Lecture 7: Incumbent advantage. Entry Deterrence and Accommodation

EC 105. Industrial Organization

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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).

- Market demand $P = 1 - Q$
- 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 (short-run) profits of firm i are:

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

- 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 (best-response) Function

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

- Incumbent anticipates and maximizes:

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

  - Incumbent not on his own best-response curve
  - By moving first, he chooses his most preferred point on rival's best-response curve.
- The (unique) SPNE is $(K_1 = \frac{1}{2}, R_2(K_1) = \frac{1-K_1}{2})$ with

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

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 this 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)
  - Capacity must be *sunk*

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: **fixed costs of entry**.
- Introduce fixed (non-sunk) cost of entry $f < \frac{1}{16}$ for firm 2.
- If $K_1 = \frac{1}{2}$ as before, F2 makes a profit. But F1 can deter entry by F2 by choosing capital K_1^b so that

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

- Three cases:
  1. For $f << \frac{1}{16}$ (very small), F1 prefers to accommodate entry (Stackelberg leader)
  2. For $f \approx \frac{1}{16}$, F1 can increase profits by deterring entry.
  3. For $f > \frac{1}{16}$, entry "blockaded". F1 blocks entry by choosing its monopoly capacity level (which is optimal)

A More General Insight: Strategic Value of Commitment

- Physical capital acts as a "barriers to entry". To be effective, barriers to entry must be *credible* or 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
  - "Loyalty revolution" in marketing/promotions (1980s)

- 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.
    - Overinvest relative to no-rival benchmark.
    - This is a much more general insight.

A General Taxonomy of Entry Models

- Consider the following two-firm, two-period model. In period 1, F1 (the incumbent) chooses an "investment" (broad interpretation) K_1. F2 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

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

- Important insight: F1's choice of K_1 depends on whether he decides to deter or accommodate entry.
  - Ultimate advantage of being first mover is that you can "pick your competition"

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.

$$\frac{d\Pi^2}{dK_1} = \frac{\partial \Pi^2}{\partial K_1} + \frac{\partial \Pi^2}{\partial x_1}\frac{dx_1^*}{dK_1} + \frac{\partial \Pi^2}{\partial x_2}\frac{dx_2^*}{dK_1}$$

- By F2 optimization, 3rd term equal to zero (*envelope theorem*).
- So two terms reman:
  - **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)
- Consider generalized Stackleberg game: F1 can build capacity before F2 enters.
  - Higher capacity makes F1 produce *more* in period 2.
  - Higher q_1 reduces profits for F2: thus K_1 makes F1 tough.
  - F1 overinvests in capacity to deter entry.

Example: Loyalty programs and entry deterrence

- F1 can invest in "loyalty" programs which make it costly for its customers to switch to F2 (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!
    - F1 will charge high prices to its captive (loyal) customers.
    - The higher K_1 (captive clientele), the higher p_1.
    - High p_1 makes it *easier*, more profitable, for F2 to enter!
    - (Assume F1 cannot price discriminate)
- Since **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.
  - Then he may decide to *accommodate* entry
  - But he can still choose K_1 to improve his post-entry position/profits
- Behavior in the entry-deterrence case was dictated by firm 2's profit.
- When entry is accommodated, behavior is 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.

$$\frac{d\Pi^1}{dK_1} = \frac{\partial \Pi^1}{\partial K_1} + \frac{\partial \Pi^1}{\partial x_1}\frac{dx_1^*}{dK_1} + \frac{\partial \Pi^1}{\partial x_2}\frac{dx_2^*}{dK_1}$$

(2nd term =0 by envelope theorem)

Accommodation of Entry

- As before, whether incumbent will over- or underinvest in K_1 to accommodate entry depends on direction of $\frac{d\Pi^1}{dK_1}$.
- 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 $\partial \Pi^1 / \partial K_1$. *Ignore this* as this does not impact whether F1 over- or underinvests.

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
    - whether investment makes you *tough* (-) or *soft* (+)
  - 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)
  - Tough/SC, Soft/SS: negative (underinvest to accommodate entry)
  - Tough/SS, Soft/SC: positive (overinvest)

A taxonomy of Entry scenarios

Thus we can summarize in four cases

1. [Tough + SS]: investment triggers a softer action by firm 2. Overinvest for both deterrence and accommodation. (Capacity investment model with quantity competition.) "Top Dog"
2. [Soft + SC]: investment induces a softer action by firm 2. Underinvest to deter entry ("Lean and Hungry Look") but overinvest to accommodate entry ("Fat Cat"). Loyalty model.
3. [Tough + SC]: investment by firm 1 induces softer action by firm 2. Overinvest to deter entry ("Top Dog") but underinvest to accommodate entry ("Puppy Dog"). Capacity w/ Bertrand.
4. [Soft + SS]: investment by firm 1 induces a more aggresive response by firm 2. Underinvest for both deterring and accommodating entry. ("Lean and Hungry Look")

Capacity investment game: remarks

F1's behavior in Stackelberg capacity competition game:

- Under period 2 competition in *quantities*
  - We are in the "Tough+SS" box (Top Dog). F1 overinvests both to dfeter and accommodate entry
- Under period 2 competition in *prices*
  - We are in "Tough+SC" box. F1 overinvests to deter entry (Top Dog)
  - .. but *underinvests* to accommodate entry (Puppy Dog)
  - Increased capacity sends credible signal that F1 will set low prices in period 2. This is undesirable for entry accommodation.

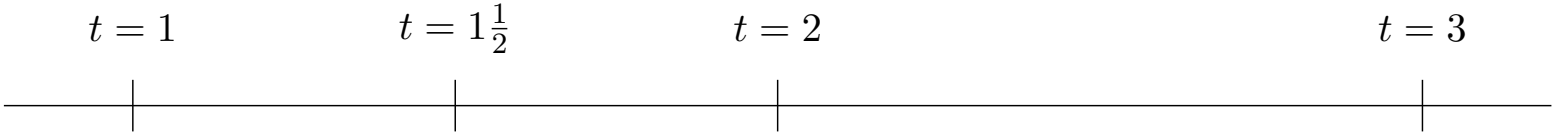
Example: Advertising with spillovers

- Incumbent's strategic variable is advertising A, which shifts up demand curves for both itself and for entrant (if it enters)
  - Advertising for iPad increases demand for *all* tablets
  - Advertising for innovative drug helps *all brands* of the drug.
- Second stage game: pricing game (strategic complements)
- We are in the "Soft+SC" box.
  - For entry deterrence: *underinvest* in A (Lean and Hungry look)
  - For entry accommodation: *overinvest* in A. (Fat cat)
- What if Cournot competition in second period?
- What if A only generates benefits for incumbent's product?

- To look for evidence of strategic entry deterrence, need market in which *entry opportunities are observed.* Difficult.
- Unique case: patent expiration in pharmaceuticals.
  - Only after patent expires can new firms enter market
- 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



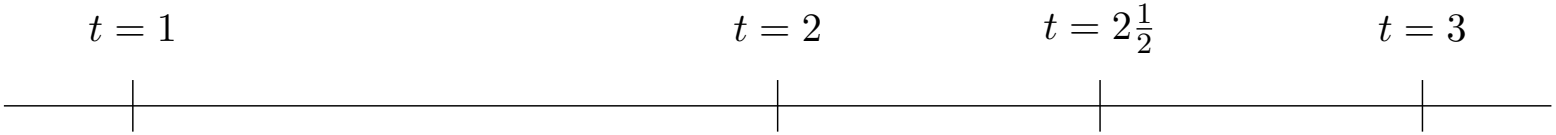
Incumbent chooses A at cost $c(A)$

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



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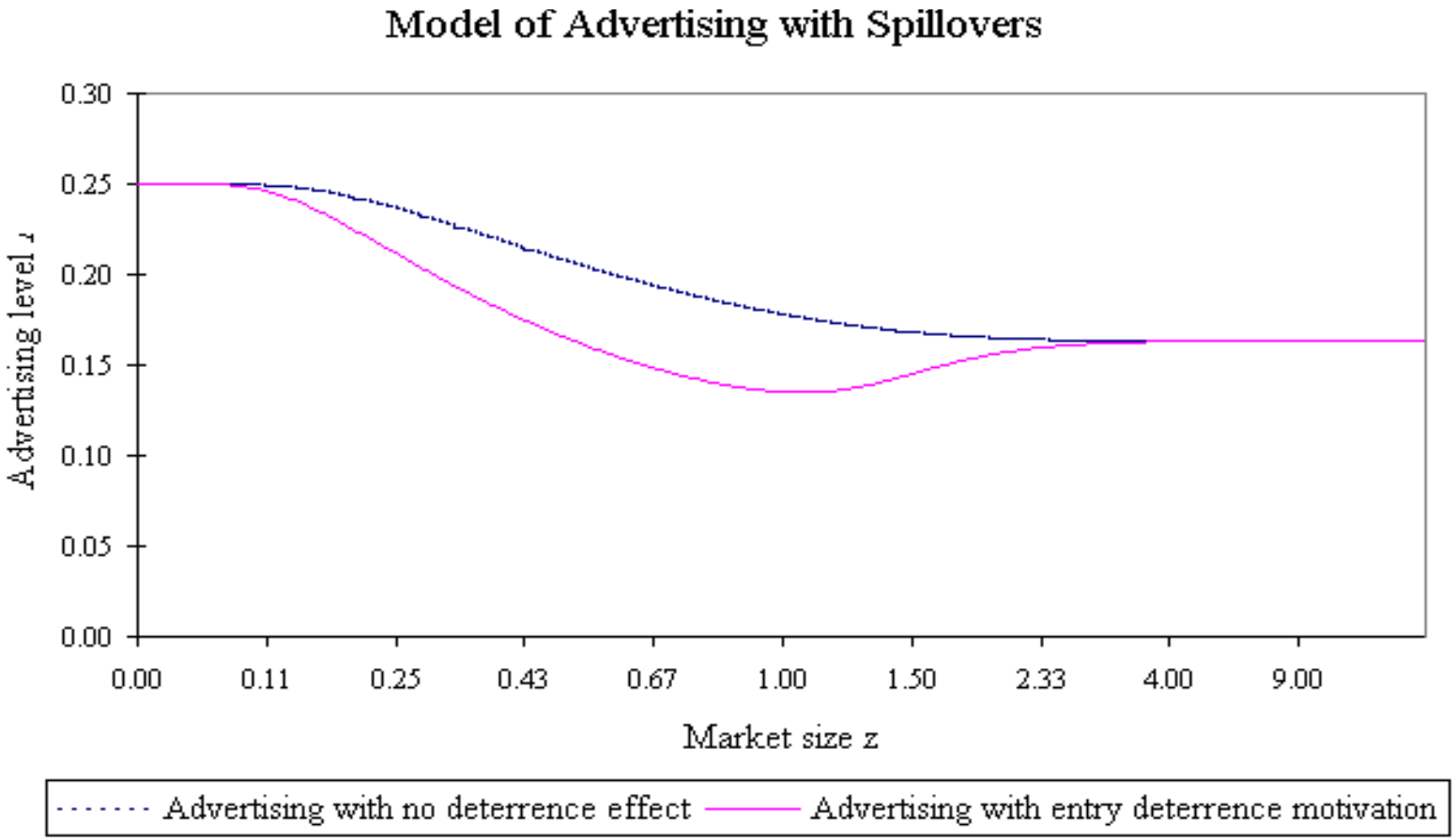


Intuition: only in medium-sized markets is entry deterrence necessary

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

Lower advetising in Q2, Q3 markets (but also Q5?)

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)		

Fewer *increases* in advertising, in Q2, Q3 markets.

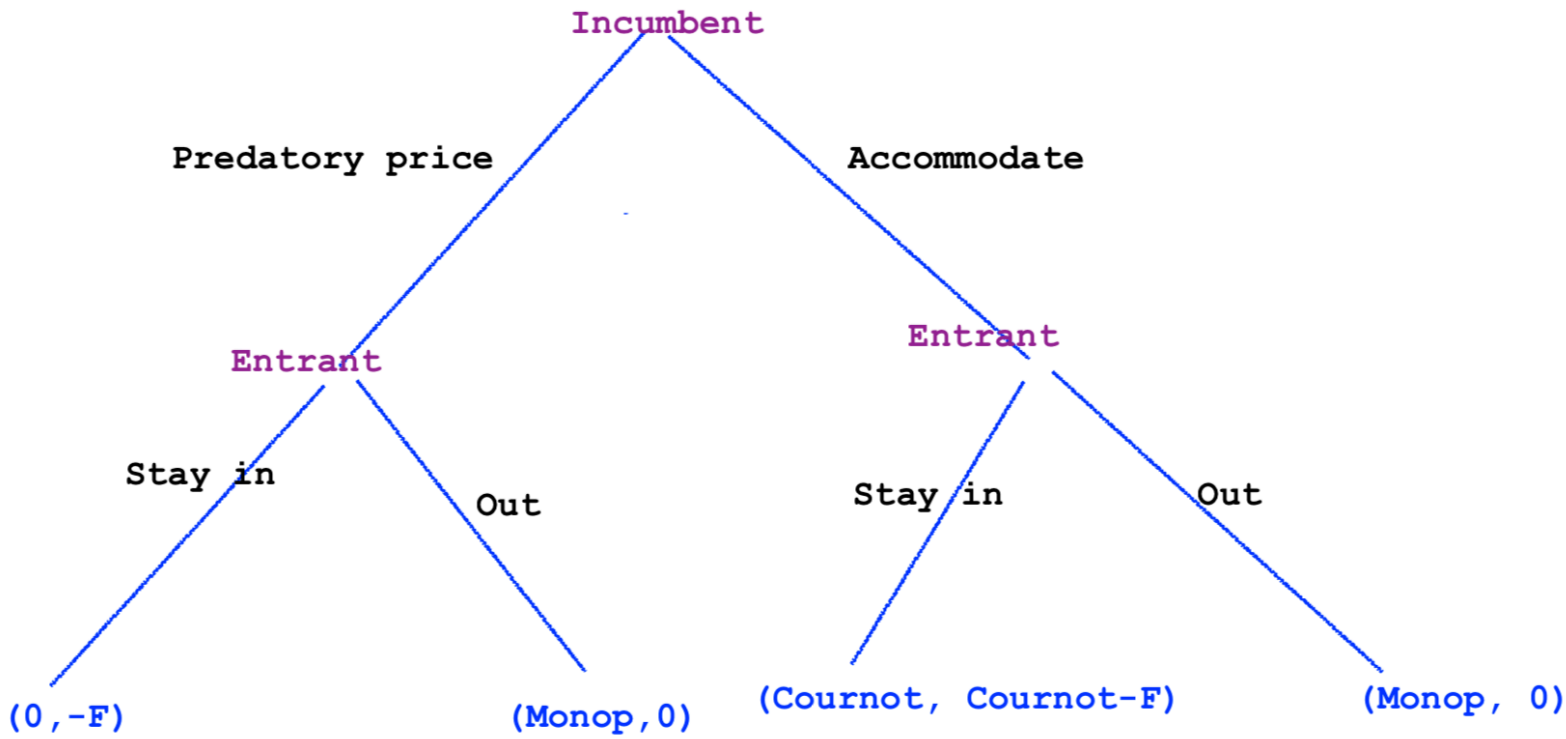
Other stories

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.
   - "poison pills" in takeover battles.
   - Long-term contracts with suppliers

Predatory pricing 1

- Incumbent prices below competitor's cost, and drives it out of business.
- Single-period case (game tree): similar to limit pricing model, except that entrant is already in the market.


Incumbent
Predatory price
Accommodate
Entrant
Entrant
Stay in
Out
Stay in
Out
(0,-F)
(Monop,0)
(Cournot, Cournot-F)
(Monop, 0)

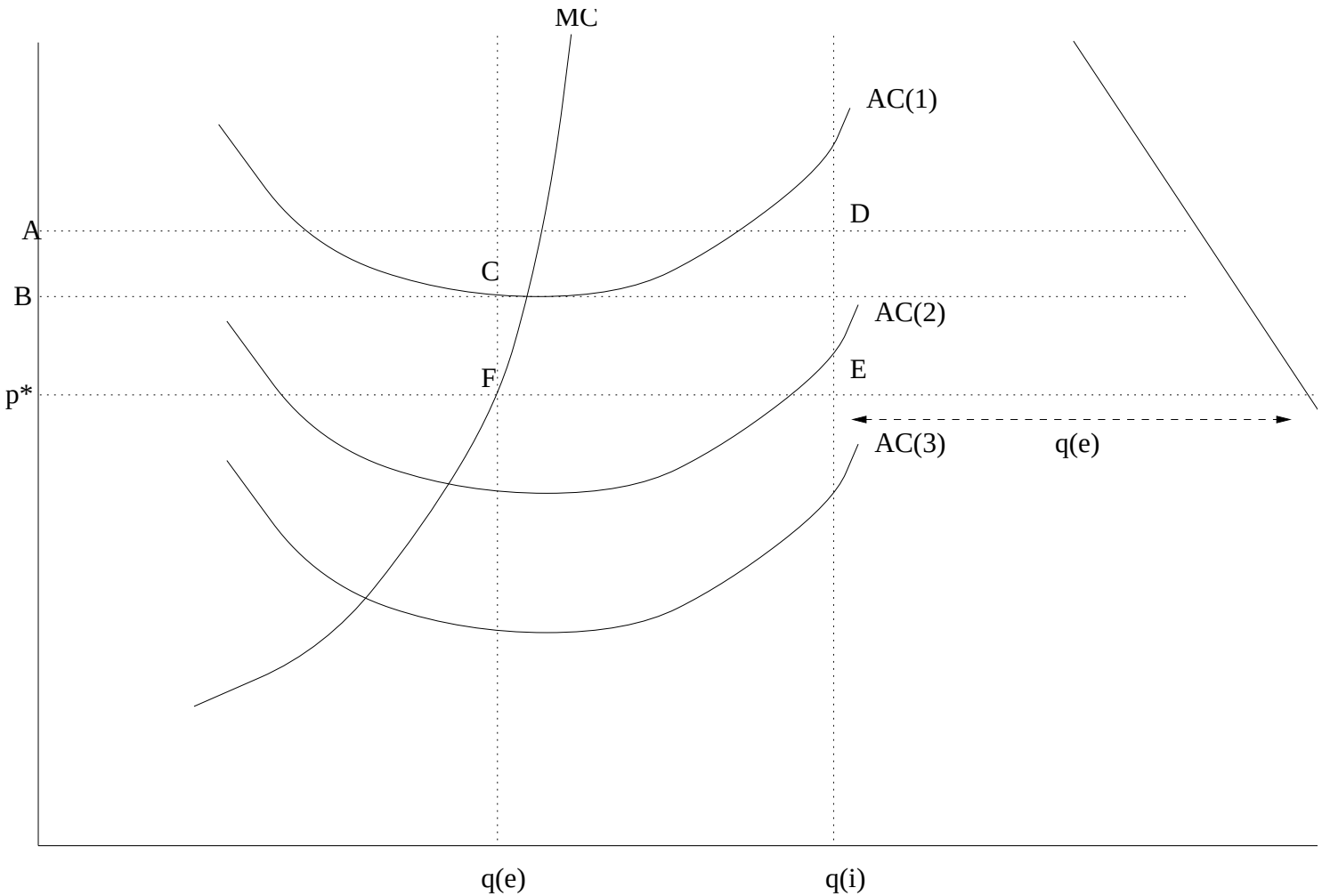
Problemmatic argument

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, "deep pockets": 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

- More generalky, 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?
- In general, for a RRC strategy to be credible, you need $\pi^{monop} - \text{Cost}(RRC) > \pi^{duop}$.

Raising rivals' costs: examples

- 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.

First Mover Advantage??

- While we have focused here on advantages for incumbents
- First mover does not have the advantage in all games
  - Stackelberg version of Bertrand?
- Moreover, When market is uncertain, *second mover* may have advantages
  - Enter after market uncertainty is resolved.
  - Many tech sectors characterized by 2MA:
    - Microsoft Windows, iPod, iPhone, iPad
  - Tesla/Elon Musk??