Lecture 7: Incumbent advantage. Entry Deterrence and Accommodation

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Outline

1. First-mover advantage
   - A More General Insight
   - Deterrence of Entry
   - Accommodation of Entry
2. Empirical evidence: Pharmaceutical firms' behavior at patent expiration
3. Some other incumbent advantage stories

First-mover advantage

- It is often argued that early entrants to a market have an advantage over later entrants.
- Here we consider scenario where incumbent may enjoy advantage
  - Stackelberg model: sequential Cournot model
  - More general taxonomy of incumbent/entrant models
  - Predatory pricing; raising rivals' costs

A Simple Model

- Heinrich von Stackelberg (1934).
- Two firms. Firm 1 (the incumbent) chooses a level of capital K_1, which is then fixed. Firm 2 (the potential entrant) observes K_1 and then chooses its level of capacity K_2, which is also fixed.
- The profits of firm i are:

$$\Pi^i(K_1, K_2) = K_i(1 - K_1 - K_2)$$

- Recall these are the reduced-form profit functions that come from short-run price competition with given capacities.
- Key assumptions here are that
  1. $\Pi^i_j < 0$ (each firm dislikes capital accumulation by the other firm) and
  2. $\Pi^i_{ij} < 0$ (capital levels are strategic substitutes)

"Stackelberg"

- Solve for the SPNE of this game by backward induction.
- Entrant's Reaction Function

$$K_2 = R_2(K_1) = \frac{1 - K_1}{2}$$

- Incumbent anticipates and maximizes:

$$\Pi^1(K_1) = K_1 \left(1 - K_1 - \frac{1 - K_1}{2}\right)$$

- The (unique) SPNE is $(K_1 = \frac{1}{2}, R_2(K_1) = \frac{1-K_1}{2})$
- Results in outcomes

$$K_1 = \frac{1}{2}, K_2 = \frac{1}{4}, \Pi^1 = \frac{1}{8}, \Pi^2 = \frac{1}{16}$$

Accommodation of Entry

- Despite identical profit functions, firm 1 (the incumbent) obtains a higher profit by **limiting the size** of firm 2's entry.
- **First Mover Advantage** (in <u>this</u> game).
  - Compare (Figure here) with Cournot: $K_1 = K_2 = \frac{1}{3}$, $\Pi^1 = \Pi^2 = \frac{1}{9}$.
- Intuition is the same for more general profit functions:
  1. By raising K_1, firm 1 reduces the marginal profit from investing for firm 2 (as long as $\Pi^2_{21} < 0$)
  2. Thus firm 2 invest less, which benefits its rival (as long as $\Pi^1_2 < 0$)
- Irreversibility is crucial (F1 is not on its reaction curve ex post)

Entry Deterrence

- In the previous model firm 1 can not deter entry: small scale entry is always profitable. But this small scale entry becomes unprofitable under increasing returns to scale.
- Introduce fixed (non-sunk) cost of entry $f < \frac{1}{16}$ for firm 2.
- If $K_1 = \frac{1}{2}$ as before, firm 2 makes a profit. But f1 can choose capital K_1^b so that

$$max_{K_2}[K_2(1 - K_2 - K_1^b) - f] = 0$$

- For f close to $\frac{1}{16}$, F1 can increase its profits by deterring entry. For f "small", prefers to accommodate entry as before. For $f > \frac{1}{16}$ F1 can block entry simply by choosing its monopoly capacity level

Quantities and Capacities

- Stackelberg wrote his two-stage game in terms of quantities
- Difficulties:
  1. What does quantity competition mean ?
  2. Why does one of the firms enjoy a first mover advantage?
  3. Why does quantity have a commitment value?
- Spence and Dixit made the Stackelberg story consistent by basically interpreting quantities as capacities. With this:
  1. Profit functions are reduced-form profit functions from the capacity constrained price competition game
  2. 1st mover advantage may come from one firm acquiring the technology earlier
  3. Capacities have a commitment value (if they are sunk)

First Mover Advantage

- First mover does not have the advantage in all games
- As a simple example, consider Bertrand competition
- Real-world examples: Microsoft Windows, iPod, iPhone, iPad.

A More General Insight: Strategic Value of Commitment

- Physical capital may facilitate the erection of barriers to entry. Other kinds of capital may have the same effect if they have **commitment value** (if they are irreversible, at least in the short run).
- Example: clientele.
  - Reduces demand for potential entrant
  - More so the more imperfect the consumers' information and the more important the costs of switching suppliers
- Stackelberg model's main point is that commitments matter because of their **influence on the rival's actions**.
  - In the capacity-accumulation game, the incumbent overinvests to force the entrant to restrict his own capacity. But this is a much more general insight.

A General Taxonomy of Entry Models

- Consider the following two-firm, two-period model. In period 1, firm 1 (the incumbent) chooses an "investment" (broad interpretation) K_1. Firm 2 observes K_1 and decides whether to enter.

  1. If 2 does not enter, incumbent enjoys a monopoly position in the second period: $\Pi_1^m(K_1, x_1^m(K_1))$.

  2. If 2 enters, the firms make simultaneous second-period choices x_1 and x_2, determined by a (assumed unique and stable) Nash equilibrium: $x_1^*(K_1)$ and $x_2^*(K_1)$. Profits are then

     $$\Pi_1(K_1, x_1^*(K_1), x_2^*(K_1)) \text{ and } \Pi_2(K_1, x_1^*(K_1), x_2^*(K_1))$$

     (by convention, firm 2's entry cost is part of Π^2).

The benchmark Model

- Entry is **deterred** if K_1 is chosen so that

$$\Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) \leq 0$$

- Entry is **accommodated** if

$$\Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) > 0$$

Deterrence of Entry

- To deter entry, incumbent chooses K_1 such that

$$\Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) = 0$$

- How would firm 1 best achieve this? Take the total derivative of Π^2 with respect to K_1. By the envelope theorem we can ignore the effect of K_1 on Π^2 through firm 2's second period choice. Two terms remain:

$$\frac{d\Pi^2}{dK_1} = \frac{\partial \Pi^2}{\partial K_1} + \frac{\partial \Pi^2}{\partial x_1}\frac{dx_1^*}{dK_1}$$

  - **Direct effect** on firm 2's profit $\partial \Pi^2/\partial K_1$. (often $\partial \Pi^2/\partial K_1 = 0$, negative in the clientele example).
  - **Strategic effect**: K_1 changes firm 1's ex post behavior (by dx_1^*/dK_1) thus affecting firm 2's profit (in proportion $\partial \Pi^2/\partial x_1$).

Over and Underinvest

- To keep with Tirole's terminology, we will say that investment K_1 makes firm 1 **tough** if $d\Pi^2/dK_1 < 0$ and **soft** if $d\Pi^2/dK_1 > 0$.
- To deter entry firm 1 wants to to invest (choose K_1) to make Π^2 low. If investment makes her tough (soft), firm 1 should **overinvest** (respectively, **underinvest**)

  (over or under invest relative to the solution of the game when K_1 is not observable by firm 2 prior to its decision)

Example: Modified version of Spence-Dixit model.

- Firm 1 chooses an investment K_1, which determines firm 1's second period marginal cost, $c_1(K_1)$, $c_1' < 0$. In the second period, firms 1 and 2 compete in quantities: $x_1 = q_1$ and $x_2 = q_2$ (we ignore 2's choice of investment).

- In the second period firm 1 maximizes

$$q_1(P(q_1 + q_2^*) - c_1)$$

  - A higher K_1 shifts firm 1's reaction curve to the right. Assuming that quantitites are strategic substitutes, when firm 1's cost decreases the firm has an **incentive to produce more, which lowers the marginal value of output for firm 2**. The new equilibrium involves a higher output for firm 1 and a lower output for firm 2.

- Main point here: **investment makes firm 1 tough. Hence overinvestment is appropriate to deter firm 2's entry.**

Example: Development of a pre-entry clientele.

- Expenditures that make switching costly to at least some of its customers (ex frequent flyer discounts).
  - The direct effect of K_1 is to reduce firm 2's potential market ($\partial \Pi^2 / \partial K_1 < 0$).
  - Strategic effect has the opposite impact on firm 2's profit *if firm 1 is not able to price discriminate between its customers*.
    - Would like to charge high price to captive customers and low price to the non-captive segment of the market.
    - In the absence of price discrimination, however, an intermediate price is quoted, which increases with the size of the captive clientele.
- **A large clientele reduces how aggresive firm 1 is in price competition.**
- Entry deterrence might require **underinvestment**

Accommodation of Entry

- Suppose now that firm 1 finds deterring entry too costly.
- Behavior in the entry-deterrence case was dictated by firm 2's profit.
- When entry is not deterred, but only accommodated, behavior is again determined by firm 1's profit. The incentive to invest is given by the total derivative of $\Pi^1(K_1, x_1^*(K_1), x_2^*(K_1))$ with respect to K_1.
- From the envelope theorem, the effect on Π^1 of the change in firm 1's second period action is of second order. Thus, our basic equation in the entry-accommodation case is

$$\frac{d\Pi^1}{dK_1} = \frac{\partial \Pi^1}{\partial K_1} + \frac{\partial \Pi^1}{\partial x_2}\frac{dx_2^*}{dK_1}$$

Accommodation of Entry

- Again, we can decompose this derivative into two effects.

$$\frac{d\Pi^1}{dK_1} = \frac{\partial \Pi^1}{\partial K_1} + \frac{\partial \Pi^1}{\partial x_2}\frac{dx_2^*}{dK_1}$$

1. The direct or cost-minimizing effect is $\partial \Pi^1 / \partial K_1$.
2. Strategic effect results from the influence of the investment on firm 2's second period action.

Accommodation of Entry

1. Assume that $\partial \Pi^i / \partial x_j$ have the same sign for all i.
   - If the second period competition is in quantities $\partial \Pi^i / \partial x_j < 0$
   - If the second period competition is in prices $\partial \Pi^i / \partial x_j > 0$
2. Note that

$$\frac{dx_2^*}{dK_1} = \left(\frac{dx_2^*}{dx_1}\right)\left(\frac{dx_1^*}{dK_1}\right) = R_2'(x_1^*)\left(\frac{dx_1^*}{dK_1}\right)$$

- With [1] and [2] we obtain

$$sign\left(\frac{\partial \Pi^1}{\partial x_2}\frac{dx_2^*}{dK_1}\right) = sign\left(\frac{\partial \Pi^2}{\partial x_1}\frac{dx_1^*}{dK_1}\right) \times sign\left(R_2'\right)$$

- Thus the sign of the strategic effect and therefore the under or overinvestment prescription is contingent on
  - The sign of the strategic effect in the entry-deterrence game, and
  - The slope of firm 2's reaction curve:
    - $R_2' > 0$: "strategic complements" (eg. Bertrand price competition)
    - $R_2' < 0$: "strategic substitutes" (eg. Cournot quantity competition)

Accommodation of Entry: a taxonomy

- We thus have four cases, depending on whether investment makes firm 1 tough or soft and on whether second-period actions are strategic substitutes or complements (whether reaction curves are downward or upward sloping).

1. [Tough + strategic substitutes]: investment triggers a softer action by firm 2. Overinvest for both deterrence and accommodation. (Spence-Dixit model with quantity competition.) "Top Dog"
2. [Soft + Strategic Complements]: investment induces a softer action by firm 2. Underinvest to deter entry ("Lean and Hungry Look") but overinvest to accommodate entry ("Fat Cat"). Clientele model, with post-entry price competition.
3. [Tough + Strategic Complements]: investment by firm 1 induces softer action by firm 2. Overinvest to deter entry ("Top Dog") but underinvest to accommodate entry ("Puppy Dog"). Spence-Dixit game with post-entry price competition.
4. [Soft + Strategic Substitutes]: investment by firm 1 induces a more aggresive response by firm 2. Underinvest for both deterring and accommodating entry. ("Lean and Hungry Look") Advertising with spillovers, with post-entry quantity competition.

Capacity investment game: A Remark

- In the modified Spence-Dixit game with quantity competition, note that firm 1's strategy is the same whether it wants to deter or accommodate entry, because being tough both hurts and softens firm 2 in the quantity game.
- However, in the price game, firm 1's strategy is very different depending on whether it wants to deter or accommodate entry, because being tough both hurts and make more aggressive firm 2 in the price game.

Example: Advertising with spillovers

- Incumbent's strategic variable is advertising A, which shifts up demand curves for both itself and for entrant (if it enters)
- Second stage game: pricing game (strategic complements)
- For entry deterrence: larger A makes firm 1 *soft*, so *underinvest*
- For entry accommodation: larger A makes firm 2 less aggressive (set higher price) in post-entry pricing game, so *overinvest*.
- What if Cournot competition in second period?
- What if A only generates benefits for incumbent's product (enhances product differentiation)?

- To look for evidence of strategic entry deterrence, need market in which *entry opportunities are observed.* Difficult.
- Unique case: patent expiration in pharmaceuticals.
- Look at behavior of branded producers around patent expiry.
- Focus on three variables:
  1. Detailing advertising
  2. Journal advertising
  3. Proliferation of presentational forms
- Focus on how these variables change as a function of *market size*. Absent strategic entry deterrence motives, these variables should be monotonic in market size.
- Paper by G. Ellison and S. Ellison

Strategic vs. unstrategic choices

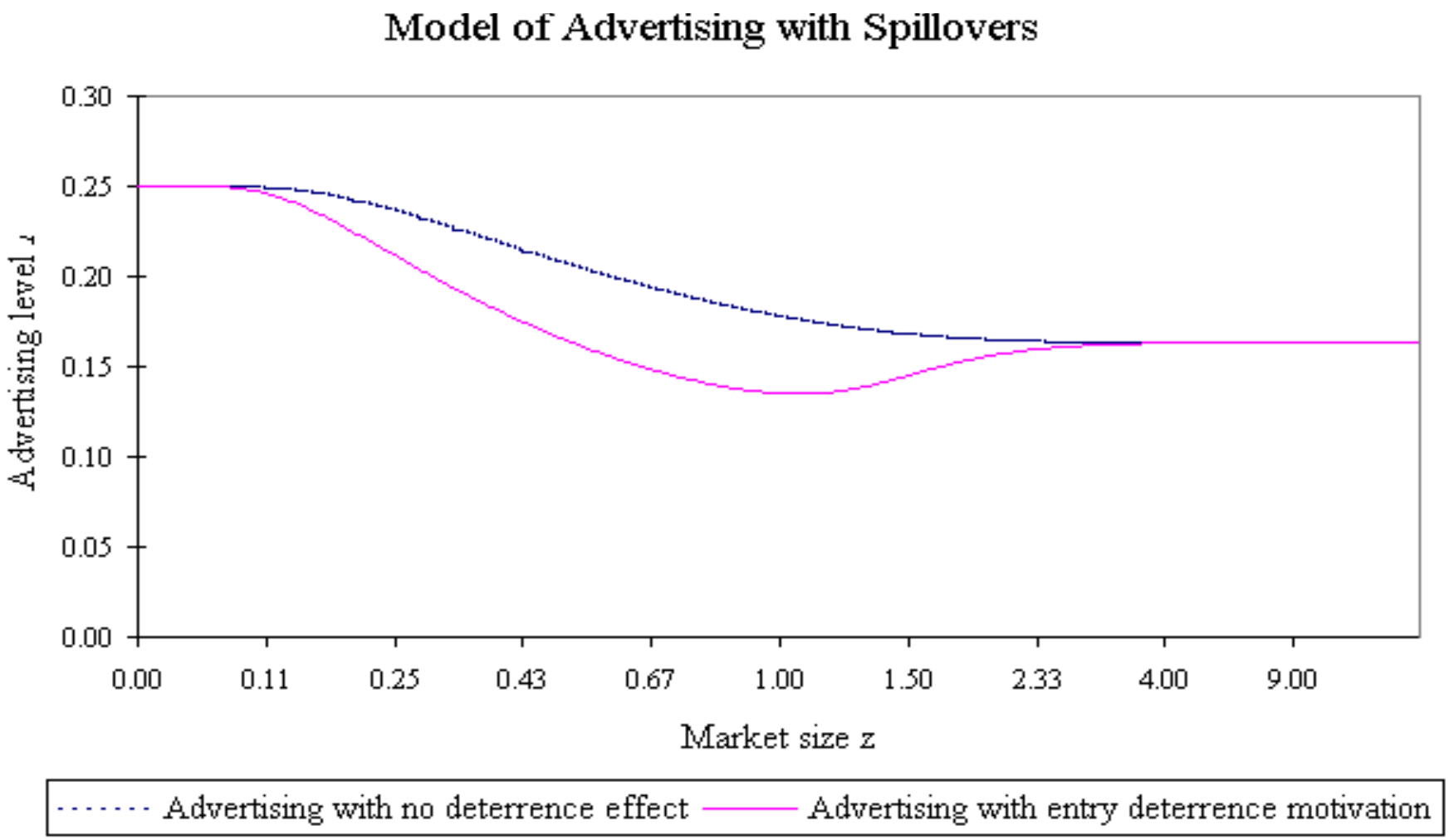
Strategic Entry Deterrence Model

$t = 1$	$t = 1\frac{1}{2}$	$t = 2$	$t = 3$
Incumbent chooses A at cost $c(A)$	Potential entrant observes A	Potential entrant learns E. Chooses whether to enter at cost E	Monopolist chooses x_1 or duopolists choose x_1, x_2 Profits: $\pi_i(x_1, x_2, A)$

Investment With No Entry Deterrence Motive

$t = 1$	$t = 2$	$t = 2\frac{1}{2}$	$t = 3$
Incumbent chooses A at cost $c(A)$	Potential entrant learns E. Chooses whether to enter at cost E	Potential entrant observes A	Monopolist chooses x_1 or duopolists choose x_1, x_2 Profits: $\pi_i(x_1, x_2, A)$

Example: advertising with spillovers



Data: summary statistics

Table 3: Summary statistics

Variable	Number of Observations	Mean	Standard Deviation
$Entry3Yr$	63	0.59	0.50
$Revenue3$	63	39,355	55,754
$\log(Revenue3)$	63	9.40	2.00
$HospFrac$	63	0.21	0.30
$Chronic$	63	0.63	0.42
$TherSubs$	63	8.48	6.04
$Detail3/Revenue3$	69	0.005	0.008
$Journal3/Revenue3$	70	0.014	0.022
$PresHerf3$	70	0.54	0.29
$DPrice_t/DPrice_{t-1}$	245	1.019	0.067
$HPrice_t/HPrice_{t-1}$	233	1.010	0.129

Results: monotonicity test 1

Table 7: Incumbent behavior versus market size: quintile means and monotonicity tests

	Variable mean for drugs in revenue quintile					Monotonicity test p-value	
Variable	Q 1	Q 2	Q 3	Q 4	Q 5	H-H Test	E-E Test
$Detail3/Revenue3$	0.0051	0.0012	0.0055	0.0084	0.0041	0.274	0.161
$Journal3/Revenue3$	0.011	0.005	0.011	0.024	0.018	0.053	0.197
$PresHerf3$	0.78	0.64	0.49	0.44	0.35	0.336	0.187

Results: monotonicity test 2

Table 8: Changes in incumbent behavior as expiration approaches: quintile means and monotonicity tests

	Fraction increasing by quintile					Monotonicity test p-value	
	Q 1	Q 2	Q 3	Q 4	Q 5	H-H Test	E-E Test
$Detail3$	0.75	0.22	0.25	0.54	0.62	0.307	0.031
	(4)	(9)	(12)	(13)	(13)		
$Journal3$	0.50	0.43	0.17	0.29	0.31	0.321	0.696
	(2)	(7)	(12)	(14)	(13)		
$PresHerf$	0.33	0.42	0.38	0.50	0.62	0.083	0.217
	(6)	(12)	(13)	(14)	(13)		
$DPrice$	0.70	0.58	0.75	0.54	0.92	0.430	0.601
	(10)	(12)	(12)	(13)	(13)		
$HPrice$	0.50	0.50	0.54	0.77	0.73	0.573	0.854
	(8)	(12)	(13)	(13)	(11)		

Other stories

Other examples of behavior that incumbent engages in to maintain advantage:

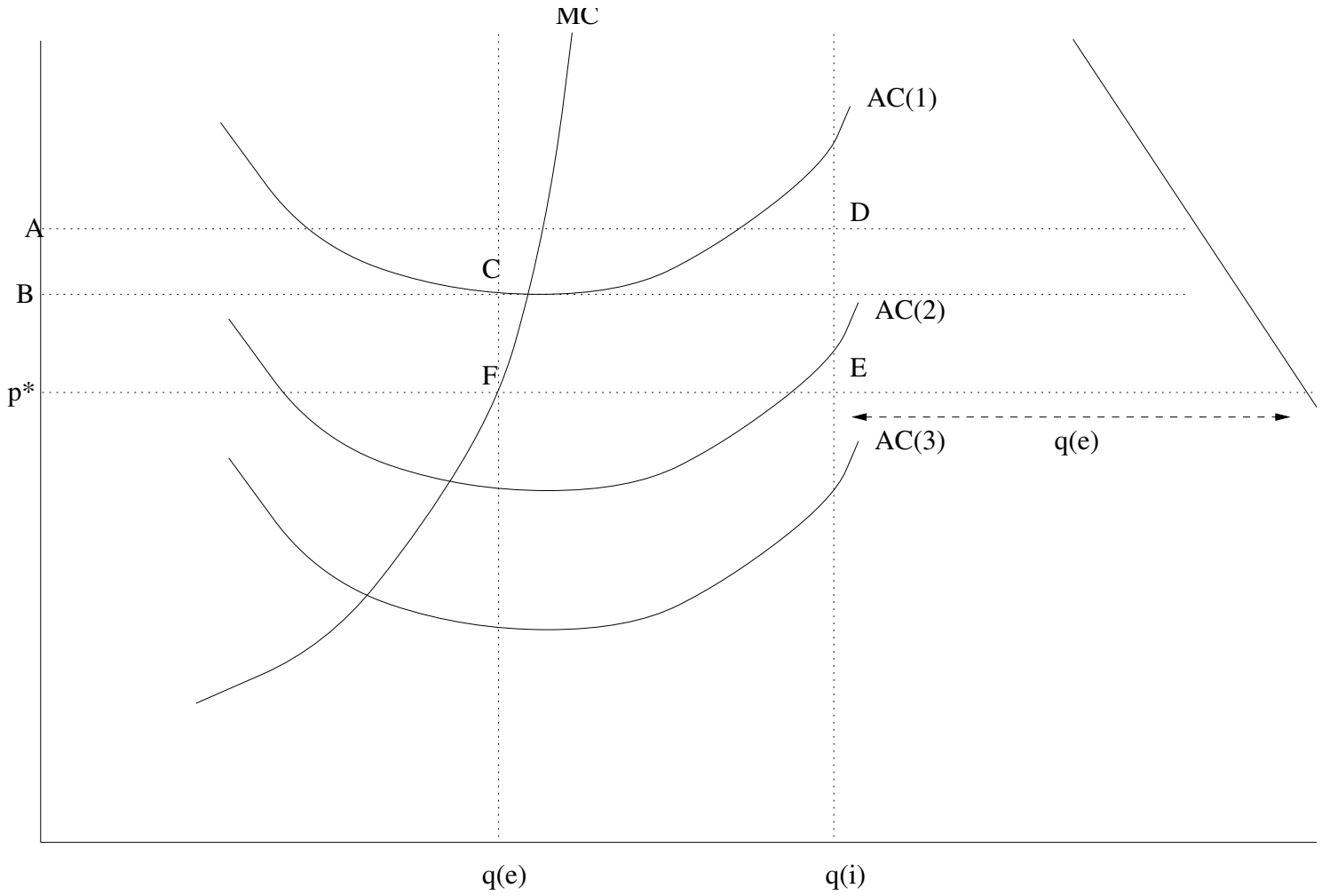
1. Predatory pricing: lowering price to drive rivals out of market
2. Raising rivals' costs. Closely related to "poison pills" in takeover battles.

Predatory pricing 1

- Incumbent prices below competitor's cost, and drives it out of business.
- Single-period case (game tree): identical to "traditional" limit pricing model, except that entrant is already in the market.
  1. Formally: incumbent threatens to produce to keep market price at (say) $P*$, below rival's AC.
  2. If entrant believes this, it is price taker and produces on its MC curve, at $q(e)$. Incumbent must produce $q(i)$ to depress price to $P*$.
  3. Graph, assuming identical firms. Incumbent suffers larger losses than rival!
- With identical firms, predation is not likely to be credible threat

Illustration: Predatory Pricing

(Carlton/Perloff)



Predatory pricing 2

Some ways incumbent can have advantage which makes predation threat credible:

- Size differences: Larger incumbent firm has access to funds which smalled rival doesn't. Can make predation a preferred strategy in the long-term.
- Imperfect information: uncertainty about incumbent's costs. Graph. If incumbent's costs are $AC(3)$, then even at quantity $q(i)$ it is making positive profit. But if incumbent really has lower cost, entrant shouldn't be in the market to begin with!

Raising rivals' costs 1

Incumbent may deter entry (or drive rivals out) by activities which raise its rivals' costs of production.
Incumbent advantage already assumed: difficult to disentangle

- competitive business practices of dominant firm
- malignant behavior towards rivals

Example: Microsoft forces PC manufacturers who pre-install Windows OS to bundle it with Internet Explorer.

- Raises its rival's (Netscape) selling costs
- But is this competitive business practice, or malignant behavior?

Raising rivals' costs 2

General schematic diagram.

In general, for a RRC strategy to be credible, you need $\pi^m - C > \pi^d$.

Raising rivals' costs 3

- Government regulation: quotas verses tariffs. Industry may prefer quotas because limited number of import licenses locks potential rivals out of market.
- "Sleeping patents": incumbent has more incentive to invent and patent (but never produce) potential substitutes to its product. Preemptive-innovation. Is buying out small firms a related phenomenon?
- Raise consumer switching costs: frequent flyer miles, preferred customer cards, etc. Rivals must price lower to overcome consumers' brand loyalty.