The tradeoff of intellectual property rights reconsidered*

Cristiano Antonelli**

Abstract: Intellectual property rights have a twin effect on the economic system. On the one hand they increase the incentives to the introduction of new technological knowledge. On the other they increase the costs of the generation of new knowledge because they limit the access to an indispensable input such as existing knowledge. A tradeoff between such positive and negative effects can be formalized so as to identify of the 'correct' levels of knowledge rents...

Keywords: knowledge rents, intellectual property right regimes, essential facility, liability rule.

Jel classification: O31.

1. Introduction

According to Kenneth Arrow, knowledge, as an economic good, suffers of many limitations. Such limitations lead to dramatic market failures in the organization of its generation and in the governance of its dissemination. Markets are unable to fund the correct amount of resource to its generation and to organize the necessary levels of division of labor. The spontaneous generation and usage of technological knowledge in

* A preliminary version of this paper has contributed the international seminar "Contributions to the Development Agenda on Intellectual property Rights" held at the UNUINTECH, Maastricht, September 23rd and 24th, 2005. I acknowledge the comments of many participants, including Suma Athreye, Leonardo Burlamaqui, Ana Celia Castro, Benjamin Coriat, Roberto Jaguaribe. This work has been made possible by the funding of the European Union Directorate for Research, within the context of the Integrated Project EURODITE (Regional Trajectories to the Knowledge Economy: A Dynamic Model) Contract nrº 006187 (CIT3), in progress at the Fondazione Rosselli.

** Professor da Università di Torino; Dipartamento di Economia "S. Cognetti di Martiis" Via Po, 53 - 10124 Torino, Itália; cristiano.antonelli@unito.it.

the market place are afflicted by both insufficient allocation of resources and reduced levels of efficiency: a clear case for undersupply takes place. Intellectual property rights are a major institutional device designed to match the limitation of knowledge as a private economic good. Intellectual property rights however have a number of undesired side-effects that need to be assessed carefully assessed in order to introduce possible institutional changes, such as a procedure for the identification of the optimum level of knowledge rents, the implementation of the notion of knowledge as an essential facility and the application of the liability rule. The rest of the paper is structured as follows. Section 2 reviews the emerging evidence about the many facets of the knowledge tradeoff. Section 3 elaborates the notion of knowledge rents, makes explicit their positive effects in terms of provision of incentives and resources to the generation of new knowledge and their negative effects in terms of the consequent increased costs of an indispensable input in the generation of new knowledge such as external knowledge. Building upon these bases Section 3 elaborates a simple procedure to identify the 'correct' levels of knowledge rents. The conclusions summarize the results of the analysis and put them in perspective.

2. The knowledge tradeoff reconsidered

Intellectual property rights and patents are institutional instruments designed to increase the incentives of firms to generate new technological knowledge and introduce technological innovations and to increase the viability of market coordination. So far intellectual property right are institutions designed to create markets and hence make possible all the advantages of unplanned and spontaneous coordination among agents, in terms of dissemination of information and incentives, signaling of new opportunities, division of labor and specialization. By means of intellectual property rights impersonal transactions can take place and the traditional coordination among agents within markets and among markets can take place without further public intervention. Intellectual property rights can be considered a market-creating activity: property

rights on inventions make it possible to trade them with all the well known advantages in terms of division of labor and hence specialization and productivity. Resources can be allocated in the factor markets and knowledge can be exchanged both in the product markets and in the markets for intermediary production factors. Agents and firms can specialize in the generation of knowledge modules where each has a comparative advantage. Markets for knowledge both as an intermediary input for the production of new knowledge and as an input for the introduction of new technologies can flourish.

Intellectual property rights granted to inventors, lead to monopolistic market power in the markets for the products that use the new knowledge. Such monopolistic power provides incentives to innovators to undertake risky activities finalized to the introduction of innovations. Monopoly makes it possible to increase both incentives and resources to the generation of new knowledge via the increased appropriability based on legal barriers to imitation. Now inventors are less scared by the risks of uncontrolled leakage of their knowledge and have an appropriate incentive to invest resources in research activities. Moreover the rents stemming from the now proprietary knowledge can be used to fund additional research and hence the creation of further knowledge.

Patents play a major role as signaling devices, which help the identification of the available bits of complementary knowledge and their owners so as to reduce search costs. With a weak intellectual property right regime in fact the holders of each bit of knowledge have much a stronger incentive rely upon industrial secrets as a way to reduce the informational leakage with the radical reduction of the dissemination of the relevant bits of disembodied knowledge. Secrecy, the alternative to intellectual property rights, to secure exclusive ownership can have dramatic effects generally in terms of networking costs and specifically in the form of technological communication costs, and hence upon the amount of knowledge complementarities which can be effectively activated (Arundel, 2001).

Intellectual property rights moreover are a remedy to tight vertical integration between the generation of new technological knowledge and its application to the production of new goods or to new production

processes. The public good nature of technological knowledge pushes the knowledge-creating firm to use it as an intermediary input for the sequential production of economic goods. Vertical integration and direct embodiment of technological knowledge within the borders of a single company in the production of goods limits severely the emergence of the markets for knowledge as a good per se, with negative consequences in terms of reduced scope of application of technological knowledge. When technological knowledge has high levels of fungibility, i.e. has a wide scope of application, vertical integration has strong negative effects as it impedes the valorization of such a broader array of possible applications.

In conclusion intellectual property rights perform many positive functions in the economic system. First, they favor appropriability, and hence secure rewards to inventors. In so doing intellectual property rights help increasing the incentives for the creation of technological knowledge and provide resources for its generation. Second, they favor the dissemination of knowledge as they make publicly available the information about new technological advances. In so doing patents act as powerful signaling devices that may favor the distribution of resources among a variety of possible directions in the activities geared towards the efficient generation of new technological knowledge (Landes and Posner, 2003). Thirdly, they reduce the incentives to embody directly, by means of downstream vertical integration into the production of goods that use the new knowledge, and hence they limit the negative effects in terms of reduced scope of application of knowledge, especially when it has high levels of fungibility. Finally, they improve the viability of the markets for knowledge and facilitate the interactions among holders of bits of complementary knowledge. Patents in fact can help reducing knowledge transactions costs in the markets for knowledge because they reduce information asymmetries, the risks of opportunistic behavior and make it easier for demand and supply to meet by means of impersonal transactions in market place where a large number of customers and sellers interact. Hence effective property right systems favor the creation of specialized and dedicated markets for disembodied technological

knowledge where the firms can specialize in the production of knowledge as a good per se (Arora, Gambardella and Fosfuri, 2001).

Intellectual property rights however have many shortcomings and undesired effects. The literature has been adding new analytical evidence about many such negative effects (Machlup and Penrose, 1950; David, 1993; Kingston, 2001).

The first knowledge tradeoff

The foundations of the first tradeoff between dynamic efficiency and static inefficiency are laid down in the context of competitive analysis. The first tradeoff consists in the identification by means of a classical cost-benefit analysis of the balance between the increased dynamics efficiency provided by patents, by means of increased appropriability and hence larger incentives to fund the production of knowledge, and the loss in static efficiency determined by patents, as ingredients for the creation of monopolistic market power in the markets for goods.

Monopolistic power, as it is well known, reduces static efficiency. Firms can charge monopolistic prices and hence appropriate a large share of the total surplus stemming from the introduction and application of new knowledge. The understanding of the increased monopolistic market power engendered by intellectual property rights suggests to limit the scope for patents and their duration.

The first tradeoff has been traditionally regarded as a transient problem. The monopolistic market power in the markets for products based upon proprietary technological knowledge and the technological innovations stemming from its implementation was deemed to be temporary because of the Schumpeterian assumptions about the irreversible flows of entry of new competitors attracted by extra-profits and able to inventaround and imitate the original technological knowledge of the early incumbent. Hence the welfare losses generated by the divergence between marginal and average costs were assumed to be short lived. The short-term duration of monopolistic power in the markets for goods manufactured with the new knowledge seemed to be a solution to the tradeoff between dynamic and static efficiency.

The second knowledge tradeoff

The second knowledge tradeoff is identified as a result of a closer analysis of the implications of the notion of knowledge indivisibility. The new approach is based upon the discovery of knowledge cumulability, i.e. the diachronic complementarity between different vintages of knowledge. Following Newton much emphasis is now given to a famous sentence of the English scientist: "To make science means standing on giants' shoulders". Intellectual property rights limit the access to the new vintages of knowledge, at least for a considerable period of time: in so doing they delay the possibility for new generations of dwarfs to climb upon the shoulders of previous giants.

Intellectual property rights now are seen not only as the cause of the static inefficiency associated with monopolistic market power stemming from patents, but as a source of dynamic inefficiency as well. Intellectual property rights in fact increase the incentives to generate new knowledge, but may reduce dramatically the efficiency of the generation activity. Intellectual property rights in fact limit the vertical or diachronic dissemination of knowledge: the access and use of prior vintages of knowledge are put at risk. The efficiency of the generation of new technological knowledge is now reduced by the delays in the access to the last vintage of knowledge. The new generations of inventors cannot rely upon the last progress being made. Hence additional resources are necessary to rediscover what has been already invented. Duplication of efforts can take place. In the extreme case the generation of new knowledge can be actually inhibited by the duration of the life of the exclusive property rights assigned by patents to inventors. Intellectual property rights limit the working of knowledge cumulability (Scotchmer, 2004).

The third knowledge tradeoff

A third knowledge tradeoff has been recently identified when the analysis of the indivisibility of knowledge has made it possible to appreciate the role of external knowledge as an essential intermediary input in the production process of new knowledge. The generation of technological knowledge is now considered to be characterized by relevant externalities,

both technical and pecuniary. External knowledge is now viewed as an indispensable and necessary input into the generation of new knowledge by each agent, As a consequence the non-appropriability of knowledge has not only negative effects but also positive ones. The access to knowledge spilling from inventors helps others to inven (Antonelli, 2001).

According to the localized technological change approach, technological change is the emergent property of an economic system, if, when and where the latent complementarities among the fragmented bits of indivisible knowledge possessed by a myriad of agents dispersed and isolated, are valorized and exploited. The actual chances of generating a new relevant bit of knowledge for each agent depend upon the levels of accumulation of skills and competence, education and access to information and knowledge originally implemented by the other agents in the community. The empirical evidence gathered in the applied economics of knowledge confirms that the knowledge complementarity among agents matters in implementing the rates of generation of new knowledge and hence in the introduction of innovation (Antonelli, 2008).

The building blocks of this approach can be summarized as it follows: a) Knowledge is at the same time an output of a dedicated generation process and an input in the generation of further knowledge; b) Because of knowledge indivisibility, at each point in time the modules of technological knowledge possessed by each agent have high levels of complementarity both with other modules of prior technological knowledge possessed by other firms and parallel knowledge being implemented by other firms; c) No firm can claim to be able to command all the relevant knowledge; d) External knowledge is an indidpensable input in the production process of new knowledge; e) The access to existing knowledge is a key condition for the actual generation of new knowledge (Antonelli, 2003 and 2007).

Both the horizontal or synchronic and vertical or diachronic dissemination of knowledge are put at risk by strong intellectual property rights regimes. Poor dissemination and high exclusivity put at risk the access to external knowledge for each agent and hence the working of knowledge complementarity. Hence additional resources are necessary to rediscover what has been already invented elsewhere at the same time.

Duplication of efforts can take place. This reduces the future flow of additional units of new knowledge.

In sum, intellectual property rights have clear advantages as market-creating institutions that favor the identification of the correct levels of incentives, the allocation of resources, the exchange in the market place of knowledge modules and hence higher levels of specialization and efficiency. Intellectual property rights however engender at least three classes of negative effects. First, monopolistic power in the markets for the products embodying the new knowledge with clear losses in terms of static efficiency. Second, the efficiency in the generation of new knowledge is reduced by the delays in the dissemination of prior knowledge, associated to the duration of patents. Such delays last as long as knowledge is made proprietary by patents. Third, the efficiency in the generation of new knowledge is hampered by the limitations in the access to complementary sources of knowledge being generated in parallel at each point in time.

Intellectual property rights are a necessary institution for the enhancement of the social capability to generate new technological knowledge. The present intellectual property rights however needs to be improved in order to take advantage of the potential for increasing returns in the generation of new knowledge stemming from knowledge cumulability and knowledge complementarity and consequent knowledge externalities. It seems clear that the present intellectual property right regime impedes the working of such external increasing returns. A strong contradiction takes place between the need to remunerate the generation of knowledge and the need to increase its dissemination and recombination.

3. The optimum level of knowledge rents

The amount of innovations being introduced depends both on the levels of knowledge rents and upon the costs of knowledge. Knowledge royalties, secured by exclusive intellectual property rights in fact, as it is well know, are an important mechanism by means of which it is possible to

reward inventors and hence a mechanism that makes it possible to articulate incentives, favor trade and to provide funds towards the generation of new knowledge. The limitations to the access to external knowledge engendered by exclusive property rights and the levels of royalties granted to inventors however increase the costs of production of new knowledge. Hence exclusive property rights and knowledge royalties on the one hand increase the profitability of inventions, but on the other have negative effects upon the cost of the generation of new knowledge. From a social viewpoint it is clear that their combined effect should be assessed so that the 'correct' amount of rents could be identified.

In this perspective it becomes clear that the the levels of knowledge rents associated with intellectual property rights should be identified taking into account both, their positive effects in terms of incentives to the introduction of new technological innovations, and their negative effects in terms of decreased efficiency in the generation of new knowledge. The net social surplus, stemming from the introduction intellectual property rights, in other words, is the result of joint consideration of both positive and negative effects of exclusive intellectual property rights.

Let us specify formally the points articulated so far, in the following simple model based upon three elementary equations, where KC are the unit cost of the production of knowledge and KR are the unit knowledge rents that inventors can appropriate by means of intellectual property rights. Both KC and KR are a function of the levels of royalties and exclusivity (RE):

(1) KC = a (RE)
(2) KR = b (RE)
(3) Π = KR (RE) - KC (RE)

Assuming that both a' and b' are positive and that a"<b" the traditional profit maximization procedure applies and makes it possible to identify the maximum amount of rents that inventors should receive and hence the maximum amount of knowledge that an economic system can achieve by means of the tuning of the levels of rewards assigned to inventors and the exclusivity of intellectual property rights. The optimum

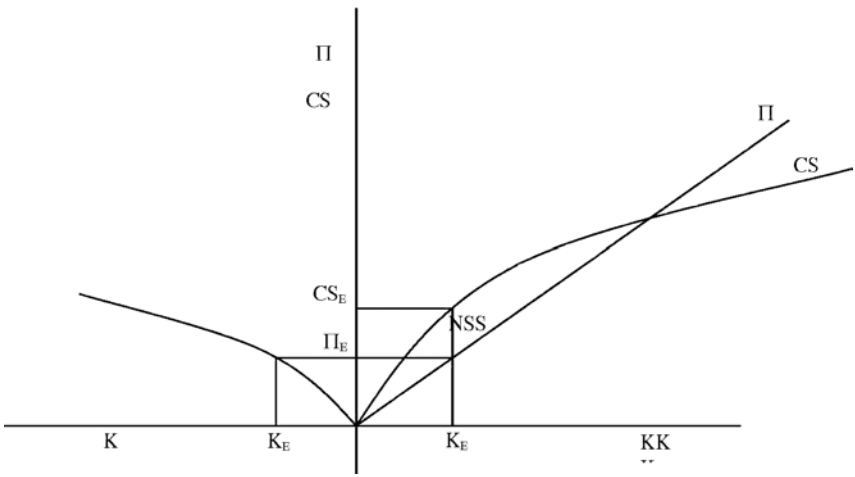
amount of knowledge rents is clearly identified where dKC/dRE= dKR/dRE..With such a combination of knowledge costs and knowledge rents, the system will be able to generate the 'correct' amount of technological knowledge.[1]

Diagram 1 provides the traditional graphic expression of the profit maximization and helps the identification of the optimum levels of knowledge exclusivity and royalties an economic system can afford in order to obtain the optimum rate of generation of technological knowledge.

This simple procedure can be applied empirically so as to take into account the actual effects of knowledge royalties and exclusivity on both knowledge revenues and knowledge costs, according to the specificities of the national, industrial, regional context of analysis. The variety of innovation systems can enrich the application of the basic intuition so as to enable the tuning of intellectual property rights conditions according to the local characteristics.

Appropriate tuning of the characteristics of intellectual property rights can lead to increase the benefits associated with patents and reduce their costs with a clear positive social effect.

DIAGRAM 1: THE TRADE-OFF OF INTELLECTUAL PROPERTY RIGHTS



The application of the notion of essential facility to the economics of knowledge and the implementation of the liability rule in the design

of intellectual property rights can help to implement this approach (Reichman, 2001; Antonelli, 2007).

4. Conclusions

The debate on the knowledge tradeoff has been reviewed and the need for a reconsideration of the present intellectual property right regime has been articulated.

From a social viewpoint it is clear that the levels of knowledge rents are not a goal per se, but only a tool. Knowledge rents have been identified as a social cost that is necessary to bear in order to stir and fund the generation of new technological knowledge and yet should be minimized. The correct levels of knowledge rents can be identified when both their positive and the negative effects of the intellectual property regime are assessed and compared

The present intellectual property right regime should be reconsidered From a welfare point of view the maximization of the rate of generation and use of technological knowledge is the single acceptable target.

Notes

[1] This model complements the one based upon the analysis of the deived demand for knowledge elaborated in Antonelli (2007).

O trade-off dos direitos de propriedade intelectual reconsiderado

Resumo: Os direitos de propriedade intelectual tem um efeito duplo sobre o sistema econômico. De um lado, eles favorecem a introdução de novo conhecimento tecnológico. De outro, reduzem a competição e, com freqüência, podem limitar o ritmo de introdução de novo conhecimento. Entre tales efeitos positivos e negativos tem lugar um "tradeoff". A aplicação das noções de serviços

essenciais e regras de responsabilidade legal à economia do conhecimento podem corrigir o balanço entre esse tradeoff e contribuir no ritmo de avanço de conhecimento tecnológico e de seu uso efetivo no sistema econômico. O refinamento dos direitos de propriedade exclusiva faz possível minimizar as rendas do conhecimento e favorecer a disseminação e o uso de conhecimento no sistema econômico tomando a vantagem de sua comutatividade intrínseca e da sua complementaridade.

Palavras-chave: Rendas do conhecimento; regimes sobre direito de propriedade intelectual; serviços essenciais; regras de responsabilidade.

References

ANTONELLI, C. *The microeconomics of technological systems*. Oxford: Oxford University Press, 2001.

_____. *The economics of innovation, new technologies and structural change*. Londres: Routledge, 2003.

ANTONELLI, C. "Knowledge as an essential facility". In Journal of Evolutionary Economics, 17, 451-471, 2007.

ANTONELLI, C. *Localized technological change: Towards the economics of complexity*, London: Routledge, 2008.

ARORA, A.; FOSFURI, A.; GAMBARDELLA, A. *Markets for technology. Cambridge*: The MIT Press, 2001.

ARROW, K.J. "Economic welfare and the allocation of resources for invention". In: Nelson, R.R. (org.) *The rate and direction of inventive activity: Economic and social factors*. Princeton: Princeton University Press for N.B.E.R, 1962. 609-625.

ARUNDEL, A. "The relative effectiveness of patents and secrecy for appropriation". In: *Research Policy* 30: 611-624, 2001.

DAVID, P.A. "Knowledge property and the system dynamics of technological change". In: *Proceedings of the World Bank Annual Conference on Development Economics*. Washington: The World Bank, 1993.

KINGSTON, W. "Innovation needs patents reforms". In: *Research Policy* 30: 403-423, 2001.

LANDES, W.; POSNER, R. *The economic structure of intellectual property law*. Cambridge: The Belknap Press of Harvard University Press, 2003.

MACHLUP, F.; PENROSE, E. "The patent controversy in the nineteenth century". In: *Journal of Economic History* 10: 120, 1950.

REICHMAN, J. "'Of green tulips and legal kudzu': Repackaging rights in subpatentable invention". In: *Vanderbilt Law Review* 53: 17-43, 2000. Reimpresso em DREYFUSS, R.; ZIMMERMAN, D. (orgs.) *Expanding the boundaries of intellectual property*. Oxford: Oxford University Press, 2001.

SCOTCHMER, S. *Innovation and incentives*. Cambridge: MIT Press, 2004.

Recebido para publicação em março de 2008
Aprovado para publicação em abril de 2008