Tech Change, Dynamic Efficiency, Market Structure

17.1 Invention and Tech Change

17.2 Failure of the Market for Ideas

17.3 Effects of Market Structure on Tech Change
- **Monopoly**
- **Competition vs Monopoly**
- **Monopoly and Potential Entrant**
- **Oligopoly and Incentive to Innovate**

17.4 Effects of Tech Change on Market Structure

17.1 Invention and Tech Change

Factors of long run growth in income:
1) **Adequate infrastructure** - legal and cultural attitudes that support entre
2) **Quantity of physical capital**
3) **Level of human capital**
   Human capitals change results from investments in education
4) **Level of technology** - entire body of knowledge of bringing inputs together to produce g&s
   Technological change results from investments in R&D

Contributions to US economic growth:
50% from increases in physical capital (2)
20% from increases in human capital (3)
40% from increases in technological change (4)
-10% from government regulations and shorter avg work week

Economics of Technological Change

1) Production Function - produce same amount with fewer inputs

Production Function

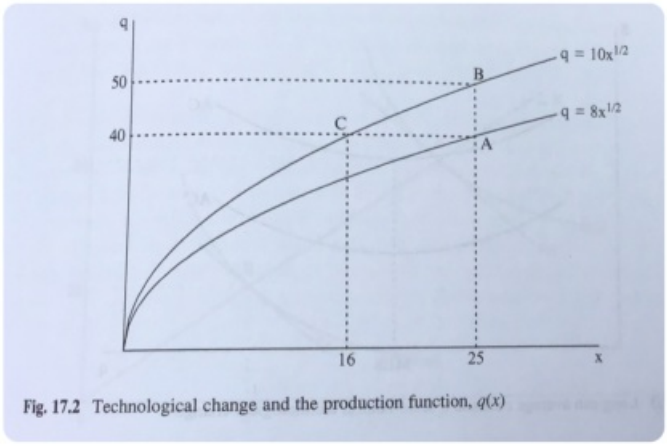

Fig. 17.2 Technological change and the production function, $q(x)$

Tech change where quality moves from 8 to 10.

Now, producing 40 units requires 16 input instead of 25 input

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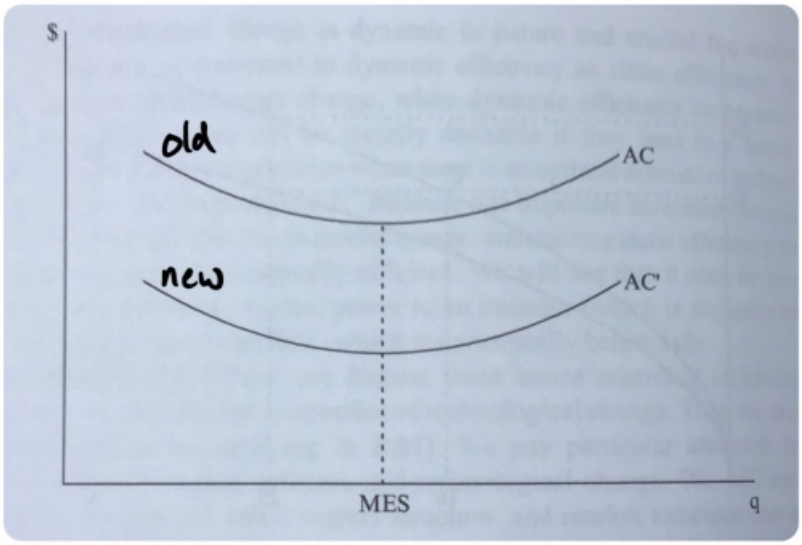
2) MES - Scale Neutral

Avg Cost Function

and our Min Eff Scale (MES)



Scale Neutral = no effect on MES

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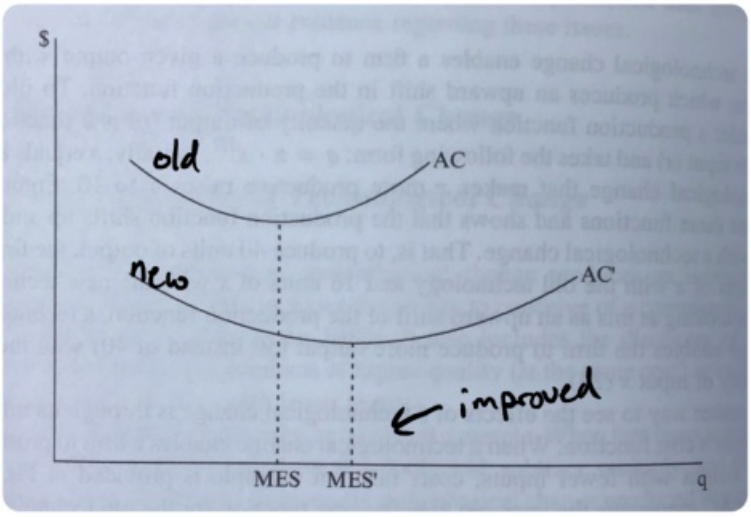
3) MES - Scale Increasing

Avg Cost Function
and our Min Eff Scale (MES)



Scale Increasing = causes MES to increase

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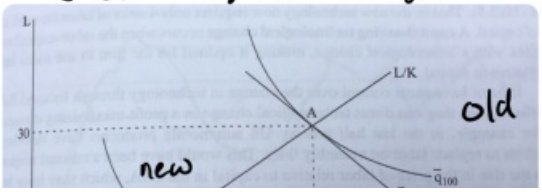
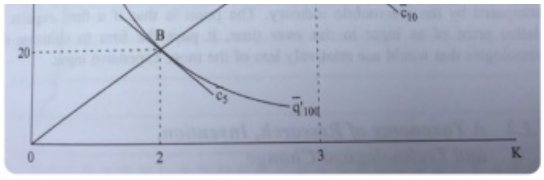
4) Neutral Tech Change

Sub Possibilities
(Tech Change on Isoquant)



Old
100 units
30 L

New
100 units
20 L



3 k
Ratio = 10

2 k
Ratio = 10

Same total production and labor/cap ratio = neutral tech change

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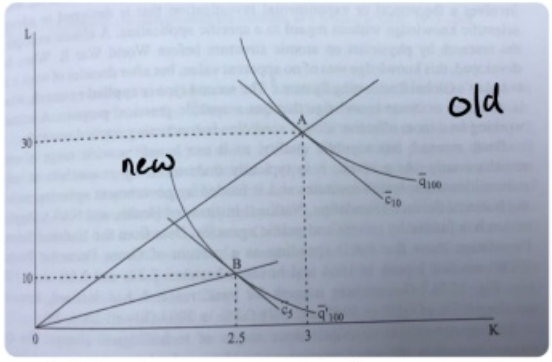
5) Labor Saving Tech Change

Sub Possibilities
(Tech Change on Isoquant)



Old
100 units
30 L
3 k
Ratio = 10

New
100 units
10 L
2.5 k
Ratio = 4

Different total production and labor/cap ratio = labor saving tech change

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Research and development:
1) Basic research = advance scientific knowledge, not directed at one specific thing
2) Applied reseach = designed to create knowledge that has a specific practical purpose

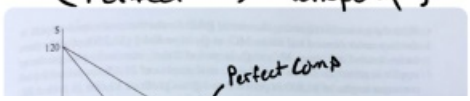
Stages of tech change:
1) Invent (create new idea / solve tech possibility)
2) Innovate (apply invention, result in new product / process)
3) Imitation (product is widely used)

The government can:
1) Subsidize
2) Create prizes
3) Create intellectual property rights

Market Structure and Technological Change

Trade secret: alternate to patent
Better where you don't want to reveal what you are patenting (eg Coke recipe)

Schumpeter Tech Change
(Perfect → Monopoly)



Before R+D

After

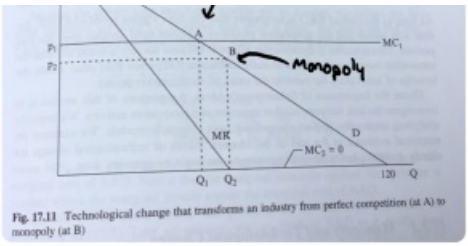


Fig. 17.11 Technological change that transforms an industry from perfect competition (at A) to monopoly (at B)

MC = 70 MC = 0
P = 70 P = 60
Q = 50 Q = 60

Inefficient → P of 60
- MC of 0
60

Still worth it if benefit to society > 60

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1) Monopoly

Monopoly

Setup
- Monopoly → Improve Quality
- $q(p, R\&D)$ → quantity is a function of price and R&D

Profit
- $\Pi = TR - TC$
- $\Pi = p \cdot q(p, R\&D) - (Cq + R\&D)$

Derive
- $\frac{\partial \Pi}{\partial R\&D}$

Result
- $\frac{R\&D}{TR} = \frac{\text{Elasticity of R\&D}}{\text{Elasticity}}$

Conclude
1) Greater R&D when expected demand increase is greater
2) Greater R&D when lower elasticity of demand (eg cigarette)

Setup
- Monopoly → Lower costs
- $q(p)$ → quantity is a function of Price
- $C(R\&D)$ → cost is a function of R&D, falls at decreasing rate

Profit
- $\Pi = TR - TC$
- $\Pi = p \cdot q(p) - (C(R\&D) \cdot q + R\&D)$

Derive
- $\frac{\partial \Pi}{\partial R\&D}$

Result
- $\frac{\partial C}{\partial R\&D} < 0$ (costs fall as R&D increase)

Conclude
1) Greater R&D when cost savings greater than R&D expense
2) Greater R&D when benefits of R&D increase with scale

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2) Monopoly vs Perfect Comp

Monopoly

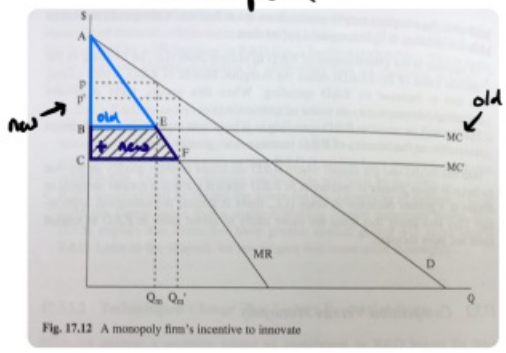

Fig. 17.12 A monopoly firm's incentive to innovate

Minor tech change when
new price (P') > old cost (MC)

Perfect Comp

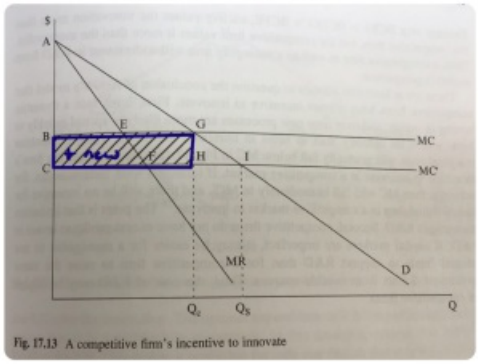

Fig. 17.13 A competitive firm's incentive to innovate

Implications:

1) More R&D investment from firms with higher competition
Potential issue: Over time, competing firms will be able to lower their MC as well. Imitation discourages R&D.

2) Society values innovation more than both monopolist and perfect comp
Potential issue: Perfect comp doesn't have excess profits to invest. This makes R&D more expensive.

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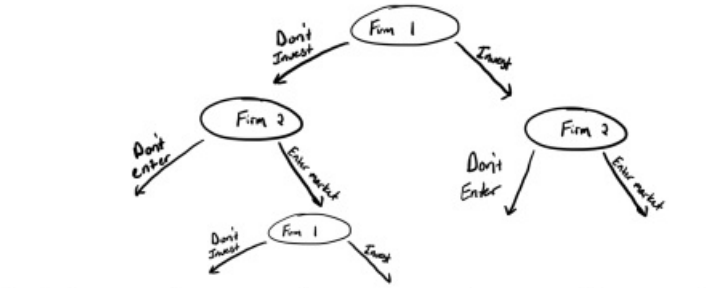
3) Innovation Game w Potential Entry

$P = 100 - Q$

Before → $MC = 40$

After → $MC = 10$



Firm 1	900	400	100	2025 - R and D	1600 - R and D
Firm 2	0	400	1600 - R and D	0	100

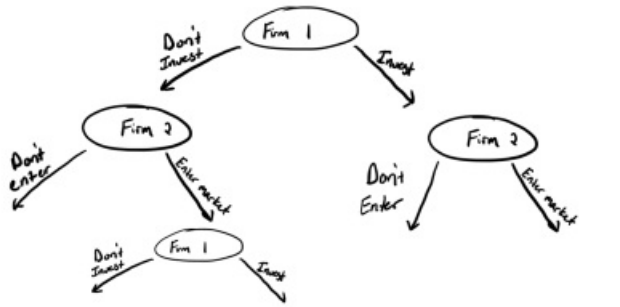
✓

3) Innovation Game w Potential Entry and Additional Sunk Cost

R and D as a strategic barrier to entry

R and D cost = 1500

Additional sunk cost to enter = 200



Firm 1	900	400	100	525	100
Firm 2	0	200	-100	0	-100

✓

4) Oligopoly, Lerner Index

The R&D to sales ratio will be greater when
1) Price elasticity of demand falls and
2) Industry concentration (HHI) increases

$$L = \frac{P - MC}{P} = \frac{1}{n \cdot elast} = \frac{HHI}{elast}$$

$$\frac{\text{Number of firms} \cdot \text{R and D}}{TR} = \frac{HHI}{\text{elasticity}}$$

Evidence

1. **Government incentives** - patent system and research grants
   20% tax credit on R&D
   Government supplies 26% of grant funding
2. **Private firm incentives** - firms will invest when they will see the gains on investment
3. **Market structure** - no clear link.
   Arrow - Competitive firms will invest
   Schumpeter - Large firms in highly concentrated industries will invest
   Causal flow - a tech change may influence market structure

High tech firms invest more -- more patents
Some evidence that market structure effects R&D