School of Business,
Economics and Law
GÖTEBORG UNIVERSITY

Monopoly
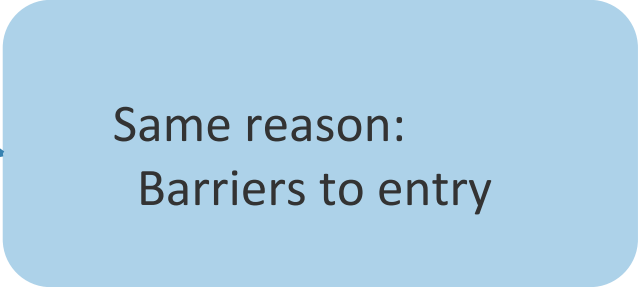
Johan Stennek

Monopoly

- <u>Q</u>: Examples of monopoly?

  – SJ on the route Stockholm – Linköping?

  – Pharmaceutical companies with patent?

  – District heating?

  – Hemnet?

Monopoly

- <u>Q</u>: How do you define monopoly?
- Definition – supply side
  - One firm producing the product
  - No close substitutes
  - Barriers to entry

  > Same reason:
  >   Barriers to entry

- Definition – demand side
  - Many "small" buyers (consumers, small firms)

- Implication: Firm can set price without thinking about
  - Other firms (existing or not)
  - Individual consumers

Barriers to entry

- <u>Q</u>: Examples of entry barriers?

- Legal
  - Patents to protect R&D: pharmaceuticals (substitutes?)
  - Copy rights: Books (substitutes?)
  - Consumption control: liquor
  - Fiscal: gambling

- Economies of scale / market size
  - District heating in cities
  - Food retailing in rural areas
  - Telecom networks

- Exclusive access to essential resource
  - Natural resource
  - Exclusive distribution agreement

- Network effects
  - Hemnet

Q: Why study monopoly?

- Still some important monopolies
  - Pharmaceuticals, district heating, …

- Policy evaluations
  - competition policy: ban on exclusion + merger control
  - press subsidies
  - deregulation

- Preparation for studying competing firms

Examples

- Pharmaceuticals
  - Huge costs for R&D
  - Patents for 20 years => Monopoly

- Striking stylized fact
  - Prices for the same drug differ hugely between countries

Examples

- Lipitor
  - Reduces cholesterol
  - Manufacturer prices per dosage in 1998 (10 mg tablets)
    - US: $ 1.46
    - Sweden: $ 0.94

- Losec
  - Ulcer treatment
  - Manufacturer prices per dosage in 1998 (20 mg tablets)
    - US: $ 2.99
    - Sweden: $ 1.74

Examples

Average percentage deviation from European mean prices for 90 pharmaceutical products in 1998

| Country	Deviation
Greece	-28
Spain	-20
Portugal	-13
Italy	-13
France	-10
Finland	-2
Austria	-2
Norway	-1
Sweden	-1
Belgium	-1
Netherlands	+2
Denmark	+3
Germany	+11
United Kingdom	+19
Switzerland	+25

Examples

- Questions

  – Why are prices for the same good different in different geographical markets?

  – Why do prices differ from costs (= similar in all countries)?
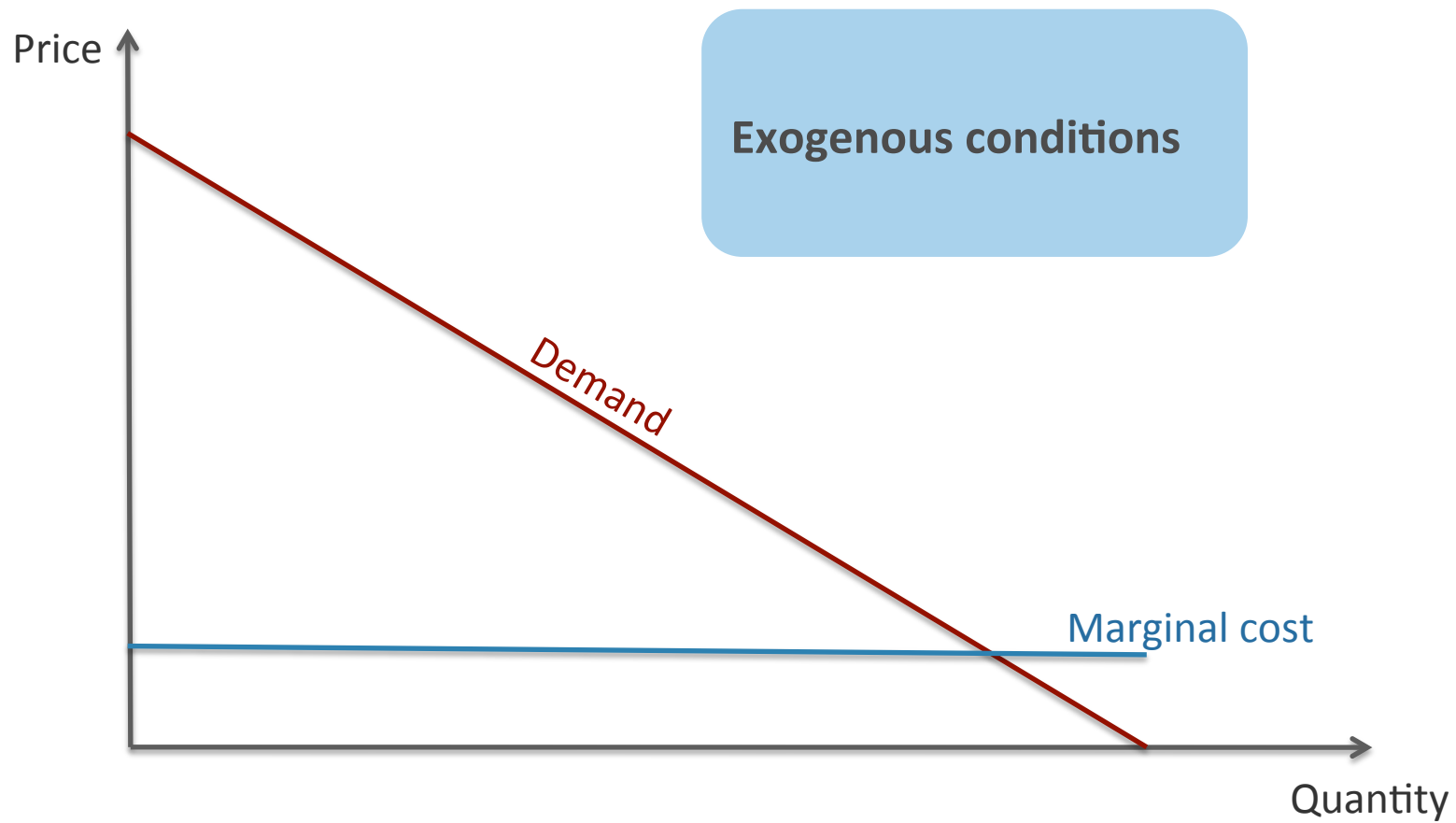
  – Is this pattern good or bad?

The monopoly model

Monopoly model

- ## Behavioral assumption
  - Firm wants to maximize profits

- ## Choice
  - Price
  - Quantity

- ## Exogenous conditions
  - Demand function [P(q) or Q(p)]
  - Cost function   [C(q)]
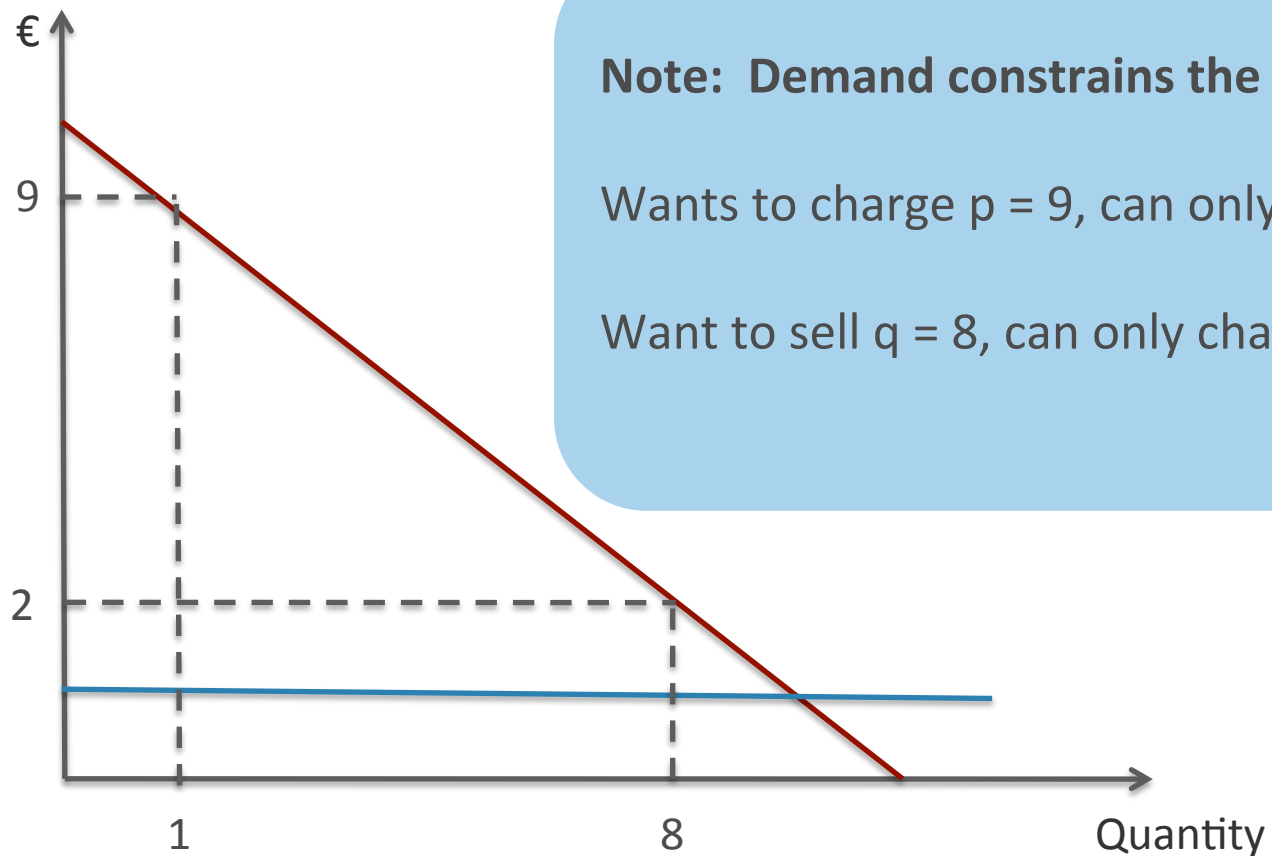
Monopoly model

Price

Quantity

Choice variables
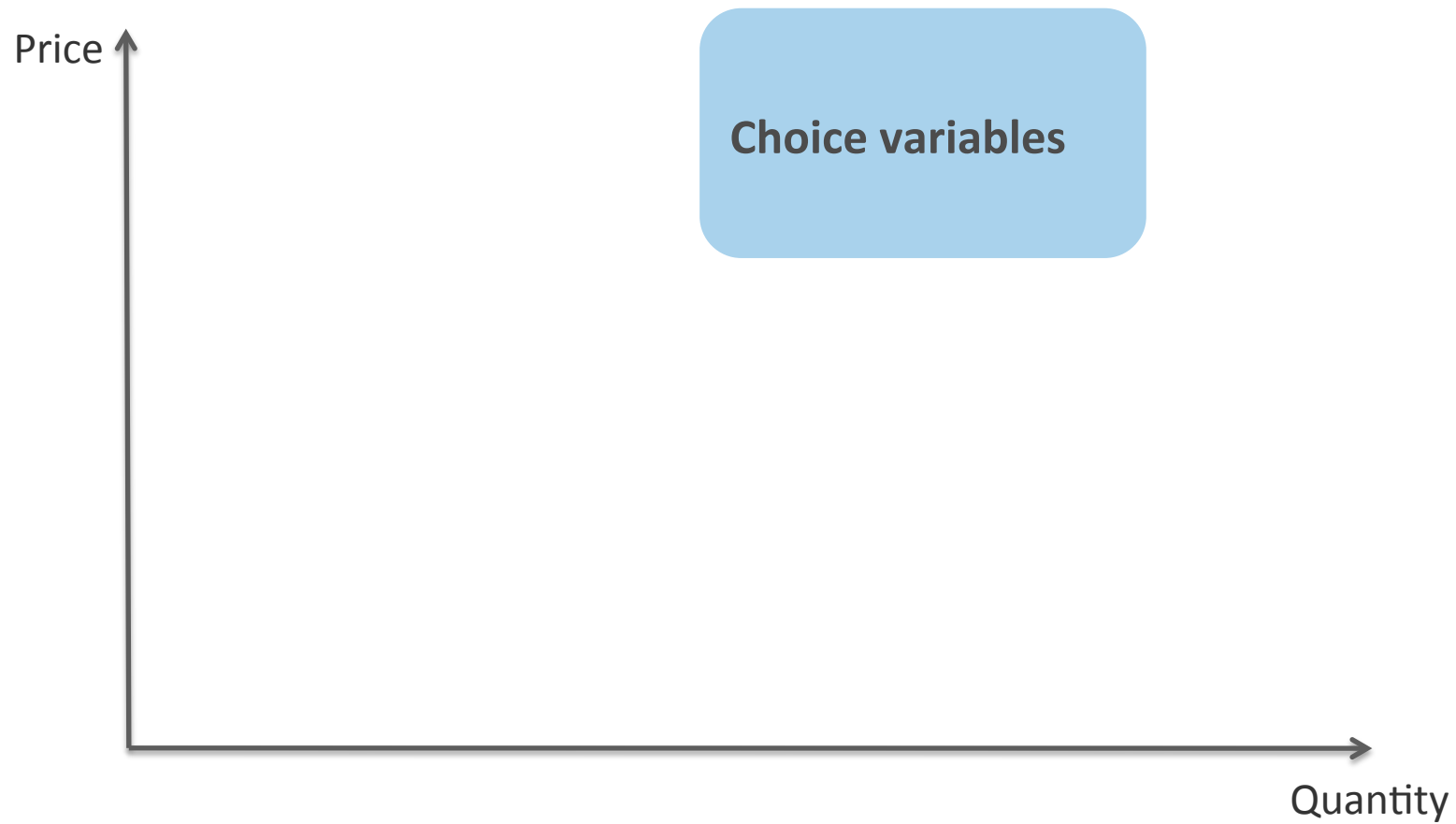
Monopoly model

Monopoly model

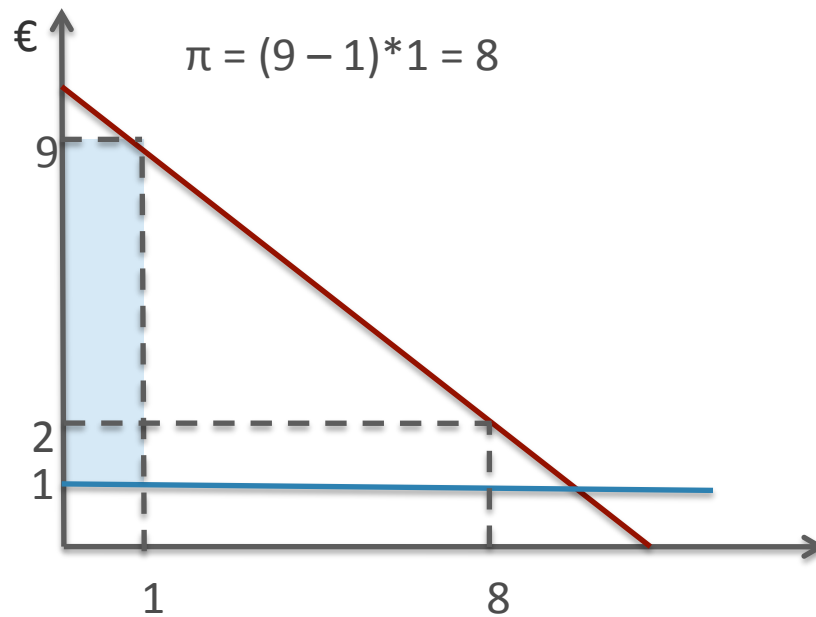**Note: Demand constrains the monopolist**

Wants to charge p = 9, can only sell q = 1

Want to sell q = 8, can only charge p = 2

Monopoly model

$\pi = (9 - 1)*1 = 8$

$\pi = (2 - 1)*8 = 8$

Very high margin: 8 = 9 − 1
Very low sales: 1
=>   low profit: 8
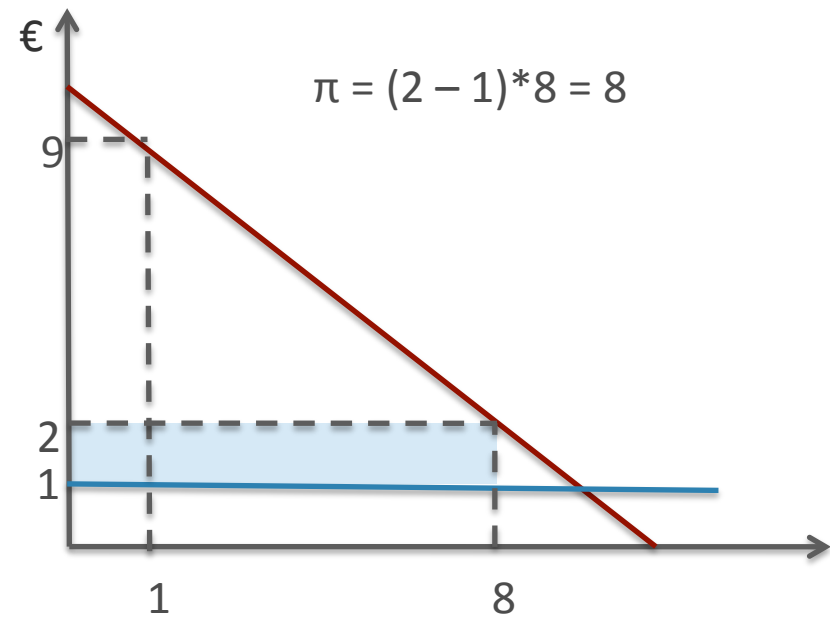
Very low margin: 1 = 2 − 1
Very high sales: 8
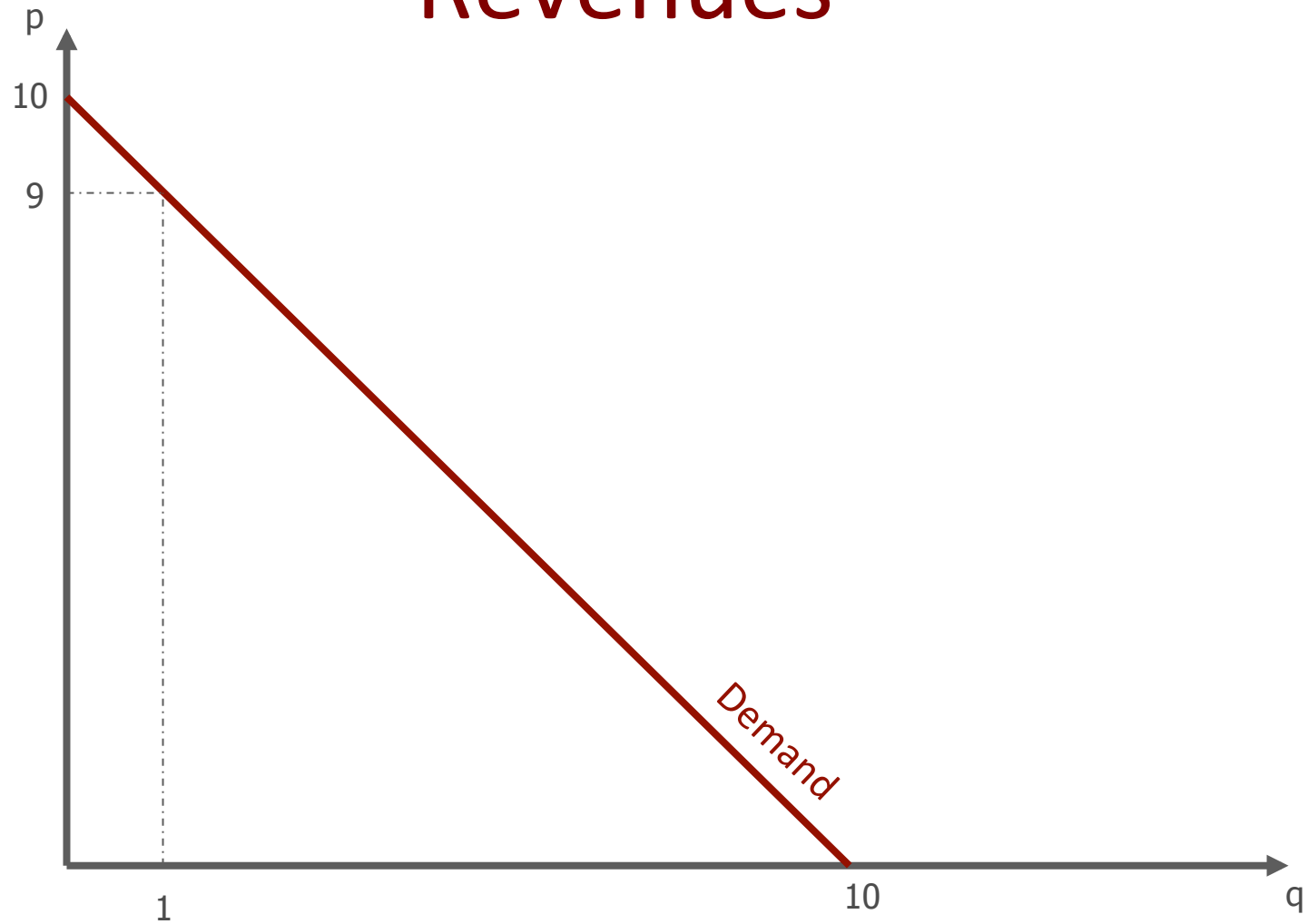=>   low profit: 8

Monopoly model

- Demand constrains the monopolists behavior
  - Trade-off between margin and sales
  - Need to strike a balance

- Now let's try to find this balance
  - Profit = Revenues - Cost
  - Need to study how revenues depend on sales

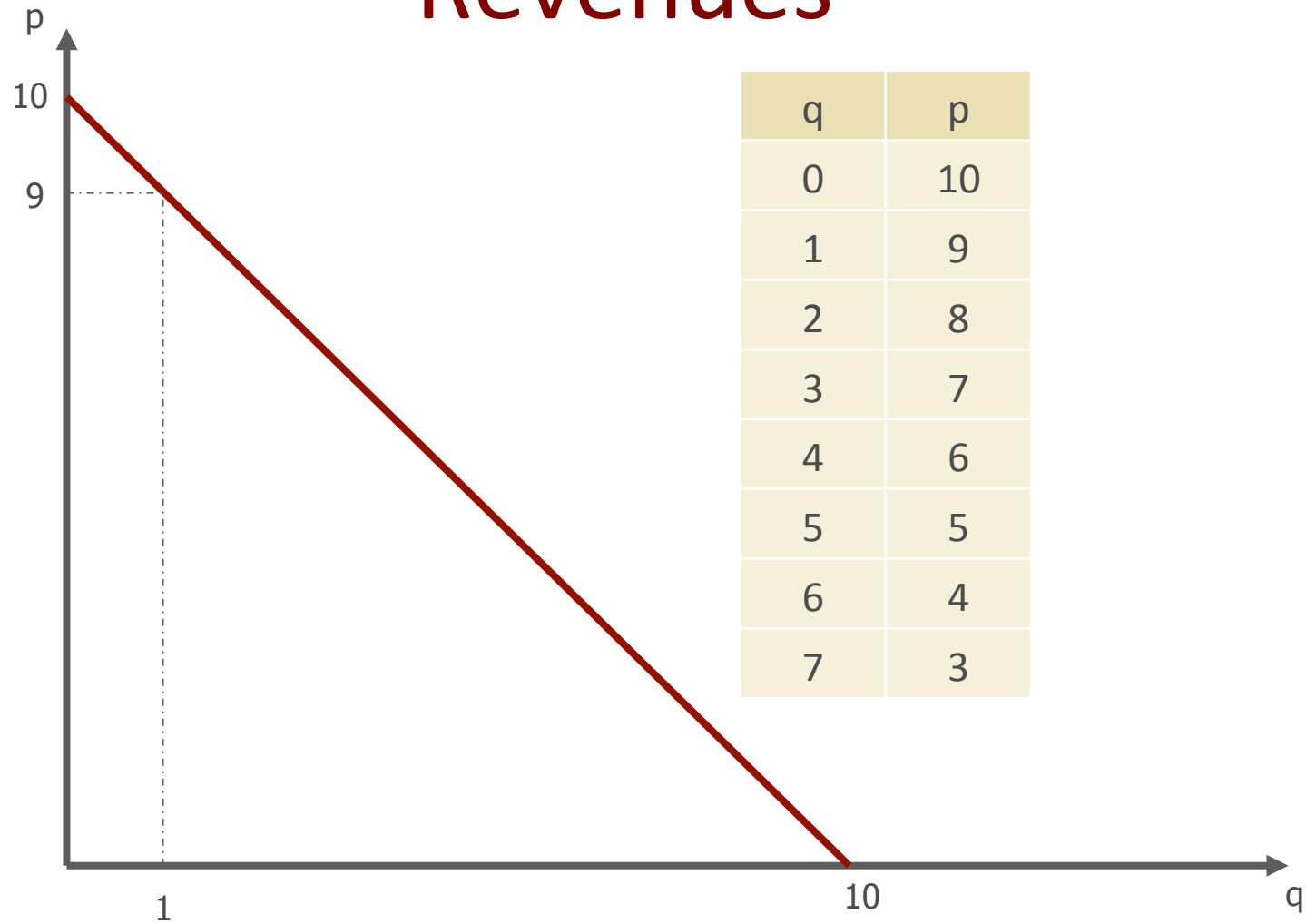# How do revenues depend on sales?

Revenues
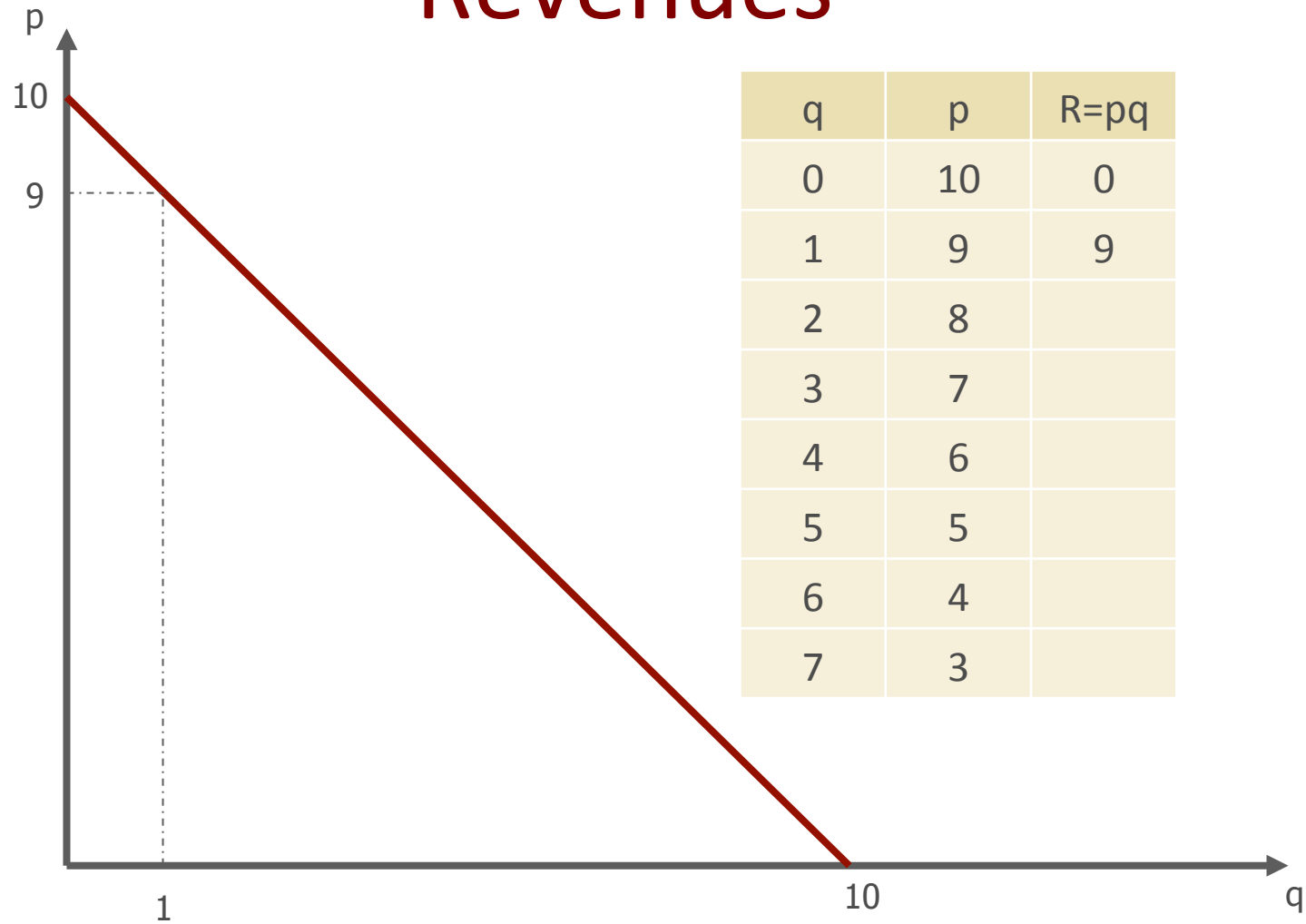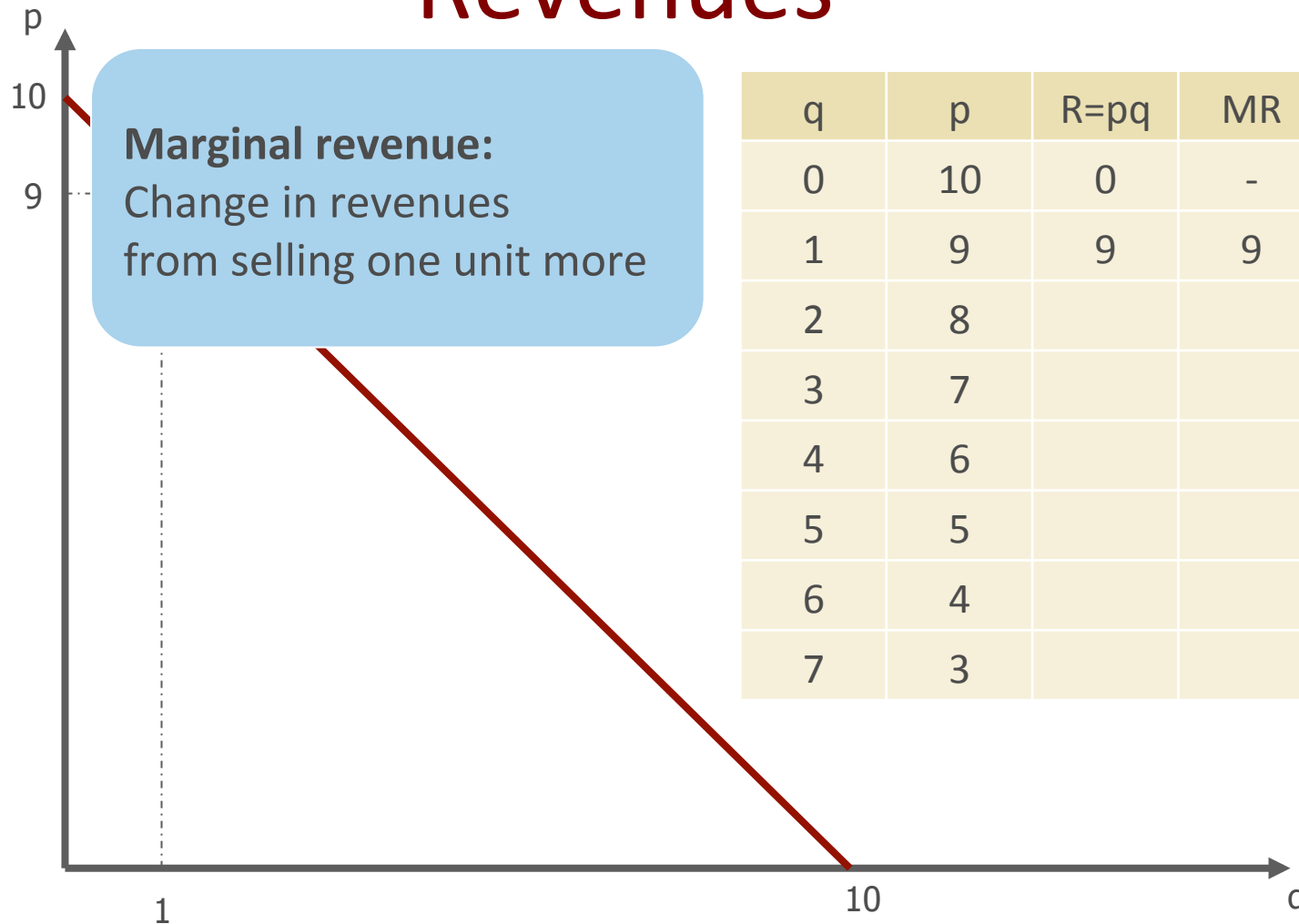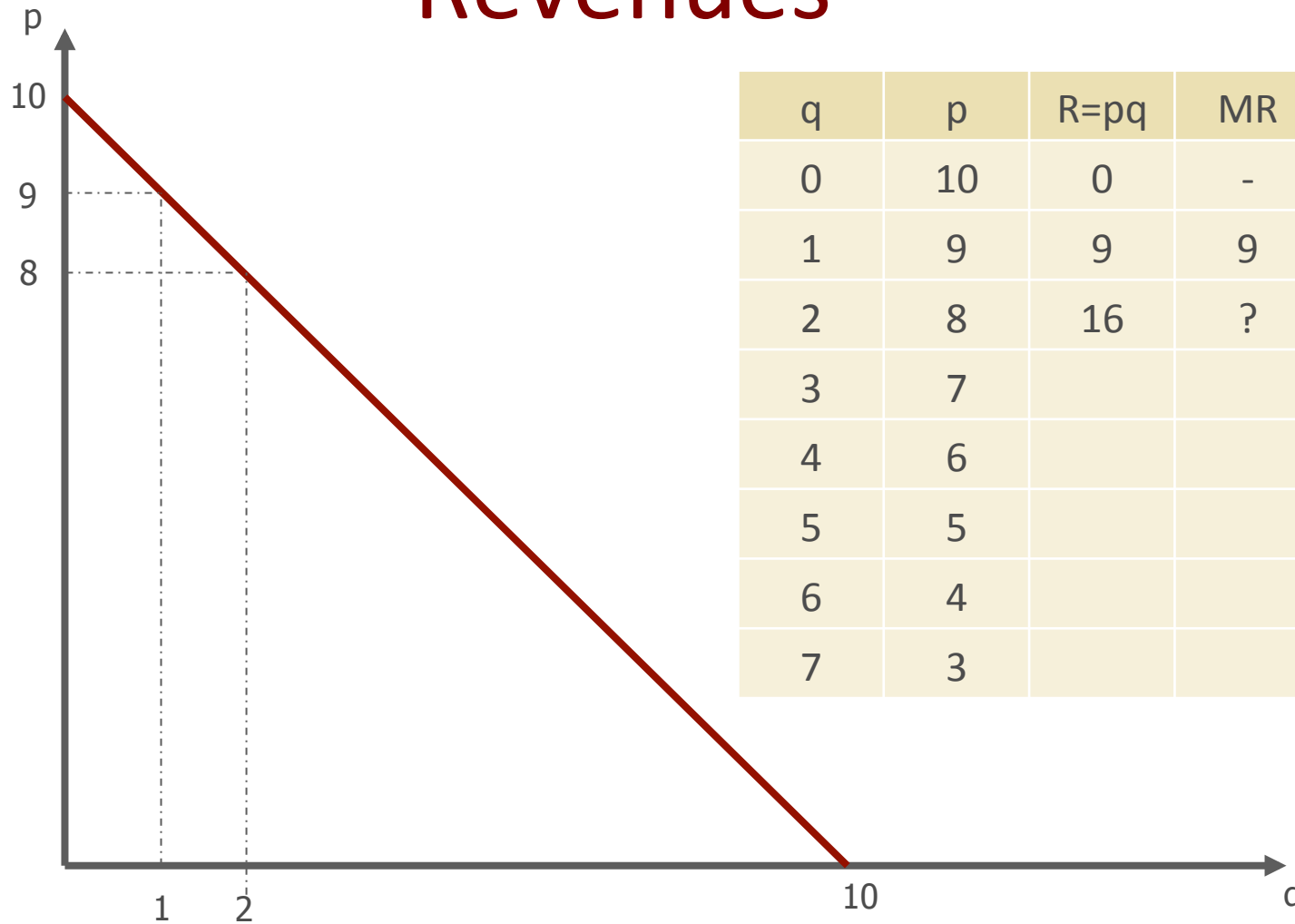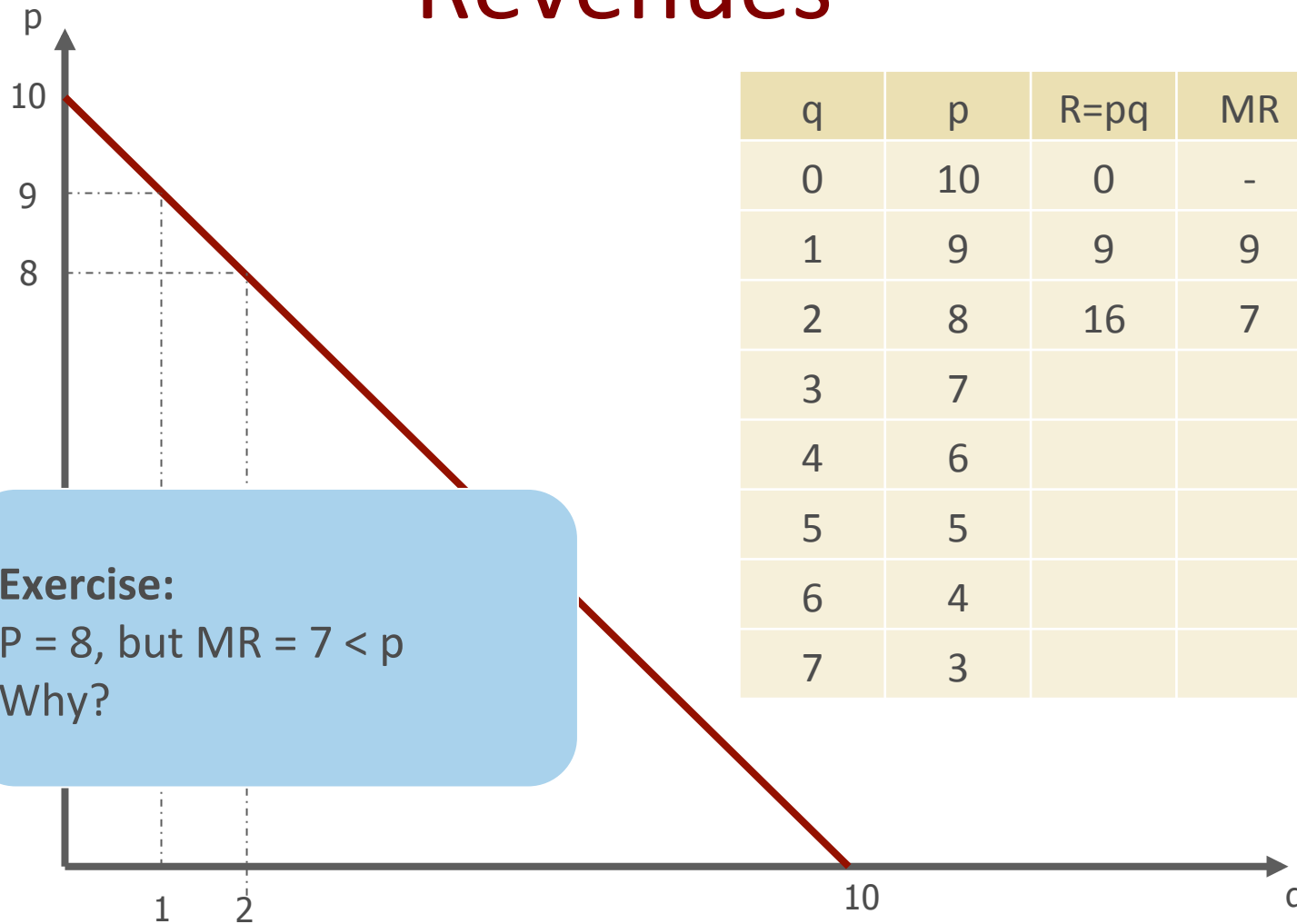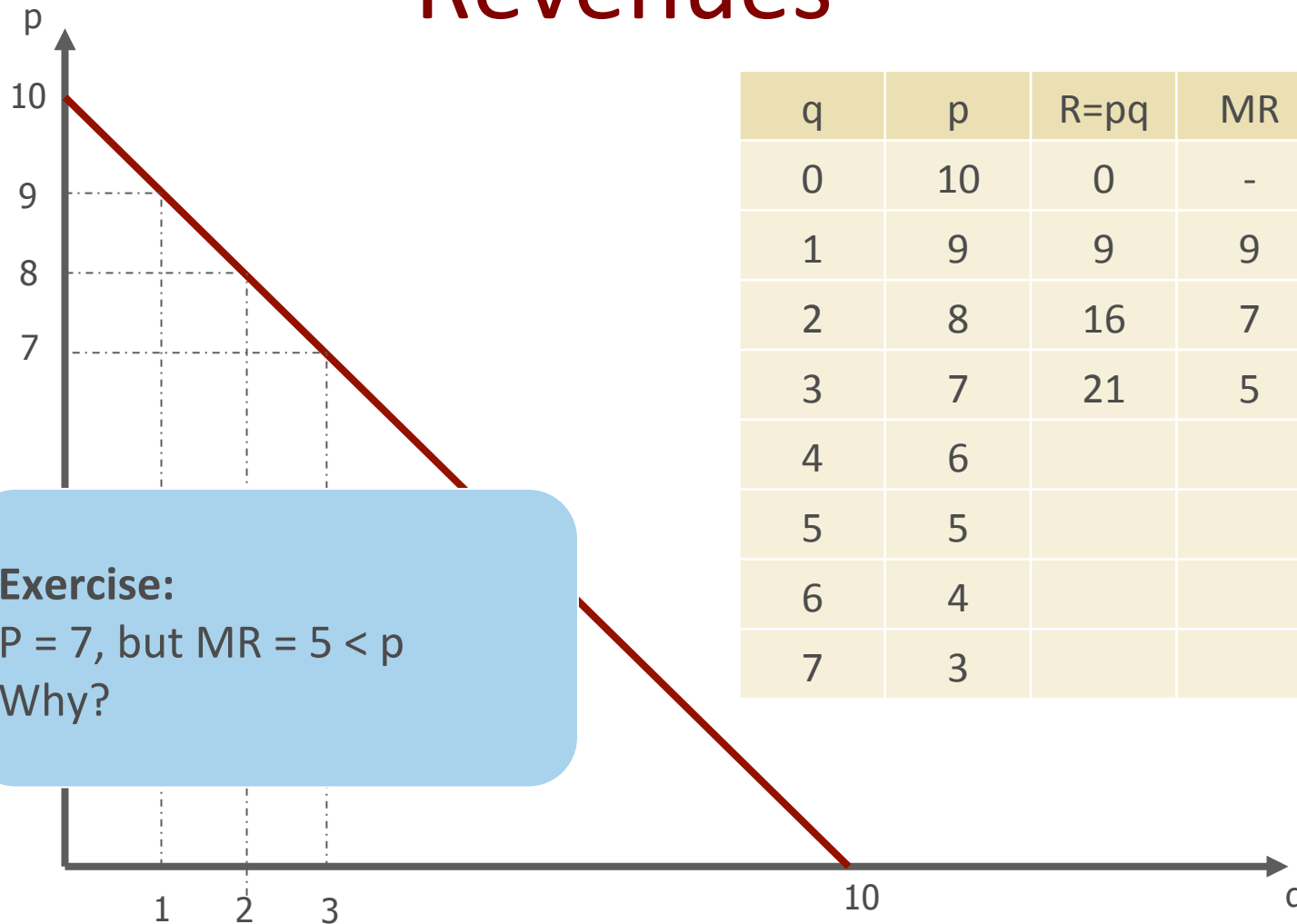
Revenues

q	p
0	10
1	9
2	8
3	7
4	6
5	5
6	4
7	3

Revenues

q	p	R=pq
0	10	0
1	9	9
2	8	
3	7	
4	6	
5	5	
6	4	
7	3	

Revenues

Marginal revenue:
Change in revenues
from selling one unit more

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8		
3	7		
4	6		
5	5		
6	4		
7	3		

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	?
3	7		
4	6		
5	5		
6	4		
7	3		

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7		
4	6		
5	5		
6	4		
7	3		

Exercise:
P = 8, but MR = 7 < p
Why?

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7		
4	6		
5	5		
6	4		
7	3		

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7		
4	6		
5	5		
6	4		
7	3		

the "inframarginal" consumer now pays 8 wherefrom the marginal revenue decreases with one unit

-1

+8

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7	21	?
4	6		
5	5		
6	4		
7	3		

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7	21	5
4	6		
5	5		
6	4		
7	3		

Exercise:
P = 7, but MR = 5 < p
Why?

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7	21	5
4	6		
5	5		
6	4		
7	3		

the inframarginal consumers now pay 7 and the marginal revenue decreases with 2 more units

-2

+7

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7	21	5
4	6	24	3
5	5		
6	4		
7	3		

Revenues

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7	21	5
4	6	24	3
5	5	25	1
6	4		
7	3		

Revenues

The more I sell, the more costly it is to lower price by €1
=>
MR is falling (normally)

q	p	R=pq	MR
0	10	0	-
1	9	9	9
2	8	16	7
3	7	21	5
4	6	24	3
5	5	25	1
6	4		
7	3		

Revenues

Price

Revenues

$$TR = P(q)q$$

Quantity

P(q)

Revenues

Price

Revenues

$$TR = P(q)q$$

If I sell one unit more:

$$MR = P(q) +$$

Price of additional unit

Quantity

P(q)

Revenues

Price

Revenues

$$TR = P(q)q$$

If I sell one unit more:

$$MR = P(q) + P'(q)q$$

Reduction in price on all units

Price of additional unit

Quantity

P(q)

Revenues

Price

Revenues

$$TR = P(q)q$$

If I sell one unit more:

$$MR = P(q) + P'(q)q < P(q)$$

MR < P

P(q)

Quantity

Revenues

Price

Revenues

$$TR = P(q)q$$

If I sell one unit more:

$$MR = P(q) + P'(q)q$$

Marginal revenue   *P(q)*   Quantity

Revenues

Price

Revenues

$$TR = P(q)q$$

If I sell one unit more:

$$MR = P(q) + P'(q)q$$

P(q)

MR(q)

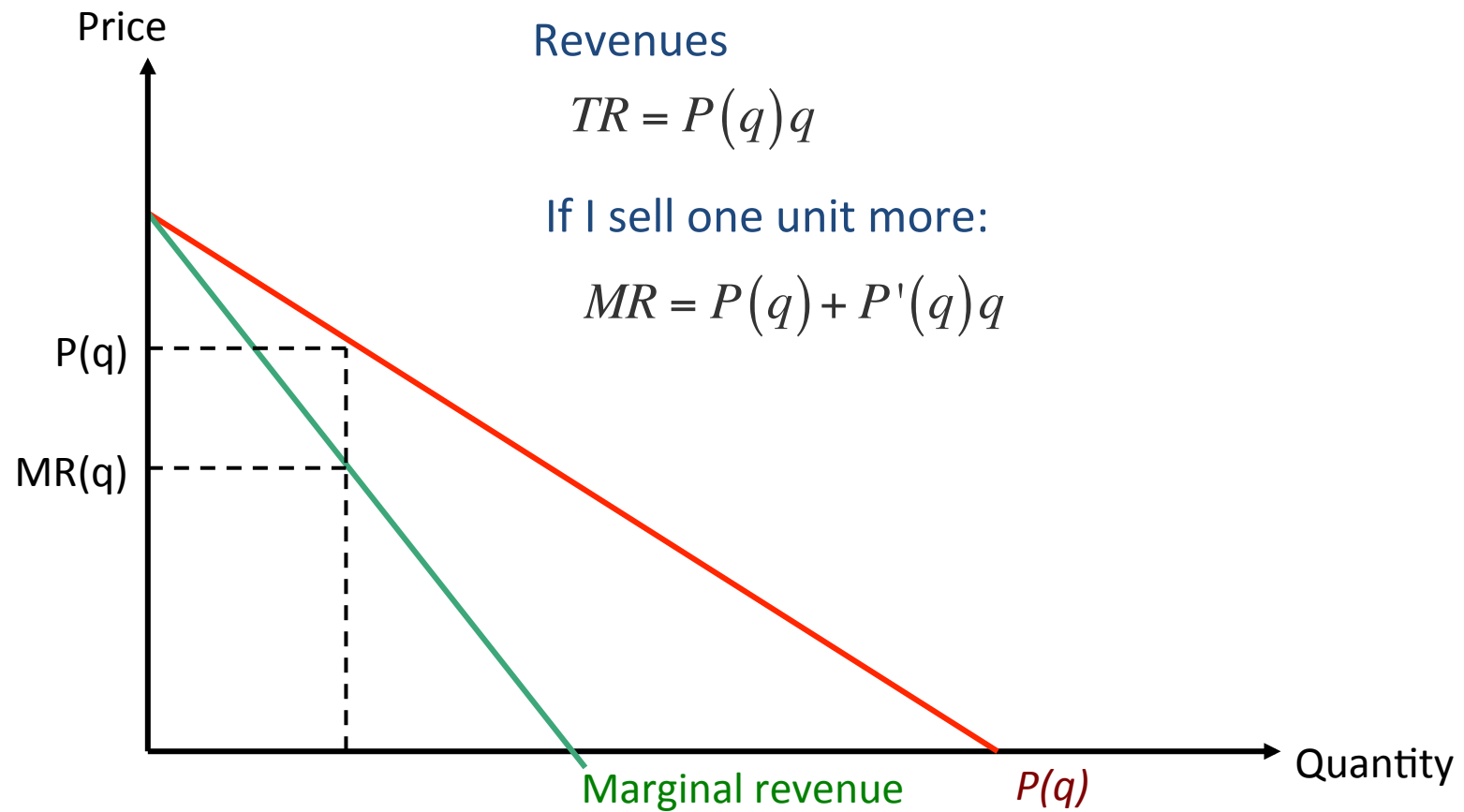Marginal revenue   *P(q)*

Quantity

Monopolist's choice of quantity

Choice of quantity

- Exercise: Set up monopoly problem and solve for optimal quantity!

  – Cost function: $C(q)$

  – Inverse demand: $P(q)$

Choice of quantity

Profit

$$\pi(q) = P(q) \cdot q - C(q)$$

Choice of quantity

Profit

$$\pi(q) = P(q) \cdot q - C(q)$$

First order condition

$$\pi_q(q) = P(q) + P_q(q) \cdot q - C_q(q) = 0$$

Choice of quantity

Profit

$$\pi(q) = P(q) \cdot q - C(q)$$
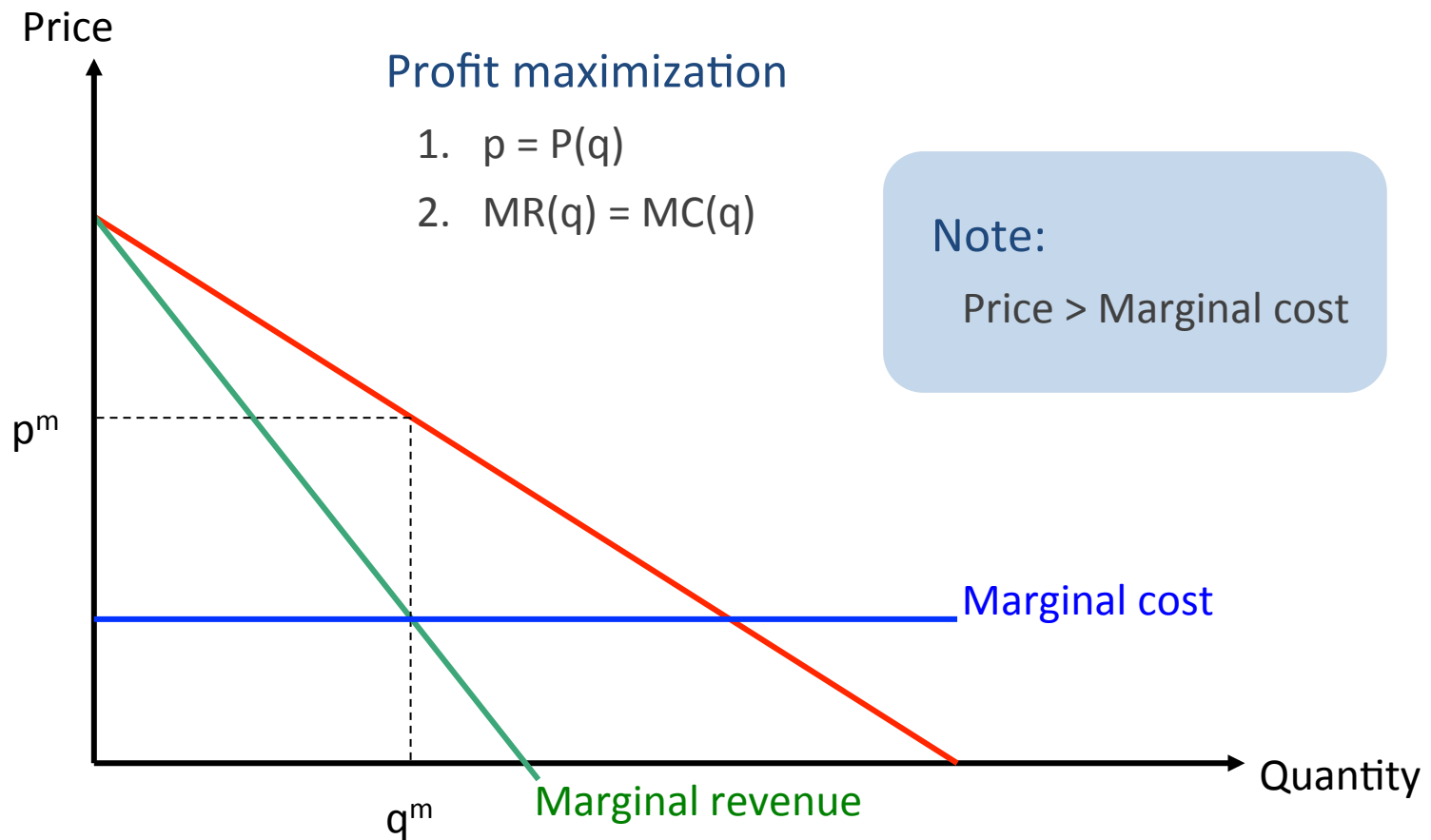
First order condition

$$\pi_q(q) = P(q) + P_q(q) \cdot q - C_q(q) = 0$$

Rewrite

$$P(q) + P_q(q) \cdot q = C_q(q)$$

Interpretation?

Choice of quantity

Price

Profit maximization

1. $p = P(q)$
2. $MR(q) = MC(q)$

Note:

Price > Marginal cost

p^m

Marginal cost

Marginal revenue

q^m

Quantity

Monopoly

- Definition
  - A firm has *market power* if it can set a price above marginal cost, without losing all sales

Choice of quantity

First order condition

$$\pi_q(q) = P(q) + P_q(q) \cdot q - C_q(q) = 0$$

Second order condition

$$\pi_{qq}(q) = 2 \cdot P_q(q) + P_{qq}(q) \cdot q - C_{qq}(q) < 0$$

Example:

Marginal cost constant or increasing $\Leftrightarrow$ $C_{qq} \geq 0$

Demand linear or concave $\Leftrightarrow$ $P_{qq} \leq 0$

Choice of quantity

- Exercise: Set up monopoly problem and solve for optimal quantity and price!

  - Constant unit cost: c
  - Linear inverse demand: $p = a - b \cdot q$

  (No need to check 2nd order condition)

Choice of quantity

Profit

$$\pi(q) = P(q) \cdot q - C(q) = [a - b \cdot q] \cdot q - c \cdot q$$
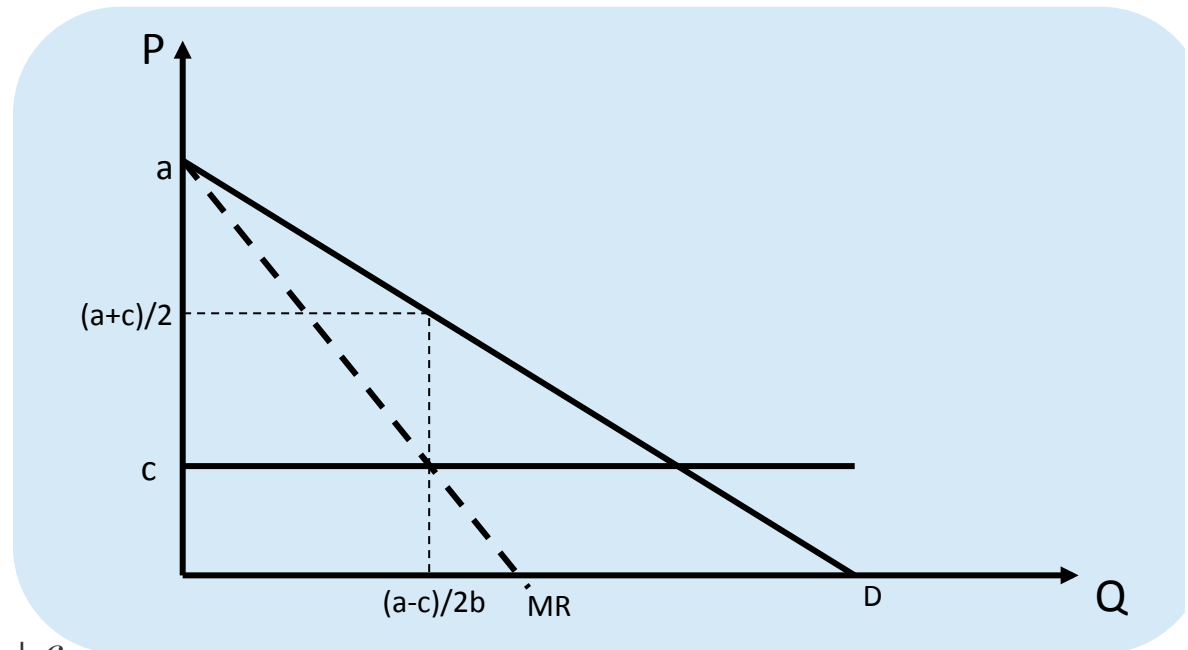
First order condition

$$\pi_q(q) = [a - b \cdot q] - b \cdot q - c = 0$$

Solve for q

$$q = \frac{a - c}{2 \cdot b}$$

Find p

$$P(q) = a - b \cdot q = a - b \cdot \left[\frac{a - c}{2 \cdot b} \right] = \frac{a + c}{2}$$
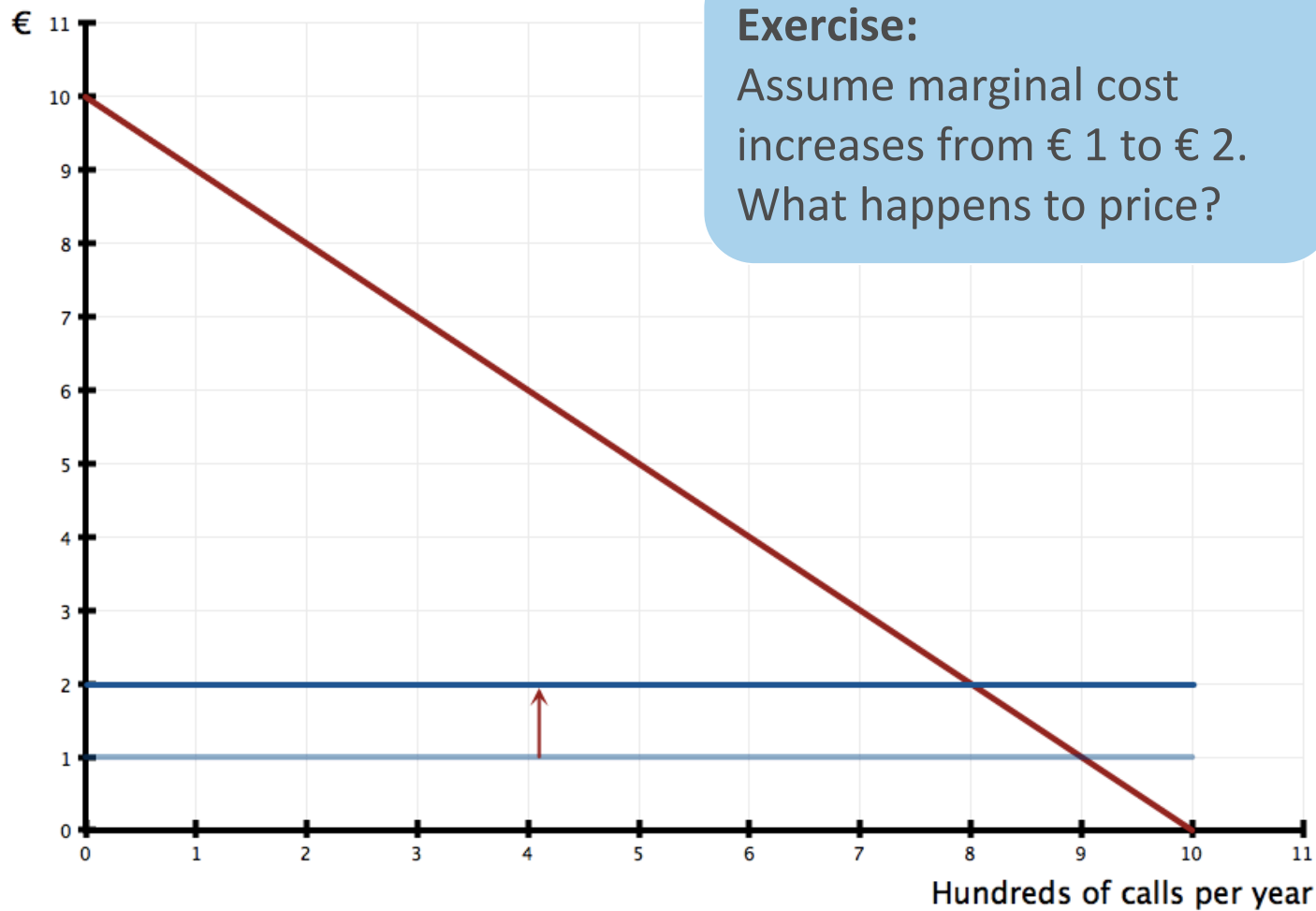
What determines price?

1. Cost

What determines price?

Exercise:
Assume marginal cost increases from € 1 to € 2. What happens to price?

Hundreds of calls per year

What determines price?

Solution: Cost increase € 1
Monopolists wants to produce 50 units less
Price increase € .5

What determines price?

- Conclusion: Price is increasing in cost
  - Marginal cost   (but not fixed cost)
  - Pass through = 1/2   (but only in linear case)
  - In general: pass through 0 - ∞

  - By symmetry
    - If cost reduced, firms reduce price
    - but not necessarily by same amount

What determines price?

- ## Questions
  - So, don't fixed costs matter at all for prices?
- ## Answer
  - Short term: No!
    - Only marginal cost.
  - Long run: Yes!
    - If average costs are not covered => exit => less competition => higher prices

Formal analysis

Profit

$$\pi(q) = (P(q) - c) \cdot q$$

First order condition

$$\pi_q(q) = (P(q) - c) + P_q(q) \cdot q = 0$$

Rewrite

$$P(q) + P_q(q) \cdot q = c$$

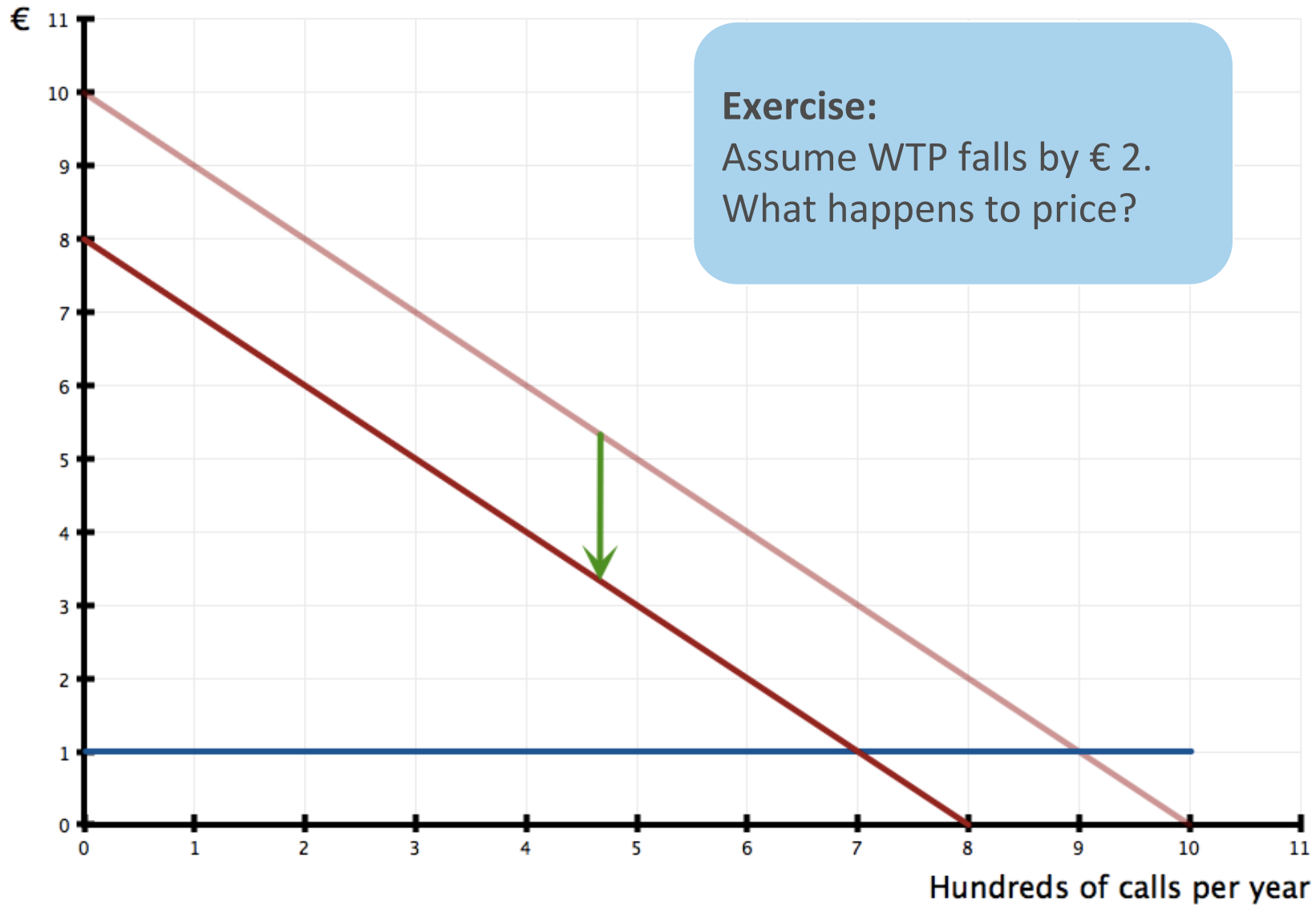Differentiate to study effect of change in cost

$$2 \cdot P_q(q) \cdot dq + P_{qq}(q) \cdot q \cdot dq = dc$$

Rewrite

$$\frac{dq}{dc} = \frac{1}{2 \cdot P_q(q) + P_{qq}(q) \cdot q} < 0 \qquad \text{(Second order condition for maximization)}$$
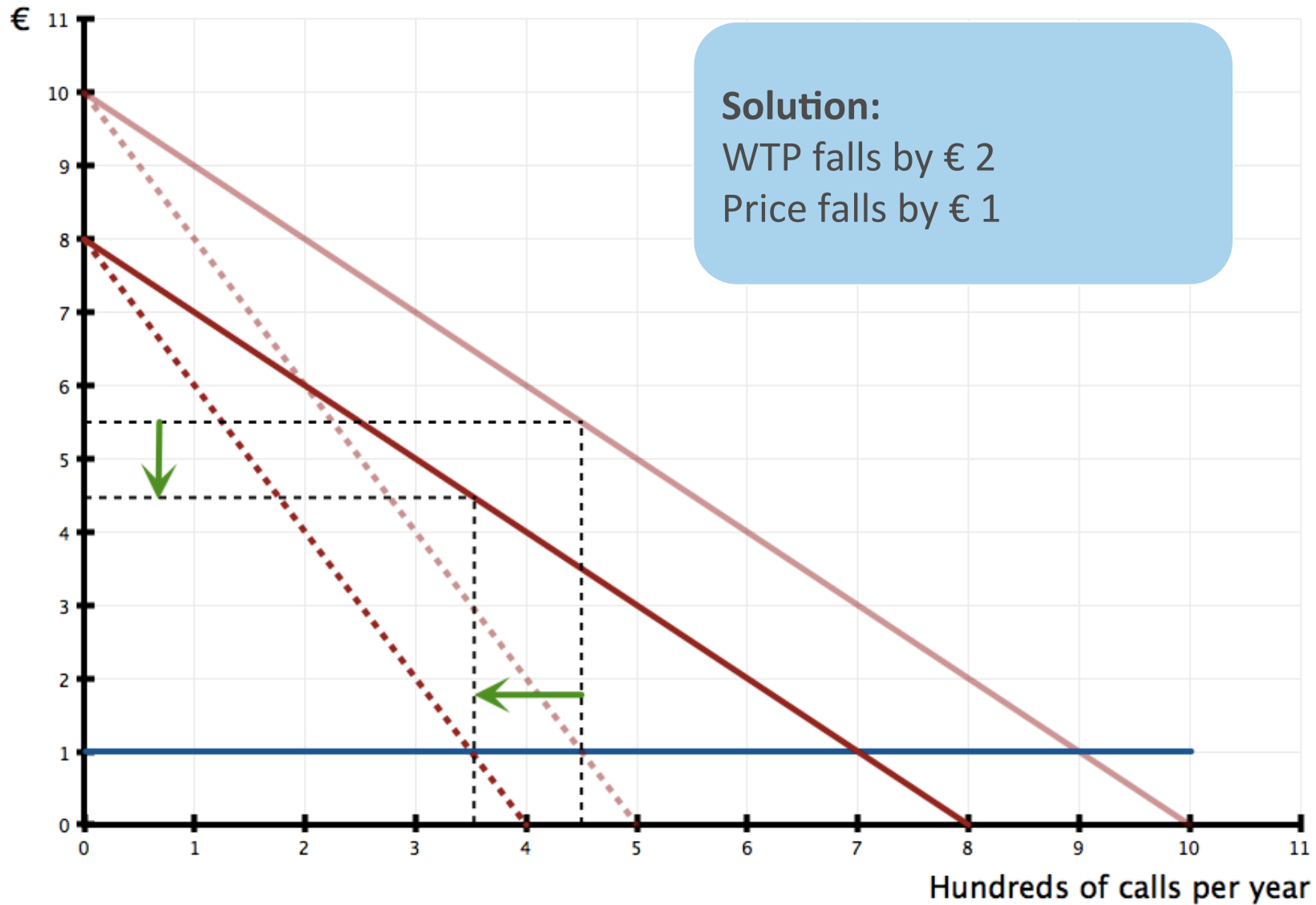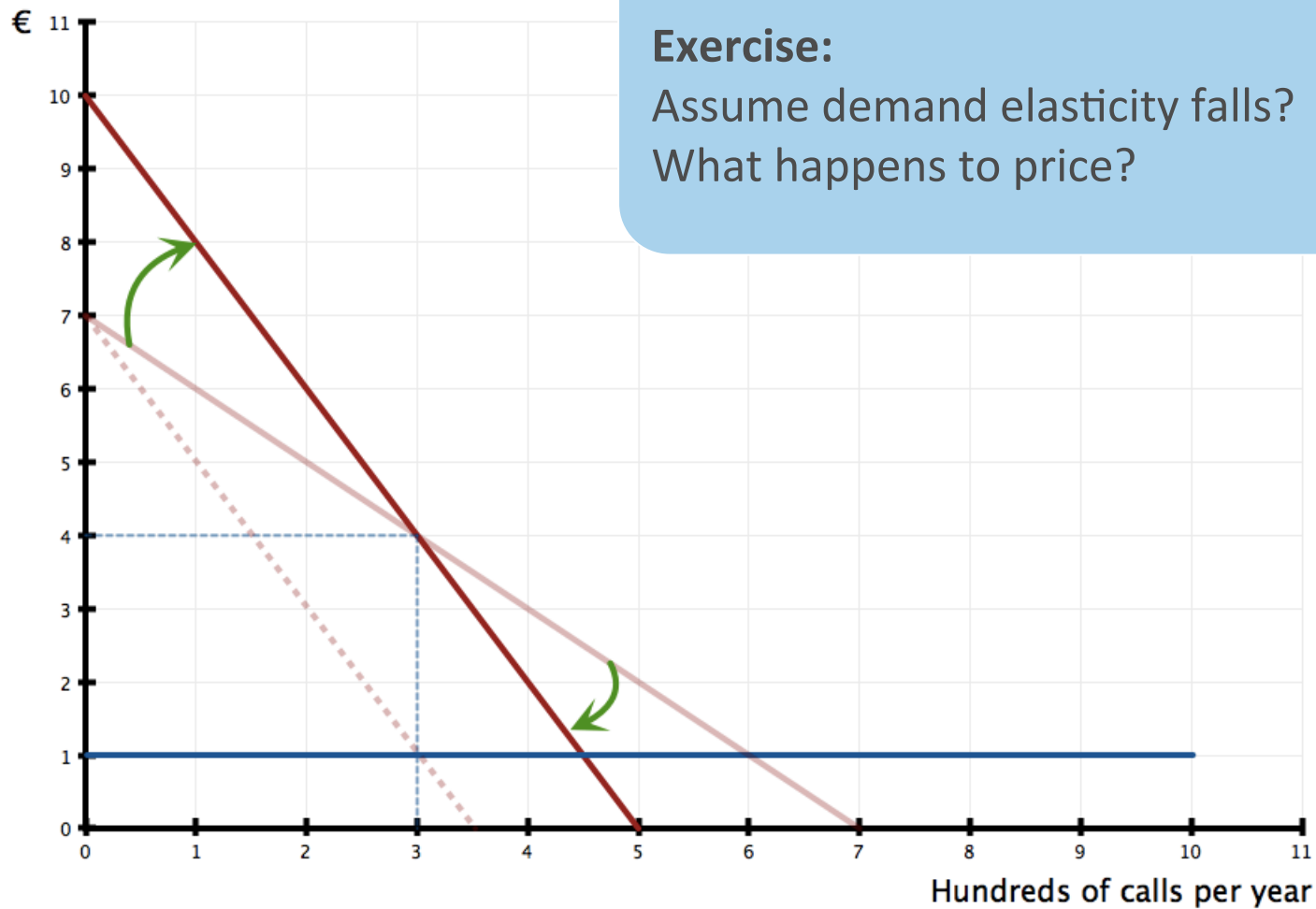
2. Demand

What determines price?

Exercise:
Assume WTP falls by € 2.
What happens to price?

Hundreds of calls per year

What determines price?

Solution:
WTP falls by € 2
Price falls by € 1

Hundreds of calls per year

What determines price?

Exercise:
Assume demand elasticity falls?
What happens to price?

Hundreds of calls per year

What determines price?

Solution:
Price is increased!

Hundreds of calls per year

What determines price?
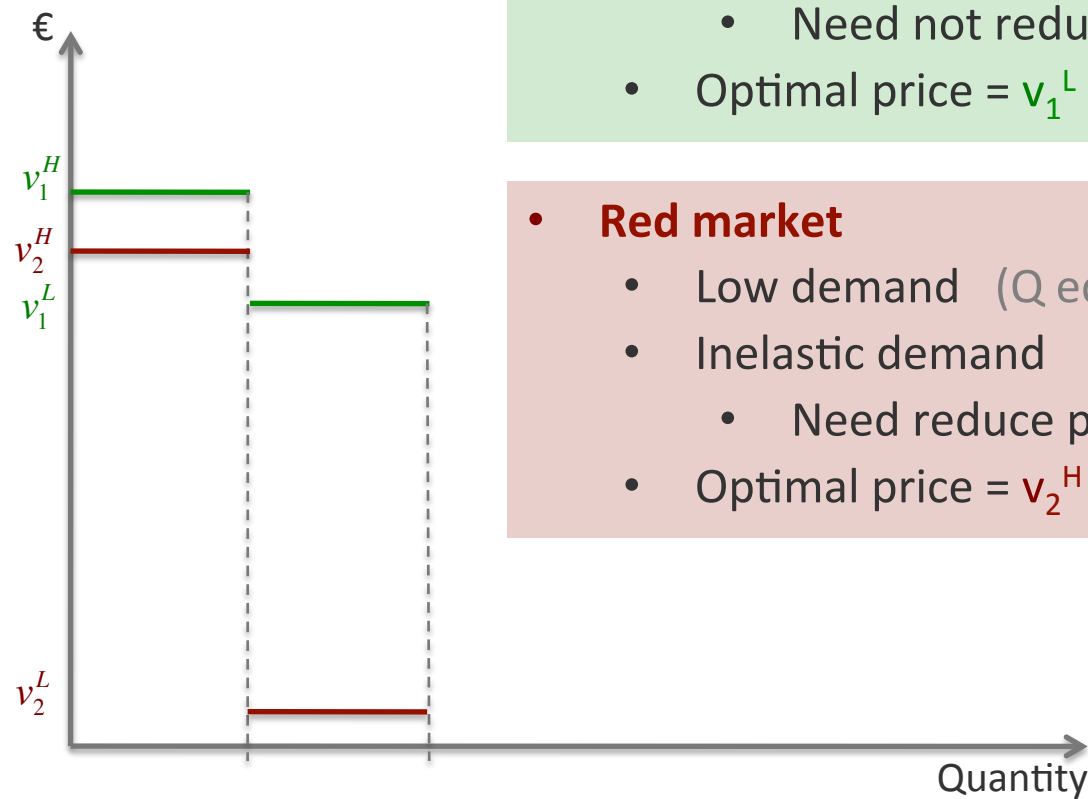
- **Green market**
  - High demand
  - Elastic demand
    - Need not reduce price much to sell 2nd unit
  - Optimal price = v_1^L

- **Red market**
  - Low demand   (Q equal or lower at every price)
  - Inelastic demand
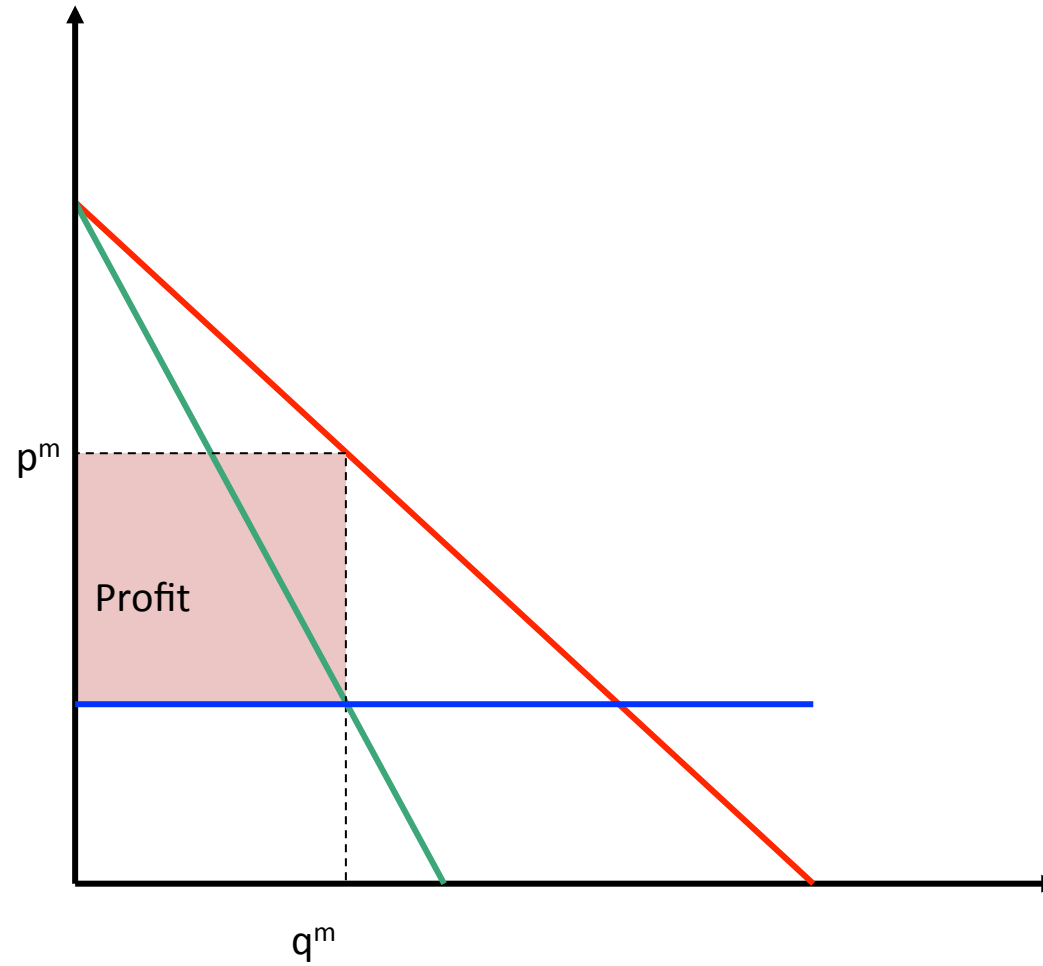   - Need reduce price much to sell 2nd unit
  - Optimal price = $v_2^H > v_1^L$

€

v_1^H

v_2^H

v_1^L

v_2^L

Quantity

Welfare & Efficiency

Welfare

- <u>Q</u>: How much welfare is created in a market?
  - Firm owners?

    = profit

  - Consumers?

    = consumer's surplus   (<u>Q</u>: define CS)

    consumer's surplus = WTP – p

  - Employees?

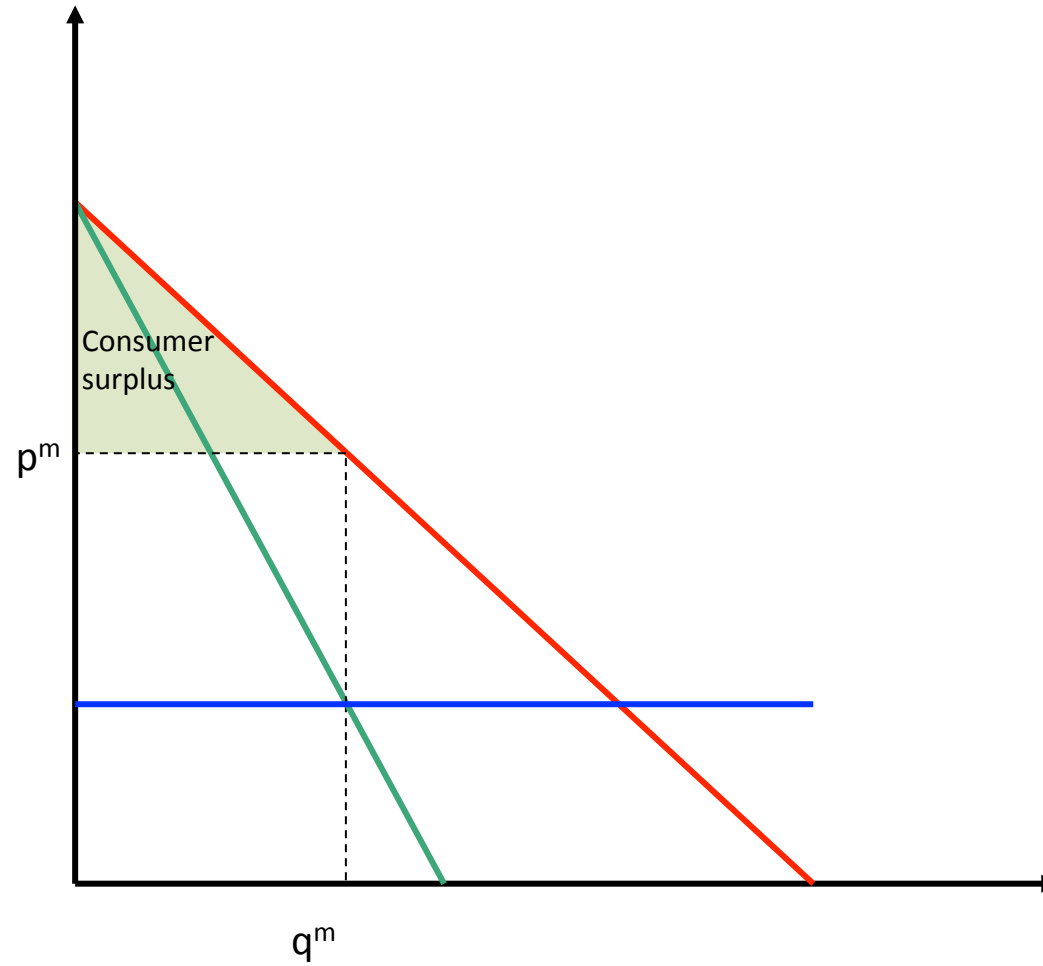   = no gain if w = cost of working (which is assumed)

Monopoly
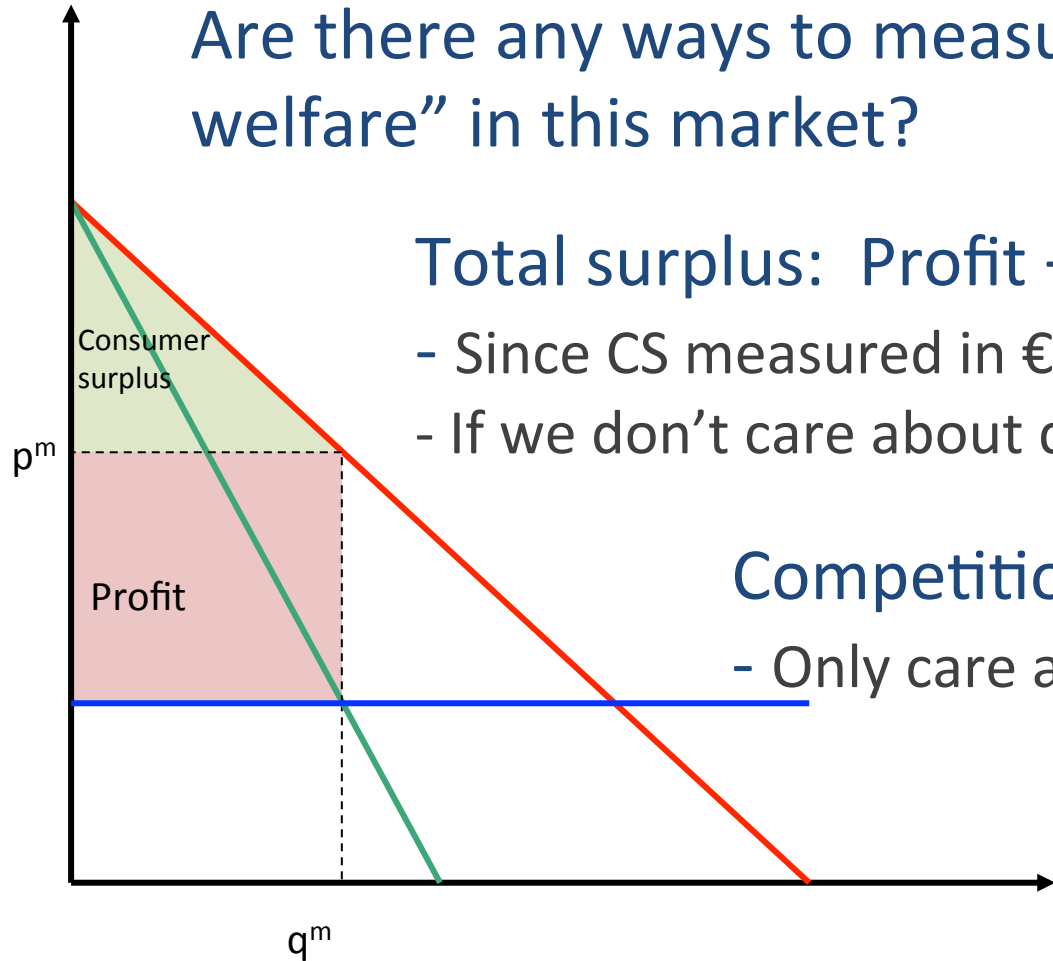## Welfare

Monopoly
Welfare

Monopoly
Welfare

Are there any ways to measure the "total welfare" in this market?

Total surplus: Profit + CS

- Since CS measured in €

- If we don't care about distribution

Competition authorities?

- Only care about CS!

Consumer surplus

Profit

p^m

q^m

65

Efficiency

- Is it possible to increase welfare in this market?
  - <u>Q</u>: Define Pareto efficiency
    - Allocation is in-efficient if it is possible to improve situation for one agent without making it worse for somebody else
  - <u>Q</u>: Define Compensation principle
    - Allocation is in-efficient if it can be changed in such a way that those who gain could compensate those who lose
    - Akin to "Total Surplus"

Efficiency

- Q: Is it possible to increase welfare in this market?
  - Pareto efficiency
  - Compensation principle

Efficiency
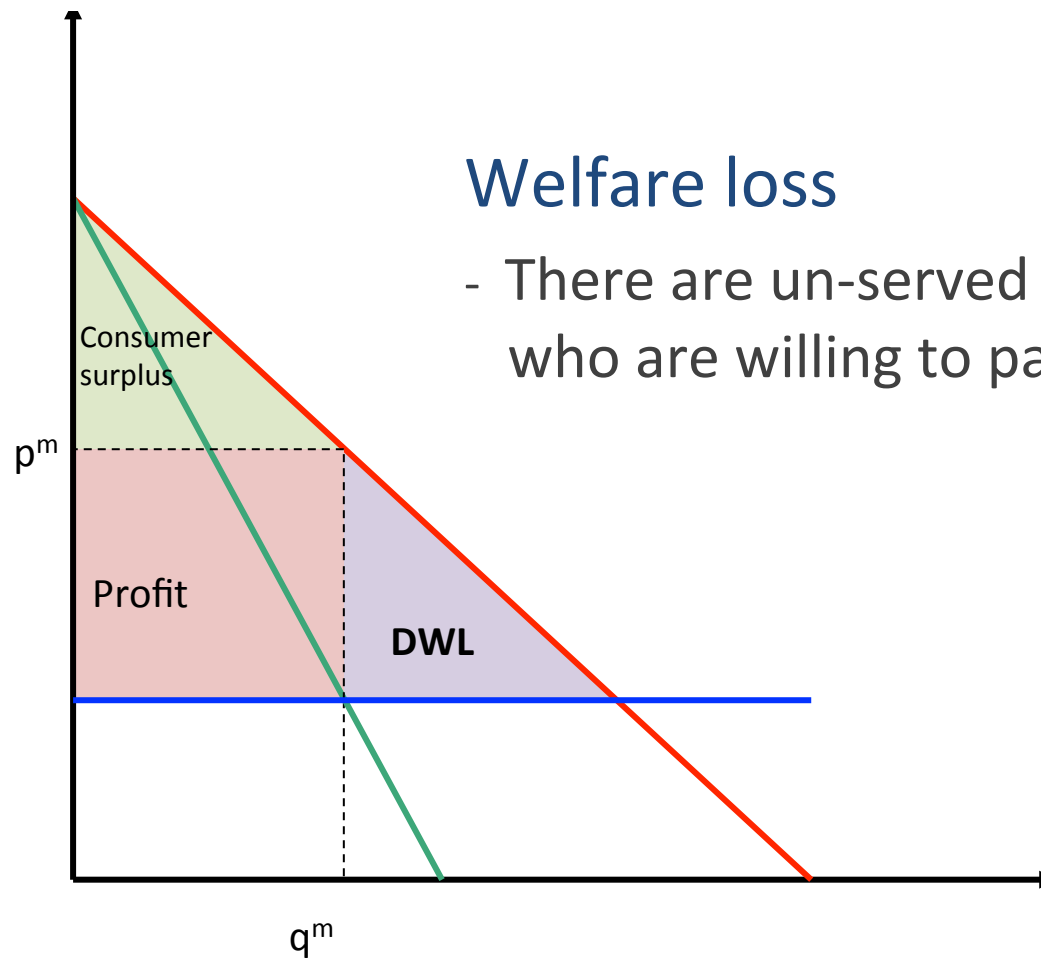
Welfare loss

- There are un-served customers,
  who are willing to pay more than cost

Efficiency

Q: There is "money on the table"
- Why doesn't the firm sell more?
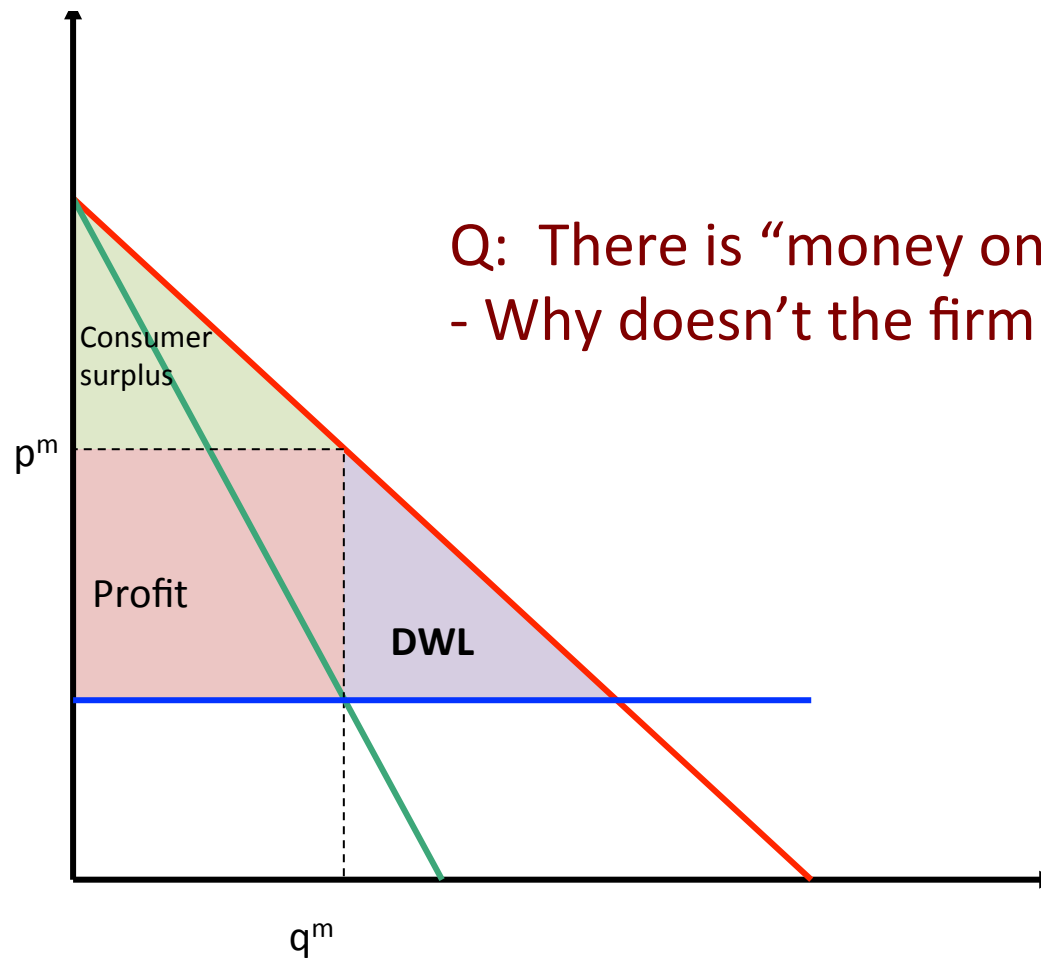
Efficiency

A: To sell one more unit, the monopolist has to lower price, not only on the last unit, but on all units

$$TR = P(q)q$$
$$MR = P(q) + P'(q)q < P(q)$$

Price

$P(q)$

$P(q) + P'(q)q$

Marginal revenue

P(q)

Quantity
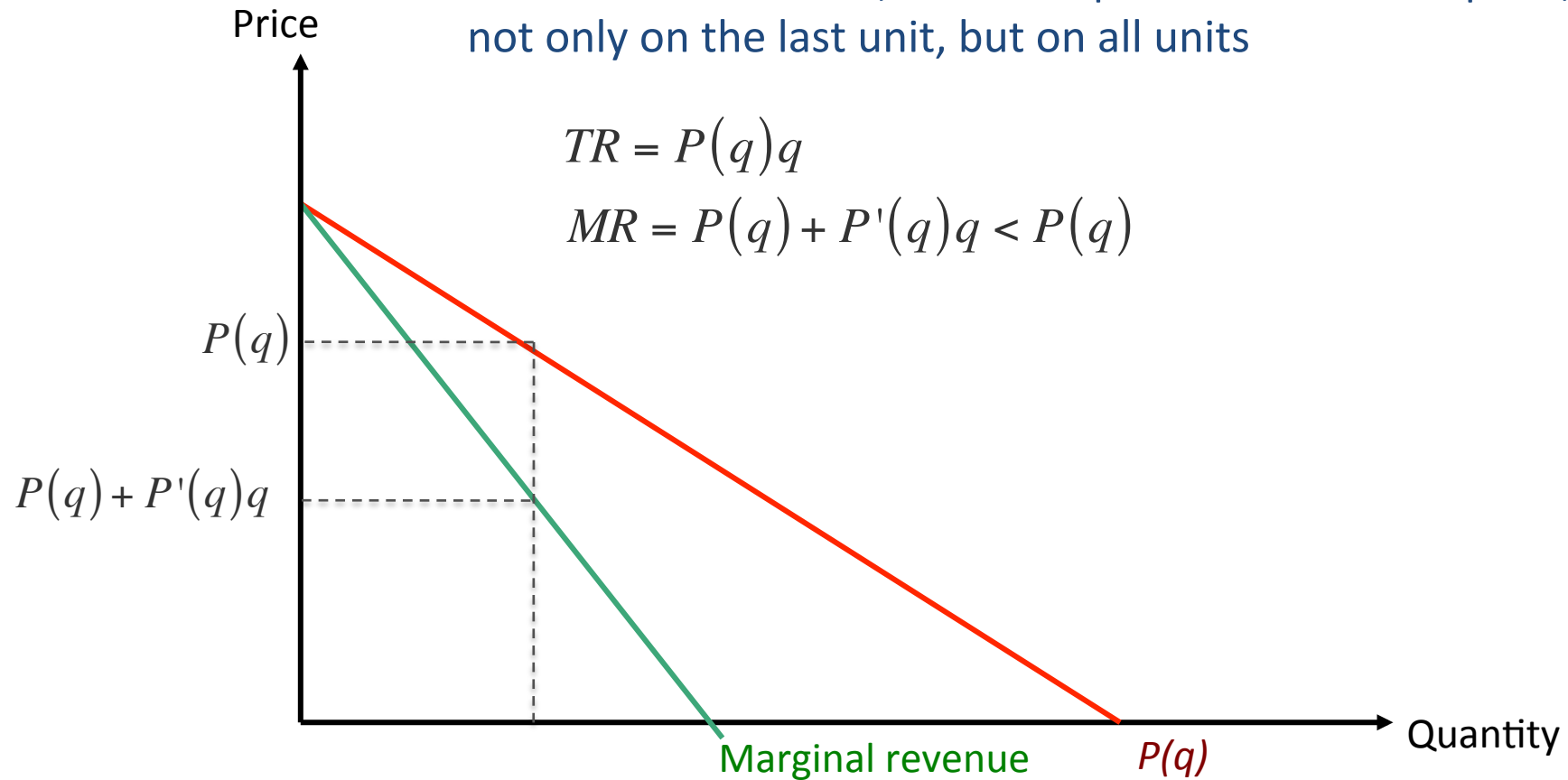
Efficiency

- Q: Other inefficiencies caused by monopoly?
  - Dead weight loss

  - Cost: Can pass on cost increases to consumers

  - Rent-seeking: Monopoly profit worth lobbying for

  - Other
    - Choice of quality
    - Investment
    - …

Price setting

Same question as before – slightly different analysis
Derive convenient formula

Price setting

- Previously

$$\max_q \pi(q) = P(q) \cdot q - C(q)$$

- Q: How do we rewrite as decision over p?

$$\pi(p) = p \cdot D(p) - C(D(p))$$

Here we use the demand function *D(p)*

not the indirect demand function *P(q)*

Composite function: C(*D(p)*)

Price setting

Profit

$$\pi(p) = p \cdot D(p) - C\big(D(p)\big)$$

Q: First order condition?

Price setting

Profit

$$\pi(p) = (p - c)D(p)$$

First order condition

$$\pi_p(p) = D(p) + p \cdot D_p(p) - C_q(D(p)) \cdot D_p(p) = 0$$

Recall: Chain rule

Price setting

Profit

$$\pi(p) = (p - c)D(p)$$

First order condition

$$\pi_p(p) = D(p) + p \cdot D_p(p) - C_q(D(p)) \cdot D_p(p) = 0$$

Factor out $D_p(p)$

$$\pi_p(p) = D(p) + \left[p - C_q(D(p)) \right] \cdot D_p(p) = 0$$

Price setting

Profit

$$\pi(p) = (p - c)D(p)$$

First order condition

$$\pi_p(p) = D(p) + p \cdot D_p(p) - C_q(D(p)) \cdot D_p(p) = 0$$

Factor out $D_p(p)$

$$\pi_p(p) = D(p) + \left[p - C_q(D(p))\right] \cdot D_p(p) = 0$$

Rewrite

$$\frac{p - C_q}{p} = -\frac{D(p)}{p \cdot D_p(p)}$$

Price setting

Rewrite

$$\frac{p - C_q}{p} = -\frac{D(p)}{p \cdot D_p(p)}$$

Q: What is this?

Price setting

Rewrite

$$\frac{p - C_q}{p} = -\frac{D(p)}{p \cdot D_p(p)}$$

Elasticity of demand

$$\eta(p) \equiv \frac{p \cdot D_p(p)}{D(p)}$$

Market power (Lerner index)

$$L \equiv \frac{p - MC}{p}$$

Price setting

Rewrite

$$\frac{p - C_q}{p} = -\frac{D(p)}{p \cdot D_p(p)}$$

Interpretation

$$L = -\frac{1}{\eta(p)}$$

Elasticity of demand

$$L = \frac{}{p}$$

Caution

This expression "hides" the fact that the level of demand also matters

Inverse elasticity rule

Monopolist's market power determined by consumers' price sensitivity

3rd degree price discrimination

3rd degree price discrimination

- Conclusion: Price depends on demand
  - High demand ⇔ high WTP ⇒ high price (typically)
  - Low price sensitivity ⇒ High price (typically)

- 3rd degree price discrimination
  - Recall pharmaceutical market
    - Low prices in Greece, Spain, Portugal
    - High prices in Switzerland, Germany, UK
  - Definition of P.D:
    - Charge different price for same product to different consumers

3rd degree price discrimination

- Q: Under what conditions can firms charge different prices from different consumers based on WTP?

  - Information about WTP
  - No arbitrage (but internal market)

3rd degree price discrimination

- Q: Is it a good or a bad thing that prices of pharmaceuticals is lower in Greece than in Sweden?

  - Bad: Inefficient distribution of given amount of goods

  - Good: If price discrimination illegal, firms may set high price, and not sell in poor countries

But: Even better if $p_{Greece} = p_{Switzerland} = mc$

3rd degree price discrimination

- What if firm must earn p > c to finance R&D. Are price differences then good or bad?

  - Good: It may be <u>fair</u> that countries with low income pays less

  - Good: To minimize <u>total global welfare</u> loss, charge high price in country with low price sensitivity (Ramsey pricing)

Price Regulation

Price Regulation

- Q: Current regulation

  - Competition law
    - Abuse of dominant position
    - Dominant firms may not "impose unfair prices"
    - Never used

  - Sector specific regulation
    - Rental apartments
    - Telecom; District heating (has been discussed)
    - On-patent medicines; Pharmacies

  - Rationing and price regulation during crisis
    - If Sweden cut off from imports (food, oil, …)
    - Removed?

Price Regulation

- Q: Why so little price regulation?

- Q: Problems with price regulation?

  1. P = MC may not work when there are fixed costs
  2. Information
  3. Incentives for innovation
  4. Regulatory uncertainty
  5. Administrative costs

Price Regulation

- ## Fixed costs

  - DWL overestimates potential gain from regulation

  - P > MC to finance fixed costs

  - Alternative: subsidize & use taxes $\Rightarrow$ DWL moved

Price Regulation

- Q: What information would regulator need?
  - If no fixed costs only MC
  - Otherwise
    - Cost function
    - Demand function

Price Regulation

- Incentives for innovation

  – Monopoly: High WTP $\Rightarrow$ high price

  – Firms incentives to invent new products that people are willing to pay for

Price Regulation

- ## Regulatory uncertainty

  - 2013 Swedish Market Court decided a case about what prices TeliaSonera was allowed to charge for broadband services in 2000

Price Regulation

- Administrative costs
  - Example: TeliaSonera's external legal advice at least €1mn

Case study:
Value-Based Pricing of Medicines

VBP

- Dilemma

  - Efficient use of existing medicines

    - p = MC

  - Incentives to develop new medicines

    - Huge fixed costs $\Rightarrow$ p > MC
    - Efficient incentives $\Rightarrow$ p must be related to WTP

VBP

- ## Solution: Patents $\Rightarrow$ p > MC
  - Pros: Investment incentives
  - Cons: Large DWL, since
    - WTP high
    - MC low

- ## Solution 2: Subsidize medicines
  - Average subsidy in Sweden 80%
  - People will consume despite high price!

VBP

- Exercise: Compute monopoly price
  - Demand: $q = v - p^{Consumer}$
  - Cost: $C = c \cdot q$
  - Subsidy: $p^{Consumer} = \lambda \cdot p^{Producer}$,

- Exercise: Compare
  - No subsidy $\lambda = 1$ and $\lambda = 0.2$
  - Assume: $v = 10$; $c = 1$

VBP

- ## Monopoly solution

$$\pi = (p^P - c) \cdot \left(v - \lambda \cdot p^P \right)$$

$$\frac{\partial \pi}{\partial p^P} = \left(v - \lambda \cdot p^P \right) - \lambda \cdot (p^p - c) = 0$$

$$p^P = \frac{\dfrac{v}{\lambda} + c}{2} \qquad p^C = \frac{v + \lambda \cdot c}{2} \qquad q = v - \frac{v + \lambda \cdot c}{2} = \frac{v - \lambda \cdot c}{2}$$

- ## Comparison

$$p^P = \frac{10 + 1}{2} = 5.5 \qquad p^C = \frac{10 + 1}{2} = 5.5 \qquad q = \frac{10 - 1}{2} = 4.5$$

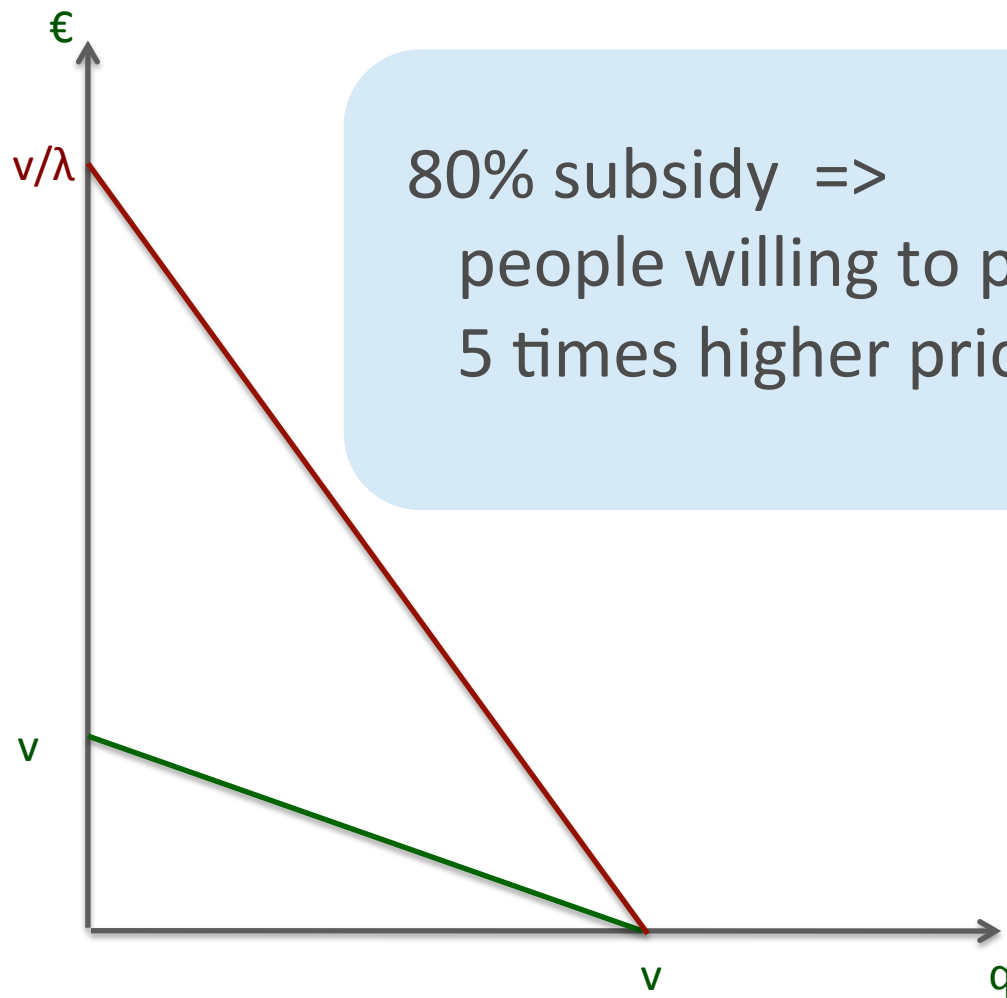$$p^P = \frac{\dfrac{10}{0.2} + 1}{2} = 25.5 \qquad p^C = \frac{10 + 0.2 \cdot 1}{2} = 5.1 \qquad q = \frac{10 - 0.2 \cdot 1}{2} = 4.8$$

VBP

- Subsidy + Monopoly pricing
  - Subsidy turned into gift to firms
  - Little effect on DWL
  - Little insurance to citizens

VBP

80% subsidy =>
    people willing to pay
   5 times higher prices

VBP

- Solution: VBP (= form of price regulation)
  - Company apply to be included in the subsidy
  - Tandvårds- och Läkemedelsförmånsverket (TLV)

VBP

- Company provides information about value of drug
  - People with different deceases
  - People with different side-effects

VBP

- Company provides information about value of drug
    - People with different diseases
    - People with different side-effects
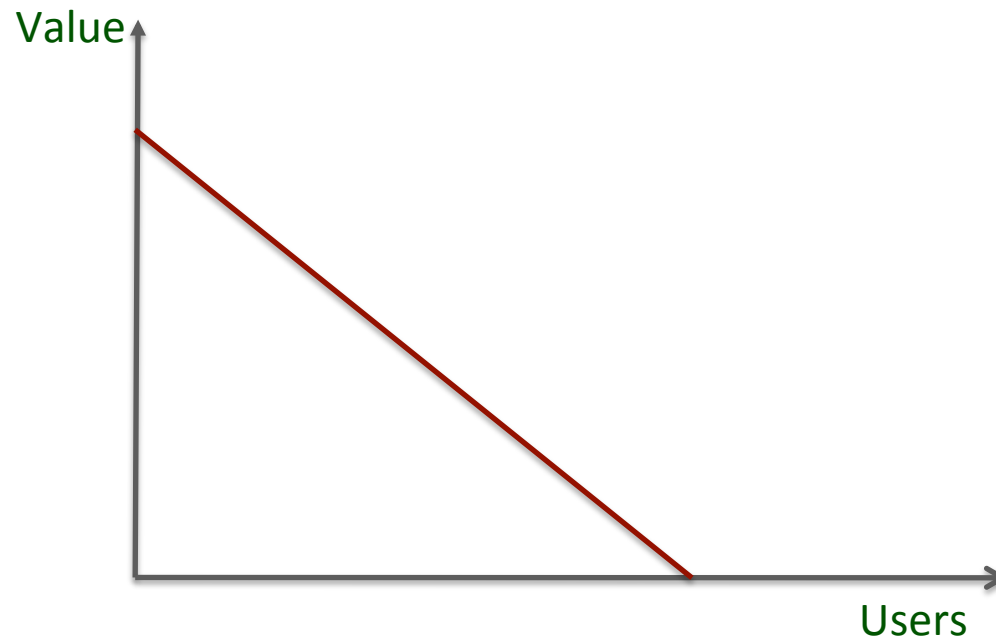
VBP

- Note 1
  - Value is for average individual
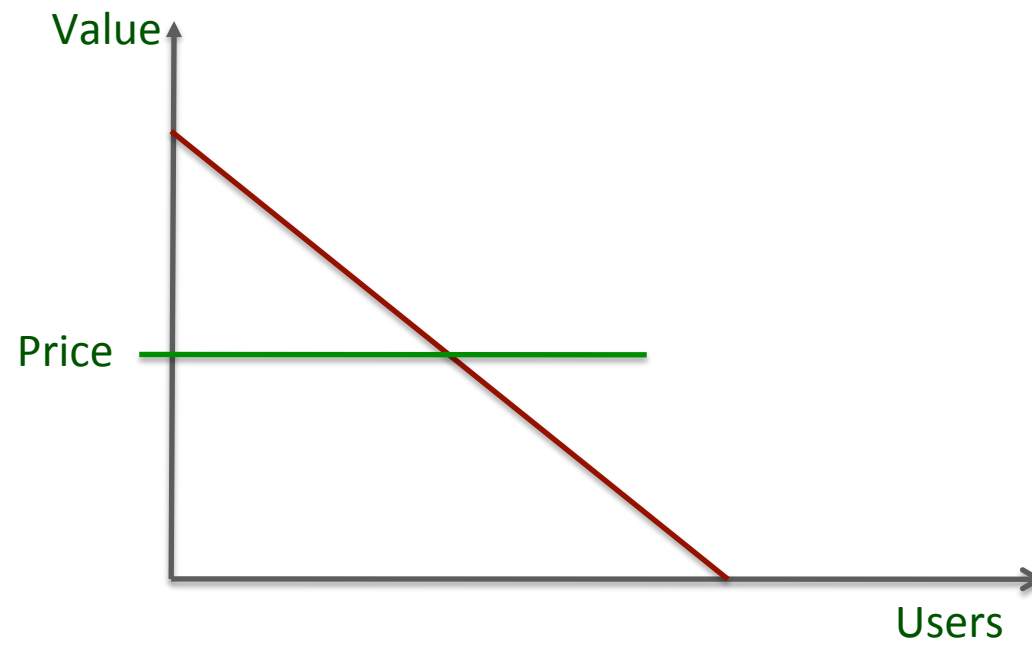   (Income differences are assumed away)

VBP

- Note 2
  - Companies must undertake substantial research to prove value
    - Medical effects
    - Economic value of medical effects

VBP

- Price
  - Company sets price
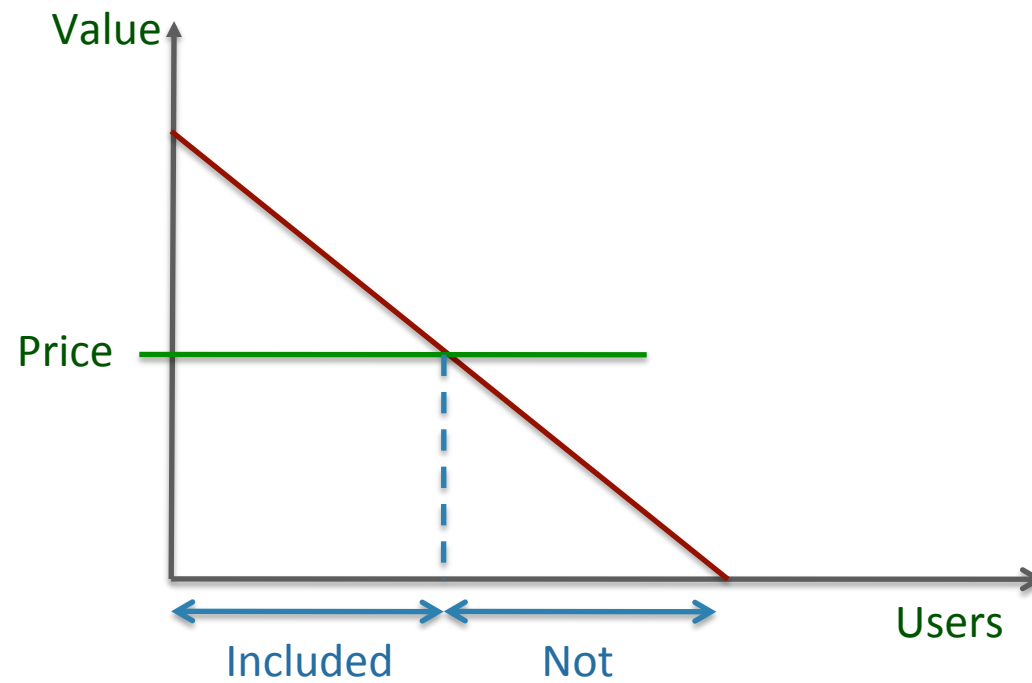 - TLV decides which users get the drug subsidized

VBP

Firm sets price

Value

Price

Users

VBP

TLV sets quantity

VBP

- Conclusion
  - Value-based pricing = normal "monopoly" pricing
  - But the firm cannot "steal" the subsidy

- Motivation
  - P = "social value of drug" gives firms incentives to develop drugs creating value