

EE481: Industrial Economics

Patents and Technological Change (Chapter 16)

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We ask the following questions

Please read Chapter 16 of “Modern Industrial Organization” by Carlton and Perloff.

- If there is no patents or government incentives, would there be too little research and development (R&D)?
- If there is too little R&D, what method(s) should be used to encourage it?
- What is the optimal patent duration?
- How does the market structure affect the incentives to innovate?

Distinctions Between Patents, Copyrights and Trademarks

- Patents = exclusive rights to produce.
 - Encourages firms to innovate.
- Copyrights = exclusive rights to produce, publish (usually for art works).
 - Encourages the creation of new works.
- Trademarks =
 - Encourages firms to..

Incentives for inventions are needed

- Many new inventions give huge benefits to people.
- Without patents, the private gain could be less than social gain.
 - The society would gain more if there is more invention.
 - Innovation..
- To increase social gain, more incentives are given to the inventors
 - Patents and copy rights are given so that the profits (incentives) from R&D increase.
 - Patents also encourages disclosure.

Patents, Prizes, Research Contracts and Joint Ventures

- The government can encourage R&D through patents, prizes, research contracts and joint ventures.
- Giving R&D incentives has some costs (patents, prizes, etc.), but new inventions benefit the society.
 - The government wants to **maximize** the **net** social benefits, e.g. social benefits - costs.

Patents, Prizes, Research Contracts and Joint Ventures

- How?
- For example, the government could support research projects.
 - Suppose the government wants to create a 3-D phone.
 - It would like to do this through research contracts, which does not guarantee success.
 - Hiring more firms to research on the same thing increases probability of at least 1 firm success, but also increases cost.
 - If it can calculate the social benefits, cost of research, probability of success, then it can find the best number of projects to encourage.

The optimal number of firms

Table 1: Costs and Benefits of Research Programs

n	E(Marginal Social benefit)	E(Payoff) when Prize = B	$\rho(n)$	$B \times \rho(n)$	$C(n)$	$B \times \rho(n) - C(n)$
6	1.50	2.93	0.70	17.61		11.61
7	1.23	2.71	0.76	18.97		11.97
8	1.00	2.51	0.80	20.08		12.08
9	0.82	2.33	0.84	20.98		11.98
10	0.67	2.17	0.87	21.72		11.72
11	0.54	2.03	0.89	22.32		11.32

Source: Carlton and Perloff (2005), page 540.

where B is the value of prize = 25, $\rho(n)$ is probability of (at least 1 firm) success, $C(n)$ is social cost (assume = 1 for each firm), $B \times \rho(n)$ is the expected social benefit, $B \times \rho(n) - C(n)$ is the net social benefit.

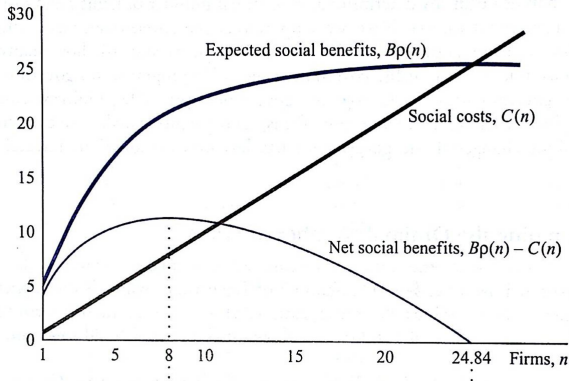
- The optimal number of firms varies with E(marginal social benefits), $B, \rho(n)$ and $C(n)$.

The optimal number of firms

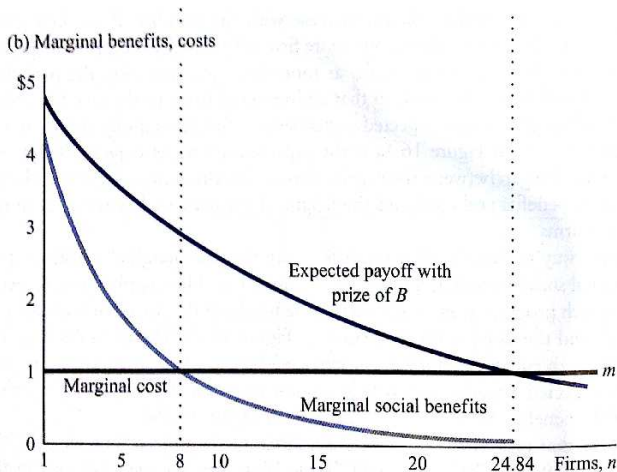
FIGURE 16.1

Costs, Expected Benefits, and Net Social Benefits from R&D

(a) Total benefits, costs



The optimal number of firms



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Government-financed research

Government can finance (or encourage) research through:

- Tax credits
- Pay firms to conduct research
 - If E (marginal social benefits), $B, \rho(n)$ and $C(n)$ are known, the government could find the optimal number of firms to hire.
 - In reality, the government would have to estimate those numbers.
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Prizes (1)

The government only gives prizes to successful projects. What is the optimal value of prize?

- If prize is too low $\rightarrow$ not enough R&D
- If prize too high $\rightarrow$ excessive research
- Firm invests if $E(\text{prize}) \geq$
- The optimal price is where $E(\text{prize}) =$

Prizes (2)

- Suppose that when there are n firms carrying out a research, the probability that at least 1 firm will make the discovery is $\rho(n)$. Note: $\rho(n)$ is increasing with the number of firms n .
- If all firms are identical, the prob that each firm would make the discovery would be $\rho(n)/n$.
 - Suppose cost of R&D = m , then $E(\text{prize}) = \text{prize} * (\rho(n)/n)$ would have to be $\geq m$.
 - Thus, to find optimal prize:
- Suppose $n = 8$ results in the socially optimal outcome (as shown in Table 1), we have $\rho(n) = 0.80$.
- If $m = 1$, substituting all the numbers gives prize = 10.

Patents

- The biggest reason why R&D is not carried out as much as the society would like is that once an invention is discovered, it is possible for others to copy.
- Patents give rights for firms to be the **ONLY** owner/producer of their invention(s).
 - Patents create market distortion (exploitation of monopoly power)
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 - The optimal length of patent depends on the cost of invention, probability of success, social benefits etc.
 - In any case, if other firms could invent even better products. Old patents may become valueless.

Value of a Patent (Permanent Patent)

If the patent (monopoly right) lasts forever. What would be the value of it? Suppose:

- 1 Demand in each period: $p = 6 - 5Q$
- 2 Average cost = Marginal cost of production = 1
- 3 Only 1 firm made the discovery.
- 4 The interest rate, r , is 10 percent

This would give $\pi^m = 1.25$ per period. If the monopoly right is forever, then

Value of a Patent (Finite Patent Length)

The value of a patent that lasts for t periods of time is:

$$\frac{\pi^m}{(1+r)} + \frac{\pi^m}{(1+r)^2} + \dots + \frac{\pi^m}{(1+r)^t}.$$

For example, if $t = 10$, we have

$$\text{Patent Value} = \frac{1.25}{(1.1)} + \frac{1.25}{(1.1)^2} + \dots + \frac{1.25}{(1.1)^{10}} = 7.68$$

Optimal Patent Length (1)

Now, if we know the value of a patent, probability of success $\rho(n)$ and cost of a project m , we can calculate the number of projects undertaken in equilibrium.

- A firm undertakes a project if $E(\text{gain}) \geq \text{cost}$, where $E(\text{gain}) = \text{Patent Value} \times \text{Prob}(\text{success})$.
- Suppose $t = 10$ (thus patent value = 7.68) and $m = 1$, we have

$$\text{Patent Value} \times \text{Prob}(\text{success}) \geq \text{cost}$$

$$7.68 \times (\rho(n)/n) \geq 1$$

$$\rho(n)/n \geq \frac{1}{7.68}$$

$$(1 - e^{-\alpha n})/n \geq 0.13$$

- If $\alpha = 0.2031$, we get $n = 5.09$. (I used a numerical method to solve for this number. It's complicated. You won't need to solve this in the exam.)

Optimal Patent Length (2)

Table 2: Optimal Patent Length (# of projects needs to be countable)

Length of Patent (t)	# of projects (n)	Net social Benefit
9	4	7.84
10	5	8.42
11	5	8.29
12	6	8.53
13	6	8.41

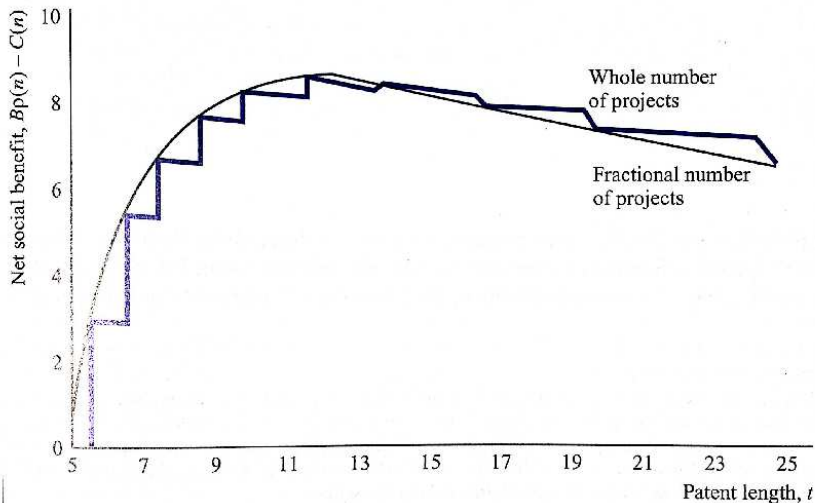
Source: Carlton and Perloff (2005), page 551.

Here, net social benefit is maximized when $t = 12$ and $n = 6$.

Optimal Patent Length (3)

FIGURE 16.2

Net Social Benefit Varies with Patent Length



Government Uncertainty

- Accurate information on the cost of research, social benefit and probability of success are needed for the government to find the optimal value if prize or length of patent.
- Under full information
 - patents are less desirable because they distort pricing.
 - giving prize or research contract would be better because after the discovery, government can let anyone use the innovation.
- Under imperfect information
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Eliminating Patents

- Because patents give monopoly power (market power), it creates deadweight loss (and thus economics inefficiency). This means, some consumers with.. would not be able to consume.
- Most of the debate is on the pharmaceutical industry.
 - with patents, many people die while there exists medicine that can treat them.
 - without patents, there the medicine may not be invented.
 - how can we have new medicine and keep the price low at the same time?
- Please Carlton and Perloff (2005), at the end of chapter 16 for more details.

Are Cheap Drugs a Good Thing?

“Allowing prescription drug firms to earn profits with prices above the competitive level increases the investment in pharmaceutical research. Government pricing restrictions over the last ten years in Europe have held down the prices of prescription drugs relative to the prices received in the US. Prior to the price restrictions, Europe and the US both spent approximately \$10 billion a year on drug research. Currently, Europe spends just over \$20 billion compared to the \$30 billion expenditures by the US. Between 1993–1997, Europe produced 81 new molecular entities while the US produced only 48. Europe produced only 44 new molecular entities from 1998–2002. During the same period, the US developed 85. The European price controls have limited the earnings capabilities of the drug companies there and innovation has declined.”

Source: “The Trouble with Cheap Drugs,” The Economist, January 31, 2004.

Market Structure and Incentive to Innovate

- How does the market structure affect the incentives to innovate?

If firms don't have to worry about others inventing the product first

- a monopoly would ..
- in this case, competitive firms invent.. than a monopoly.

If firms have to worry about others inventing the product first

- a monopoly..
- compared with firm in a competitive market, a monopoly would have a greater incentive to innovate because..

Reference and Further Reading



Carlton, D.W. and J.M., Perloff.
Modern Industrial Organization. 4th Edition.
Pearson Addison Wesley Press, 2005.