

EE481: Industrial Economics

Patents and Technological Change (Chapter 16)

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28/11/2014

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?

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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).
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Trademark Case: Starbung

In 2013, “Starbucks Coffee Company” sued Starbung for using its logo.



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Patent Case: Compulsory License

Compulsory License = Government grant of license to 3rd party to use patent without consent of patent holder

- Brazil (Antiretroviral (ARV)) - domestic price ↓ by 50-70%
- Thailand (Antiretroviral (ARV) and Cancer drugs)
- India (Cancer drugs)
- etc.

Sometimes the US government responded by removing special treatments on bilateral trade agreements.

- Do think governments should give compulsory license?

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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.

Incentives for inventions are needed

- Many new inventions give huge benefits to people.
- Innovation has a “positive externality” $\Rightarrow$ market failure
- To increase social gain, the government gives more incentives to inventors.
 - Through patents, copy rights, research grants.
 - Patents also encourages disclosure for future research.
 - .. but in some cases, firms do not register for patents because they don't want to disclose their secrets.

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Patents, Prizes, Research Contracts and Joint Ventures

- Patents = right to be a monopoly on the product for a certain period of time.
- Prizes = big money rewarded only if the project is successful
- Research contracts = funding to support research/innovation projects, no success guaranteed.
- Joint ventures = allowing firms to cooperate on their R&D.

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Research Contracts

Suppose the government wants to find a cure for cancer.

So, it gives research grants to researchers at the universities/research centers.

- How many research grants should it give?
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The optimal number of firms or projects

Suppose

- 1 The cure for cancer has a social value of $B = 25$ million THB.
- 2 The probability of success $\rho(n)$ increases as the number of projects increases.
where $(\rho(n) = 1 - e^{-0.205n})$
- 3 It costs 1 million THB to fund 1 project.

We want to find the number of projects (n) that maximizes the net social benefit.

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When $n = 8$, net social benefit is maximized.

Table 1: Costs and Benefits of Research Programs

n	$\rho(n)$	E(Social Benefit) $B \times \rho(n)$	$C(n)$	Net Social Benefit $B \times \rho(n) - C(n)$
6	0.70	17.61	6	11.61
7	0.76	18.97	7	11.97
8	0.80	20.08	8	12.08
9	0.84	20.98	9	11.98
10	0.87	21.72	10	11.72
11	0.89	22.32	11	11.32

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

The optimal number of firms or projects

When $n = 8$, net social benefit is maximized.

⇒ and marginal E(social benefit) = marginal cost

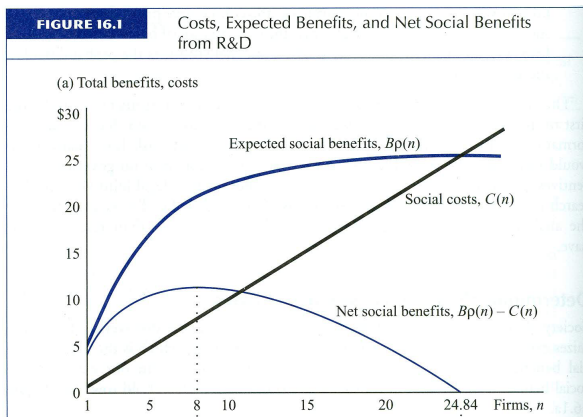
Table 2: Costs and Benefits of Research Programs

n	$\rho(n)$	E(Soc. Benefit) $B \times \rho(n)$	Marginal E(Soc. Ben.)	$C(n)$	Marginal cost	Net Soc. Benefit $B \times \rho(n) - C(n)$
6	0.70	17.61	-	6	1.00	11.61
7	0.76	18.97	1.23	7	1.00	11.97
8	0.80	20.08	1.00	8	1.00	12.08
9	0.84	20.98	0.82	9	1.00	11.98
10	0.87	21.72	0.67	10	1.00	11.72
11	0.89	22.32	0.54	11	1.00	11.32

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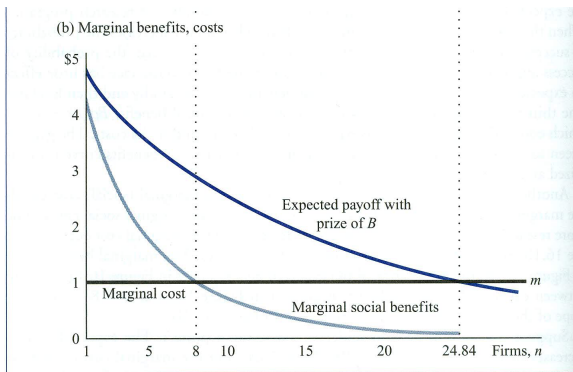
The optimal number of firms

This is very similar to profit-maximization. But instead of revenue and cost, you have social benefit and social costs.



The optimal number of firms

Net benefit is maximized when marginal social benefit = marginal cost.



Prizes

What should be the optimal value of prize?

- If prize is too low $\rightarrow$ not enough R&D
- If prize is too high $\rightarrow$ excessive research
- We know that firm invests if $E(\text{prize}) \geq \text{cost of research}$.
- So, the optimal price is where $E(\text{prize}) = \text{cost}$.

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Optimal Value of Prize

The optimal value of prize

$$E(\text{prize}) = \text{cost}$$

$$\text{prize} \times \left(\frac{\rho(n)}{n} \right) = m$$

$$\text{prize} = m \div \left(\frac{\rho(n)}{n} \right)$$

where n = number of firms, $\rho(n) = 1 - e^{-0.205n}$ = probability of at least 1 firm succeeding, m = cost of research

- Suppose $n = 8$ results in the socially optimal outcome, we have $\rho(n) = 0.80$.
- If $m = 1$, substituting all the numbers gives prize = 10.

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Prizes (extra note)

- As a result, government sets the prize = 10
- ASSUME that firms know the total number of firms that compete for the prize
- There would be exactly 8 firms in the equilibrium
 - if more than 8, some firms will drop out
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- Patents give rights for firms to be the ONLY owner/producer of their invention(s).
- This creates a good incentive to innovate BUT
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 - So, a patent should not last forever.
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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

$$\text{Patent Value} = \frac{\pi^m}{(1+r)} + \frac{\pi^m}{(1+r)^2} + \dots + \frac{\pi^m}{(1+r)^\infty} = \frac{\pi^m}{r} = \frac{1.25}{0.1} = 12.5$$

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

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

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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 $n \leq 5.09$. (I used a numerical method to solve for this number. It's complicated. You won't need to solve this in the exam.)

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- 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 $n \leq 5.09$. (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 (1)

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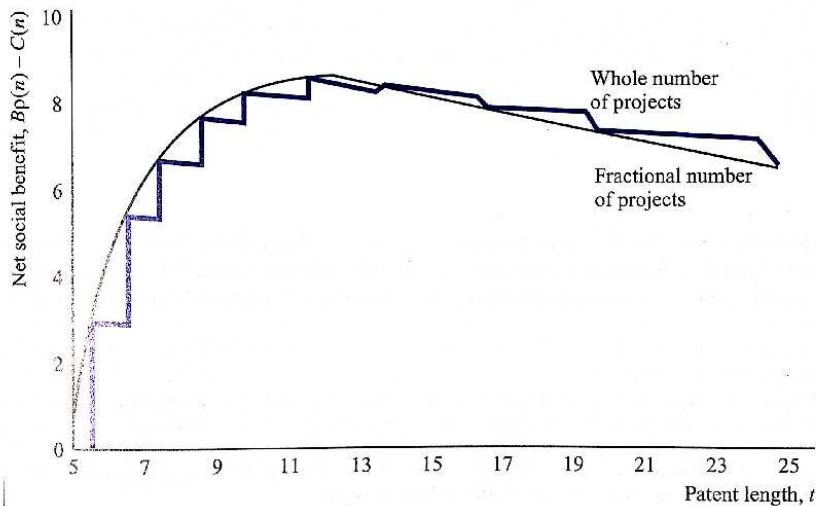
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Optimal Patent Length (2)

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 of 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
 - patents maybe more desirable
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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 .. not bother to invent.
- In this case, competitive firms invent.. more (or faster) than a monopoly.

If firms **have** to worry about others inventing the product first

- A monopoly.. has an incentive to innovate to maintain its monopoly position.
- Compared with firm in a competitive market, a monopoly would have a greater incentive to innovate because.. the reward from successful innovation is greater.

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Reference and Further Reading



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