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How do patent laws influence innovation?

INTRODUCTION

For the past six centuries, granting economic agents the legal rights to protect their intellectual property (IP) has played a pivotal part in driving innovation and ultimately economic growth. One of the most commonly used forms of IPs is a patent; a word originating from the Latin word 'patere,' which, ironically enough, means "to lay open." It is an exclusive license authorised by a government to an inventor, excluding others from using, selling and importing their invention for a limited period of time, typically lasting up to twenty years. It's no secret that new inventions and technology, in their non-rival nature, are typically easily to replicate as firms find it less costly and time-consuming to imitate rather than innovate themselves. (Encaoua, 2006, p. 4; Nordhaus, 1969) Intellectual property rights such as patent laws were therefore introduced as a means of correcting this market failure within competitive markets, by protecting such inventions for a fixed amount of time.

Ever since its conception in the fifteenth century, the patent system has undoubtedly evolved in its complexity and variety as well as in its economic implications. Its existence reportedly dates back to as far as 1474 with the Venetian Patent Statute being the first recorded statutory patent system, established by the Republic of

Venice; its impact on the central principles of the patent so substantial that the legal enhancements being made to such systems in the modern age, progressive and efficient as they are, have made less of an impact in comparison. (May (2002) p. 160). Said patent statute was created as a means of facilitating and preserving innovation; a notion which economists undoubtedly and understandably stood by for centuries. Further, over the past two decades, the surge in technological advancements in the digital age has been complemented by the expansion and strengthening of such patent systems. (Cohen et. al, 2000) A record-breaking three million patent applications were filed globally in 2016, according to World Intellectual Property Indicators (Wipo.int.,2017). However, empirical studies that have looked into the legal refinements made to patent systems in the last three decades, have seldom found positive effects regarding innovation. (Williams, 2014;). Thus, it is becoming increasingly more apparent that as technological advancements continue to be made and legal complexities of such systems continue to grow, so do too the resulting effects they have on the incentives to create new technology. This paper aims to discuss the evolution of and the literature concerning the relationship between patent systems and innovation, and the numerous optimal patent systems that have been proposed as a means of preserving its efficacy.

LITERATURE:

Traditional analyses of the effectiveness of patent laws within economic literature have mainly focused on the relationship between such laws and their ability to drive innovation. Whilst opinions differ on the ways in which patent laws influence innovation, there seems to be a general consensus that they provide incentives for

private economically efficient research and development (R&D) and ultimately innovation, through monopoly profits. (Scotchmer, 1999; Budish et al, 2016; Nordhaus (1969); Specifically, by limiting ease of accessibility to inventions for third parties, patents provide a monetary incentive for firms to create original technology, allowing the inventor, alone, to enjoy a higher share of social returns from investment through supra-competitive prices; this is often referred to as the 'reward theory' (Kitch, p. 266). However, it has also been argued that patents only provide an incentive for private R&D when there is asymmetry in the knowledge of the value of the invention at hand (Schankerman. 1999), p. 198). More often than not, the inventor has more information on the costs and benefits of the technology than the patent authorities do and so can make more self-reinforcing, profitable decisions. (Schotchmer, 1999, p.181); therein lie the asymmetries of information. And although this situation of asymmetry, and resulting monopoly profits, have served as the drivers for private R&D for inventors, they are also the reason why patents simultaneously have a counteractive effect on innovation and social welfare in wider society.

As an economic rule, the existence of asymmetric information means someone always loses out and that there exists a level of inefficiency in the market. It is in this sense that patents are generally deemed to be monopolies, despite their inability to fit into the conventional description of one. One of the ways in which they arguably identify with this market situation is through the loss in consumer welfare due to the decision of monopoly pricing (Budish et al, 2016) This has been shown to have particularly harmful effects regarding social welfare in the healthcare industry in developing economies, where the monopoly pricing of AZT means that HIV-positive pregnant women in developing countries cannot prevent transmission of the disease to their

children. (Kremer, 1998) The monopoly-pricing feature of the patent system ultimately means that consumer surplus is abused, consequently leading to a case of deadweight loss, and underinvestment in, as well as a distortion of research. The opportunity for inventors to capture the benefits of monopoly pricing inevitably leads to a case of patent races i.e. a competition between a group of inventors to discover and patent an invention first. And whilst the competitive nature of this type of behavior can arguably speed up the creation of new technology, it also leads to the duplication of numerous existing inventions (Kremer, p. 1140, Kitch, p. 269, Scotchmer, 1999) and consequently, a duplication of R&D costs. (Scotchmer, 1999)

In other words, where new technology could be being created, inventions that already exist but are patented are instead being imitated in the form of substitutes, and wasteful costs that did not need to be repeatedly incurred to create the same invention are unfortunately being so. This in itself poses as another major way in which patents are inefficient and in fact hamper innovation, as competitors are rewarded by stealing rents from patent holders through such substitute inventions (often of lower quality), instead of working in harmony to innovate and create complements. (Kremer, 1998, p. 1142). Another limitation of the patent system is the inventor's inability to capture the positive externalities that they create for other researchers through knowledge spillovers once the patent runs out. (Kremer, 1998, p 1141) This is yet another factor that diminishes the incentive for original research and once again, leads to patent races. It is easier for a firm to operate as a competitor that creates substitutes using the information they have gained from a knowledge spillover as a means of benefiting from monopoly pricing, instead of investing time and effort into creating new technology that perhaps might not give them the same benefits. Cohel et. al (2000) found that the

majority of firms in complex product industries do not consider patents, arguably as a result of the potential creation of patent races, but instead use secrecy and exploitation of complementary capabilities as the key way of protecting their inventions. (Orsenigo et. al, 2010). This has even worse implications for innovation as, whilst trade secrets may protect existing innovations, its excludability of knowledge to wider society hinders the opportunity for further innovation from knowledge diffusion. This in itself shows that there exist structural inefficiencies within patent laws that need to be corrected, as evidently, firms within said industries do not trust its ability to reward their creativity and protect their inventions, thus hampering innovation.

What becomes apparent in economic literature analysing patents is that depending on the nature of the industry within which the relationship is analysed, different conclusions regarding R&D efficiency are drawn. This has become more and more defined due to the global expansion of patent systems. In 1980, the implementation of the Patent and Trademark Act Amendments opened the doors for universities, non-profit research institutions and small businesses within the U.S. to patent technology and inventions created under governmentally funded research programmes within their organisations. (M. Cohen et al, 2000) Similarly, in 1998, the broadening of patenting in the field of biotechnology was also underway within the European Union; a directive which was initially delayed primarily due to the unethical nature of patenting living matter, and has only expanded further since. Similar acts were also set in place later on in Australia and Japan. This global expansion of who is legally allowed to patent has widened the way in which patent laws influence innovation tremendously. In 2014, the Institute for Prospective Technological Studies of the European Commission's Joint Research Centre (JRC)

published a report containing an analysis of the patenting activity displayed by the top 100 companies of the IRI Scoreboard. It stated that seven companies operating in the electronic and electrical equipment industry including Siemens, Sharp and Mitsubishi Electric, had the highest level of R&D efficiency with regards to patents, closely followed by those firms in the 'leisure' and 'software' industries. Firms operating within the 'pharmaceuticals and health' sector however, scored as those among the least R&D efficient with regards to patents. Although these results are not sufficient to be considered conclusive, it is not completely outrageous to assume that the way in which patent laws affect innovation can in large part differ depending on the sector in question. (Albino et. al, 2009; Orsenigo et al, 2010; Teh & Roos, 2015)

In sectors where the process of knowledge and technological development result from numerous steps of R&D, patent laws can most certainly reduce not only the incentives for, but the opportunity for, private R&D and innovation. (Williams, 2013; Scotchmer (1991) This is particularly true of firms within the 'pharmaceuticals and health' industry where innovation is most definitely cumulative. Logically, the opportunity for new scientific discoveries to be made is dependent on the existence of the knowledge we already have as a result of scientific inventions made in the past. Thus, when too many owners hold rights over the latter, this limits the incentives to develop the former for later generations (Merton, 1973; Scotchmer, 1991). Empirical evidence extracted by Walsh et al (2002) showed that advancements in molecular biology, automated sequencing techniques and bio-informatics have led research concerning these subjects to highly depend on discoveries made in the past. Patent laws, in this field, therefore

act as a barrier to existing knowledge/technology needed in order to achieve future innovation.

Further, the blocking of wider access to such discoveries through biological patents also creates a situation of a "tragedy of the anti-commons;" a paradoxical case where scarce resources are being underused due to the fact that too many rights holders prevent each other from using them (Heller, 1998). In other words, a resource goes unused due to the fact that its vast number of owners cannot cooperate with one another on who should be given the rights to use it, yet again severely limiting the opportunity for innovation and preventing the carrying out of socially desirable R&D. In 2013, Williams conducted an empirical study using newly collected data on the sequencing of the human genome by the Human Genome Project, a public research project and Celera, a private corporation. They found that enforcing an intellectual property to protect genes sequenced by Celera led to a relatively negative effect on resulting innovation and scientific R&D on the order of 20-30%, compared to when it was widely accessible to the public. Despite Celera filing for patent applications on 6,500 whole or partial genes, most of these applications were not accepted so they had to resort to another form of intellectual property protection. Whilst this paper does not analyse a case of gene patenting specifically, it does critically measure subsequent scientific R&D and knowledge development as a result of the intellectual property protection directly. Had it been a case of gene patent protection, the level of subsequent innovation would have been difficult to measure through patent citations, as they cannot measure cumulative innovation on technologies that are not patented. This study therefore provides a measurable way of exploring how intellectual property rights, similar to

patents, affect innovation. Suffice it to say that the enforcement of patent laws within the biotechnology, pharmaceuticals and health industry is mostly inefficient and generally produces undesirable results with regards to social welfare as well as innovation.

In 1994, Cohen et. al (2000) used findings from a survey questionnaire carried out by 1478 R&D labs in the U.S. manufacturing sector to study, amongst many others, the relationship between patents and their ability to influence new technology. They found that firms in "discrete" product industries, such as chemicals, appear to use patents to block the potential of substitutes by competitors. Firms in "complex" product industries such as telecommunications equipment or semiconductors, however, are more likely to use patents to force competitors into negotiations over technology rights. Teh & Roos (2015) also came to the same conclusions about "discrete" and "complex" products respectively, when examining innovation performance through the analysis of patent data within the Australian state of South Australia. However, despite their reasoning behind using patents, both types of industries share the fact that the patenting of such products consequently hampers innovation, or at least influence it inefficiently; if access to rivals' knowledge is crucial to being a competitor, and only firms containing this knowledge through patent portfolios have access to it, then patenting becomes the driver for this barrier to entry and the resulting innovation that would have otherwise accompanied it.

Since the fifteenth century, the gradual global advancement of patenting has given way for several mechanisms to evolve within economies, and industries, of varying

natures. Literature regarding patent systems has analysed patent buyouts, uniform vs. differentiated patents (differing length of patent lives) and their respective abilities to influence innovation efficiently. Several efforts have been made at discovering the optimal patent policy with regards to patent length and breadth, however economic literature has produced conflicting results. Nordhaus (1969) proposed one of the first well-defined models to illustrate the key factors in determining optimal patent length. He concluded that there is a trade-off that exists between innovative activity and competition; longer patents allow more time for society to benefit from the R&D taking place that otherwise would not have. However, at the same time, they lead to a decline in social welfare (through monopoly pricing) as they mean that consumers have a shorter period during which they can benefit from the invention. (Budish et al, 2016, p. 1; Takalo, 2001)

Nordhaus's work has no doubt paved the way for literature on the functioning of differing patent system models. Scotchmer (1999) was one of the first to suggest that fees reveal the quality-level of patents. She points out the fact that the current patent system in place gives disproportionate rewards that are not dependent on the actual R&D costs (i.e. through monopoly pricing). In a competitive market without price controls, competition amongst firms is the key to keeping prices down. As mentioned before, patents however serve as state-approved monopolies; this is especially the case with the sale of certain prescription drugs. This element of the system together with the expanding of patenting to the pharmaceuticals industry, has currently led to the soaring of drug prescription prices in the U.S., in many cases, beyond what some consumers can afford. According to an article published by Fortune, per capita prescription expenses were $1,016 in the U.S. in

2016, whilst the comparable country average was $593 (Sherman, 2019). This patent renewal system would eliminate this element of asymmetric information by revealing the value of the technology so that inventors are rewarded with a socially desirable rate of return on the research investment. She also argues that the existence of patent races is a result of the asymmetry of information that exists between inventors and patent authorities, as well as firms within a patent race, and suggests that the solution to this is a patent renewal system. Specifically, she shows that the patent renewal system serves as a direct revelation mechanism in which inventions of higher quality/value are rewarded with longer patent lengths and inventions of lower value are revealed, and thus deterred, through shorter patent lengths. In 1999, Cornelli and Schankerman explored a similar type of model with moral hazard and asymmetric information, whereby renewal fees are used as a tool to establishing optimally differentiated patent lives that help to improve social welfare, as well as encourage innovation. This type of patent system could potentially serve as an incentive for firms to innovate in high-quality inventions as opposed to low-quality ones, increasing the efficiency of the patent system and that of the type of innovation it encourages. By discouraging substitutions through patent races, firms will have more of an incentive to create original, high-value research that will be rewarded with longer patent lengths.

Another type of model for influencing innovation and eliminating the incentives for patent races is a patent buyout mechanism. Kremer (1998) discusses the French government's decision to purchase the Daguerreotype photography patent and place it in the public domain in 1839, as an example of how this type of mechanism increases incentives for innovation. He was in complete agreement with Scotchmer

(1999) and Cornelli & Schankerman (1999) that the first step to creating a more efficient patent system is to eliminate the asymmetries of information. In order to bridge the gap of asymmetries between the inventor and the public, the French government combined direct governmental support of research with components of the patent system by purchasing said patent and placing the technology involved, in the public domain. This was then unsurprisingly followed by an abundance of subsequent technical developments shortly afterwards. Kremer points out that this type of patent system has the potential to not only eliminate monopoly-pricing distortions and encourage original research, but that it also makes room for subsequent, socially desirable innovation to take place through knowledge diffusion. Williams (2013) in fact references Kremer's (1998) buyout mechanism with regards to the aforementioned Human Genome Project. She states that had the government paid Celera a fee to buy out Celera's intellectual property protection and placed it in the public domain, the results would have been more socially desirable in comparison.

CONCLUSION:

Despite this, the vast ways in which patents truly encourage innovation are difficult to empirically measure. For one thing, innovation is not something that can be easily quantified nor is it well defined enough that the time during which it enters the economy can be specified. (Rosenberg & Kline, 1986) In addition to this, it is also extremely difficult to then prove that the patent law, alone, causes the identified changes in the direction and level of innovation. Specifically, exogenous factors such as market dynamics and the efficacy of legal systems as well as

differing structural economies etc. mean that attributing innovation levels to patent laws alone is near impossible. Boldrin and Levine (2013) stated that even empirical literature in favour of patents is weak as most of it uses data on patents rewarded, which has no correlation with measured productivity. However, despite all arguments against patent laws driving innovation, without the option of protecting their intellectual property, inventors would in all likelihood choose to keep their trade secrets to themselves. In 1981, North went so far as to attribute the slow growth of technological change up until the Industrial Revolution, to the lacking in a system that rewards innovation (Faundez, 2016). For centuries now, patent laws have not only enabled inventors to reap the monetary benefits of initial costs incurred from their inventions, but after (and arguably before) the patent expires, competitors as well as the public have been able to enjoy them also.

Suffice it to say, the need to understand patent laws and their implications is higher than ever, with the number of patent applications increasing incrementally every single year and now in developing economies, no less. And although our understanding of the relationship between patent laws and innovation is still somewhat limited, what can be concluded from economic literature is that when considering the construction of patent systems and their potential in influencing innovation efficiently, each economy needs to be analysed individually. The general consensus that the existence of patent laws fosters innovation seems to still be there. However, economic literature on sector specificity has shown us that economies with different specialist markets need to have differing patent laws that complement the nature of the industry appropriately. As mentioned before, the legal and moral expansion of the patent system to the pharmaceuticals industry has

meant that patented drugs are now not subject to price caps, nor are patent holders at the mercy of competitors for up to as long as twenty years. This has caused a huge increase in prescription drug costs, with only one in four of people in America being able to afford them, according to a Bankrate Money Pulse survey. Patents within this industry have definitely served as an incentive to innovate, however it begs the question of just how sustainable and efficient this type of innovation is and whether it should be prioritised over the social wellbeing of those in society. As pointed out by Burk and Lemley (2009), what needs to be remedied is that despite the differing ways in which industries such as pharmaceuticals to semiconductors to software innovate, they are all governed by the same patent system. So the notion that patent laws influence innovation might still ring true, but perhaps we need to revise the features of such systems and tailor them to the type of industry, as well as the type of economy accordingly.

Bibliography:

Acemoglu, D., Bimpikis, K. and Ozdaglar, A. (2011). Experimentation, Patents, and Innovation. American Economic Journal: Microeconomics, 3(1), pp.37-77.

Albino, V, Petruzzelli, AM, & Rotolo, D. (2009). Measuring patent value: An empirical analysis of the US biotech industry. Retrie

Boldrin, M. and Levine, D. (2013). The Case Against Patents. Journal of Economic Perspectives, 27(1), pp.3-22.

Budish, E., Roin, B. N. and Williams, H. (2016) "Patents and Research Investments: Assessing the Empirical Evidence," American Economic Review, 106(5), pp. 183–187

Burk, D. and Lemley, M. (2009). The Patent Crisis and How Courts Can Solve It. University of Chicago Press.

Cohen, Nelson, R. and P. Walsh, J. (2000). PROTECTING THEIR INTELLECTUAL ASSETS: APPROPRIABILITY CONDITIONS AND WHY U.S. MANUFACTURING FIRMS PATENT (OR NOT). NATIONAL BUREAU OF ECONOMIC RESEARCH.

Cornelli, F., and M. Schankerman. 1999. "Patent Renewals and R&D Incentives." RAND Journal of Economics 30:197–213.

Encaoua, D., Guellec, D. and Martínez, C. (2006) "Patent systems for encouraging innovation: Lessons from economic analysis," Research Policy, 35(9), pp. 1423–1440.

Faundez, J. (2016). Douglass North's Theory of Institutions: Lessons for Law and Development. Hague Journal on the Rule of Law, 8(2), pp.373-419.

Heller, M. (1998). Can Patents Deter Innovation? The Anticommons in Biomedical Research. Science, 280(5364), pp.698-701.

Kitch, Edmund W. 1977. "The Nature and Function of the Patent System." Journal of Law and Economics, 20(2): 265–90.

Kline, S, & Rosenberg, N. (Eds.) (1986). An overview of innovation. In R Landau & N Rosenbert (Eds.), The positive sum strategy: Harnessing technology for economic growth (pp. 275-304). Washington, DC: National Academy Press.

Kremer, M. 1998. "Patent Buyouts: A Mechanism for Encouraging Innovation." Quarterly Journal of Economics 113:1137-1167

May, C. (2002) “The Venetian Moment: New Technologies, Legal Innovation and the Institutional Origins of Intellectual Property,” Prometheus, 20(2), pp. 159–179

Merton, R., The Sociology of Science (Univ. of Chicago Press, Chicago, 1973).

Moser, P. (2013). Patents and Innovation: Evidence from Economic History. Journal of Economic Perspectives, 27(1), pp.23-44.

Nordhaus, William. 1969. Invention, Growth, and Welfare: A Theoretical Treatment of Technological Change. MIT Press.

Orsenigo, L. and Sterzi, V. (2010). Comparative Study of the Use of Patents in Different Industries. Knowledge, Internationalization and Technology Studies, Università Commerciale Luigi Bocconi, pp.1-32.

Scotchmer, S., (1991) "Standing on the Shoulders of Giants: Cumulative Research and the Patent Law." Journal of Economic Perspectives, 5(1), pp. 2

Scotchmer, S. (1999). “On the Optimality of the Patent Renewal System.” The RAND Journal of Economics, 30(2), pp. 181-196

Sherman, E. (2019). http://fortune.com. [online] Fortune. Available at: http://fortune.com/2019/03/08/health-care-drug-prices/

Takalo, T. (2001) “On the optimal patent policy,” Finnish Economic Papers. Finnish Economic Association, 14(1), pp. 33–40.

Teh, K. and Roos, G. (2015). A patent perspective of South Australian innovation: An indicator within the regional innovation system story. University of Adelaide Press.

Vezzani, A., Montobbio, F. and Tarasconi, G. (2014). The patenting activity of the top IRI Scoreboard Companies: an introductory note. European Commission: Joint Research Centre, Institute for Prospective Technological Studies.

Walsh, J.P., Arora, A. and W.M. Cohen (2002), "The patenting and licensing of research tools and biomedical innovation", Science, Technology and Economic Policy Board of the National Academies, forthcoming.

Williams, H. L. (2013) "Intellectual Property Rights and Innovation: Evidence from the Human Genome," Journal of Political Economy, 121(1), pp. 1–27.

Wipo.int. (2017). Patents. [online] Available at: http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2017-chapter2.pdf