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A primer on patent and innovation

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Strategic Management of Intellectual Property: New Stakes and New Perspectives
La gestión estratégica de la propiedad intelectual: nuevas problemáticas y nuevas perspectivas

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A primer on patent and innovation

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In this paper, the patent system will be briefly reviewed and some particular problems in designing and using it will be considered within the broad framework of the relationships between patent and innovation. The bulk of the argument is that economists typically consider the patent system as a necessary evil: innovation will benefit from the incentive created by a patent but it may suffer if patents discourage the combining and recombining of inventions to make new products and processes. Thus the relationship between patents and innovation is guaranteed to be a complex one, and one that may vary over time and across industries.

Part 1 deals with some simple economics of patents involving analysis of the basic problem to be solved (imperfect appropriability), the complexity of the design of solutions to that problem, since more than one thing have to be done at the same time, and the centrality of the topography of technical advances as an important factor determining the relation between patent and innovation. Part 2 reviews the costs and the benefits as well as the different classes of effects of patent on the creation, development and commercialization of new or improved products and processes. Part 3 emphasizes that the search for an "optimal design" of the patent system is difficult. There are strong variations across sectors in the conditions, procedures and impact of innovation, which means that a truly uniform system treats "unlike things" alike and this is not what should be done in a "perfect optimal world".

While this paper is focusing heavily on the relationships between patents and the economics of innovation, it must be clear that the patent system is only one option among others, as peculiar ways to solve the tension between the maximization of inventor's private interests and the socially optimal use of knowledge. The theoretical option taken by most economists assumes the availability of different classes of institutions which have been designed to respond through various incentives and co-ordinations mechanisms to the generic problem of optimizing the production and use of knowledge. Economists and policy makers are interested not so much in one or the other particular mechanism but in the design of "superior" solutions to the knowledge trade off – given the social value of the knowledge (is it an essential or a cumulative knowledge) and the characteristics of the market (demand elasticity, size).

On the economic fundamentals of the patent system

Imperfect appropriability

The initial step in constructing a rationale in the domain of patent involves the classical source of market failures as analysed in Arrow (1962) and in the following literature. This approach focuses attention upon the special characteristics of knowledge as an economic commodity, which will be seen to affect its generation and distribution. As Rockett did in a very recent survey (2009), let do an intellectual experiment (which actually has some historical precedents): no intellectual property right exist. Further, as soon as an innovative product is sold or used, a variety of individuals become familiar with the invention, creating the seeds for imitation. If the innovation generates profits, potential imitators are attracted to the innovation to produce their own version of it. This process creates a variety of suppliers of the innovative product or process, driving down its price and so the profits of the original innovator. If the process is quick or very cheap, then very little surplus is captured by the initial innovator. Any innovator anticipating this process will not invest in the innovation in the first place. In essence, the innovator contributes to a common pool of knowledge when she creates and practices an innovation. This positive externality, if it is not captured by the inventor, generates a private under-incentive to innovate.

The foregoing describes what has come to be referred to as the "appropriability problem," the existence of which is invoked in the mainstream economics literature as the primary rationale for government interventions by means of various policy instruments. The patent resolves the problem by making the embodiment of the innovation a private good even though the underlying knowledge remains a public good.

Of course the importance of the appropriability problem as a disincentive to innovate and the resulting private and social value of patents as a mean to correct the problem need some qualification. There is a whole series of phenomena which, naturally or intentionally, lessen the problem (Foray, 2006).

Qualification of the argument: imperfect appropriability does not apply any time and everywhere and is not always a problem

"Imperfect appropriability" theory treats only one extreme case, knowledge, expressed in an appropriate form for its diffusion (writing, computer programme, digital image, film). But a knowledge base – that of a firm, institution or even sector – is not reducible to pure "codified" knowledge. It is composed of tacit knowledge, know-how and practical experiences as well as research materials, instruments and tools, all of which are more easily controllable goods. Thus, very few research results, inventions or new technological practices are formalized from the start to the point of being a "simple" set of codified instructions so that experiments and results can be reproduced by scrupulously following the codified instructions (in the way that anyone, by reading the manual, can get their new washing machine going). When knowledge is expressed completely in this form of codified instructions (of which software is the most interesting example), it is indeed practically impossible to control it, at least in the community of specialists and practitioners able to understand and interpret the instructions. In reality, however, knowledge and results are far more often presented as a combination of formalized instructions and tacit knowledge, based on practical experiences that can be acquired only in the laboratory where the discovery was made. Thus, the tacit dimension of knowledge affords those who have it a degree of control, since only voluntary demonstration and learning on site allow its acquisition.

Hence, there is a sort of natural excludability that this tacit dimension bestows on knowledge. This represents a transitory source of intellectual capital, producing rents for the innovators who have the know-how. They benefit from it until the new knowledge is sufficiently codified, articulated, clarified and hence diffused so that the rents dwindle away. This transitory tacit dimension is therefore a way of controlling access to new knowledge, thereby lessening the appropriability problem. Imitation is a process which is costly and may take a long time. On this base ***being first in inventing a new knowledge*** may be sufficient in certain cases to capture a good fraction of the benefits. In fact the supply of copies cannot instantly undergo infinite expansion. Hence the fact of being first is an asset that can command a positive price under competitive conditions.

Another qualification of the argument of imperfect appropriability relates to the role of complementary assets. Very often the exploitation of new knowledge requires specific capacities that only the inventor has, such as technological capacities needed to implement the innovation and to manufactor the products in industrial conditions. Even if the idea is harnessed by others, only the one who has these capacities is able to exploit it. Moreover, the control of a particular market is a kind of complementary asset essential to the exploitation of an innovation. In all these cases, although knowledge can be imitated, the profits associated with its implementation remain internal.

Finally, even if imperfect appropriability remains an important problem, other sources of profit for innovators than the monopoly rent can undermine the severity of the problem, (Hirshleifer, 1971). By definition, innovators are the only ones to have information on future changes in the price of certain inputs that their innovation is likely to cause. Before revealing their innovation, they are therefore in a position to speculate on these factors. It is the inventor of a water-mill who will buy cheaply all land through which a river runs; it is the agent who discovers the use of oil who pays next-to-nothing for the wasteland polluted by the oil fields.

In all these cases the question of maintaining control over innovation is no longer relevant; on the contrary. Imitation and diffusion are not only tolerable, they become highly desirable. Thus, this mechanism makes it possible to reconcile in the best possible way the preservation of private interests and the maximization of social returns (distribution of knowledge). This solution shifts the source of private profits and, as a result, does not affect innovation diffusion. Better still, by playing on effects that depend on the diffusion of the innovation, it forces the creator to disclose the new knowledge freely.

Designing incentives is difficult since two things have to be done in the same time

The fact remains that imperfect appropriability does exist in many circumstances and that patent is obviously a central mechanism to fix the problem. However an important issue for the design of instruments to help to correct imperfect appropriability is that helping innovators and knowledge producers to get a better control on the innovation in order to capture a significant fraction of the benefits stemming from their R&D investments and creative efforts is only one part of the policy problem. The other part is about maximizing access and spillovers so that the society will quickly benefit from the new knowledge which has been produced. There is something like a conflict of objectives which makes the design of policy instruments quite complicated.

Broad and rapid diffusion of new and "superior" knowledge is good for social well-being. It is quite obvious that efficiency and growth are promoted by the rapidity with which new knowledge and new technologies are disseminated: the greater the share of individuals, firms or countries that make use of superior products and processes and the sooner they do so, rather than being confined to inferior substitutes, the more widespread and substantial the growth benefits should be.

However, we know also that rapid dissemination can be the enemy of innovation. If a firm undertakes considerable expenditure of money and effort to carry out its innovation

program, but finds that other firms rapidly share in the fruits, why should that firm devote time, effort and funding to continue that program? To summarize rapid dissemination is good for social well-being but bad for private returns: no one wants to invest in the creation of new knowledge if free sharing and dissemination occur rapidly. This is the economic (or knowledge) trade off between the need for the knowledge producer to capture some of the benefits associated with the economic use of the new knowledge and the need for society to get a rapid and large access to that knowledge.

There is a technical point here which is useful to make: the production of knowledge entails very often high fixed cost, while once produced it is available at zero marginal cost.[1] This is why, in a ***static world***, when the new knowledge has been invented, there is no point to ration it by price since the knowledge already exists and cost nothing to replicate (idea of "infinite expansion"). In this case, if charging for access excludes some would-be consumers, the result is waste. Wants go unsatisfied that could have been satisfied at no cost. However, in a ***dynamic world*** (in which knowledge needs to be produced), the knowledge producers want their costs to be covered and seek for economic rents: marginal cost pricing would leave most costs uncovered, even at large scales. A practical way to reconcile ***static and dynamic efficiencies*** is thus to find mechanisms that allow knowledge producers to capture benefits while not excluding those classes of consumers that need access and use at no or negligible costs.

This is why it is important to devise social mechanisms to allow the knowledge producer to capture (at least) a fraction of the benefits generated by the invention. But, from the point of view of society, the efficiency of these mechanisms will depend on the kind of balance which is built between the two elements of the trade off: providing a means for the knowledge producer to capture the benefits of his effort; maximizing the social dissemination of the knowledge. Institutions that govern the creation and diffusion of knowledge have always been molded by this so-called ***knowledge trade-off***. They will be assessed according to the way they allow for an efficient management of this trade off.

Patents: a mechanism devised "to do the two things"

Among these institutions, intellectual property rights and patents are of particular significance: patent is a legal device which is generally defined as a right to exclude. It ensures inventors the right to a temporary monopoly on a technical invention. It is a property title that is valid in time and geographic space. It is obvious that the patent system *per se* does not create private monopolies; this is innovation which allows a firm to get a unique position and exit somewhat from perfect competition; while the patent system just allows the firm to secure this position (but not fully) for a certain period of time.

Patent is one of the rights granted to the creators of intellectual products. Ideas are, of course, recognized as being part of humanity's common base and therefore not appropriable by a private person. In this respect, they are outside the law. A literary subject, an artistic principle, a political idea, or a scientific vision, for example, cannot be monopolized. What can however tilt over into private property is the concretization of the idea, theme or principle. Only then may it be the object of a private right.

In exchange for patent rights the inventor must publicly divulge the technical details on the invention. This is the typical response of the patent system to the knowledge trade off. The public availability of the technical description is an essential element. It is the basis of the balance between the inventor's interest and those of society. This does not mean that other people can use the knowledge which is made publicly available through a patent application. It means rather that the patent system facilitates "the show", contributes to make the knowledge visible, support informational spillovers. Before its creation in the 16th century, inventors were hostile to the idea of revealing new knowledge.

Designing incentives for what?

It is a frequent misperception that the policy purpose of patents is primarily to reward and thereby encourage invention, defined as the initial creation of an idea for a new product or process. Based on this misperception, some argue that patents are not necessary, because creativity is inherent in the human spirit, and new ideas are all around us. Patent's enemies are quick to extract the names of Leonardo, Gutenberg or Michelangelo from the history of art to make their case that patent is not indispensable to boost creativity!

But the economic function of patents is not just to reward invention, but to provide a secure economic environment for the investment that converts ideas in reality (Jaffe, 2005). This "D" part of R&D is expensive, and is often carried out most effectively in the private sector. Thus fostering the investment in development is a key policy problem. Patents are not the only mechanism for protecting and thereby encouraging this investment, but they are important one. They are particularly important for start up firms dependent on external finance, and for inventions that must be transferred or licensed from one firm to another in order to make the transition to the commercialization phase.

1. The fact that marginal cost of reproduction is zero is essentially due to the fact that knowledge, once produced, is not destroyed by use and consumption. Its benefits can be enjoyed undiminished by many users concurrently as well as sequentially. However, the proposition "knowledge is available at zero marginal costs" does not imply anything about the cost of using the knowledge. Very often knowledge is usable together with resources available only at positive, and often very high cost. For example, to be used effectively knowledge needs educated people.

The unanticipated effects of patents on innovation in "complex technology" situations

Patent is likely to encourage innovation (above). But this relation is not so simple; it is depending on the topography of technical advance in a field, in particular how inventions are linked to each other, and in the extent to which rapid technical advance requires a diversity of actors and minds. We can differentiate two cases in which the relation between patent and innovation is likely to lead to unanticipated situations (such as heavy transaction costs and even innovation blockage) (Merges and Nelson, 1994).

By cumulative technology legal and economic scholars mean one in which today's advances lay the basis for tomorrow's, which in turn lay the basis for a next round, etc..Innovative cumulativeness has implications both for the social value of discoveries and for the ease with which firms can be given incentives to create them. The social value of an invention is compounded by the fact that the discovery facilitates or becomes a basis for future discoveries. However, cumulativeness makes it especially difficult to turn social value into private value, as must be done if firms will have incentive to innovate. This is particularly true when future innovations are improved versions of previous innovations. Later products can supplant the earlier products in the market, thus terminating the profitability of the products that facilitated them. In that case, there may be too little incentive to provide the earlier products (Scotchmer, 1991).

By system's technology, scholars mean a technology in which a useful product is made out of different components, each of which might be invented independently. But if a patent on one component that is key to a variety of systems is defined broadly, the holder of that patent may be able to block others from commercializing those systems without license. On the other hand the holder of a broad patent on another essential component may be able to block the holder of the former patent from building a state of the art system.

One of the main themes to emerge is that firms have powerful economic incentives to resolve this kind of conflicts in intellectual property rights caused by the complexity of relationships between patent and cumulative or system's technologies through contracting, either with research joint ventures or licensing. Cross-licensing and pooling arrangements become central for achieving the coordination of inventive activities among a large number of owners of items of intellectual property, in very complex technological environment.

On costs, benefits and different classes of effects: theory and empirical evidence

Costs and benefits (private and social point of views)

The patent system has many virtues. The most visible is in its main role which is to provide an incentive (an economic motivation) to future inventors. Patent is a legal device which is generally defined as a right to exclude. It ensures inventors the right to a temporary "monopoly" on a technical invention for a certain period of time. During such period, the innovator will recover R&D fixed costs by charging a price above marginal cost (which is what a monopolist can do).

It facilitates the market test of new inventions because it allows disclosure of related information while protecting against imitation.

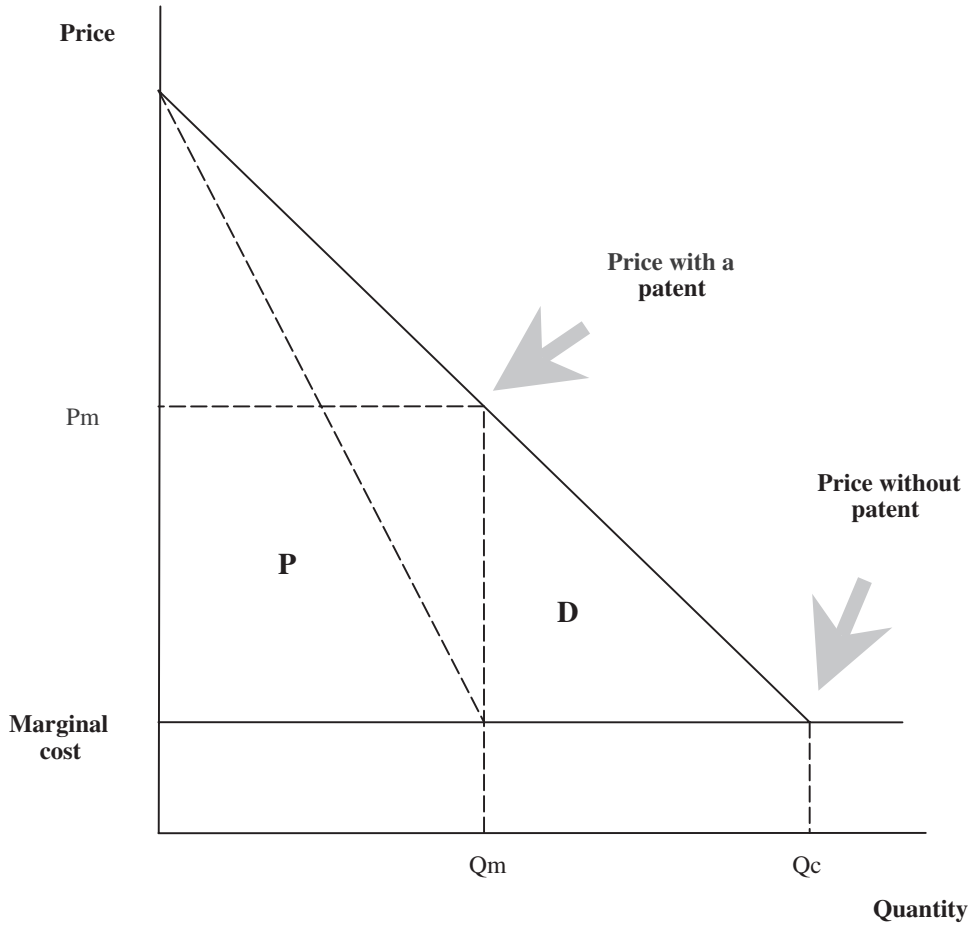
Patents create transferable rights and can therefore help to structure complex market transactions on technologies. Patents are an essential element of the legal infrastructure of the markets for technologies that are in certain industries a source of great efficiency (see below).

Patents are a means to signal and assess the future value of the technological efforts of young companies for which other classes of "intangibles" cannot be used for proper evaluation.

Finally the patent system as a reward mechanism has some virtue in terms of the whole management of the system (contrasting for instance with a prize-based mechanism): the value of invention is determined *ex post*, through market processes; the cost of the system is mainly borne by consumers instead of taxpayers.

However, by imposing exclusive rights, the patent restricts de facto the use of knowledge and its exploitation by those who might have benefited from it had it been free. This is a case for social inefficiency (recall that in a ***static world*** knowledge once produced is available at 0 marginal cost). In this case, if charging for access excludes some would-be consumers, the result is waste. Wants go unsatisfied that could have been satisfied at no cost. The example of AIDS drugs illustrates this point: AIDS drugs are relatively inexpensive to produce. They are sufficiently inexpensive to produce, that the benefits to in lives saved exceed the costs of producing the drugs by orders of magnitude. But because of patents, no price competition is permitted and the patent holders (the large pharmaceutical companies) charge such an enormous premium over the cost of producing the drugs – to reap large profits from sales in rich countries – that individuals in many countries cannot afford them. Here is an example where the overpricing has real and enormous social costs. However, as already said, in a ***dynamic world*** (in which knowledge needs to be produced), the knowledge producers want their costs to be covered and seek for capturing the economic rents they have produced. This is for what the patent system has been designed.

FIGURE 1



Box 1 : Economic effects of patent under static conditions

Figure 1 shows the demand for a newly marketed product (the solid line D). In the absence of patent protection, innovations are freely available so that price is equal to marginal cost and output is Qc. When the inventor is granting a patent and prices the innovation to maximize his profit, the price is Pm and output falls to Qm. The triangle D represents the welfare loss consumers associated with introducing product patents.

On the other hand, the most obvious dynamic gains is the inventor's profit, the square marked P.

Some other shortcomings of the system are caused simply by inappropriate modes of use of patents, from a social point of view. A case in point is the so called "strategic use" of patents by firms. Some firms use them as bargaining chips in cross-licensing agreements. Such strategic use has little to do with protecting innovation while increasing asymmetric powers in bargaining and negotiation between the big and the small players. There is now strong evidence that in some industries the increasing number of patent applications is explained not by the need to protect more innovations but by some strategic use purposes (Hall, 2003). In this respect many shortcomings in the patent system are not inevitable, for they are not intrinsically associated with the concept of intellectual property but result from a mode of use that leads to blockages or slows down innovation. (see below paragraph 2).

Given both advantages and shortcomings, the patent system has often been qualified as a "***necessary ill***". Economists agree that the patent system is a good thing for innovation and growth, provided the negative effects on the economy are reduced; and particularly the negative effect on the diffusion and large use of the knowledge. In this respect, the challenge is in the "design" of the device (and may be this design should vary across sectors, see below) as well as in the enforceability of simple rules which can help to minimize the negative effects. These rules are quite obvious and well-known. However, they were ill-treated and ill-used during the most recent period: the requirement of a technical description of the invention to maintain

a fair balance between the inventor's private interests and the interest of society; the exclusion of science from the domain of patentability through criteria of industrial application (or utility); an accurate application of the criterion of inventive activity and inventive step to clearly delimit the area of human activity and identify the degrees of innovativeness which are required to be appropriated by a patent.

Patent excess in the knowledge economy and the new questions raised by economists

The concern just mentioned deals with some inappropriate modes of use of patents, from a social point of view. A case in point is the so called "strategic use" of patents by firms. This is the situation in which the various leaders of an industry each hold an IP portfolio, much of which is regularly infringed by competitors. As Barton (2007) points out, none of the firms usually brings suit on those patents, because each knows that the defendant would respond with a counterattack based on those of the defendant's patents that it itself is infringing. Litigation is too much like a nuclear weapon, and the relation becomes one mutually assured destruction! Each firm must therefore maintain an IP portfolio for bargaining-chip, i.e. defensive, purposes. But, and here is the point important for innovation and industrial dynamics, there is no reason not to use the portfolio against possible new entrants who might affect the oligopoly rents available to the incumbents, and, therefore, as a tool to block innovation. This is the most typical actual use of patents, notably in the semi-conductor industry, financial services or agricultural biotechnology. This pattern arises frequently in oligopolistic context. Such strategic use has little to do with protecting innovation while increasing asymmetric powers in bargaining and negotiation between the big and the small players: "*I just don't know what is in my portfolio of 8000 patents*" is a good quotation from a Chief R&D Officer of a large and well known company that illustrates the magnitude of the problem. As a result many industries and technological fields are now characterized by the formation of patent thickets – an expression describing the proliferation of overlapping and not clearly delineated patents. Efforts and costs devoted to sorting out conflicting and overlapping claims to IPR are increasing, as is uncertainty about the nature and extent of legal liability in using knowledge inputs. It is also possible that intellectual property-related transaction costs may increase so much that the result can be the deadlock of knowledge exploitation and accumulation (anti-commons).

It is not clear that the new situation involving intensive patenting activities, large amount of cross-licensing, aggressive patent enforcement strategies and privatization of some basic research activities is better than the preceding one that was characterized by a moderate level of patenting activities, firms allowing diffusion of their own knowledge in return for low cost absorption of other's knowledge, and a large public research domain. The latter seems to be a system with lower transaction costs and lower risk of seing some innovative projects to be blocked by patent thickets, while the former does not seem distinctly superior in terms of knowledge production.

What is important to understand is that it is (was?) relatively easy to get a large number of patents granted or patents including a high number of claims while these applications do not strictly aim at protecting corresponding innovations. Such easiness is explained by the modes of operation of patent offices, the mere fact that the patent criteria (novelty, inventive steps, utility) are far from being unambiguous and perfectly clear and the fact that for large companies the marginal costs of patent application and of patent renewal are negligible. If a firm wants to conduct a strategic use of patent, basically it can do it.

In sum, recent trends toward i) strategic use, ii) patents moving up to the domains of scientific research (research tools) and iii) the broadening of the possible subject matters (business methods, software, living organisms) which leads to some weakening of the basic rules; all these trends cause economists questioning more deeply the ways patents are granted and the role of economic incentives as shaping behaviors and strategies both of the private innovators and of the patent office. Such questions became quite central as economists started to clearly see that some other mechanisms may do a better job, supporting innovation without creating exclusivity and monopoly. For instance, we can observe the current booming of some social systems – such as "open-source" and "open collaborative research" - in which high rates of innovation are correlated with rich and instantaneous free revealing pattern, implying that private inventors do not always rely on exclusivity and excludability mechanisms to capture the private benefits from their intellectual creative work.

The good news is that these problems are not inevitable, for they are not intrinsically associated to the idea of allocating intellectual property right but they are the result from some economic and strategic behaviors that can be controlled or the pure manifestation of a transition period in which patent officers have to learn how to deal with new subject matters. For instance, Cockburn (2002) shows that out of some 5500 patents in class 705 of USPTO (business methods), more than 2700 cited no prior art and were characterized by lax standards for enablement and disclosure (something like a shift from literal description in rigourous terms as "direction of use" which allows for effective reproduction of the invention to a vague communication of an idea). However, it may be the case that the weakening of the basic rules can be traced to poor application of patent principles not a fundamental inapplicability of these principles. Problems in new fields are mainly transitory dealing with the fact that there is a time lag between the emergence of new classes of subject matter and the kind of experimental learning that must occur in patent offices about proper treatment of applications in the new fields. As Barton (2007)

argues now, many very recent evolutions, although not changing dramatically the current state of affair, suggest the pendulum of IP may be beginning to swing back, at least at the US level.

Patent, innovation and competition

We already stated that without intellectual property protection, potential innovators would be afraid that competitors would copy (competition by imitation) and, therefore, would not invest in R&D. But conversely, without competition, the monopolist who holds intellectual property rights would not have any incentive to invest further in innovative activities since this firm would already control the market and would be able to impose monopoly prices. Therefore both causal chains – *patent stimulates innovation and competition stimulates innovation* - need to be adequately combined in order to promote dynamic competition. As a consequence, the patent law itself is in need of a "pro-competitive" design: in terms of competition, the patent system excludes a certain type of competition which is the competition by copying (usually defined as a competition on prices) but should not exclude another type of competition which is a competition by substitution (or innovation). Market access with better products should always be possible. By impeding competition through imitation, the patent system allows the innovator to profit from a monopoly position within a certain period of time.

This inter-relationship between innovation, patent and competition needs some qualifications. First, the effect on competition is particularly positive as far as entry and new firms are concerned: the patent system facilitates entry of new firms with limited assets. Second, a negative effect is that the short term monopolies which are created by innovation and patents may become long term in network industries.

A new function of an increasing relevance: lubricating markets for technology and supporting vertical specialization

Patents play a central role in sustaining a particular industry structure – vertical specialization – which proves to be an effective way to boost innovation. The argument is the following:

Well-enforced patents raise the bargaining power of small firms that develop and supply technological solutions. Assimetry in size and bargaining power are common in transactions between small technology specialists and downstream product developers. Problems arise because the small technology suppliers have no means to appropriate the rents from their innovations other than a legal stake on these innovations. Weak or no patent would have two consequences: the technology supplier may try to integrate downstream to secure the rent on their technologies by embodying them in the final product;or they exit from the activity. In both case, the division of labor is weakened because either the small company becomes an integrated firm itself or the product developers have to integrate upstream to compensate the lack of supply by independent suppliers.

This is, in any case, an unfortunate consequence because this structure exhibits many virtues regarding creativity and innovation:

– efficiency gains from specialization: cost effectiveness, speed

– high powered incentives: rewards are more closely tied to the profits of each party's efforts

– if new knowledge and ideas are generated inside vertically integrated firms and held as trade secrets, knowledge spillovers and social returns are likely to be lower than if they are disclosed in patent applications by small vertically disintegrated technology suppliers.

The argument here is not that patent has a direct effect on creativity; but being instrumental in organizing and sustaining a certain industry structure, which is good for innovation, it has an indirect positive impact on innovation and creativity: patents play a positive role in enhancing industry R&D efficiency by fostering the emergence and entry of specialized technology-services or research firms.

Summary on costs, benefits and real effects

The main effect is that patent creates an incentive for R&D; this is for that purpose that it has been "invented". However, evidence is mixed, which basically means that empirical and theoretical research has not proved any automatic and stable model or formula that could be used to predict that any strengthening of a patent system will result in such an increase in the quantity of resources allocated to innovative activities. The mixed evidence means also that there are strong variations across sectors: patents may provide incentives for innovation in certain industries; but in most industries patents are less important than other mechanisms such as first mover advantage and commercialization capabilities.

The first order benefit of patent may be in lubricating the market for technology and encouraging a division of labor in innovative activities.

The major cost is about access: monopoly pricing generates static inefficiency. It may impede the combination of new ideas and inventions and raises transaction costs.

In terms of competition, patent facilitates entry of new firms with limited assets but create short term monopolies which may become long term in network industries.

Many of the problems caused by patents are because patents are poorly written, inlegalese, to claim as much while disclosing as little.

Patent design: one size does not fit all

A lot of evidence demonstrates that patents are doing good in some sectors but they also doing harm in others. When looking at surveys about industry manager's perception of the usefulness and effectiveness of the patent system as a mean to appropriate innovation benefits, we see strong variations ranging from the case of pharmaceuticals using the system in a very enthusiastic way to a more qualified appreciation in biotechnology, to the mixed views of the computer and semi-conductor industries to the somewhat negative views of software developers and Internet services.

Beyond surveys, the theoretical literature on optimal breath and length is making the same argument: the optimal length of patent life can hardly be uniform across the whole range of industries and inventions, inasmuch as it is sensitive to the price elasticity of demand in the related end-product market, and to the responsiveness of the production costs of the new product to the amount of resources devoted to R&D.

So innovation and the relationships of patents to innovation differ by industry. One size does not fit all; a truly unitary patent law would therefore treat "unlike things" alike.

Should we think of and go for a system which would be more technology-specific; prescribing explicit rules for specific fields? Should we acknowledge that specific industries have specialized patent needs and taylor the system accordingly?

While it is relatively easy for economic theory to show that optimal design should differ significantly across technologies and industries, a strong case can be made that this is a Pandora box that should not be opened.

Optimal design implies patent legislation differentiation….

Patent is a tool to support of innovation; but the conditions, procedures and modes of innovation differ strongly across sectors. Many dimensions of innovation are concerned with sectoral variations (Kahin, 2007): discrete versus complex products; cost of invention and commercialization; pace of innovation and cumulativeness; public good characteristics; network characteristics; transaction costs. One obvious response to these variations from sector to sector is to explicitly legislate different patent standard for different industries to supplement patent protection in some fields with a *suis generis* status. The economic effects of patents are quite different in software and biotechnology; two of the industries in which the call for specific legislation is loudest. Thus, in a perfect "optimizable" world the patent system might well be tailored to give optimal incentives to each different industries.

…which will put the entire system at risk

However, it is relatively easy to argue that some kind of fine tuning according to technological heterogeneity will ultimately fail and will likely to weaken the system. Of course, as mentioned above, the theory can identify certain features of technology that make strong or long patent less desirable; however it might be extremely difficult to identify these features in particular technologies; more a matter of degree than of clear categories. Even if one could in principle restrict the applicability of patents based on such analysis of intrinsic technological principles; it is likely that – in practice – such efforts would fail. Drafters of patent application will always be more ingenious than the writers of patent rules. So prescribing patent protection for certain technologies will simply drive applications to be written so that they appear in other, more favourable, classes. Also such a policy process toward more technology specific system will never avoid lobbyist from different industries seeking for special treatments.

Activating policy levers…

One argument, developed by Burk and Lemley (among others), is that despite the appearance of uniformity, patent law are diversified. There is enough flexibility already in the system to cope with diversity of situations. The idea is that patent laws give the courts and offices substantial freedom to adjust general rules to specific cases by means of flexible legal standards, called policy levers. The key issue for the patent offices and authorities is to learn how to use these policy levers and to be incentivized to do so.

According to Burk and Lemley (2009), policy levers are legal principles that can be applied with sensivity to the industry and the factual context of the cases. They differentiate between policy levers that expressly treat different industries differently and those that treat different inventions differently without explicit regard to industries. The exclusion of abstract ideas from patentability or the use of the utility doctrine in the US are examples of existing policy levers. New doctrines could in the future serve as policy levers. For example a fortified right to experimental use could be valuable for industries like software where it is difficult to design around a patented product without reproducing the product. A new type of patentability inquiry could assess whether innovation in a particular industry is highly costly and risky, in which case a lower incentive step or a more liberal disclosure standard might be merited.

…AND BUILDING ECONOMIC INSIGHT WITHIN THE SYSTEM

The challenges for courts and offices are huge. Some (or many) have to move from poor practices to an effective use of the policy levers (Hunt and Kahin, 2008). Policy levers are policy tools that need to be properly understood as legal principles that can be applied with sensitivity to the industry and factual context of the cases. And so the challenges for the offices and courts is to understand deeply conditions, procedures and the economic logic of innovation in each industry and the potential effect of using one lever in a specific case.

As a conclusion the problem is where insights about innovation economics should be built into the system, since understanding what policy lever should be used in what circumstances is about economics of innovation. There is obviously an issue of capacities and knowledge as well as of incentives. There are a lot of reasons for offices and courts to wash their hands of involvements in policy calibration and fine tuning. To their credits, a number of offices have recruited chief economists, a step that is long overdue. Finally the case is even stronger for the patent offices in the less developed countries to build economic knowledge in order to use properly and effectively the policy levers to serve the innovation needs of their countries.

Conclusion: Patent and the search for the design of "superior" solutions to support knowledge access and production

How the knowledge trade off should be solved (and so what kind of mechanism should be used) depends obviously of the nature of the knowledge and the characteristics of the economic environment. For example, if the issue to be addressed is to encourage invention of vaccines for tropical diseases, there are two arguments for not using the patent system to encourage innovation and for developing, rather, a kind of prize-based or optimal procurement mechanism: first companies know that poor countries will not afford to buy the new product at a monopoly price and therefore the private rationale to use patent is weakened (or companies anticipate that they will be forced to sell the product at some lower price and again the economic motivation to undertake the research will be undermined); second, the access to the new knowledge will be so vital that creating a monopoly would generate very high social costs and inefficiencies.

Economists and policy makers are interested not so much in a particular mechanism but in the design of "superior" solutions to the knowledge trade off. This is certainly the most interesting policy question: what is the right mechanism for a socially efficient solution to the appropriability problem? Helping the market to invent a new vaccine, an orphan drug, a new encryption method or a new environmental technology involves the design and deployment of different classes of solutions. From this field of questions, patent certainly emerges as a vital institution for technology policy. Its efficiency and effectiveness crucially depend on the industry/sector where it is applied, how the flexibility which is present in the legal system can be used to concur with innovation and sector specificities, and to what extent the general framework of incentives (which also concerns the patent office) may be improved so as to minimize misuse and abuse of the system by various parties.

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