Chapter A.2 – Perfect Competition and Monopoly

Competition Policy and Strategy – German Title: Wettbewerbspolitik und -strategie

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English Version of my 2020 lecture

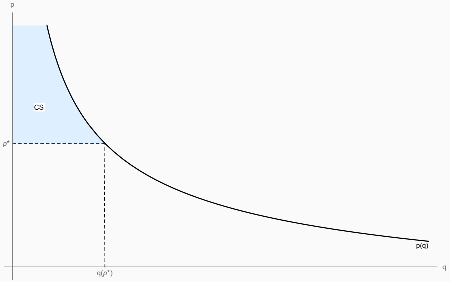
Perfect Competition – Allocative Efficiency

- Comparative Statics
  - Compare two different situations, e. g., monopoly and perfect competition.
  - Compare market parameters such as quantities, prices, welfare, etc.
  - *ceteris paribus*: all else equal. For instance, a reduction in prices charged by a profit-maximizing monopolist *ceteris paribus* (short: c.p.) leads to an increase in welfare.
- Welfare analysis
  - Welfare (W): Sum of consumer surplus (CS) and industry profits (Π).
  - Consumer surplus of a single consumer: difference between maximum willingness to pay (short: WTP) and price p.
  - Consumer surplus in the market (CS): sum of each consumer's consumer surplus.
  - Profit of a single firm i, π_i: difference between revenue R_i and costs C_i.
  - Industry profits Π: sum of each firm's profits.

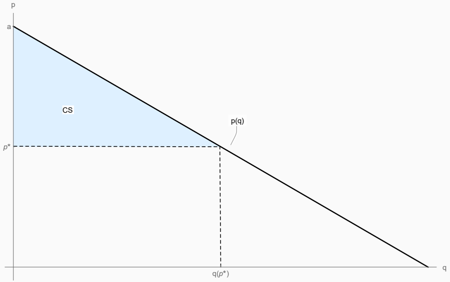
Perfect Competition – Allocative Efficiency

Consumer surplus (CS)

- Demand function $q(p)$ and inverse demand function $q^{-1}(p) = p(q)$
- Compute CS at a given price p^*:
  - $CS(p = p^*) = \int_{p^*}^{a} q(p)\mathrm{d}p$ using demand function $q(p)$ with a as WTP.
  - $CS(p = p^*) = \int_{0}^{q(p^*)} p(q)\mathrm{d}q - p^* q(p^*)$ using inverse demand function $p(q)$.



(a) CS non-linear demand, $a \to \infty$.



(b) CS non-linear demand.

Perfect Competition – Allocative Efficiency

Industry profits (Π)

- Let there be n **identical** firms in the market (Index $i \in \mathcal{N} = \{1, \ldots, n\}$ refers to one specific firm).
  - Every firm has equal costs: $C_i(q) = C(q)\ \forall i \in \mathcal{N}$, with $C(q) = F + VC(q)$.
  - Every firm has access to same information (here: perfect information; no uncertainty).
  - Homogeneous goods
  - ...
- In equilibrium: every firm produces the same quantity
- Firm i's profit: $\pi_i(q) = R(q) - C(q) = p(q)q - C(q)$.
- Industry profits: $\Pi = \sum_{i \in \mathcal{N}} \pi_i(q)$; with n identical firms: $\Pi = n\pi_i$ (Index i can be dropped).
- Producer surplus PS equalts difference between price and marginal costs of every unit sold $\Rightarrow$ PS ignores fixed costs F!

Perfect Competition – Allocative Efficiency

Different types of costs

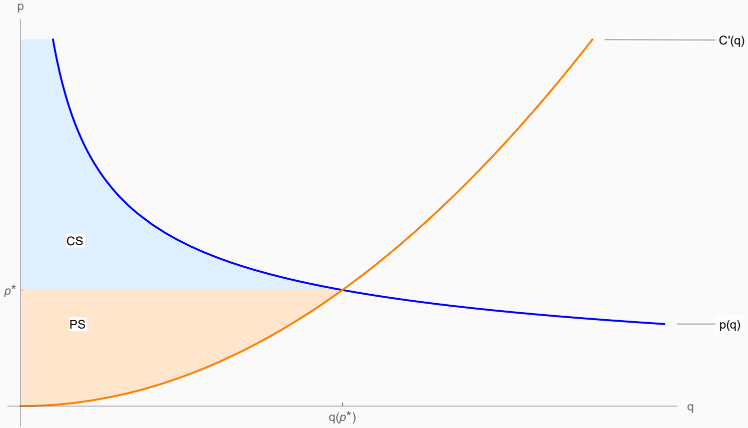
- Fixed costs F do not vary with output (e.g, production plants, land, ...).
- Variable costs (VC) $c(q)$: vary with output (with $c(0) = 0$, e.g., olives in production of olive oil, ...).
- Cost function $C(q) = F + c(q)$:
  - Marginal costs $MC = \frac{dC(q)}{dq} = C'(q) = c'(q)$: costs of the next (infinitesimally small) unit of production.
  - Average costs $AC = \frac{C(q)}{q} = \frac{F+c(q)}{q}$: Average costs per unit.
  - Average variable costs $\frac{c(q)}{q}$: Average of the variable costs per unit.
- It follows that:

$$PS(p = p^*) = p^* q(p^*) - \int_0^{q(p^*)} c'(q)\mathrm{d}q = p^* q(p^*) - (c(q^*) + \underbrace{X}_{\text{constant of integration}})$$

Perfect Competition – Allocative Efficiency

Welfare (W)

- Assume $F = 0$ such that $PS = \Pi$.
- At a given price p^*, we have $W(p^*) = CS(p^*) + PS(p^*)$



Perfect Competition – Allocative Efficiency

Welfare (W)

- We have:
  - $CS(p = p^*) = \int_0^{q(p^*)} p(q)\mathrm{d}q - p^* q(p^*)$
  - $PS(p = p^*) = p^* q(p^*) - \int_0^{q(p^*)} c'(q)\mathrm{d}q$
- Revenues of the firm ($p^* q(p^*)$) are equal to consumers' expenditures (re-allocation!).
- It follows that $W = CS + PS = \int_0^x (p(q) - c'(q))\,\mathrm{d}q$
- What is the level of output x^* that maximizes welfare?

$$\max_x \; W(x) = \int_0^x p(q) - c'(q)\mathrm{d}q$$

- Welfare is maximized when $p(x) = c'(x)$ holds. (Beware of Leibniz integral rule!)

Perfect Competition – Allocative Efficiency

Welfare (W)

- Welfare is maximized when **price equals marginal costs**.
- Produce until WTP of the marginal consumer is equal to marginal costs.
- Maximum exists because demand is falling (diminishing marginal utility of consumption) or marginal costs are increasing (decreasing marginal product of variable inputs).
- Pareto optimality: Vilfredo Pareto, 1848–1923; Debreu, G. (1954). Valuation equilibrium and Pareto optimum. *Proceedings of the National Academy of Sciences of the United States of America*, 40(7), 588-592.

  a Pareto optimum is a state where no consumer can be made better off without making another consumer worse off.

- This state is reached in equilibrium in perfect competition.

Perfect Competition and Monopoly – Perfect Competition

- Perfect Competition: (s. McNulty, P. J. (1968). Economic theory and the meaning of competition. *The Quarterly Journal of Economics*, 639-656.)

  Perfect competition, the only clearly and rigorously defined concept of competition to be found in the corpus of economic theory, which is free of all traces of business behavior associated with "monopolistic" elements, means simply the existence of an indefinitely large number of noncompeting firms.

- Assumptions of Perfect Competition
  - Price taking
  - Small agents (atomistic market)
  - Homogeneous goods
  - Perfect information
  - Free access to production technology and market (no barriers to entry or exit)
- Assumptions are restrictive. The model usually serves as a benchmark to evaluate market outcomes. However, in some market the model may predict market outcomes accurately.

Perfect Competition and Monopoly – Perfect Competition

- Firm i takes market prices as given and chooses output such that profits are maximized:

$$\max_{q_i} \; \pi_i(q_i) = \underbrace{pq_i}_{R_i(q_i)} - C(q_i).$$

- The profit maximizing quantity satisfies

$$\pi_i'(q_i) = p - C'(q_i) \overset{!}{=} 0 \;\Leftrightarrow\; \underbrace{p = C'(q_i)}_{\text{price = marginal costs}}.$$

- Firms increase output until price (here equals marginal revenue) is equal to marginal costs.
- If $p > C'(q_i)$ ($p < C'(q_i)$) production of the next unit increases (decreases) profits such that an increase (decrease) in output raises profits.

Short run

- Number of firms **exogenously given** (no market entry or exit)
- Positive and negative profits are possible
- Equilibrium:
  - Every firm chooses output such that $p = C'(q_i)$.
  - Rearranging of $p = C'(q_i)$ yields i's **individual supply function** $q_i(p)$.
  - With n identical firms, the **industry supply function** reads $S(p) = nq_i(p)$ (horizontal aggregation).
  - Short-run equilibrium price p_{SR} follows from $S(p) = q(p)$.
  - We get each firm's output in the short-run equilibrium using $q_{SR} = q_i(p_{SR})$. Accordingly, $\pi_{SR} = q_{SR}p_{SR} - C(q_{SR})$ gives each firm's equilibrium profits in the short run.
  - Short-run industry outputs are $Q_{SR} = nq_{SR}$ in equilibrium, with corresponding consumer surplus $CS_{SR} = \int_0^{Q_{SR}} p(q)\mathrm{d}q - Q_{SR}p_{SR}$.
  - Welfare reads $W_{SR} = CS_{SR} + \Pi_i(q_{SR}) = CS_{SR} + n\pi_i(q_{SR})$.

Long run

- Market entry, exit and capacity adjustments lead to profits of zero in long-run equilibrium (zero profit condition). Number of firms now **endogenous**.
- Note that economic profits rely on opportunity (economic) costs (adequate rents, etc.) such that accounting profits are positive.
- Equilibrium:
    - Zero profits imply $\pi_i = pq_i - C(q_i) = (p - \frac{C(q_i)}{q_i})q_i \overset{!}{=} 0 \;\Leftrightarrow\; p = \frac{C(q_i)}{q_i}\; \forall q_i > 0$. In other words, price equals average costs (AC) in long-run equilibrium.
    - Every firm maximizes profits, i.e., $p = C'(q_i)$ continues to hold.
    - For increasing marginal costs, it follows that marginal and average costs intersect where average costs are minimized:

$$AC'(q) = \frac{C'(q)q - C(q)}{q^2} \overset{!}{=} 0 \;\Leftrightarrow\; C'(q) = \frac{C(q)}{q}.$$

    - From $C'(q) = \frac{C(q)}{q}$, we get each firm's long-run equilibrium output, q_{LR}. Accordingly, $p_{LR} = C'(q_{LR})$ or $p_{LR} = \frac{C(q_{LR})}{q_{LR}}$ is the ensuing price.

Perfect Competition and Monopoly – Monopoly

- Only one firm on the supply side (monopolist).
- Possible reasons for monopoly:
  - Exclusive access to resources (e.g., De Beers)
  - Technical advantage or patents (e.g., pharmaceuticals)
  - Network effects (e.g., search engines, social media)
  - "Pure" monopoly is rare. Usually, firms enjoy market power with few small competitors (quasi monopolist).
- It follows that monopolist can **influence prices** (no price taking!).
- Usually, monopolist has better options than choosing a single (linear) price by using, e.g., two-part tariffs. Such strategies are analyzed in our IO course (master), which can also be found on Economics2Go!

Profit maximization

- Price endogenously determined.
- If monopolist increases output, market prices decrease (falling inverse demand). Vice versa, an increase in price leads to a decrease in sales (falling demand function). Accordingly, irrelevant whether monopolist's instrument is price or quantity.
- Let's assume monopolist maximizes profits using output as the instrument

$$\max_q \ \pi(q) = \underbrace{p(q)}_{\text{inv. demand}} q - C(q).$$

- Optimality obtains when

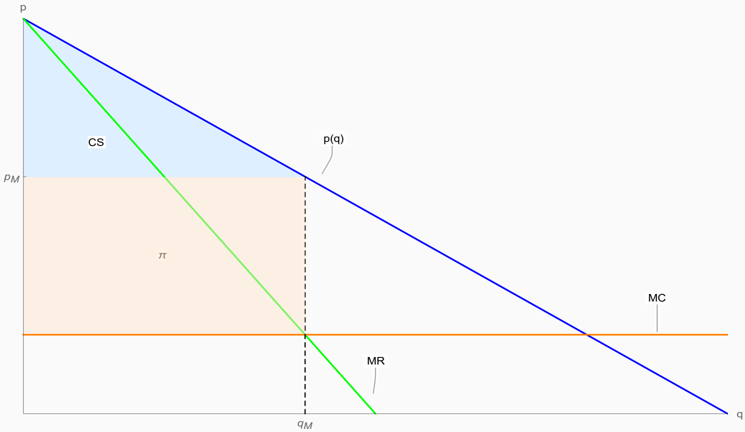
$$p'(q)q + p(q) - C'(q) \overset{!}{=} 0.$$

- Marginal increase in output leads to
  - falling market prices for all infra-marginal units ($p'(q)q$ with $p'(q) < 0$) and
  - increasing sales due to marginal unit ($p(q) > 0$) being sold.

Perfect Competition and Monopoly – Monopoly

Profit maximization

- Optimality obtains if $p'(q)q + p(q) = R'(q)$, i.e., if marginal revenue equals marginal costs $C'(q)$.



Perfect Competition and Monopoly – Monopoly

- Monopolist's price above marginal costs in equilibrium.
- Profits/PS higher than in perfect competition, consumer surplus and welfare lower.
- Monopoly prices in elastic range of demand. Amoroso-Robinson condition follows from FOC:

$$\underbrace{\frac{p(q) - C'(q)}{p(q)}}_{LI} = \underbrace{-p'(q)\frac{q}{p(q)}}_{\frac{1}{\eta}}$$

- LHS is Lerner-Index (LI):
  - Measures market power in an industry: percentage markup on marginal costs.
  - $LI = 0$ in perfect competition as $p = C'(q)$ in equilibrium.
  - With linear demand $p(q) = a - bq$ and constant marginal costs $C'(q) = c$, monopoly price reads $p_M = \frac{a+c}{2}$ and $LI \leq 1$ und $\eta \geq 1$.

Annex – Derivation of Amoroso-Robinson Condition (Slide 15)

- Optimality requires $p'(q)q + p(q) = C'(q)$, i.e., $p(q) - C'(q) = -p'(q)q$.
- Multiply both sides with $\frac{1}{p(q)}$ to get $LI = -p'(q)\frac{q}{p(q)}$.
- (Own) Price elasticity of demand is defined as $\eta := -\frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}}$. With continuously differentiable demand $q(p)$, we have $\eta = -q'(p)\frac{p}{q}$. It follows that $\frac{1}{\eta} = -p'(q)\frac{q}{p(q)}$.
- It follows that $LI = \frac{1}{\eta}$ in monopoly equilibrium.