Chapter 8: Entry, Accommodation, and Exit

- Barrier to entry (no government intervention)
- 4 elements of market structure (Bain, 1956)
  - Economies of scale - Natural Monopoly
  - Absolute cost advantages - Superior technology
  - Product Differentiation advantage - Niche
  - Capital requirement - difficulty to find financing

3 kinds of behavior by incumbent:
1. Blockaded entry - market is not attractive to competitor
2. Deterred entry - strategic behavior from the incumbent
3. Accommodated entry - let it be....

Limit pricing model
- price is so low that it prevents entry (Bain, 1956)
- Incumbent acquires a large capacity to deter entry (Spence (1977, 1979) Dixit (1979, 1980))
• Asymmetric information - signalling aspect (Milgrom Roberts (1982))
1 Fixed costs: natural monopoly and contestability

Fixed cost as a barrier to entry.

1.1 Fixed costs vs sunk costs

Fixed costs are
- independent from the produced quantity
- and are sunk costs in the short run.

\[
C(q) = \begin{cases} 
  f + cq & \text{if } q > 0 \\
  0 & \text{if } q = 0
\end{cases}
\]

1.2 Contestability

- First approach to natural monopoly
- homogeneous good industry
- \(n\) firms
- same technology, costs \(c(q)\) with \(c(0) = 0\)
- 2 groups of firms: \(m\) incumbents \((i = 1, \ldots, m)\), \(m - n \geq 0\) potential entrants.
- industry configuration: \(\{q_1, q_2, \ldots, q_m\}\) for incum-
bents

- \( p \) price charged by incumbents

**Definition 1.** *Industry configuration is feasible* if the market clears.

**Definition 2.** *Industry configuration is sustainable* if no entrant can make a profit taking the incumbent’s price as given. There exists no price \( p_e \leq p_c \) and no quantity \( q_e \leq D(p_e) \) such that \( p_e q_e > c(q_e) \).

**Definition 3.** *A perfectly contestable market* is one in which any equilibrium industry configuration must be sustainable.

- See graph to illustrate the concept

Theory of contestability predicts:
1. There exists a unique operating firm in the industry,
2. the firm makes zero profit,
3. average cost pricing prevails.
But with different demands, or cost functions, natural monopolies may not be sustainable.

- The theory of perfectly contestable markets can be seen as a generalization of Bertrand competition with increasing returns-to-scale (Baumol et al., 1982)
- But prices seem to adjust more rapidly than decisions about quantities or entry.
- Short run capacity commitments.

1.3 War of attrition

- Another approach to natural monopoly
- 2 firms in a fight for a monopoly position.
- Time is continuous from 0 to infinity
- $r$ rate of interest
• Same cost of production

\[ C(q) = \begin{cases} 
  f + cq & \text{if } q > 0 \\
  0 & \text{if } q = 0 
\end{cases} \]

• price adjustments are instantaneous

• If the 2 firms are in the market at time \( t \), \( p = c \) (Bertrand). Each firm loses \( f \) per unit of time.

• If one firm, price is \( p^m \) and profit is \( \Pi^m - f > 0 \) for this firm and 0 for the other.

• Both firms are in the market at date 0.

• At each instant each firm decides whether to exit. Exit is costless. A firm that drops out never returns; the remaining firm stays forever.

• **Symmetric equilibrium** in which at any instant each firm is indifferent between dropping or staying.
  – if one firm drops out: 0 forever;
  – if both firms are still in the market at date \( t \), each firm drops out with probability \( xdt \) between \( t \) and \( t + dt \).

  Profit of one firm from staying is
  \[* - f dt \] is the other is still in,
if the other has dropped (which arises with probability \( x dt \))

Thus

\[
0 = -f dt + \frac{\tilde{\Pi}^m - f}{r} x dt + 0
\]

and the probability of dropping is

\[
x = \frac{rf}{\tilde{\Pi}^m - f}
\]

War of attrition:
1. there are 2 firms in the industry for a (random) length of time; then one exists
2. firms earn no \textit{ex ante} profit, but may have \textit{ex post} profit,
3. the price is first competitive and then price is the monopoly price.
2 Sunk costs and Barrier to entry

- The Stackelberg-Spence-Dixit model
- Sunk costs have a commitment value
- Dynamic game - Stackelberg (1934)
- 2 firms
  - firm 1, incumbent
  - firm 2: potential entrant
- Timing:
  - Firm 1 chooses $K_1$;
  - Firm 2 observes $K_1$ and chooses $K_2$.
- Profits
  \[
  \Pi^i(K_i, K_j) = K_i(1 - K_i - K_j)
  \]
  \(i, j = 1, 2\) for \(i \neq j\)
- Properties:
  - $\frac{\partial \Pi^i}{\partial K_j} < 0$ - each firm dislikes capital accumulation by the other,
  - $\frac{\partial^2 \Pi^i}{\partial K_j \partial K_i} < 0$ - capital levels are strategic substitutes.
No fixed costs of entry

• Firm 2 maximizes
  \[ \Pi^2 = K_2(1 - K_1 - K_2) \]
  and thus
  \[ K_2(K_1) = \frac{1 - K_1}{2} \]

• Firm 1 maximizes
  \[ \Pi^1 = K_1(1 - K_1 - K_2(K_1)) \]
  and thus
  \[ K^s_1 = \frac{1}{2} > K^s_2 = \frac{1}{4}, \quad \Pi^1 = \frac{1}{8} > \Pi^2 = \frac{1}{16} \]

• First mover advantage.

• If simultaneous game
  \[ K^n_1 = K^n_2 = \frac{1}{3} \]
  \[ \Pi^1 = \Pi^2 = \frac{1}{9} \]

• Firm 1 accommodates more capital than in simultaneous game, firm 2 less.

• Firm 1 accommodates entry.

• Graph

• Commitment value: “burning one’s bridge”.
Fixed cost $f$

- Profit of 2 is

$$\Pi^2(K_1, K_2) = \begin{cases} 
  K_2(1 - K_1 - K_2) - f & \text{if } K_2 > 0 \\
  0 & \text{if } K_2 = 0
\end{cases}$$

- If $f > \frac{1}{16} \Rightarrow$ no entry
- If firm 1 chooses $K_1^s = \frac{1}{2}$, 2 will choose $K_2^s = \frac{1}{4}$ and make a profit of $\frac{1}{16} - f > 0$.
- Firm 1 may decide to choose $K_1$ to deter entry.
- $K_1^b$ the level of capital such that firm 1 deters entry
  $$\max\{K_2(1 - K_1 - K_2) - f\} = 0$$

- $K_1^b = 1 - 2f^{0.5}$.
- If $f$ tends toward $\frac{1}{16}$, equilibrium of deterred entry,
- If $f = 0$ (or small), equilibrium of accommodated entry,
- If $f > \frac{1}{16}$, firm 1 blocked entry simply by choosing its monopoly capital level, $K_1^m = \frac{1}{2}$.
2.1 Welfare implication

- $p = 1 - K$ demand function, where $K = K_1 + K_2$ is the industry capacity and output.
- $p$ is the market price.
- Welfare loss from monopoly or duopoly pricing is $WL = \frac{p^2}{2}$.
- If entrant enters, and entry cost, the welfare loss is $\frac{p^2}{2} + f$.

**No entry cost**

- simultaneously choice
  \[ p_n = \frac{1}{3} \]
- Sequentially
  \[ p_s = \frac{1}{4} \]
- Thus,
  \[ p_n > p_s \]
  and $WL_n > WL_s$
Entry costs $f$

The losses are

- if simultaneous decisions
  \[ WL_n = \frac{p^2}{2} + f = \frac{1}{18} + f \]
- and if sequential decisions and entry deterrence
  \[ WL_s = \frac{(2\sqrt{f})^2}{2} = 2f \]
- Thus
  \[ WL_n < WL_s \text{ if } f > \frac{1}{18} \]
- The welfare analysis of entry deterrence is ambiguous because entry can result in biases in either direction.
3 A Taxonomy of Business Strategies

- In Stackelberg model: commitment.
- The incumbent over-invests to force the entrant to restrict its own capacity.
- Here: over-investment and under-investment.

- 2 periods
- 2 firms:
  - incumbent (firm 1),
  - potential entrant (firm 2).

Timing:
- **In period 1,**
  - firm 1 chooses $K_1$ (investment, capacity...);
  - Firm 2 observes $K_1$ and decides whether to enter.
- **In period 2,** if entry, both firms simultaneously choose $(x_1, x_2)$ (quantities, prices...)
In period 2
• If no entry, firm 1 chooses $x_1^m(K_1)$ that maximizes $\Pi^{1m}(K_1, x_1^m(K_1))$.
• If entry, the NE is $(x_1^*(K_1), x_2^*(K_1))$ that solves the maximization program of each firm $\Pi^i(K_1, x_i, x_j^*)$ for $i, j = 1, 2$ and $i \neq j$.

In period 1
• What is the incumbent’s first period choice, $K_1$?
• Entry is **deterred** (and blockaded) if $K_1$ is chosen such that
  $$\Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) \leq 0$$
• Entry is **accommodated** if
  $$\Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) > 0$$
• Assume that $\Pi^{1m}(.)$ and $\Pi^1(.)$ are strictly concave in $K_1$ and $x_1^*(.)$ are differentiable.
3.1 Deterrence of entry

- The incumbent chooses $K_1$ so as to just deter entry
  \[ \Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) = 0 \]

- Total derivative of $\Pi^2$ with respect to $K_1$
  \[ \frac{d\Pi^2}{dK_1} = \frac{\partial \Pi^2}{\partial K_1} + \frac{\partial \Pi^2}{\partial x_1} \frac{\partial x_1^*}{\partial K_1} + \frac{\partial \Pi^2}{\partial x_2} \frac{\partial x_2^*}{\partial K_1} \]

- where
  \[ \frac{\partial \Pi^2}{\partial K_1} \] is the \textbf{direct effect} ($DE_d$)

  \[ \frac{\partial \Pi^2}{\partial x_1} \frac{\partial x_1^*}{\partial K_1} \] is the \textbf{strategic effect} ($SE_d$)

  \[ \frac{\partial \Pi^2}{\partial x_2} \frac{\partial x_2^*}{\partial K_1} = 0 \] (envelope theorem)

- $DE_d$:
  - $- \frac{\partial \Pi^2}{\partial K_1} < 0$ if $K_1$ is clientele accumulated,
  - $- \frac{\partial \Pi^2}{\partial K_1} = 0$ if $K_1$ is an investment that affects firm 1’s technology.

- $SE_d$: $K_1$ changes firm 1’s \textit{ex post} behavior ($\frac{\partial x_1^*}{\partial K_1}$), and thus affect 2’s profit ($\frac{\partial \Pi^2}{\partial x_1}$).
• Terminology:
  – The investment makes firm 1 **tough** if $\frac{d\Pi_2}{dK_1} < 0$
  – the investment makes firm 1 **soft** if $\frac{d\Pi_2}{dK_1} > 0$

• To deter entry firm 1 wants to look tough.

**Taxonomy of business strategies:**

- **top dog** - be big or strong to look tough or aggressive,
- **puppy dog** - be small or weak to look soft or inoffensive,
- **lean and hungry look** - be small or weak to look aggressive or tough,
- **fat cat** - be big or strong to look soft or inoffensive.

• If investment makes firm 1 tough ($\frac{d\Pi_2}{dK_1} < 0$), the firm 1 should **overinvest** to deter entry - **top dog** strategy;

• If investment makes firm 1 soft ($\frac{d\Pi_2}{dK_1} > 0$) the firm should **underinvest** to deter entry; **lean and hungry look**.
Example: (simplified version of Spence-Dixit model)

- firm 1 chooses $K_1$,
- $K_1$ determines 2d period MC, $c_1(K_1)$ with $c'_1 < 0$.

**i.** If **quantity** competition in second period, $(x_1, x_2) = (q_1, q_2)$ (strategic substitutes).

$$\frac{d\Pi^2}{dK_1} = \frac{\partial \Pi^2}{\partial x_1^*} \frac{\partial x_1^*}{\partial K_1} < 0$$

- as $\frac{\partial q_1^*}{\partial K_1} > 0$ and $\frac{\partial \Pi^2}{\partial q_1} < 0$.
- The investment makes firm 1 tough ($\frac{d\Pi^2}{dK_1} < 0$), it should **overinvest** - **top dog strategy** - to deter firm 2’s entry.

**ii.** If **price** competition, $(x_1, x_2) = (p_1, p_2)$ (strategic complements).

$$\frac{d\Pi^2}{dK_1} = \frac{\partial \Pi^2}{\partial x_1^*} \frac{\partial x_1^*}{\partial K_1} < 0$$

- as $\frac{\partial p_1^*}{\partial K_1} < 0$ and $\frac{\partial \Pi^2}{\partial p_1} > 0$.
- The investment makes firm 1 tough ($\frac{d\Pi^2}{dK_1} < 0$) it
should **overinvest** - **top dog strategy** - to deter firm 2’s entry.

### 3.2 Accommodation of entry

- If it is too costly to deter entry, firm 1 may want to accommodate entry.
- The incentive to invest is given by the total derivative
  \[
  \frac{d\Pi^1}{dK_1} = \frac{\partial \Pi^1}{\partial K_1} + \frac{\partial \Pi^1}{\partial x_1} x_1^* + \frac{\partial \Pi^1}{\partial x_2} x_2^*
  \]
- where \( \frac{\partial \Pi^1}{\partial K_1} \) is the **direct effect** \((DE_a)\)

\[
\frac{\partial \Pi^1}{\partial x_1} x_1^* = 0 \text{ (envelope theorem)}
\]

\[
\frac{\partial \Pi^1}{\partial x_2} x_2^* \text{ is the **strategic effect** } (SE_a)
\]

- \( DE_a \) is cost minimizing effect. We ignore it.

- \( SE_a \)
  - Firm 1 should **overinvest** if \( SE_a > 0 \).
  - Firm 1 should **underinvest** if \( SE_a < 0 \).

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• Assume that
  \[ \text{sign}(\frac{\partial \Pi^1}{\partial x_2}) = \text{sign}(\frac{\partial \Pi^2}{\partial x_1}) \]

• i.e.,
  – perfect substitutes \( (\frac{\partial \Pi^i}{\partial x_j} < 0) \)
  – or perfect complements \( (\frac{\partial \Pi^i}{\partial x_j} > 0) \)

• By the chain rule
  \[ \text{sign}(\frac{\partial \Pi^1}{\partial x_2} dx_2^*) = \text{sign}(\frac{\partial \Pi^2}{\partial x_1} dx_1^*) \times \text{sign}(R_2') \]

• sign of \( SE_a \) is contingent on the sign of the \( SE_d \) and on the slope of firm 2’s reaction curve.

• Firm 1 induces a soften behavior by 2 through its investment strategy.
4 different situations

1. If investment makes 1 **tough** (\(SE_d < 0\)) and \(R' < 0\), then \(SE_a > 0\). 1 should **overinvest** (to soften 2’s action) - **top dog strategy**.

2. If investment makes 1 **tough** (\(SE_d < 0\)) and \(R' > 0\), then \(SE_a < 0\). 1 should **underinvest** (not to trigger aggressive response from 2) - **puppy dog strategy**.

3. If investment makes 1 **soft** (\(SE_d > 0\)) and \(R' < 0\), then \(SE_a < 0\). 1 should **underinvest** (to look tough) - **lean and hungry strategy**.

4. If investment makes 1 **soft** (\(SE_d > 0\)) and \(R' > 0\), then \(SE_a > 0\). 1 should **overinvest** (to look soft) - **fat cat strategy**.

- If \(R' > 0\), firm 1 wants to look inoffensive so as to force its rival to be soft.
<table>
<thead>
<tr>
<th>Strategic complements</th>
<th>Investment</th>
<th>makes firm 1 firm 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R' &gt; 0$</td>
<td>A Underinvest</td>
<td>A overinvest</td>
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<td></td>
<td>Dog Puppy</td>
<td>Fat cat</td>
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<td></td>
<td>Overinvest</td>
<td>Lean an</td>
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<td>Top Dog</td>
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<tr>
<td>Strategic substitutes</td>
<td>$A$ or $D$ Overinvest</td>
<td>$A$ or $D$ under</td>
</tr>
<tr>
<td>$R' &lt; 0$</td>
<td>Top Dog</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Lean an</td>
</tr>
</tbody>
</table>

$tough (SE_d < 0)$  
$soft (SE_d > 0)$
Previous Example:

i. Competition in **quantities** (strategic substitutes).

\[ R' < 0 \text{ and } SE_d < 0 \text{ then } SE_a > 0 \]

- Firm 1 should **overinvest - top dog strategy** to deter firm 2’s entry (to hurt firm 2), or to accommodate entry (to soften 2’s behavior).

ii. Competition in **prices**, (strategic complements).

\[ R' > 0 \text{ and } SE_d < 0 \text{ then } SE_a < 0 \]

- To deter entry, firm 1 should **overinvest - top dog strategy**.
- To accommodate entry, firm 1 should **underinvest - puppy dog strategy**, so as not to look aggressive and trigger an aggressive reaction from 2.
4 Application of the Taxonomy

- $K_1$ can be any decision taken in first period.
- Must be observed by firm 2.

4.1 Voluntary limitation of capacity

- **Accommodation** game (Chapter 5)

**Timing**
- **In period 1**, firms choose capacities $K_1$ and $K_2$, $SEP_d < 0$.
- **In period 2**, firms compete in price (strategic complements), $R' > 0$.

$$\text{sign}(SEP_a) = \text{sign}(SEP_d) \times \text{sign}(R') - +$$

$$SEP_a < 0$$

- **Puppy dog** behavior: firms underinvest in the first period not to trigger a tough price competition.
4.2 The principle of differentiation

- **Accommodation** game (Chapter 7)

**Timing**
- **In period 1**, firms choose their location, \( SE_d < 0 \).
- **In period 2**, firms compete in price (strategic complements), \( R' > 0 \).
  \[
  SE_a < 0
  \]
- There is also a direct effect \( DE_a > 0 \).
- **Puppy dog** behavior: firm 1 should locate as far as possible from the other firm.

4.3 Learning by doing

- The quantity (or price) chosen in the first period induces MC of second period to decrease.

i. **Timing** (competition in quantities)

- **In period 1**, firms choose their output, \( SE_d < 0 \).
- **In period 2**, firms compete in quantities, \( R' < 0 \).
If entry accommodation: **top dog** behavior. Firms overinvest.

If entry deterrence: **top dog** behavior. Firms overinvest.

**ii. Timing (competition in prices)**

- **In period 1**, firms choose their prices, \( \frac{d\Pi^2}{dK_1} < 0 \).
- **In period 2**, firms compete in prices, \( R' > 0 \).

\[ SE_a < 0 \]

If entry deterrence: **top dog** behavior. Firm 1 overinvests.

If accommodation: **puppy dog** or **top dog** behavior. Not clear.