*Econ. Innov. New Techn.,* 2004, Vol. 13(5), July, pp. 417–442

Taylor & Francis
Taylor & Francis Group

# IF 'INTELLECTUAL PROPERTY RIGHTS' IS THE ANSWER, WHAT IS THE QUESTION? REVISITING THE PATENT CONTROVERSIES

BIRGITTE ANDERSEN*

*Department of Management, Birkbeck, University of London, Malet Street, Bloomsbury, London, WC1E 7HX*

*(Received 16 September 2002; In final form 21 November 2003)*

A typology on the rationales for intellectual property rights (IPRs), primarily in relation to patents, is developed. The focus is on natural rights and moral rationales, economic incentive rationales, increased competition and 'market protection of entrepreneurial talent' rationales, and the economic rationales of organising science, technology and creativity. Whilst reviewing the controversies surrounding IPR legislation, the importance of this typology is justified. It will provide a good conceptual underpinning and analytical framework for achieving a finer empirical understanding of the social and economic effects of IPRs, and this understanding is urgently needed when designing policy fostering the knowledge-driven techno-economic paradigm in the twenty-first century.

*Keywords*: Intellectual property rights (IPRs); Patents; Rationales; Typology; Policy

*JEL classification*: 031; 034; 038

## 1 INTRODUCTION

Capturing value from intellectual capital and knowledge-based assets has become the new mantra. The battles are not for control of raw materials, but for the control of the most dynamic strategic asset, namely 'productive knowledge'. Finding ways in which institutions can help firms with this increasingly important practice has become an explicit agenda for many governments.

Meetings in industry, national governments and international agencies as well as consultants seem to indicate a consensus or belief that increased privatisation and recognition of the intellectual capital and knowledge-based assets of firms will better enable them to capture the value from their productive knowledge assets. See, e.g. EU's (2002) hearing regarding business methods patents; OECD (1999) regarding measuring and reporting intellectual capital; the Trade Related Aspects of the Intellectual Property Section (TRIPS) of the World Trade Organization (WTO), which came into force in 1994 as a part of the Uruguay Round to enforce intellectual property world wide; the Bayh–Dole Act in the US in 1980 to create incentives

* Tel.: +44 (0) 2078217648; E-mail: b.andersen@bbk.ac.uk

ISSN 1043-8599 print; ISSN 1476-8364 online 
DOI:10.1080/1043859042000188692

for transferring new technology from university laboratories to the private sector[1] and the new financial frameworks from the 1980s, where unprofitable firms can be listed on Nasdaq as long as they are able to report intangible assets.[2] Furthermore, entering a new economy, or techno-economic paradigm, in which knowledge assets rather than physical assets are the primary sources of wealth generation and economic growth, we have experienced a tightening of the intellectual property rights (IPRs) system in terms of: (i) integrating new areas of protection (even beyond science-based principles, e.g. business methods patents[3]), (ii) exclusive rights also on pure ideas (e.g. genetic codes[4] and some mathematics[5]), (iii) an increased period of protection, as well as (iv) the introduction of the 'submarine patents'-scheme in the US.[6]

Innovation policy is designed around some IPR legal regimes. The current tightening of such policy is obviously based upon a 'vision' of why this might provide the answer. However, we cannot base our policy on visions alone. Firstly, we need to address the question to which IPR systems supposedly provide the answer. Secondly, we need to assess whether the IPR really is the best instrument for our political (i.e. social and economic) objectives.

The current need for setting out clear objectives for the IPR system, and for understanding the operation and social and economic effects of IPR policies, is due in part to the emergence of new types of science and technologies, and the changing ways in which IPRs are governed within sectoral systems, as products and processes have become increasingly complex both in their knowledge bases and in the ownership of such. This need has also increased in importance as a consequence of the harmonising effect of globalisation policies.

Thus, this article aims to review critically and classify the rationales for IPRs, drawing upon past and current academic scholars. Applying theoretical logic, speculations on the effects of IPRs will also be discussed. The controversies surrounding IPR legislation will form central part of the discussion. Emphasis will be on natural rights and moral rationales (Sec. 2), the economic incentive rationales (Sec. 3), the increased competition and 'market protection of entrepreneurial talent' rationales (Sec. 4), and the economic rationales for organising science, technology and creativity (Sec. 5).[7] Finally, based upon the critical review in the previous sections, this article develops a 'typology' on the rationales for IPRs. The overall design, use and justification for the typology will be concluded in Section 6.

As is clear from this article, most of the theoretical contributions to the debate are historically rooted, although the focus in recent times has changed from 'the role of the entrepreneur and invention protection' towards 'appropriation from IPRs and the increasing importance of the venture capitalist as well as strategic interaction in the market place for ideas'. For the earlier classics on the early history of IPRs and patent grants, including a thorough exploration of the underpinning economic logic, see Machlup and Penrose (1950), Machlup (1958) and Kaufer (1989).

[1] See Mowery *et al*. (1999) and Mazzoleni and Nelson (1998a) for an overview and discussion of the Bayh–Dole Act.

[2] Coriat and Orsi (2002) argue that the most important intellectual assets in this respect are portfolios of patents and other IPRs.

[3] See EU (2002), as well as Andersen (2003) for discussion of the EU's hearing of business methods patents.

[4] See special issue of Academic Medicine (December 2002) and Bulletin of Medical Ethics (December 1996/ January 1997) for discussion on human genome patents, which is one of the most controversial topics in the current debate.

[5] See Besen and Raskind (1991) and Coriat and Orsi (2002).

[6] Mowery and Graham (2004) presents and discusses this scheme, which allows patent applications to be updated (refilled) while they are being processed, encouraging patent application submissions at a very early stage of the discovery.

[7] The rationales have also been discussed elsewhere with respect to IPR policy implications in the electronic age (Andersen, 2003).

In some respect the typology in this article can be compared to the functional approach[8] and categorising of theories on the benefits and costs of patents proposed by Mazzoleni and Nelson (1998a,b). However, in a crucial respect the typology proposed in this article is different. Whereas Mazzoleni and Nelson's (1998a,b) proposed categories can be considered as empirically grounded theory in the sense that they are grounded on empirical data and analysis, the typology proposed in this article is grounded on theoretical logic already proposed in various theoretical and philosophical frameworks of analysis. Thus, whereas their categorising of theories (including the broadness and depth in which they are discussed) is mainly in relation to *economic incentive rationales*[9] where empirical analysis has taken place, the theoretically grounded approach in this article aims to be 'all-inclusive'. In Mazzoleni and Nelson's (1998a,b) approach we also learn how different IPR uses apply to different industries, different firm size, and how the individual versus public (e.g. university) versus private ownership of IPRs matters. The typology proposed in this article does not aim to discuss the specificities of industries and firms in relation to the IPR rationales. That is, instead of focusing on empirical relationships or results from empirical surveys, it aims to discuss the theoretical (social and economic) logic regarding the operation and performance (i.e. dynamics) of the IPR system.

Of course, it would be best to integrate the two, i.e. the all-inclusive approach to the rationales for IPRs, and the empirical results of the worth of the rationales in relation to the specificities of firms, industries and individual and public ownership. However, despite important contributions, more empirical research still needs to be done on just about *all* aspects of the rationales for IPRs. In addition, the state-of-the-art regarding many of the essential empirical contributions is well summarised and discussed in Mazzoleni and Nelson (1998a,b). There are also numerous other outstanding empirical single contributions adding to the IPR debate that I cannot do justice to in the limited space allocated to this article. Thus, I have decided to discuss mainly the essential theoretical contributions to the IPR controversies, and be selective and brief on empirical contributions to the debate.

With respect to the IPR context, I illustrated in previous work (Andersen *et al*., 2000a; Andersen, 2003) that, although protection of symbolic material and creative expression have increased the scope for copyrights and trademarks in the electronic age, the patent system protecting product and process inventions is still of primary importance, and even increasing in application for most service and manufacturing sectors in the new economy. This article focuses on such IPRs designed to protect knowledge embodied in mainly industrial, product and process innovations. Although such protection mainly takes the form of patents (which is the focus of analysis in this article), trade secrets and design rights are also used on occasion for such purposes. Many copyright rationales regarding protection of ideas embodied in symbolic material and creative expressions, are similar to those for patent protection, so they are somewhat implicitly addressed. However, I do not include any special attention to the specificities of the operation and performance of the copyright system. The rationales for trademarks are of very different nature and impossible to incorporate in the short space of this article. Protection of 'effort' (an important part of copyright law for data base protection) will also not be discussed.

[8] Since all activities have costs and benefits attached to them, an important issue for a functionalist approach to property rights is to attach the costs and benefits to the owners of the property relative to the non-owners, as well as relative to social and economic efficiency (Sell and May, 2001; Demsetz, 1967).

[9] Mazzoleni and Nelson's (1998a,b) catalogue of patent theories is mainly constructed around economic incentive theories including: (i) invention motivation theories, (ii) induce commercialization theories and (iii) induce information disclosure theories. The fourth group of theories presented by Roberto Mazzoleni and Richard Nelson, i.e. (iv) exploration control theory, can also be considered as economic incentive theories as they are related to how patents can provide incentives to allocate resources more efficiently.

## 2 SOCIAL CONTRACT THEORY: NATURAL RIGHTS AND MORAL RATIONALES

John Locke [1632–1704] (1980) argued for a 'natural rights theory of the social contract'. In this context ideas are protected under the principle of natural law, in the sense that somebody's idea is a 'natural right'. It follows that governments do not create property rights but are instituted to serve as their objective guardians. Jean-Baptiste-Ambroise-Marcellin Jobard (who, in the beginning of the nineteenth century, wrote on the natural aspects of rights) was a prolific advocator of perpetual patent protection. He believed that the IPR system provides the answer for protecting human creativity and personality from unfair exploitation. He introduced the term 'monautopoly' (meaning monopoly of oneself). Basically, in accordance with the 'natural rights theory of the social contract' everyone has a permanent and inalienable natural right to the sole disposal of themselves and their work.

This normative aspect of social contract is contested by a 'positive theory of the social contact'. The first advocator for this was Thomas Hobbes [1588–1679] (1968) who contended that there is nothing natural about a right if we need the power of government to enforce them. That is, it is impossible for government to enforce a right without implementing its views on the notions of rights and wrongs, justice and injustice, so to claim that the rights are natural is a contradiction in terms. Thomas Hobbes changed the very essence of the concept of natural rights to the assumption that humans have a natural inclination to preserve themselves. Assuming the rationality of humans, and to avoid a 'war of all against all' Thomas Hobbes argued for the necessity of government. The utilitarian philosopher Jeremy Bentham [1748–1832] also drew a distinction between normative theory and positive theory, and adamantly opposed the theory of natural rights. He introduced ethical principles or morals into property right theory and laid the responsibilities for identifying and enforcing these in the hands of the state. In this context, it is not only the society's s duty to protect the inventor, but also to secure the inventor a fair share of the reward when exploiting the inventor's knowledge and ideas. The idea is that it would be immoral if the law let everybody freely use the work of inventors without their consent and without compensation or equivalent in return. The rationale is basically that justice requires that society compensate and reward its people for their services in proportion to what they cost and how useful they are to society. Those believing in the IPR system here consider that the most appropriate way to secure inventors is by issuing IPRs.[10]

However, the arguments against the view that the IPR system is designed to protect the inventor are manifold.

### 2.1 Rights Versus Privileges

Sened (1997), who is a devoted advocate of positive theory, takes a critical view and contends that we need to pay more attention to how social contracts (through which governments protect the individual rights of their citizens) emerge and evolve. Governments also reflect the interests of social groups. Ideas based on 'natural rights' need to be seen in contrast to the positive origin of property and individual rights, where it could be claimed that society gives one some kind of 'privilege'.

This reflects the alternative view that our IPR regime cannot be approached with a functional problem-solving approach, in the sense that there is nothing rational about it. This puts the aim of this article on the rationales for IPRs into a different light. The critical theorists, Sell and May (2001), present a number of key 'moments' in the history of IPRs that eventually led

[10] The classical writings on the theories of the origin of rights and social contracts are comprehensively reviewed in Sened (1997) and Richard (2002).

to particular IPR agreements (TRIPS being one of them). They maintain that key 'moments' in the history of IPRs are not final improvements to legislation governing IPRs or the culmination of a history of legal rationalisation. Rather, the design of an IPR system at any one time is based on a particular constellation of political power, and when the power relations change, the IPR arguments become contested and open to amendment through political engagement.

Machlup and Penrose (1950) also maintained that the term 'intellectual property right' based on the origin of a natural or moral right (as opposed to intellectual monopoly privilege) was a very deliberate choice on the part of politicians working for the adoption of a patent law in the nineteenth century. This period was for liberty and equality and against privileges and monopolies[11] of any sort.

### 2.2 The Social Origin of Inventions and the Existence of Technological Inter-dependence

A basic contention against IPRs in the context of natural rights and moral rationales is that technological inventions are mostly a social creation of collective, cumulative and interrelated work to which we all contribute, and, therefore, no one person or firm should be able to claim the property. Ownership of technological inventions here might be immoral, and actually against the principle of natural rights, as the IPR system in this case may prevent inventors from using or appropriating from ideas that they have collectively been a part of creating if someone else is granted the IPR. Thus, it is proposed that the IPR system decreases the moral rights for most subscribers to the system.

The social origin of inventions argument (which can also be termed distributed innovation processes) was put forward by Plant (1934). Research on patent scope by Merges and Nelson (1990, discussed in Sec. 4.1.1) revealed how inventions happen along multi-product trajectories that are cumulative, path-dependent and complex, in the sense that each innovation along the trajectory relies on its own or others' current or past ideas. I have used patent statistics to illustrate how technological trajectories increasingly rely on broader knowledge bases, and have also become less concentrated in the sense that a range of different firms now participate in the same technological evolution (Andersen, 2001).

Furthermore, from the 'social origin of inventions'-argument suggesting that the next novelty on the road can be hit on by a range of inventors, it follows that we should not reward those 'lucky' enough to be the first to hit on the technological solution, which is of sufficiently novel character to merit IPR protection. Due to the randomness of the system, it is almost impossible for the rewards to go to those who deserve it. This may, in turn, have a negative impact on the IPR incentive rationale (discussed in Sec. 3.1.1). In addition, it can be argued that the patent system on average causes more losses than profits even to inventors, as inventors have to pay for using the ideas they have contributed to when other people have patented them. This problem of inventors paying to use their own ideas could in principle be solved by rewarding inventors with cash prizes rather than temporary exclusive property rights (Davis, 2004). This reward system would, however, not solve the problem surrounding the social origin of inventions where everyone deserves a fair share for their effort, as it is impossible to calculate the effort-share that has been conducted on an individual basis. Basically, the patent system can here be viewed as inflicting injury upon others as it is impossible to compensate or pay rewards in proportion to effort conducted and the service provided to society.

[11] See further Section 4.2.1 for the discussion on whether patents confer economic monopolies or merely competitive properties.

### 2.3 The Reward May Not Reflect the Value Created by the Inventor

According to the moral rationale of IPRs, justice requires that society compensate and reward its people for their services in proportion to what they cost and how useful they are to society. However, I would assert that it is very unlikely that the economic or money value (reflected in the reward system) of the idea is entirely created by the inventor. Money value tends to be circumstantial and indeed also a product of the external environment (notice analogy with housing markets), and does not reflect the 'true' value created by the inventor. Circumstantial and external elements include economic climate and investment confidence, other inventors making complementary inventions in the 'region' of the invention and strategic interaction in markets for ideas where inventors are locked in to (or out of) technological webs. The belief that society, or the market economy by its own working, ensures that the 'reward system' generates rewards based on the true value of the invention, or solely the value created by the inventor, is doubtful.

### 2.4 The Intellectual Property Right System is 'General' and Compensates and Rewards Equally All Novel Technological Ideas

It can be argued that it is a problem that the IPR system is 'general' and compensates and rewards equally all novel technological ideas, whether they are the result of great effort or a side product of accidental inventive activity. However, history has revealed that most often inventions are generally not accidental, but that to invent the unthinkable and complex, scientists must specialise. In addition, in patent law today, inventions are not patentable if they are 'obvious', meaning discoverable at low cost. Yet, the troublesome question of which ideas are novel enough to be granted patent protection is often faced with great challenges. At one extreme, there is nothing new under the sun. At the other extreme, every different new combination of knowledge, creative expression or technology constitutes a new idea. In specifying the criteria of novelty sufficient for IPR protection, the designers of any IPR system must go through the difficult process of selecting a position somewhere on the spectrum marked by these extremes (Cheung, 1986), and the problem-solving for this seems to become even more ambiguous within digital and micro-electronics where new combinations are produced more easily or with very little effort (Andersen, 2003).

### 2.5 The Schumpeterian Theory of the Innovator's Head-Start Profit

'The Schumpeterian theory of the innovator's head-start profit' can be used against the reward rationale for industrial inventions. The argument is that if an inventor is really ahead of other inventors then the time interval before catching up and imitation have happened (which is difficult as it requires learning) should already secure profits and rent for the inventor; thus there is no need for government to compensate or reward inventions in the first place. However, book-publishing or pre-recorded music, for example, where imitation is easy, would still need to be protected under 'the theory of innovator's head-start profit' principle. The essential issue is the rate by which new ideas spread (i.e. the rate of imitation and catching up): the faster the speed, the more protection is needed to ensure reward, and the slower the speed, the less IPR protection is needed to ensure reward. Large rewards from the innovator's head-start can especially be obtained without IPR protection when the inventor experiences increasing return dynamics and 'lock-in to their particular technological trajectories'. This can happen by random events or due to strategic corporate interaction in markets for ideas (see Andersen, 2003, in Sec. 4.1).

A related consequence is that IPR incentive rationales may not be necessary to induce inventive activities (discussed in Sec. 3.1.1). Scherer *et al.* (1959), Mansfield (1986), Levin

*et al*. (1987) and Cohen *et al*. (2000) indicate that in many industries, and in many large established firms, a head-start on commercialisation of an idea is enough to yield profit from the invention, and that patents in those cases are not needed to induce the development.

## 3 ECONOMIC INCENTIVE RATIONALES: THE SOCIAL BENEFITS FROM PATENTS

That we have seen an increasing incentive to patent is a stylised fact. In an empirical study of patenting records in the US, I have shown empirically that patenting records have steadily increased (with small periodical disturbances) since the 1890s in all broad technological sectors, including chemicals, electrical/electronics, mechanicals, transport and non-industrial (Andersen, 1998; 2001). The only exception is the period surrounding and just after World War II. This illustrates an increasing incentive for firms and individuals as well as the public sector to privatise knowledge-based assets. Furthermore, there is a relationship between research and development (R&D) (i.e. inventive and innovative effort) and patenting is well documented (Scherer and Ross, 1990). However, whether this relationship is based on patents stimulating some incentives to conduct R&D, or whether patents are merely the outcome of organised R&D conducted, or both, has been a matter for enquiry.

Patents seen as an incentive mechanism has been a classical view since the early days of the creation of the patent system. The rationales for the IPR system are here based on 'political expediency'. It is believed that placing IPRs on knowledge-based ideas provides the answer to stimulating a variety of different 'economic incentives' in the strategic behaviour of inventors. Basically, the efficiency of an incentive system is that it drives people to do things they would not otherwise have done, and these incentives will thus result in some benefit to society as a whole. The incentive arguments in the IPR literature are threefold: incentives to invent, be creative and innovate, as well as motivating the direction of such (Sec. 3.1), incentives to use and allocate resources more efficiently (Sec. 3.2) and incentives to disclose ideas in libraries and trade (this will be discussed in Sec. 5.1 in relation to knowledge spillover from IPRs).

### 3.1 Incentives to Invent, Be Creative and Innovate, as well as Motivating the Direction of Such

The basic proposition of utilitarian classical economists[12] (including Jeremy Bentham [1748–1832], Adam Smith [1723–1790], Jean-Baptiste Say [1767–1832], John Stuart Mill [1806–1873] and John Bates Clark [1847–1938] is that as IPRs provide 'the prospect of reward', this in turn encourages creative and technological advance by providing increased incentives to invent, invest in, and further develop new ideas, and that without such incentives the invention inducement would be weakened. North (1981) also points out that sustained inventions and innovations first began after the establishment of IPRs to raise the private rate of return. However, the 'IPR-induced incentives to invent' rationale for the IPR system rests on two assertions:

(i) Not enough inventions will be made without effective incentives: neither invention nor exploitation of inventions will take place unless inventors and capitalists believe they will yield profits, which make it worth their while to make their efforts and risk their money.
(ii) IPRs are the cheapest and most effective way for society to hold out these incentives.

[12] Cited by Plant (1934), Machlup and Penrose (1950), Cheung (1986), as well as Towse and Holzhauer (2002).

Along similar lines, it has been argued that even if the IPR system is not the most essential ingredient to make people invent and innovate, it helps when it comes for motivating the direction of such invention and innovation. That is, only the inventions with most commercial opportunities will be explored for profit purposes, so in that sense it promotes 'useful inventions' (i.e. those that people want). Basically, according to the classical economists, as mentioned above, as IPR privileges offer prizes to creative minds they arouse the mental powers and give them a direction.

However, while there is agreement that industrial progress is desirable and inventions are necessary for industrial progress, there is less support for the above-mentioned two assertions. The arguments are outlined below.

### *3.1.1 Challenging Assumption (i) Above: Not Enough Inventions Will Be Made Without Effective Incentives*

(a) *Inventive activity is inborn from childhood and often accidental*: Many classical economists[13] (including Frank William Taussig [1859–1940] and Arthur Cecil Pigou [1877–1959] maintained that IPRs are superfluous and unnecessary, as inventive activity is inborn from childhood and inventions are often accidental. However, as put forward in Section 2.1.4, much evidence suggests inventions are generally not accidental and scientists must specialise to invent the unthinkable.

(b) *The problem of 'uncertainty', 'indivisibility' and 'appropriability'*: According to Arrow (1962), although property rights on ideas are clearly useful when it comes for creating a market of ideas and stimulating inventive activity, they are nonetheless inferior to direct government investment in inventive activities. His contention is that even under patent law basic research is bound to be under-rewarded. The reasons are: 'uncertainty', 'indivisibility' and 'appropriability'.

Arrow (1962) notes that invention production is inherently uncertain in the sense that the inventor cannot calculate the risk as in many other risk-bearing or -spreading activities, so the risk-averse may decide against using resources on research and invention. Hence, due to risk-averse behaviour, he maintains that the patent system will not create optimal inventive effort, but under-investment.

Appropriability problems are also that the owner of an idea may not be able to exploit the idea as effectively as other, and due to uncertainty this risk is unknown, so the risk-averse entrepreneurs may decide against patenting their inventions in the first place. Furthermore, investing in knowledge production for market exploitation may not be as efficient as other investments. Due to the indivisible nature of ideas, once the idea is shared or sold there is no need for the user of the idea or information to come back for more. That is, the use of an idea or information is infinite and it never faces decreasing returns to scale or is used up, so the nature of sharing or trading ideas on the market is very different from other intermediates or commodities. Use of ideas or information does not depend on the rate of production as with other intermediates, such as oil. Thus, although Arrow in principle agrees with the transaction cost argument that the only way to trade or share intangible ideas and information is by protecting them by a property right, he still argues that such protection is inefficient for market creation as the inventor may lose control of its use. Arrow (1962) also contends that the legal protection is only a partial barrier, because information can flow despite patent protection (e.g. mobility of personnel among firms is suggested). A related problem mentioned by Arrow is the disclosure problem, where the demand for information cannot be optimally defined, as the value for the purchaser is not known until it has been partly revealed. However, when revealed

[13] Cited by Plant (1934), Machlup and Penrose (1950), Cheung (1986) and Towse and Holzhauer (2002).

in a patent document, a patent does not prevent anyone from thinking about the patented idea, and through pure inspiration producing a different competitive product not embodying or rewarding the original idea.

According to Arrow (1962), these phenomena have negative implications for the 'incentive rationale' for patents. This shall be seen to be in sharp contrast to the 'social origin of inventions'-argument where the patent system is inefficient because it over-rewards the patentee resulting in a variety of individual and social costs (see Sec. 3.1.2). That is, in a completely different type of appropriability argument put forward by Plant (1934), although inventions are socially created from a bundle of cumulative past and current ideas (see Sec. 2.1.2), the patent is granted on the grounds of the full invention. That is, marginal patents do not exist, but the person who hits the right note at the right time gets the full monopoly reward on the particular invention, and the rest participating in the social activity of inventing are left out. It could also be speculated that this lottery version of the patent system might lead to under-investment in inventive activity for the risk-averse. It is interesting to see how Arrow (1962) focuses on how the IPR system under-rewards the one who has been granted the patent right, while Plant (1934) focused on how the IPR system over-rewards the patentee. Hence, the appropriability problems mentioned by Arrow and Plant are for different parties.

In an empirical study of the data from the 1993 EU-conducted Community Innovation Survey, Arundel (2001) showed how the probability of firms rating secrecy as more valuable than patents declines with an increase in firm size for product inventions, while there is no such relationship for process inventions. Regarding the controversies on appropriating the returns from R&D and the role of patents in inventions protection as well as inventive incentives from patents, Scherer *et al*. (1959), Mansfield (1986), Levin *et al*. (1987) and Cohen *et al*. (2000) showed that incentives from patents in the US manufacturing sector depend on the nature of the industry and are positively correlated with firm size (see Sec. 2.1.5).

Finally, appropriability problems for the inventor also include the problems of management and transaction costs in enforcing the system. Such costs are not trivial (see Sec. 3.1.2) and they may reduce or undermine the efficiency of the IPR system as an incentive mechanism.

(c) *Incentive to joint ventures or venture capitalists*: More recently, Cohen *et al*. (2000) showed in an empirical survey that the motives to patent often extend beyond directly profiting from the patented innovation through either its commercialisation or licensing (see Sec. 4.1.1 on corporate strategies). Along similar lines Teece (1986) points out that if a firm can get a strong patent, it may be in a good position to bargain a joint venture or licence deal with another firm that has the production and marketing capabilities. Coriat and Orsi (2002) explain how changing financial regulatory frameworks in the 1980s allowed unprofitable firms to include a whole range of intangible assets in their financial statements (the most important being their IPR assets in general and their patent portfolios in particular) in order be listed on the Nasdaq for venture capital generation. This model, together with a series of other institutional complementaries, was very successful, but also central to the creation of the bubble.

However, Machlup and Penrose (1950) maintained that in situations where the inventors are employed by a manufacturer or capitalist, or are manufactures themselves, they often find themselves in a bargaining situation where they have no option but to sell their patents or copyrights at a price below their value. These bargaining situations often go against the reward system idea (see e.g. Andersen *et al*. 2000b regarding revenue distribution from copyrightable material in the music industry), both in terms of the moral rights issues (discussed in Sec. 2) and in terms of the idea of creating special incentives to invent. Thus, in the words of Machlup and Penrose (1950): If the inventors could not hope to reap the fruits of their work, . . . another theory could be substituted for the weakened theory of the patent as an incentive to invent: a theory of the patent as an incentive to venture capital for the financing of the development and pioneer exploitation of inventions.

Basically, it is less risky to finance the implementation of an idea into products for markets if the idea is covered by an IPR. The Bayh–Dole Act of 1980 in the US encourages public universities to patent their knowledge bases. This Act came about mainly as an incentive mechanism to enhance knowledge spillover, by encouraging venture capitalists to invest in commercialising the (now IP-protected) knowledge bases of public universities (see Sec. 5.1.4 for critical discussion of this spillover rationale).

The function of the patent as a stimulus to the inventor's financier has been given more emphasis.

### *3.1.2 Challenging Assumption (ii) Above: Intellectual Property Rights Are the Cheapest and Most Effective Way for Society to Hold Out Incentives to Invent, Invest in and Further Develop Productive Knowledge*

The innovation incentives argument is based on the idea that the IPR system costs nothing or only imposes trivial costs. In that sense society gets something for almost nothing. However, a range of thinkers claims that heavy social costs are unavoidable. Social costs include several subject matters, as follows:

(a) *The opportunity cost of investment in arbitrary technological trajectories*: Diversion of activity caused by the patent reward system can be into less productive channels. The diversion could be from inventing in one field of research into other less productive pursuits, just because patent protection can more easily be obtained or to a higher extent be enjoyed in that field. Plant (1934) asserted that the patent system provides specific favourable conditions for certain types of inventions and thereby diverges the activities in society into arbitrary solutions. Thus, technological trajectories will become arbitrary. Within corporate strategic management, it has also been argued by Rivette and Kline (2000) that R&D and branding tend to be pursued in those areas in which patents can help to establish a market share. These are not necessarily the 'best' product or process innovations. The strength of the potential patent position is a leading factor in deciding what research to pursue.

(b) *Administration and enforcement costs*: Bureaucracy concerning administering and enforcing the IPR system includes costs of court personnel, lawyers, IPR portfolio managers, others engaged in patent applications and litigations and royalty management, and such costs are not trivial.

(c) *The monopoly or anti-competition costs of 'blocking patents'/setting territories*: The extension of monopoly power over individual firms often goes way beyond the scope of an individual patent. The issue of strategic patent blocking put forward by Rivette and Kline (2000) becomes relevant here. Basically, since the strength of the potential patent position is an important factor in deciding what research to pursue, it is important to consider how patent positions are strategically established. Building a wall of patents around category-leading products can help companies defend against imitators and can secure market share. An example of the importance of patent walls around technological webs is in the strategies of firms. Firms are afraid of specialising too narrowly. Many firms adopt the policy of always being at 'all platforms'.

Patent walls can be used to impose threats of patent infringement suits to block potential rivals. This is increasingly common practice. The money currently paid to IPR lawyers is unprecedented, as IPRs protect the key competitive strategic asset (or intellectual capital) of many firms. However, as pointed out by Rivette and Kline (2000), building a patent wall around the product or process is not the only way to hold back competitors. If your competitor has patented an invention, but has not patented the surrounding application-innovations, a corporate strategy can be to patent these, so your competitor is locked out of further developing the market, or is at least totally dependent on you. This is the essence of bracketing. It need not be explained that such forms of patent blocking reduce competition and hence social welfare.

Owning IPRs let companies develop favourable partnerships and licensing relationships. In addition, as one firm is not powerful enough to set standards alone, and to avoid the existence of mandatory standards, cross-licensing (often based on strategic choice of partners) has often been the solution. Collaboration is also often around open-architecture patent pools (i.e. each participant contributes something to the development trajectory on a royalty-free basis) to which they all file their relevant patents. When it comes to the specificities of the cross-licensing agreements, or sharing the royalties (from external contracts) in patent pools, bargaining power can play a role.

(d) *Opportunity costs in depriving others from using the most efficient solution*: However beneficial the patent may be for the inventor who receives the privilege, the community will not automatically benefit from an idea if it is protected by an IPR, and this in turn deprives society of the benefits that would flow from the more widespread use of these ideas. That is, although development rights are free of royalties (so spillover is in principle free), the subsequent production and trade rights embodying the ideas are not free (Cheung, 1986).

Thus the temporary prevention, or high cost, of the use of the most efficient processes by most other producers can be considered as a welfare loss or social cost.

(e) *Opportunity costs of depriving inventors of what they had before (assuming invention is a social process)*: Assuming that invention is a social or collective process to which many contribute (see Sec. 2.1.2), the opponents of the patent system (basing their views on Plant, 1934) would argue that a patent or copyright deprives others of what they had before (e.g. the opportunity to use the same idea that the patentee now owns).

(f) *The welfare cost of broad patent scope*: Along the lines of the arguments in (d) and (e), Merges and Nelson (1990) note that the higher the scope of the protected idea, the higher the potential costs to society. In similar context, Gilbert and Shapiro (1990) also demonstrate that there is a tradeoff between patent length and breadth when providing rewards to innovators. Winter (1993) focuses on the social costs of non-free exploration of ideas, where society specialises in expensive innovation rather than cheaper imitation, in order to avoid the region occupied by the patent holder. To reduce such costs, Robert Merges and Richard Nelson argued for the idea of an IPR policy of 'compulsory licensing' (see Sec. 4.1.1). Scherer (1959) also proposed forced licensing in antitrust cases as a remedy against monopolisation.

(d) *The cost of patent panic*: As argued in Section 2.1.2, the patent system can be compared to a lottery in the sense that most inventive activity is a social process, yet those who hit the next novelty on the road get the monopoly while the rest are precluded. This might be one of the reasons for patent panic where everyone patents everything they come across, despite the consumption of financial resources this entails, rather than sensible patenting strategies. Another reason for patent panic is also the fear that competitors will establish patent walls or conduct bracketing, so firms try to patent everything to avoid such situations. Some firms interviewed for an EU fifth framework project ['Patents and services'; contract no ERBHPV2-CT-1999-06] expressed concern regarding the huge-resource costs involved with such patent panic, triggered mainly to protect against constant threats of infringement cases or problems regarding being locked-out of the development trajectory.

Moreover, according to Kingston (2001), for complex technologies, patents are now used as much as a bargaining currency to prevent 'lock-out' from use of state-of-the-art components developed by competitors, as they are as stimulus to R&D. He then discusses the need for patent reforms towards compulsory licensing and open source patent pools.

(h) *Royalties as social costs*: A standard static efficiency argument against the IPR system is that, as the manufacturers also has to pay royalties '$R$' to the inventor of the product that they produce, the price of the good exceeds marginal costs ($\mathrm{MC} + R = P$), and this therefore reduces welfare. However, those believing in the IPR system would here contend that

'*R*' necessarily reflects the costs of having a property right system enforcing more efficient allocation of resources (see Sec. 3.2 below). However, the answer from the system disbelievers presented in Section 3.1.2 would naturally be that the social costs should not be treated as 'trivial'.

## 3.2 Incentive to Use and Allocate Resources More Efficiently

When understanding the economics of IPR law Posner (1992) focuses on the static and dynamic effects with respect to resource allocation. Just as with property rights on land, it should follow that with IPRs, ideas are used or owned by the most efficient entrepreneurs, as it makes sense for the less efficient inventors to licence or sell their ideas. This is the static efficiency argument. Posner's (1992) dynamic efficiency argument reads that in a world without IPRs, where anyone is free to use others' ideas, inventive activity would be biased towards inventions that could be held secret, as well as biased towards activities that involve minimum preparatory investment. An implication is that, in the absence of IPR protection, inventors are not encouraged to conduct their inventive activities, as without an IPR they will not be able to recover the costs of R&D (i.e. pricing at marginal production costs in order to compete with imitators means that the inventor or entrepreneur will not recover R&D costs) or expect any special reward. The main dynamic point in this context is that legal protection of property rights creates incentives to use resources more efficiently through investment in planning and development of resources. Innovation-enhanced competition here encourages inventors to come up with the most competitive product or process that either uses resources most efficiently, or holds a desired new attribute, or both. Both the static and dynamic efficiency arguments rest on the assumption that ideas are scarce, just as land resources are.

However, there are many arguments against IPRs as an incentive to use and allocate resources more efficiently.

### *3.2.1 The Deliberate Creation of Statute That Creates Scarcity*

Plant (1934) maintained that property rights on ideas are of a very different nature, whereas the system of property rights on land under property law is useful as it creates more efficient use of scarce resources. Plant suggested that patents are not the consequence of scarce resources as in the case of property rights on land, but they are the deliberate creation of statute that creates scarcity. Along similar lines, David (2001) also argues that the creation of scarcity within information and knowledge spaces is inefficient, as the dynamic nature of information or knowledge spaces (facing increasing returns to scale) is very different from physical land spaces (facing decreasing returns to scale). Basically, information or knowledge spaces are likely to be enriched and rendered more accurate and more fully documented the more researchers are allowed to participate. According to Paul David, it is through wide and complete disclosure and the sceptical efforts to replicate novel research findings that scientific communities build bodies of reliable knowledge.

However, whereas David and Olsen (1992) contend that spillover best occurs through patented ideas (which speeds up knowledge diffusion through licensing, see Sec. 5.1), the later David (2001, presented above) argues that knowledge is best developed though little IPR protection. A question that can be raised here is whether there is a trade-off between the speed of knowledge diffusion through patented ideas, and developing the best science (i.e. the best trajectories) through very little protection or through a different type of open disclosure. Perhaps little protection is needed at an early state of the trajectory to allow for free exploration (as also suggested by Winter, 1993; Nelson, 2004), and clearer codification in patent disclosures is needed at a later stage to allow for diffusion.

### *3.2.2 Implications of Avoiding a Technological Region Occupied by an Intellectual Property Right Holder*

Winter (1993) contends that although it might be true that patents lead to more innovative effort, from a social welfare point of view, the IPR system does not necessarily lead to more efficient allocation of resources. He notes that inefficiencies might occur if patents are granted to inventors at an early stage of a technological trajectory. When a new trajectory is still being explored by a variety of inventors, an early granting of patents might disrupt and deprive the free exploration phase, and we might be diverted in an inefficient direction. It follows that Sidney Winter would not be a great supporter of the US scheme on 'submarine patents' encouraging patent application submissions at a very early stage of the discovery (see Sec. 1, and Mowery and Graham (2004) for a detailed account on the scheme).

Furthermore, a system with strong IPR protection may result in more resources devoted to expensive inventive and innovative R&D effort (in order to avoid a technological region occupied by a patent holder) rather than to cheaper imitative effort. This need for an inventor to avoid a technological region occupied by a patent holder will not only increase the cost of making a new economically comparable invention (as first noted in Sec. 3.1.2 (f)), but it might also result in inefficient technological trajectories.

### *3.2.3 Disincentives Created by the Inventor's Pre-invention Monopoly Profits*

Arthur (1988) argues that in industries where the fixed set-up costs are high in comparison to the cost of reproduction, individuals and organisations have a strong incentive to identify and stick with a single option. This certainly also applies to knowledge and information-based products and services. Once the costs of development have been recouped, every single additional reproduction (or re-application) of intangible ideas is pure profit. Thus, in this fashion, IPRs may encourage investment in arbitrary or sub-optimal technological trajectories and thereby create inefficient use of resources. Along similar lines, Arrow (1962) suggests that the patent system results in under-allocation of resources to invention. He argues that under monopolistic situations the incentive to innovate will be lower than under competitive conditions. Although monopoly situations will increase appropriability possibilities, Arrow maintains that this is offset by the disincentives created by the inventor's pre-invention monopoly profits.

However, even under competitive conditions Arrow (1962) argues that allocation of resources for invention is less than socially desirable due to uncertainty, indivisibility and appropriability problems (see Sec. 3.1). To solve this allocation problem, he proposes government involvement and government expenditures, and he even suggests thinking about alternative methods of compensation and reward systems. However, David and Olsen (1992) discuss how Kenneth Arrow's argument on 'loss from monopolies' rests on the assumption that monopolists are actively using their patented ideas, but that this is only the case for a short or brief period. David and Olsen (1992) then emphasise how licensing is a fact of life in most industries, and how the knowledge spillover gains from such activities are under-rated (see Sec. 5).

## 4 INCREASED COMPETITION AND 'MARKET PROTECTION OF ENTREPRENEURIAL TALENT' RATIONALES: INDUSTRIAL DEVELOPMENT FROM PATENTS

That many patented inventions actually progress to innovation is a stylised fact, although this depends on industry and is negatively correlated to firm size (Sanders, 1964; Napolitano and Sirilli, 1990). As illustrated in the sections below, some believe that property rights on ideas (i.e. making ideas rival) are the most efficient answer to stimulate innovations and industrial

development from patents. Here it is believed that innovation, industrial development and social welfare happen through enhanced competition (Sec. 4.1.) or through market protection of entrepreneurial talent (Sec. 4.2). Thus, the rationales for IPRs can also be regarded here as 'political expediency'.

## 4.1 The Innovation-Enhanced Competition and 'Nature of Ideas' Argument

The fact that knowledge can be consumed jointly, and can be reproduced very cheaply, means that it has some of the qualities of a public good (usually referred to as the 'expansible' or 'non-rival' aspect of a public good). But, unlike a public good, it is possible for the creator of an idea to exclude others from using it in production and trade, by use of an IPR. This rival aspect of ideas embodied in the production and trade of goods and services is believed to stimulate innovation-enhanced competition by providing incentives to innovate in using scarce resources more efficiently (i.e. process invention) or inventing the next new thing (i.e. product invention). Thus, IPRs are here believed to stimulate a competitive dynamic environment as well as to strengthen continuous innovators.

However, there are many contrary arguments in the literature.

### *4.1.1 The Problem of Patent Scope and Corporate Strategic Behaviour*

It is clearly debatable whether society experiences more competition by creating temporary monopolies (or exclusive rights on ideas). The whole argument of corporate strategies surrounding IPRs and strategic patent blocking becomes relevant here. Whereas Arrow (1962) maintained that patent grants lack sufficient blocking power for the inventors who cannot fully appropriate from their ideas (see Sec. 3) so there is too little rivalry, others, such as Plant (1934), contended that patent monopolies provide such extreme privileges and appropriation opportunities to the inventor against other producers and even the consumers (see Sec. 3) that rivalry becomes reckless. Both cases are competition-distorting. Like Plant (1934), Merges and Nelson (1990) suggest that inventive rivalry is good for inventive progress, but that too strong patent protection will distort such progress due to patent blocking slowing down cumulativeness. The basic contention is that most innovations take place in a social context, in the sense that complex and multi-component products are the norm in many industries, and individual patents often cover only a single component or sub-component. Essentially, there is no simple 'one to one' mapping of products and property rights, but each product includes a variety of patents of different types and with different scopes and durations. The breath of the patent scope is very important for understanding the monopoly effects of the patent system. Due to cumulativeness in the innovative processes, a more narrow protection favours secondary inventions, but sacrifices the economic incentives that otherwise would be offered for breakthrough inventions, whereas broad protection has the opposite effect (as knowledge has become scarce and costly for secondary inventions). Merges and Nelson (1990) illustrate how history has shown that strengthening patent protection will not increase invention, due to the increased costs of the patent scope. Maintaining that patents do help to reach certain ends, Merges and Nelson (1990) discuss the idea of compulsory licensing to eliminate some of the problems with too broad patent scope enabling blocking power, and to enhance more inventive rivalry.

Hence, patent blocking from too broad patent scope here is argued to destroy competition. This is also why 'pure ideas' – i.e. laws of nature (physics laws), theoretical principles (e.g. some mathematics), and natural species (an exemption being the controversial right to patent gene-codes in some regions of the world[14]) – are not normally eligible for patent

[14] See Section 1 for references regarding other aspects of the controversial debate.

protection. Patenting such 'pure ideas' would block innovation and competition due to too broad patent scope, and thereby also block progress for industrial development and social welfare.

Blocking actions can also be channelled through patent or copyright assignments (i.e. outright transaction or transfer/sale of rights) or through cross-licensing. Such blocking actions are also often used to produce immunity from litigation because of the high (and increasing) costs of infringement suits. Thus, the value of patents essentially depends on its blocking power. Therefore, as illustrated in Rivette and Kline (2000) in Section 3.1.2, firms lay out their patent portfolios when making long-term investment decisions regarding which products to commercialise and which technological trajectories to participate in. It is essentially about positioning, but signalling is also important in this game. Cohen *et al*. (2000) have also showed in an empirical survey that, in addition to the prevention from imitating or copying, the most prominent motives for patenting include the prevention of rivals from patenting related inventions (i.e. conduct 'patent blocking' actions), as well as the use of patents in negotiations and the prevention of infringement suits. The specific strategies are, however, industry specific. Thus, commercialisation or strategic licensing has become more important for corporate value creation than direct protection from imitation.

Granstrand (1999) also sheds light on the strategic use of IPRs by companies holding large portfolios of such rights. He formulates different IPR-based anti-competition strategies (such as strategic patent searching and patent blocking as well as patent walls or fencing, etc.), by which companies set their territories and appropriate revenues from IPRs well beyond the recovery of their R&D costs.

The historical evidence cited by David (1985) and Arthur (1988, 1996) suggests various circumstances that make a technological idea prone to increasing returns and lock-in and therefore competition-distorting. David and Arthur emphasised how lock-in can occur from random events. However, in a previous study of IPRs in the electronic age, I show how IPRs can enforce such lock-in mechanisms. Basically, as IPRs on a locked-in idea generates profit over time, this encourages corporate strategies to take advantage of such increasing returns dynamics to generate lock-in situations (Andersen, 2003). The basic assumption is that the increasing returns dynamics of IPR-based sectors (especially in the intangible economy where many products are purely knowledge-based) enforced by corporate strategic interaction have implications for the value of IPRs, so it encourages anti-competitive behaviour. In this manner, I show how firms' intellectual capital or inventive ideas are informally protected even without the formal IPR legal framework. The situations are those in which the following dynamics play a role: (i) learning effects and increasing returns to adaptation, (ii) network externalities, (iii) technological webs, (iv) informational increasing returns to adaptation, and (v) knowledge-based intangibles underpinning increasing returns to scale. Hence, in this context IPRs serve mostly as a means by which knowledge embodied in products and processes can be exploited for excessive rent creation. Therefore, one should reconsider how legitimate the market protection rationale of the IPR system is during increasing returns dynamics. This in turn also have implications for, not only a winner takes all dynamics, but also the existence of sub-optimal technological trajectories or arbitrary technological solutions.

### *4.1.2 Production and Trade Rights Versus Development Rights*

When discussing patent blocking, we need to consider what the patent protects and what it does not protect. Development rights (i.e. the right to use the idea to develop another idea) are not directly protected. However, production rights (i.e. the right to use the idea to produce) and trade rights (i.e. the right to trade a commodity embodying the idea) are protected through a patent. Yet it could be suggested that the development rights are indirectly protected by the

production and trade rights, as there is no point in developing an idea if you cannot use it for commercial purposes. According to Cheung (1986), the exclusive rights to produce and trade a product also imply exclusive rights to improve a patented idea: 'In short, the rule for improvement would seem to read: You may tinker with my patent any way you please, but plan to pay me when you produce any commodity over which I have some claim; moreover, to avoid my possible excessive demands, it may be wise for you to obtain a license from me in advance'. Hence, a patent does imply some exclusive rights on development to the extent that the improvement is dominated by the original invention.

## 4.2 The 'Market Protection of Entrepreneurial Talent' for Industrial Development Rationale

It is proposed that efficient IPR protection allows profit-oriented firms to enter (or develop) an industry or market. This rationale of IPRs has also been compared to that of tariff protection. Just as with tariffs, a patent protects against market entry. The idea is that a temporary production and trade privilege will allow a firm or industry to develop and mature. This, in its turn, causes (or opens space for) industrial development and progress.

Kitch (1977) suggested that IPRs allow breathing room for the inventor to invest in development without fear that another firm will steal the idea. Furthermore, the temporary trade privilege in the form of an IPR should, just as with a tariff, help a firm or an industry to cover the fixed costs of inventing and setting up the producing of a new product and thereby enhance the incentive to invent and innovate (see Sec. 3 on incentive rationales).

### *4.2.1 The Tariff Protection Analogy Debate*

Comparing patent protection with tariff protection and comparing exclusive rights (in the form of a patent) with monopoly privileges in general tends to help patent opponents and weaken patent defenders. Against patent protection during the final shaping of the patent system in the nineteenth century was the free trade argument. Those against tariffs were also generally against patents. However, those for tariffs were for patents. It was contended that IPRs were important for entrepreneurial talent to create and develop a market, just as the function of tariffs were for firms and industries.

However, Jeremy Benthan [1748–1832], one of the advocators for patent protection, argued that the exclusive rights given to inventors have nothing in common with general monopolies which are so justly decried. Along similar lines, Adam Smith [1723–1790], a prolific advocator for free trade, suggested that although monopolies in trade deranged the more or less natural distribution of stock in society and were therefore hurtful to society, a temporary monopoly granted to an inventor of a new machine could be justified as a means of rewarding risk and expense and thereby encourage new ventures (cited in Machlup and Penrose, 1950). Basically, we need to acknowledge that, in *principle*, we need to distinguish between a property right and a monopoly (Machlup, 1958; Kitch, 2000; Merges 2000). Whereas (i) an exclusive right on an idea can be associated with an IPR, (ii) a monopoly on an idea is associated with protection from competition. Those two are very different properties.

(i) The *exclusive right to intellectual property* in the patent case reads like something along these lines: Anyone who develops an idea exactly like one developed earlier by someone else will be formally prohibited, by a patent granted to the first inventor, from using it or

selling it or importing it, unless a special contract is in place. This is so even if the work was entirely independent.[15]

(ii) The *protection from competition* monopoly-argument reads like the ability to sell into a market with a vertical or downward sloping demand curve. This is often associated with long run persistent profits for the monopolist and a welfare loss for society. The twist here, as maintained by the IPR system supporters, is of course that the IPR system increases the incentive to invent, so the dynamic efficiency of the system will be more than offset the static welfare loss.

However, although patents do not possess an economic monopoly *in principle*, it is not difficult to imagine how the exclusive right might lead to a monopoly *in practice*. A central question here is whether a monopolistic situation regarding patents is an exceptional case or a general case (Kitch, 2000).

Furthermore, Rivera-Batiz and Romer (1991) point out that patents combined with free trade would reduce costs and enhance efficiency, as economic agents can use more efficient technology developed elsewhere, as well as specialise in areas in which they have the comparative advantage. Section 5 discusses further the view that the incentive to share ideas in trade is stimulated through patent legislation. However, I do not think that it would be wrong to assert that global free trade in 'science and technological'-based ideas does not make sense to a country who has no such ideas whatsoever, or who is at a development stage and tries to break out of the traditional raw supplier role in order to step on the next development stage and specialise in manufacturing. For such countries licensing fees can act as a cost and barrier to enter global markets. That is, developed or industrialised countries benefit from the IPR system, in the sense that (always being first) they have been able to use it as a way of financing development, whereas the less-developed countries (being the followers) mainly experience it as a development cost and barrier to enter global markets. In addition, the free trade supporters did not take into account how the efficiency of the market for ideas also depends on the efficiency of the local IPR offices, whose role is also to educate the users of the system and enforce the system (see Christensen, 2004; in Sec. 5.1.4 as regards the role of the patent system in knowledge spillover). With respect to cultural industries and creative expressions (which all countries have), I (Andersen *et al*., 2000b) co-studied the global music industry where we found how the efficiency of the local copyright system, local collecting societies and other local support institutions play an immensely important role for the grain from trade. Finally, the existence of corporate strategic interaction in the marketplace for ideas also distorts the free trade ideology in practice. These are some of the critical issues that can be raised in relation to the TRIPS of the WTO.

An aim should be to understand the dynamic effects of the exploitation of the general profile of corporate power endorsed by IPRs, and the accountability of that power. An aim should also be to understand the dynamic effects of the exploitation of IPRs on less-developed regions that have expressed problems with the global IPR system in its current form.

## 5 ECONOMIC RATIONALE OF ORGANISING SCIENCE, TECHNOLOGY AND CREATIVITY: INCREASED INFORMATION SPILLOVER

In order to secure a stream of inventions and innovations it is important that new ideas become generally known to society. The argument is that, in the absence of protection for novel ideas,

[15] However, independent discoveries are in principle allowed in copyright law. This is based on the assumption that it is impossible to develop new arts and crafts in the exact same form, as it is an expression of the creator's personality. However, within natural science, the same discovery is possible, since inventions in natural science are developed using laws and principles of nature rather than the personalities of the scientists.

inventors will keep their inventions secret and they will die with them. Hence, it is in the interests of society to induce inventors to disclose their secrets for the use of future generations of inventors, and some believe that IPRs provide the answer here (see Sec. 5.1). The economic rationale of organising science, technology and creativity also includes the institutional aspects of the IPR system as an underpinning technology-support system reducing transaction costs with respect to information spillover in technological development and trade (see Sec. 5.2).

Hence, the rationale is that IPRs should help to facilitate the sharing of ideas, creative efforts and new technologies nationally and worldwide. It is believed that this creates faster knowledge spillover and a more coherent technological and industrial development, which in turn will strengthen the national or global economy. Thus, the IPR rationale for increased information spillover can be regarded as a 'political expediency' rationale.

However, even if it is debatable whether IPRs create more spillover (see Sec. 5.1 for discussion), patent statistics often have been the means by which spillover or technology diffusion or transfer have been measured. Data has been patent citations (see Jaffe *et al*., 1993; Almeida, 1996; Jaffe and Trajtenberg, 2002), licensing agreements, and the outward transfer of patent ownership.

### 5.1 'Incentives to Disclose Ideas' Rationale

Granting exclusive rights to inventors for their innovations in terms of efficient IPR protection can be regarded as a contract the inventor gets from government if the inventor agrees to disclose the idea in question (see (a) below). As an idea or information good is non-rival by nature, exclusive rights on such will also help the inventor to directly exploit, or appropriate from, the idea as a value-driven intellectual capital, which in its turn will provide an incentive to share the idea in trade (see (b) below).

(a) *Negotiated incentive to disclose ideas in libraries*: Patents and copyrights, when filed, provide immediate information to rivals who can incorporate such into their own knowledge bases even though they cannot make direct commercial use of it. The rationale here is that IPRs are necessary as incentives to induce inventors to disclose their new inventions instead of keeping them secret. That is, perhaps there would be enough incentive to invent without patents, but the invention would not be disclosed due to the inventor not wishing to lose control of the idea. Hence, by issuing patents protecting the inventions, inventors agree to disclose their inventions that, thus, become part of society's knowledge base. To avoid interpretation of patents as 'privileges' this assertion has been developed as part of 'social contact theory'. In this statute a patent is not regarded as a privilege granted by society, but as a bargain between society and the inventor.

(b) *Incentive to disclose ideas in trade*: Secondly, a rationale is that IPRs provide direct incentives for sharing ideas through trade in the sense that knowledge, by definition, faces increasing returns to scale. It can be claimed that, although knowledge is not a new feature of capitalist production, it takes on a greater weight in the globalising economy when protected by an IPR. Assessing this trend is complemented by the public good nature of knowledge or ideas themselves. But, unlike a public good, it is possible for the creator of an idea to exclude others from using it by use of IPRs, opening the possibility for wider commercial exploitation (Rivera-Batiz and Romer, 1991). In this context, IPRs are in principle able to create a market for knowledge, and as ideas face increasing return to scale by nature, this give rise to increasing rent or profit as markets expands.

The information spillover effects from patents is taken seriously in the formal-modelling neoclassical economic literature. Rivera-Batiz and Romer (1991) build upon Arrow's (1962) notion of perfect knowledge spillover once ideas are disclosed in a patent document (it was

argued that owners of ideas have thereby lost control of appropriation from such ideas; see Sec. 3.1.1). It can be said that Rivera-Batiz and Romer thereby consider the communication rationale of the patent system. Basically, Rivera-Batiz and Romer (1991) incorporate perfect knowledge spillover and knowledge accumulation from patents directly into an endogenous growth model: 'Holders of patents on previous designs have no technological or legal means of preventing designers of new goods from using the ideas implicit in the existing designs. The stock of A [knowledge or ideas] that can be put to use, with no compensation, by any individual researcher is therefore the entire stock of knowledge about the previous designs, provided that there exists a communication network that makes this information available'.

However, although an IPR does not involve any R&D rights, Rivera-Batiz and Romer (1991) did not envisage a problem that the production and trade rights also have knock-on effects on the R&D right. Basically, there is no point in developing if you cannot exploit your idea, so the spillover may not be so perfect after all (see Cheung, 1986, in Sec. 4.1.2, for a discussion of this).

David and Olsen (1992) emphasise how patent grants may improve economic welfare when there are learning externalities or spillover. The basic contention is that patents improve economic efficiency by speeding up learning by doing and quickening the diffusion of existing innovation. David and Olsen criticise the fact that the national patent systems require patent holders to pay a significant amount of annual fees, even after they stop directly using their patented idea but keep the IPR for licensing purposes. This reflects the view that patent monopolies are simply imposing a deadweight welfare burden upon the economy.

However, many do not believe in the 'incentives to disclose ideas' rationale of patents.

### *5.1.1 The Complexity of Bargain Agreements in Social Contracts*

As discussed by Machlup and Penrose (1950), there are many (conflicting) objections to such bargain agreements in social contracts that challenge the information disclosure and spillover rationales from IPRs:

- If inventors chose to keep inventions secret, society will not lose much because usually similar ideas are developed elsewhere (due to the social or collective nature of inventions; see Sec. 2.1.2).
- It is practically impossible to keep ideas secret so the idea will be revealed even without an IPR. Eager competitors will find a way to find out (e.g. reverse engineering, espionage). This argument resembles the appropriability problem in Sec. 3.1.1.
- Where inventors think that they will succeed in guarding a secret, they will not take out a patent. Patents are only taken out where the secret is difficult to keep or where others develop similar ideas. There is, therefore, a net loss in the system since rational inventors would only use the patent system to restrict access to markets, and would not cause disclosure of unique inventions.
- Since patents are only granted at a certain stage of an invention, the patent system encourages secrecy in the development stage. Without patents, inventors would quickly publish their ideas under development to secure recognition and fame. Thus, patent systems encourage secrecy and when patent disclosure finally comes about, it is at a huge social cost in terms of 'lost past disclosure at the development stage'. It might even be argued that if ideas were published before they had developed into patentable inventions, ideas would ripen more quickly and would become available for practical application elsewhere much sooner.

### *5.1.2 Invention Diffusion and High Barriers to Imitate*

According to Winter (1993), as resources for advancing or using knowledge are scarce and expensive in a patent system, more R&D is spent on innovative effort. However, in the absence of a patent system, R&D spent on innovative effort is very expensive compared to the less-expensive imitative effort. Furthermore, he argues that this rival-based patent system, where each firms develops its own competitive trajectory, may result in too many sub-optimal solutions and arbitrary technological trajectories. Thus, Winter states that best practice productivity levels in most firms would be higher in a system without patents. He concludes that 3-year patents are sufficient to allow a small role for imitation, but that a longer period would reduce imitation entirely and raise non-optimal R&D effort. The length of a patent is 20 years in most countries today. Despite Winter's contribution, it is evident that we know more about how the patent system affects invention and innovation from a supply side perspective (see Secs. 3 and 4) than the role it plays in the adoption of ideas and spillover from a knowledge-demand side perspective.

### *5.1.3 The Role of Public Institutions in Knowledge Spillover to, or Within, the Private Sector*

The IPR system is also said to enhance knowledge spillover to the wider private community through several public institutions. Firstly, there is the most obvious (but under-researched) role of the patent office. Christensen (2004) maintains that the success of the patent system is still locally rooted despite globalisation in IPR legislation. In a current debate on the issue, his basic contention (based on a survey on what firms used the local Danish patent office for) is that the national patent and trademark office enhance knowledge spillover from the patenting process, and should, therefore, not be abolished in the era of institutional internationalisation. Well-organised local IPR offices provide an important role in educating and supporting the local users of the international IPR system, as well as developing a vibrant local IPR-community by bringing users of the system and IPR service firms together.

The Bayh–Dole Act of 1980 in US is another institution that encourages spillover. This Act is mainly an incentive to encourage universities to patent their ideas, which in turn should have a knock-on effect on venture capitalists who would then invest in commercialising the protected knowledge bases of public universities. The Bayh–Dole Act (summarised by Mowery *et al*., 1999; Mazzoleni and Nelson, 1998a,b) rests on the assumption that inventions serve no economic purpose unless and until they are developed into commercial use, and that a company would be unlikely to engage in the development of a university invention unless it controls the property rights (i.e. unless universities are in a position in which they can sell or licence their invention, or, if government holds them, they have a commitment to non-exclusive licensing agreements). Although there is evidence that the Bayh–Dole Act has led universities to advertise and push their inventions more actively, Mazzoleni and Nelson (1998a,b) argue that we know very little about whether this has facilitated more technological transfer. The discussions presented in this article can explain some of the controversial elements of the Bayh–Dole Act. For example, even if the Bayh–Dole Act helps certain ends (i.e. helping universities and individuals to develop a clear strategy regarding how best to commercialise their ideas), it is still an Act about taking very basic knowledge out of the public domain. Very basic inventions tend to have broader patent scope, which can induce welfare loss (see Merges and Nelson, 1990; in Secs. 3.1.2 (f) and 4.1.1), or welfare loss from firms avoiding technological trajectories where basic knowledge has been made scarce and expensive (see Winter, 1993, in Secs. 3.1.2 (f), 3.2.2 and 5.1.3). Nelson (2004) advocates very strongly that basic scientific findings should be kept in the public domain. In a range of empirical examples, he illustrates that

inventions produced by universities generally are so basic that firms have plenty of opportunities to commercialise the ideas and patent follow-up inventions. It is the openness of basic inventions for multiple exploration paths in the market economy that makes the evolutionary process of technological advance more powerful. It follows that the necessity of the ownership of a basic invention as the incentive to create follow-up inventions for commercialisation is overrated. Furthermore, the objectives of firms' and universities' knowledge bases, as well as their role in society, are very different. The market positioning of firms and universities are also very different, and this may affect the bargaining situation.

In a somewhat different light and different context, it is also (controversially[16]) suggested that public money spent on military research need not be a dead-weight burden to society if patented. Patents in the military can enhance spillover to the civil and commercial knowledge base (Molas-Gallart *et al*., 2000). It should, however, be noted that military inventions are often protected by trade secrecy, and that (when patented) patents containing national security-sensitive information (as is often the case with the military) are protected by special secrecy acts (e.g. the Invention Secrecy Act of 1951 in the US case) that restrict disclosure of the invention and withhold the grant of a patent. This requirement can be even imposed when the application is generated and entirely owned by a private individual or company.

### 5.2 Rationale of Uniformity, Order, Increased Information, Increased Spillover and Better Advice

A central 'political expediency' rationale of organising science and technology at the macro level is that an IPR system not only provides economic incentives, but also offers information on new trajectories, structural changes in technological development, and the technological capabilities of firms, industries, sectors and nations. That is, patents granted in specific fields of activity often follow identifiable trajectories or paradigms associated with the use of particular patent classes. An understanding of the trajectories being followed at a particular time may yield qualitative predictions about the nature of the improvements that are likely to be forthcoming in the near future. The information provided through the IPR system allows governments to be more effectively advised on science and technology policy matters. For example, so far, patent statistics have shown promise and some success in analysing: international patterns of innovative activities in relation to trade and production; patterns of innovative activities amongst firms, and their effects on competence as well as performance and industrial structure; rates and directions of innovative activities in different technical fields and industrial sectors and links between science and technology. For the European contribution, see e.g. the numerous works of Keith Pavitt and Parimal Patel and colleagues at the Science and Technology Policy Research Unit, John Cantwell and colleagues at the University of Reading, as well as Bart Verspagen, Luc Soete and colleagues at Maastricht Economic Research Institute on Innovation and Technology, as well as a previous research project by me (summarised in Andersen, 2001). In a recent contribution from US, Jaffe and Trajtenberg (2002) emphasise the direct information and communication rationales from patent grants and associated citations. Also, a national and international IPR system brings in national and international uniformity in the way the knowledge base is organised into scientific classes, increasing the scope of analysis and comparison.

The transparency of systems of organised knowledge also seeks to promote cross-country trade in IPRs, and hence international integration of science, technology and creative efforts, stimulating prosperity world-wide. Basically, the transaction cost rationale for the IPR system is manifold: (i) A standardised system simplifies contracts in buying and selling knowledge.

[16] See Alic *et al*. (1992) regarding a critical reappraisal of traditional military/industry relationships.

(ii) It also reduces information asymmetry and increases trust since the full idea is disclosed in a patent document. (iii) The transparency of knowledge helps to prevent the duplication of creative effort and encourages coordination and broadening of activities, allowing inventive resources to be used more efficiently. Patents are, therefore, granted early (before invention has been carried to the point of commercial feasibility) in order to head-off costly duplication of expensive development work. (The very early granting of patents is, however, controversial; see Winter, 1993, in Sec. 3.2.2 and Nelson, 2004, in Sec. 5.1.4.) (iv) Through open disclosure (i.e. reduced information asymmetry), IPRs also provide an informal or formal way of collaborating around technological trajectories.

No one really objects to the usefulness of the information spillover rationale for promoting information on science and technology matters, as well as for promoting trade in ideas and standard-setting.

## 6 CONCLUSION

The complexity surrounding IPR systems is manifold, and we cannot take the effect or efficiency of any IPR regime for granted. The IPR regime should, therefore, be used cautiously. In this article, I have illustrated that IPR systems are not neutral; they set the rules of the game in which individuals and organisations interact, and in which corporate leaders and stakeholders are shaped and technological trajectories selected or reinforced. As the nature of IPR systems is not neutral, I agree with the view of 'positive theory of the social contract' (in Sec. 2), that it is impossible for a government to enforce a right without implementing its views on the notions of rights and wrongs, justice and injustice. I would suggest that the existence and design of IPR law have implications on wealth distribution in society. I, therefore, maintain that the rationales and social and economic effects of the IPR system are vital and must be addressed at the political level. For policy design it is important to state the aims and objectives with respect to what we wish to achieve from IPR systems.

Based on the views of those who believe in the IPR system (as reviewed in Secs. 2–5), a typology on the complexity of IPR rationales has evolved in this article. This is presented in Figure 1.

The typology can help policy makers, analysts and academics when designing and analysing the IPR system. That is, the gain from stronger IPR protection is far from axiomatic. As shown in this article, there are many controversies in the theoretical literature regarding the aim, operation and effects of the IPR system. By illuminating the conflicts, contradictions and tradeoffs in the IPR system in this article, the proposed typology, mapping out the rationales for IPRs, will help policy makers, analysts and academics not just to 'assume' the IPR system, but to use the typology to address critically why we have it, how it works and what effects from the system we will aspire to.

With respect to why we have the IPR system, there may be tradeoffs between the moral or ethical aspects of the IPR system with respect to protecting the inventor, and the economic performance effects of the IPR system for certain sectors or society as a whole. With respect to the operation of the IPR system and its effects, it is evident that there are many different views in the theoretical literature. In summary, many of the social contract and political expediency rationales (based on mainly *theoretical logic*) are problematic as they assume that all inventors (individuals or firms) are autonomous rational profit-maximising agents, and that the aggregate of their behaviour maximises their own as well as social welfare. The arguments do not take into account the effects of technological inter-dependence, strategic interaction and collaboration in competitive markets, the specific nature of productive knowledge, power-relationships in bargaining situations or the opportunity costs of using the IPR system as a political instrument.

| | | |
|---|---|---|
| Social contract theory | Natural rights and moral rationales | ➢ The natural and moral right to claim the intellectual property.<br>➢ The moral right to compensation and reward. |
| Political expediency, as a means to affect economic behaviour, as a mechanism to obtain welfare goals | Increased competition and 'market protection of entrepreneurial talent' rationales: industrial development from patents | ➢ The innovation enhanced competition and 'nature of ideas' argument.<br>➢ The 'market protection of entrepreneurial talent' for industrial development rationale. |
| | Economic incentive rationales: the social benefits from patents | ➢ Incentive to invent, be creative and innovate, as well as motivating the direction of such.<br>➢ Incentive to use and allocate resources more efficiently.<br>➢ Incentive to disclose ideas |
| | Economic rationale of organising science, technology and creativity: increased information spillover | ➢ Rationale of uniformity, order, increased information, increased spillover and better advice. |

FIGURE 1 Typology on the rationales for IPRs.

However, understanding the social and economic effects of the legal exclusive rights created by IPR regimes is a challenging task, especially if we wish to include realistic assumptions of the governance of IPRs at the corporate and sectoral level. This includes considering different structures of ownership, taking into account portfolios of rights (not single rights) in innovation systems, as well as taking into account licensing possibilities, and considering modes of interaction. In this context it is a problem that the current law and economics agenda on IPR equates competition with perfect competition and monopoly with pure monopoly. The architecture of the intellectual property system is a hybrid structure of the both.

It is difficult to advance the understanding of the specific operation of the IPR system without more empirical research. We know little about the *empirical* social and economic effects. We need to establish more empirical research to explore further and more genuinely the social and economic effects of such systems. The typology developed in this article (see Fig. 1) can assist in guiding empirical research when addressing the issue of whether IPR systems operate in accordance with their rationales, which should be set out in our political aims and objectives. The results may differ across technological sectors, industries, perhaps even across regions and over time.

Basically, we should not decide on IPR policy before knowing if, and under what conditions, IPR really is the appropriate policy instrument to achieve our goals in the first place. However, here I do not suggest that the performance of an IPR system can, or should, only be evaluated on the grounds of whether its existence is beneficial or creates social costs. For reasons of policy, we need more insight regarding the most *appropriate design* (or legal structure) of the IPR system. 'What type' and 'how many' exclusive rights should the system confer? Design includes issues like: (i) length of protection obtained; (ii) type of knowledge protected (e.g.

should basic procedures to obtain DNA codes, some mathematics, non-technical business methods, be protected?); (iii) scope of knowledge protected (allowing or encouraging IPR protection of basic ideas in university laboratories or not); (iv) licensing law (opportunity to block or compulsory licensing); (v) costs and procedures of obtaining and holding a right and; (vi) type and costs of the remedies available for infringement.

Thus, it is suggested that the proposed typology will provide a good conceptual underpinning and analytical framework for critically addressing the rationales, operation and performance of IPR regimes in order to achieve a finer empirical understanding of the social and economic effects of IPRs, an understanding which is urgently needed when designing policy fostering the knowledge-driven techno-economic paradigm in the twenty-first century.

### *Acknowledgements*

Many suggestions and profound comments have helped me to develop and further advance this article. In this respect I would especially like to thank Richard Nelson, Theo Papaioannou, F. M Scherer, as well as the issue editor, Lee Davis, and the three anonymous referees of this journal. Also thanks to Giampaolo Garzarelli, Bronwyn Hall, Fiona Macmillan, Jonathan Michie and Klaus Nielsen for their valuable comments. Furthermore, I would like to acknowledge the British Academy for providing me with funding for a research project on the *Rationales for Intellectual Property Rights*, of which this particular study forms a part. In this connection I am indebted to Maria da Graca Derengowski Fonseca for support and thought-provoking discussions while I am at visiting fellow at the Institute of Economics at Universidade Federal do Rio de Janeiro.

### *References*

*Academic Medicine* (2002) *Special Issue Regarding Human Genome Patents*, **77**(12).

Alic, J., Branscomb, L., Brooks, H., Epstein, G. and Carter, A. (1992) *Beyond Spinoff: Military and Commercial Technologies in a Changing World*. Cambridge, MA: Harvard Business School Press.

Almeida, P. (1996) Knowledge Sourcing by Foreign Multinationals: Patent Citation Analysis in the US Semiconductor Industry. *Strategic Management Journal*, **17**, 155–165; Also published in Cantwell, J. (ed.) *Foreign Direct Investment and Technological Change*, Vol. 2. which forms part of *The Globalization of the World Economy Series*. Cheltenham: Edward Elgar.

Andersen, B. (1998) The Evolution of Technological Trajectories 1890–1990. *Structural Change and Economic Dynamics*, **9**(1), 5–35.

Andersen, B. (2001) *Technological Change and the Evolution of Corporate Innovation: The Structure of Patenting 1890–1990*. Cheltenham: Edward Elgar.

Andersen, B. (2003) The Rationales for Intellectual Property Rights in the Electronic Age. In Jones, D. (ed.) *The New Economy Handbook*. San Diego, CA: Elsevier Academic Press, pp. 987–1024.

Andersen, B., Howells, J., Hill, R., Miles, I. and Roberts, J. (eds) (2000a) *Knowledge and Innovation in the New Service Economy*. Cheltenham: Edward Elgar.

Andersen, B., Kozul-Wright, Z. and Kozul-Wright, R. (2000b) Copyrights and Competition: The Case of the Music Industry. (UN) (UNCTAD) Discussion Paper, 43.

Arrow, K. (1962) Economic Welfare and the Allocation of Resources for Inventions. *The Rate and Direction of Inventive Activity: Economic and Social Factors*. Princeton, NJ: National Bureau of Economic Research, pp. 609–625.

Arthur, B. (1988) Competing Technologies: An Overview. In Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L. (eds) *Technical Change and Economic Theory*. London: Pinter Publishers, pp. 590–607.

Arthur, B. (1996) Increasing Returns and the New World of Business. *Harvard Business Review*, **July-August**.

Arundel, A. (2001) The Relative Effectiveness of Patents and Secrecy for Appropriation. *Research Policy*, **10**, 611–624

Bessen, S. and Raskind, L. (1991) An Introduction to the Law and Economics of Intellectual Property. *Journal of Economic Perspectives*, **5**(1), 3–27.

*Bulletin of Medical Ethics* (1996/1997) *Special Issue Regarding Ethics and Patenting of Human Genes*, 124.

Cheung, S, (1986) Property Rights and Invention. In Palmer, J. (ed.) *Research in Law and Economics: The Economics of Patents and Copyrights*, **8**, 5–18.

Christensen, J.L. (2004) Inter and Intra-Organizational Learning Processes in the Interaction between Firms and Patent Offices. In Christensen, J.L. and Lundvall, B.-A. (eds) *Product Innovation, Interactive Learning and Economic Performance*. Cheltenham: Edward Elgar.

Cohen, W. Nelson, R. and Walsh, J. (2000) Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not). NBER Working Paper, No. w7552

Coriat, B. and Orsi, F. (2002) Establishing a New Intellectual Property Rights Regime in the United States. Origins, Content and Problems. *Research Policy*, **31**, 1491–1507.

David, P. (1985) CLIO and the Economics of QWERTY. *American Economic Review*, **75**(2), 332–337.

David, P. (2001) Will Building 'Good Fences' Really Make 'Good Neighbours' in Science. Report to European Commission (DG-Research) STRATA-ETAN workshop on IPR aspects of internal collaborations.

David, P. and Olsen, T. (1992) Technology Adoption, Learning Spillovers, and the Optimal Duration of Patent-Based Monopolies. *International Journal of Industrial Organization*, **10**, 517–543, North-Holland.

Davis, L. (2004) The Changing Role of Intellectual Property Rights. *Economics of Innovation and New Technology*, **13**(6&7).

Demsetz, H. (1967) Towards a Theory of Property Rights. *American Economic Review*, **57**(2), 347–359.

EU (2002) EU's hearing on 'Industrial Property' and 'The Economic Impact of Patentability of Computer Programs' (2002), see http://europa.eu.int/comm/internal_market/en/indprop/studyintro.htm

Gilbert, R. and Shapiro, C. (1990) Optimal Patent Length and Breath. *RAND Journal of Economics*, **21**, 106–112.

Granstrand, O. (1999) *Economics and Management of Intellectual Property*. Cheltenham: Edward Elgar.

Hobbes, T. (*1968 - new edition*) *Leviathan.* New York: Penguin Classics.

Jaffe, A. and Trajtenberg, M. (2002) *Patents, Citations and Innovations: A Window on the Knowledge Economy*, Cambridge, MA: MIT Press.

Jaffe, A.B., Trajtenberg, M. and Henderson, R. (1993) Geographical Localisation of Knowledge Spillovers, as Evidenced by Patent Citations. *Quarterly Journal of Economics*, **58**(3), 577–598.

Kaufer, E. (1989) *The Economics of The Patent System*. Chur: Harwood Academic.

Kingston, W. (2001) Innovation Needs Patents Reform. *Research Policy*, **30**, 403–423.

Kitch, E. (1977) The Nature and Function of the Patent System. *Journal of Law and Economics*, **20**(1), 265–290.

Kitch, E. (2000) Elementary and Persistent Errors in the Economic Analysis of Intellectual Property. *Vanderbilt Law Review*, **53**(6), 1728–1741.

Levin, R., Klevorick, A., Nelson, R. and Winter, S. (1987) Appropriating the Returns from Industrial Research and Development. *Brookings Papers on Economic Activity*, 3.

Locke, J. (*1980 - new edition*) *Second Treatis on Government.* Indianapolis, IN: Hackett.

Machlup, F. (1958) *An Economic Review of the Patent System: Study of the Subcommittee on Patents, Trademarks and Copyrights of the Committee on the Judiciary*, US Senate, 85th Congress, 2nd Session, Study Number 15, Washington: United States Government Printing Office, pp. 1–86.

Machlup, F. and Penrose, E. (1950) The Patent Controversy in the Nineteenth Century. *Journal of Economic History*, **10**(1), 1–29.

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

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

Mazzoleni, R. and Nelson, R. (1998b) Economic Theories about the Benefits and Costs of Patents. *Journal of Economic Issues*, **32**(4).

Merges, R. (2000) Intellectual Property Rights and the New Institutional Economics. *Vanderbilt Law Review*, **53**(6), 1857–1877.

Mergers, R. and Nelson, R. (1990) On the Complex Economics of Patent Scope. *Columbia Law Review*, **90**(1), 839–961.

Molas-Gallart, J., James, A. and Rigby, R. (2000) National Case Study of Civil-Military Interface: The UK's Defence Evaluation and Research Agency - In Search of a Successful Model of Technology Transfer. *Section of a Report to the Royal Swedish Academy of Engineering Sciences*, September.

Mowery, D. and Graham, S. (2004) Submaries in Software? Continuations in US Software Patenting in the 1980s and 1990s. *Economics of Innovation and New Technology*, **13**(5).

Mowery, D., Nelson, R., Sampat, B. and Ziedonies, A. (1999) The Effects of the Bayh–Dole Act on US University Research and Technology Transfer. In Branscomb, L., Kodama, F., Florida, R. (eds) *Industrializing Knowledge, University-industry linkages in Japan and the United States*. Cambridge, MA: MIT Press.

Napolitano, G. and Sirilli, G. (1990) The Patent System and the Exploitation of Inventions: Results of a Statistical Survey Conducted in Italy. *Technovation*, **10**(1), 5–16.

Nelson, R. (2004) The Market Economy, and the Scientific Commons. *Research Policy Forthcoming*.

North, D. (1981) *Structure and Change in Economic History*, New York: W.W. Norton & Company.

OECD: *Measuring and Reporting Intellectual Capital*. Amsterdam, 9–11 June 1999, http://www.oecd.org/EN/document/0,EN-document-628-1-no-20-16345-628,00.html

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

Posner, R. (1992) 'The Economic Theory of Property Tights: Static and Dynamic Aspects', Extracts from Property in R. *Posner, Economic Analysis of Law*, 4th ed. Toronto: Little, Brown and Company, pp. 32–39.

Richard, D. (2002) The Ideology of Intellectual Property Rights in the International Economy. *Review of Social Economy*, **18**(4), 521–541.

Rivera-Batiz, L. and Romer, P. (1991) Economic Integration and Endogenous Growth. *The Quarterly Journal of Economics*, May.

Rivette, K. and Kline, D. (2000) *Rembrandts in the Attic: Unlocking the Hidden Value of Patents*. MA: Harvard Business School University Press.

Sanders, B. (1964) Patterns of Commercial Exploration of Patented Inventions by Large and Small Corporations into Commercial Use. *Patent, Trademark, and Copyright Journal*, (8), 51–92.
Scherer, F.M. and Ross. D. (1990) *Industrial Market Structure and Economic Performance*. 3rd ed. Boston, MA: Houghton Mifflin.
Scherer, F.M. *et al*. (1959) *Patents and The Corporation*. 2nd ed. Boston, MA.
Sell, S. and May, C. (2001) *Moments in Law: Contestation and Settlement in the History of Intellectual Property*, **8**(3), 467–500.
Sened, I. (1997) *The Political Institution of Private Property*. Cambridge: Cambridge University Press.
Teece, D. (1986) Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. *Research Policy*, **15**, 285–305.
Towse, R. and Holzhauer, R. (eds) (2002) *The International Library of Critical Writings in Economics. The economics of Intellectual Property*, Vol I, II, III and IV. Cheltenham: Edward Elgar.
Winter, S. (1993) Patents and Welfare in an Evolutionary Model. *Industrial and Corporate Change*, **2**, 211–231.