

## Live Exercise 3: Optimal Patent Length – the Ideas Model

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### Solutions

Group exercise ( $\approx 20$  minutes)

- Work in groups of 2–3.
- Show all intermediate steps.
- Parts (a)–(c) are computational; part (d) is a short discussion.

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### Problem: Patent length and the ideas model

A patent regulator is evaluating two candidate drugs under the Scotchmer ideas model. Each drug is characterised by a pair  $(\nu, F)$ , where  $\nu$  is the per-period consumer surplus under competitive supply and  $F$  is the fixed development cost.

The regulatory parameters are:

$$\pi = \frac{1}{2}, \quad \lambda = \frac{1}{4}, \quad r = \frac{1}{4},$$

where  $\pi$  is the share of per-period consumer surplus appropriated by the patent holder as profit,  $\lambda$  is the per-period deadweight loss as a share of  $\nu$ , and  $r$  is the discount rate. The current (discounted) patent length is  $T = 20$ .

Drug	$\nu$	$F$
Alpha	10	60
Beta	5	10

#### (a) Private investment condition

For each drug, determine whether a firm will voluntarily invest given  $T = 20$ .

The investment condition is:  $\pi\nu T \geq F$ .

#### (b) Net social value

For each drug, compute the net discounted social value of development:

$$\text{Social value} = \frac{\nu}{r} - \lambda\nu T - F.$$

(Note: with  $r = \frac{1}{4}$ , the perpetual benefit per unit of  $\nu$  is  $\frac{1}{r} = 4$ .)

Does either drug yield a positive net social surplus at  $T = 20$ ?

(c) Socially optimal patent length for Drug Beta

Find the minimum patent length  $T^*$  that just induces private investment in Drug Beta. At  $T = T^*$ , compute the net social value and state your conclusion.

(d) Discussion (5 minutes)

At  $T = 20$ , both drugs are privately profitable yet socially wasteful. Drug Beta becomes socially efficient at a much shorter patent length.

1. What does this imply for the design of a uniform patent length (the same  $T$  for all drugs)?
2. Why is it difficult in practice to implement drug-specific patent lengths, even if they would be welfare-improving?

## Solution

Parameters:  $\pi = \frac{1}{2}$ ,  $\lambda = \frac{1}{4}$ ,  $r = \frac{1}{4}$  (so  $\frac{1}{r} = 4$ ),  $T = 20$ .

(a) Private investment condition

Drug Alpha ( $\nu = 10$ ,  $F = 60$ ):

$$\pi\nu T = \frac{1}{2} \times 10 \times 20 = 100 \geq 60. \quad \checkmark \quad \text{Invests.}$$

Drug Beta ( $\nu = 5$ ,  $F = 10$ ):

$$\pi\nu T = \frac{1}{2} \times 5 \times 20 = 50 \geq 10. \quad \checkmark \quad \text{Invests.}$$

Both drugs are privately profitable at  $T = 20$ .

(b) Net social value

$$\text{Social value} = \frac{\nu}{r} - \lambda\nu T - F.$$

Drug Alpha:

$$\frac{10}{0.25} - \frac{1}{4} \times 10 \times 20 - 60 = 40 - 50 - 60 = -70 < 0. \quad \text{Socially wasteful.}$$

Drug Beta:

$$\frac{5}{0.25} - \frac{1}{4} \times 5 \times 20 - 10 = 20 - 25 - 10 = -15 < 0. \quad \text{Socially wasteful.}$$

Neither drug yields positive net social surplus at  $T = 20$ . The discounted deadweight loss during the long patent period ( $\lambda\nu T$ ) exceeds the present value of social benefit ( $\nu/r$ ), net of development cost.

Intuition: With  $r = 1/4$ , the present value of the perpetual benefit stream is only  $\nu/r = 4\nu$  – the high discount rate makes future competitive benefits worth little today. Meanwhile, 20 periods of monopoly pricing generate a large deadweight loss.

(c) Socially optimal patent length for Drug Beta

Set the investment condition to equality and solve for  $T^*$ :

$$\pi\nu T^* = F \Rightarrow \frac{1}{2} \times 5 \times T^* = 10 \Rightarrow T^* = 4.$$

Social value at  $T^* = 4$ :

$$\frac{5}{1/4} - \frac{1}{4} \times 5 \times 4 - 10 = 20 - 5 - 10 = 5 > 0. \quad \checkmark$$

A patent of length  $T^* = 4$  is sufficient to induce investment in Drug Beta and generates a positive net social surplus of 5. The current 20-period patent is five times longer than necessary: the excess deadweight loss from periods 5–20 is a pure social waste – Drug Beta would have been developed anyway.

(d) Discussion

Uniform patent length: A single  $T$  must simultaneously incentivise high-cost drugs (large  $F$ , need long protection) and avoid over-rewarding low-cost drugs (small  $F$ , short protection suffices). With heterogeneous  $(\nu, F)$  pairs, no uniform  $T$  can be first-best: it will either leave high- $F$  drugs underdeveloped or generate excessive deadweight loss for low- $F$  drugs.

Drug-specific patent lengths: A regulator would need to observe each drug's  $(\nu, F)$ , which are private information held by the firm. Firms have strong incentives to overstate  $F$  to obtain longer protection. Solving this requires screening mechanisms or revelation procedures that are administratively complex and litigation-prone. In practice, partial adjustments are made through supplementary protection certificates, compulsory licensing provisions, and tiered examination standards – but a clean drug-by-drug  $T^*$  remains infeasible.

## Bibliography