set of closely related industries with significant strategic patenting behaviour (Hall 2005).

8 Another useful study focused solely on imitation is Mansfield et al. 1981.

There is a significant exception—the pharmaceutical and fine chemicals industries. These are industries where patent boundaries are clear, where the time and cost of imitation is lower than average, and where industry leaders report that innovations would not take place absent patents.[9] It makes sense to look separately at the economic consequences of patents for such clear and highly codified technologies. Bessen and Meurer (2008) separate out the pharmaceutical industries and find a large private net benefit for such firms, in contrast to the negative outcome for firms in other industries. Even here, however, it is not clear that patents are essential. One of the few natural experiments in patent policy was the extension of patents to chemical products in Italy in 1978. While this led to an increase in patenting, there was no consequent increase in R&D expenditure, nor any increased focus on new chemical entities (Scherer and Weisburst 1995).

There will always be individual exceptions to these general findings. Such selective anecdotes are frequently used to illustrate the benefits or costs of patent systems. This is not a sound basis for policy design. If there are special circumstances in certain technologies—and there is substantial evidence that there are—then tailored programs should be designed *if these would deliver a net welfare gain*. But the fact that a few companies may benefit from the patent system as currently designed is not a rationale for maintaining it if the overall impact is negative (Edwards 1949).

The empirical surveys referred to above can be used as a basis for estimating the proportion of patents induced by patent systems. Unfortunately industry and patent classifications do not cross-map well. Nor do the later surveys provide estimates of the proportion of innovations that depended on patents. However the CMS found that 63 percent of process patents and 74 percent of product patents were acquired for defensive purposes (Cohen et al. 2000: 18), and may well not be needed if there were no patent system. So up to 37 percent of process and 26 percent of product patents might cover innovations that need patents to be induced.[10] Estimating induced patents (in industries other than

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9 Though in the CMS, patents were not reported as the most important appropriability mechanism in pharmaceuticals. They were reported as a close second to secrecy and were closely followed by lead time (Cohen et al., 2000: Table 1).

10 Mansfield (1986) specifically asked what proportion of innovations would not have been commercially introduced without patents, and reported that this percentage was 65 for pharmaceuticals, 30 for chemicals, 15 for machinery, and zero for office equipment, motor vehicles, rubber and textiles.

pharmaceuticals/chemicals) at 25 to 50 percent is likely to provide an upper estimate of induced patents.

In small nations where the vast majority of patents are granted to foreigners one also needs to consider whether there is likely to be an inducement effect for overseas innovators. In Australia, for example, 88 percent of patents are granted to innovators from Japan, North America and Europe. It is unlikely that the possibility of gaining an Australian patent would make a difference to innovation investment for most innovators in these large markets, so it is assumed that none of these innovations are induced by the Australian patent system. For innovators from smaller markets, including New Zealand and a range of other countries, the possibility of an Australian patent grant might be critical to the investment.

Based on this reasoning, it can be estimated that between 1990 and 2005, some 9,171 to 13,992 innovations were induced by the Australian patent system (see Table 1). Thus between 180,000 and 185,000 (92.3 to 95.3 percent) of granted patents were for innovations that would have occurred in the absence of the Australian patent system. In the much larger US market, a larger share of patents are induced. The assumptions lead to an estimate of between 284,643 and 459,925 induced innovations, or 35 to 57 percent of granted patents. This generous estimate of induced innovation still leaves a *minimum* of 43 percent of patents granted to innovations which would have occurred in the absence of a patent system.

The remainder of this paper reviews, very briefly, the evidence on the range of costs and benefits associated with patent systems. The discussion is summarised in Table 2.

Impacts on innovation

Induced innovations are critical to estimating the major social benefit from patents. If the embodied new knowledge spills over to other firms and industries, it may create positive social benefits. These knowledge flows translate into productivity improvements and subsequent innovation in the recipient firms. There is remarkably little direct evidence on

Table 1 Estimated induced patents, Australia and USA

	granted patents	proportion induced	estimated induced patents	patents not induced
Australia, 1990-2005				
Patents granted to residents of USA, Canada, Europe and Japan	170,610	0%	0	170,610
Patents to residents of Australia, New Zealand and other countries, of which:	23,635			
Pharmaceutical and fine chemical patents	4,349	100%	4,349	0
All other classes	19,286	50%	9,643	9,643
		25%	4,822	14,465
Total granted patents	194,245			
Estimated maximum induced			13,992	
Estimated minimum induced			9,171	
USA, 2001-2005				
Pharmaceutical and fine chemical patents	109,362	100%	109,362	0
All other classes	701,125	50%	350,563	350,563
		25%	175,281	525,844
Total granted patents	810,487			
Estimated maximum induced			459,925	
Estimated minimum induced			284,643	

Notes: Australian data are from http://www.ipaustralia.gov.au/about/statistics.shtml (accessed 5 March 2007), Table P31 (Mar06) Countries of Origin of Granted and Certified Patents, and Table P63 (May06) Grants of Standard Patents by Technology ("pharmaceuticals" and "fine organic chemicals").

US data are for utility patents, from http://www.uspto.gov/go/taf/reports.htm (by patented technology), June 2006 version (accessed 5 March 2007). Estimates for pharmaceuticals and fine chemicals are based on utility patents granted in the Life and Agricultural Sciences and Testing Method and the Compositions and Synthetic Resins; Chemical Compounds classes.

such social benefits.[11] Mansfield's seminal work (Mansfield et al. 1977) measured gross consumer surpluses generated by 17 innovations. One had negative social returns. Of the remainder, social returns exceeded private returns for 12, but half these had private returns over 25 percent so would have proceeded anyway. The BIE's in-depth study of social returns to 16 Australian industrial innovations, attempted to trace the likelihood and magnitude of both consumer surplus benefits and knowledge spillovers. Fourteen of the 16 innovations were intermediate products. Knowledge spillovers were found to be low or very low for 13 of the innovations, and consumer surplus increases were low for six and

[11] Most studies of knowledge spillovers are econometric models attempting to measure the return to R&D spending in other firms, industries, or in the economy generally. These studies are reviewed in Sena 2004 and US CBO 2005, who reach opposing conclusions as to the likelihood and magnitude of knowledge spillovers.

moderate for another three. General community spillovers (improved quality of life or environment impacts) were low or non-existent for 14 of the innovations (BIE 1994a).

While such positive externalities form the most important likely benefit of patent systems, they are clearly difficult to measure, and may be more tenuous that often supposed. They can be counted as a benefit of patent systems only if they flow from induced innovations. The higher the inventive step requirement, the more likely that patent innovations contain new knowledge and thus generate spillover benefits.

It is well known that most of the private and social value of patents lies in a very small proportion of them (Griliches 1990; Sena 2004). But for innovations generally, there is no direct or systematic correlation between private and social returns.[12] The small literature on patent renewal rates focuses largely on estimating the private value of patents. Provided renewal costs are more than symbolic,[13] it could be assumed that firms will only renew patents that remain of real value to their business.[14] In the mid-1990s Mischlewski and Dormer estimated that in Australia only about 10 percent of patents ran the then full life of 16 years (Mischlewski and Dormer 1995). Others have used the idea that those patents which are renewed to the statutory limit are the most valuable, and found that a very small proportion of patents hold a large share of the value (see, e.g., Harhoff et al. 1998).

Some innovations are productivity-enhancing. While theoretical treatments of such innovations are frequent, there appear to be no empirical estimates of the proportion of innovations which have this effect. Such innovations—particularly where they are general purpose technologies like electric power or computers—can have major positive impacts on economic growth. But major positive benefits do not occur until the innovation has been widely adopted (David 1990). There are no estimates of the proportion of induced innovations which have major or minor impacts in improving productivity.

It is to be expected that new patented technologies will diffuse slowly, due to the exercise of the granted monopoly power to raise price and restrict output. National innovation surveys show that the bulk of innovative activity in high income countries is innovation that

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12 Nor are there any theoretical arguments to suggest why there should be any such relationship (Machlup 1958). Machlup also notes that both private and social returns will depend on how an innovation is exploited.

13 This is actually a very questionable assumption. Users of the patent system have been very successful in persuading Patent Offices of the need to reduce the price they pay for their legislated monopolies. As a result there has been a real decline in the cost of application and renewal fees in some jurisdictions.

14 Though Mooney and Oppenheim (1994a: 154-155) suggest that some firms simply renew all patents for the full term. They suggest this may cost no more than reviewing each patent each year.

is new to the industry or the firm rather than new to the country or the world. For example, the 2004-05 Australian Innovation Survey, found 82 percent of product or process innovations fell into these categories (Australian Bureau of Statistics 2007: 12). It is this *spread* of technology through the economy that provides the major boost to national productivity levels.

Another suggested benefit from patent systems is bringing innovations forward in time. Both Kitch and Dreyfuss suggest that this timing effect is the major benefit of a patent system. Kitch commented in 1977 that:

> "… the inventor's contribution is not the invention itself—which eventually would have been made by someone else—but the time of the invention. The patent should reward not the whole value of the invention, but for the value of being first." (Kitch 1977: 285)

Dreyfuss commented earlier this year that:

> "In the fullness of time, it is highly likely that every invention will be made; to a large extent, the real goal of patent law is not to induce invention, but instead to induce it sooner rather than later." (Dreyfuss 2008: 438)

However despite the views of these two legal scholars, there seems to be no documented evidence of this effect, even anecdotal. This suggests that, if this benefit exists at all, its effect is likely to be small.

Innovation resources may be shifted from unpatentable to patentable areas of research, as a consequence of patent systems. Evidence from nineteenth century World Fairs suggests that patent systems do not affect the level of innovation, but do affect the industries/ technologies in which it occurs (Moser 2005). Cole (2001) considers this cost, and refers to research that in some fields the probable patent strength of alternative technology options has a major impact in determining research directions (Rivette and Kline 2000). There is little disagreement that such an effect is a logical consequence of patent incentives, but there appears to be no systematic evidence on its magnitude.

Unlike copyright, patents do not simply prevent copying. They prevent the commercial use of independently made identical inventions.[15] Both these costs are consequences of the patent system. To a large extent losses due to the prevention of copying are implicit in losses due to slower dissemination of new technology. But the loss due to reduced ability of

15 Patents are thus quite unlike the ownership of tangible property. Property rights in a house prevent others from using that house. But they do nothing to prevent others from acquiring their own houses, nor making them identical. Patents provide the right to prevent anyone else making commercial use of a particular area of technology.

competitors to innovate independently is important (Nelson 2006: 1108). Bessen and Meurer (2008) argue that most litigation involves cases of inadvertent infringement, and that the costs of determining the boundaries of patented technology are substantial.

All these effects need to be assessed against the understanding that knowledge cumulates, and that every innovation draws on previous knowledge, including knowledge in patented artefacts. There is no point at which an “initial innovator” can be clearly identified. Acquisition of knowledge is costly, and imitation involves substantial knowledge inputs. It can also lead to improvements, and sometimes sequential incremental innovation lead to radical breakthroughs (Mandeville 1996). Given the objective of encouraging innovation, the very substantial costs to innovators of establishing the boundaries to property already granted through the patent system needs to be recognised (Bessen and Meurer 2008). This transaction cost relates directly to determining the technological space within which innovators may freely operate. If a technological space becomes crowded with large numbers of patents, the costs to other innovators can rise substantially. The higher the inventive step threshold, the less likely this crowding is to occur.

Companies devote considerable resources to 'inventing around' patents. Plant suggested this was an important aspect of the maldistribution of resources caused by the patent system (Plant 1934: 46). In a remarkable piece of “spin” (or “framing” to use a more academic term), the *costs* of inventing around are now often claimed as a *benefit* of patent systems. Machlup took short shrift with this:

> "… from merely defending the need of "inventing around a patent" as a minor item of waste, the discussion has recently proceeded to eulogize it as one of the advantages of the system, indeed as one of its justifications. … The production of the knowledge of how to do in a somewhat different way what we have already learned to do in a satisfactory way would hardly be given highest priority in a rational allocation of resources." (Machlup 1958: 51)

At its extreme the prevention of independent invention can hold up major technology developments. Perhaps the most famous example is James Watt, whose refusal to license his patents is generally considered to have held up the Industrial Revolution by several decades (Ashton 1948; Boldrin and Levine 2008). Other famous examples are the Wright brothers' stabilisation and steering systems for aircraft and Edison's incandescent lamp (Cohen 2005). Examples of technological hold-ups do not need to be pervasive to have a large social cost: if "the technology in question is sufficiently important, only one or a few instances … may impose considerable social cost" (Cohen 2005: 63). In some industries there is a very high degree of concentration in patent ownership. For example, 75 percent of agricultural patents are held by just six companies (Phillips et al. 2004).[16]

Another consequence of a patent system for innovation can be efforts by an inventor to tie up all possible applications of a new idea. The use of resources to discover and claim ownership to all possible means of doing something is inefficient. In the CMS survey, a large majority of firms reported taking out patents either to block rivals, or to improve their position in negotiating licenses with other firms (Cohen et al. 2000). The associated resources, including resources to develop alternative variants, are resources that would not be needed if a patent system did not exist.

> "The net effect of such an array of techniques [patent pools and cartels, bottleneck patents, patent blitzkrieg, umbrella patents and accordion patents] is that competitors would not be able to differentiate valid and invalid patents and the cost of litigation or, alternatively, of inventing around becomes so high that they would refrain from indulging in any activity that is protected by the network of patents." (Endeshaw 1996: 92)

Another cost is consequent on the prevention of independent invention—so-called 'defensive patenting'. Cohen et al. (2000) found that a large majority of patents were taken out for defensive reasons (63 to 74 percent). The greater the volume of patenting, the more the pressure to patent defensively (Macdonald 2002: 144). This cost would disappear if independent invention were allowed as a defence in infringement cases (Scotchmer 1998).

Another, recently popular, argument in support of patent systems is that they encourage the development of technology markets. There are two aspects to this: outright sale and licensing. Patents appear to have been more often traded in the late nineteenth century (Lamoreaux and Sokoloff 1997, 1999), than they are now. A study of patent renewal rates notes that patent rights are seldom marketed (Pakes et al. 1989: 356). The sole empirical estimate of recent trading of patents indicates that 18 percent of US patents held by small innovators are traded at least once in their lifetime (Serrano 2006). Ocean Tomo, an “intellectual property merchant banc” held its first patent auction on 6 April 2006. Of 394 patents offered, 26 percent were sold at auction (Bessen and Meurer 2008: 181). The “Fall” 2008 auction lists only 118 lots, and listing fees are US$1,000 to 6,000.[17] Given the boundary problems associated with most patents, it is surprising that so many are traded.

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16 There seem to be no studies on patent ownership concentration since Watson and Holman 1970.

17 http://www.oceantomo.com/auctions.html (accessed 19 October 2008).

Licensing of patents usually involves arrangements for the purchase of associated know-how as well as the patented technology (Boehm 1967). Firms are notoriously loathe to disclose information about the terms and conditions of such licenses.[18] Between 23 and 28 percent of firms in the CMS indicated that a reason for obtaining patents was to earn licensing revenue (Cohen et al. 2000). A large minority of patents are used in some way in a technology market.

Dissemination of technology information

A number of authors consider information dissemination to be the principal rationale for a patent system, while others consider it an important secondary benefit. Even in countries where the principal rationale is the innovation incentive, patent statutes often require clear disclosure, sometimes as an explicit condition of grant. Machlup (1958) dismissed as entirely fallacious the idea that technology disclosure is a benefit of patent systems.[19] But what empirical evidence is there on the use of patents for information on new technologies?

In an early 1980s survey of Australian engineers, only 14 percent reported using patent information to track new technologies. This was partly due to legalistic language: one respondent commented "I could hardly recognize my own inventions in legalese" (Mandeville et al. 1982: 209). A companion survey indicated that the major use of patent data was *for using the patent system*. The 1984 IPAC review noted that "… much of the technical information in patent documents is not, or is only some years later, disclosed elsewhere. Indeed, one study found that less than 10 percent of the information contained in patents appears in other technical media" (IPAC 1984: 53).[20] The IPAC committee considered this might be due to poor technical content, lack of awareness by potential users, and difficulties in interpreting the information.

Other reasons can be added. The important ways in which information flows along supply chains, and the role of customers and suppliers in the innovation process have been increasingly understood as key drivers of competitive advantage (Porter 1990). In a 1996 study of small UK manufacturing firms Macdonald (2003) found they looked principally to

[18] Mooney and Oppenheim (1994a; 1994b) were unable to obtain any useful information of this and had to omit it from their survey of UK patent costs.

[19] Arguing that as there was an incentive only to patent that which could not be kept secret, the dissemination of information could not be claimed as a benefit of the patent system. This view is also put forward by Boldrin and Levine (2008:186).

[20] The study referenced is Liebesny et al. 1974.

customers, suppliers and competitors for ideas. He found the two major reasons for patent searches were checking on infringements and preparing patent applications. Another frequent use was to check on competitors: but on their patenting activity not their technology.[21] Oppenheim (2000), also looking at small UK manufacturing firms, found the major reason for non-use of patent data to be irrelevance to company needs (54 percent), with a further 17 percent saying such information was available from other sources.

Patent Offices regularly write about the high value of patent information, often despite survey work they have commissioned. A very large survey of European R&D performing manufacturing firms, conducted in 1994 for the EPO, found that patent data were "rated lowest as sources of information on technical developments" (EPO 1995b: 105).[22]

The one empirical study finding that firms do use patent data is a small survey, *undertaken through the auspices of a business association*, reporting that 90 percent of large firms find patent data useful for their own R&D, and that 44 percent found usefulness increased over the past ten years (Sheehan et al. 2003). Whether the value for their own R&D derives from purposes related to the patent system (avoiding infringement, inventing around etc.) or for purposes to do with following the latest developments in technology is not reported.

Besides the complexity of patent language, non-use of patent data as a source of technology information may be due to the very low level of inventiveness apparent in many patents. Further, built-in delays in publication can eliminate any value in fast-moving areas.

Patent classes are not well designed for identifying and tracking developments in specific technologies. They often contain widely differing inventions (Desrochers 1998).[23] At the same time, searching for a single type of innovation can require searching dozens of sub-classes.[24] Word search is not always a good alternative as there is evidence that patentees deliberately hide critical information. Where keywords are missing, finding relevant patents can be impossible. Stallman provides a very telling example of this problem: a US patent

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21 Indeed, Macdonald suggested that, for SMEs, the patent system is a net demander of information rather than a net supplier.

22 More important sources reported were "talks with customers, specialised literature and trade magazines, trade fairs and talks with suppliers as their main sources of information on the latest technology".

23 Water pistols and holy water dispensers are in the same patent class (Griliches 1990:1666).

24 Sorensen and Stuart searched 2,400 patent classes to ensure a complete identification for semiconductor product, device and design inventions (Sorensen and Stuart 2000: 91).

on natural order recalculation in spreadsheets.[25] He notes that the key terms 'spreadsheet', 'natural order recalculation' and 'topological sorting' did not appear in the specifications (Stallman 2001). The obscurity of patent titles has been highlighted (Murphy 2002) and Labich commented two decades ago "A company's patent lawyers can protect the company's proprietary position without giving away too much in the application process" (Labich 1988: 30).

The empirical evidence thus suggests that the possible benefit of disclosure of detailed information about new technologies may be minimal.[26] This value may have fallen recently if preliminary work indicating increased secrecy about patented innovations is more widely confirmed. Grushcow measured scientists' secrecy by the delay between presentation at a scientific meeting and formal publication of the work in a peer-reviewed journal.[27] On this basis he shows that scientists seeking to patent their work withhold presentation at scientific meetings (Grushcow 2004). His data also suggest increased secrecy among university scientists, even when patents are not being sought. These findings are paralleled in the UK, where Macdonald (2003) notes "The British Technology Group, which specialises in exploiting university patents, is especially keen to suppress academic discussion." These findings suggest that it may even be necessary to assign a negative value to the impact of a patent system on the dissemination of new technology information.

There is now an extremely large literature suggesting that the novelty and inventiveness criteria for issuing patents has fallen to a very low level (a small selection includes Merges 1999; Hunt 1999; Lunney 2001; Lunney 2004; Jaffe and Lerner 2004; Lemley et al. 2005-06). Given this strong consensus, many granted patents will not contribute *any* leading edge technology information. With the very large volume of patent applications and grants, where a high proportion are minimally inventive (if at all), the costs of searching would be very high compared to any expected gain.

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[25] Meaning cell values are re-calculated in logical order (ie cells that depend on others are calculated after the earlier cells are re-calculated).

[26] An early quantitative estimate of the private value of patent information to firms estimated this at 0.75 percent of R&D expenditure (Taylor and Silberston 1973: 212). Using data for 1992, Mooney and Oppenheim (1994b: 148) estimated that only about 3 percent of outlays by British industry on patents and patent information were on patent information. These values include the value of using patent data for purposes associated with using the patent system as well as for any use for technology search in itself.

[27] With a short gap indicating that the data were shared at a scientific meeting, and a long gap suggesting they were not.

Overall then it seems that this benefit is rarely evidenced in the real world. The possible exception is large firms. But it would be useful to establish if their use is for reasons to do with the patent system, or as a source of technological information.

Competition and resource allocation

The current dominant economic paradigm, and the perspective taken in this paper, is that competition in markets for goods and services is most likely to lead to both an efficient allocation of resources, and to maximising consumer satisfaction. An essential characteristic of a competitive market is numerous suppliers and buyers. This also implies that alternative suppliers can freely enter and exit any market.

In sharp contrast to competitive markets are those monopolised by a single supplier. Monopolists are likely to restrict output in order to be able to charge higher prices, thus earning greater profits. Because this prevents marginal cost and marginal price equality, it leads to a poorer outcome in terms of resource allocation, reducing both overall output and consumer satisfaction. Competitiveness and resource allocation are thus, from an economicviewpoint, flip sides of the same coin. Any market situation characterised by at least a degree of monopoly power, is likely to mean less than optimal resource allocation.

As noted above, some consider that only a small proportion of patents are actually used, and that most patented innovations have close substitutes, meaning little market power can be exercised. This is to suggest that patents are largely ineffective, in that they do not prevent competitors from offering very similar innovations. It also suggests that patents are granted for very similar innovations, implying the boundaries of granted patent property may overlap. Certainly if a patent is not used, there can be no static efficiency loss associated with it. Given use, there will also be variable degrees to which an innovator is able to charge higher prices, so the actual estimation of such losses for a patent system involves two steps, both challenging.

Information on what proportion of patents is used, and in what manner is thus critical to assessing the economic impact of patent systems. The 1984 IPAC review recommended that patentees should be required to provide details of patent use when they renewed their patents. This need involve very little cost to patentees, but would provide invaluable information about the impact of patent systems. A second source, which would provide

Table 2 Patent system costs and benefits: importance and empirical evidence

Type of effect	Importance	Existing empirical evidence?
Impacts on innovation:		
Induced innovation	critical	substantial; can use appropriability studies to estimate
Earlier timing	marginal	non-existent
Inventive resources shifted to patent work	unknown / moderate	anecdotal
Negative impacts on other innovators: - no copying - inventing around - complete blocking - fences and thickets	 moderate? moderate? low risk/large impact	 almost none almost none some historical evidence
Technology market	unknown	anecdotal except for C19th
Licensing costs and benefits		
Information dissemination	limited	evidence suggests zero value, with possible exception of large firms
Secrecy	minor	single study
Competition and resource allocation		
Used patents	critical	almost none
Dynamic efficiency gains from induced innovations: - knowledge spillovers - productivity improvements	important	some indirect estimates of knowledge spillovers; little on productivity enhancing share of induced innovation
Increased foreign direct investment	marginal	evidence suggests insignificant
Static efficiency losses	important	almost none
Slower diffusion of patented innovations	unknown possibly important	almost none
Impact on entry of firms	important	several studies with varying findings
Patent races	small?	scattered
Defensive patenting	frequent but modest	could estimate from appropriability studies
Waste of non-invention resources		
Transaction costs		
Applying for and renewing patents	moderate	a few studies
Establishing patent boundaries / Noise	possibly very significant	cost impact on search not documented
Monitoring and enforcing patents	important	some useful litigation studies; one on total cost impact
Lobbying	small but central	very scattered
Abuses of the system	unknown	

complementary information, would be to use national innovation surveys to find out the proportion of innovating firms affected by patents owned by other companies. Firms could be asked whether, and how often, they have received advice that they are infringing others' patents, and what this has cost them.

If the patent system did not divert resources from other activities, it would fail in its principal purpose. The *rationale* for patents is that the net social return from induced activities is higher than from the abandoned activities. Is this demonstrated empirically? Because of the massive difficulties in accurately measuring such variables as the quality of education, knowledge and capital equipment, it is hard to demonstrate conclusively whether the returns to one are greater than the returns to another. All are generally agreed to be significant inputs into economic growth. But whether a country will benefit more at a particular point from more input into skilled labour formation, investment in infrastructure or capital equipment or industrial innovation is not a question that can be answered with any certainty. A good review of studies in this area is US CBO 2005.

An important variant of this idea that patents will draw more resources into inventive activity is the argument put strongly to low income countries during the Uruguay Round GATT negotiations—that stronger patent, copyright and trademark law would lead to higher levels of foreign direct investment (FDI). This idea was based on a study undertaken for the World Bank (Mansfield 1994), but this has been substantially criticised by Heald (2004). A dissertation completed at around the same time as Mansfield's study found that *at best* the relationship between strong intellectual property rights and FDI was insignificant (Kondo 1994).

Certainly modern econometric studies show substantial estimated social returns to industrial expenditure on R&D. But these studies are plagued by measurement problems. Measures of the real input to improvements are likely to miss much of business input into improvements (Carter 1996). Total factor productivity (frequently the dependent variable) is, of course, the famous residual in economic growth, with all the measurement problems that implies. Cole considers Griliches' rough guesstimate that not more than a quarter of total productivity growth is attributable to patented inventions to be an over-estimate (Cole 2001). In addition, Griliches' estimate (Griliches 1990: 1699) was in respect of all patented innovations, not *induced* patented innovations, which are a small proportion of patented innovations. Boldrin and Levine (2008) compare productivity growth in US agriculture generally and corn in particular to changes in intellectual property 'protection' for plants, and find no evidence of any increase in productivity following the introduction of the 1970 US *Plant Variety Protection Act*. So the central question remains: do we really know if we get a better return by tilting the playing field in this way?

A possibly more tractable, but equally important, issue is the entry and exit of firms. There has been much discussion over the role that patents play in this. Historically, there have been examples of patents both assisting in the entry of firms from outside an industry, and in entrenching dominant firms in an industry. For example, industry outsiders are thought to have played an important role in the development of railway technology in the USA in the 19th century (Merges 2003). Equally, there have been examples of the ownership of patents being used to keep competitors out of a market (see above). One empirical study has found that the fear of litigation may cause smaller entrant firms to avoid areas where incumbents are heavy users of patents (Lerner 1995). Nonetheless "[d]irect evidence on the "stifling" versus "stimulating" impacts of patents on innovation and competition is not easy to find" (Cockburn and MacGarvie 2006: 1). Cohen (2005) notes that this is an area where there is no systematic evidence. Despite the importance of new firm entry to the functioning of competitive markets, there are as yet insufficient data for determining whether the patent system has a positive or negative effect.

In the winner-takes-all patent market, if two or more inventors develop a practical application at the same time, then only one wins the monopoly grant. Does this constitute a waste of resources? There is substantial evidence of simultaneous invention,[28] so that cases where several people invent approximately the same innovation at around the same time may be the norm rather than the exception, and may be a natural phenomenon rather than one induced by patent systems. In fact there are likely to be substantial practical variations in the resulting artefacts, and investment in research and development is an important part

28 See, for example Mokyr 2002. Machlup and Penrose (1950) also comment that this understanding was widespread during the Great Patent Debate of the nineteenth century. In an 1878 US Supreme Court decision, where dominant firms in an industry won a significant victory over patents held by small industry outsiders, Justice Bradley commented; "Like almost all other inventions, that of double brakes came when, in the progress of mechanical improvement, it was needed; and being sought in many minds, it is not wonderful that it was developed in different and independent forms" (quoted in Perelman 2002:19).

of the learning needed for the adoption and adaptation of new technologies (Cohen and Levinthal 1989). So 'patent races' may not be unambiguously positive or negative in terms of their economic impact. Recently patent races have expanded to become *portfolio* patent races (see, e.g., Cohen 2005: 62). Such broader races might impose significantly different costs and benefits, including the substantial blocking of innovation by rival firms.

Transaction / regulatory costs

The most frequently mentioned costs of patent systems are the private costs of applying for, renewing and defending patents, and the private costs incurred through patent litigation.

Only four papers with *systematic* evidence on filing and renewal costs have been found.[29] The sole academic study involved considerable estimation, and was presented with an error rate estimate of +/- 37 percent (Mooney and Oppenheim 1994a, 1994b). Nonetheless the estimates—that filing, renewal, litigation and information service costs were around 6 percent of the value of gross trade (imports and exports) of patented goods provides an interesting perspective on this aspect of the cost equation.[30]

The European Patent Office (EPO) has estimated that the cost of obtaining a "standard" patent through the EPO was two to four times higher than in the USA or Japan (EPO 1995a). Van Pottelsberghe and François attempt to relate these costs to market size, but this explains little of the cost difference (van Pottelsberghe de la Potterie and François 2006). A more recent EPO survey confirmed this, and also found costs to be slightly higher for SMEs than for larger companies.[31] Nearly 60 percent of the surveyed companies had their own IP department; one-third were unable to estimate their total expenditure on patents. One conclusion was that there is considerable variation in the cost of applying for a patent between regions, and between patents. One Patent Attorney responded that some "inventions are closer to the prior art than others - it is more difficult to draft applications for the closer ones and to prosecute the application through to grant" (Roland Berger Market Research 2004: 43).

[29] The American Intellectual Property Law Association (AIPLA) regularly gathers data on such costs in respect of the US market, but these data are not available in the public domain except where quoted elsewhere, for example in Bessen and Meurer 2008: 132.

[30] A more appropriate yardstick would of course be expenditure on research and development.

[31] Based on a sample of companies with EPO patent grants in 2002 or 2003, and discussions with Patent Attorneys and translation service firms (Roland Berger Market Research 2004). This study had a very low response rate, and respondents are dominated by frequent patentees.

For Australia, the Patent Office indicates a cost range of between $A6,000 and $A10,000 for filing a standard application, and paying relevant costs through to grant, including Patent Attorney fees. They indicate a further likely outlay of $8,000 if the patent is renewed for the full 20 year period possible.[32] Data on grants and renewals could be combined with this information to generate estimates of total outlays.

There is a much larger empirical literature on the costs of monitoring and enforcing patents. This focuses on patent litigation, especially its risk, validity or infringement outcomes, and impacts on firms of different sizes. The probability of a particular patent being involved in a litigation suit is significantly lower when the patent holder has a large portfolio of patents, except for pharmaceutical patents (Lanjouw and Schankerman 2001). In a further study these authors find that individuals and firms with small patent portfolios have a much higher risk of patent litigation, and conclude that "small patentees are at a significant disadvantage in protecting their patent rights because their greater litigation risk is not offset by more rapid resolution of their suits" (Lanjouw and Schankerman 2004). These findings are confirmed for Europe: 30 percent of smaller European firms with patents granted in 1994-97 reported copying by larger firms. They also reported particular difficulty in winning infringement cases in the USA (EU 2000). These studies focus on cases where lawsuits are filed, which may well be a minority of infringement cases. There seem to be no studies on infringement costs where cases are settled before any lawsuit is filed. Nor do there seem to be any on the cost of monitoring to identify infringement.

Recent work by Bessen and Meurer (2008) provides very useful new estimates of the total private cost of patent litigation, focusing on the impact on firm market value. Costs are shown to substantially exceed (already substantial) direct legal costs. Their estimates cover US publicly traded firms and indicate that, at least for non-pharmaceutical firms, the costs due to litigation now exceed the private benefits of the patent system. They point out that litigation risk is an inevitable consequence of innovation in a world with patents, and suggest that most infringement is inadvertent. If so, an independent invention defence would eliminate much of this cost.

[32] http://www.ipaustralia.gov.au/patents/fees_index.shtml, accessed 4 July 2008.

There is now a large literature on public choice theory and regulatory capture. Public policy is most often captured when there a few well-organised beneficiaries of the intervention, with those who pay being widely dispersed. This of course typifies the patent system. The patent community, particularly patent lawyers and major users of the system, engage in extensive lobbying in their own interests.[33] But patents, like tariffs, have hidden costs, spread throughout the community. One reason the economics profession is so opposed to regulation of markets (except where large net gains are clearly identifiable) is that there is an incentive to spend very large sums on lobbying. Barton provides an interesting perspective on the costs and benefits of the patent system by providing, for the USA, data on the ratio of intellectual property lawyers to $US billions spent on R&D. This ratio has increased from under 45 in 1970 to about 75 in the late 1990s (Barton 2000).

A problem with any form of regulation is argument and dispute over boundaries. Bessen and Meurer (2008) demonstrate vividly that most patent boundaries are so poorly drawn that third party innovators are totally unable to identify, at any remotely reasonable cost, the boundaries of technology that is owned, and technology that is free to be exploited. But the very volume of patents, many of them over-lapping, written in extremely hard-to-read language, and with poor classification and keyword systems, means a vast amount of noise in the system. This creates significant costs for innovating firms.

Commentators often allege abuse of the patent system. Extreme care is needed in this area. It is not an abuse of the patent system to charge such a high price for a new and more effective HIV/AIDS drug that it is out of reach of many who would benefit from it. This is a direct consequence of the design of the patent system. Abuses are those actions that undermine the *purpose* of patent legislation, and attitudes to this change over time. Machlup considered that combining trademarks with patents, to effectively extend the term of market power, was an abuse (Machlup 1958: 10-11). Nowadays it is standard practice for patented pharmaceuticals to be heavily marketed under a trademark, and it is evident that this operates to extend market power beyond the patent term.

[33] For example, "The penultimate Senate draft of the American Inventors Protection Act of 1999 mandated a General Accounting Office study of business method patents, but this was removed at the behest of the patent bar." (Kahin 2003). Bessen and Meurer comment that the Federal Trade Commission (US FTC 2003) recommendation which was most prominently rejected by the Intellectual Property Owners Association was Recommendation 10 "expand consideration of economic learning and competition policy concerns in patent law decisionmaking" (Bessen and Meurer 2008: 293-4).

Priorities

Given the importance of innovation, the possibility that poor patent policy can significantly inhibit innovation, and increasing evidence that the costs of patent systems are higher than suspected, and the benefits lower, developing a solid evidence base for patent policy is a priority. The development, over the past two decades, of a series of comparative national innovation surveys indicates the importance of innovation. Surprisingly these surveys contain very little useful data on patents. They could easily be expanded to throw light on two critical issues—the proportion of innovations induced by patents, and the extent to which patents held by one firm create costs for other innovating firms. Requiring data on use at the time of patent renewal would provide important complementary evidence on patent system costs.

Other important issues for research are sounder evidence on dynamic benefits, including spillover benefits, and impacts on the entry of firms. Further information on the extent to which patent holders are able to extract monopoly rents is also needed for a fuller understanding of the competitive impact of the patent system. In the area of transaction costs, the issue of identifying patent boundaries has clearly become urgent, and research is needed on how this impacts on firms' innovation decisions and investments. Finally, given the small number of beneficiaries of the system,[34] and evidence of their substantial impact on patent policy (Drahos 2002; Sell 2003) it would be of public interest to know how much they spend lobbying to tilt the patent playing field in their preferred direction.

Noting the dearth of relevant data for patent policy analysis, Bakels and Hugenholtz (2002) called for the establishment of a patent observatory in Europe, so far with no avail. This is not the first call for better evidence on patents, but such recommendations do not seem to be acted on, even when they are by formal review committees. Kahin (2003) has noted several instances where lobbyists have prevented research or data collection on the impact of software and business method patents. Patent policy is too important to national economic well-being to allow narrow sectional interests to prevent the collection of evidence on its impact.

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[34] Bessen notes that a very small number of companies take nearly 80 percent of the benefits of the US patent system in respect of publicly listed US firms (Bessen 2006: 19)

References

Ashton, T.S., (1948), *The Industrial Revolution, 1760-1830*, Oxford: Oxford University Press.

Australian Bureau of Statistics, (2007), *Patterns of Innovation in Australian Businesses 2005*, Canberra: Australian Bureau of Statistics, Cat. No. 8163.0.

Bakels, R.B. and P.B. Hugenholtz, (2002), *The Patentability of Computer Programs: Discussion of European-Level Legislation in the Field of Patents for Software,* Study commissioned by the European Parliament.

Barton, J.H., (2000), 'Reforming the Patent System', *Science,* 287:5460, 1933-1934.

Bartow, A., (2000), 'Separating Marketing Innovation From Actual Invention: A Proposal for a New, Improved, Lighter, and Better-Tasting Form of Patent Protection', *Journal of Small and Emerging Business Law,* 4:1, 1-25.

Bessen, J.E., (2006), *Estimates of Firms' Patent Rents from Firm Market Value,* Boston University: School of Law Working Paper No. 06-14.

Bessen, J.E. and R.M. Hunt, (2004), *An Empirical Look at Software Patents,* Philadelphia: Federal Reserve Bank of Philadelphia, Working Paper No. 03-17/R.

Bessen, J.E. and M.J. Meurer, (2008), *Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk*, Princeton and Oxford: Princeton University Press.

BIE, (1994a), *Beyond the Innovator: Spillovers from Australian Industrial R&D*, Canberra: Bureau of Industry Economics Occasional Paper 16.

_______, (1994b), *The Economics of Patents*, Canberra: Bureau of Industry Economics Occasional Paper 18.

Blonder, G., (2005), 'Cutting Through the Patent Thicket', *Business Week*, 20 December.

Boehm, K., (1967), *The British Patent System*, Cambridge: Cambridge University Press.

Boldrin, M. and D.K. Levine, (2008), *Against Intellectual Monopoly*, Cambridge: Cambridge University Press (also at http://www.dklevine.com/general/intellectual/againstfinal.htm).

Carter, A.P., (1996), 'Measuring the Performance of a Knowledge-Based Economy' in D. Foray and B.-Å. Lundvall (eds), *Employment and Growth in the Knowledge-based Economy*, Paris: OECD, pp. 61-68.

Cockburn, I.M. and M.J. MacGarvie, (2006), *Entry, Exit and Patenting in the Software Industry,* Cambridge, Mass.: National Bureau of Economic Research, NBER Working Paper 12563 (October).

Cohen, W.M., (2005), 'Patents and Appropriation: Concerns and Evidence', *Journal of Technology Transfer,* 30:1-2, 57-71.

Cohen, W.M. and D.A. Levinthal, (1989), 'Innovation and Learning: The Two Faces of R&D', *The Economic Journal,* 99:397, 569-596.

Cohen, W.M., R.R. Nelson, and J.P. Walsh, (2000), *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not),* Cambridge, MA: National Bureau of Economic Research, NBER Working Paper 7552.

Cole, J.H., (2001), 'Patents and Copyrights: Do the Benefits Exceed the Costs?' *Journal of Libertarian Studies,* 15:4, 79–105.

Crowley, P., (2004), *Innovation in the New Member States and Candidate Countries: Output, Barriers and Protection,* Luxembourg: Eurostat, Statistics in Focus: Science and technology 13/2004 (November).

David, P.A., (1990), 'The Dynamo and the Computer: An Historical Perspective on the Modern Productivity Paradox', *American Economic Review,* 80, 355-361.

Desrochers, P., (1998), 'On the Abuse of Patents as Economic Indicators', *Quarterly Journal of Austrian Economics,* 1:4, 51–74.

Drahos, P., (2002), *Information Feudalism: Who Owns the Knowledge Economy*, London: Earthscan.

Dreyfuss, R.C., (2008), 'Nonobviousness: A Comment on Three Learned Papers', *Lewis & Clark Law Review,* 12:2, 431-441.

Edwards, C.D., (1949), *Maintaining Competition: Requisites of a Governmental Policy*, New York: McGraw-Hill.

Endeshaw, A., (1996), *Intellectual Property Policy for Non-Industrial Countries*, Aldershot/ Brookfield/ Singapore/ Sydney: Dartmouth.

EPO, (1995a), *Cost of Patenting in Europe: Results of Surveys Carried Out by the European Patent Office,* European Patent Office.

_______, (1995b), 'Utilisation of Patent Protection in Europe', *World Patent Information,* 17:2, 100-105.

EU, (2000), *Enforcing Small Firms' Patent Rights,* CORDIS/Innovation Policy Studies available at ftp://ftp.cordis.europa.eu/pub/innovation-policy/studies/studies_enforcing_firms_patent_rights.pdf, accessed 6 Nov 2006.

Firestone, O.J., (1971), *Economic Implications of Patents*, Ottawa: University of Ottawa Press.

Gans, J.S., P.L. Williams, and D. Briggs, (2004), 'Intellectual Property Rights: A Grant of Monopoly or an Aid to Competition?' *The Australian Economic Review,* 37:4, 436-445.

Griliches, Z., (1990), 'Patent Statistics as Economic Indicators: A Survey', *Journal of Economic Literature,* 28:4, 1661-1707.

Gruen, N., I. Bruce, and G. Prior, (1996), *Extending Patent Life: Is It in Australia's Economic Interests?,* Canberra: Industry Commission, Industry Commission Staff Information Paper (June).

Grushcow, J.M., (2004), 'Measuring Secrecy: A Cost of the Patent System Revealed', *The Journal of Legal Studies,* 33, 59–84.

Hall, B.H., (2005), 'Exploring the Patent Explosion', *Journal of Technology Transfer,* 30:1-2, 35-48.

Hanel, P., (2008), 'The Use of Intellectual property Rights and Innovation by Manufacturing Firms in Canada', *Economics of Invention and New Technology,* 17:4, 285-309.

Harhoff, D., F.M. Scherer, and K. Vopel, (1998), *Exploring the Tail of Patent Value Distributions,* Mannheim: Center for European Economic Research (January).

Heald, P.J., (2004), 'A Skeptical Look at Mansfield's Famous 1994 Survey', *Information Economics and Policy,* 16:1, 57-65.

Hunt, R.M., (1999), *Nonobviousness and the Incentive to Innovate: An Economic Analysis of Intellectual Property Reform,* Philadephia: Federal Reserve Bank of Philadelphia, Working Paper 99-3 (April).

IPAC, (1984), *Patents, Innovation and Competition in Australia*, Canberra: Industrial Property Advisory Committee.

IPCRC, (2000), *Review of Intellectual Property Legislation Under the Competition Principles Agreement: Final Report,* Canberra: (Intellectual Property and Competition Review Committee), Commonwealth of Australia.

Jaffe, A.B. and J. Lerner, (2004), *Innovation and its Discontents: How Our Broken Patents System is Endangering Innovation and Progress, and What to Do About It*, Princeton: Princeton University Press.

Kahin, B., (2003), 'The Expansion of the Patent System: Politics and Political Economy', *First Monday,* 6 1 (www.firstmonday.org/issues/issue8_3/kahin/index.html).

Kitch, E.W., (1977), 'The Nature and Function of the Patent System', *Journal of Law and Economics,* 20, 265-290.

Kondo, E., (1994), *Patent Laws and Foreign Direct Investment: An Empirical Investigation*, Boston: Harvard University, PhD dissertation.

Labich, K., (1988), 'The Innovators', *Fortune,* 6 June, 27-32.

Lamoreaux, N. and K. Sokoloff, (1997), *Inventors, Firms, and the Market for Technology: U.S. Manufacturing in the late Nineteenth and Early Twentieth Centuries,* Cambridge, Mass.: National Bureau of Economic Research, NBER Working Paper H0098 (April).

_______, (1999), *Inventive Activity and the Market for Technology in the United States, 1840-1920,* Cambridge, Mass.: National Bureau of Economic Research, NBER Working Paper 7107 (May).

Lanjouw, J.O. and M. Schankerman, (2001), *Enforcing Intellectual Property,* Cambridge, Mass.: National Bureau of Economic Research, NBER Working Paper 8656.

_______, (2004), 'Protecting Intellectual Property Rights: Are Small Firms Handicapped?' *Journal of Law and Economics,* 47:1, 45-74.

Larsson, A., (2004), *Innovation Output and Barriers to Innovation,* Luxembourg: Eurostat, Statistics in Focus: Science and Technology 1/2004 (January).

Lemley, M.A., (2001), 'Rational Ignorance at the Patent Office', *Northwestern University Law Review,* 95:4, 1495-1532.

Lemley, M.A., D.G. Lichtman, and B.N. Sampat, (2005-06), 'What to Do about Bad Patents?' *Regulation,* 28:4, 10-13.

Lerner, J., (1995), 'Patenting in the Shadow of Competitors', *Journal of Law and Economics,* 38:2, 463-495.

Levin, R.C., A.K. Klevorick, R.R. Nelson, and S.G. Winter, (1987), 'Appropriating the Returns from Industrial Research and Development', *Brookings Papers on Economic Activity, Special Issue on Microeconomics,* 1987:3, 783-831.

Liebesny, F., J.W. Hewitt, P.S. Hunter, and M. Hannah, (1974), 'The Scientific and Technical Information Contained in Patent Specifications: The Extent and Time Factors of its Publication in Other Forms of Literature', *The Information Scientist,* 8:3, 165-177.

Lunney, G.S., Jr., (2001), 'E-Obviousness', *Michigan Telecommunications Technology Law Review,* 7, 363-422.

_______, (2004), 'Patent Law, The Federal Circuit, and the Supreme Court: A Quiet Revolution', *Supreme Court Economic Review,* 11, 1-79.

Macdonald, S., (2002), 'Exploring the Hidden Costs of Patents' in P. Drahos and R. Mayne (eds), *Global Intellectual Property Rights: Knowledge, Access and Development*, Basingstoke: Macmillan, pp. 13-39.

_______, (2003), 'Bearing the Burden: Small Firms and the Patent System', *The Journal of Information, Law and Technology (JILT),* 2003:1 (http://www2.warwick.ac.uk/fac/soc/law/elj/jilt/2003_1/macdonald/).

_______, (2004), 'When Means Become Ends: Considering the Impact of Patent Strategy on Innovation', *Information Economics and Policy,* 16:1, 135-158.

Machlup, F., (1958), *An Economic Review of the Patent System,* Washington, D.C.: US Government Printing Office, Study No. 15 of the U.S. Senate Subcommittee on Patents, Trademarks and Copyrights.

Machlup, F. and E. Penrose, (1950), 'The Patent Controversy in the Nineteenth Century', *The Journal of Economic History,* X:1, 1-29.

Mairesse, J. and P. Mohnen, (2003), 'Intellectual Property in Services: What Do We Learn from Innovation Surveys?' Presented at Intellectual Property Rights (IPR), Innovation and Economic Performance Conference, Paris: OECD.

Mandeville, T.D., (1996), *Understanding Novelty: Information, Technological Change, and the Patent System*, Norwood, N.J.: Ablex.

Mandeville, T.D., D.M. Lamberton, and E.J. Bishop, (1982), *Supporting Papers for the Economic Effects of the Australian Patent System*, Canberra: Australian Government Publishing Service.

Mansfield, E., (1986), 'Patents and Innovation: An Empirical Study', *Management Science,* 32:2, 173-181.

_______, (1994), *Intellectual Property Protection, Foreign Direct Investment and Technology Transfer,* World Bank: International Finance Corporation, Discussion Paper 19.

Mansfield, E., J. Rapoport, A. Romeo, S. Wagner, and G. Beardsley, (1977), 'Social and Private Rates Return from Industrial Innovations', *Quarterly Journal of Economics,* 71, 221-240.

Mansfield, E., M. Schwartz, and S. Wagner, (1981), 'Imitation Costs and Patents: An Empirical Study', *The Economic Journal,* 91:364, 907-918.

Mazzoleni, R. and R.R. Nelson, (1998), 'The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate', *Research Policy,* 27, 273-284.

Merges, R.P., (1999), 'As Many as Six Impossible Patents before Breakfast: Property Rights for Business Concepts and Patent System Reform', *Berkeley Technology Law Journal,* 14:2, 577-615.

_______, (2003), 'The Uninvited Guest: Patents on Wall Street', *Economic Review - Federal Reserve Bank of Atlanta,* 88:4, 1-14.

Mischlewski, D. and M. Dormer, (1995), *Patents and Innovation: An Investigation of the Commercialisation of Inventions Patented by Australian Organisations*, Ashfield, NSW: Watermark Patent and Trademark Attorneys.

Moir, H.V.J., (2008), *Who Benefits? An Empirical Analysis of Australian and US Patent Ownership,* Canberra: ANU, Centre for Governance of Knowledge and Development, CGKD Working Paper.

Mokyr, J., (2002), 'Innovation in an Historical Perspective: Tales of Technology and Evolution' in B. Steil, D.G. Victor, and R.R. Nelson (eds), *Technological Innovation and Economic Performance*, Princeton: Princeton University Press, pp. 23-46.

Mooney, B. and C. Oppenheim, (1994a), 'The Cost of Patent Protection to U.K. Industry', *Journal of the Chartered Institute of Patent Agents,* 23:4, April, 144-160.

_______, (1994b), 'How Much Does British Industry Pay for Patents and Patent Information?' *World Patent Information,* 16:3, 140-149.

Moser, P., (2005), 'How do Patent Laws Influence Innovation? Evidence from Nineteenth Century World Fairs', *American Economic Review,* 95:4, 1214-1236.

Murphy, F.H., (2002), 'The Occasional Observer <www.uspto.gov> a New Source for What is Happening in Operations Research Practice', *Interfaces,* 32:3, 26-29.

Nelson, R.R., (2006), 'Reflections on David Teece's "Profiting from technological innovation…" ', *Research Policy,* 35:8, 1107-1109.

Oppenheim, C., (2000), 'Patent Information Usage in British Small and Medium Sized Enterprises', http://scientific.thomson.com/free/ipmatters/bti/8199738/ [8 March 2007].

Pakes, A., M. Simpson, K. Judd, and E. Mansfield, (1989), 'Patent Renewal Data', *Brookings Papers on Economic Activity, Special Issue on Microeconomics*, 331-401.

Perelman, M., (2002), *Steal This Idea: Intellectual Property and the Corporate Confiscation of Creativity*, New York: Palgrave.

Phillips, R.L., J. Chen, R. Okediji, and D. Burk, (2004), 'Intellectual Property Rights and the Public Good', *The Scientist,* 18 (14), 8-.

Plant, A., (1934), 'The Economic Theory Concerning Patents for Inventions', *Economica, New Series,* 1:1, 30-51.

Porter, M.E., (1990), *The Competitive Advantage of Nations*, New York: Free Press.

Rivette, K.G. and D. Kline, (2000), 'Discovering New Value in Intellectual Property', *Harvard Business Review,* 78:1, 54-66.

Robson, S. and L. Ortmans, (2006), 'The First Findings from the UK Innovation Survey, 2005', *Economic Trends,* 628, 58-64.

Roland Berger Market Research, (2004), *Study on the Cost of Patenting*, Munich: European Patent Office, (http://www.european-patent-office.org/epo/new/cost_analysis_2005_en.pdf [23 January 2007]).

Scherer, F.M., S.E. Herzstein, A. Dreyfoos, W. Whitney, O. Bachmann, P. Pesek, C. Scott, T. Kelly, and J.J. Galvin, (1959), *Patents and the Corporation: A Report on Industrial Technology under Changing Public Policy*, Boston: privately published.

Scherer, F.M. and S. Weisburst, (1995), 'Economic Effects of Strengthening Pharmaceutical Patent Protection in Italy,' *International Review of Industrial Property and Copyright Law,* 26:6, 1009-1024.

Scotchmer, S., (1998), *The Independent-Invention Defense in Intellectual Property,* Berkeley, CA: Berkeley, Berkeley Olin Program in Law & Economics, Working Paper Series: 1132.

Sell, S.K., (2003), *Private Power, Public Law: The Globalization of Intellectual Property Rights*, Cambridge: Cambridge University Press.

Sena, V., (2004), 'The Return of the Prince of Denmark: A Survey on Recent Developments in the Economics of Innovation', *The Economic Journal,* 114, 312-332.

Serrano, C.J., (2006), *The Dynamics of the Transfer and Renewal of Patents,* Toronto: University of Toronto, Department of Economics, Working Papers.

Sheehan, J., C. Martinez, and D. Guellec, (2003), 'Understanding Business Patenting and Licensing: Results of a Survey', Presented at Intellectual Property Rights (IPR), Innovation and Economic Performance Conference, Paris: OECD.

Sorensen, J.B. and T.E. Stuart, (2000), 'Aging, obsolescence, and organizational innovation', *Administrative Science Quarterly,* 45:1, 81-112.

Stallman, R.M., (2001), 'The Danger of Software Patents' Speech at Government Model Engineering College, India at http://www.gnu.org/philosophy/stallman-mec-india.html

Taylor, C.T. and Z.A. Silberston, (1973), *The Economic Impact of the Patent System: A Study of the British Experience*, Cambridge: Cambridge University Press.

US CBO, (2005), *R&D and Productivity Growth: A Background Paper,* Washington, DC: The Congress of the United States (Congressional Budget Office) (June).

US FTC, (2003), *To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy,* Washington, D.C.: Federal Trade Commission.

van Pottelsberghe de la Potterie, B. and D. François, (2006), *The Cost Factor in Patent Systems,* Brussels: Solvay Business School/Centre Emile Bernheim, University Libre de Bruxelles. , Working Paper 06/002, .

Watson, D.S. and M.A. Holman, (1970), 'The Concentration of Patent Ownership in Corporations', *The Journal of Industrial Economics,* 18:2, 112-117.