NUMERO: **2537A** ANNO: 2022

A P P U N T I

STUDENTE: Pieretto Letizia

MATERIA: Industrial economics - Prof. Benfratello

INDUSTRIAL ECONOMICS

MONOPOLY

PERFECT COMPETITION

- perfect competition provides high level of welfare
- completely flat (horizontal) individual demand curve

HYPOTHESES:

- large number of buyers and sellers → industry is fragmented both the demand and the supply because we have LOT producers
- homogeneous product → what is produced by one producer is indistinguishable for the consumer; is undifferenciated
- perfect information
- equal access to resources in terms of technologies

CONSEQUENCES

- firm is a price taker → firm does not make the price, take the price given by the market. Any increase in the price would result in a zero quantity sold
- free entry and exit → no entry or exit barriers, depends on the profits

OPTIMALITY CONDITIONS

- short-run: capital is given and n° of firms is fixed

$$MR = p = MC$$

↓

no matter which kind of industry structure, optimality condition MR = MC, what changing depending on the structure is MR

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 3 di 116

CONSUMER THEORY

- consumer wants to maximize his utility

$$V = \max u(x)$$
$$px = m$$

V = max utility at given prices and income

↓

INDIRECT UTILITY FUNCTION

x = consumer's demand function

$$\frac{\left(\frac{\partial u(x^*)}{\partial x_i}\right)}{\left(\frac{\partial u(x^*)}{\partial x_0}\right)} = \frac{p_i}{p_0}$$

at the optimum, marginal utilities weighted by the prices must be equal

- indirect utility function $v(p, m)$ → effect for the consumer when price changes

PROPERTIES
- IT IS non increasing in p and non decreasing in m
- IT IS CONTINUOUS and quasi-convex

QUASI-LINEAR UTILITY FUNCTION

- partial equilibrium analysis → effect of changes in prices of a specific good on consumers' utility → isolate that good from other good
- 2 assumption
  - no income effect
  - substitution effect on the other goods is small too
- typical of "goods" which have a relatively low weight on the consumer budget

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 5 di 116

$S(q)$ = gross surplus, utility of consumer

$$CS = S(q) - p(q)\,q = \int_0^{q^*} p(q)\,dq$$

$$CS = \frac{dS(q)}{dq} = p(q)$$

positive function of the quantity

PERFECT COMPETITION AND WELFARE

- perfect competition is the market structure that maximise total welfare, where W = consumer surplus + producer surplus
- goverment ideally want perfect competition in all market
- representative consumer approach → consumer that represent all the other → market demand $x(p)$ and a quasi linear $u(x) + y$ where x is the good under examination and y everything else → $u'(x) = p$ → demand function is indipendent of income
- representative firm → cost function $C(x)$ with $C' > 0$, $C'' > 0$ and $C(0) = 0$ → $p = C'(x)$ → in equilibrium demand = supply → $U'(x) = p = C'(x)$ → marginal willingness to pay for x just equals its marginal costs of production

WELFARE ANALYSIS

$$W = CS + PS = \int_0^x u'(x) - px + px - \int_0^x C'(x)$$

$$W = \int_0^x u'(x) - C'(x)$$

competitive equilibrium level of output maximizes total surplus

$u'(x) = C'(x)$ → marginal utility = marginal cost

GENERALIZATION : more than one goods and of consumers and firms who differ for their utility or costs

- perfect competitions maximizes total welfare

- firms can have market power as sellers or as buyers

(2) externalities

- market prices do not always fully reflect the activities of either producers or consumers
- consumption or production has **indirect effect** on other consumption or production not reflected in market prices

(3) public goods → provide by the government

- **non-excluisve**, **nonrival** goods that can be made available cheaply but which are difficult to prevent other from consuming → once it is made public, others can duplicate it (ex new technologies)
- **exclusive good** → good for which I exclude other people from benefit of this good
- **rival good** → can benefit only a single person

(4) incomplete information

- consumers must have accurate information about market prices or production quality for markets to operate efficiently
- **lack of information can change supply**
  - ↳ buy product with no value
  - ↳ do not buy enough products with value
- some markets may never develop (ex used cars)

economic motivation

- existence of market power (monopoly, duopoly...)
- externalities (+ or -)

in monopoly I have a downward sloping demand → if I want to increase n° of units to sell, I have to decrease the price

the price is the MR for the last unit I sell, but if I have to decrease the price of all the units that I sell (no price discrimination) → **MR < price**

$$MR = \text{price of last unit} - \text{what I lose by selling all the units I was selling before at lower price}$$

↓

infra marginal units

$$MR = P + P/\varepsilon_D$$

ε_D = price elasticity of demand
- ∞ if demand flat
- 0 if demand vertical

$$\frac{P - MC}{P} = \frac{1}{|\varepsilon_D|}$$

links the ability to raise price above MC with the elasticity of demand

price markup → the more elastic is demand, the less is the markup

MONOPOLY POWER

- measure the monopoly power by the **extent to which price is greater than MC**
- **Lerner's index of Monopoly Power** $[0, 1]$

$$L = \frac{P - MC}{MC} = \frac{1}{|\varepsilon_D|}$$

at the level of the firm → ε_D is for the firm!!! (not for the market)

- pure monopoly is rare
- **a firm's monopoly power is determined by the firm's elasticity of demand**

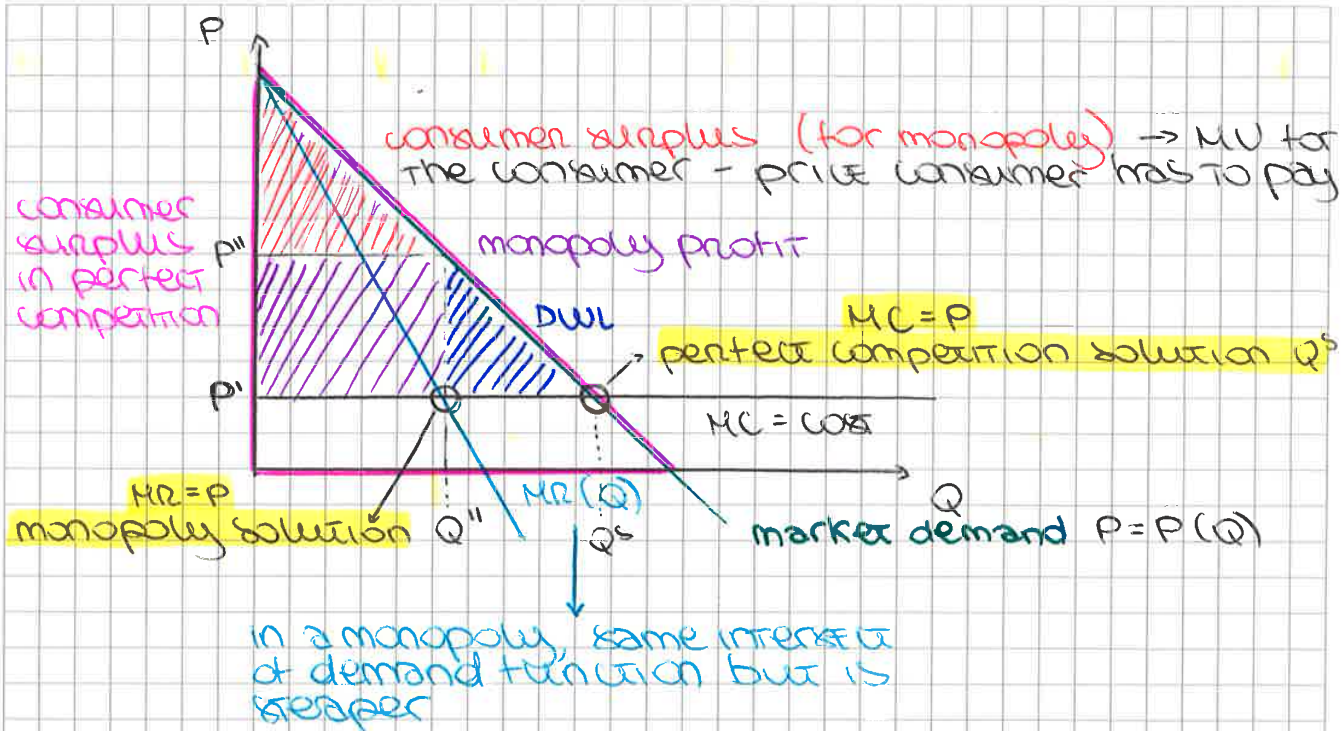
© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 11 di 116

- firms would like to create **barriers to entry** to keep new firms out of the market (patents, copyrights, licenses, economies of scale) → enjoy extraprofit without attracting new firms

- **entry barriers** from 2 perspective
  - **corporate strategy**
    - a key of corporate strategy is profitable entry deterrance
  - **public policy** (are negative, not happy)
    - public policy should aim at eliminating entry barriers and detect entry deterrance → allows perfect competition

- governments create entry barriers when they grant exclusive rights to produce to incumbent from preventing additional entry → **legal restriction on entry**
  - natural monopoly
  - source of revenues
  - redistribute rents among citizens
  - intellectual property rights (difficult to enforce)

- **structural barriers to entry** protect market power
  - they are technology structure
    - economies of scale → average costs are decreasing, so the average cost is huge
    - sunk expenditure of the entrant → expenditure peculiar to a given product, can not be recovered if you exit from the market
    - absolute cost advantage → incumbent may face lower costs or a better access to existing facilities
    - **switching cost** → cost taking now by consumers, cost for switching from one product to the other → sunk expenditure by consumers and product differentiation
    - consumer might not view the offerings of other firms as substitute



in a monopoly, same interest of demand function but is steeper

monopoly profit + DWL → loss consumer surplus

- monopoly profit → additional profit for the monopolist, price - marginal cost
- DWL → dead weigh loss → loss in consumer surplus not transformed in profit, but completely loss (for presence of monopoly)

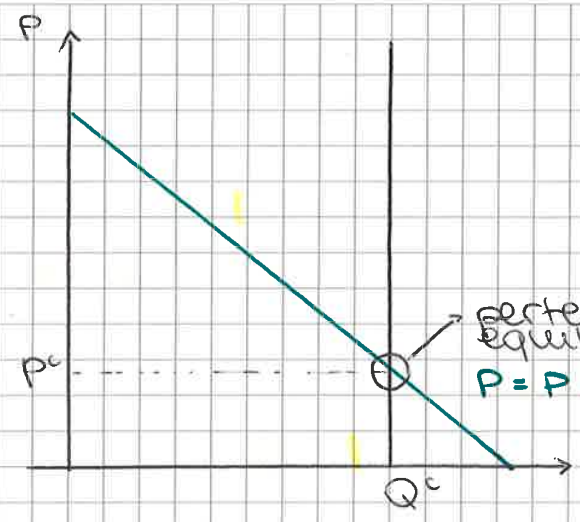
P'' - P' (↑) → is called price distortion of monopoly is the difference between monopolistic price and perfect competition price

Q'' - Q^s (↓) → is called quantity distortion, the presence of market power distorce equilibrium quantity
↳ quantity below perfect competition

MONOPOLY DEAD WEIGHT LOSS

- DWL → measure the surplus that would have been created with a competitive market, but social lost due to level of the price which is fixed by the monopolist
  ↳ combination of price distortion and quantity distortion

PERFECT COMPETITION



Q^c = fixed quantity supply

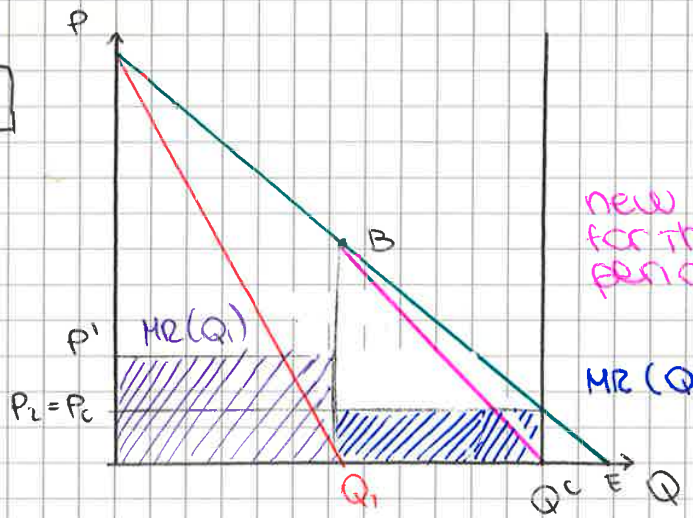
P^c = competitive price

perfect compet. equilibrium

$P = P(Q)$ → standard demand

$MC = 0$ → horizontal axis till the quantity is Q^c, after $MC = \infty$

MONOPOLY



For monopoly the optimal → $MR = MC$ → Q_1 = quantity sold, P_1 = monopolistic price

but monopolist remains with unsold quantity $Q_c - Q_1$ → residual demand (B - E) → people that didn't buy the good

in the second period consider the residual demand → find new price P_2 and new demand → in order to sell additional units the monopoly must reduce the price

intertemporal price discrimination → increase his profit by decreasing prices over time → moving down the demand curve

- strategic consumer → have incentives to delay purchasing if they anticipate that the monopolist will lower prices in the future

- advantage of monopoly → dynamic efficiency → ability to introduce innovation, adopte technologies advantages
  - Shumpeter → The best market structure for innovation is monopoly because he have lot of profit that can inverse in research and development activity
  - Arrow → monopoly is not the best market structure because he has no competitors (more adopte) and this do not push him to introduce new technologies and innovation

- government can regulate monopoly power through price regulation → impose price max to the monopoly
  - in competive markets, price regulation creates a DWL
  - price regulation can eliminate DWL with a monopoly

REGULATION VS COMPETITION POLICY

- competition policy → attempts to avoid situations where market power can be exploited; regulation deals with those situation

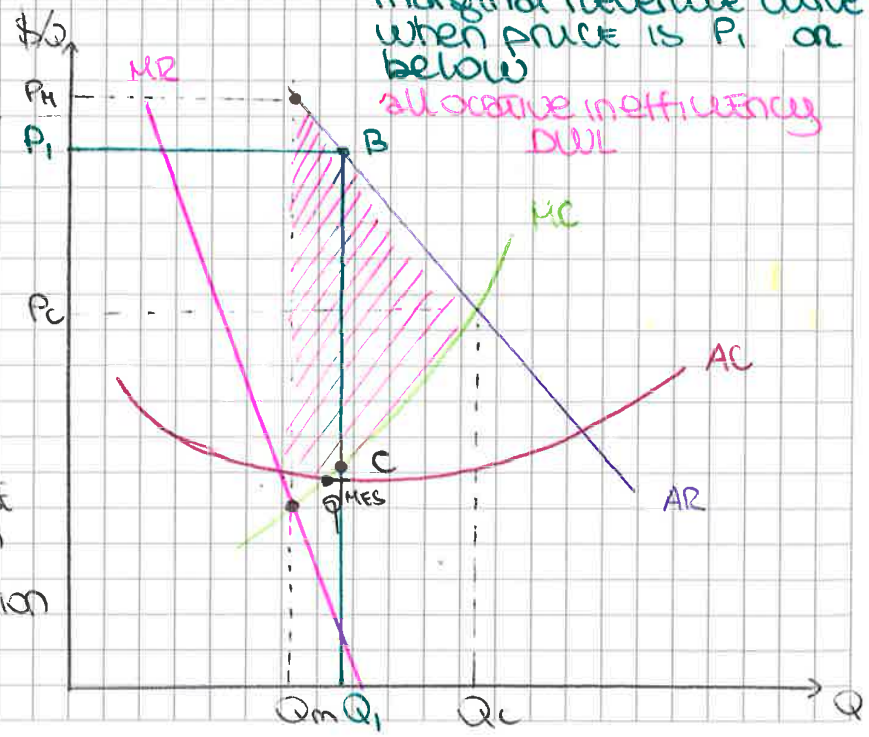
PRICE REGULATION

downward sloping demand

FOR MONOPOLY
$Q_m \rightarrow MC = MR \rightarrow P_m$

government want to reduce allocative inefficiency because price P_m is too high

FOR PERFECT COMPETITION
$Q_c \rightarrow AR = MC \rightarrow P_c$



marginal revenue curve when price is P_1 or below

allocative inefficiency DWL

- natural monopoly exist if, over the relevant range of output, the cost of function is subadditive

- single product industry the cost function is subadditive → production of quantity q to the single firm is less than the sum of the cost of producing quantity q_i for n firms

$$C(q) < \sum_{i=1}^{N} C_i(q_i) \qquad \sum_{i=1}^{N} q_i = q, \quad N \geq 2$$

more convinient to produce in a single firm than to split production across N firms

- presence of economies of scale is sufficient but not necessary

- multi-product industry The cost is subadditive if

$$C(q^1, q^2, \dots q^M) < \sum_{i=1}^{N} C_i(q^1 \dots q^M) \qquad \sum q_i^j = q^j$$

it is cheaper to produce the output vector with a single firm than with more than one firm

- sufficient conditions to have natural monopoly in a multi product setting
  - → presence of economies of scope → advantage doing scope of the production. Scope is the variety of production → advantage of producing goods together

$$C(q_1, 0) + C(0, q_2) > C(q_1, q_2)$$

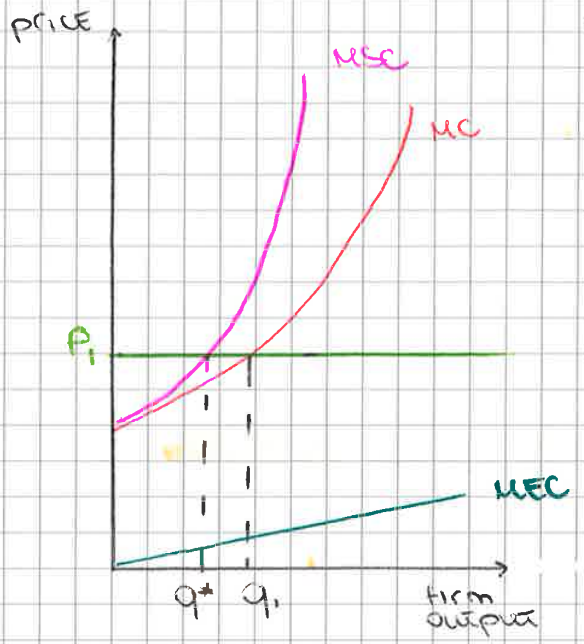
  - → average incremental costs should be decreasing

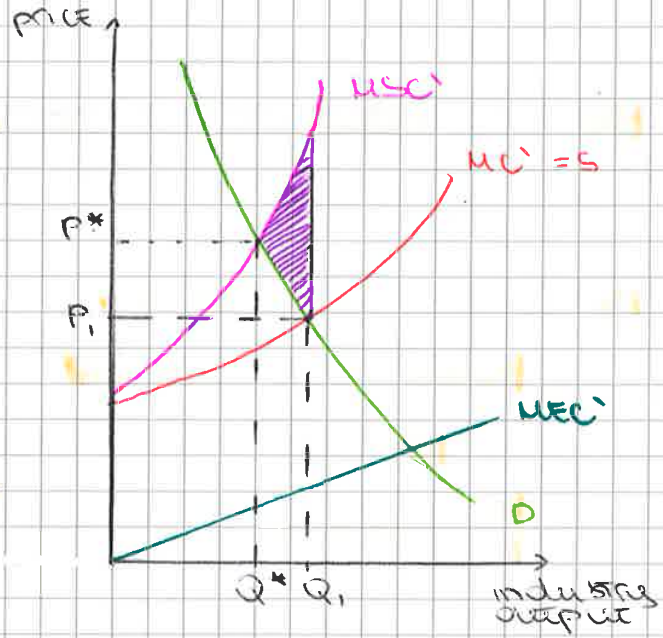
$$AIC = \frac{IC(q_1, q_2)}{q_1}$$

$$IC(q_1, q_2) = C(q_1, q_2) - C(0, q_2)$$

↳ stand alone cost of product 2

EXTERNAL COSTS





MEC → EXTERNALITIES

in the short run equilibrium → supply of the market = demand → Q_1

but we have ←

from the level of the society we have to consider MSC = MC + MEC for each level of quantity

there is MEC of production from the waste released. The MSC is true cost of production

important result → equilibrium level optimal from the point of view of society is lower than the one without externalities → $Q^* < Q_1$

when we have negative externalities the perfect competition quantity is too high

//// → aggregate social cost of negative externality

↳ allocative inefficiency of perfect competition → by not producing at the efficient level, there is a social cost on society

the firm has no incentive to buy from the farmer the right to pollute

if A = 50 → 600 − 50 = 550 → firm will not pollute

370 → farmer

(2b) A < 120 and there is no law that prevents the paper mill from polluting the river → the mill hold relevant property rights

if A = 50

farm has incentive to negotiate with the firm the right not pollute

600 + 370 = 970

970 − 50 = 920 > 850 → any sharing of the 70 is beneficial at both parties

farmer give to the firm 85 for the promise not to pollute

370 − 85 = 285 > 280 → farmer

600 − 50 + 85 = 635 > 600 → firm

case 2 : high cost of abatement

(2a) A > 120 and the law guarantees the farmer acces to clean water → the farmer holds the relevant property rights

if A = 200

firm has incentive to buy from the farmer the rights to pollute

970 − 220 = 770 < 850 → any sharing of the 80 is benitical to both parties

firm will give to the farmer 160 for the rights to pollute

370 − 120 + 160 = 410 > 370 → farmer

600 − 160 > 600 − 200 → firm

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 25 di 116

- an additional agents who enters the network generates a positive externality to the existing agents since "connection" possibilities are enlarged
- metcalfe's law → the value of telecommunication network is proportional to the square of the n° of connected users

A SIMPLE MODEL (ROHLFS)

How the externality affect the market demand and marked equilibrium?

p → fixed price to be connected to a telecom network

utility function ↓ increases if the n° of users $n \in [0,1]$ increases

$$U(\theta) = \begin{cases} n(1-\theta) & \text{if he connects} \\ 0 & \text{if he not connect} \end{cases}$$

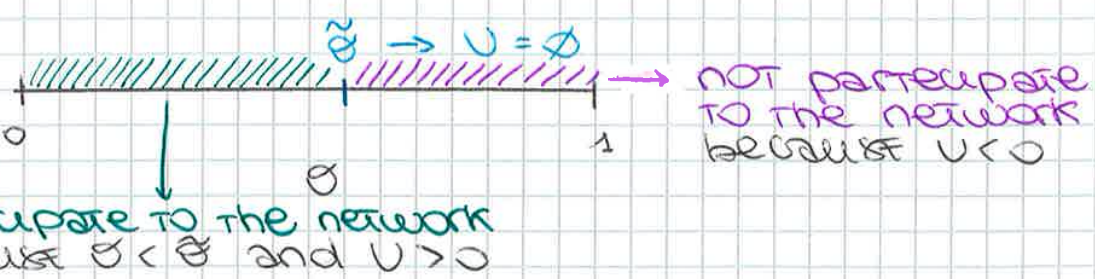
θ → parameter inversely proportional to the willingness to pay → $\theta \in [0,1]$
↳ indicates a consumer type

$\tilde{\theta}$ → consumer indifferent between being connected or not, for a given p and number of users n
↳ marginal consumer → the first that exit if p↑ or if n↓

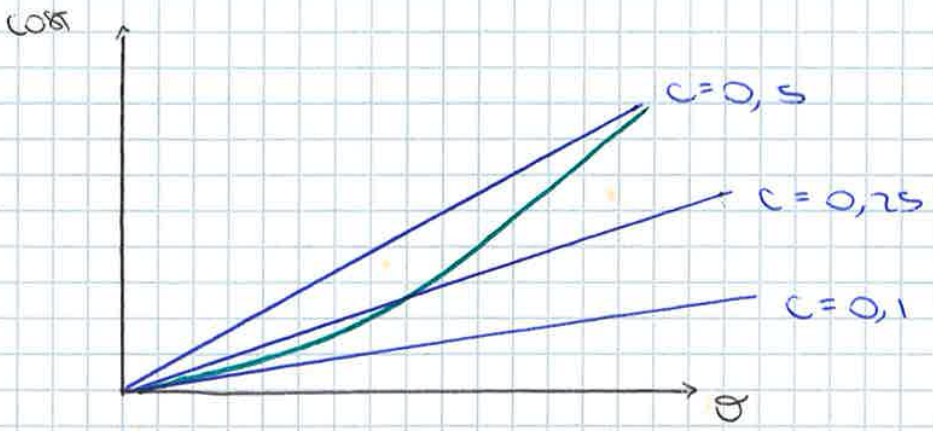
$$n(1-\tilde{\theta}) - p = 0$$

utility of partecipation is equal to ∅

in the equilibrum ⟶ $\tilde{\theta} = n$
↳ n° of potential users should be equal to the n° of existing users



- from a social point of view, a 100% coverage should be reached



— = TOTAL COST = $c \cdot q$ where c = marginal cost

— = gross surplus

best solution → $\theta = 1$ because the difference between gross surplus and TC is maximized and this difference is the TOT welfare

should a private firm choose to cover all the market or not? → NO!

↓

in monopoly $\pi(\tilde{\theta}) = p\tilde{\theta} - c\tilde{\theta} = \underbrace{\tilde{\theta}(1-\tilde{\theta})}_{p}\tilde{\theta} - c\tilde{\theta}$

↳ $\tilde{\theta}^* = \frac{1+\sqrt{1-3c}}{3}$ $\tilde{\theta}$ negative related to marginal cost c

↳ produce less than perfect competition

INTERCONNECTION

- interconnection → when several networks are interconnected
  - ↳ consumer would like to be connected to a network as large as possible
- There may be cases where a large incumbent may find it attractive to avoid interconnection with new entrants in order to preserve its market power
- interconnection allows a better welfare of the society more welfare of the consumer and decrease market power

TWO SIDED - PLATFORM TYPES

- platform → place where is the two-side of the market (the buyer and the seller) and allows the match

DIFFERENT KIND OF GOODS

1. NON-RIVAL
   - for any given level of production, the MC of providing it to an additional consumer is zero
   - the consumption by an individual does not reduce the quantity consumed by other individuals
2. NON-EXCLUSIVE
   - people cannot be excluded from consuming the good. It is difficult to charge a price for their use

↓

a. COMMON PROPERTY RESOURCES
   - are goods which are rival but not excludible (ex forests, sea, lakes...)

b. PUBLIC GOODS
   - are goods which are non rival and not excludible (ex. national defense, public lighting...)

COMMON PROPERTY RESOURCES

- are rival goods so that the use of each agent reduces the use of the others → negative externalities because consumption is too high
- remedies of the government
  - ↳ create a market giving the good to a private agent that create a price

GAME THEORY

GAME THEORY

- game theory is a set of tools that is used to model the behaviour or choices of players when the payoff (profit) of a choices depends on the choices of other players. Recognized payoff interdependency gives rise to interdependent decision making or strategic interaction

- the optimal choice of a player will depend on his expectation of the choices of others playing the same "game"

- elements of a game
  - players
  - rules about the game we are modelling
  - outcomes, which depend on the actions chosen by players
  - payoffs, which represent the players' preferences over the outcomes of the game

TYPES OF GAMES

1. classified according to the timing of the moves and uncertainty about the payoffs of rivals
   - static of complete information
   - dynamic of complete information
   - static of incomplete information
   - dynamic of incomplete information

imperfect information → refers to dynamic games where players do not know exactly the past history of the game

chosen by i's rivals

$$\pi_i(s_i, s_{-i}) > \pi_i(s_i', s_{-i})$$

s_i = strictly dominant strategy

- a rational player will always play a dominant strategy

PRISONER'S DILEMMA → most famous game which has a solution in dominant strategies

		P2: TO RAT	P2: TO CLAM
P1	TO RAT	-3, -3	0, -5
	TO CLAM	-5, 0	-1, -1

|| TO RAT is dominant strategy for both players although TO CLAM would be better for both

ITERATIVE ELIMINATION OF DOMINATED STRATEGIES

- one possibility is the equilibrium we get one we eliminated dominated strategies

$$\pi_i(s_i', s_{-i}) > \pi_i(s_i, s_{-i})$$

s_i = strictly dominated strategy

- a rational player will never play a dominated strategy, so it can be discarded by the other players as a possible strategy

RATIONALIZABLE STRATEGIES

- a strategy s_i is a best response for player i TO s_{-i} if

$$\pi_i(s_i, s_{-i}) \geq \pi_i(s_i', s_{-i})$$

s_{-i} specific combination of strategies of all opponents

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 35 di 116

OLIGOPOLY - HOMOGENEOUS GOODS

- **oligopolies**
  - → industries in which a **few firms compete**
  - → **market power is collectively shared**
  - → firms cannot ignore their competitors' behaviour
  - → **strategic interaction** → game theory

- The analysis of strategic behaviour of several price-maker firms operating within a specific market can be tackled with reference to **different issue** and introducing **different assumption**

FIRM'S OBJECTIVE

- assume a **duopoly**, homogeneous product, **costant MC** ("linear" cost)

$$\pi_1 = pq_1 - cq_1$$

$$Q = q_1 + q_2 \qquad \text{market demand}$$

$$\pi_1 = p(Q)q_1 - cq_1 \qquad \text{single price in the market because of homogeneous p}$$

firm i maximise its own profit when $R_i' = C$

COURNOT MODEL - QUANTITY COMPETITION

- **marginal revenue**

$$R_1' = \frac{\partial R_1(Q)}{\partial q_1} = p(Q) + \frac{\partial p(Q)}{\partial q_1} q_1$$

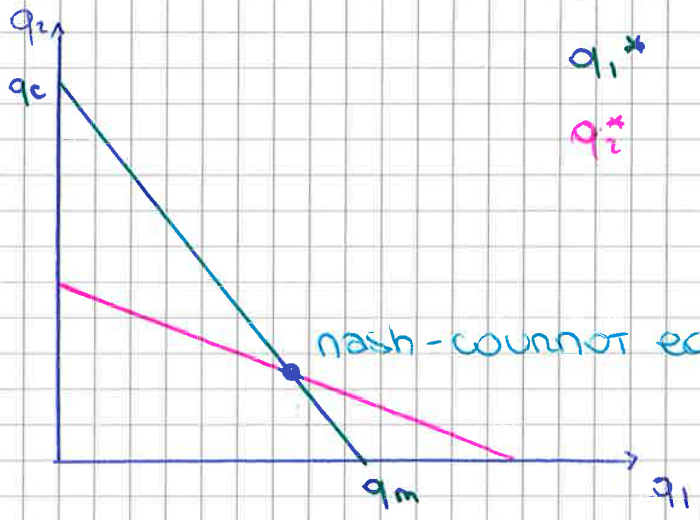
an **increase** in q_2 **reduces** p and so the marginal revenue of the rival firm 1 → the more the rival produce, the lower the profit 1 can obtain

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 37 di 116

$\pi_1 = p^* q_1^* - c q_1^*$

$\boxed{\pi_1 = b (q_1^*)^2}$

the reaction curve



q_1^*

q_2^*

$\frac{a-c}{2b}$

q_m = optimal prod. of firm 1 is the monopoly level ($q_2 = 0$)

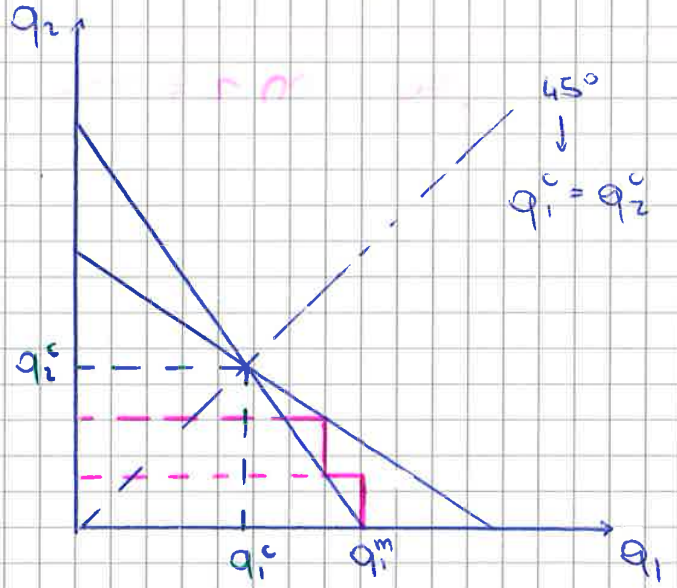
q_c = firm 2 produces the competitive level

$\pi_1 = 0 \rightarrow p = c$

$\pi_m > \pi_1 + \pi_2$

when mc are the same the equilibrium is symmetric (produce the same quantity)

adjustment process



q_1^m → firm 1 decides to produce monopolistic quantity

after is not in the interest of firm 2 to produce zero → reaction function 2 → produce a strictly positive quantity

and so on...

close to Nash-Cournot quantity

$p_{competition} < p_{cournot} < p_{monopoly}$

$q_1 + q_2 > q_m$

COURNOT MODEL WITH n FIRMS

- solve a system of n FOCs
- suppose symmetry in cost

$$q_1^*(q_2 \dots q_n) = \frac{a-c}{2b} - \frac{\sum_{i=1}^{n} q_i}{2}$$

in a symmetric equilibrium

$$q^* = \frac{a-c}{(n+1)b} \qquad p^* = \frac{a+nc}{n+1}$$

$$\pi^* = \left[\frac{a-c}{n+1}\right]^2 \frac{1}{b}$$

when n increases, the quantity produced q^* decreases and p^* decreases

The symmetric linear Cournot model converges to perfect competition as the n° of firms increases

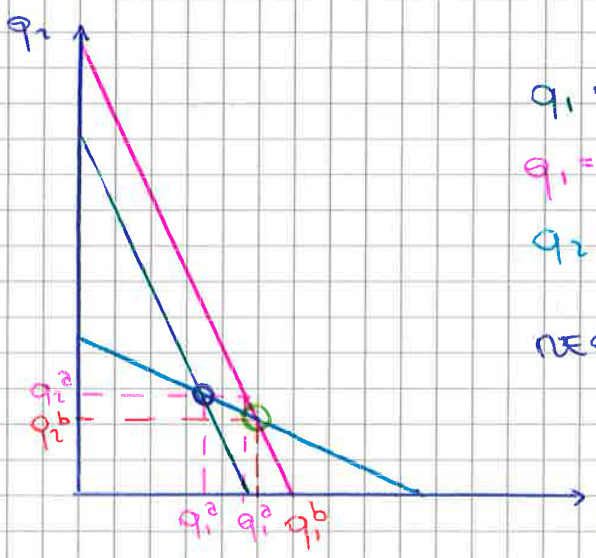
THE LERNER INDEX IN COURNOT GAME

$$R_1' = \frac{\partial R(q)}{\partial q_1} = p + \frac{\partial p}{\partial q_1} q_1 \qquad \text{but} \quad \frac{\partial p}{\partial q_1} = \frac{\partial p}{\partial Q}$$

$$R' = p + \frac{\partial p}{\partial Q} q_1 \frac{Q}{Q} \frac{p}{p}$$

$$R' = p - p \frac{q_1}{Q} \frac{1}{n}$$

n is the absolute value of the PRICE ELASTICITY of the market demand



$q_1 = R_1^a(q_2)$

$q_1 = R_1^b(q_2)$

$q_2 = R_2(q_1)$

reduction in cost for 1

$c_1 < c_2 \rightarrow q_1 > q_2$

so the RF shifts to the right

↓

new equilibrium

the horizontal intercept for 1 is the monopolistic quantity $\left(\frac{a-c_1}{2b}\right)$ → if MC decreases, the horizontal intercept increases

the vertical intercept is that firm 1 considered not convenient to produce any single additional quantity because firm 2 is already produced a quantity such that $p = MC$ which is the perfect competition quantity.
if the 2 marginal costs are different, the new vertical intercept considers MC, so if it MC decreases it is necessary another level of the quantity produced by the firm 2

cost asymmetries with n firms

$$\frac{p - c_i}{p} = \frac{s_i}{\eta}$$

m_i = markup of the firm i

the size of the firm is not the cause of market power: the size s_i on the relative cost efficiency

weighted average markup

$$s_1 m_1 + s_2 m_2 + \dots + s_n m_n = \frac{HHI}{\eta}$$

cannot model → firms compete each other, negative externalities, but at the end firms can coexisting in the market and impose their quantity. If market power face down finishises the larger n° of firms

BERTRAND MODEL

- firms set their own price
- 2 firms
  - homogeneous products
  - identical constant marginal cost : c
  - set price simultaneously to maximize profits
- consumers → are extremely reactive (no switching cost)
  - the firm with lower price attracts all demand $Q(p)$
  - at equal prices, market splits at α_1 and $\alpha_2 = 1 - \alpha_1$

firm i faces demand

$$Q_i(p_i, p_j) = \begin{cases} Q(p_i) & p_i < p_j \\ \alpha_i Q(p_i) & p_i = p_j \\ 0 & p_i > p_j \end{cases}$$

- 2 ways to solve the model
  - Bertrand conjecture → rivals do not modify their prices. Given the rival's price, the firm undercuts the other but this dynamic process lead to an equilibrium in which $p = c$, a situation in which no firm has incentive to increase or decrease prices
  - Nash equilibrium concept → Bertrand-Nash equilibrium → pair of prices (p_1^B, p_2^B)

$$\begin{cases} \pi_1(p_1^B, p_2^B) \geq \pi_1(p_1, p_2^B) & \text{for any } p_1 \\ \pi_2(p_1^B, p_2^B) \geq \pi_2(p_1^B, p_2) & \text{for any } p_2 \end{cases}$$

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 45 di 116

In an homogeneous product Bertrand duopoly with identical and constant c, the equilibrium is such that

- firms set price equal to c
- firms do not enjoy any market power

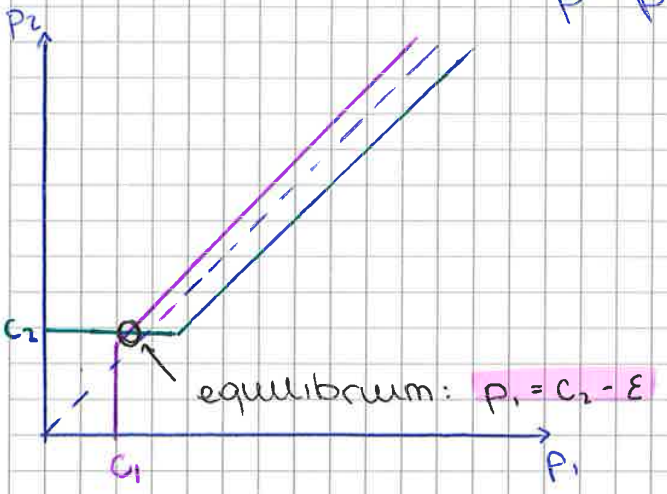
ASYMMETRIC COST IN BERTRAND

- If $c_2 > c_1$ firm 1 has a cost advantage
- If $p_2 = c_2$ (different marginal costs) → firm 1 can undercut

$$p_2 = c_2$$
$$p_1 = c_2 - \varepsilon$$

equilibrium

The more efficient firm remains the monopolist because I have strong competition → remains the only firm in the market but it doesn't mean that $p = p_m$



$c_1 < c_2$

for any $p_1 < c_2$ firm 2 has as best response $p_2 = c_2$

PRICE VS QUANTITY COMPETITION EQUILIBRIA

$Q(p) = a - p$

$c_1 = c_2 = c$ →

BERTRAND	COURNOT
$p_1 = p_2 = c$	$q_1 = q_2 = \frac{a-c}{3}$
$q_1 = q_2 = \frac{a-c}{2}$	$p = \frac{a+2c}{3}$
$\pi_1 = \pi_2 = 0$	$\pi_1 = \pi_2 = \frac{(a-c)^2}{9}$

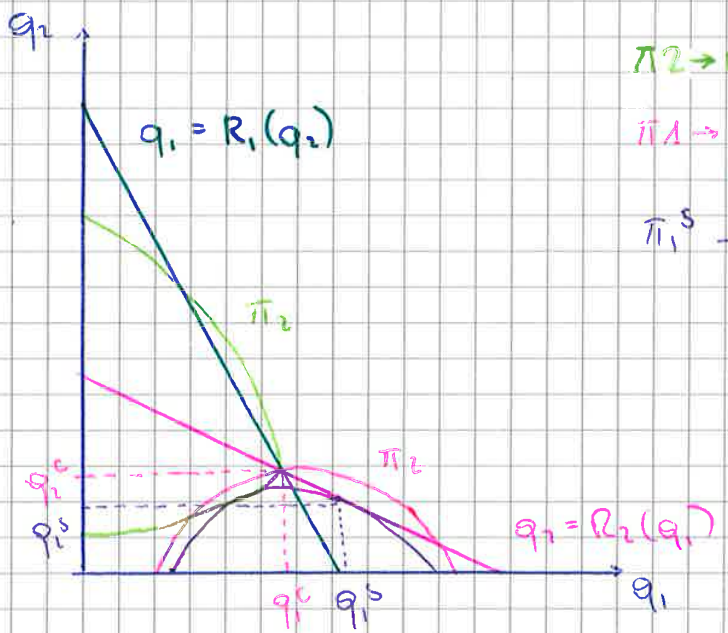
STACKELBERG GAME

- a weakness of Cournot / Bertrand model is that firms move simultaneously
- Stackelberg model → leadership → we have a "leader" competing with other firms ("followers") that wait the leader's decision before moving
- similar to Cournot model, but with a different sequence of moves
  - firm 1 is the leader and moves first → has the ability to commit to a level of output
  - firm 2 is the follower and moves after

1° stage: only leader moves

2° stage: only follower moves knowing the quantity chosen by the leader

- backward induction to find a SPNE: firm 1 foresees the firm 2's reaction and chooses q_1 to maximize π_1



$\pi 2$ → isoprofit curve

$\pi 1$ → isoprofit curve if firm 1 use Cournot model

π_1^s → firm 1 chooses the quantity to max π_1 (Stang)

↓

firm 1 sets $q_1 = q_2$ and so it produces a quantity above the Cournot one

GAME THEORY II

DYNAMIC GAMES and EXTENSIVE FORM REPRESENTATION

- a game is **dynamic** when the **actions** of the players are NOT undertaken simultaneously but within an **extended time span**
- **players move sequentially**. They might play more than once
- **perfect information** → when each player knows the history of the game
- dynamic games allow one to study the issues of
  - **commitment**
  - **credibility**: is a crucial in Industrial Organization
- the extensive form representation of a game is an **oriented graph with no loops**, composed of vertices (or nodes) which are connected by arcs (or lines or branches) → **game tree**

relevant information

1. n° and identity of players
2. ordering of the moves
3. choices available
4. information each player has
5. the payoff over all possible outcomes of the game (final nodes)

- **action** → what is associated with arcs
- every final node belongs to a specific **path** → order sequence of actions
- an **information set** is a group of nodes at which the player has common information about the history of the game and his available choices
- **singleton** → player's information of a single decision node

NORMAL and EXTENSIVE FORM REPRESENTATION

dynamic games have also the normal form representation

ex.

		P_2			
		(U,U)	(U,D)	(D,U)	(D,D)
P_1	U	5,2	5,2	1,0	1,0
	d	4,4	6,0	4,4	6,0

nash equilibrium? → (5,2) and (4,4)

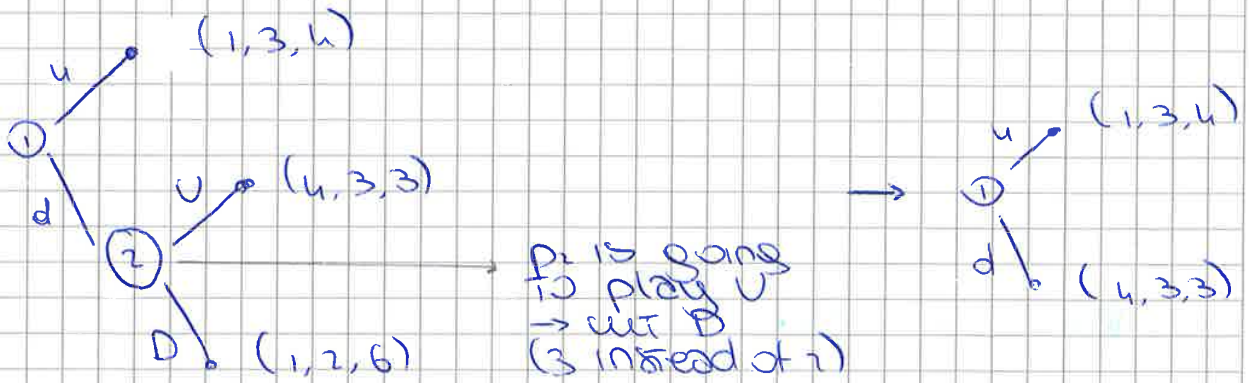
[U, (U,U)] and [d, (D,U)] → different in terms of RATIONALITY

↓

more rational because contains actions that are really in the interest of P_2

SUBGAMES

- a **subgame** is a game in extensive form is a **portion of the graph** such that
  - it starts from a singleton
  - all the nodes that can be reached from that singleton are included in the portion of the graph
  - if a node in particular information set is in the subgame, then all members of that information set belong to the subgame
- not all **Nash equilibria** in dynamic games are equally rational → contain **non-credible threats**
- **principle of sequential rationality** → requires that an equilibrium strategy must be rational for the corresponding player not only at the initial node, but also in every subgame
- **subgame perfect Nash Equilibrium (SPNE)** is a Nash Equilibrium which respects the principle



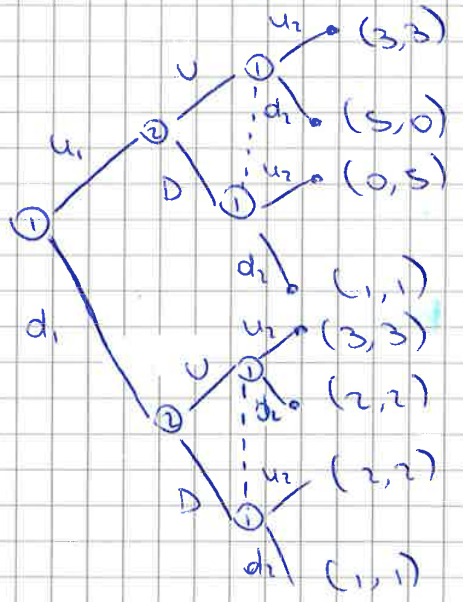
SPNE (d, U, D')

TWO-STAGE GAME (imperfect information)

- is a special case of dynamic games with imperfect information

P1 moves in stage 1

in stage 2, P1 and P2 move simultaneously, knowing the move of P1 in stage 1



3 subgames

we can use backward induction to find the SPNE

in an imperfect information setting, this requires to solve backward a sequence of static games corresponding to each subgame

If P1 plays u1

P1 \ P2	U	D
u2	3,3	0,5
d2	5,0	1,1

↳ nash eq. (d2, D)

If the stage game has a unique Nash Equilibria, then the SPNE of the stage game repeated T times (T finite) is simply the Nash Equilibria of the stage game in every game

The outcome in every subgame does not depend on the outcome of the previous stages

② Infinitely repeated games

- the game is a supergame and it is convenient to reinterpret the stages as time periods
- a discount factor δ to discount future payoffs → how much is worth today a dollar received in the next period
  - ↳ related to the discount rate r

$$\delta = \frac{1}{1+r} < 1$$

the higher r the less patient are the agents

- payoff in a supergame $V_i = \sum \delta^{t-1} \pi_i [a_i(t), a_{-i}(t)]$

δ^{t-1} → probability that the game is continued and also the preference over time

$\delta < 1$ → is equivalent to indefinite repetition

- To find SPNE of the supergame we cannot use backward induction since there is not an end of the game

↓

one SPNE is to play like in a finitely repeated game, the NE for the stage game in each period

- "Trigger strategy" → the past actions of the players can trigger a change in behaviour

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 57 di 116

- Schelling argued that four elements were required for your move or action to be strategic

1. sequential moves → you are able to move before the other players make their final moves
2. communication → the other players must be aware of your move or action before they move
3. affect incentives → your move must change your incentives or choices when it is your turn to move in the future. The move must change your optimal behaviour or choice in the future
4. rational expectations → as your move changes your incentives or choices, it must change what your rivals think is your optimal future course of action thereby affecting their behaviour and increasing your payoff

- strategic choices → change the behaviour because they create a commitment (of your opponent)
- tactical choices → you do but do not change the behaviour of your opponent
- strategic choices must occur prior to tactical choices
- strategic variables cannot be changed in the short run
- price and quantity are tactical decisions when prices can be changed quickly and changes in prices do not require significant sunk expenditures
- non-price decisions are strategic if they cannot be quickly changed and changes require significant sunk costs

ENTRY DETERRENCE

- the simplest model of entry deterrence is the Stackelberg game

If we substitute firm 2's best-response function into the profit function for firm 2, we will derive an expression that shows the maximum profits firm 2 can earn for any q_1

GET $\pi_2 = 0 \rightarrow$ find q_1'

$$\pi_2(q_2, q_1) = (a - bq_1 - bq_2)q_2 - cq_2 - f$$

$$R_2 = q_2$$

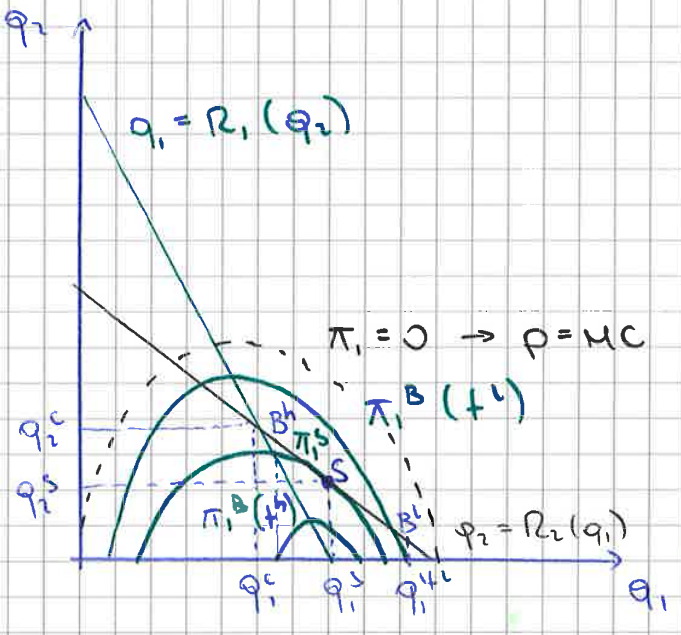
$$R_2 = \frac{a - bq_1 - c}{2b}$$

reaction function for firm 2 in order to find limit output

$$\pi_2^*(q_1) = \frac{(a - bq_1 - c)^2}{4b} - f \rightarrow \pi_2^* = 0$$

$$\boxed{q_1' = \frac{a - c - \sqrt{4bf}}{b}}$$

as f increases, the limit output decreases



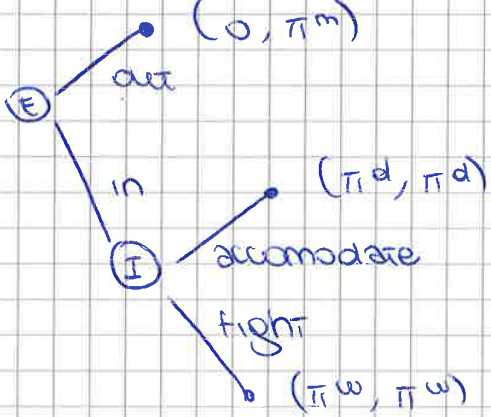
$0 < f^L < f^h$ fixed cost

in $B^L \rightarrow$ firm 2 does not find convenient anymore to produce a positive quantity $\rightarrow \pi_2 = 0 \rightarrow$ disinti-nuity on RF_2 that become equal to $\emptyset$

so in the case there are low fixed cost, the incumbent prefers to produce the stackelberg output although it allows the other firm to enter the market

ENTRY DETERRANCE

- we consider a game with two stages
  - 1° → the entrant decides to enter or not
  - 2° → in case of entry, the incumbent can fight or accomodate



$\pi^m > \pi^d > 0 > \pi^w$

π^m = monopoly

π^d = duopoly

π^w = from a price war (is negative)

2 nash equilibria

	in	out
acc.	(π^d, π^d)	$(\pi^m, 0)$
fight	(π^w, π^w)	$(\pi^m, 0)$

entry deterrance equilibrium is NOT subgame perfect!

$(0, \pi^m)$ → no credible because I will always choose π^d instead of 0

(π^d, π^d) → is my perfect equilibria SPNE (unique strategies) → entry deterrance is impossible

need of commitment → if the incumbent can invest (paying a sunk cost c) in the price warior to entry, it may be able to transform its threat of a price war into a commitment and credibly deter entry

- if either one of these inequalities does not hold → SPN equilibrium path is (passive, in, accomodate)

THEORY OF CONTESTABLE MARKETS

so far → incumbents may induce the behaviour of potential entrants

now → potential entrants may induce the behaviour of the incumbent?

- perfectly contestable market → is one where "entry is absolutely free and exit is absolutely costless"
- costless exit is possible because production entails no sunk costs (no loss of the investments)
- incumbent firms are vulnerable to the possibility of hit-and-run entry → possibility that firms outside the market enters, hit (they served the market and earn some profits) and then run → if their prices are such that a profitable entry opportunity exists given an expectation by the entrant of fixed incumbent's prices
- a necessary condition for an equilibrium is that an entrant that has access to the same technology cannot enter and earn economic profits → hit-and-run entry forces the incumbent to limit price
- threat of entry ensure that market power is constrained (economies of scale) or eliminated (constant or diseconomies of scale)
- the sufficient conditions are
  - all producers, actual and potential, have access to the same technology

- IT IS A SECOND BEST OPTIMUM, THE ONE A REGULATOR WOULD LIKE TO ACHIEVE
- BOTTOM LINE → IF THE MARKET IS PERFECTLY CONTESTABLE, THEN THE REGULATION IS USELESS

- THE IMPORTANT INSIGHT SUGGESTED BY THE THEORY IS THAT FIXED COSTS ARE NOT NECESSARY SUNK → WHEN THEY ARE NOT SUNK, THE ISSUE OF MARKET POWER IN MARKETS WITH FIXED COSTS NEED TO BE A CONCERN
- FIXED COSTS THAT ARE NON SUNK ARE NOT INCURRED IF THE FIRM SHUTS DOWN
- ANTITRUST AND REGULATION FOR HIGHLIGHTING THE ROLE OF POTENTIAL COMPETITION AS AN ALTERNATIVE TO ACTUAL COMPETITION AND FOR HIGHLIGHTING THE CRUCIAL DIFFERENCE BETWEEN FIXED AND SUNK COSTS

ENTRY BARRIERS (Bain, 1956)

- CONDITION OF ENTRY → IS "THE EXTENT TO WHICH, IN THE LONG RUN, ESTABLISHED FIRMS CAN ELEVATE THEIR SELLING PRICES ABOVE THE MINIMAL AVERAGE COSTS OF PRODUCTION AND DISTRIBUTION WITHOUT INDUCING POTENTIAL ENTRANTS TO ENTER THE INDUSTRY"
  - IS THE DIFFERENCE BETWEEN THE MINIMUM AVERAGE COSTS AND MARKET PRICE. IT REFLECTS THE EXTENT TO WHICH INCUMBENTS CAN RAISE PRICES AND EARN ECONOMIC PROFITS WITHOUT ATTRACTING ENTRY

- CONDITIONS OF ENTRY IS DETERMINED BY THREE FACTORS THAT CONTRIBUTES TO ENTRY BARRIERS
  - ECONOMIES OF SCALE
  - ABSOLUTE COST ADVANTAGES
  - PRODUCT DIFFERENTIATION

  } STRUCTURAL CHARACTERISTICS → DEPENDS ON THE BEHAVIOUR OF THE INCUMBENT

- such an advantage might arise because incumbents
  - have a proprietary technology which allow them to have lower costs, protected by a patent or trade secret
  - are owners of a superior input or have a monopoly on an input required for production
  - can acquire factors of production on more favourable terms, especially capital

- assuming homogeneous products, the incumbency advantage provided by a cost advantage and its implications for entry deterrance depends on whether competition post entry is Bertrand or Cournot
  - Cournot: marginal cost advantages ensure that post entry market shares will be asymmetric and make it easier for the incumbent to credibly commit to maintain output in the face of entry
  - Bertrand: then a cost advantage is crucial as the incumbent can price up to the average costs of entrant without worry of attracting entry even if there are no sunk costs associated with entry or economies of scale

3 product differentiation

- product differentiation is a competitive disadvantage for entrants if it leads to buyer preference for the established products (brand loyalty)
- to overcome this preference the entrant must bribe consumers to switch to its products by charging a lower price, add, higher quality

© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 69 di 116

- TO maximize profit → MR = MC

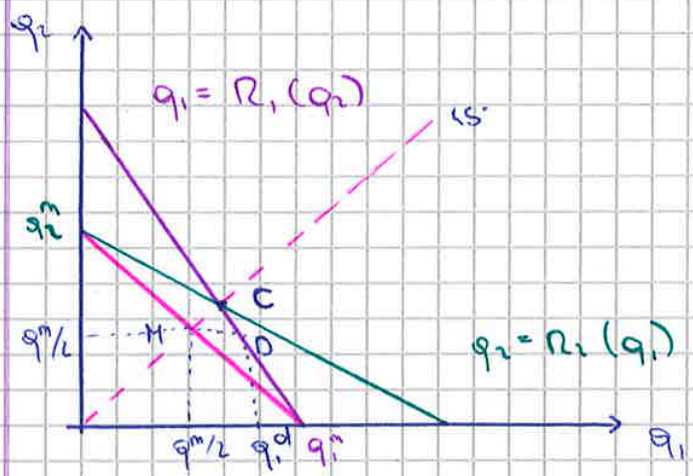
$$R' = C_i'(q_i)$$

- If marginal costs are different, those with higher (lower) marginal costs will produce less (more)

OLIGOPOLY JOINT PROFIT MAXIMIZATION

- The condition of equalized marginal costs also represents a way for maximizing aggregate (joint) profits in an oligopoly
- If marginal costs are equal, then the aggregate output is shared evenly among oligopolist
- With different marginal costs, the more (less) efficient oligopolist will produce more (less)
- Joint profit maximization could be achieved through
  - → explicit agreement → firms mutually devise a common plan of actions
  - → tacit agreement → firms coordinate their behaviour by observing or anticipating their rival behaviour

COURNOT VS COLLUSION



C = COURNOT POINT

M = POINT OF JOINT MAXIMIZATION (LINEAR COSTS)

REPEATED GAMES

- suppose a Cournot stage game repeated T times
- the collusive solution cannot be achieved if T is finite → the only SPNE is the Cournot solution of the stage game repeated T times

GRIM PUNISHMENT STRATEGY

- produce $q^M/2$ in the first stage
- in the following stages, produce $q^M/2$ if all the players always produced $q^M/2$ before, otherwise produce q^C

$$\frac{1}{1-\delta}\frac{\pi^M}{2} \geq \pi^D + \frac{\delta}{1-\delta}\pi^C$$

↳ Cournot

discount factor δ which makes this strategy a SPNE

$$\delta \geq 9/17$$

this equilibrium needs no explicit agreement

comparing behaving collusive forever with making defection today and then for the next period to have Cournot payoff (for the third period)

- minimum discount factor which sustains collusive equilibria

$$\bar{\delta} = \frac{\pi^d - \pi^M/2}{\pi^d - \pi^C}$$

collusive and defection profits depend on the collusive quantity

DETERMINANTS OF δ

- δ used by oligopolists to discount future profits depends on
  - the cost of capital → if it is convinient to make defalcation today → the higher cost of capital, the lower is δ
  - the growth / decreasE rate of the profits in the industry
  - the probability that the firm will be able to make profits in the future

FACTORS OF COLLUSION

- we can distinguish between legal and structural factors

① LEGAL

- effectiveness of ANTITRUST Policy → attack collusion because it is against social welfare

② STRUCTURAL

- n° of firms in the industry → the higher is the n° of firms the more difficult is collusion
- product differentiation → collusion is more likely with homogeneous products because price is relevant. With product differentiation the collusion is more difficult because firms should agree not only about price but also about adv, R&D, quality...
- uncertainty of demand → is difficult to predict correctly the demand and is difficult to interpret if there is deviation from the agreement

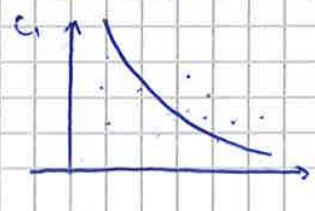
© Proprietà riservata dell'autore - Digitalizzazione e distribuzione a cura del CENTRO APPUNTI - Corso Luigi Einaudi, 55/B - Torino / Pagina 75 di 116

HORIZONTAL AND VERTICAL DIFFERENTIATION

- horizontal product differentiation → each product would be preferred by at least one consumer → consumers have different tastes, no unanimity
- vertical product differentiation → everybody would prefer one over the other product → different quality
- at equal prices
  - consumes do not agree on which product is the preferred one → products are horizontally differentiated
  - all consumers prefer one over the other product → products are vertically differentiated

TWO MODELLING APPROACHES (TO HORIZONTAL)

- product differentiation depends on consumers' preferences
- Two modelling approaches
  - non-address models: preferences are specified on goods → representative consumer approach: consumers are assumed to be identical and have a variable demand for all products (spence model)
  - address models: preferences are specified on the underline characteristics space → characteristics approach: consumers have heterogeneous preferences and choose only one product among the available products (HOTELLING model)



c1 and c2 are the 2 characteristics of a good → characteristics replace the standard utility function

where $\bar{a} = \frac{a}{b+d}$; $\bar{b} = \frac{b}{b^2-d^2}$; $\bar{d} = \frac{d}{b^2-d^2}$

- **maximization program** (c = cost)
  - → **Cournot** $\max_{q_i} (\bar{a} - b q_i - d q_j - c_i) q_i$
  - → **Bertrand** $\max_{p_i} (p_i - c_i)(\bar{a} - \bar{b} p_i + d \bar{p}_j)$

- **best response functions**
  - → **Cournot** $q_i = \frac{a - d q_j - c_i}{2b}$ — downward → strategic substitutes
  - → **Bertrand** $p_i = \frac{\bar{a} - \bar{d} p_j + \bar{b} c_i}{2\bar{b}}$ — upward → strategic complements

- **comparison of equilibria**

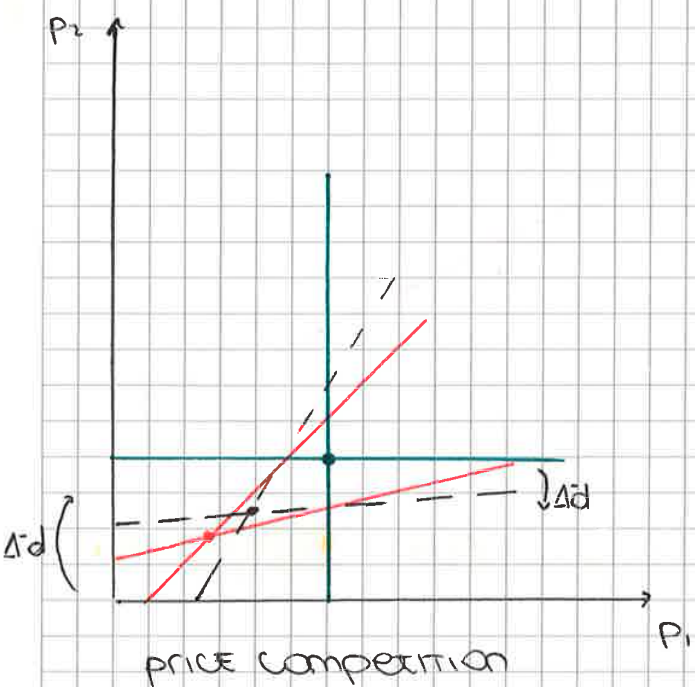
$p_i^C - p_i^B > 0$ and $\pi_i^C - \pi_i^B > 0$

↓

price as the strategic variable gives rise to a more competitive outcome than quantity as the strategic variable

- if $c = 0$
  - → **Cournot**
    $q_1^* = q_2^* = \frac{\bar{a}}{2b+d}$ → if $d=0$ is the monopolistic q_i, ↓ d ↑ product differentiation; ↑ market power
    $\pi_1^* = \pi_2^* = \frac{\bar{a}^2 b}{(2b+d)^2}$
    $p_1^* = p_2^* = \frac{\bar{a} b}{2b+d}$
  - → **Bertrand**
    $p_1^* = p_2^* = \frac{\bar{a}}{2\bar{b} - \bar{d}}$
    $q_1^* = q_2^* = \frac{\bar{a}\bar{b}}{2\bar{b} - \bar{d}}$

max monopolistic power and max level of product differen. when $d=0$



price competition

change of d: **BERTRAND**

bertrand equilibrum

↓ d → ↑ product differentiation

↓

monopolistic equilibrium

2 characteristics approach (HOTELLING)

- price competition with horizontally differentiated products
- firms may avoid intense competition by offering product that are imperfect substitutes
- **HOTELLING model**
  - 2 firms have to choose where to locate in a hypothetical linear city of lenght 1 and which price to set
  - consumers are uniformly located in the linear city and they buy only one of the 2 goods
  - consumers incur in a disutility from travelling to get the good
  - localization (distance) is the only relevant characteristics and price and distance will induce consumers to choose which good to consume
- disutility from travelling is linear in distance thraught τ

τ = parameter of product differentiation

- assume $r_2 + \tau > r_1$ → product 2 more attractive for some consumers

- **indifferent consumer**

$$\hat{x} = \frac{1}{2} + \frac{(r_1 - r_2) - (p_1 - p_2)}{2\tau} = q_1(p_1, p_2)$$

r_1 and r_2 → gross utility

- **demand for firm 2**

$$q_2 = 1 - \hat{x}$$

- firm 1 chooses p_1 to max $(p_1 - c)q_1$
- FOCs

$$\begin{cases} p_1^* = c + \tau + (r_1 - r_2)/3 \\ p_2^* = c + \tau - (r_1 - r_2)/3 \end{cases}$$

$$q_1^* = \frac{1}{3} + \frac{(r_1 - r_2)}{6\tau} > \frac{1}{2}$$

high-quality firm sets a higher price and sells more

© location game

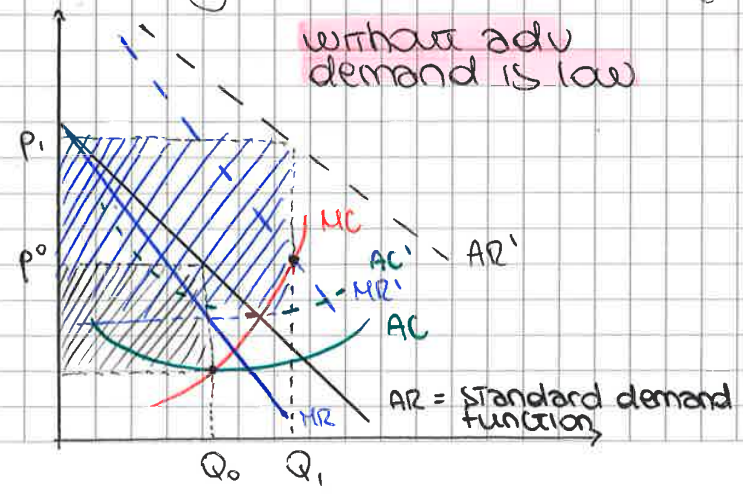
- suppose **constant price**: $\bar{p}$
- suppose **constant marginal cost** $c < \bar{p}$
- decision: how to position product (where to locate) in product space (in the linear city)
- **consumers**
  - mass 1 uniformly distributed on $[0, 1]$ location = ideal point in product space
  - buy at most one unit from one of the firms
  - **utility** $v_i(x) = r - \tau|x - l_i| - \bar{p}$
  - **indifferent consumer** $\hat{x} = (l_1 + l_2)/2$

ADVERTISING

- now the monopolist can advertise
- advertising is connected to market power
- persuasive view → emphasizes that advertising distorts consumer preferences and creates brand-loyalty, leading to anticompetitive effects
- informative view → emphasizes that advertising conveys information to consumers. Therefore, it can have pro-competitive effects
- economists try to think that the choice of individual has to be taken in a situation of incomplete information → advertising conveys to me some informations
- when you make a choice, you must be informed → if you are informed there are some cost for search informations → search costs: effort you are doing to try to get information about the existence, the quality and the price of the good

OPTIMAL CONDITION FOR A MONOPOLIST

- suppose a monopolist who
  - → does not discriminate
  - → knows how its quantity demanded depends on its price p and its advertising expenditures A
    $Q(p, A)$ with $\partial Q / \partial A > 0$
  - → advertising expenditures A are fixed cost and they do not affect marginal costs



Q^0, P^0 → equilibrium point without advertising

/// → profit Π_0

with adv → demand shifts to the right and the average cost curve moves upward

/// → profit Π_1 (increase)

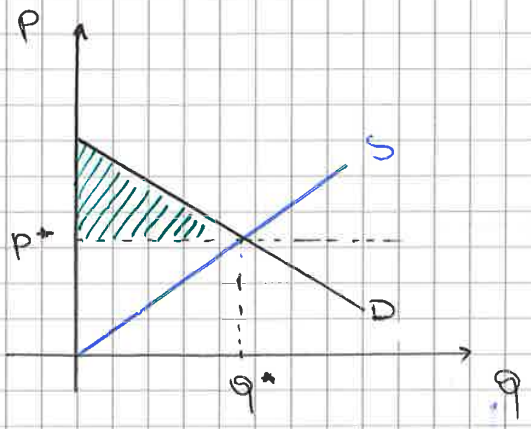
PRICE DISCRIMINATION & PRICING STRATEGY

CAPTURING CONSUMER SURPLUS

- demand curve → is a willingness-to-pay schedule
  the difference between the max willingness-to-pay and the price paid is consumer surplus

- price is a measure of the utility that the consumer gets from consumption

$$P_x = \frac{MU_x}{MU_y} P_y$$



/// = consumer surplus

the willingness to pay is getting lower and lower, the higher is the quantity

- all pricing strategies are means of capturing consumer surplus and transferring it to the producer
- profit max for a monopolist p*, q*
  - raising price some consumers will be lost, leading to lower profits
  - lowering price will gain some consumers, but lower profits
- if the monopolist is NOT force to charge a single price
  - charge higher price to the high willingness to pay
  - charge a lower price to people with the lower willingness to pay

  both actions will allow the firm to capture more consumer surplus

- incremental revenue is exactly the price at which each unit is sold
- additional profit from producing and selling an incremental unit is the difference between demand and marginal cost
- first-degree price discrimination increases social welfare compared to single pricing by the monopolist
- is almost never possible
  - impractical to charge every customer at a different price
  - firms usually do not know reservation price of each customer
  - preventing reselling is sometimes unfeasible

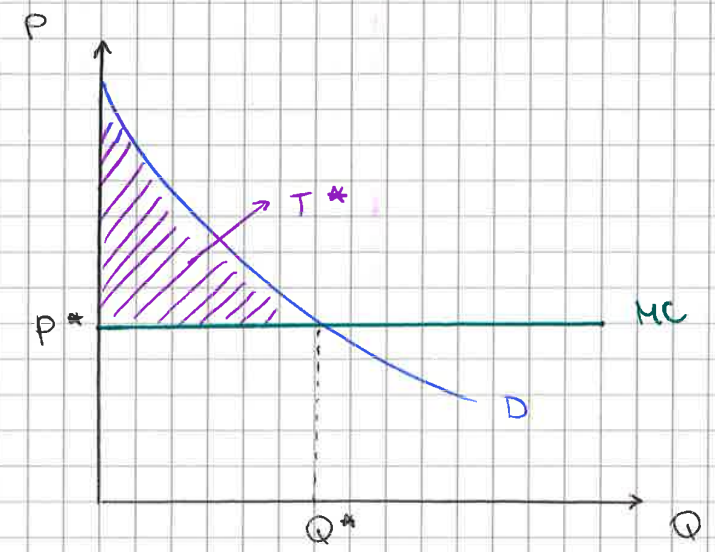
SECOND-DEGREE PRICE DISCRIMINATION

- unable to identify its consumers → it can offer a menu of choices to all consumers
  - by "self selecting"
- consumers purchase many units of good in a given time period → the same consumer is willing to pay different amounts depending on the quantity consumed
- is the practice of charging different prices per unit for different quantities of the same good → quantity discounts (non linear pricing)

block pricing

- consider the demand by one "typical" consumer purchasing different units of a good
- by block pricing → the firm sells the different "blocks" at a decreasing price
- social welfare is enhanced as both profits and consumer's surplus increase

1 single consumer



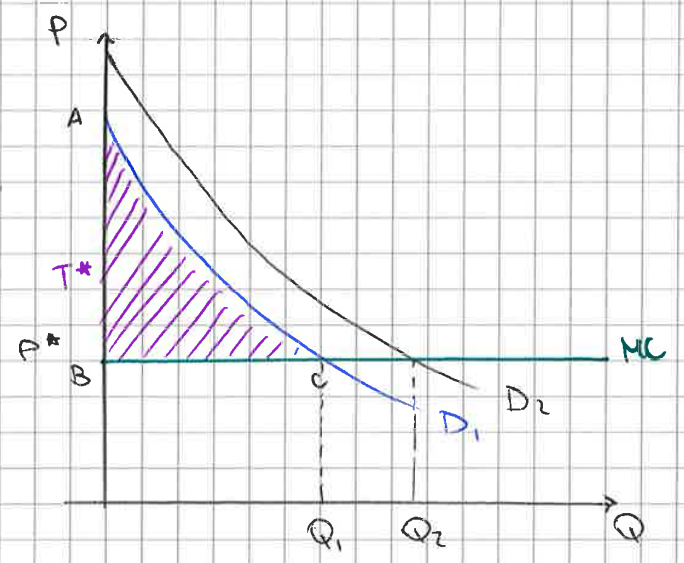
- usage price $P^* = MC$
- entry fee $T^* = CS$
- firm captures all consumer surplus as profit

P^* is the max price that the consumer is willing to pay for the quantity Q^*

- the imposition of an entry fee T^* and the usage price P^* is equivalent to a contract which allows the consumer to pay the amount $T^* + P^* Q^*$ and have the quantity Q^*, where Q^* is the quantity at which $P = MC$

- CS comes from the lower quantities that the consumer is willing to pay

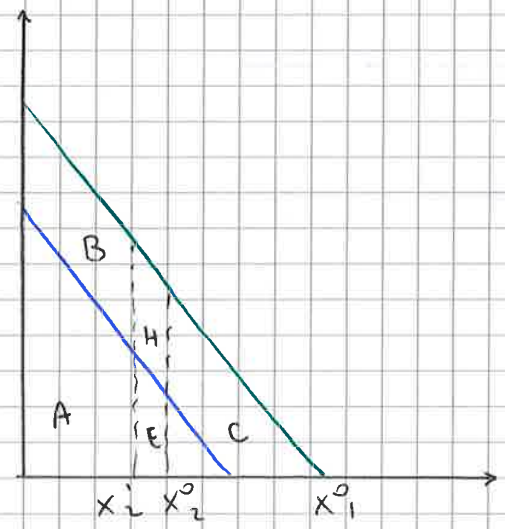
2 2 different consumers, same entry fee



- 2 consumers: high-demand and low-demand
- usage price $P^* = MC$
- max entry fee $T^* = ABC$ is such that the CS of the low-demand group is $\emptyset$

- this is not optimal two-part tariff → the firm is not capturing any surplus from the high-demand consumers

(b)

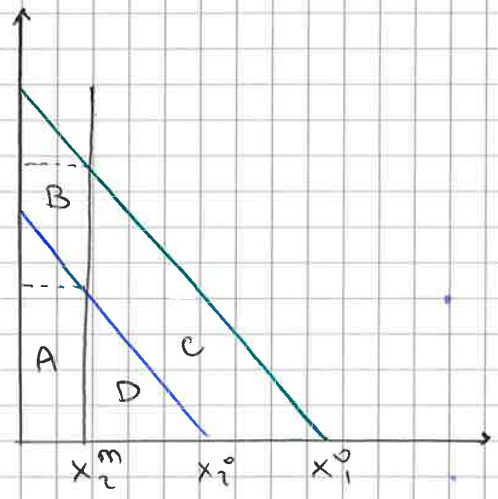


- The firm charges a little less for x_2^1, so that it can charge a higher amount for x_1^0
→ This decreases profits by E on type 2 and increases them by H + E on type 1

↓

net increase in profit = H

(c)



- continue reducing the amount offered to type 2 until the decrease in profits on type 2 just the equals the increase on type 1

D = DWL → units between x_2^m and x_2^0 that are not supplied to the low-demand consumer

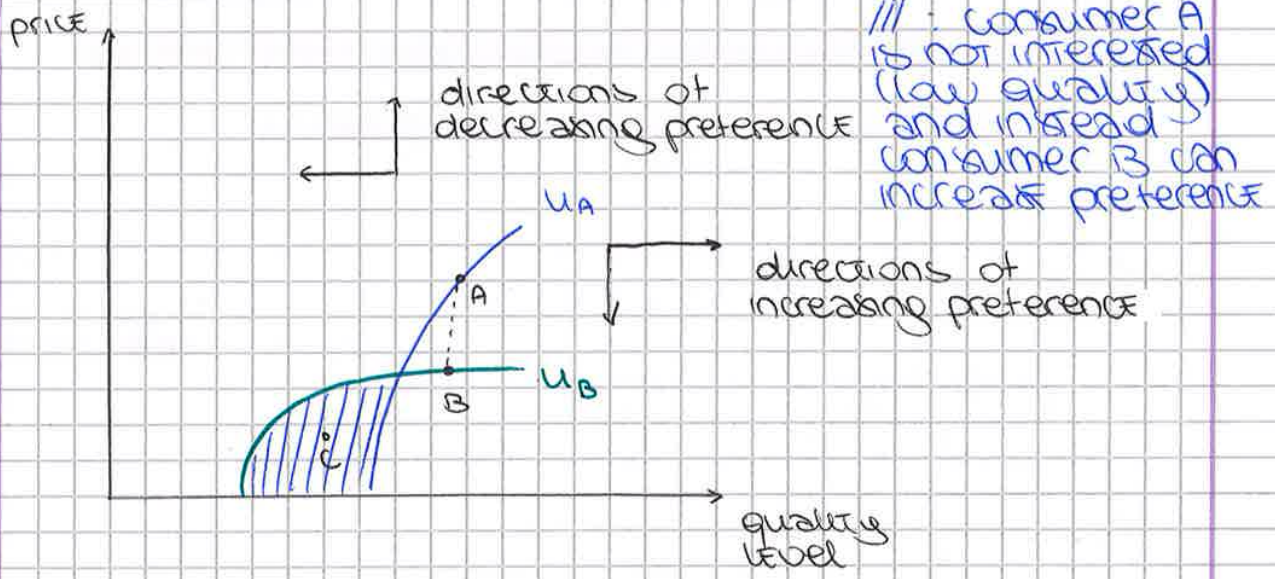
- charge A+D+C for x_1^0 and A for x_2^m → type 1 will either get a net surplus of B, type 2 a surplus of 0, and monopolists' profits will be maximized

- The idea is to reduce the CS increasing the firm profit managing the quantity and the surplus for the two packs

DA RIGUARD. 20/05

VERSIONING

- If a similar good is available at a lower price, rational consumers may decide to buy it even if they are not very price sensitive
- Least price-sensitive consumers tend to be more quality-sensitive



/// : consumer A is not interested (low quality) and instead consumer B can increase preference

u_A, u_B → independent choices

u_B → price-sensitive customers

u_A → quality-sensitive customers

- versioning → is the strategy of selling 2 or more versions of a product with different quality levels at a different prices
- reducing the quality of the lower-price offer, the firm makes it unattractive for less-price-sensitive consumers
- more price-sensitive consumers will be more tolerant to quality degradations
- Type of versioning → damaged good strategy → create a low-end version of the full-priced good by deliberately damaging the product

- the effectiveness of bundling depends upon the degree of negative correlation between the 2 demands
- mixed bundling → is the practice of selling 2 or more goods both as a package and individually
  - when there is not an high negative correlation, if you implement the pure bundling strategy you will be losing some people, people below the line of bundling
  - we use mixed strategy also when there are significant MC

TYING

- TYING → is the practice of requiring a customer to purchase one good in order to purchase another
- it allows firm to meter demand and practice price discrimination more effectively and to transfer monopoly power from one good to the other

EMPIRICAL ANALYSES

- y = life of the engine (expected life)
- average of the n engines → collect a sample

$$\bar{Y} = \frac{1}{n} \sum_{i=1}^{n} y_i$$

average is the estimation of the whole distribution, condense a vector of dimension n of information
↳ very sensitive to outliers

- test of hypotesis → state the hypotesis that the expected life $\mu = 200000$ Km