

Tax policy – is it a better alternative to patent policy?

Aniruddha Bagchi

Kennesaw State University, USA

government, firms could be remunerated for innovation using patents. We show that under reasonable conditions (such as the ability to customise the tax rate for each firm), patent protection is preferable if the marginal costs of the imitators are sufficiently high. Production inefficiency created by imitation is the reason for this. If the marginal costs of the imitators are similar to that of the innovator, the author shows that patent breadth to replicate the outcome of the tax/subsidy scheme in Cournot and Bertrand competition.

Key words: Patent; Tax; Welfare

JEL classifications: D43; H25; L13; O34

Correspondence to: Arijit Mukherjee, Nottingham University Business School, Wollaton Road, Nottingham, NG8 1BB, UK.
Email: arijit.mukherjee@nottingham.ac.uk; Fax: +44 (0)115 9515444

* We would like to thank Sugata Marjit, Matthew Mitchell and Peter Near for helpful discussions. Aniruddha Bagchi

Tax policy –is it a better alternative to patent policy?

marginal costs of the imitators compared to the innovator. Patent system is preferable than a tax/subsidyscheme with no patent protection if the marginal costs of the imitators are

2.2. Tax/subsidy scheme to induce innovation

Now consider a situation with no patent protection, but the government imposes tax on profits and lumpsum tax on the consumers and uses the tax revenue to cover any loss of the innovator due to imitation. This can happen provided the sum of total gross profit and consumer surplus is higher than the cost of R&D, i.e., if welfare is positive.

If n firms (i.e., the innovator and $(n-1)$ imitators) produce like Cournot oligopolists, straightforward calculation gives the equilibrium output of the innovator and the imitator as

$$q_1^{NP,t} = \frac{1 - (n-1)c}{n-1} \text{ and } q_i^{NP,t} = \frac{1 - 2c}{n-1}, i = 2, \dots, n, \text{ respectively. We assume that --}$$

Now compare welfare under “patent protection” and “no patent protection with tax/subsidy”.

We find that $W^{NP,t} - W^P$ if $\frac{(1 - (n-1)c)^2}{(n-1)^2} - \frac{(n-1)(1-2c)^2}{(n-1)^2} - \frac{(n-c(n-1))^2}{2(n-1)^2} - \frac{3}{8} > 0$ or

$c < \frac{3-n}{10-6n} c^*$, where $c^* \in (0, \frac{1}{2})$.

Both the patent system and the tax/subsidy scheme induce innovation for $R \in (\frac{(1 - (n-1)c)^2}{(n-1)^2}, \frac{1}{4})$, and the patent system generates higher welfare and therefore, is preferable compared to the tax/subsidy scheme for $c \in (c^*, \frac{1}{2})$.

The reason for the above result is as follows. The tax/subsidy scheme increases competition but also creates production inefficiency in the industry if the marginal costs of the imitators are higher than that of the innovator. On one hand, it

The tax/subsidy scheme creates higher welfare and therefore, is preferable compared to patent protection for $c \in (0, c^*)$. As discussed in the introduction, this result holds if the patent breadth is large enough to eliminate imitation. However, the authority can choose an appropriate patent breadth to replicate the outcome of the tax/subsidy scheme. Hence, for $c \in (0, c^*)$, the tax/subsidy scheme and the patent system with an appropriate patent breadth will create the same welfare.

The above discussion is summarised in the following proposition.

Proposition 1: Consider $R = \left(\frac{(1 - (n-1)c)^2}{(n-1)^2}, \frac{1}{4} \right)$. The patent system preventing imitation is preferable than the tax/subsidy scheme for $c \in \left(c^*, \frac{1}{2} \right)$. If $c \in (0, c^*)$, the tax/subsidy scheme and the patent system with an appropriate patent breadth will generate the same welfare.

3. The case of Bertrand competition

The purpose of this section is to show that the result shown in the previous section under Cournot competition also holds under Bertrand competition.

We assume in this section that the inverse demand function faced by the i th firm, $i = 1, 2, \dots, n$, is given by

$$P_i = 1 - kx_i - \sum_{j=1}^n \chi_j, \quad i = j, \quad \text{where } k = \frac{1}{n-1}, \quad 1 - \chi_j = \dots$$

The corresponding demand function is given by

utility function $U = \sum_{i=1}^n x_i - \frac{1}{2} [k \sum_{i=1}^n x_i^2 + 2 \sum_{i < j} x_i x_j]$. Under this utility function and the demand structure, the market size is not affected by the number of products.

3.1. Patent protection to induce innovation

If there is patent protection and only firm 1, the innovator, produces the product, like subsection 2.1, we get the equilibrium net profit of firm 1 as $\frac{1}{4} R$, and the corresponding welfare as $W^P = \frac{3}{8} R$.

We assume that $R > \frac{1}{4} k$, where

$$\frac{[k(n-2)][2k^2 - 2(3 - \alpha(n-2)(n-1) - 2n) - k(5 - \alpha(n-1) - 2n)]}{(k - \alpha)[2k - (n-3)]^2 [k - (n-1)][2k - (2n-3)]^2}$$

implying that

firm 1 will not innovate in the absence of patent protection and tax/subsidy scheme, since, in the absence of patent protection and the tax/subsidy scheme, the net profit of firm 1 will be $NP_1 = R - 0$.

3.2. Tax/subsidy scheme to induce innovation

Now consider the tax/subsidy scheme, which will induce the innovator to innovate if the tax revenue can at least cover the cost of R&D, and this can happen if the welfare is positive.

If n firms (i.e., the innovator and $(n-1)$)

respectively. The corresponding outputs are

$$q_1^{NP,t} = \frac{[(k - (n - 2))(2k^2 - 2(3 - c)(n - 2)(n - 1) - 2n) - k(5 - c(n - 1) - 2n)]}{(k - c)[2k - (n - 3)][k - (n - 1)][2k - (2n - 3)]} \quad \text{and}$$

$$q_i^{NP,t} = \frac{[(k - (n - 2))(2(1 - c)k^2 - 2(3 - c)(n - 1) - 2n) - k(5 - 2c(n - 2) - 2n)]}{(k - c)[2k - (n - 3)][k - (n - 1)][2k - (2n - 3)]}, \quad i = 2, \dots, n.$$

We assume that $\frac{(k - c)[2k - (2n - 3)]}{2k^2 - 2k(n - 2) - 2(n - 1)}$.

The gross equilibrium profit of the innovator and the imitator are respectively

$$\pi_1^{NP,t} = \frac{(k - (n - 2))[2k^2 - 2(3 - c)(n - 2)(n - 1) - 2n) - k(5 - c(n - 1) - 2n)]^2}{(k - c)[2k - (n - 3)]^2[k - (n - 1)][2k - (2n - 3)]^2} \quad \text{and}$$

$$\pi_i^{NP,t} = \frac{(k - (n - 2))[2(1 - c)k^2 - 2(3 - c)(n - 1) - 2n) - k(5 - 2c(n - 2) - 2n)]^2}{(k - c)[2k - (n - 3)]^2[k - (n - 1)][2k - (2n - 3)]^2}, \quad i = 2, \dots, n.$$

The government can raise a tax revenue equal to the cost of R&D and can use this tax revenue to subsidise the innovator for the cost of R&D provided the sum of total gross industry profit and consumer surplus is higher than the cost of R&D, i.e.,

$$\begin{aligned} & (k - (n - 2))[2c(k - c)(3k - (n - 4))(n - 1)(2k - (2n - 3))] \\ & (k - c)(3k - (n - 4))n(2k - (2n - 3))^2 \\ & c^2(n - 1)(12k^4 - 28k^3 - (n - 2)k^2 - (89 - 89 - 20n)) \\ & 4(1 - c)(6 - c) - 2^3(2)(13 - (2 - 13))] \\ & 2(k - c)[2k - (n - 3)]^2[k - (n - 1)][2k - (2n - 3)]^2 \end{aligned}$$

Welfare under the tax/subsidy scheme is

$$W^{NP,t} = \frac{(k - (n - 2)) [2c(k -) (3k - (n - 4)) (n - 1) (2k - (2n - 3))]^2}{(k -) (3k - (n - 4)) n (2k - (2n - 3))^2} \\ c^2 (n - 1) (12k^4 - 28k^3 - (n - 2) k^2 - (89 - (89 - 20n)) \\ - 4(n - 1) (6 - (n - 6)n - 2k^3 - (n - 2) (13 - n(2n - 13))))] \\ 2(k - k) [2k - (n - 3)]^2 [k - (n - 1)]$$

Figure 1: $(W^{NP,t} - W^P)$ for $n = 2$ and $\beta = .5$

The above analysis shows that the results under Bertrand competition are similar to that of Cournot competition. The reasons for the results under Bertrand competition are similar to that of under Cournot competition.

The following proposition summarises the result under Bertrand competition.

Proposition 2: Consider $R \in (\frac{1}{4}, 1)$. The patent system preventing imitation is preferable than the tax/subsidy scheme for sufficiently higher values of c . If c is not sufficiently high, the tax/subsidy scheme and the patent system with an appropriate patent ' τ ' are equally preferred.

restricts output to increase profit. It is generally believed that patent protection is ~~issued~~ ^{granted} if the patent authorities and the innovators have similar information (Scotchmer, 1999).

References

- Arrow, K.J., 1962, 'Economic welfare and the allocation of resources for inventions', In *The Rate and Direction of Inventive Activity: Economic and Social Factors* by R.R. Nelson, Princeton, NJ: Princeton University Press.
- Clarke, R. and D. Collie, 2003, 'Product differentiation and the gains from trade under Bertrand duopoly', *Canadian Journal of Economics*, 36: 658-73.
- Cornelli, F. and M. Schankerman, 1999, 'Optimal patent renewals', *Rand Journal of Economics*, 30: 197-213.
- Cogel, M. M., 2006, 'Taxes, efficiency, and redistribution: discriminatory taxation of villages in Ottoman Palestine, Southern Syria, and Transjordan in the sixteenth century', *Explorations in Economic History*, 43: 332-356.
- Gallini, N., 1992, 'Patent policy and costly imitation', *Rand Journal of Economics*, 23: 526-3.
- Gandal, N. and S. Scotchmer, 1993, 'Coordinating research through research joint ventures', *Journal of Public Economics*, 51: 173-193.
- Gilbert, R., and C. Shapiro, 1990, 'Optimal patent length and breadth', *Rand Journal of Economics*, 21: 106-112.
- Heady, C., 1993, 'Optimal taxation as a guide to tax policy: a survey', *Fiscal Studies*, 15-41.
- Klemperer, P., 1988, 'Welfare effects of entry into markets with switching costs', *Journal of Industrial Economics*, 37: 159-65.
- Klemperer, P., 1990, 'How broad should the scope of patent protection be?', *Rand Journal of Economics*, 21: 113-30.
- Lahiri, S. and Y. Ono, 1988, 'Helping minor firms reduces welfare', *Economic Journal*, 98: 1199-1202.

- Langinier, C. and G. Moschini, 2002, 'The Economics of Patents', in *Intellectual Property Rights and Patenting in Animal Breeding and Genetics* by S. Newman and M. Rothschild, CAB International, 350.
- Leffler, K. and C. Leffler. 2004. Efficiency tradeoffs in patent litigation settlements: Analysis gone astray. *USFL Review*, p.33.
- Leahy, D. and P. Neary. 2009. Multilateral subsidy games. *Economic Theory*, 166.
- Loury, G.C., 1979, 'Market structure and innovation', *Quarterly Journal of Economics* 93: 395–410.
- Minehart, D. and S. Scotchmer, 1999, 'Ex Post regret and the decentralized sharing of information', *Games and Economic Behavior* 17: 114–131.
- Nordhaus, W.D., 1969, *Inventions, growth and welfare: a theoretical treatment of technological change*. Cambridge, MA: MIT Press.
- O'Donoghue, T., S. Scotchmer and F.J. Thisse, 1998, 'Patent breadth, patent life, and the pace of technological progress', *Journal of Economics and Management Strategy* 7: 1–32.
- O'Donoghue, T. and J. Zweimuller. 2004. Patents in a model of endogenous growth. *Journal of Economic Growth*, 9: 81–123.
- Ordover, J. A. 1991. A patent system for both diffusion and exclusion. *Journal of Economic Perspectives* 5: 43–60.
- Scherer, F.M., 1972, 'Nordhaus' theory of optimal patent life: a geometric reinterpretation', *American Economic Review* 62: 422–427.
- Scotchmer, S. 1991. On the optimality of the patent renewal system. *Rand Journal of Economics* 30: 181–196.
- Shubik, M. and R. Levitan, 1980, *Market Structure and Behaviour* Harvard University Press, Cambridge, MA.