PRICING

Overview

- Context: Many firms face a tradeoff between price and quantity. To sell more, they must charge less. What price should they set? Should they simply apply a standard markup to cost?
- Concepts: demand elasticity, marginal revenue, marginal cost, elasticity rule, market power.
- Bottom line: optimal price is a trade-off between margin and quantity sold, as given by the *elasticity rune:*

$$p = \frac{MC}{1 + \frac{1}{\epsilon}}$$

Example: Ice-cream pricing

Ice-cream pricing

- Ice-cream truck: driver/operator rents truck, buys ice-cream rom factory, keeps all of the profits
- Fixed cost (truck rental): \$15/hour
- Marginal cost (wholesale cost of ice-cream): \$3
- inverse demand (per hour): $p = 10 - 0.5\,q$
  (see table on next page)
- What price generates the most profit?

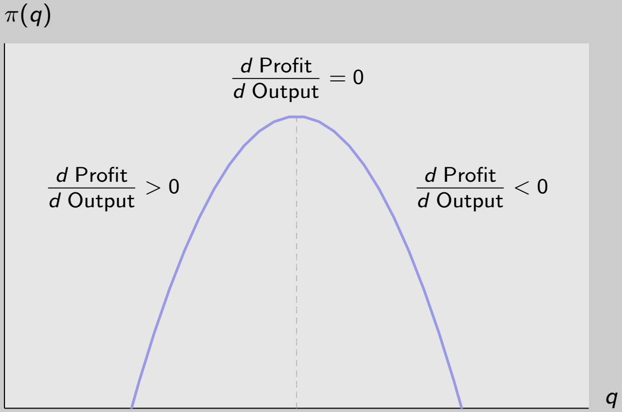
Ice-cream pricing

price	demand	revenue	total cost	increm. revenue	increm. cost	profit
10.0	0.0	0.0	15.0			-15.0
9.5	1.0	9.5	18.0	9.5	3.0	-8.5
9.0	2.0	18.0	21.0	8.5	3.0	-3.0
8.5	3.0	25.5	24.0	7.5	3.0	1.5
8.0	4.0	32.0	27.0	6.5	3.0	5.0
7.5	5.0	37.5	30.0	5.5	3.0	7.5
7.0	6.0	42.0	33.0	4.5	3.0	9.0
6.5	7.0	45.5	36.0	3.5	3.0	9.5
6.0	8.0	48.0	39.0	2.5	3.0	9.0
5.5	9.0	49.5	42.0	1.5	3.0	7.5
5.0	10.0	50.0	45.0	0.5	3.0	5.0
4.5	11.0	49.5	48.0	-0.5	3.0	1.5

Optimal pricing: calculus

- Since there is a one-to-one correspondence between price and demand (the demand curve), we can either determine optimal price or optimal output
- Profit is normally an inverted-U-shaped function of output
- If slope is positive, then higher output lads to higher profit
- If slope is negative, then lower output leads to higher profit
- At the optimal output level, derivative of profit with respect to output is zero. This is a necessary (though not sufficient) condition

Profit maximization



Profit maximization: calculus

- Profit and marginal profit:

$$\pi(q) \equiv R(q) - C(q)$$

$$\frac{d\,\pi(q)}{d\,q} = \frac{d\,R(q)}{d\,q} - \frac{d\,C(q)}{d\,q}$$

- Marginal revenue: $MR \equiv \frac{d\,R(q)}{d\,q}$
- Marginal cost: $MC \equiv \frac{d\,C(q)}{d\,q}$
- Profit maximization implies that $\frac{d\,\pi(q)}{d\,q} = 0$, which is equivalent to

$$MR = MC$$

MR=MC

Notes on marginal revenue

- What do you get from selling an extra unit?
  You get the price for which you sell it, but the additional (marginal) revenue is less than that.
- Price must be lowered in order for an extra unit to be sold; this lowers the marginal on all units sold.
- Formally,

$$MR \equiv \frac{d\,R}{d\,q} = \frac{d\,(p \times q)}{d\,q} = p + \frac{d\,p}{d\,q}\,q < p$$

The elasticity rule

$$MR = p + \frac{d\,p}{d\,q}\,q = p + \frac{d\,p}{d\,q}\,\frac{q}{p}\,p = p + \frac{1}{\frac{d\,q}{d\,p}\,\frac{p}{q}}\,p = p\left(1 + \frac{1}{\epsilon}\right)$$

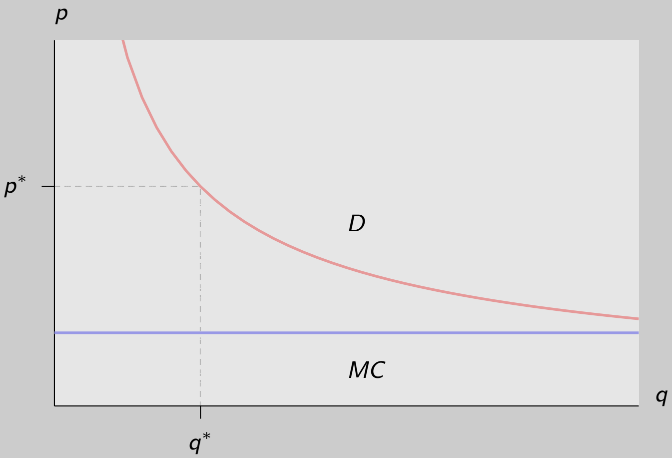
Therefore, $MR = MC$ implies that $p\left(1 + \frac{1}{\epsilon}\right) = MC$, or

$$p = \frac{MC}{1+\frac{1}{\epsilon}}$$

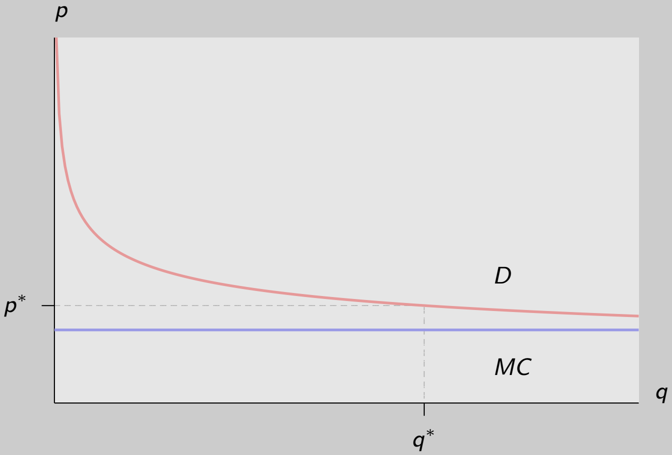
Alternatively, this may be written as $p - MC = -p\,\frac{1}{\epsilon}$, or simply

$$m \equiv \frac{p-MC}{p} = \frac{1}{-\epsilon}$$

Demand elasticity and monopoly margin



Demand elasticity and monopoly margin



Margin and markup

- Two alternative ways of measuring gap between price and marginal cost:

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

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

- Corresponding elasticity rules:

$$m = \frac{1}{-\epsilon}$$

$$k = \frac{1}{-\epsilon - 1}$$

Example

- Product: new drug, protected by patent
- Estimated elasticity: -1.5 (constant)
- Marginal cost: $10 (for a 12-dose package)
- What's the profit maximizing price?
- What are values of margin, markup at optimal price?
- Check elasticity rules

Ice-cream pricing (reprise)

- Recall that $F = 15$, $MC = 3$, $p = 10 - 0.5\,q$
- Elasticity is not constant, so elasticity rule is not very useful
- Apply $d\,\pi(q)\,/\,d\,q = 0$ directly (or $MR = MC$):

$$\pi(q) = \left(10 - \frac{1}{2}\,q\right) q - 3\,q - 15$$

$$\frac{d\,\pi}{d\,q} = -\frac{1}{2}\,q + \left(10 - \frac{1}{2}\,q\right) - 3$$

$$\frac{d\,\pi}{d\,q} = 0 \quad \Rightarrow \quad q = 7$$

$$\Rightarrow \quad p = 10 - \frac{1}{2}\,q = 6.5$$

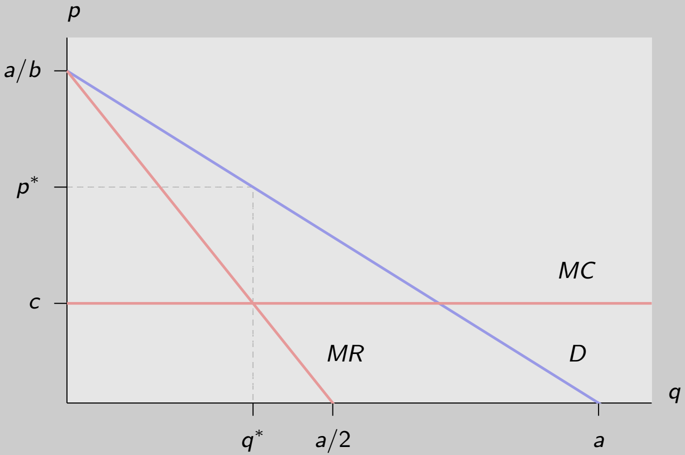
Ice-cream pricing (reprise)

- We didn't use the elasticity rule to find p^*, but nevertheless elasticity rule holds at $p = p^*$

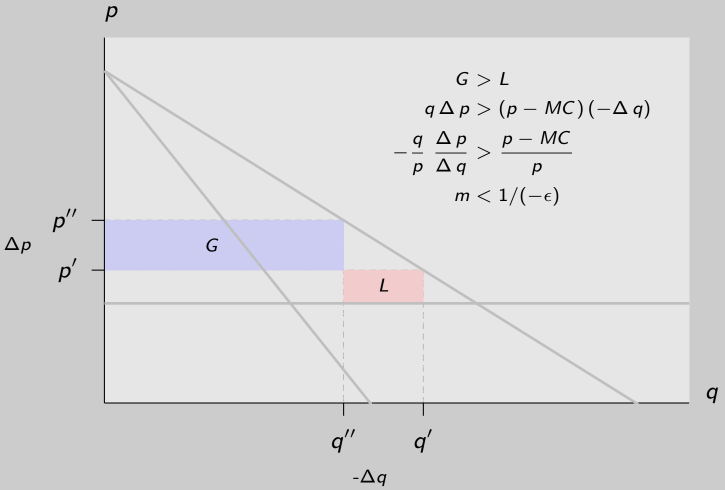
$$\frac{1}{-\epsilon} = -\frac{d\,p}{d\,q}\,\frac{q}{p} = \frac{1}{2}\,\frac{7}{6.5} \quad = \quad .5385$$

$$m = \frac{p - MC}{p} = \frac{6.5 - 3}{6.5} \quad = \quad .5385$$

Optimal pricing: graphical derivation



Optimal pricing: graphical intuition



Comments on elasticity rule

- Standard markup is a bad idea: you want higher markups for products with lower elasticities
- If $|\epsilon| < 1$, always better off by increasing price
- Every firm is a "monopolist," but the extent of its monopoly power is given by $1/|\epsilon|$
- Question: "what will the market bear?" Answer: $MC / \left(1 + \frac{1}{\epsilon}\right)$
- If a firm sells multiple products, some complications may arise. More on this below

Complications, I: demand interactions

- What if firm sells two products that are related?
- Examples:
  - Substitutes (e.g., *Unilever*)
  - Complements (e.g., *Gillette*)
  - Bundles (e.g., supermarkets)
- How does this influence optimal pricing strategy?

Complications, II: dynamic interactions

- What if firm sells a product over a number of periods?
- Examples:
  - Buz effects (e.g., movies)
  - Network effects (e.g. social networks)
  - Habituation effects (e.g., videogames, cigarettes)
  - How does this influence optimal pricing strategy?

Takeaways

- Optimal price depends on:
  - marginal cost
  - what the market will bear (demand elasticity)
- In a competitive market (high $|\epsilon|$), optimal markup is low. If your product has unique characteristics and/or you're the only producer (low $|\epsilon|$), then optimal markup can be high.
- If you sell various related products, then optimal pricing becomes more complicated
- What's missing:
  - more complex pricing schemes (Chapter 6)
  - competition (Chapters 8 and 9)