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COMPLEMENTARY RESEARCH STRATEGIES, FIRST-MOVER ADVANTAGE AND THE INEFFICIENCY OF PATENTS

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ABSTRACT

In a realistic framework where the potential innovators' research lines are imperfectly correlated and imitation takes some time, this paper studies an industry regulated by an authority which can tax (subsidize) the firms' pure profits (R&D expenditures). By comparing the market equilibrium emerging when there is patent protection with the market equilibrium emerging without patents, the paper finds that social welfare is higher in the absence of patents. This result is driven by the fact that—without patents--more than one successful inventor may implement its discovery and enter the market, thus reducing the deadweight loss due to imperfect competition.

Keywords: Innovation, temporary monopoly, lead time, market regulation, patents.

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1 INTRODUCTION

The fundamental trade-off between the incentive to invent and the welfare loss due to imperfect competition was already emphasized by pioneering works on the role of patents in fostering innovation (see Nordhaus, 1969; Scherer, 1972). This trade-off arises because of the non-rival character of knowledge, which implies that an invention loses any economic value for its inventor once it is known and no legal barrier prevents its free use. The imposition of this legal protection guarantees (temporary) market power to the inventor in the exploitation of its invention, thus rewarding his efforts, but in the same time it causes the social inefficiency that is typical of monopoly.

In the last two decades, however, empirical studies have challenged the idea that patents are crucial in providing incentives to innovators. The evidence appears consistent with the view that the knowledge incorporated in production processes and products is difficult to imitate: secrecy and lead time seem to play a role more important than patents in protecting the fruits of inventive efforts and R&D investment (see Levin et al., 1987; Cohen et al., 2000).[1] This paper intends to show that more efficient outcomes can be reached by relying on these market mechanisms, possibly combined with policy instruments such as the taxation of firms' pure profits or the subsidization of firms' R&D expenditures, rather than by a patent regime. The paper's formal analysis is conducted in a framework that can be considered the most realistic for dealing with innovation, namely in an environment where imitation takes some time, thus giving a first-mover advantage to inventors, and potential innovators' research lines are not perfectly correlated, thus creating some complementarity among them.

The set-up presented in the paper follows Bessen and Maskin (2000) in emphasizing that in general the firms' innovative activity is characterized by the existence of some complementarity among the research strategies of different potential innovators: having independent research units

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[1] For a recent review of the empirical and theoretical literature on the role of patent regimes in fostering innovation, see Encaoua et al. (2005).

that pursue the same technological goal raises the probability that someone will succeed. An obvious implication of this complementarity is that the duplication of research efforts is not necessarily socially inefficient. However, under a regime with patents, only one firm can get the patent and act as a monopolist. Hence, no additional social value is created when more than one firm discovers the innovation. This is not true in the absence of patent protection, since in this case all the firms that have discovered the innovation can implement it and enter the product market, thus reducing the deadweight loss due to imperfect competition. Bessen and Maskin (2000) neglect this effect and, therefore, find that a regime without patent protection is socially preferable to a regime with patents only in the presence of sequential innovation, namely only when each successive invention builds on the preceding one. In contrast, the model presented here accounts for the fact that the social value generated by an innovation depends on the degree of ex-post competition, i.e., it increases with the number of successful innovators competing in the market. Consequently, the model shows that social welfare is higher in the absence of patent protection than with patents even when there is no sequential innovation.

One could argue that a regime with no patent protection but with lead time allowing successful innovators to make pure profits is practically equivalent to a permissive patent regime in which independent invention is a valid defense in cases of infringement (see La Manna et al., 1989; Maurer and Scotchmer, 2002). This is not actually the case, since by patenting an invention a firm discloses its technology, thus making practically impossible for a third party to distinguish between genuine claims of independence and fraudulent ones. Moreover, in contrast with Maurer and Scotchmer (2002), which claim that the defense of independent invention improves efficiency also by lowering the firms' incentive to enter the patent race, the model presented here shows that the absence of patent protection exacerbates the market's tendency to under-invest in R&D in all those circumstances in which the market-determined number of firms undertaking R&D is inefficiently low even in the presence of patent protection.

Given the possibility--both in the regime with patent protection and in the regime without it—that the market-determined number of firms undertaking R&D is different than the socially optimal one, the public authority may use the taxation of firms' pure profits (when the market-determined number of firms undertaking R&D is inefficiently large) or the subsidization of firms' R&D expenditures (when it is inefficiently low) to cure the market failure. While R&D subsidization has been examined in the literature and advocated for its efficiency (Spence, 1984), usefulness as a supplemental policy tool (Romano, 1989) or for its transparency (Romer, 2002), the optimal use of a tax on pure profits as an instrument to reduce the number of potential innovators and the market's tendency to over-invest in R&D has not been object of much interest. As a matter of fact, even the literature on public finance has not devoted particular attention to this subject.[2] Therefore, the current paper studies the possibility of supplementing a regime with patent protection and a regime without it by a tax on pure profits or by a subsidy to R&D expenditure.

The paper is organized as follows: Section 2 presents the model; section 3 and 4 analyze, respectively, the regime characterized by patent protection and the regime characterized by the absence of patent protection; section 5 concludes.

2 THE MODEL

2.1 Market demand

We consider the industry producing the good X. The market demand for X is given by

$$X=\beta-\gamma P,\ \beta>0,\ \gamma>0, \tag{1}$$

where P is the market price of good X.

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[2] It is significant that both a general theoretical treatment of the distortions introduced and corrected by taxation (Auerbach and Hines, 2002) and a general analysis of the implications and possible reforms of the corporate income tax (Devereux and Sørensen, 2006) ignore the issue.

2.2 Production

In this industry each firm can produce X by utilizing the following constant-returns-to-scale technology:

$$x = A_i L^{\alpha} K^{1-\alpha},\ 0 < \alpha < 1,\ i=o,h, \tag{2}$$

where x is the quantity of X produced by each firm, A_i is the state of technology, L is labor and K is the stock of capital. As in Dasgupta and Stiglitz (1980), there is the possibility of implementing a process innovation: a firm that implements this innovation has a higher total factor productivity than a firm which does not innovate, i.e., the state of technology of the former is A_h, while the state of technology of the latter is A_o, where $A_h > A_o$.

The cost of using an unit of labor, w, and the cost of using an unit of capital, r, are given for the firms operating in the industry producing X. Hence, the minimum cost of producing x for a firm is the following

$$c(x, C, A_i) = \frac{C}{A_i} x,\ C \equiv w^{\alpha} r^{1-\alpha}\left[\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} + \left(\frac{\alpha}{1-\alpha}\right)^{-\alpha}\right],\ i=o,h. \tag{3}$$

2.3 Market equilibria

If all firms utilize the same technology, then every firm's has the same cost function. Hence, a large number of identical firms operate in this industry and the market for good X is perfectly competitive. Thus, the equilibrium price of good X is equal to the firms' marginal cost:

$$P^i = \frac{C}{A_i},\ \frac{C}{A_o} < \frac{\beta}{\gamma},\ i=o,h. \tag{4}$$

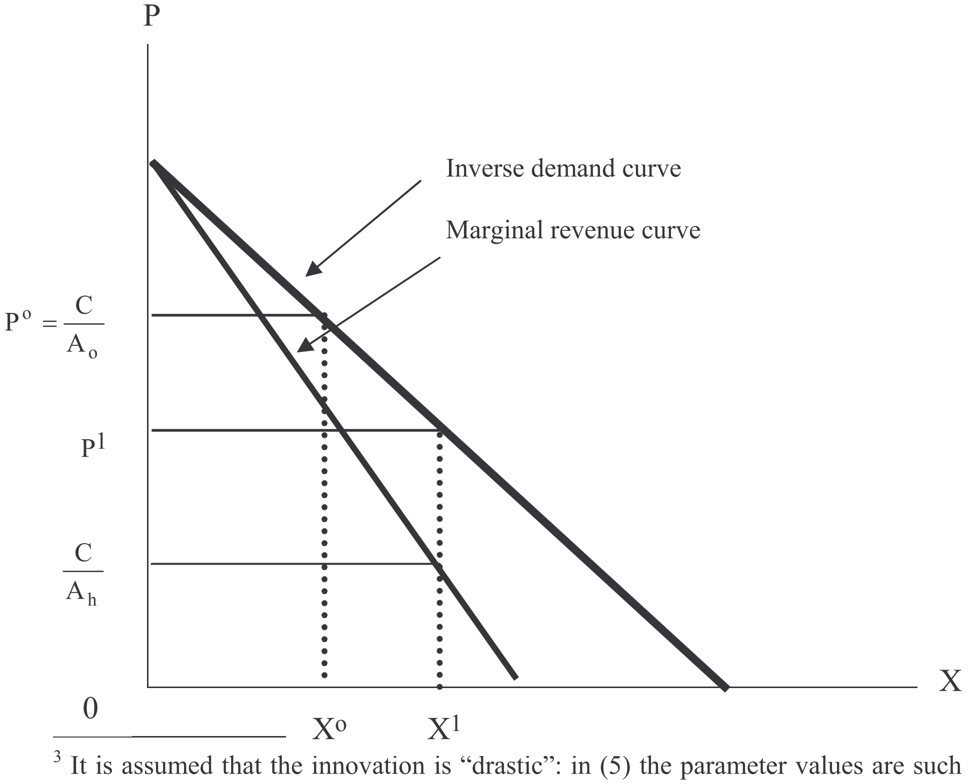
Consistently, the producer's surplus is zero ($PS^i=0$), and the consumers' surplus is given by $CS^i = \frac{1}{2\gamma}\left(\beta - \frac{\gamma C}{A_i}\right)^2$, i=o,h, where PS^o (PS^h) and CS^o (CS^h) are, respectively, the producer's surplus and the consumers' surplus when no (every) firm operating in the industry implements the innovation.

In the case in which only one firm implements the innovation, the equilibrium price is

$$P^1 = \frac{\beta}{2\gamma} + \frac{C}{2A_h}, \quad \frac{C}{A_o} > \frac{\beta}{2\gamma} + \frac{C}{2A_h}. \tag{5}$$

In this case, the innovator acts as a monopolist on the market for X, since it is not convenient for any firm operating with the less efficient technology to compete with the innovator. Moreover, note that the consumers are better off than in the absence of innovation.[3] Indeed, under monopoly, the producer's surplus is equal to $PS^1 = \frac{1}{4\gamma}\left(\beta - \frac{\gamma C}{A_h}\right)^2$, where $PS^1 > PS^o = PS^h = 0$, and the consumers' surplus is given by $CS^1 = \frac{1}{8\gamma}\left(\beta - \frac{\gamma C}{A_h}\right)^2$, where $CS^h > CS^1 > CS^o$. It is straightforward that the social benefit generated by the industry when only one firm implements the innovation is strictly larger than the social benefit generated when no firm implements the innovation and strictly lower than the social benefit generated when all firms implement the innovation: $CS^h > PS^1 + CS^1 > CS^o$ (see Fig.1).

FIGURE 1 Monopoly pricing under patented innovation



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[3] It is assumed that the innovation is "drastic": in (5) the parameter values are such that the monopoly price is strictly lower than the firms' marginal (and average) cost in the absence of innovation.

We assume that in the case in which a relatively small number N of firms implement the innovation, $N \geq 2$, they act as Cournot oligopolists on the market for X. Also in this case, indeed, it is not convenient for any firm operating with the less efficient technology to compete with the innovators. Hence, in a Cournot oligopoly with N symmetric firms, the equilibrium price is

$$P^N = \frac{\beta}{(N+1)\gamma} + \frac{NC}{(N+1)A_h}, \tag{6}$$

the producers' surplus is equal to $PS^N = \frac{N}{(N+1)^2\gamma}\left(\beta - \frac{\gamma C}{A_h}\right)^2$, where $PS^o = PS^h < PS^N < PS^{N\text{-}1}$, and the consumers' surplus is given by $CS^N = \frac{N^2}{2\gamma(N+1)^2}\left(\beta - \frac{\gamma C}{A_h}\right)^2$, where $CS^h > CS^N > CS^{N\text{-}1} > CS^o$, $2 \leq N < \infty$. One may easily check that the social benefit generated by the industry when N firms implement the innovation is strictly larger than the social benefit generated when N-1 firms implement the innovation, $2 \leq N < \infty$: $CS^h > PS^N + CS^N > PS^{N-1} + CS^{N-1} > CS^o$, although $PS^N < PS^{N-1}$. It is intuitive, indeed, that the presence of a greater number of firms adopting the more efficient technology reduces the market power of each producer, thus decreasing both the producers' surplus and the social loss due to imperfect competition.

2.4 R&D activity

There is free entry, in the sense that there is an unlimited number of firms which may decide to undertake R&D so as to develop the innovation that improves the existing technology. The cost of undertaking R&D is fixed and indivisible, and if a single firm incurs this cost d, the probability that it makes the discovery improving the state of technology from A_o to A_h is q.[4] Following Bessen and Maskin (2000), we assume that there is complementarity among the research lines of the potential (risk-neutral) innovators, in the sense that these lines are not perfectly correlated and

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[4] Following Bessen and Maskin (2000), we assume for simplicity that a firm's R&D decision is a binary choice: to do it or not to do it.

thereby a greater number of firms investing in R&D enhances the probability that a discovery occurs within a given time. Again following Bessen and Maskin (2000), we model this complementarity by assuming that, if more than one firm undertakes R&D, the event that one of these firms is successful is statistically independent of that of any other firm undertaking R&D.[5] Hence, the total probability of improving the state of technology is:

$$[1-(1-q)^{M}], \tag{7}$$

where M is the number of firms investing in R&D.

3 PATENTS

3.1 Net social benefit from R&D activities

In this section we assume that there are patents and that they give perfect protection to discoveries. Moreover, it is assumed that only one firm obtains the patent even if it is not the only firm that makes the discovery: if more than one firm makes it, one may think that the patent is granted to the firm that makes the discovery first (“winner takes all”), or—alternatively--one may think that the patent is granted at random to one of the firms making the discovery. As Bessen and Maskin (2000) point out, the assumption that only one firm can obtain the patent gets at the idea that patents have *breadth*, so that a patent holder can block the implementation of other firms’ discoveries that are similar, but not identical, to its own. Under these assumptions, the patent holder can act as a monopolist in the market for good X, and the net social benefit that one can expect to get from the industry producing X when M firms invest in R&D is the following:

$$[1-(1-q)^{M}]\left(PS^{1}+CS^{1}\right)+(1-q)^{M}CS^{o}-Md\,,\ M\geq 1. \tag{8}$$

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[5] Obviously, the assumption that a single firm’ success is statistically independent of that of any other firm undertaking R&D is sufficient but not necessary for complementarity. Thus, it can be relaxed without undermining the conclusions of the paper.

It is worth to emphasize that the expected social benefit generated by M firms investing in R&D would be larger if more than one firm could utilize the newly discovered technology, thus reducing the deadweight loss due to monopoly.

3.2 Socially optimal number of firms investing in R&D

Given (8), it is socially optimal to have at least one firm investing in R&D if and only if

$$d \leq q\left(PS^1 + CS^1 - CS^o\right). \tag{9}$$

However, the complementarity among the firms' R&D activities implies that it may be socially efficient to have more than one firm investing in R&D. Indeed, assuming that (9) holds, the socially optimal number of firms undertaking R&D, say M*, is that integer value of M≥1 satisfying

$$q(1-q)^M\left(PS^1 + CS^1 - CS^o\right) < d \leq q(1-q)^{M-1}\left(PS^1 + CS^1 - CS^o\right), \tag{10}$$

where the first term is the increment in the expected social benefit due to an additional firm investing in R&D when M firms are already undertaking R&D, the second term is the increment in social cost due to an additional firm investing in R&D, and the third term is the expected social benefit due to an additional firm investing in R&D when M-1 firms are already undertaking R&D. Note that the uniqueness of M* is guaranteed by the fact that the increment in the expected social benefit due to an additional firm investing in R&D declines with M, while the increment in social cost due to an additional firm investing in R&D is constant.

3.3 Market-determined number of firms investing in R&D

The patent holder does not appropriate the entire social benefit created by the innovation, since a portion of this benefit is appropriated by the consumers. Indeed, the net return that a firm expects from its investment in R&D is given by

$$\frac{[1-(1-q)^M]}{M} PS^1 - d\,,\ M \geq 1, \tag{11}$$

where each of the M firms undertaking R&D has a probability $\frac{[1-(1-q)^M]}{M}$ of getting the patent. Note that this probability decreases with M.

Clearly, a firm invests in R&D only if (11) is positive. Hence, the equilibrium number of firms undertaking R&D, say M', is equal to zero if $d > qPS^1$ or to that integer value of $M \geq 1$ satisfying

$$\frac{[1-(1-q)^{M+1}]}{M+1} PS^1 < d \leq \frac{[1-(1-q)^{M}]}{M} PS^1 \ \text{ if } d \leq qPS^1 . \qquad (12)$$

Again, M' is unique because a firm's probability of getting the patent decreases with M, while the private cost of investing in R&D is not affected by M.

Differently than in Bessen and Maskin (2000), where in the static model with patents the equilibrium level of innovative activity is greater than or equal to the social optimum, the following proposition holds:

Proposition 1 With patents, the market-determined number of firms undertaking innovative activity is greater than, equal to, or smaller than the social optimum, i.e., $M^* \overset{\leq}{>} M'$.

Proof: Numerical examples show that $M^* \overset{\leq}{>} M'$.[6]

The difference with respect to Bessen and Maskin (2000) depends on the more realistic framework that we consider, in which the patent holder cannot appropriate the entire increment in social welfare due to a successful innovation.

3.4 Optimal regulation

The possibility that the market equilibrium displays over-investment or under-investment in R&D in the presence of patents raises the question of how a regulator can intervene to eliminate the market inefficiency. One may think of a tax on pure profits as the natural instrument to cure the

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[6] Let $C=A_o=1$, $\beta=A_h=2$, $\gamma=1.5$, $d=0.035$, $q=0.5$. Given these parameter values, one has: $CS^o=0.0833333$, $CS^1=0.1302083$, $PS^1=0.2604166$, $M^*=3<M'=7$. Let $C=1$, $A_o=0.8$, $\beta=2$, $A_h=4$, $\gamma=1.5$, $d=0.09$, $q=0.25$. Given these parameter values, one has: $CS^o=0.005208333$, $CS^1=0.220052$, $PS^1=0.4401041$, $M^*=3>M'=2$.

market inefficiency when the market tends to over-invest in R&D and of a subsidy proportional to the expenditure in R&D as the instrument to cure under-investment.[7]

Assuming that M*<M' (over-investment) and that the regulatory authority introduces a tax on pure profits, the net (after-tax) return that a firm expects from its investment in R&D becomes

$$\frac{[1-(1-q)^{M}]}{M}(PS^{1}-d)(1-t)-\frac{(1-q)^{M}}{M}d,\ 0\leq t\leq 1,\ M\geq 1, \tag{13}$$

where t is the tax rate. In (13), the first term represents the firm's (after-tax) pure profits weighted by the probability that a firm investing in R&D gets the patent, while the second term represents the expected loss if it invests in R&D but does not get it.

Again, a firm invests in R&D only if (13) is positive. Hence, the optimal t, say t*, is that value of t satisfying[8]

$$\frac{[1-(1-q)^{M^*+1}]}{M^*+1}[PS^{1}(1-t)+td]<d\leq\frac{[1-(1-q)^{M^*}]}{M^*}[PS^{1}(1-t)+td],\ M\geq 1. \tag{14}$$

In sum, a tax on pure profits works by affecting the firms' expected net returns from investing in R&D. As M*<M', it can be calibrated so as to induce exactly M* firms to undertake R&D.

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[7] In the presence of a tax on pure profits (or of a subsidy proportional to R&D expenditure) and asymmetric information between the authority and private agents, the latter are tempted to report pure profits below (or R&D expenditures above) their true value. This problem of opportunistic behavior is very common in public finance and must be taken into account while designing the optimal use of tax and subsidy instruments to cure market distortions. For simplicity, the model ignores this issue, whose treatment is beyond the scope of this paper.

[8] For simplicity, we assume that the weight attached to the tax revenue in the social welfare function is the same as that attached to the consumers' surplus, to the producers' surplus or to the R&D expenditures. In other words, we assume that the social value of the reduction in other taxes and/or of the increase in public expenditure made possible by the tax on the monopolist's profits is the same as the social value of the consumers' surplus, the monopolist's profits and the other potential innovators' R&D expenditures. Thus, the optimal t maximizes $\left[q\sum_{i=1}^{M}(1-q)^{i-1}\right][(PS^{1}-d)(1-t)+CS^{1}]+\left[1-q\sum_{i=1}^{M}(1-q)^{i-1}\right](CS^{o}-d)-(M-1)d+\left[q\sum_{i=1}^{M}(1-q)^{i-1}\right]t(PS^{1}-d)$, which is equal to (8). Clearly, the model can account for a social welfare function characterized by different weights.

Assuming that M*>M’ (under-investment) and that the regulatory authority introduces a subsidy proportional to the expenditure in R&D, the net return (inclusive of the subsidy) that a firm expects from its investment in R&D becomes

$$\frac{[1-(1-q)^{M}]}{M}PS^{1}-(1-s)d,\ 0\le s\le 1,\ M\geq 1, \tag{15}$$

where s is the fraction of the R&D expenditure that the authority reimburses to all firms investing in innovation.

Since a firm invests in R&D only if (15) is positive, the optimal s, say s*, is that value of s satisfying[9]

$$\frac{[1-(1-q)^{M^*+1}]}{M^*+1}PS^{1}<(1-s)d\le\frac{[1-(1-q)^{M^*}]}{M^*}PS^{1},\ M\geq 1. \tag{16}$$

In sum, a subsidy works by affecting the firms’ cost of investing in R&D. As $M^*>M'$, it can be calibrated so as to induce exactly M* firms to undertake R&D.

4 NO PATENT PROTECTION

4.1 Net social benefit from R&D activities

In this section we assume that discoveries have no patent protection and that all the firms which make the discovery can implement it. The firms which do not make the discovery cannot imitate instantaneously the innovative firms: in the absence of any patent protection imitation is cost free but takes some time since the innovators are not bound to reveal any information about their

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[9] For simplicity, we assume that the weight attached to the subsidies in the social welfare function is the same as that attached to the consumers’ surplus, to the producers’ surplus and to the portion of R&D expenditures which is paid by the firms. In other words, we assume that raising funds for subsidies does not create any particular distortion. Thus, the optimal s maximizes $\left[q\sum_{i=1}^{M}(1-q)^{i-1}\right]\left(PS^{1}+CS^{1}\right)+\left[1-q\sum_{i=1}^{M}(1-q)^{i-1}\right]CS^{o}-M(1-s)d-Msd$, which is equal to (8). Again, the model can account for a social welfare function that takes into account the possible distortions generated by the taxes necessary to finance the R&D subsidies.

invention. Under these circumstances, every firm making the discovery can act temporarily as an oligopolist (or as a monopolist if only one firm makes it). Once imitation occurs, perfect competition is re-established in the market for good X. Therefore, the net social benefit that one can expect to get from the industry producing X in the absence of patents when M firms invest in R&D is the following:

$$\theta\sum_{i=1}^{M}\prod_{j=0}^{i-1}(M-j)\frac{(PS^{i}+CS^{i})q^{i}(1-q)^{M-i}}{i!}+(1-\theta)[1-(1-q)^{M}]CS^{h}+(1-q)^{M}CS^{o}-Md\,,\ M\geq 1, \quad (17)$$

where θ, $0<\theta\leq 1$, is the fraction of time in which only the firm(s) that made the discovery can utilize the more advanced technology and 1-θ is the fraction of time in which all firms are able to apply it.[10]

The following proposition applies:

Proposition 2 The net social benefit that one can expect to get when M firms invest in R&D is higher in the absence of patents than in the presence of patents, i.e.,

$$\theta\sum_{i=1}^{M}\prod_{j=0}^{i-1}(M-j)\frac{(PS^{i}+CS^{i})q^{i}(1-q)^{M-i}}{i!}+(1-\theta)[1-(1-q)^{M}]CS^{h}+(1-q)^{M}CS^{o}-Md\geq$$
$$\geq[1-(1-q)^{M}]\left(PS^{1}+CS^{1}\right)+(1-q)^{M}CS^{o}-Md\,.$$

Proof: Comparing (8) and (17), it is apparent that i) for any given M the total probability of discovery is the same under patents as without them, but in the absence of patents there is a non-zero probability when M>1 that more than one firm implement the innovation, thus reducing the deadweight loss due to imperfect competition, and ii) in the absence of patents all firms can imitate the innovator(s) after a time interval of length θ, thus eliminating the deadweight loss due to imperfect competition for a time interval of length 1-θ.

4.2 Socially optimal number of firms investing in R&D

In the absence of patents, a greater number of firms investing in R&D increases the social benefit that one can expect to get from the industry producing X not only by raising the total

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[10] For simplicity, we omit time discount.

probability of discovery because of complementarity (as under patents), but also by making more likely that the deadweight loss due to imperfect competition will be reduced because of the larger number of efficient competitors entering the market for X. Assuming again that (9) holds (i.e., assuming that under patents it is socially optimal to have at least one firm investing in R&D), the socially optimal number of firms undertaking R&D in the absence of patents, say M**, is that integer value of M≥1 satisfying

$$\begin{aligned} &\theta\sum_{i=1}^{M}\prod_{j=0}^{i-1}(M-j)\frac{(PS^{i+1}+CS^{i+1}-PS^{i}-CS^{i})q^{i+1}(1-q)^{M-i}}{i!}+q(1-q)^{M}[\theta(PS^{1}+CS^{1})+(1-\theta)CS^{h}-CS^{o}]< \\ &\qquad < d \le \theta\sum_{i=1}^{M-1}\prod_{j=0}^{i-1}(M-1-j)\frac{(PS^{i+1}+CS^{i+1}-PS^{i}+CS^{i})q^{i+1}(1-q)^{M-1-i}}{i!}+ \\ &\qquad\qquad +q(1-q)^{M-1}[\theta(PS^{1}+CS^{1})+(1-\theta)CS^{h}-CS^{o}]. \end{aligned} \tag{18}$$

Again, the uniqueness of M** is guaranteed by the fact that the increment in the expected social benefit due to an additional firm investing in R&D declines with M (see the Appendix), while the increment in social cost due to an additional firm investing in R&D is constant. Furthermore, the following proposition holds:

Proposition 3 The socially optimal number of firms undertaking R&D is greater without patents than in the presence of patents, i.e., M**≥M*.

Proof: By comparing (10) and (18), one can easily verify that for any given M≥1 the increment in the expected social benefit due to an additional firm investing in R&D is larger without patents than in the presence of patents, while the increment in social cost is the same under the two regimes.[11] Together with the fact that under both regimes the increment in the expected social benefit due to an additional firm investing in R&D declines with M, this proves Proposition 3.

Finally, one can prove the following proposition:

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[11] For any given M>1, the increment in the expected social benefit due to an additional firm investing in R&D is strictly larger without patents than in the presence of patents.

Proposition 4 The socially optimal level of net benefit that one can expect to get from the industry producing X is higher in the absence of patents than under patents, i.e.,

$$\theta\sum_{i=1}^{M^{**}}\prod_{j=0}^{i-1}(M^{**}-j)\frac{(PS^i+CS^i)q^i(1-q)^{M^{**}-i}}{i!}+(1-\theta)[1-(1-q)^{M^{**}}]CS^h+(1-q)^{M^{**}}CS^o-M^{**}d\geq$$

$$\geq[1-(1-q)^{M^*}]\left(PS^1+CS^1\right)+(1-q)^{M^*}CS^o-M^*d\,.$$

Proof: Given Proposition 2 and the fact that M** is the socially optimal number of firms undertaking R&D in the absence of patents, the following inequalities hold:

$$\theta\sum_{i=1}^{M^{**}}\prod_{j=0}^{i-1}(M^{**}-j)\frac{(PS^i+CS^i)q^i(1-q)^{M^{**}-i}}{i!}+(1-\theta)[1-(1-q)^{M^{**}}]CS^h+(1-q)^{M^{**}}CS^o-M^{**}d\geq$$

$$\geq\theta\sum_{i=1}^{M^*}\prod_{j=0}^{i-1}(M^*-j)\frac{(PS^i+CS^i)q^i(1-q)^{M^*-i}}{i!}+(1-\theta)[1-(1-q)^{M^*}]CS^h+(1-q)^{M^*}CS^o-M^*d\geq$$

$\geq[1-(1-q)^{M^*}]\left(PS^1+CS^1\right)+(1-q)^{M^*}CS^o-M^*d$, thus demonstrating Proposition 4.

Note that the socially optimal level of net benefit that one can expect to get from the industry producing X is strictly higher in the absence of patents than under patents, except in the special case in which θ=1 and M**=M*=1 (in this case, the socially optimal level of net benefit is the same under the two regimes).

4.3 Market-determined number of firms investing in R&D

In the absence of patents, the net return that a firm expects from its investment in R&D is

$$\theta\left\{\frac{[1-(1-q)^M]}{M}PS^1-\frac{(M-1)q^2(1-q)^{M-2}(PS^1-PS^2)}{2}-f(q,PS^1-PS^3,\ldots,PS^1-PS^M)\right\}-d\,,\ M\geq1,\quad(19)$$

where $f\left(q,PS^1-PS^3,\ldots,PS^1-PS^M\right)\begin{matrix}>0 & \text{if } M\geq3\\ =0 & \text{otherwise.}\end{matrix}$ By comparing (11) and (19), one can easily verify that the firm's expected return from investing in R&D is strictly lower without patents than under patents, except in the special case in which θ=1 and M=1 (in this case, the firm's expected return is the same under the two regimes). It is not surprising that the possibility of imitation by the firms which do not innovate (θ<1) reduces the firms' incentive to invest in R&D. However, even if there is no possibility of imitation (θ=1), the absence of patent protection has a depressing effect on the incentive to invest in R&D when more than one firm undertakes R&D (M>1). Under these circumstances, indeed, the higher probability of entering the market (differently than in the presence of patents every successful innovator enters the market and makes pure profits) does not compensate the lower profits that a successful innovator expects to make once in the market (the probability of acting as a monopolist is smaller than in the presence of patents).

The equilibrium number of firms undertaking R&D in the absence of patent protection, say M”, is equal to zero if $d > q\theta PS^1$ or to that integer value of M≥1 satisfying

$$\theta\left\{\frac{[1-(1-q)^{M+1}]}{M+1}PS^1 - \frac{Mq^2(1-q)^{M-1}(PS^1-PS^2)}{2} - f(q, PS^1-PS^3, ..., PS^1-PS^{M+1})\right\} < d \leq$$

$$\leq \theta\left\{\frac{[1-(1-q)^{M}]}{M}PS^1 - \frac{(M-1)q^2(1-q)^{M-2}(PS^1-PS^2)}{2} - f(q, PS^1-PS^3, ..., PS^1-PS^{M})\right\} \text{ if } d \leq \theta q PS^1 . \tag{20}$$

The uniqueness of M” is guaranteed by the fact that the firm’s expected return from investing in R&D declines with M,[12] while the private cost of investing in R&D is not affected by M. Moreover, the following proposition holds:

Proposition 5 The market-determined number of firms investing in R&D is greater under patents than without them, i.e., M’≥M”.

Proof: By comparing (12) and (20), one can easily verify that for any given M≥1 the firm’s expected return from investing in R&D is higher with patents than without them, while the cost of

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[12] To verify that the firm’s expected return from investing in R&D declines with M, consider that $\theta\left\{\frac{[1-(1-q)^{M+1}]}{M+1}PS^1 - \frac{Mq^2(1-q)^{M-1}(PS^1-PS^2)}{2} - f(q, PS^1-PS^3, ..., PS^1-PS^{M+1})\right\} -$
$-\theta\left\{\frac{[1-(1-q)^{M}]}{M}PS^1 - \frac{(M-1)q^2(1-q)^{M-2}(PS^1-PS^2)}{2} - f(q, PS^1-PS^3, ..., PS^1-PS^{M})\right\} = -\theta\sum_{i=2}^{M} q^i(1-q)^{M-i}\left(\frac{PS^{i-1}}{i-1} - \frac{PS^i}{i}\right) -$
$-\theta g\left(q, \frac{PS^2}{2} - \frac{PS^3}{3}, ..., \frac{PS^{M-2}}{M-2} - \frac{PS^{M-1}}{M-1}\right) < 0$, where $g\left(q, \frac{PS^2}{2} - \frac{PS^3}{3}, ..., \frac{PS^{M-2}}{M-2} - \frac{PS^{M-1}}{M-1}\right) \begin{matrix} > 0 \text{ if } M \geq 4 \\ = 0 \text{ otherwise.} \end{matrix}$

R&D is the same under the two regimes.[13] Together with the fact that under both regimes the firm's expected return from investing in R&D declines with M, this proves Proposition 5.

It is worth to emphasize that the socially optimal number of firms undertaking R&D is greater in the absence of patent protection than with patents, while the reverse is true for the market-determined number of firms undertaking R&D. Hence, whenever M*>M', the absence of patents can exacerbate the market's tendency to under-invest in R&D. This is at odds with Maurer and Scotchmer (2002), which claim that the defense of independent invention improves efficiency also by lowering the firms' incentive to enter the patent race, thus reducing the wasteful duplication of R&D efforts. This different conclusion is due to the fact that the present model accounts for the complementary of firms' research strategies, which may imply that the market-determined number of firms undertaking R&D is inefficiently low even in the presence of patent protection. However, also in the absence of patent protection, the market-determined number of firms undertaking R&D may be larger than the social optimum. Therefore, the following proposition holds:

Proposition 6 Without patents, the market-determined number of firms undertaking R&D is greater than, equal to, or smaller than the social optimum, i.e., $M^{**} \underset{>}{\leq} M''$.

Proof: Numerical examples show that $M^{**} \underset{>}{\leq} M''$.[14]

Although in the absence of patents it is theoretically possible to have over-investment in R&D, it is apparent that this possibility becomes less likely--while the possibility of under-investment becomes more likely--under this regime than in the presence of patent protection, since M**≥M* and M'≥M''.

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[13] For any given M>1, the firm's expected return from investing in R&D is <u>strictly</u> higher in the presence of patents than without them.

[14] Let $C=A_o=1$, $\beta=A_h=2$, $\gamma=1.5$, $d=0.1$, $q=0.5$, $\theta=0.8$. Given these parameter values, one has: $M^{**}=4>M''=1$. Let $C=A_o=1$, $\beta=A_h=2$, $\gamma=1.5$, $d=0.1$, $q=0.9=\theta$. Given these parameter values, one has: $M^{**}=1<M''=2$.

4.4 Optimal regulation

As in the preceding section, one may think of a tax on pure profits as the natural instrument to cure the market inefficiency in case of over-investment and of a subsidy proportional to the expenditure in R&D as the instrument to correct under-investment. Since the formal analysis of the regulator's problem is similar to that of the previous section, we focus exclusively on the case that--in the absence of patents--is likely to be more relevant, namely the case in which the market tends to exhibit under-investment. In this case, the optimal s, say s**, is that value of s satisfying[15]

$$\theta\left\{\frac{[1-(1-q)^{M^{**}+1}]}{M^{**}+1}PS^1 - \frac{M^{**}q^2(1-q)^{M^{**}-1}(PS^1-PS^2)}{2} - f(q, PS^1-PS^3,\ldots,PS^1-PS^{M^{**}+1})\right\} < d \le$$

$$\le \theta\left\{\frac{[1-(1-q)^{M^{**}}]}{M^{**}}PS^1 - \frac{(M^{**}-1)q^2(1-q)^{M^{**}-2}(PS^1-PS^2)}{2} - f(q, PS^1-PS^3,\ldots,PS^1-PS^{M^{**}})\right\}. \tag{21}$$

The possibility of subsidizing R&D expenditure so as to overcome the inefficiency arising from the weak private incentive to invest in R&D in the absence of patent protection, allows to reach the socially optimal level of R&D investment. Thus:

Proposition 7 In the market equilibrium emerging when there is no patent protection and the regulatory authority sets s=s** (if $M^{**} > M''$, or alternatively, t=t** if $M^{**} < M''$), the social welfare generated by the industry producing X is higher than in the market equilibrium emerging when there are patents and the regulatory authority sets s=s* (if $M^* > M'$, or alternatively, t=t* if $M^* < M'$).

Proof: Proposition 7 follows from Proposition 4, and from the fact that when there is no patent protection and the regulatory authority sets s=s** (or t=t**) the market equilibrium exhibits M"=M**, while when there are patents and the regulatory authority sets s=s* (or t=t*) the market equilibrium exhibits M'=M*.

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[15] Again, the weight attached to the subsidies in the social welfare function is assumed to be the same as that attached to the consumers' surplus, to the producers' surplus and to the portion of R&D expenditures which is paid by the firms.

5 CONCLUSION

In a realistic framework where the potential innovators’ research lines are not perfectly correlated and imitation takes some time, this paper has studied an industry regulated by an authority which can tax (subsidize) the firms’ pure profits (R&D expenditures). By comparing the market equilibrium emerging when there is no patent protection with the market equilibrium emerging when there are patents, the paper finds that social welfare is higher in the absence of patent protection than in the presence of patents. This result is driven by the fact that—without patents--more than one successful inventor may implement its discovery and enter the market, thus reducing the deadweight loss due to imperfect competition.

This basic result may be refined by taking into account the costs of managing the patent system and the possible distortions caused by the taxes necessary to finance the R&D subsidies (or the welfare gains due to the tax reductions and/or public expenditure increases made possible by the revenues raised through a tax on innovative firms’ pure profits). Further research may also explore how this result is affected by the inclusion in the analysis of those problems of opportunistic behavior which naturally arise in the presence of asymmetric information between the authority regulating the market and private agents.

APPENDIX

Proof that in the absence of patents the increment in the expected social benefit due to an additional firm investing in R&D declines with M

To prove that in the absence of patents the increment in the expected social benefit due to an additional firm investing in R&D declines with M, M≥1, it is sufficient to show that

$$\begin{aligned}&\theta\sum_{i=1}^{M}\prod_{j=0}^{i-1}(M-j)\frac{(PS^{i+1}+CS^{i+1}-PS^{i}-CS^{i})q^{i+1}(1-q)^{M-i}}{i!}+q(1-q)^{M}[\theta(PS^{1}+CS^{1})+(1-\theta)CS^{h}-CS^{o}]-\\&-\theta\sum_{i=1}^{M-1}\prod_{j=0}^{i-1}(M-1-j)\frac{(PS^{i+1}+CS^{i+1}-PS^{i}+CS^{i})q^{i+1}(1-q)^{M-1-i}}{i!}-q(1-q)^{M-1}[\theta(PS^{1}+CS^{1})+(1-\theta)CS^{h}-CS^{o}]<0,\end{aligned}\tag{A1}$$

where (A1) states that the difference between the increment in the expected social benefit due to an additional firm investing in R&D when M firms are already undertaking this activity and the increment in the expected social benefit due to an additional firm investing in R&D when M-1 firms are already undertaking this activity is negative. To verify that (A1) holds, one can rewrite it as

$$\theta\sum_{i=2}^{M}\prod_{j=1}^{i-1}(M-j)\frac{[(PS^{i+1}+CS^{i+1}-PS^{i}-CS^{i})-(PS^{i}+CS^{i}-PS^{i-1}-CS^{i-1})]q^{i+1}(1-q)^{M-i}}{(i-1)!}+ \\ +q^{2}(1-q)^{M-1}\left\{\theta[(PS^{2}+CS^{2}-PS^{1}-CS^{1})-(PS^{1}+CS^{1}-CS^{o})]+(1-\theta)(CS^{o}-CS^{h})\right\}<0. \qquad \text{(A2)}$$

In its turn, to check that (A2) holds, consider that: $CS^{1}>CS^{o}$, $CS^{h}>CS^{o}$,

$$(PS^{i+1}+CS^{i+1}-PS^{i}-CS^{i})-(PS^{i}+CS^{i}-PS^{i-1}-CS^{i-1})=\left[\frac{2}{2\gamma(i+1)^{2}}-\frac{1}{2\gamma(i+2)^{2}}-\frac{1}{2\gamma i^{2}}\right]\left(\beta-\frac{\gamma C}{A_{h}}\right)^{2}=$$

$$=-\left[\frac{4(1+3i)+6i^{2}}{2\gamma(i+1)^{2}(i+2)^{2}\gamma i^{2}}\right]\left(\beta-\frac{\gamma C}{A_{h}}\right)^{2}<0,\ i\geq 2,\ \text{and}\ \ PS^{2}+CS^{2}-2PS^{1}-CS^{1}=\left[\frac{8}{18\gamma}-\frac{5}{8\gamma}\right]\left(\beta-\frac{\gamma C}{A_{h}}\right)^{2}<0.$$

REFERENCES

Auerbach, A.J. and Hines, J.R. Jr. (2002), "Taxation and Economic Efficiency," in: A.J. Auerbach and M. Feldstein (edited by), *Handbook of Public Economics*, Volume 3, Elsevier Science B.V., Amsterdam: 1347-1421.

Bessen, J. and Maskin, E. (2000), "Sequential Innovation, Patents, and Imitation," MIT Working Paper Department of Economics, No. 00-01 (revised version March 2006).

Cohen, W.N., Nelson, R.R. and Walsh, J.P. (2000), "Protecting their Intellectual Assets: Appropriability Conditions and why US Manufacturing Firms Patent or Not," NBER Working Paper, No. 7552.

Dasgupta, P. and Stiglitz, J. (1980), "Uncertainty, Industrial Structure, and the Speed of R&D," *Bell Journal of Economics*, 11: 1-28.

Devereux, M.P. and Sørensen, P.B. (2006), "The Corporate Income Tax: International Trends and Options for Fundamental Reforms," European Commission Economic Papers No. 264.

Encaoua, D., Guellec, D. and Martinez, C. (2005), "Patent Systems for Encouraging Innovation: Lessons from Economic Analysis," mimeo.

La Manna, M., MacLeod, R. and de Meza, D. (1989), “The Case for Permissive Patents,” *European Economic Review*, 33: 1427-1443.

Levin, R.C., Klevorick, A.K., Nelson, R.R. and Winter, S.G. (1987), “Appropriating the Returns from Industrial Research and Development,” *Brookings Paper on Economic Activity*, 783-820.

Maurer, S.M. and Scotchmer, S. (2002), “The Independent Invention Defense in Intellectual Property,” *Economica*, 69: 535-547.

Nordhaus, W. (1969), *Invention, Growth, and Welfare*, MIT Press, Cambridge

Romano, R.E. (1989), “Aspects of R&D Subsidization,” *Quarterly Journal of Economics*, 104: 863-873.

Romer, P. (2002), “When We Should Use Intellectual Property Rights?,” *American Economic Review*, 92(2): 213-216.

Scherer, M. (1972), “Nordhaus Theory of Optimal Patent life: A Geometrical Reinterpretation,” *American Economic Review*, 62(3): 422-427.

Spence, M. (1984), “Cost Reduction, Competition and Industry Performance,” *Econometrica*, 52: 101-121.

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