

# Lecture 11: Vertical control

EC 105. Industrial Organization.

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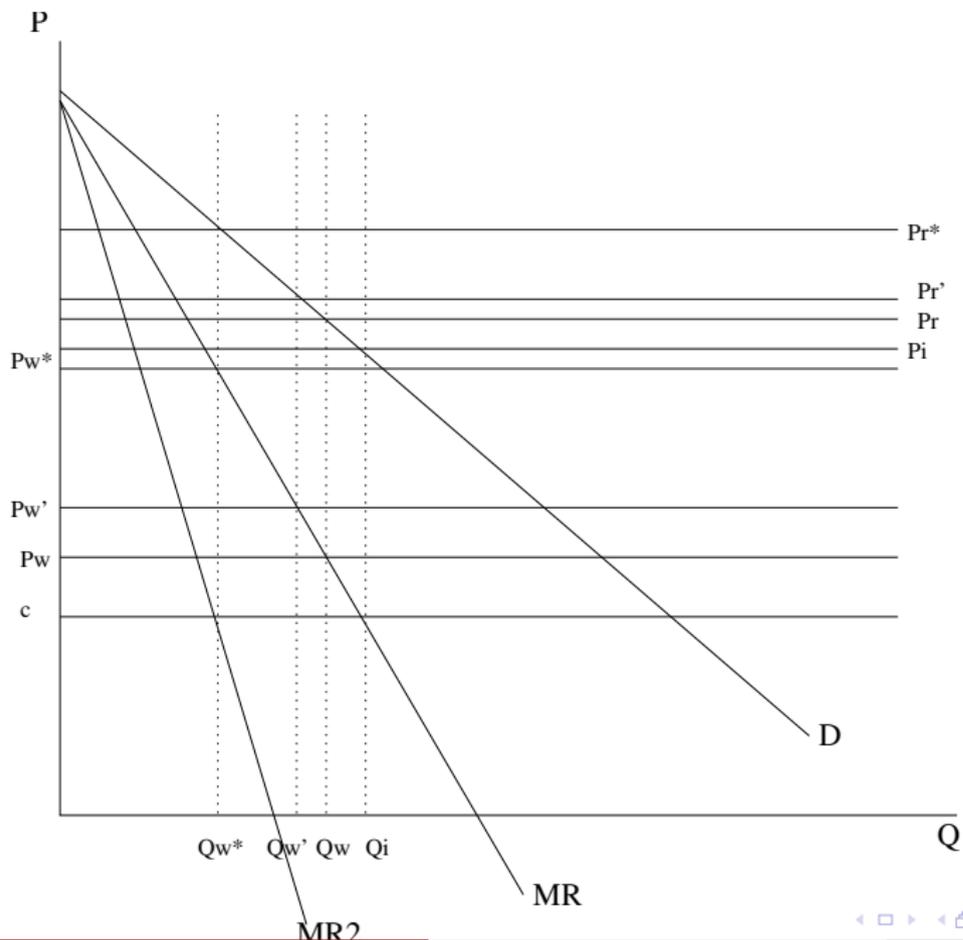
# Outline

# Vertical integration and vertical restraints

- Up to now, consider only firm who produces as well as sells final product
- Most industries characterized by *upstream vs. downstream* firms.
- Question: focus on problems in vertical setup, and upstream firm's incentives to either **vertically integrate** or approach the integrated outcome using **vertical restraints**.
- Upstream: produce product. Downstream: retailer/distributor who sells the product
  - ① Double marginalization
  - ② Free-riding
- Upstream: produce inputs. Downstream: produce and sell final product
  - ① Input substitution
  - ② Price discrimination
  - ③ Contracts
- Don't focus on cost aspects (Stigler)

# Double marginalization 1

- Monopolist upstream manufacturer; marginal cost  $c$ , chooses wholesale price  $p_w$
- Monopolist downstream retailer; marginal cost is  $p_w$ , chooses retail price  $p_r$
- Graph
- Integrated firm: choose  $p_r$  so that  $MR(q) = c \rightarrow q_i$
- Nonintegrated outcome: solve backwards
  - 1 Retailer: sets  $p_r$  so that  $MR(q) = p_w$ .  $MR(q)$  is the demand curve faced by manufacturer: **Monopoly retailer restricts output.**
  - 2 Manufacturer maximizes using retailer's demand curve: lower quantity, higher price relative to integrated firm.
- Total profits lower in non-integrated scenario.



- Integrated monopolist:  $(Q_i, P_i)$
- Nonintegrated: monopolist retailer sets retail price where  $P_w = MR$ .  
Thereby, wholesaler faces demand curve of MR.
- Wholesaler optimally sets  $P_w^*$  so that  $c = MR_2$  (so “double marginalization”): outcome is  $(P_w^*, P_r^*, Q_w^*)$
- Total profits lower in non-integrated scenario.

## Double marginalization 2

Example:  $Q = 10 - p$ ;  $c=2$

Integrated firm:  $q_i=4$ ,  $p_i=6$ ,  $\pi_i=16$

Non-integrated scenario (solve backwards):

- Retailer:

- ① Given  $p_w$ ,  $\max_{p_r} (p_r - p_w)(10 - p_r)$

- ② FOC:  $10 - p_r - (p_r - p_w) = 0 \rightarrow p_r = \frac{10+p_w}{2}$ .

- ③ Demand, as a function of  $p_w$ :  $Q(p_w) = 10 - \frac{10+p_w}{2} = 5 - \frac{p_w}{2}$ . This is demand curve faced by manufacturer (and coincides with MR curve of retailer)

- Manufacturer

- ①  $\max_{p_w} (p_w - 2)(5 - \frac{p_w}{2})$

- ② FOC:  $5 - \frac{p_w + p_w - 2}{2} = 0 \rightarrow p_w = 6$

- $p_w = 6 \rightarrow p_r=8$ ,  $q_n = 2$ . Lower output, higher price.

- $\pi_w = 4$ ,  $\pi_r = 8$ . Lower total profits.

- Lower total profits is incentive to integrate. What else can mftr. do?

## Double marginalization 3

- Main problem is that monopoly retailer sets  $p_r > p_w$ . How can this be overcome?
  - **Resale price maintenance (RPM)**  
Price ceiling:  $p_r = p_w$ . Illegal?
  - Quantity forcing: force retailer to buy  $q = q_i$  units (sales quotas)
  - General: increase competition at retail level. With PC retail market,  $p_r = p_w$  and problem disappears.
- Alternatively, set  $p_w = c$  and let retailer set  $p_r$  so that  $MR(q) = c = p_w$ . Then recoup integrated profits  $\pi_i$  by **franchise fee**. Only works if franchise market is competitive.

# Free-riding in retail sector 1: “downstream moral hazard”

- DM arises since retail sector is not competitive. Now consider problems which arise if retail sector is competitive.
- Assume monopolist mfr. and retail sector with two firms competing in Bertrand fashion.
- Demand function  $Q(p, s)$ , depending on price  $p$  and retail services (advertising)  $s$ .
- Problem: Assume demand goes up if *either* firm advertises. One firm has no incentive to advertise if other firm does: **free-riding**.
- Examples: in-store appearances, online perfume discounters
- Solve the game backwards:
  - Bertrand competition: zero profits no matter what. Neither firm advertises → low demand.
  - Mfr. faces lower demand and lower profits.

## Free-riding in retail sector 2

- Main problem: under Bertrand competition, retail profits don't depend on whether or not there is advertising. Correct problem by tying retailer profits to their advertising activities: general principle of the **residual claimant**.
  - 1 **Exclusive territories**: grant retailers monopoly in selling manufacturer's product. Now retailer's profits increase if it advertises, but run into DM problem. Explain make-specific new car dealerships?
  - 2 Limit number of distributors (same idea)
  - 3 Resale price maintenance: set *price floor*  $\underline{p} > p_w$ . Again, this ties retailers' profits to whether or not they advertise.
- Free-riding at manufacturer level: If there is upstream competition, one mftr's efforts to (say) improve product image can benefit all manufacturers → **exclusive dealing**: forbid retailer from selling a competing manufacturer's product.
- Empirical evidence: perfumes

# Input substitution 1

- Now consider the case where upstream firm produces an input that is used by downstream firms in producing final good.
- Main ideas: Monopoly pricing for one of the inputs shifts downstream demand for input away from it.
- Can lead to socially inefficient use of an input.
- By integrating with DS industry, monopolist increases demand for its input (and perhaps profits).
- Occurs no matter if downstream industry is competitive or not.

## Input substitution 2

Example (diagram):

- Market demand for final good:  $p = 10 - q$
- Two inputs:
  - 1 Competitive labor market, wage  $w = 1$
  - 2 Energy  $E$  produced by an upstream monopolist. Monopolist produces with marginal cost  $m = 1$  and sells it at price  $e$ .
- Final good produced from a production function  $q = E^{1/2}L^{1/2}$ .
- Competitive downstream industry: final good is sold at  $p = MC(q)$ .
- Analyze 3 things (C/P pp. 551-552):
  - 1 Calculate  $MC(q)$  function for DS industry
  - 2 Integrated outcome
  - 3 Non-integrated outcome

# Input substitution 3

- Calculating DS marginal costs
- First solve for DS firm cost function  $C(w, e, Q)$ : given input prices  $w$  and  $e$ , what is minimal cost required to produce output  $Q$ ?
  - DS firms combine  $E$  and  $L$  to produce a given level of output  $Q$  at the lowest possible cost:

$$C(e, w, Q) = \min_{E, L} eE + wL \text{ s.t. } Q = E^{1/2} L^{1/2} \quad (1)$$

given input prices  $e$ ,  $w$ , and output level  $Q$ .

- Substituting in the constraint:

$$C(e, w, Q) = \min_E eE + w \left( \frac{wQ^2}{E} \right) \quad (2)$$

- FOC:  $E = Q \left( \frac{w}{e} \right)^{1/2}$ , and  $L = Q \left( \frac{e}{w} \right)^{1/2}$ . Substitute back into cost function.
- $C(e, w, Q) = 2Q(we)^{1/2}$ . Marginal cost =  $\frac{\partial C}{\partial Q} =$

$$MC(e, w, Q) = 2(we)^{1/2}. \quad (3)$$

# Input Substitution 4

Integrated firm: Monopoly also controls DS industry

- In integrated firm, set  $e = m = 1$ , so that  $MC = 2$ .
- $\max_p (p - 2)q = (p - 2)(10 - p)$ .
- $p_i = 6$ ,  $q_i = 4$ .  $E_i = L_i = 4$ .
- $\pi_i = (6 - 2) * 4 = 16$ .

# Input substitution 5

## Non-integrated scenario

- DS: Chooses quantity  $q$  so that  $p = MC \Leftrightarrow p = 10 - q = 2(we)^{1/2} \implies q = 10 - 2(we)^{1/2}$
- Given this  $q$ , demand for  $E$  is:

$$E = 10 \left( \frac{1}{e} \right)^{1/2} - 2$$

- US:  $\max_e (e - 1) * E = (e - 1) * \left[ 10 \left( \frac{1}{e} \right)^{1/2} - 2 \right]$
- FOC (complicated!):  $5e - 2e^{3/2} + 5 = 0$
- $e_u = 7.9265$ .  $MC = 5.6308 = p_u$ .  $q_u = 4.3692$ .
- At these input prices,  $(\frac{w}{e}) \ll \frac{w}{m} = 1$ , so use much more labor (much less energy) than optimal.
- $\pi_u^{US} = 10.75$ ,  $\pi_u^{DS} = 0$  (DS is competitive). Lower profits for US firm.
- Story holds only if two input are *substitutes*.

# Long-term contracts

- In vertical structure, can observe contracts between US and DS firms
- Can they be anti-competitive?
- Consider common type of contract: *Exclusive dealing*. Upstream seller dictates that it is sole source for downstream retailer.

## Chicago school answer: No

- Reduced competition means higher wholesale price  $\iff$  lower profits for retailer
- Since signing ED contract is voluntary, retailer would never voluntarily enter into a relationship with lower profits.

Consider these issues in one model: Aghion/Bolton model

# Setup

Graph: Incumbent ( $\mathcal{I}$ ) and entrant ( $\mathcal{E}$ ) upstream seller; one downstream retailer/buyer ( $\mathcal{B}$ )

$\mathcal{B}$  demands one unit of product, derives utility 1 from it.

$\mathcal{I}$  produces at cost  $1/2$ , sells at price  $P$ .

$\mathcal{E}$  has cost  $c_e$ , unknown to  $\mathcal{B}$  or  $\mathcal{I}$ ; it is uniformly distributed between  $[0, 1]$ . If enter, sells at price  $\tilde{P}$ .

Two stage game:

- ①  $\mathcal{I}$  and  $\mathcal{B}$  negotiate a contract.  $\mathcal{E}$  decides whether or not to enter.
- ② Production and trade:
  - Contract must be obeyed.
  - Bertrand competition between  $\mathcal{I}$  and  $\mathcal{E}$ .

# In the absence of contract 1

Graph:

- Bertrand competition if  $\mathcal{E}$  enters: market price is  $\max\{c_e, 1/2\}$ 
  - If  $c_e < 1/2$ ,  $\mathcal{E}$  sells, at  $\tilde{P} = 1/2$ .
  - If  $c_e > 1/2$ ,  $\mathcal{I}$  sells, at  $P = c_e$ .
- $\mathcal{E}$  enters only when profit  $> 0$ : only when  $c_e < 1/2$ . Cost threshold  $c^*$  is  $1/2$ . This is with probability  $\phi = 1/2$ . This is efficient:  $\mathcal{E}$  enters only when technology is superior to  $\mathcal{I}$ .
- If  $\mathcal{E}$  doesn't enter,  $\mathcal{I}$  charges 1.

## In the absence of contract 2

Sumup:

- Expected surplus of  $\mathcal{B}$ :  $\phi * \frac{1}{2} + (1 - \phi) * (1 - 1) = \frac{1}{4}$ .
- Expected surplus of  $\mathcal{I}$ :  $\phi * 0 + (1 - \phi) * (1 - 1/2) = \frac{1}{4}$ .
- $\mathcal{B}$  and  $\mathcal{I}$  will write contract only when it leads to higher expected surplus for *both*  $\mathcal{B}$  and  $\mathcal{I}$ . This is Chicago school argument.
- Question: Is there such a contract which would deter  $\mathcal{E}$ 's entry (ie., lower cost threshold  $c^* < 1/2$ )?

# With a contract 1

Consider a contract b/t  $\mathcal{B}$  and  $\mathcal{I}$  which specifies

- ①  $P$ : price at which  $\mathcal{B}$  buys from  $\mathcal{I}$
- ②  $P_0$ : penalty if  $\mathcal{B}$  switches to  $\mathcal{E}$  (*liquidated damages*)

What is optimal  $(P, P_0)$ ?

- What is  $\mathcal{B}$ 's expected surplus from contract?  $(1 - P)$  if buy from  $\mathcal{I}$ ; in order to generate sale,  $\mathcal{E}$  must set  $\tilde{P}$  s.t.  $\mathcal{B}$  gets surplus of at least  $(1 - P)$ . So:  $\mathcal{B}$ 's expected surplus is  $(1 - P)$ .
- $\mathcal{B}$  get surplus of  $\frac{1}{4}$  without contract, so will only accept contract if surplus  $\geq \frac{1}{4} \Leftrightarrow (1 - P) \geq \frac{1}{4}$ .
- When will  $\mathcal{E}$  enter? If  $\mathcal{E}$  enters, it will set  $\tilde{P} = P - P_0$ . In order to make positive profit  $c_e \leq \tilde{P} = P - P_0$ .
- $\mathcal{E}$  enters with probability  $\phi' = \max\{0, P - P_0\}$ .

## With a contract 2

- $\mathcal{I}$  proposes  $P, P_0$  to maximize his expected surplus, subject to  $\mathcal{B}$ 's participation:

$$\begin{aligned} \max_{P, P_0} \phi' * P_0 + (1 - \phi') * (P - 1/2) \\ \text{subject to } 1 - P \geq 1/4. \end{aligned} \tag{4}$$

- Set  $P$  as high as possible:  $P = 3/4$ .
- Graph: optimal  $P_0 = 1/2$ , so that  $\mathcal{I}$ 's expected surplus =  $5/16 > 1/4$ .
- $\mathcal{B}$ 's expected surplus:  $1/4$ . as before.
- $\mathcal{E}$ : only enter when  $c_e \leq P - P_0 = 1/4$ . Inefficient: when  $c_e \in [1/4, 1/2]$ , more efficient than  $\mathcal{I}$ , but (socially desirable) entry is deterred.

Would parties want to renegotiate the contract?

- Assume contract is renegotiated if both  $\mathcal{I}$  and  $\mathcal{B}$  agree to do so.
- If  $\mathcal{E}$  enters and offers  $\tilde{P} = 2/5$ :
  - $\mathcal{B}$  offers to buy from  $\mathcal{E}$ , and pay  $1/4$  to  $\mathcal{I}$ .
  - $\mathcal{I}$  accepts, since  $1/4$  is same surplus he could get if  $\mathcal{B}$  “punished” him by purchasing from him at  $P = 3/4$ .
  - $\mathcal{B}$  strictly better off, since  $1 - 2/5 - 1/4 = 0.35$  is greater than  $1/4$ , his surplus under original contract.
- The exclusive dealing contract is not *renegotiation-proof*.
- Same argument for  $\tilde{P}$  up to  $1/2$ :
  - No exclusive contracts are renegotiation-proof.
  - Once we take this into account, socially efficient outcome obtains, where  $\mathcal{E}$  enters if her costs  $c_e \leq 1/2 = c_i$ .

## Remarks

- Contract deters entry by imposing switching costs upon buyer:  
much-observed practice: Loyalty-reward programs (Frequent-flyer miles, Buy 10/Get 1 free, etc.)
- Falls under category of raising rivals costs: recall that this is profitable if  $\pi^m - K \geq \pi^d$ . Here  $\pi^d=?$ ,  $K=?$ ,  $\pi^m=?$
- What if two competing incumbent sellers?
- What if  $\mathcal{E}$ 's cost known? Then Chicago result holds: contract will never be desired by *both*  $\mathcal{I}$  and  $\mathcal{B}$ .
- What if  $\mathcal{B}$  is risk averse (ie., dislikes variation in payoffs)?
  - Under contract: guaranteed surplus of  $1/4$ , no matter if  $\mathcal{E}$  enters or not
  - Without contract, gets  $1/2$  if  $\mathcal{E}$  enters, but  $0$  if  $\mathcal{E}$  stays out.
  - Prefers contract since it is less risky: if extremely risk-averse, exclusive contract could even survive renegotiation (ie., if incumbent can set  $P$  very close to  $1$ ).

## A “pure” incentive problem

- Consider a pure incentive problem where you and a partner are deciding how to divide up a pot of earnings.
- Who should make the proposal?
- (Assume no third parties. Prone to corruption, “rent-seeking”)
- “Decentralization” principle.

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# Sum-Up

- Inefficiencies in vertical relationship
  - ① double marginalization: DS monopoly contracts output too much
  - ② Free-riding (DS moral hazard): DS competition provides too few retail services
- Reasons for vertical integration
  - ① Input substitution: too little of monopoly input is used
  - ② Contracts between upstream and downstream firms: can have anti-competitive effects (but somewhat fragile result..)