

- ▶ Providing a rationale for the “leverage theory”.

- ▶ Leverage theory:

Tying is a mechanism whereby a firm with monopoly power in one market uses leverage provided by this power to monopolize a second market.

- ▶ Criticism (Posner, Bork):

Can't work. There is only one monopoly profit that can be extracted.

- ▶ Example:

2 goods: A (monopoly), B (competitive).

consumer's valuations:  $v_A$ ,  $v_B$ .

producer's costs:  $c_A$ ,  $c_B$ .

- ▶ Consumers buy the bundled commodity only if its price is no greater than  $v_A + c_B$ . The monopolist's profit is at most  $v_A - c_A$ , the profit it sells A independently.

# Whinston's reply

- ▶ The literature presumes a competitive market on tied good.
- ▶ Leverage theory is not about price discrimination, but about the ability of the monopoly to foreclose other firms in the other market when it has monopoly power on one.
- ▶ Commitment to tie is important. In practice, this is achieved, by for example, making components incompatible with other firm's products.

- ▶ Absent commitment, tying is not a profitable strategy for monopolist:  
Any equilibrium is equivalent to one where independent pricing is allowed.
- ▶ With commitment, tying can be profitable because of its potential to exclude other firms in the tied market. That is, tying can drive its rival's profit below the point where remaining in market is profitable.

- ▶ Two goods: A, B

Two firms: 1, 2

- ▶ Firm 1 is monopoly for good A. Both firms compete in market of good B.

Fixed costs for entering market B :  $K_1, K_2$ .

- ▶ Unit costs of production:  $c_A, c_{B1}, c_{B2}$ .

- ▶ Consumer: indexed by  $d \in (0, 1)$ , with total measure 1. Each needs at most one unit of A, and B.

- ▶  $\gamma$ : valuation for good A.  $\gamma > c_A$ .

- ▶  $v_{Bi}(d)$ : consumer d's valuation of firm i's good B.

- ▶ Resale is prohibited.
- ▶ If there is no tie-in, prices are simply  $(p_A, p_{B1}, p_{B2})$ .
- ▶  $x^i(p_{B1}, p_{B2}) \leq 1$ : Firm  $i$ 's sale of good B.

$$\frac{\partial x^i}{\partial p_{Bj}} \begin{cases} \geq 0, \text{ for } i \neq j, \\ \leq 0, \text{ for } i = j; \end{cases}$$

strict inequality if  $x^i \in (0, 1)$ .

- ▶ If there is no tie-in, then firm 1 always sets  $P_A = \gamma$ .

$$p_{Bi}^*(p_{Bj}) \equiv \arg \max_{p_{Bi}} (p_{Bi} - c_{Bi}) x^i(p_{B1}, p_{B2})$$

$(p_{B1}^*, p_{B2}^*)$  is the equilibrium prices in B market without tying.

# Tying without commitment: 2-stage game

- ▶ 1st stage: Each firm decides whether to be active in market B. If yes, sunk cost  $K_i$  is incurred.

- ▶ 2nd stage: Simultaneously pick prices.

Firm 1:  $(p_A, p_{B1}, \bar{p})$ , where  $\bar{p}$  is the price of the bundled commodity.

Firm 2:  $p_{B2}$ .

It must be that  $\bar{p} \leq p_A + p_{B1}$ .

- ▶ 2nd stage game is neither Bertrand nor Cournot. It is price competition with differentiated commodities.



# Tying with commitment: 3-stage game

- ▶ 1st stage: Firm 1 commits to one of 3 possibilities: Good A, good B, or a bundle.
- ▶ 2nd and 3rd stage: Same to 1st stage and 2nd stage above.
- ▶ Without commitment, any SPE outcome is equivalent to a SPE outcome of independent pricing game (i.e., the game where firm 1 sells goods A and B independently).

Proof:

Consider a SPE with tying,  $((p_A^0, p_{B1}^0, \bar{p}^0), p_{B2}^0)$ .

Want to show:

There exists SPE in independent pricing game,  $(\hat{p}_A, \hat{p}_{B1})$  such that profits are same for both firms under  $((\hat{p}_A, \hat{p}_{B1}), p_{B2})$  and  $((p_A^0, p_{B1}^0, \bar{p}^0), p_{B2})$  when  $p_{B2} = p_{B2}^0$  and are the same for firm 2 for any  $p_{B2}$ .

1. If  $p_A^0 > \gamma$ .

Then all are buying bundle. Moreover,  $\bar{p}^0 \geq \gamma$  (If  $\bar{p}^0 < \gamma$ , firm 1 can do better by offering one bundle at price  $\gamma$ )

Let  $\hat{p}_A = \gamma$ ,  $\hat{p}_{B1} = \bar{p}^0 - \gamma$ .

2.  $\gamma \geq p_A^0$ .

We must have  $\bar{p}^0 > p_A^0$ , Otherwise firm 1 can earn more by offering only bundle at price  $\gamma$ .

Let  $\hat{p}_A = p_A^0$ ,  $\hat{p}_{B1} = \bar{p}^0 - p_A^0$ .

► Reason:

It always worth it that consumers buy A either alone or in bundle. In the tying case, consumers choose between A and bundle by imputing an effective price.

$\bar{p}_1 - p_A$ , or

$\bar{p}_1 - \gamma$ , if  $p_A > \gamma$ , to the B1 portion of bundle.

► With commitment:

Firm 1 needs to commit to one of the following production types:

1. A,B                      1 & 2 are equivalent, and better than 5 & 6.
2. A, B, AB              4 is equivalent to 1.
3. B, AB                      3 is equivalent to 7. ( $\bar{p}^0$  vs.  $p_B^0 + \gamma$ )
4. A, AB
5. A
6. B
7. AB

As a result, we need only to compare 1 with 7.

Firm 2 makes less than the independent pricing game.

## Proof.

In independent pricing game,  $p_{B1}^*(p_{B2})$  maximize

$$[(p_{B1} - c_{B1})]x^1(p_{B1}, p_{B2}).$$

That is

$$(p_{B1}^* - c_{B1})x_1^1(p_{B1}^*, c_{B1}) + x^1(p_{B1}^*, c_{B1}) = 0.$$

If firm 1 bundles and sets price  $\bar{p}$ , then demand for its bundles is  $x^1(\bar{p} - \gamma, p_{B2})$  and  $\bar{p}^*$  maximize

$$(\bar{p} - c_A - c_{B1})x^1(\bar{p} - \gamma, p_{B2}).$$

That is

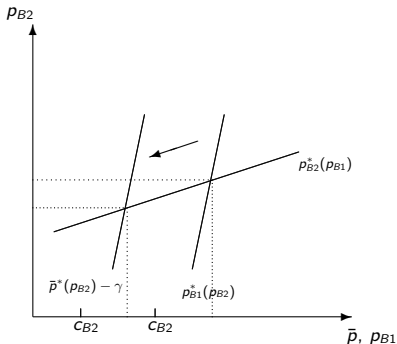
$$(\bar{p}^* - c_A - c_{B1})x_1^1(\bar{p}^* - \gamma, p_{B2}) + x^1(\bar{p}^* - \gamma, p_{B2}) = 0.$$

Note that if  $\gamma = c_A$ , then  $\bar{p}^*(p_{B2}) = p_{B1}^*(p_{B2}) + \gamma$ .

Since  $\gamma > c_A$ , it must be that  $\bar{p}^*(p_{B2}) < p_{B1}^*(p_{B2}) + \gamma$ .



- Firm 1's best response price for good B is lower under bundling: In order to sell A, firm 1 must also sell B. That makes it to cut price for B.



- Sometimes the loss of firm 2 is so large that it is not worthwhile to stay in market. In that case tying forecloses market B.

Example (commitment to tie)

Assume

$$c_{B1} - c_{B2} > K_2 > 0, K_1 = 0$$

The NE of independent pricing game has firm 2 making all sales of B ( $p_{B2} = c_{B1}$ ) a profit of  $c_{B1} - c_{B2} - K_1 > 0$ .

If firm 1 commits to bundling, and  $c_{B2} - c_{B1} + \gamma - c_A > 0$ , then firm 2 makes zero profit (gross of  $K_2$ ).



- ▶ It is important to note that if both firms are active, then firm 1 actually makes less with bundling. This is because bundling not only loses some profits from sales of good A, but also causes firm 2 to lower its price. It thus implies that firm 1 will never bundle if it cannot drive firm 2 out of market.
- ▶ Even if firm 1 can drive firm 2 out of market, it is not necessarily profitable: Although by tying it converts market B into monopoly, it now can only offer bundle.

- ▶ Consumer welfare:

As a consequence of tying, the consumers can either gain or loss.

- ▶ Two effect in force:

(1) Price effect

(2) Less variety in market B.

- ▶ (2) always hurts consumers
- ▶ (1) might help consumers: The reduction of price of good B to drive it out of market benefits the consumers.

Change in consumer welfare is thus uncertain as a result of tying.

► Example:

A consumer of type  $d$ 's valuation of  $B_i$  is  $v_{Bi} = w - \alpha_i d$ , where  $d \sim UNI[0, 1]$ . In case all consumers purchase and that both firms make sales. The equilibrium will be

$$p_A^0 = \gamma$$

$$p_{Bi}^0 = c_{Bi} + \frac{1}{3}[3\alpha_j + (\alpha_i - \alpha_j) + c_{Bj} - c_{Bi}]$$

$$\pi_1^0 = (\gamma - c_A) + \frac{1}{9}(\alpha_1 + \alpha_2)[3\alpha_2 + (\alpha_1 + \alpha_2) + (c_{B2} - c_{B1})]^2$$

$$\pi_2^0 = \frac{1}{9}(\alpha_1 + \alpha_2)[3\alpha_1 - (\alpha_1 - \alpha_2) - (c_{B2} - c_{B1})]^2$$

for independent sales.

- In the case when firm 1 can commit to bundle, the equilibrium is

$$\pi_2^0 = \frac{1}{9}(\alpha_1 + \alpha_2)[3\alpha_1 - (\alpha_1 - \alpha_2) - (c_{B2} - c_{B1}) - (\gamma - c_A)]^2,$$

which is smaller because  $\gamma > c_A$ . Note that firm 2's profit falls as good A's surplus,  $\gamma - c_A$ , increases.

- ▶ (a) If  $\alpha_1 = 0$ :

Then  $\pi_2^0 < 0$  and firm 2 will be foreclosed. Firm 1 thus makes monopoly profit by charging  $\bar{p} = w + \gamma$ . While all consumers are worse off, aggregate welfare can  $\uparrow$  or  $\downarrow$ : If  $c_{B2} > c_{B1}$ , aggregate welfare because all consumers are served, and production cost  $\downarrow$ .

If  $c_{B2} < c_{B1}$ ,  $\Delta W = K_2 - \alpha_2(c_{B1} - c_{B2})^2$ .

- ▶ (b) If  $\alpha_2 = 0$  and  $c_{Bi} = c_B$  :

Firm 1's profit in independent pricing game is  $\pi_1^0 = (\gamma - c_A) + \frac{1}{3}\alpha_1$ .

Assume that  $\frac{\alpha_1}{2} < \gamma - c_A$ , then firm 1's profit is higher in bundling if

$W > c_B + \frac{4}{3}\alpha_1$ .

# Heterogeneous consumers

1. Commitment to tying needs not be for purpose of foreclosure.
2. Tying can be profitable even in the absence of commitment when it is, it may lower firm 2's profit.

A. Commitment:

Commitment to offer bundle may fail to lower firm 2's profit because enough people might find good A unattractive. That is, firm 1's monopoly power may be too weak for bundling to be effective, and doing so may help rather than hurt firm 2.

► Example:

Let  $\gamma$  and  $d$  be independently distributed, and

$\text{Prob}(\gamma \leq s|d) = \text{Prob}(\gamma \leq s) \equiv F(s)$ . Assume that  $W$  be so large that all consumers buy B from one of the firms.

It can be calculated that

$$\pi_1^0 = \frac{1}{9}(\alpha_1 + \alpha_2)^{-1} [3\alpha_2 - (\alpha_1 - \alpha_2) + (c_{B2} - c_{B1}) + (E\gamma - c_A)]^2$$

$$\pi_2^0 = \frac{1}{9}(\alpha_1 + \alpha_2)^{-1} [3\alpha_1 - (\alpha_1 - \alpha_2) - (c_{B2} - c_{B1}) - (E\gamma - c_A)]^2$$

$$E\gamma = \int s dF(S).$$

Firm 2's profit is lower in bundling equilibrium if  $E\gamma > c_A$ , and higher if  $E\gamma < c_A$ . That is, if there are enough consumers who dislike product A (having  $\gamma$  and below  $c_A$ ), tying can actually raise firm 2's profit.



B. No commitment:

The monopolist may find it optimal to tie even if there is no commitment.

That is, there is no need of commitment for the monopolist to tie: it will find tying better than producing separate components unconditionally.

► Complementary products

Suppose A and B must be used in fixed proportion. Then tying is never worthwhile in reducing competition.

► Reason :

The monopolist can derive greater profit when its rival is in the market, because it can benefit through the sales of its monopolized product from the additional gains its rival generates. However, in two natural extensions, tying once again emerges as a profitable exclusionary strategy:

1. The presence of an inferior, competitively supplied alternative to the monopolized commodity.
  2. The existence of alternative uses of the monopolized commodity.
- A. Basic model

In order for consumption, it must be  $A + B_1$  or  $A + B_2$ .

A consumer of type  $d$ 's valuation of  $A + B_i$  is  $v_{A/B_i}(d)$ .

If  $A$ ,  $B_1$  and  $B_2$  are independently priced, demand for  $A + B_i$  is

$$x^i(p_A + p_{B_1}, p_A + p_{B_2}).$$

$$x_j^i \geq 0 \text{ if } i \neq j, \text{ and } \leq 0 \text{ if } i = j.$$

$$\text{Moreover, } x_i^1 + x_i^2 \leq 0.$$

- ▶ Firm 1 is trivially able to exclude firm 2 by bundling. The problem is whether it has incentive to do so.
- ▶ If tying causes firm 2 to stay out, then firm 1 can be made better by committing to produce only independent components.
- ▶ Pf: Suppose a commitment to bundle makes firm 1 inactive, and the optimal bundle price for firm 2 is  $\bar{p}^*$ . Its profit is thus

$$(\bar{p}^* - c_A - c_{B1})[x^1(\bar{p}^*, \infty) + 0].$$

- ▶ But now suppose firm 1 commits to produce independently. Then consider the following pricing policy for firm 1:  $\hat{p}_{B1} = c_{B1} - \varepsilon$ .  $\hat{p}_A = \bar{p}^* - \hat{p}_{B1}$ . If firm 2 is still inactive, this policy renders exactly the same payoff for firm 1. However, if firm 2 becomes active, the profit for firm 1 is

$$(\bar{p}^* - c_A - c_{B1})[x^1(\bar{p}^*, \hat{p}_A + p_{B2}) + x^2(\bar{p}^*, \hat{p}_A + p_{B2}) + \varepsilon x^2(\bar{p}^*, \hat{p}_A + p_{B2})],$$

which is strictly greater.

- ▶ It is important to note that while firm 1 never commits to bundling to drive firm 2 out, it can do so to price discriminate.
- ▶ E.g. If some consumers set benefit from  $A + B1$ , but moderately, and some get enormous benefit from  $A + B2$ . Then firm 1 wants set A's price very high and B1's price very low. If the intended price for B1 is so low that it's negative, then firm 1 will commit to bundle, although not with an intention to driving firm 1 out.

B. Existence of an inferior, competitively supplied A:

There exists another A2 whose cost is also  $c_A$ . However, it is inferior to A (now call it A1) in that

$$v_{a2/b_i}(d) = v_{A1/B_i}(d) - (\gamma - c_a).$$

This specification can constraint the monopolist's ability in pricing A1 + B1 when it bundles. That is, its price cannot be  $\gamma - c_A$  more of (A1 + B2)'s price. This might prompt the monopolist to tie on order to foreclose A2 (not B2).

C. A alternative use for B:

There is an alternative use of B which does not require A. Obviously, firm 1 will find it worthwhile to exclude firm 2 in order to monopolize market for B. But now it does it by producing bundle and B1 alone.