

Intellectual Property

Course note for Lecture 13 of Elements of Economic Analysis II

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1 Intuition and trade-off

In the absence of intellectual property, new products can usually be costlessly replicated. This means that the creator of the product receives no compensation, as, if she attempts to sell the product at a positive price, people will just copy it. This happens often, for example, with music piracy even though piracy is illegal; think how much worse it would be if there were no protection at all!

The reason it is important that the creator of the product, who we from now on call an “entrepreneur”, is rewarded, is that it is often costly to create the product in the first place. These costs come from many sources:

1. Creating new products is often a capital-intensive process based at labs and engineering groups. If companies cannot recoup the costs of product development, they will not develop new products.
2. Even small inventors have to take time off from other work to create new inventions. Unless they have the prospect of being supported by this invention, they are unlikely to expend the opportunity cost.
3. Even if this last opportunity cost is relatively small, the probability that a new product is really a hit is usually also quite small. Thus rewards may need to be large in absolute size to be reasonably sized in expectation and offset the required opportunity cost.

However, intellectual property also comes with a cost: it creates (partial) monopoly power and thus a deadweight loss. The higher is the price, the greater is the deadweight loss. But greater too are the monopoly profits and thus the incentives to create the product. We thus face the classic

trade-off between the benefits of incentives for innovation and the costs of deadweight loss, often called *ex-post distortion*. Intuitively it seems that the optimal protection will be larger the more elastic is innovation to incentives and smaller the larger is the ratio of deadweight loss to profits. Thus people who think innovators are very greedy and that patents do not create much distortion will support strong IP protection. On the other hand those who believe innovators are mostly motivated by non-pecuniary incentives and/or that IP creates terrible wasted opportunities ex-post will oppose intellectual property. In this note I will quantify this trade-off.

2 Model

The supply of innovations is given from the smooth supply function $S(\pi)$ where π is the profits created by the innovation. This comes from a continuous distribution of costs of innovating, which I won't explicitly discuss. Each innovation creates a new product with (the same, or average) demand function $Q(p)$ and 0 marginal cost of production (as with most innovations, there is no significant cost of copying). Just to normalize things, p represents the *fraction of the monopoly optimal price charged* and $Q(0)$ is normalized to 1 so that $Q(p)$ represents the *fraction of the total efficient market served*. The consumer surplus per product when price is p is $CS(p) = \int_{\tilde{p}=p}^{\infty} Q(\tilde{p}) d\tilde{p}$ and total consumer surplus is $S(\pi(p))CS(p)$. Profits per market are $\pi(p) = pQ(p)$ and total producer surplus is $\int_{\pi=0}^{\pi(p)} S(\pi)d\pi$, the area between the y-axis and the supply curve. Thus total social welfare is

$$S(\pi(p))CS(p) + \int_{\pi=0}^{\pi(p)} S(\pi)d\pi$$

Imagine we can directly control p . This might be possible by affecting the scope, strength, breadth or length of patent protection. How high should p be?

Taking a derivative, we obtain the first-order condition

$$\pi'(p)S'(\pi(p))CS(p) + CS'(p)S(\pi(p)) + \pi'(p)S(\pi(p)) = 0$$

or, rearranging and dropping arguments and letting $DWL(p) = CS(0) - CS(p) - \pi(p)$:

$$\pi'S'CS = DWL'S \iff \frac{S'\pi CS}{S} \frac{1}{\pi} = \frac{DWL'}{\pi'}$$

3 Basic formula

Thus we obtain the key equation we were looking for:

$$\underbrace{\epsilon_S}_{\text{elasticity of innovation supply}} \cdot \underbrace{\frac{CS}{\pi}}_{\text{ratio of external to internal benefit of innovation}} = \underbrace{\frac{DWL'}{\pi'}}_{\text{distortion to incentive ratio}} \quad (1)$$

The first factor on the left-hand side represents the responsiveness of innovation to material incentives, the elasticity of innovation supply. The second term represents the ratio of consumer surplus (the external-to-the-innovator benefits of innovation) to the private benefits. The right-hand side represents the ratio of marginal deadweight loss to marginal profits. Note that the right hand side is 0 at $p = 0$ and infinite at $p = 1$ because marginal deadweight loss is 0 at efficient prices (remember Harberger’s *triangle*) as prices are efficient there while marginal profits are 0 at the optimal price $p = 1$ as this defines it as optimal. On the other hand, assuming that the elasticity of innovation supply is bounded, the left-hand side is infinite at $p = 0$ as there $\pi = 0$ and becomes finite as p goes to 1. Thus there will be an intersection between the “benefits of incentivizing innovation” represented by the left-hand side and the “costs of incentivizing innovation” on the right-hand side. This will represent the optimal level of IP protection, p .

4 Comparative statics with constant pass-through

To keep things simple, let’s assume a constant elasticity of innovation supply and that demand comes from the very common *constant pass-through class*

$$Q(p) = (1 - (1 - \rho)p)^{\frac{\rho}{1-\rho}},$$

where ρ represents the (constant) pass-through rate. This class includes linear demand and constant elasticity demand as special cases. Can you see why it obeys our normalizations?

You will recall from Lecture 9 that as pass-through increases, so too does the ratio of dead-weight loss to profits. Thus we should expect (from the informal logic of Section 1) that as ρ decreases or as ϵ_S increases, the optimal level of protection should increase and vice versa. Under this function form assumption, Mathematica can easily compute all the relevant curves. You can play around with these on the Mathematica program posted. To show that the comparative statics we predicted hold, Figure 1 shows the effect, starting at $\epsilon_S = .5$ and $\rho = .5$ of increasing ϵ_S to 1 (on the right, with the higher curve post-shift) and ρ to 2 (on the left, with the two higher curves post-shift). As predicted the former raises and the latter lowers the optimal degree of protection.

A variety of studies have estimated the elasticity of innovation supply (Acemoglu and Linn, 2004; Dubois et al., 2010; Weingarten, 2011; Cockburn et al., 2011). While none of these estimates

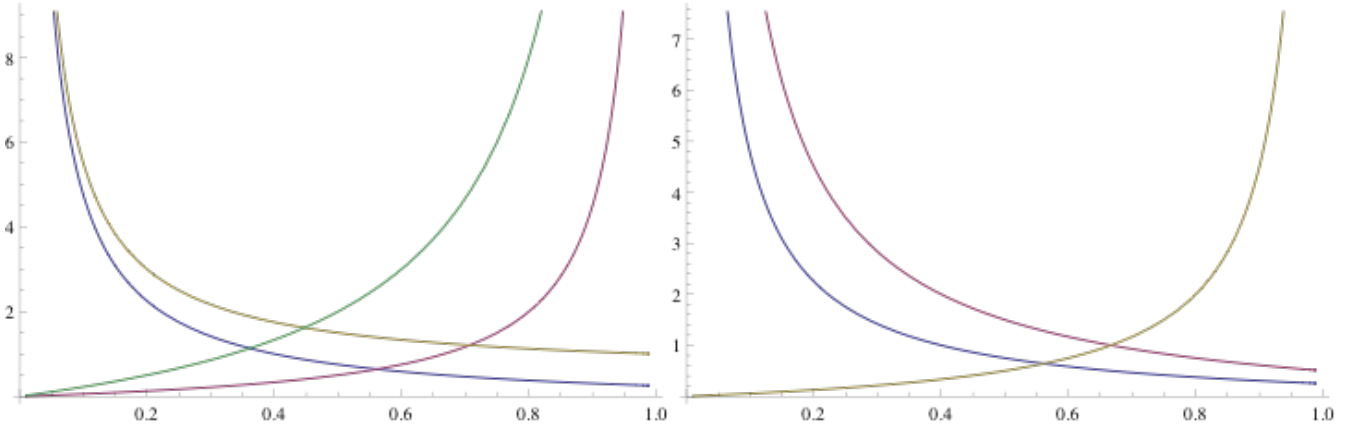


Figure 1: The effect of increasing pass-through (left) and elasticity (right) on optimal patent protection. Higher curves in both pictures are post-shift.

is terribly persuasive, they give an overall picture that the elasticity is likely to be in the range .5-1. Studies of pass-through rates, surveyed by (Weyl and Fabinger, 2011), indicate that in most monopolized markets pass-through is typically not below .5 nor above 2. Taking this to be a reasonable range we can compute the lowest p^* and the highest p^* for values in this range, the former associated with the elasticity of .5 and pass-through of 2, the later associated with the elasticity of 1 and pass-through of .5. For the former we get .45 and for the later we obtain .65, both as shown in Figure 1. This indicates that fifty percent patent protection is about right. At a 5% interest rate that requires a patent life with full protection of t where

$$.55 = 1 - .95^{t+1} \iff .45 = .95^{t+1} \iff t + 1 = \frac{\log(.45)}{\log(.95)} \approx 15.6.$$

Real world patent life is a bit longer than this (20 years) but protection is far from complete. Thus the real world system does not seem terribly far off from optimal overall. However, there may be a strong cases for patent lives differing across industries and domains (unlike current practice). For example, the elasticity of innovation supply in pharmaceuticals seems much higher than in the high tech industry while the harms in the pass-through seems higher in high tech than in pharmaceuticals. Thus there seems to be a case for weaker patent protection in high tech.

5 Broader insights

In this model we focused very specifically on the source of deadweight loss being under consumption. We could also have allowed the progress of follow-on innovation to be retarded in the licensing process, as Williams (2010) has shown is a large effect, or the administrative costs of patent litigation could impose costs. Furthermore we assumed that greater patent protection raised the price; an

alternative model of patent length is that it simply determines the duration over which the monopoly price is charged so that the deadweight loss-profit trade-off is linear in levels of protection. The reason considering these richer models is not crucial is that the basic intuitions, both qualitative and quantitative, emerge even in the simple model here. Optimal protection equates the elasticity of innovation supply, multiplied by the ratio of consumer to producer surplus to the ratio of marginal deadweight loss to marginal profits. Even if the source of each of these changed, the basic logic would remain similar and thus you should now be well-equipped to think about the trade-off between incentives for innovation and ex-post distortion.

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