Economics of Industrial Organization

Lecture 14: Intellectual Property Rights and Patent Policy

Patents; government-granted monopoly

- We have spent much of this course consider the problems of monopoly power, and different circumstances where government should consider intervening in order to prevent monopolization.
- Our general conclusion was that monopolies are undesirable and should be prevented (or regulated), except in some exceptions such as natural monopoly, where it is more efficient to not intervene.
- In intellectual property policy, policy does just the opposite; we deliberately create government-granted monopoly power in a market where it would not otherwise exist; patents and other forms of intellectual property protection (copyright, etc.). Why do we deliberately create monopoly power?

Intellectual property

- Intellectual property has two important intrinsic features.
- It tends to have high (sunk) fixed research costs.
- Once developed it tends to have low costs of using it, transmitting it or duplicating it. Once an idea has been developed, it can often be easily shared with others.
- For example; developing a new pharmaceutical product can cost hundreds of millions of dollars – and may not lead to any useful product in the end. But once the formula for such a product is developed, we can produce many copies of the drug at very low cost – and doses of the drug may be very valuable.
- A valuable idea potentially has large positive externalities.

First-best solution

- The "first-best" solution would be if we could produce all R&D where the social benefits exceeded the research costs, and then sell products based on this R&D at marginal cost.
- But this is not feasible in a market economy; firms will only produce R&D if its private benefits exceed . So we must tolerate price > MC in order to allow the developer of the patent to recoup its research costs. And not just the costs of the R&D lines that end with a successful product; the researcher must get an expected profit of at least zero at the beginning of a project, before we know if it will work or not.
- So the firm must earn sufficient profits to cover both its successful and unsuccessful research costs.

- But even tolerating monopoly is not enough. For ideas that are easy to transmit, other firms may be able to easily access the R&D once it is produced, and compete in the associated product markets, reducing the value of the idea captureable by the researcher, and so reducing the amount of R&D that is produced. So, we create monopoly rights to provide sufficient incentive for firms to invest in R&D.
- Developing an idea also reduces the costs of developing further ideas along the same research lines. So we want ideas to be publicly available, to help spur further research.
- Optimal intellectual policy must consider all these effects.

Patents

- The most important form of intellectual property is a patent.
- A patent grants a the holder an exclusive property right for some novel and useful idea or innovation for a fixed length of time (typically 20 years after filing – though firms may file early on in their development process to avoid other firms stealing their idea, so the real patent life may be much less than this).
- Anyone who wishes to use the patented idea must get permission of the patentholder, in exchange for a licensing fee.
- So the idea developer is able to act as a monopolist on products related to their idea and earn monopoly profits, either directly or through a licensee.
- The patentholder must also register the patent, which makes the details of the idea public record, so as to make future innovation easier.

Optimal patent length

- In determining the optimal patent length, we must balance the innovator's ability to earn a return on its R&D investment with the benefits that will accrue to consumers once the patent expires.
- Imagine a competitive industry in which each firm is pursuing a non-drastic innovation. Innovative efforts incur costs.
- Each firm's marginal operating cost is currently c. If a firm invests at some intensity x, it expects to reduce its operating costs from c to c – x.
- The cost of undertaking R&D at intensity x is r(x). We assume that such costs rises as the level of intensity increases, and do so at an increasing rate (ie r(x) is convex).
- Thus, R&D is expensive and exhibits decreasing returns.

- Since the product market is competitive, the initial market price is c, and output level is Q_0^C.
- A successful innovator will be able to either:
  a) produce at lower cost c – x, and set a price just below c to drive all other firms out of the market (in Bertrand fashion)
  b) License its discovery to competitors for a fee of c – x per unit produced.
- Either way, the current market price and volume remain unchanged, but the innovator earns a positive profit A per year, for T years (where T is the patent length).
  When the patent expires, all firms will have access to the technology for free. Competition will reduce the price to c – x, and output will expand to Q_T^C.
- The profit that the innovator used to earn becomes consumer surplus, and because output is higher there is an expansion of consumer surplus by area B.

- The longer the duration of the patent (the higher is T), the longer is the time over which the innovator earns profit A, and the greater is the innovator's incentive to do costly R&D.
- But the longer is T, the longer that we are forgoing receiving CS B, the welfare gain from higher output.
- Denote the per-period profit flow to the innovator (i.e. A) as $\pi^m(x;T)$ and the discount factor as δ. The present value of R&D is:

$$V_i(x;T) = \sum_{t=0}^{T-1} \delta^t \pi^m(x;T) = \frac{1-\delta^t}{1-\delta} \pi^m(x;T)$$

- Therefore, the R&D has a net value to the innovator of

$$V_i(x;T) - r(x)$$

- For a given value of T chosen by policymakers, the innovator will select a level of R&D activity $x^*(T)$ that maximizes this expression; this is the innovator's best response.

- In other words, the patent policymaker can determine the innovator's profit-maximizing research intensity x*(T).
- To choose T optimally, the policymaker will wish to pick the patent duration that maximizes the net social gain to consumers and producers given how firms choose their research intensities.
- Denote ss(x,T) the per-period increase in social surplus the innovation generates once it becomes freely available, relative to the pre-innovation surplus (ie the area A+B).
- The value of this increase in surplus is then:

$$ss(x;T) = \sum_{t=T}^{\infty} \delta^t ss(x;T) = \frac{\delta^T}{1-\delta} ss(x;T)$$

- The total net social surplus from innovation is: $NS(x^*(T),T) = V_i(x^*(T);T) + ss(x^*(T);T) - r(x^*(T))$ and the objective of policymakers is to choose the patent duration T that will maximize this expression.

- The most important consequence to note is that this means the optimal patent duration is finite.
- As the patent office initially increases T, it induces greater R&D effort and, at first, greater discounted net surplus to producers and consumers. If patent length was zero, the returns to the innovator are also zero, and so there will be no R&D and no surplus.
  If we increase T to some value T > 0, we will induce some innovation and some increase in total surplus.
- Beyond some point however, continued increases in T will reduce net social surplus even though they lead to greater R&D and so greater reductions in production cost because:
  a) It becomes progressively more expensive to lower production costs, because of our assumptions about the function r(x). So it takes progressively larger increases in T to achieve a given cost-saving.
  b) Consumer benefits will not be realized until after the patent expires, and so the larger is t, the further back we must discount these benefits.

Patent races

- Another interesting consequence of patents is caused by the "winner-take-all" nature of patent protection.
- Innovative competition can be regarded as a race; the first firm to patent an innovation receives the monopoly patent for it, while all other firms researching such an innovation receive nothing.
- Consider a patent race between two firms that can choose to invest in research with a view to developing a new product. The first to make the breakthrough wins the race, and gets exclusive (monopoly) patent rights to the invention. The loser gets nothing, and must bear the costs of the resources invested in innovation.
- Each firm estimates that if innovation is successful, they can produce the new good at MC = c, in a market with demand P = A - BQ

- The new product is assumed to be sufficiently different that it will have no impact on any existing markets (generally not true in reality).
- R&D effort by each firm will cost a fixed firm K, and these costs are sunk.
- If R&D effort is undertaken, their probability of finding a successful innovation is ρ. If only one firm is successful, the innovation is protected by patent, and the firm acts as a monopolist earning $\pi_M = \frac{(A-c)^2}{4b}$
- If both are successful, they can both make the new product, and will be involved in Cournot competition, and earn Cournot profits

$$\pi_C = \frac{(A-c)^2}{9b}$$

- Consider expected profits if only firm 1 establishes an R&D division

$$\pi_1 = \rho\frac{(A-c)^2}{4b} - K$$

- If both firms establish R&D divisions, the expect profit to each firm is given by:

$$\pi_i = \rho(1-\rho)\frac{(A-c)^2}{4b} + \rho^2\frac{(A-c)^2}{9b} - K$$

- Define for notational simplicity parameters M = $(A - c)^2/(4B)$ and S = K/M. Then these payoffs in matrix form are:

		Firm1	
		No R&D	R&D
Firm1	No R&D	0,0	0, M(ρ-S)
	R&D	M(ρ-s),0	M(ρ(9-5 ρ))/9-S), M(ρ(9-5 ρ))/9-S)

- Three possible NE's of this game.

1. Neither firm wishes to establish R&D
2. Only one firm wishes to establish R&D
3. Both firms wish to establish R&D.

But the social gain from R&D is not just the monopoly profits; it also comes from the consumer surplus from the innovation.

We can easily imagine that it can be the case that the Nash Equilibrium will provide insufficient incentive for firms to invest in R&D.