Topics and Lectures

A) Introduction

B) Competition and Monopoly

C) Technology and Cost; Industry Structure

D) Price Discrimination and Monopoly

E) Product Variety and Quality under Monopoly

1) Product variety
2) Product quality
3) Bundling & complementary products

F) Static Games

G) Dynamic Games, First and Second Movers

H) Horizontal Product Differentiation

I) Vertical Product Differentiation

J) Advertising

J) Research & Development

E) Introduction

- A monopolist can offer different varieties of a product
  - multiproduct firms
  - Examples: Procter & Gamble (Head & Shoulders)

⇒ Product differentiation:

⇒ *horizontal* product differentiation
  - consumers differ in their tastes
  - firm has to decide how best to serve different types of consumer
  - offer products with different *characteristics* but similar qualities

⇒ *vertical* product differentiation
  - products differ in quality
  - consumers have similar attitudes to quality: value high quality

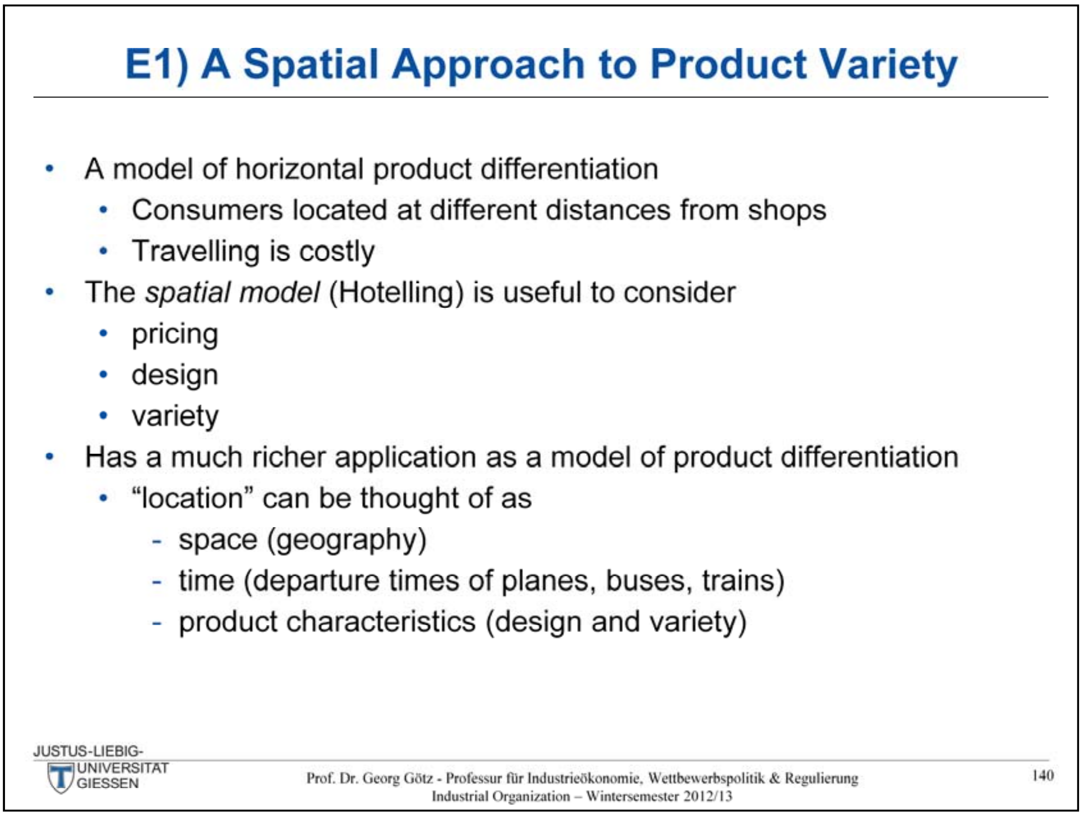
Examples: Kellogg‘s: breakfast cereals, Procter and Gamble: 12 different versions of Head &Shoulder Shampoo, Automobile producers Various types of BMW 1,3,5,7.

Hyperlink Harald Schmidt Show: rtsp://streamer2.streaming.szm.de/Sat1/schmidt/media//03/03/20/procter_56.rm

E) Introduction

- The "big" issues with product differentiation:
  - pricing
  - product variety: how many? Which qualities?
  - product bundling:
    - how to bundle
    - how to price
    - whether to tie the sales of one product to sales of another

    ⇒Next chapter
- Price discrimination



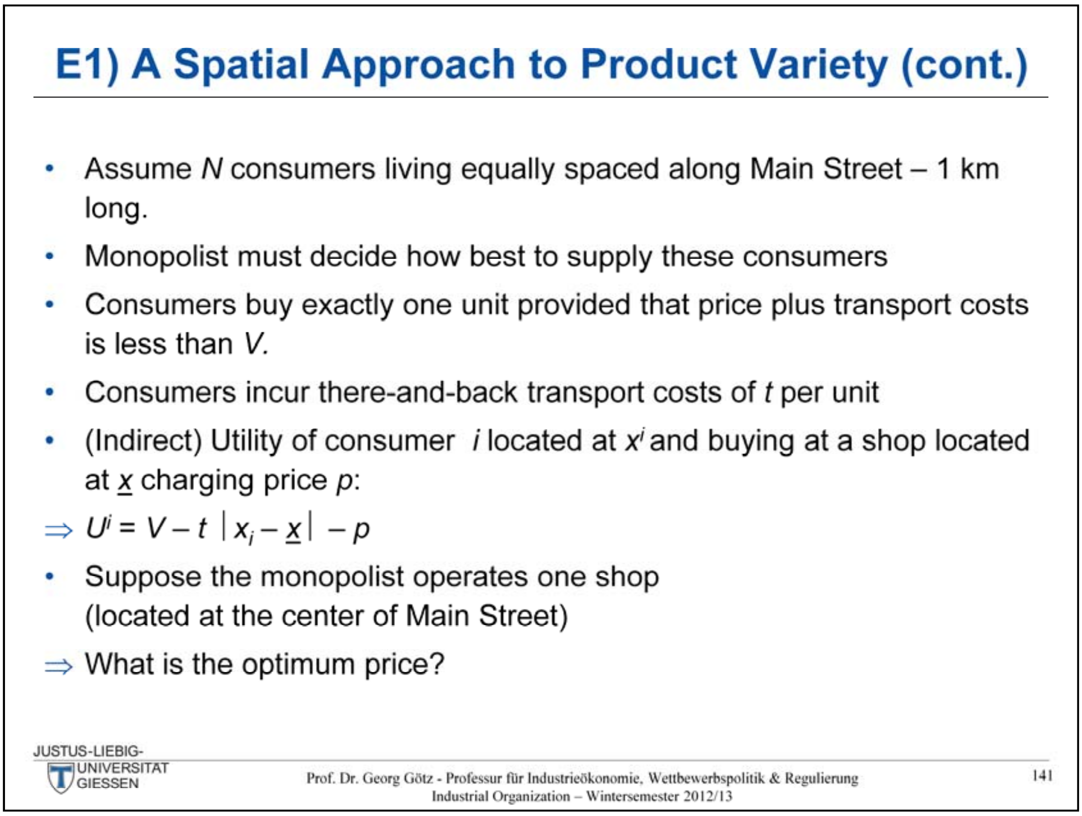
Pricing: Serving all potential customers or only part?

„Design": Where to locate?

Variety: How many shops? Shops save travelling/transport costs

Quote from Hotelling's 1929 paper:

"Distance, as we have used it for illustration, is only a figurative term for a great congeries of qualities. Instead of sellers of an identical commodity separated geographically we might have considered two competing cider merchants side by side, one selling a sweeter liquid than the other. If consumers of cider be thought of as varying by infinitesimal degrees in the sourness they desire, we have much the same situation as before. The measure of sourness now represents distance, while instead of transportation costs there are degrees of disutility resulting from the consumer getting cider more or less different from what he wants." (Harold Hotelling, EJ 1929, p. 54)



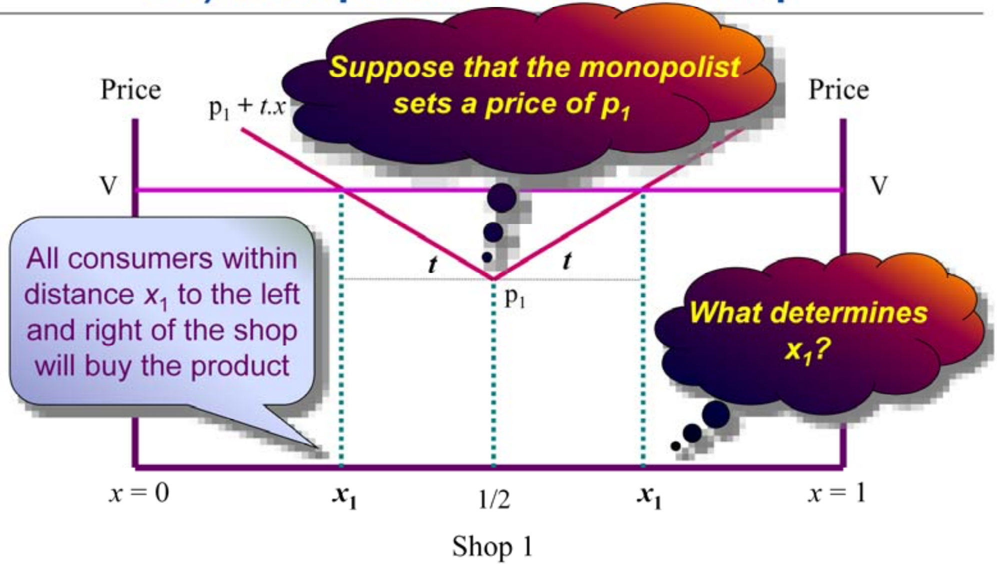
Assumption: Continuum of consumers => Distribution!

Reservation price: V

$|x_i - \underline{x}|$ distance from shop. On next slide denoted as x_1

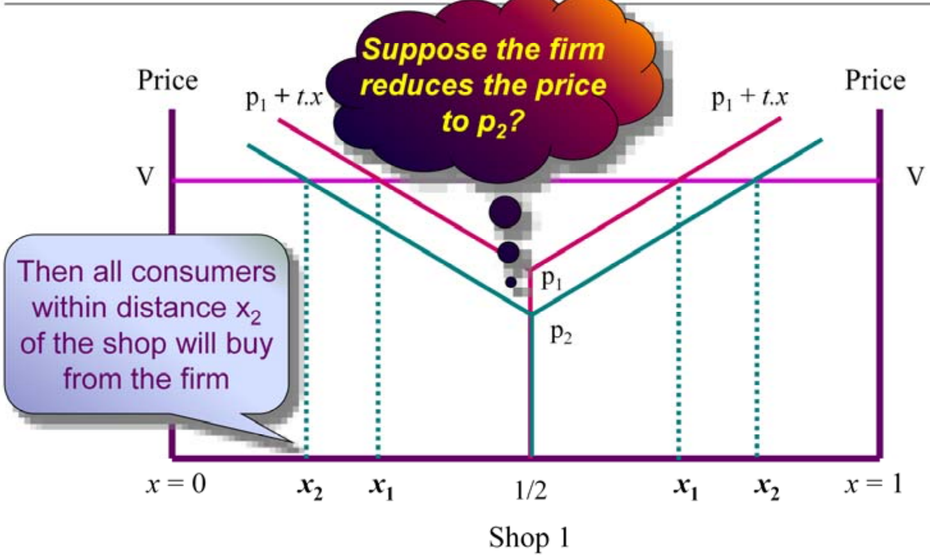
Why is it reasonable to expect that the location of the single shop is in the center? Higher prices possible if all consumers shall be served.

E1) The spatial model: One shop



$p_1 + t.x_1 = V$, so $x_1 = (V - p_1)/t$

E1) The spatial model



E1) The spatial model

- Suppose that all consumers are to be served at price p.
  - The highest price is that charged to the consumers at the ends of the market
  - Their transport costs are $t/2$: since they travel ½ km to the shop
  - So they pay $p + t/2$ which must be no greater than V.
  - *So* $p = V - t/2$.
- Suppose that marginal costs are c per unit.
- Suppose also that a shop has set-up costs of F.
- Then profit is $\pi(N, 1) = N(V - t/2 - c) - F$.

E1) Monopoly Pricing in the Spatial Model

- What if there are two shops?
- The monopolist will coordinate prices at the two shops
- With identical costs and symmetric locations, these prices will be equal: $p_1 = p_2 = p$
  - Where should they be located?
  - What is the optimal price p^*?

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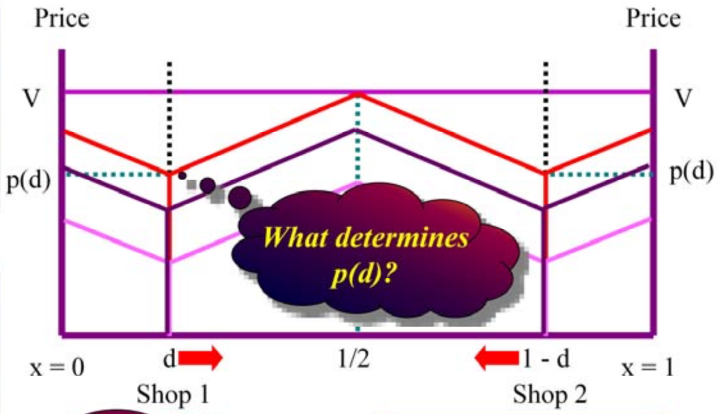
Recursive solution of the problem of how many shops to operate and where to locate them:

Solve first the pricing problem, then the location problem and finally decide how many to operate.

E1) Location with Two Shops

Suppose that the entire market is to be served

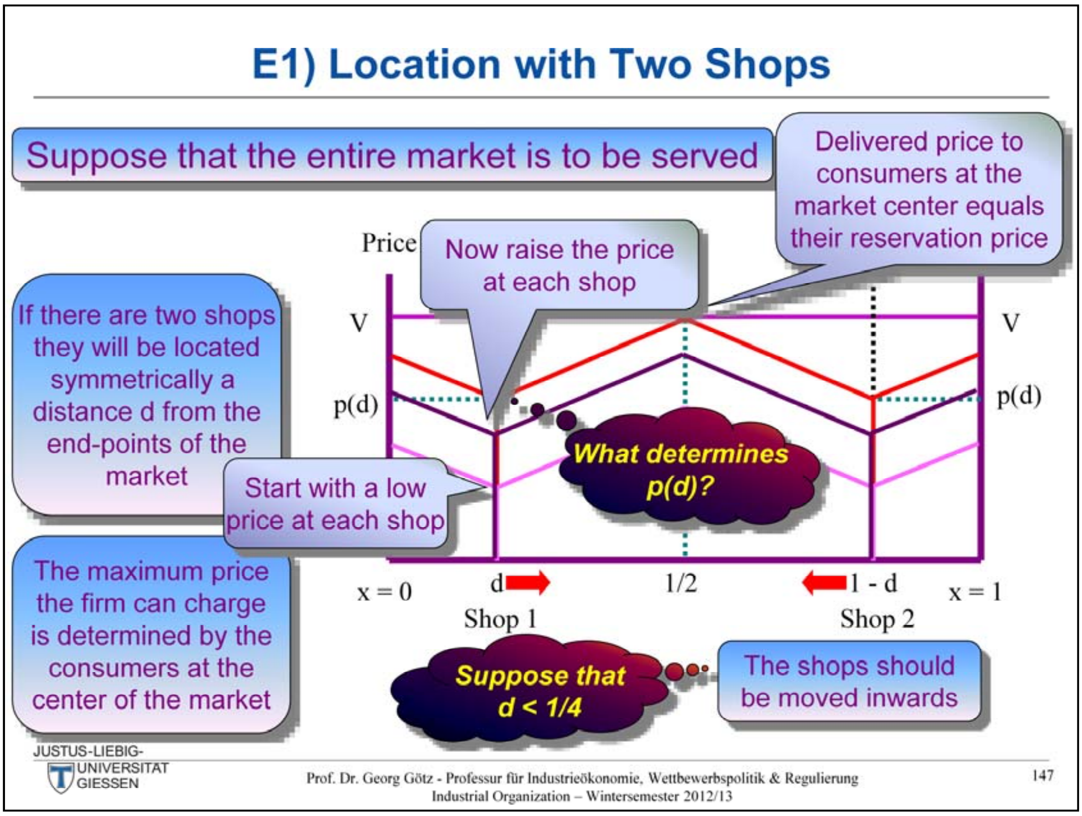
If there are two shops they will be located symmetrically a distance d from the end-points of the market



The maximum price the firm can charge is determined by the consumers at the center of the market

Suppose that d < 1/4

The shops should be moved inwards



Part not visible and not in preceding slide: Start with a low price at each shop

What determines p(d) => see next slide.

E1) Location with Two Shops (cont.)

Result for $d < 1/4$

We know that p(d) satisfies the following constraint:

$p(d) + t(1/2 - d) = V$

This gives: $p(d) = V - t/2 + t.d$

$\therefore\ p(d) = V - t/2 + t.d$

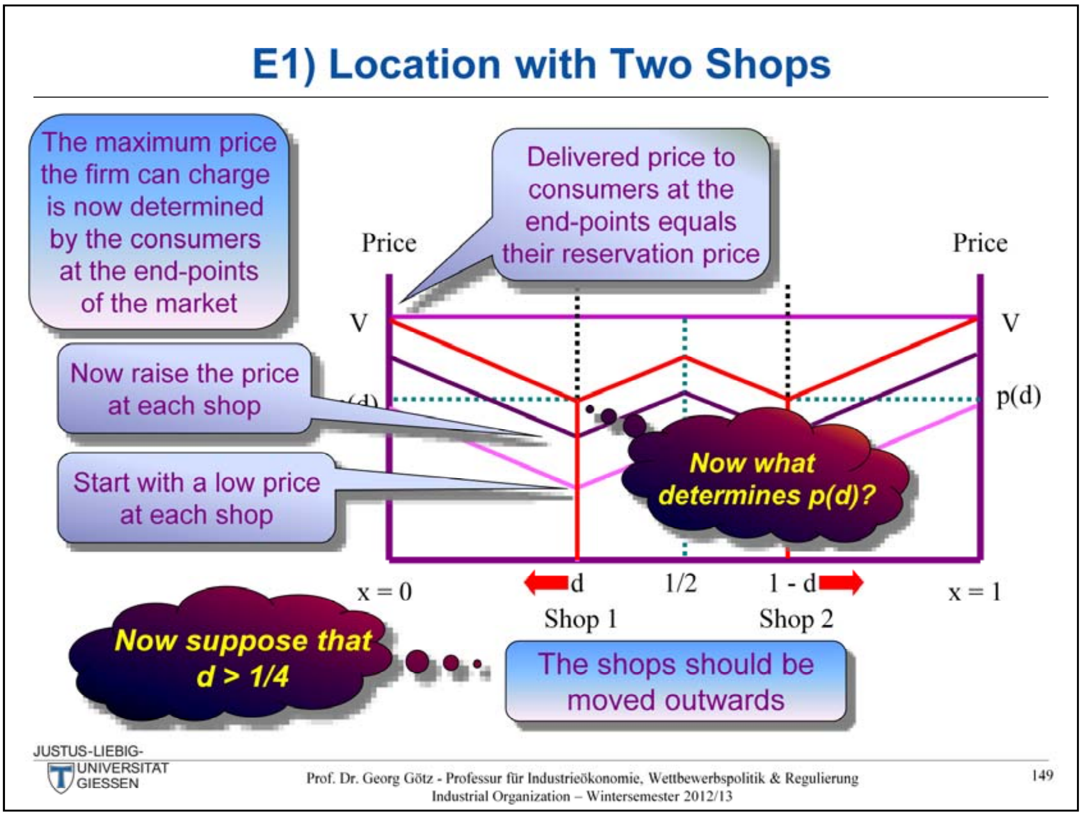
Aggregate profit is then: $\pi(d) = (p(d) - c)N$

$= (V - t/2 + t.d - c)N$

This is increasing in d so if d < ¼ then d should be increased.

Note: Profit function applies only if d<1/4!

The consumer located at the center is pivotal!



What determines p(d) => see next slide.

E1) Location with Two Shops (cont.)

Result for d > 1/4

We now know that p(d) satisfies the following constraint:
$p(d) + t.d = V$

This gives: $p(d) = V - t.d$

Aggregate profit is then: $\pi(d) = (p(d) - c)N$
$= (V - t.d - c)N$

This is decreasing in d so if d > ¼ then d should be decreased.

Aggregate profit in general terms:

$$\pi(d) = \begin{cases} (V - t/2 + t.d - c)N & \text{if } d < 1/4 \\ (V - t.d - c)N & \text{if } d > 1/4 \end{cases}$$

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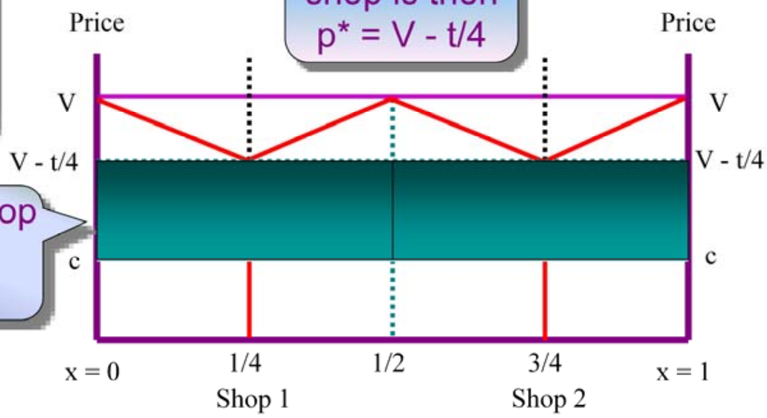
Profit function continuous but not differentiable.

Formal approach to derive optimum location: Differentiate with respect to d: profit an increasing and decreasing function, resp. of d depending on whether smaller or greater than ¼.

E1) Location with Two Shops

It follows that shop 1 should be located at 1/4 and shop 2 at 3/4

Price at each shop is then p* = V - t/4



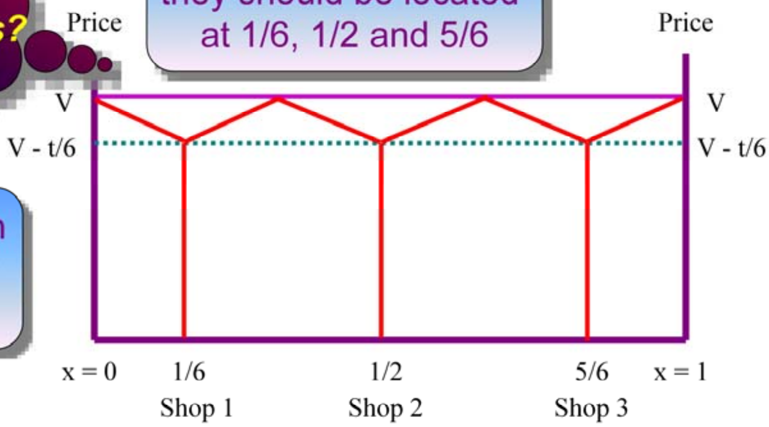
Profit at each shop is given by the shaded area

Profit is now π (N, 2) = N(V - t/4 - c) – 2F

E1) Three Shops

What if there are three shops?

By the same argument they should be located at 1/6, 1/2 and 5/6



Price at each shop is now V - t/6

Profit is now $\pi(N, 3) = N(V - t/6 - c) - 3F$

E1) Optimal Number of Shops

- A consistent pattern is emerging.
  Assume that there are n shops.
  They will be symmetrically located distance $1/n$ apart.

  The maximum distance a consumer has to travel is $1/(2n)$.

  Optimum locations are $1/(2n)$, $3/(2n)$, $5/(2n)$, …, $(2n-1)/(2n)$.

  We have already considered $n = 2$ and $n = 3$.

  When $n = 2$ we have $p(N, 2) = V - t/4$

  When $n = 3$ we have $p(N, 3) = V - t/6$

  It follows that $p(N, n) = V - t/(2n)$

  Aggregate profit is then $\pi(N, n) = N(V - t/(2n) - c) - nF$

How many shops should there be?

Remember: N: number of consumers!

Increasing the number of shops increases the price!

E1) Optimal number of shops (cont.)

Profit from n shops is $\pi(N, n) = (V - t/(2n) - c)N - nF$

and the profit from having $n + 1$ shops is:

$$\pi^*(N, n+1) = (V - t/(2(n+1)) - c)\,N - (n+1)F$$

Adding the $(n+1)$th shop is profitable if

$$\pi(N,n+1) - \pi(N,n) > 0$$

This requires $tN/(2n) - tN/(2(n+1)) > F$

(additional setup costs must be smaller than additional revenue accruing from price increase: costs vs. benefits of additional product variety!)

which requires that $n(n+1) < tN/(2F)$.

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Important: The condition of whether to add a shop is not the question whether this shop on its own breaks even! The point is that it „steals“ business from the other shops which is taken into account by the monopolist. Different from later case with oligopoly!

E1) An example

Suppose that F = \$50,000 , N = 5 million and t = \$1

Then t $N/(2F) = 50$

So we need $n(n + 1) < 50$. This gives $n = 6$

There should be no more than seven shops in this case: if $n = 6$ then adding one more shop is profitable.

But if $n = 7$ then adding another shop is unprofitable.

Check: Adding the $(n+1)$th shop is unprofitable if $\pi(N,n+1) - p(N,n) < 0$

which requires that $n(n + 1) > tN/(2F)$.

Notice: We must use the smallest/largest integer for which the conditions are just satisfied.

E1) Some Intuition

- What does the condition on n ($n(n + 1) < tN/(2F)$) tell us?
- Simply, we should expect to find greater product variety when:
- there are many consumers.
- set-up costs of increasing product variety are low.
- consumers have strong preferences over product characteristics and differ in these. (parameter t!)

Higher transport costs lead to a rapid fall in WTP with distance from optimal variety. Large reduction in price required to serve heterogeneous customers. => Better to add outlet.

E1) How Much of the Market to Supply

- Should the whole market be served?
  - Suppose not. Then each shop has a local monopoly
  - Each shop sells to consumers within distance r
  - How is r determined?
    - it must be that $p + tr = V$ so $r = (V – p)/t$
    - so total demand is $2N(V – p)/t$
    - profit to each shop is then $\pi = 2N(p – c)(V – p)/t – F$
    - differentiate with respect to p and set to zero:
    - $d\pi/dp = 2N(V – 2p + c)/t = 0$
  - So the optimal price at each shop is $p^* = (V + c)/2$
  - If all consumers are to be served then price is $p(N,n) = V – t/2n$
- Only part of the market should be served if $p(N,n) < p^*$
- *Increasing the price will increase profits. It is better not to serve the whole market!*

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Up to now: Assumption that the whole market is served, ie every consumer buys the product. But: Is this optimal?

If the calculation yields $p(N,n) > p^*$, the above optimization problem no longer applies since we have a corner solution then. Note that as soon as $p^* = p(N,n)$, the market is covered completely.

E1) How Much of the Market to Supply

- Condition on when it is optimal not to serve the whole market
  - $d\pi/dp = 2N(V - 2p + c)/t$
  - Evaluate derivative of the profit function at price $p(N,n) = V - t/2n$ (=> all consumers are served)

$$\left.\frac{d\pi}{dp}\right|_{p=V-\frac{t}{2n}} = \frac{2N}{t}\left(V - 2\left(V - \frac{t}{2n}\right) + c\right) \gtreqless 0$$

$$\left.\frac{d\pi}{dp}\right|_{p=V-\frac{t}{2n}} \gtreqless 0 \Leftrightarrow V \lesseqgtr c + \frac{t}{n}$$

- Only part of the market should be served if $p(N,n) < p^*$
- *Increasing the price will increase profits. It is better not to serve the whole market!*

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Up to now: Assumption that the whole market is served, ie every consumer buys the product. But: Is this optimal?

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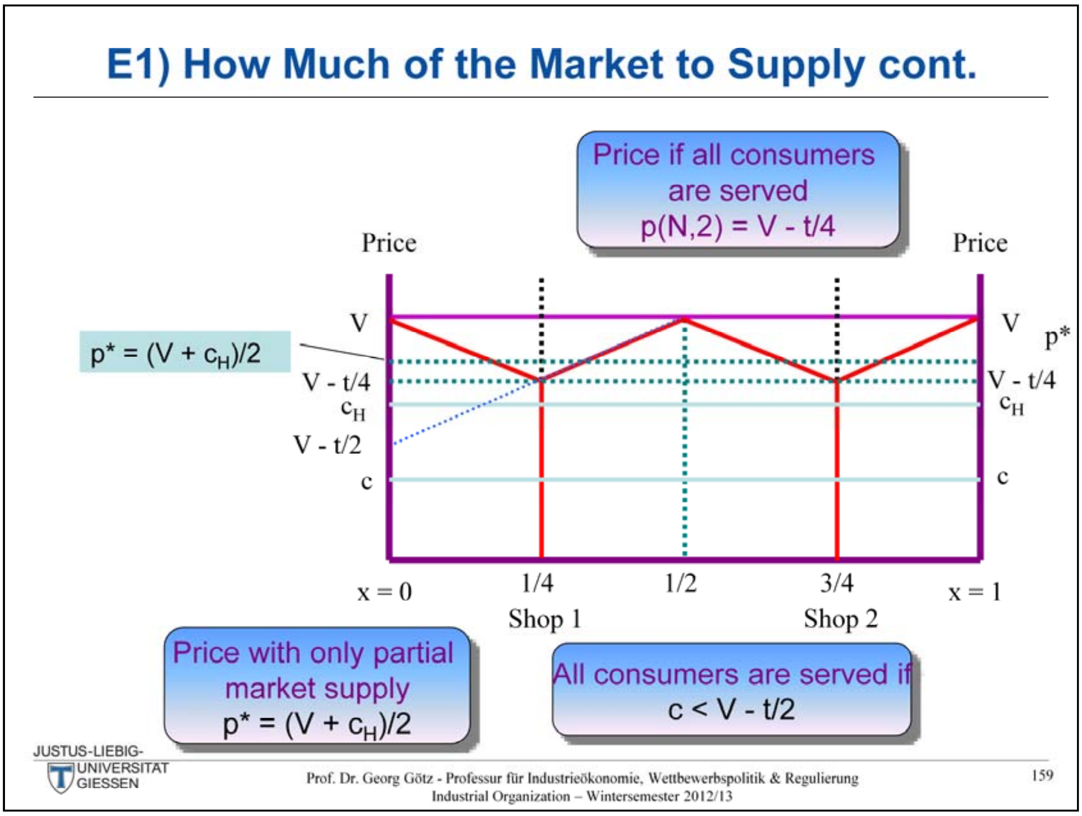


If marginal costs are high, it is better to serve only part of the market.

Price is standard monopoly price for linear demand function!

Derive the condition on c from the equation $p^* = (V + c_H)/2 == p(N,2) = V - t/4$.

E1) Partial Market Supply

- If $p(N,n) < p^*$ $\Leftrightarrow$ $c + t/n > V$ supply only part of the market and set price $p^* = (V + c)/2$
- If $c + t/n < V$ supply the whole market and set price $p(N,n) = V - t/2n$
- *Supply only part of the market:*
  - if the consumer reservation price is low relative to marginal production costs and transport costs
  - if there are very few outlets
    (Problem: Why not just add shops? Integer problem!)

Check: If the conditions would hold with equality, p^* and $p(N,n)$ coincide.

If the optimum number of outlets (setup costs vs. possible increase in prices!) is small anyway, adding an outlet if one moves to the scenario in which only part of the market is served, might lead to an overlap of market areas => Full coverage!

E1) Social Optimum

What number of shops maximizes total surplus?

Total surplus is consumer surplus plus profit

Consumer surplus is total willingness to pay minus total revenue

Profit is total revenue minus total cost

Total surplus is then total willingness to pay minus total costs

Total willingness to pay by consumers is *N V*

Total surplus is therefore *N V* - Total Cost

So what is Total Cost?

Are there too many shops or too few?

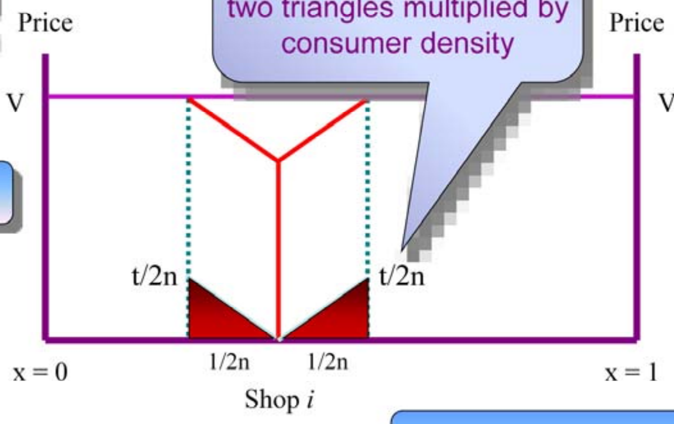
E1) Social optimum (cont.)

Assume that there are n shops

Consider shop *i*

Total cost is total transport cost plus set-up costs

Transport cost for each shop is the area of these two triangles multiplied by consumer density



This area is $t/4n^2$

E1) Social optimum (cont.)

Total cost with n shops is, therefore: $C(N,n) = n(t/4n^2)N + n.F$

$= tN/4n + n.F$

Total cost with $n + 1$ shops is: $C(N,n+1) = tN/4(n+1)+ (n+1).F$

Adding another shop is socially efficient if $C(N,n + 1) < C(N,n)$

This requires that $tN/4n - tN/4(n+1) > F$

which implies that $n(n + 1) < tN/4F$ ($< tN/(2F)$ = condition of monopolist)

The monopolist operates too many shops and, more generally, provides too much product variety

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Intuition for welfare result: Monopolist cares for profit, social welfare takes into account both profits and consumer surplus. If the monopolist establishes a new shop part of the profit gain is due to a simple redistribution from consumers, something which is not a gain in social welfare. Therefore the monopolist has a greater incentive to add shops than a social planner has!

If she adds a shop, she can increase prices for all consumers, not only for those whose transport costs decrease.

E1) Social optimum (cont.)

Total cost with n shops is, therefore: $C(N,n) = n(t/4n^2)N + n.F$

$= tN/4n + n.F$

Total cost with $n + 1$ shops is: $C(N,n+1) = tN/4(n+1) + (n+1).F$

Adding another shop is socially efficient if $C(N,n + 1) < C(N,n)$

This requires that $tN/4n - tN/4(n+1) > F$

which implies that $n(n + 1) < tN/4F$

If t = \$1, F = \$50,000, N = 5 million then this condition tells us that $n(n+1) < 25$

There should be five shops: with $n = 4$ adding another shop is efficient

The monopolist operates too many shops and, more generally, provides too much product variety

Remember: The monopolist operates 7 shops with these parameter values!

E1) Monopoly, Product Variety and Price Discrimination

- Suppose that the monopolist delivers the product.
  - then it is possible to *price discriminate*
- What pricing policy to adopt?
  - charge every consumer his reservation price V
  - the firm pays the transport costs
  - this is *uniform delivered pricing*
  - it is discriminatory because price does not reflect costs
- Should every consumer be supplied?
  - suppose that there are n shops evenly spaced on Main Street
  - cost to the most distant consumer is $c + t/2n$
  - supply this consumer so long as V (revenue) > $c + t/2n$
  - *This is a weaker condition than without price discrimination* ($c + t/n$).
  - *Price discrimination allows more consumers to be served.*

With price discrimination all consumers are served which have a willingness to pay which is greater than the costs to serve them (production plus transport costs)

E1) Price Discrimination and Product Variety

- How many shops should the monopolist operate now?

  Suppose that the monopolist has *n* shops and is supplying the entire market.

  Total revenue minus production costs is $N.V - N.c$

  Total transport costs plus set-up costs is $C(N, n) = tN/4n + n.F$

  So profit is $\pi(N,n) = N.V - N.c - C(N,n)$

  But then maximizing profit means minimizing $C(N, n)$

  The discriminating monopolist operates the socially optimal number of shops.

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Perfect price discrimination! Personalized prices!

Non-spatial examples: Cars: Sales person tries to find out „address“, ie, preferences.

Customizing of products: Transport costs not a utility loss, but an additional cost incurred by the firm in adapting ist product to customers‘ requirements.

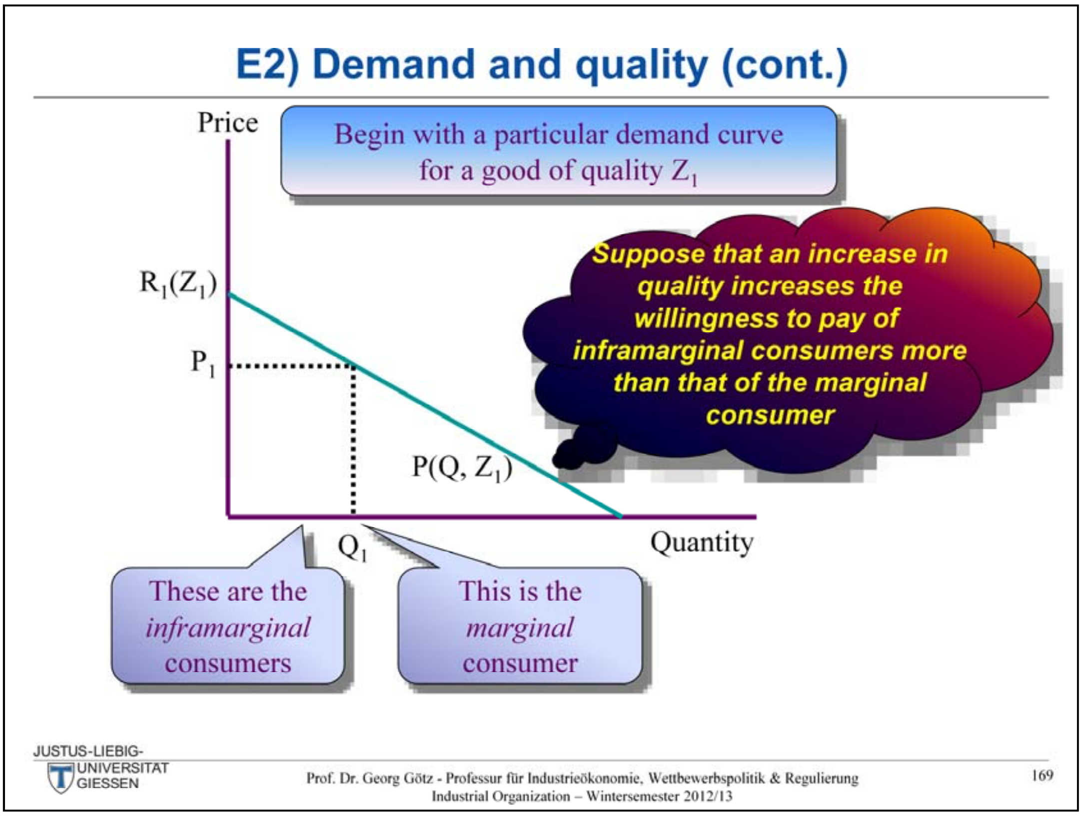
See examples in part on flexible manufacturing!

E2) Monopoly and Product Quality

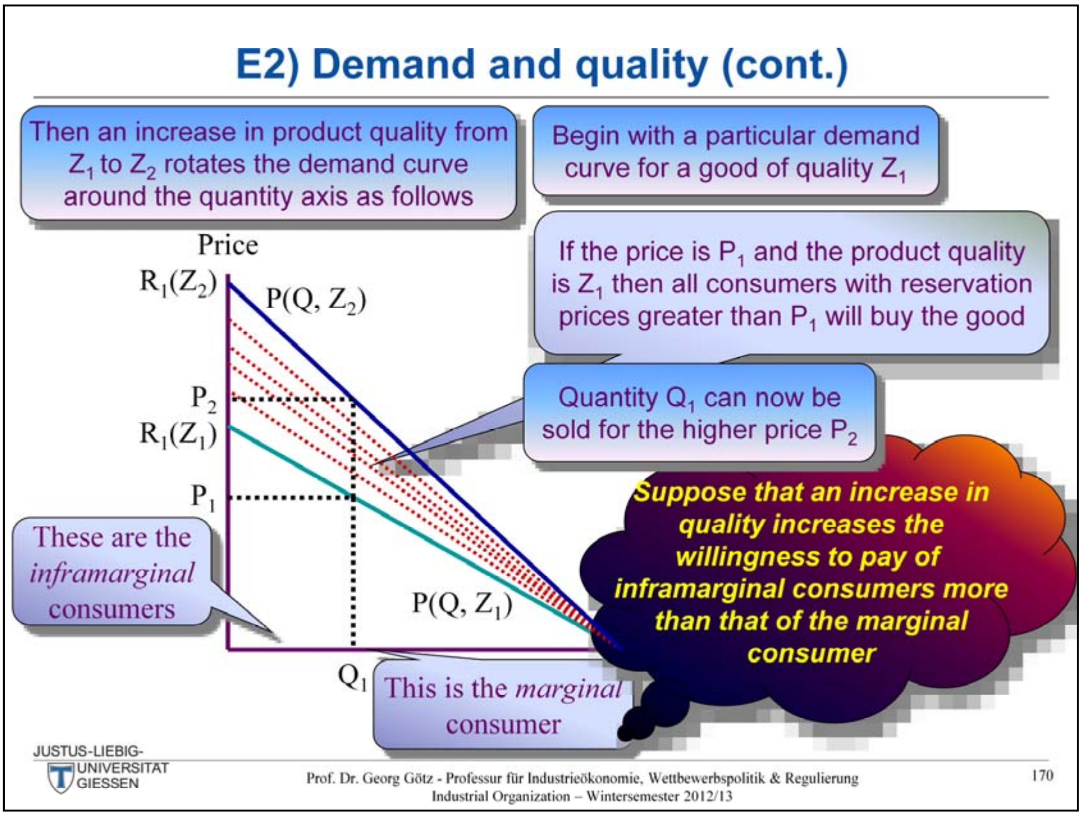
- Firms can, and do, produce goods of different qualities
- Quality then is an important strategic variable
- The choice of product quality by a monopolist is determined by its ability to generate profit
- Focus for the moment on a monopolist producing a single good
  - what quality should it have?
  - determined by consumer attitudes to quality
    - prefer high to low quality
    - willing to pay more for high quality
    - *but* this requires that the consumer recognizes quality
    - *also* some are willing to pay more than others for quality

E2) Demand and Quality

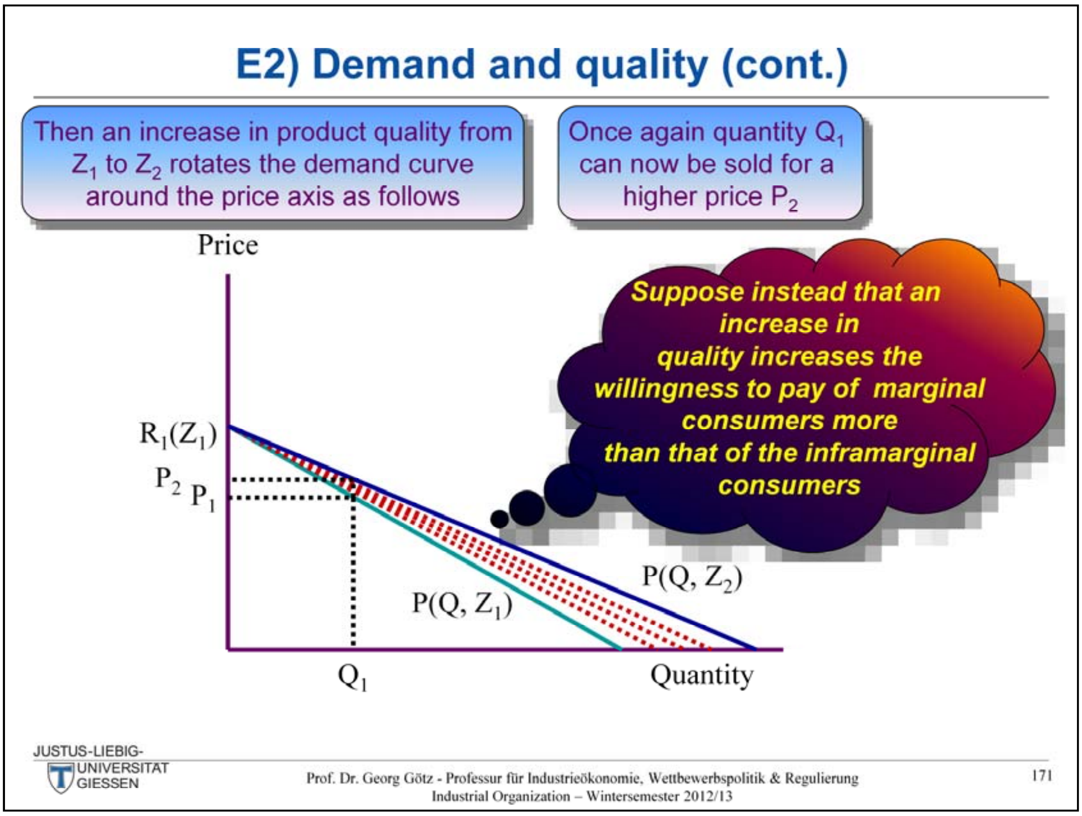
- We might think of individual demand as being of the form
  - $Q_i = 1$ if $P_i \leq R_i(Z)$ and $= 0$ otherwise for each consumer i
  - Each consumer *i* buys exactly one unit so long as price is less than her reservation price R_i
  - the reservation price is affected by product quality Z
- Assume that consumers vary in their reservation prices
- Then *aggregate demand* is of the form P = P(Q, Z)
- An increase in product quality increases demand



If the price is P_1 and the product quality is Z_1 then all consumers with reservation prices greater than P_1 will buy the good.
$R_1(Z_1)$: WTP of consumer one who has highest valuation of product.



Most cases in which quality matters to imply this pattern: Restaurants, newspapers, cars



Now: increase in quality increases the willingness to pay of marginal consumers more than that of the inframarginal consumers

Tirole's example: Concert hold distributing booklets with explanations and libretti: Poor people have a higher WTP, since they do not own or cannot afford separate books on music.

Distinction of the two scenarios will become important below!

E2) Demand and quality (cont.)

- The monopolist must choose *both* price (or quantity) and quality
- Two profit-maximizing rules
  - marginal revenue equals marginal cost on the last unit sold for a *given* quality
  - marginal revenue from increased quality equals marginal cost of increased quality for a *given* quantity
- This can be illustrated with a simple example:

  Inverse demand function: $P = Z(\theta - Q)$,
  where Z is an index of quality

  Note: This demand function results with a continuum of consumers *i* distributed over the interval $[0, \theta]$. The indirect utility function of consumer *i* is: $V_i = i\,Z – P$

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Demand function: θ is here both the market potential, ie the maximum quantity which can be sold in the market (at a zero price) and (together with Z) a determinant of the maximum WTP. If consumers have unit demand, the reservation prices of consumer i is (approximately (continuous rather than step function!)): $Z(\theta - i + 1)$. i ranges from 0 to θ)

Note the different valuations of quality can be interpreted as resulting from different levels of income!

Question for assignment: Derive the inverse demand curve from the utility functions! Hint: Note that for a given price all consumers buy for which $U \geq 0$. (The equality sign gives the so-called indifferent consumer.)

$V_i = 0 \Rightarrow i\,Z = P \Rightarrow i = P/Z$. Relation between consumer *i* and total output Q: $Q = \theta - i$.

E2) Demand and quality: an example

$P = Z(\theta - Q)$

Assume that marginal cost of *output* is zero: $MC(Q) = 0$

Cost of *quality* is $D(Z) = \alpha Z^2$

Marginal cost of quality $= dD(Z)/d(Z)$

$= 2\alpha Z$

This means that quality is costly and becomes increasingly costly

The firm's profit is:

$$\pi(Q, Z) = P.Q - D(Z) \quad = Z(\theta - Q)Q - \alpha Z^2$$

The firm chooses Q and Z to maximize profit.

Take the choice of quantity first: this is easiest.

Marginal revenue $= MR = Z\theta - 2ZQ$

$$MR = MC \Rightarrow \; Z\theta - 2ZQ = 0 \Rightarrow \; Q^* = \theta/2$$

$$\therefore \; P^* = Z\theta/2$$

Quality costs are fixed costs! Eg product design!

Optimum quantity is independent from quality in this example!! Changes in quality affect only price! That is: if monopolist prodcues higher quality she increases prices in a way that demand is unchanged.

E2) The example continued

Total revenue = P*Q* = $(Z\theta/2)x(\theta/2) = Z\theta^2/4$

So marginal revenue from increased quality is $MR(Z) = \theta^2/4$

Marginal cost of quality is $MC(Z) = 2\alpha Z$

Equating $MR(Z) = MC(Z)$ then gives $Z^* = \theta^2/8\alpha$

Does the monopolist produce too high or too low quality?

Deriving the marginal valuation of the social planner for quality (given quantity *Q*): Differentiate gross consumer surplus (GCS) wrt quality and set equal to marginal cost of quality.

$GCS = Q\,Z\,\theta - Z\,Q^2/2$

$\Rightarrow dGCS/dZ = Q\ \theta - Q^2/2\ = 3\,\theta^2/8 > MR(Z) = \theta^2/4$ => Planner chooses higher quality than monopolist

$Q = Q^* = \theta/2$

Is it possible that quality is too high?

Only in particular constrained circumstances.

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Problem of the monopolist: Here : Optimization in two step:

1. Optimum quantity given quality.
2. Substitute optimum quantity (as a function of quality) in profit function and calculate optimum quality.

Alternative approach: Differentiate profit function from above w.r.t. both quality and quantity.

$\Rightarrow$ Two equations (=foc) in two unknowns=> solve!

Problem of social planner:

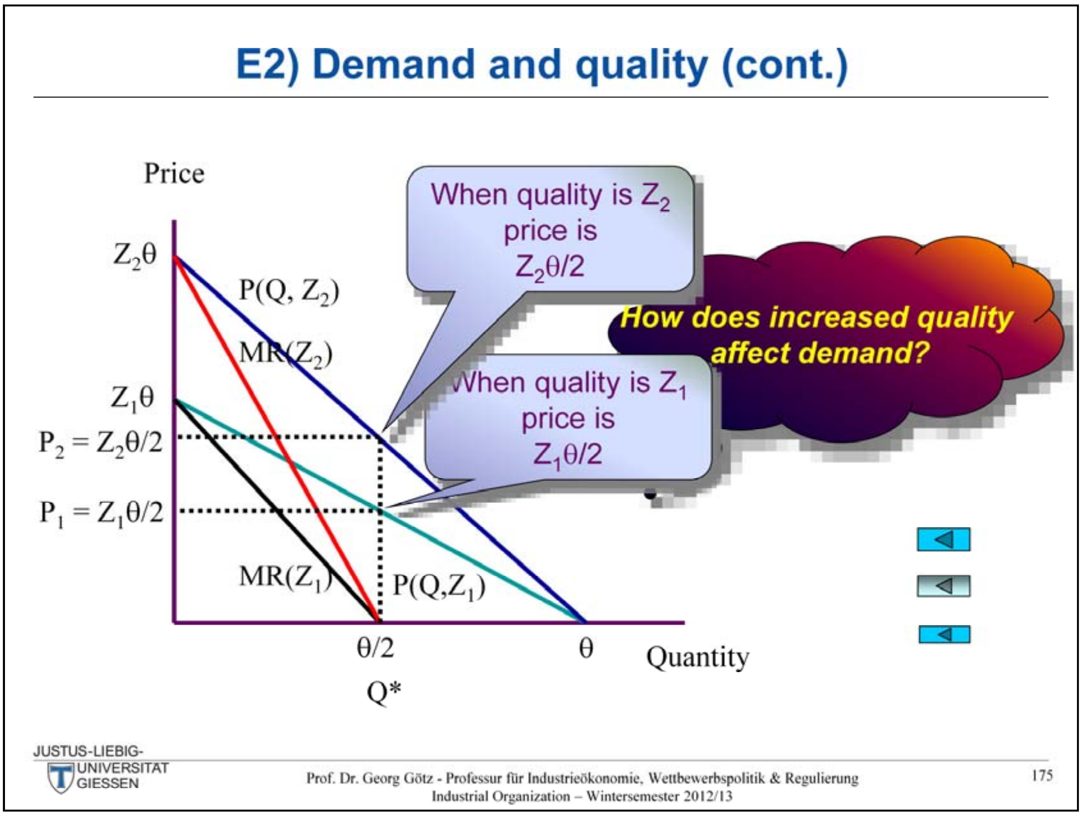
General: Max consumer surplus + profit and choose both price and quantity.

Here: Given quantity!

Note: (net) consumer surplus + profit = gross consumer surplus – costs

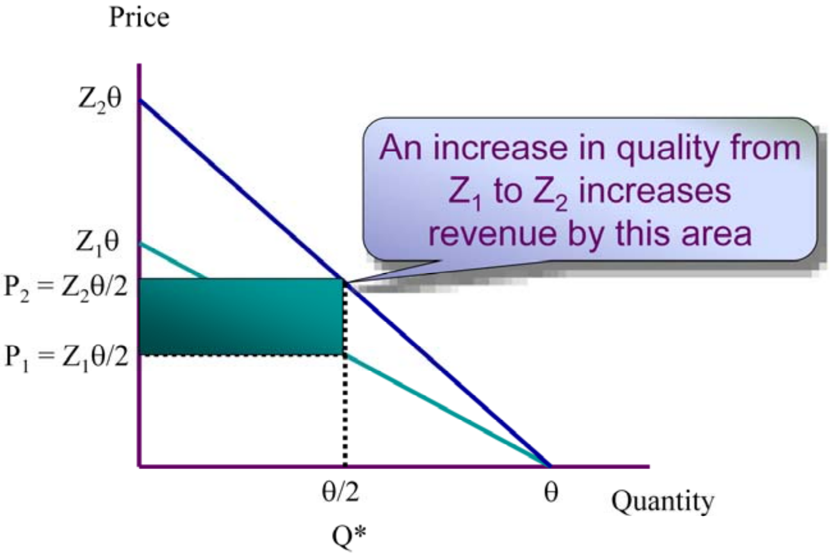
Note: If planner chooses both quality and quantity, quantity is of course equal to θ (price = MC = 0!).

Optimum quality in this case is $\theta^2/4\alpha$, which is greater than at the smaller quantity ($Z = 3\theta^2/16\alpha$)

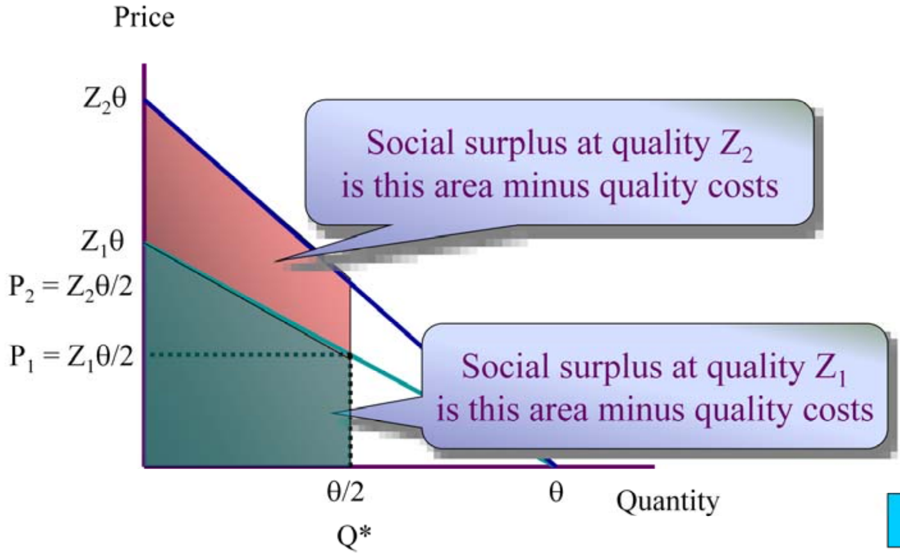


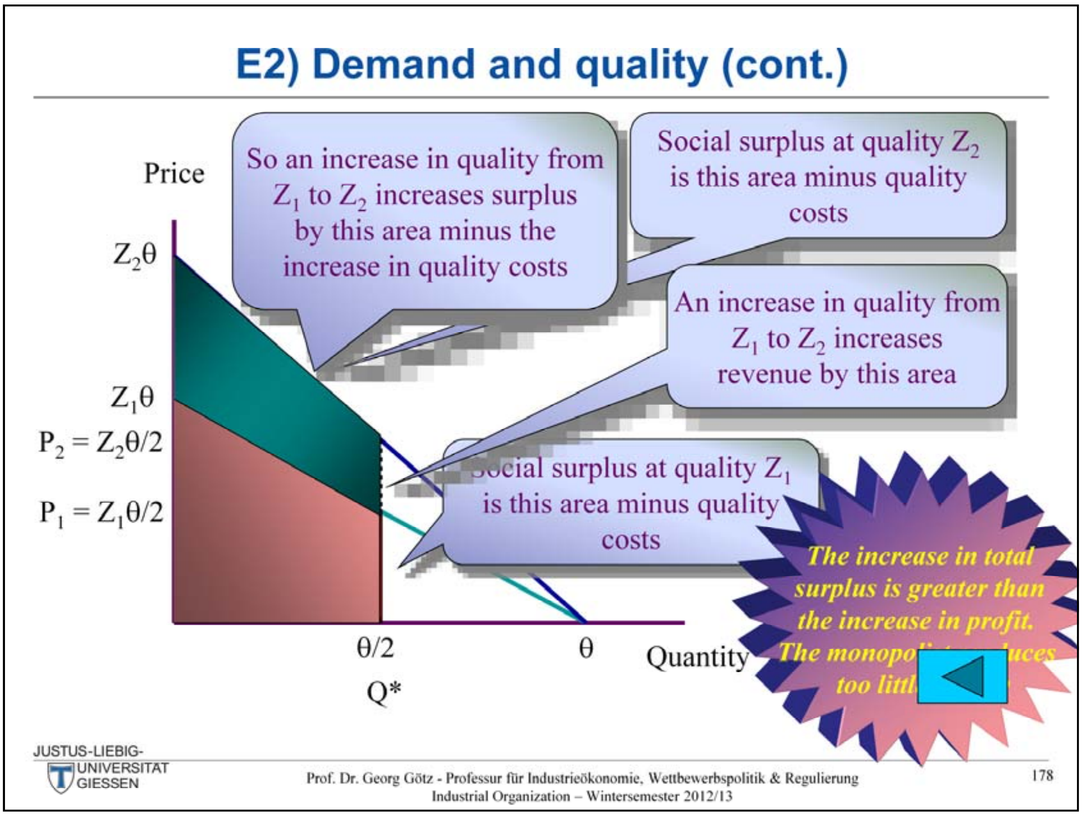
Not visible part: ***How does increased quality affect demand?***

E2) Demand and quality (cont.)



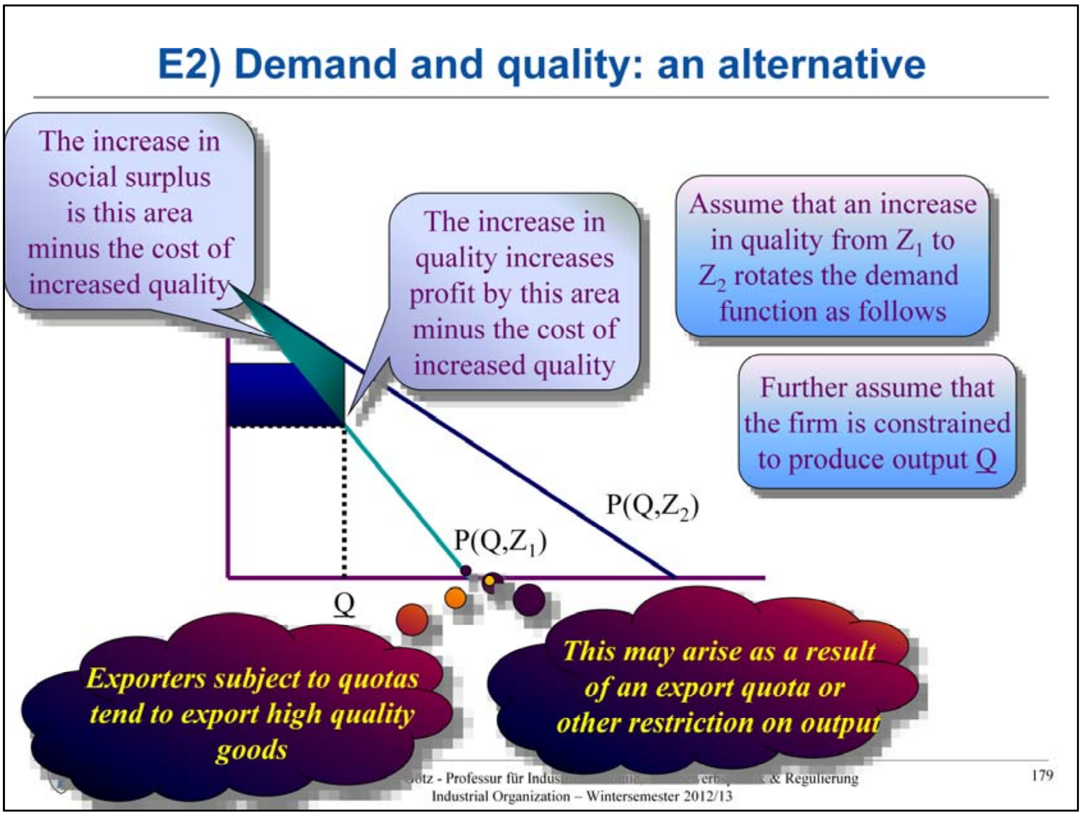
E2) Demand and quality (cont.)



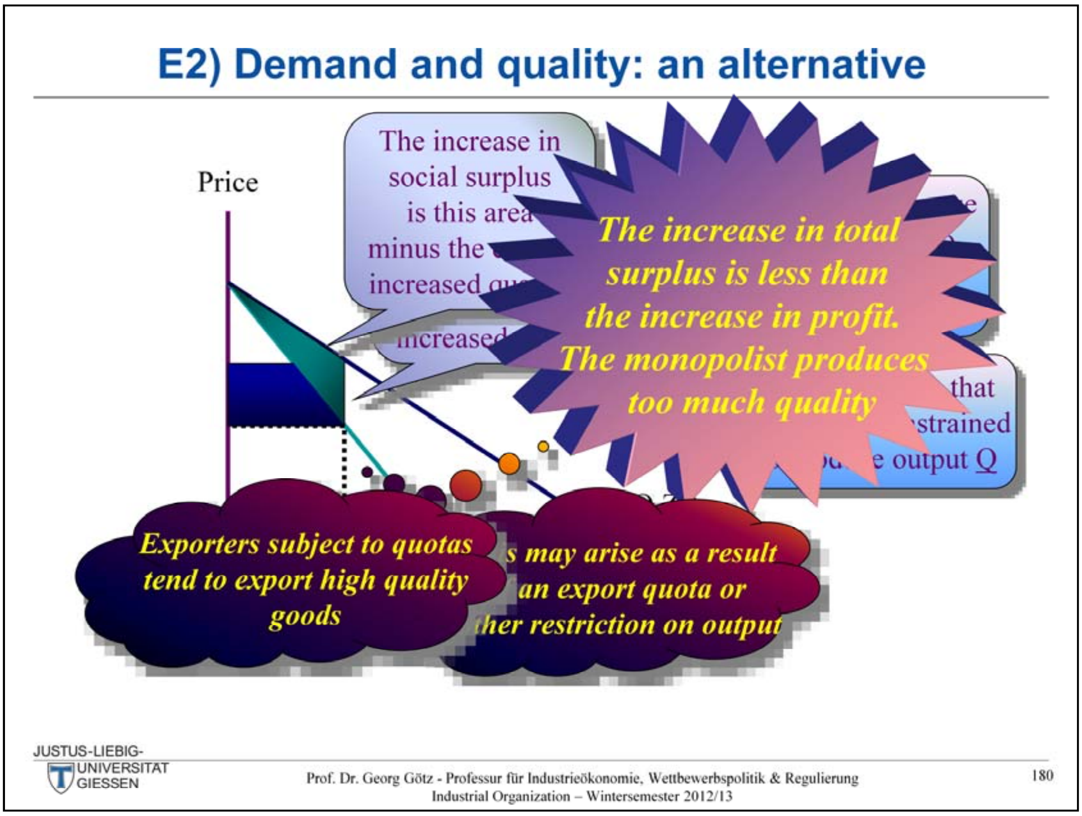


Intuition: The monopolist equates marginal revenue wrt quality with marginal costs of quality. But marginal revenue depends on the marginal quality valuation of the marginal consumer. The social planner takes into account the quality valuation of all consumers, therefore the marginal valuations of inframarginal consumers determine the quality choice.

Simpler: Monopolist incentive to provide qualit< depends on the marginal WTP (for quality) of the marginal consumer, the social planners incentive depends on the marginal WTP (for quality) of the average consumer. The social planner takes into account that the inframarginal consumers gain more from the quality increase than the marginal consumer. The monopolist cannot appropriate these gains, therefore, they are irrelevant to her decision.



Here: marginal valuation of quality of inframarginal consumers below the respective value of marginal consumer => Quality too high!



Here: marginal valuation of quality of inframarginal consumers below the respective value of marginal consumer => Quality too high!

The example given by PRN is not completely convincing. Why should the shape of the demand function be related to the existence of a quantity restriction.

Example, in which „poor people“ might care more for a quality increase: sub-compact cars: second car for „rich“ people, but primary car for poors? Toyotas?

See Problem in Assignment 3.

E2) Vertical product differentiation: Offering more than one quality

- Simple model of vertical product differentiation
- Monopolist sells two quality differentiated products to two types of consumers (with unit demand)
- Indirect utility of consumer type *i*
- $V_i = \theta_i (z - \underline{z}_i) - p \qquad (i = 1,2).$
- $\theta_1 > \theta_2$: Consumers' valuations of quality
- $\underline{z}_i$: lower bound on quality (minimum quality)
- $\underline{z}_1 > \underline{z}_2 = 0$. Marginal costs are 0 for both qualities!
- N_1 and N_2: Number of consumers of each type
- Solution procedure similar to that of second degree price discrimination: incentive compatibility constraint, etc.
- Difference in results: If *many* high valuation types: offer both products, otherwise offer only high quality product.

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Choose high quality always as high as possible (if choice is not costly): Assumption here: Qualities can be chosen from interval $[0,\bar{z}]$. Quality is costless.

Cannibalization of revenue from high quality product if additional product is offered. If many high valuation type consumers exist: Sell high quality at high price (highest price compatible with buying (participation constraint!), and serve low valuation consumers with low quality product (at price that satisfies incentive compatibility constraint of high valuation type.) High price for high quality can be reached by choosing a rather low level of quality for the low quality good.

Assignment: Problem 4, PRN, p. 160. => Further explanations then!

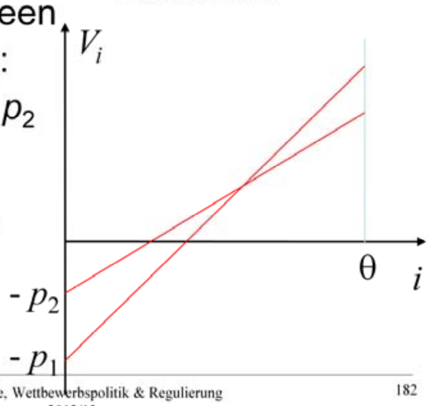
E2) Vertical product differentiation: Two qualities and many consumer types

- Two qualities z_k, $k = 1,2$. $z_1 > z_2$
- Marginal (constant) production costs: $c_1 > c_2$
- Indirect utility of consumer i buying quality z_k at price p_k
  $V_i^k = i\, z_k - p_k$, $\quad i \in [0, \theta]$.
- Consumer i who is indifferent between buying z_1 and z_2 if sold at p_1 and p_2:
  $V_i^1 = V_i^2 \quad \Leftrightarrow \quad i\, z_1 - p_1 = i\, z_2 - p_2$

$\Rightarrow \quad i = (p_1 - p_2) / (z_1 - z_2)$

$\Rightarrow$ Demand for high quality: $q_1 = \theta - i$

Illustration



Same setup as in the single quality case!

If $p_2 / z_2 = p_1 / z_1 \Rightarrow i = \underline{i}$

E2) Vertical product differentiation: Two qualities and many consumer types

- Consumer $\underline{i}$ with lowest valuation who buys a product (low quality) (Participation constraint):
  $V_{\underline{i}}^{2} = 0 \quad \Leftrightarrow \quad \underline{i} = p_2 / z_2$
- Demand for low quality product positive if its quality adjusted price is lower than that of high quality product, i.e. $p_2 / z_2 < p_1 / z_1$

$\Rightarrow$ Demand for low quality: $q_2 = i - \underline{i}$

- Profit function:

$$\Pi(p_1, p_2) = \underbrace{\left(\theta - \frac{p_1 - p_2}{z_1 - z_2}\right)}_{q_1}(p_1 - c_1) + \underbrace{\left(\frac{p_1 - p_2}{z_1 - z_2} - \frac{p_2}{z_2}\right)}_{q_2}(p_2 - c_2)$$

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Interpretation of quality adjusted price eg durability, performance (razor blades, batteries):

E2) Vertical product differentiation: Two qualities and many consumer types

- Solving the profit maximization problem (differentiating wrt prices) yields

$\Rightarrow$ $p_1 = ½\,(c_1 + z_1\,\theta),\;\; p_2 = ½\,(c_2 + z_2\,\theta)$

$\Rightarrow$ $i = ½\,\theta + ½\,(c_1 - c_2) / (z_1 - z_2)$

$\Rightarrow$ $\underline{i} = ½\,\theta + c_2 / (2\,z_2)$

$\Rightarrow$ $\underline{i} < i$ only if $c_2 / z_2 < c_1 / z_1$

$\Rightarrow$ Monopolist offers low quality product if its quality adjusted production costs are lower than those of high quality product.

$\Rightarrow$ Social planner uses the same decision rule

$\Rightarrow$ Endogenization of quality choice z_1 and z_2: production costs must increase more than proportionally with quality in order for low quality product to be offered.

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Prices as in single quality case!

Endogenization: Example:

Assume $c_1=a\,z_1+c\,z_1^2/2$;

$z_2=1$; „base product“

$c_2=a\,z_2+c\,z_2^2/2$;

Fixed costs of providing quality:

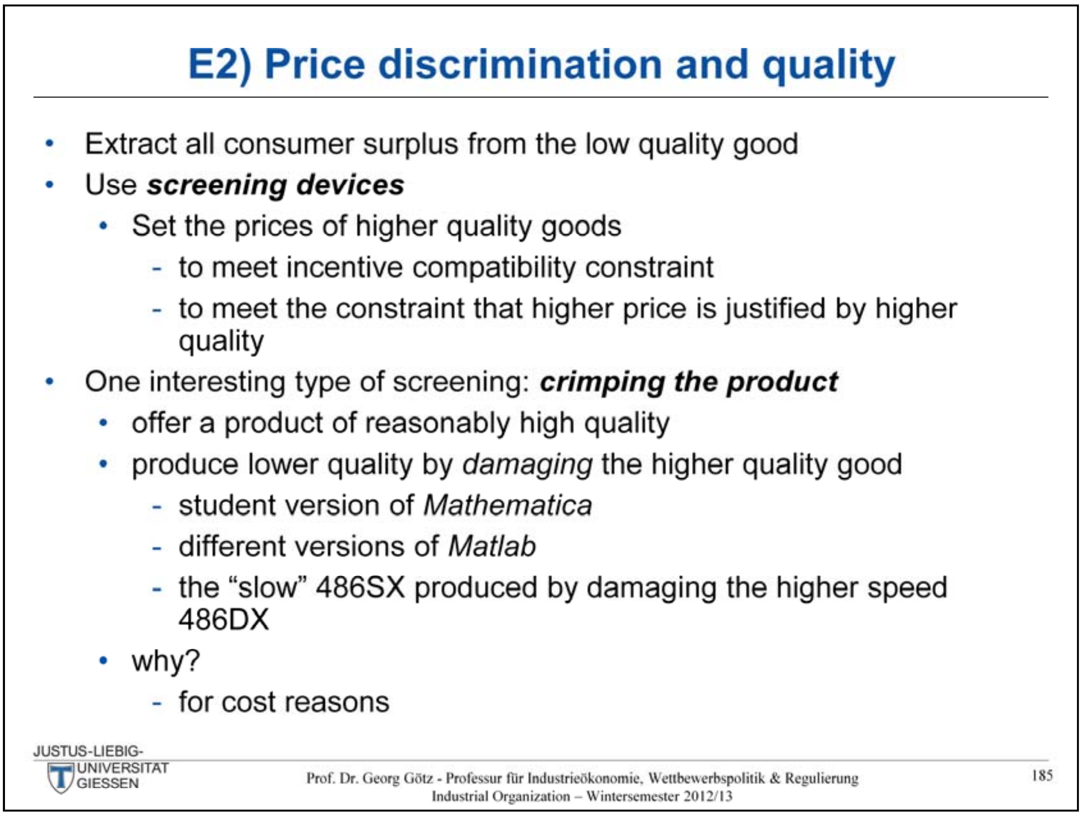
$b\,(z_1-z_2)^2/2$

Base product is freely available!

Solution: a can be zero => no problem. If parameter c is zero and a positive, only the high quality product is produced! In this case (production) costs would increase proportionally with quality!

R&D interpretation: Introduction of new product with higher quality: Start with base product and an R&D technology which leads to R&D costs of $b\,(z_1-z_2)^2/2$ for producing quality level z_1.

1. Under what conditions will the base product be driven out of the market and when not? Discussion of parameters a and c!
2. What are the respective quality levels? Quality level of high quality product (slightly) lower if only one product is offered. (Comparing apples and pears?)



Same points as we had above in the section on price discrimination!

The crimping example requires identification of different groups, ie. A different distribution of consumer types than in the preceding example.

Note that marginal production costs are roughly equal in the examples (but: support!).

E3) Bundling

- Firms sell goods as bundles
  - selling two or more goods in a single package
  - complete stereo systems
  - fixed-price meals in restaurants
- Firms also use tie-in sales: less restrictive than bundling
  - tie the sale of one good to the purchase of another
  - computer printers and printer cartridges
  - constraining the use of spare parts
- Why?
- Because it is profitable to do so!

Topic would be better treated as own topic (i.e. F) rather than part of the product differentiation part

Microsoft: Office Suite

E3) Bundling: an example

- Two television stations offered two old Hollywood films
  - *Casablanca* and *Son of Godzilla*
- Arbitrage is possible between the stations
- Willingness to pay is:

	Willingness to pay for Casablanca	*Willingness to pay for Godzilla*
Station A	**$8,000**	**$2,500**
Station B	**$7,000**	**$3,000**

$7,000

$2,500

Example from Stigler 1968.

E3) Bundling: an example

- Two telev… …ffered two old Hollyw…
  - …lla
- A… …a…
- Willi…

If the films are sold separately total revenue is $19,000

How much can be charged for Godzilla?

	Willingness to pay for Casablanca	Willingness to pay for Godzilla
Station A	\$8,000	\$2,500
Station B	\$7,000	\$3,000

\$7,000

\$2,500

Example from Stigler 1968.

E3) Bundling: an example

Now suppose that the two films are bundled and sold as a package

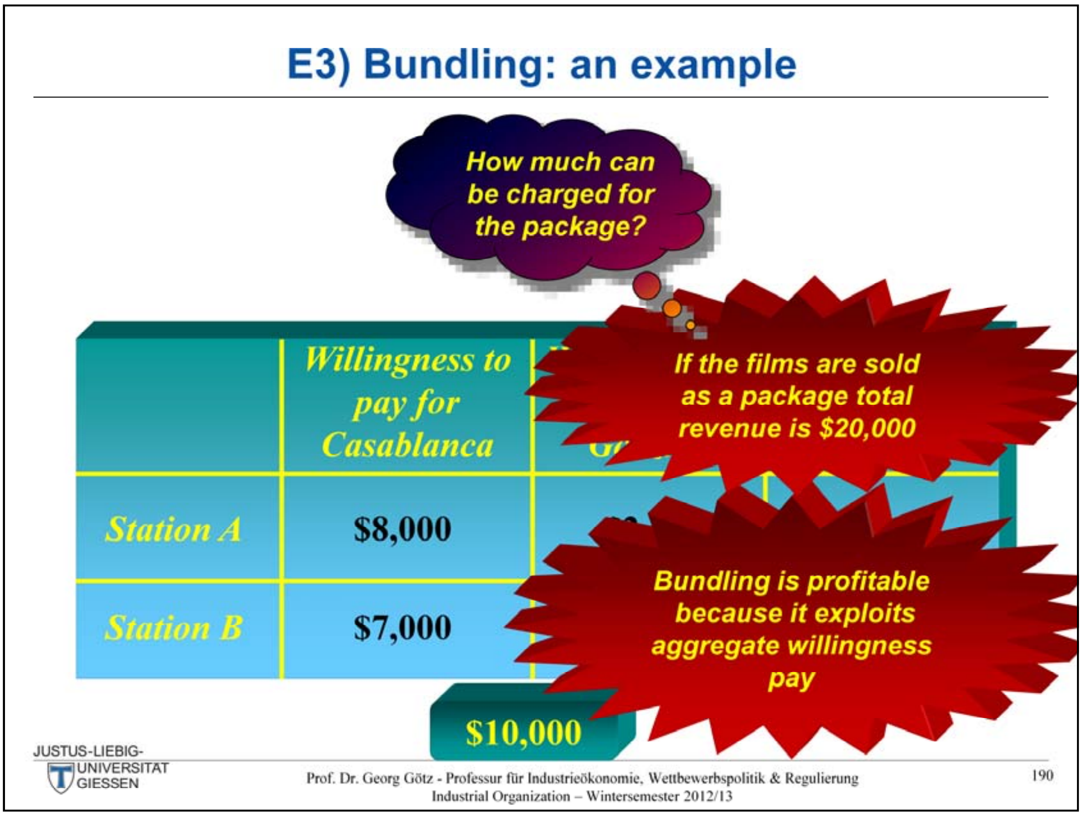
	Willingness to pay for Casablanca	Willingness to pay for Godzilla	Total Willingness to pay
Station A	$8,000	$2,500	$10,500
Station B	$7,000	$3,000	$10,000

Now suppose that the two films are bundled and sold as a package

How much can be charged for the package?

If the films are sold as a package total revenue is $20,000

Bundling is profitable because it exploits aggregate willingness pay



Now suppose that the two films are bundled and sold as a package

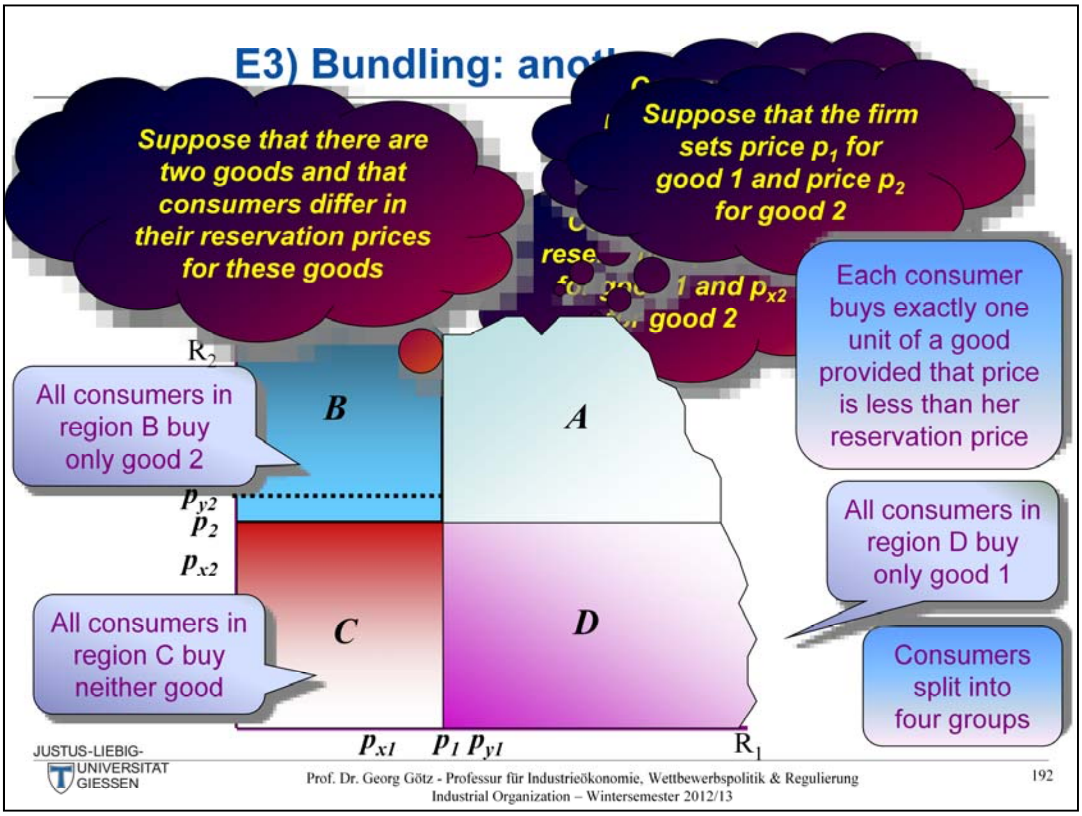
How much can be charged for the package?

If the films are sold as a package total revenue is $20,000

Bundling is profitable
because it exploits
aggregate willingness
pay

E3) Bundling (cont.)

- Extend this example to allow for
  - costs
  - ***mixed bundling***: offering products in a bundle and separately

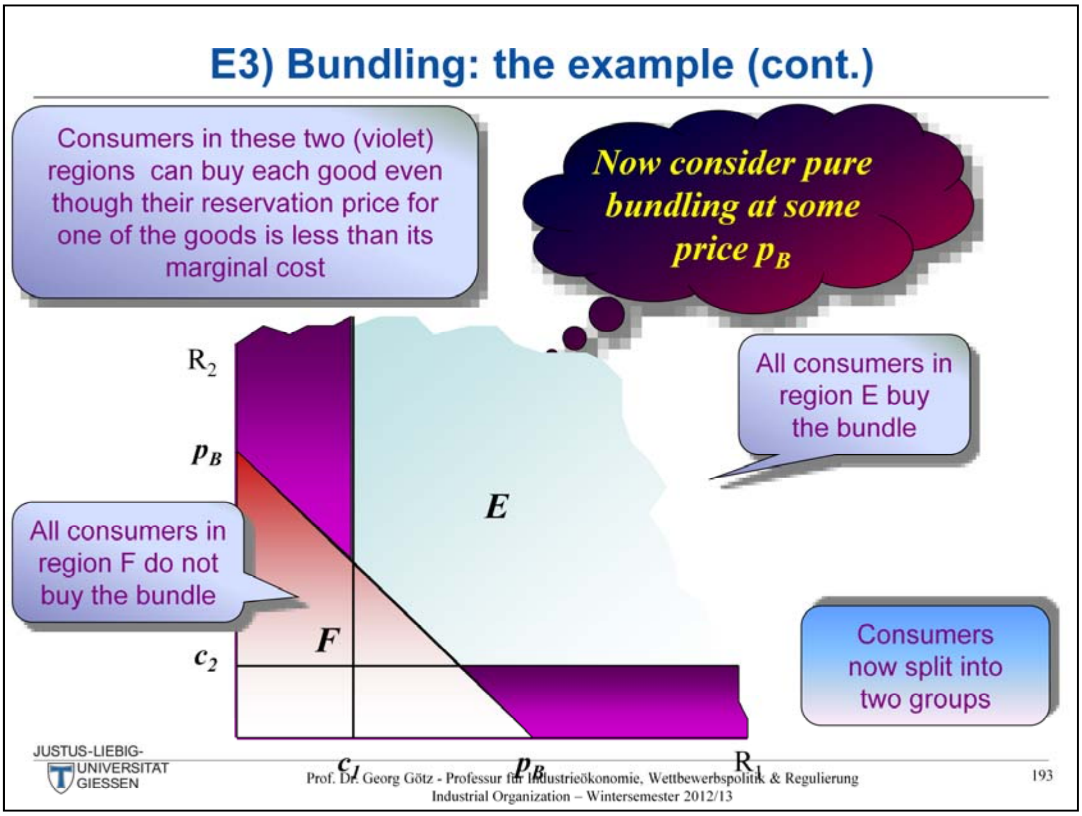


Bundling: Another example

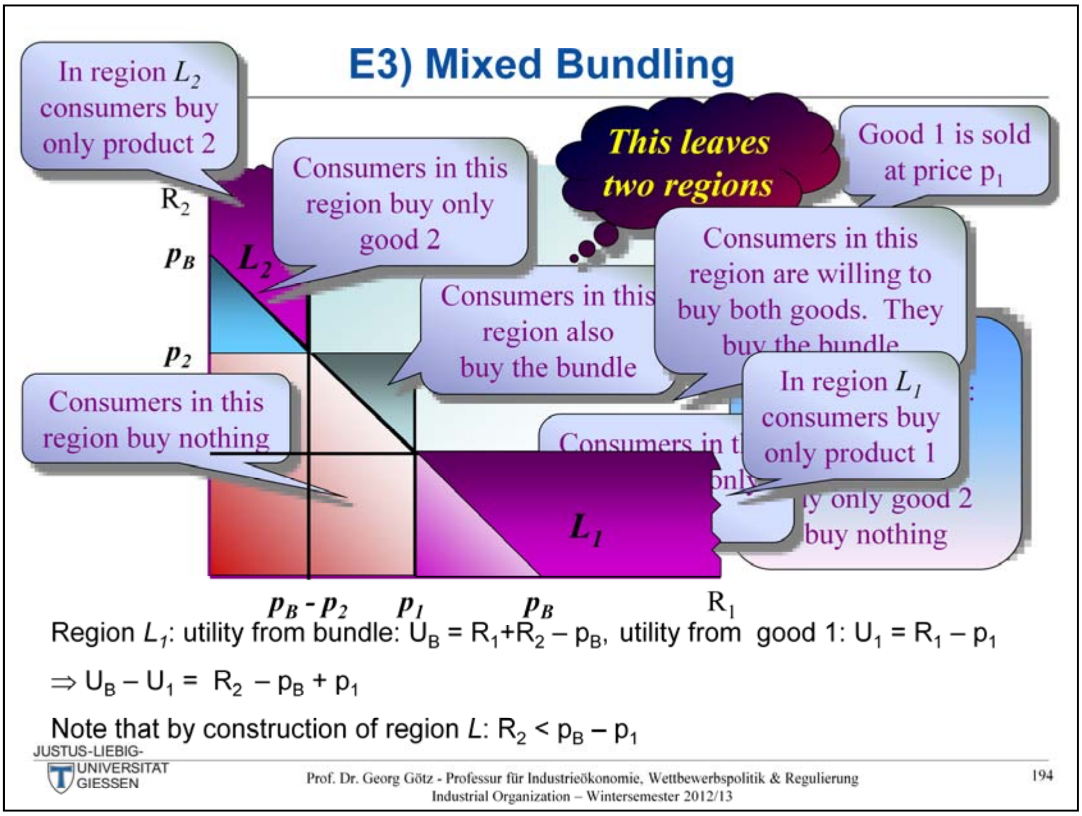
You need to make your own notes in order to understand this slide!

Assumption: Reservation price for the bundle = sum of reservation prices => restrictive. Think of complements! WTP for bundle much higher (Nuts and bolts)

Bundle: restaurant menu: (main course +) salad + dessert



Construction: $p_B = R_1 + R_2 \Rightarrow R_2 = p_B - R_1$



Compare what firms gain and loose by bundling! Pure bundling: More consumers with intermediate WTP for both products, but loss of consumers with low WTP for one product and not so high WTP for the other. Another loss. Consumers with high WTP for both products pay less by buying the bundle!

What will consumers in the violet regions buy:

Take region L_1: utility from bundle : $U_B = R_1 + R_2 - p_B$

utility from good 1: $U_1 = R_1 - p_1$

$U_1 - U_B = R_2 - p_B - p_1$

Note that by construction of region L $R_2 < p_B - p_1$

Therefore => Buy only good 1!

General result: Individual goods bought by consumers with rather different valuations for the two goods.

E3) Mixed Bundling (cont.)

- What should a firm actually do?
- There is no simple answer
  - mixed bundling is generally better than pure bundling
  - *but* bundling is not always the best strategy
- Each case needs to be worked out on its merits

To see that mixed bundling is better than pure bundling, note that the latter case is included in the former one. Just take arbitrarily high prices for the individual goods!

E3) An Example

Four consumers; two products; MC_1 = \$100, MC_2 = \$150

Consumer	Reservation Price for Good 1	Reservation Price for Good 2	Sum of Reservation Prices
A	\$50	\$450	\$500
B	\$250	\$275	\$525
C	\$300	\$220	\$520
D	\$450	\$50	\$500

E3) The example (cont.): simple monopoly pricing

Good 1 should be sold at $250 and good 2 at $450. Total profit is $450 + $300 = $750

Good 1: Marginal Cost $100			
Price	Quantity	Total revenue	Profit
$450	1	$450	$350
$300	2	$600	$400
$250	3	$750	$450
$50	4	$200	-$200

Good 2: Marginal Cost $150			
Price	Quantity	Total revenue	Profit
$450	1	$450	$300
$275	2	$550	$200
$220	3	$660	$210
$50	4	$200	-$400

E3) The example (cont.): Pure bundling

The highest bundle price that can be considered is $500

All four consumers will buy the bundle and profit is 4x$500 - 4x($150 + $100) = $1,000

Consumer	Reservation Price for Good 1	Reservation Price for Good 2	Sum of Reservation Prices
A	$50	$450	$500
B	$250	$275	$525
C	$300	$220	$520
D	$450	$50	$500

Highest price if all consumers are to be served!

E3) The example (cont.): mixed bundling

All four consumers buy and profit is \$300 +\$270x2 + \$350 = \$1,190

Try the prices p_1 = \$450; p_2 = \$450 and a bundle price p_B = \$520

Consumer	Reservation Price for Good 1	Reservation Price for Good 2	Sum of Reservation Prices
A	\$50	\$450	\$500
B	\$250	\$275	\$520
C	\$300	\$220	\$520
D	\$450	\$50	\$500

It is easy to see that it it not optimal to take the monopoly prices p_1 = \$250; p_2 = \$450 and a bundle price p_B = \$500

E3) Bundling (cont.)

- Bundling does not always work
- Requires that there are reasonably large differences in consumer valuations of the goods
- What about ***tie-in sales?***
  - “like” bundling but proportions vary
  - allows the monopolist to make supernormal profits on the tied good
  - different users charged different effective prices depending upon usage
  - facilitates price discrimination by making buyers reveal their demands
  - In general: Single two-part tariff with heterogeneous consumers (=> see Assignment 2, Problem 5)

Bundling may be viewed as discriminatory pricing since price of bundle is less than sum of individual prices.

Gains from bundling arise from the differences in consumer valuations.

Tie-in sales: Camera +films, fax-machine plus paper, printer +cartridges etc. Difference from bundling: Quanitities not fixed by seller, but chosen by buyer.

E3) Complementary Goods

- Complementary goods are goods that are consumed together
  - nuts and bolts
  - PC monitors and computer processors
- How should these goods be produced?
  - Within one firm or by different firms?
- How should they be priced?
- Take the example of nuts and bolts
  - these are perfect complements: need one of each!
- Assume that demand for nut/bolt pairs is:

$$Q = A - (P_B + P_N)$$

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Complementary products: Application which is particularly important with respect to bundling and tying

=> gives efficiency argument for bundling!

Demand function derived from utility function for perfect complements in Varian‘s terminology.

E3) Complementary goods (cont.)

This demand curve can be written individually for nuts and bolts

For bolts: $Q_B = A - (P_B + P_N)$

For nuts: $Q_N = A - (P_B + P_N)$

These give the inverse demands: $P_B = (A - P_N) - Q_B$

$P_N = (A - P_B) - Q_N$

These allow us to calculate profit maximizing prices

Assume that nuts and bolts are produced by independent firms

Each sets MR = MC to maximize profits

$MR_B = (A - P_N) - 2Q_B$

$MR_N = (A - P_B) - 2Q_N$

Assume $MC_B = MC_N = 0$

E3) Complementary goods (cont.)

Therefore $Q_B = (A - P_N)/2$

and $P_B = (A - P_N) - Q_B = (A - P_N)/2$

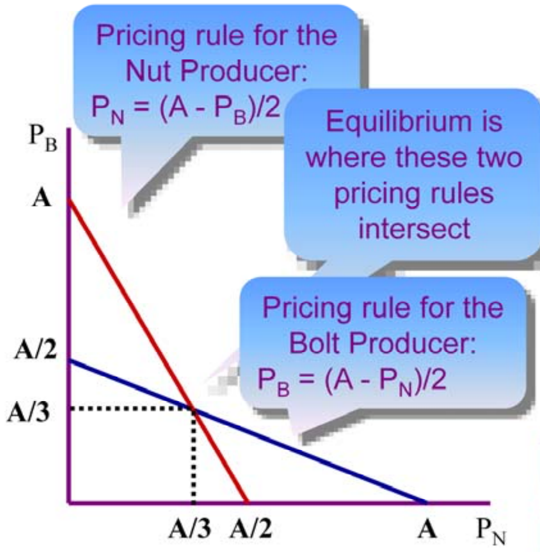
by a symmetric argument $P_N = (A - P_B)/2$

The price set by each firm is affected by the price set by the other firm

In equilibrium the price set by the two firms must be consistent

Reaction functions!

E3) Complementary goods (cont.)



$P_B = (A - P_N)/2$

$P_N = (A - P_B)/2$

$\therefore P_N = A/2 - (A - P_N)/4$

$= A/4 + P_N/4$

$\therefore 3P_N/4 = A/4$

$\therefore \mathbf{P_N = A/3}$

$\therefore \mathbf{P_B = A/3}$

$\therefore P_B + P_N = 2A/3$

$\therefore \mathbf{Q = A - (P_B+P_N) = A/3}$

Profit of the Bolt Producer $= P_B Q_B = A^2/9$

Profit of the Nut Producer $= P_N Q_N = A^2/9$

E3) Complementary goods (cont.)

What happens if the two goods are produced by the same firm?

The firm will set a price P_{NB} for a nut/bolt pair.

Demand is now $Q_{NB} = A - P_{NB}$ so that $P_{NB} = A - Q_{NB}$

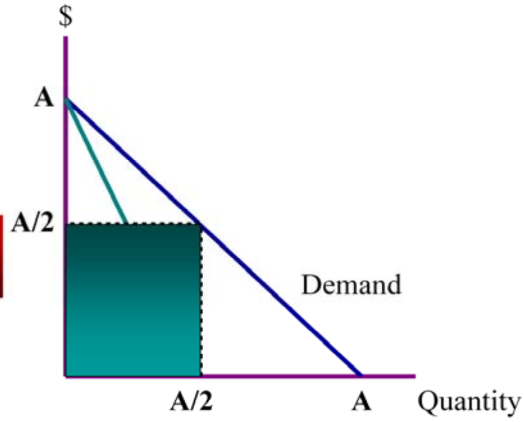
$\therefore MR_{NB} = A - 2Q_{NB}$

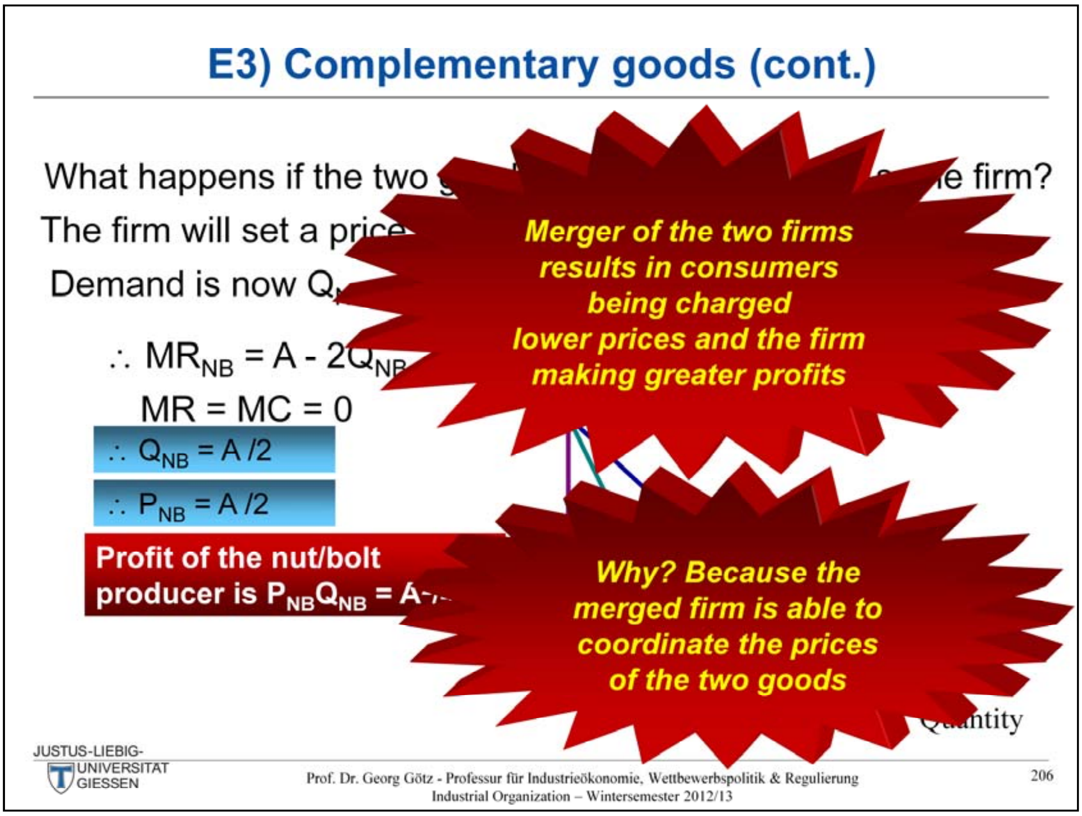
$MR = MC = 0$

$\therefore Q_{NB} = A/2$

$\therefore P_{NB} = A/2$

Profit of the nut/bolt producer is $P_{NB}Q_{NB} = A^2/4$





Merger of the two firms results in consumers being charged lower prices and the firm making greater profits

Similar result with upstream downstream monopolists: Vertical integration of two monopolist improves welfare because of the double marginalization problem => two markups. Externality: increasing own price (say from the single monopoly price) reduces demand for other firm, which implies a loss which must be greater than the gain for the firm increasing the price (Industry profits are at a maximum with a single firm!)

=> Vertical mergers are in general less of a problem than horizontal ones.

See also Varian, Chapter on factor markets!

E3) Bundling, tying, complementary products, network effects, ..., and antitrust

- Further points on complementary products:
  - Merger not always necessary to achieve efficiency: Product networks (Automated Teller Machines networks)
  - Alternatively, no problem if one of the market becomes competitive! No coordination problem because there is no markup for one of the products!
- This last alternative probably does not work if ***network externalities*** matter => positive feedback => tends to reinforce and enhance monopoly power => information technology (Microsoft).
- Complementarity between operating system and application software. Problem of *extending monopoly power* to another product line (browsers!) (in Microsoft case: Charge of defending monopoly in operating systems.)
- Antitrust problems with bundling and tying: Might be *efficiency enhancing*:
  - allow for price discrimination (note that some consumers may not be served with-out this possibility, Product might not even be developed if insufficient appro-priation of consumer surplus (ADSL and wholesale offers on a cost basis)) and
  - coordinate the marketing of complementary products.
- BUT! Tying arrangements might also foreclose competition and allow extension of monopoly power.

Preliminary points!

General conclusion from the above discussion:

Rather complicated to judge: Microsoft case and GE/Honeywell merger: Much disputed (also among economists)

⇒Would be topic for a seminar.

⇒Good for economists as consultants ;-)

For more details see PRN, Sections 8.3 and 8.4.