8.4 A taxonomy of business strategies

The main lesson from the Stackleberg-Spence-Dixit model is that commitments matter because of their influences on the rivals’ actions. In the capacity-accumulation game, the incumbents overinvest to force the entrant to restrict its capacity (zero capacity if entry is successfully thwarted). However, the overinvestment outcome depends critically on the setup of the model. It is not difficult to come up with a setup such that underinvestment is appropriate for entry deterrence. Is there a systematic way to categorizes firms’ behavior (overinvestment or underinvestment)? How to define the notions of “overinvestment” and “underinvestment”?

There is a taxonomy in IO that is used frequently to frame thoughts on many business strategies regarding entry deterrence and accommodation. This framework can be explained in a two-period, two-firm model. In the first period, firm 1 (the incumbent) chooses some variable \( K_1 \). It can be capacity or other actions. Let’s call \( K_1 \) an investment. Observing \( K_1 \), firm 2 decides whether to enter. If it does not enter, it makes zero profit. The incumbent then enjoys a monopoly position in the second period and makes profit of:

\[
\Pi^{1m}(K_1, x_1^m(K_1)),
\]

where \( x_1^m(K_1) \) is the monopoly choice in the second period as a function of \( K_1 \); e.g., \( x_1 \) can be firm 1’s output. If firm 2 enters, the firms make simultaneous second-period choices \( x_1 \) and \( x_2 \). Their profits are then:

\[
\begin{align*}
\Pi^1(K_1, x_1, x_2) \\
\Pi^2(K_1, x_1, x_2)
\end{align*}
\]

Note that firm 2’s entry cost is part of \( \Pi^2 \). Let \( \Pi^i(\cdot) \) be differentiable. Suppose that firm 1 chooses some level \( K_1 \), and firm 2 enters. The second period (post-entry) choices \( x_1 \) and \( x_2 \) are determined by a Nash equilibrium. Denote \( \{x_1^*(K_1), x_2^*(K_1)\} \) as this Nash equilibrium; assume it is unique and “stable”. Note that, uniqueness requires that \( R_1(x_2) \) and \( R_2(x_1) \) intersect only once; stability requires: \(|dR_1(x_2)/dx_2| > |dR_2(x_1)/dx_1|\).

Let’s now consider the incumbent’s first-period choice of \( K_1 \). We say that entry is
blockaded or deterred, if $K_1$ is chosen such that:

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

So, entry is accommodated if:

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

For simplicity, assume $\Pi^1(K_1, x_1^*(K_1), x_2^*(K_1))$ and $\Pi^{1m}(K_1, x_1^m(K_1))$ are strictly concave in $K_1$, and $x_i^*(\cdot)$ are differentiable.

### 8.4.1 Entry deterrence

When entry is blockaded, the incumbent acts as if there is no threat of entry and there would be no strategic interaction whatsoever. To consider entry deterrence, let’s rule out this uninteresting case. To deter entry, the incumbent chooses a level of $K_1$ so that it drives firm 2’s profit down to zero (i.e., choose $K_1$ such that it just makes: $\Pi^2(K_1, x_1^*(K_1), x_2^*(K_1)) = 0$).

So, to study entry deterrence, we need to figure out how does firm 1’s choice of $K_1$ affect firm 2’s profit. Note that,

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

Thus, the total effect of $K_1$ on $\Pi^2$ is the sum of the direct and strategic effects. In general, the direct effect: $\frac{\partial \Pi^2}{\partial K_1} = 0$; for example, $K_1$ is firm 1’s choice of capacity or production technology. It is possible that: $\frac{\partial \Pi^2}{\partial K_1} < 0$; say example, $K_1$ is the incumbent’s investment on the clientele. It is also likely that: $\frac{\partial \Pi^2}{\partial K_1} > 0$, if the incumbent’s investment has spillover or learning effects on firm 2. The strategic effect comes from the fact that $K_1$ changes firm 1’s ex post behavior (through $dx_1^*/dK_1$), thus affecting firm 2’s profits (through $\partial \Pi^2/\partial x_1$).

We call the investment makes firm 1 tough, if: $d\Pi^2/dK_1 < 0$; soft, if: $d\Pi^2/dK_1 > 0$. Obviously, to deter entry, the incumbent wants to be tough (to hurt its rivals). Consider the following taxonomy of business strategies:
• **top dog**: being big or strong to look tough or aggressive;

• **puppy dog**: being small or weak to look soft or inoffensive;

• **lean and hungry look**: being small or weak to look tough or aggressive;

• **fat cat**: being big or strong to look soft or inoffensive.

Hence, if investment makes firm 1 tough \((d\Pi^2/dK_1 < 0)\), then the incumbent should “overinvest” to deter entry; that is, it should use the “top dog” strategy. If investment makes firm 1 soft \((d\Pi^2/dK_1 > 0)\), then the incumbent should “underinvest” to deter entry; that is, it should use the “lean and hungry look” strategy. Thus, we have the following table:

<table>
<thead>
<tr>
<th>Investment makes firm 1</th>
<th>Tough</th>
<th>Soft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top dog</td>
<td>Lean and hungry look</td>
<td></td>
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</table>

Consider a slightly modified version of the Dixit model. Firm 1 chooses an investment \(K_1\). This investment determines firm 1’s second-period marginal cost \(c_1(K_1)\), with \(c'_1 < 0\). Assuming quantities are strategic substitutes, and prices are strategic complements.

• Suppose in the second period, firm 1 and 2 compete in quantities. Since a higher \(K_1\) reduces firm 1’s cost, firm 1 has an incentive to produce more. This lowers the marginal valuation of output for firm 2. To hurt firm 2, firm 1 should overinvest.

• Suppose firms are producing substitutable differentiated products, and in the second period they compete in prices. Since a higher \(K_1\) reduces firm 1’s cost, firm 1 can quote a lower price. This hurts firm 2 because firm 1 and firm 2 are competing in prices. So, again, to hurt firm 2, firm 1 should overinvest.

It is not difficult to come up with the “lean-and-hungry-look” prescription for entry deterrence. Say \(K_1\) is firm 1’s first-period investment on clientele. The direct effect is to
reduce firm 2’s potential market \( \frac{\partial \Pi_2}{\partial K_1} < 0 \). Consider the second period. Ideally, firm 1 would want to charge a high price to its captive clients and a low price to the noncaptive segment of the market, for which it competes with firm 2. In the absence of price discrimination, however, an intermediate price is quoted, which intuitively increases with the size of the captive clientele. Hence, we have a positive strategic effect. Suppose the overall effect is positive (i.e., \( d\Pi_2/dK_1 > 0 \), the strategic effect dominates the direct effect). Then the appropriate prescription for entry deterrence is to be “lean and hungry look”.

### 8.4.2 Entry accommodation

Suppose now that firm 1 finds entry deterrence too costly. In the entry accommodation game, the incumbent’s investment decision is dictated by its own profit function. So, to study entry accommodation, we need to figure out how does firm 1’s choice of \( K_1 \) affect its own profit. Note that,

\[
\frac{d\Pi^1}{dK_1} = \frac{\partial \Pi^1}{\partial K_1} + \frac{\partial \Pi^1}{\partial x_1} \cdot \frac{dx^*_1}{dK_1} + \frac{\partial \Pi^1}{\partial x_2} \cdot \frac{dx^*_2}{dK_1}
\]

Again, the total effect of \( K_1 \) on \( \Pi^1 \) is the sum of the direct and strategic effects. Note that the direct effect \( \frac{\partial \Pi^1}{\partial K_1} \) would exist even if firm 1’s investment were not observed by firm 2 before firm 2’s choice of \( x_2 \), and therefore could not affect \( x_2 \). Thus, we will ignore this effect for the purpose of the following classification. The strategic effect comes from the influence of the investment \( K_1 \) on firm 2’s second-period action. Now the incumbents would like to overinvest (underinvest) if the strategic effect is positive (negative).

An interesting thing here is that we can relate the sign of the strategic effect to the definition of tough or soft (in the entry deterrence game) and to the slope of the second-period reaction function. Let the game be symmetric in the sense that \( \frac{\partial \Pi^1}{\partial x_2} \) and \( \frac{\partial \Pi^2}{\partial x_1} \) have
the same sign. Note that:

\[
\frac{dx_2^*}{dK_1} = \frac{dx_2^*}{dx_1} \cdot \frac{dx_1^*}{dK_1} = R'_2(x_1^*) \cdot \frac{dx_1^*}{dK_1}.
\]

Thus,

\[
\text{sign}\left(\frac{\partial \Pi^1}{\partial x_2} \cdot \frac{dx_2^*}{dK_1}\right) = \text{sign}\left(\frac{\partial \Pi^2}{\partial x_1} \cdot \frac{dx_1^*}{dK_1}\right) \times \text{sign}(R'_2(x_1^*)).
\]

Hence, the sign of the strategic effect, and therefore the over- or underinvestment prescription, is contingent on the sign of the strategic effect in the entry deterrence game and on the slope of firm 2’s reaction curve. For entry accommodation, the incumbent tries to induce a softer behavior from firms 2 through its investment strategy.

<table>
<thead>
<tr>
<th>Strategic complements $(R' &gt; 0)$</th>
<th>Investment makes firm 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Puppy dog</td>
<td>Tough</td>
<td>Soft</td>
</tr>
<tr>
<td>Lean and hungry look</td>
<td>Top dog</td>
<td>Lean and hungry look</td>
</tr>
</tbody>
</table>

- **Top dog.** If investment makes firm 1 tough and the reaction curves are downward sloping, investment by firm 1 induces a soften action by firm 2; therefore, firm 1 should overinvest for strategic purposes;

- **Puppy dog.** If investment makes firm 1 tough and the reaction curves are upward sloping, firm 1 should underinvest so as not to trigger an aggressive response from firm 2;

- **Lean and hungry look.** If investment makes firm 1 soft and the reaction curves are downward sloping, firm 1 should underinvest to stay lean and hungry;

- **Fat cat.** If investment makes firm 1 soft and the reaction curves are upward sloping, firm 1 should overinvest to become a fat cat.
Consider the previously-mentioned previous modified Dixit game again. A higher investment in the first period (overinvestment; top dog) lowers the marginal cost of output in the second period. If firms are competing in quantities in the second period, firm 1 would produce more outputs. Since firm 2 would then respond with a lower output, so by playing top dog (overinvesting), firm 1 both hurts (in the entry deterrence case) and softens (in the entry accommodation case) firm 2.

If, on the other hand, firms are competing in prices in the second period, playing top dog would allow firm 1 to quote a lower price. This would trigger an aggressive response from firm 2 in a price game. For entry deterrence, this hurts firm 2. Therefore, firm 1 should play top dog to deter entry. However, for entry accommodation, firm 1 would want to avoid the aggressive response from firm 2. Therefore, to soften competition, firm 1 should play puppy dog. Hence, firm 1’s strategy is very different depending on whether it wants to deter or accommodate entry. This is because being tough both hurts and toughens firm 2 in the price game.

8.4.3 Exit inducement

What’s firm 1’s incentive to invest in $K_1$, supposing that firm 2 is also in the market in period one and must decide whether to exit in the second period? As a matter of fact, exit inducement is very similar to entry deterrence in that: For both cases, firm 1 wants to make firm 2 unprofitable in the second period. This is to say that:

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

is the relevant objective for firm 1. Thus, firm 1’s behavior in the exit inducement game is identical to that of the entry deterrence game:

<table>
<thead>
<tr>
<th>Investment makes firm 1</th>
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<tr>
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<tr>
<td>Top dog</td>
<td></td>
<td>Lean and hungry look</td>
</tr>
</tbody>
</table>
8.5 A few words on price vs. quantity competition

So far, we presume that prices are strategic complements and quantities are strategic substitutes. How strong are these presumptions? Consider quantity competition first. Assume the profits have the exact Cournot form:

$$\Pi^i(q_i, q_j) = q_i P(q_i + q_j) - C_i(q_i).$$

Hence,

$$\Pi^i_{ij} = P' + q_i P''.$$ 

We know that $P' < 0$. So to obtain the strategic substitute property, it suffices that the price function be linear ($P'' = 0$) or concave ($P'' < 0$).

Now consider price competition in a differentiated product setting. Let $q_i = D_i(p_i, p_j)$ denote the demand curve for firm $i$‘s product. The profit functions are:

$$\Pi^i(p_i, p_j) = p_i D_i(p_i, p_j) - C_i(D_i(p_i, p_j)).$$

Hence,

$$\Pi^i_{ij} = \frac{\partial D_i}{\partial p_j} + (p_i - C'_i) \frac{\partial^2 D_i}{\partial p_i \partial p_j} - C''_i \frac{\partial D_i}{\partial p_i} \frac{\partial D_i}{\partial p_j}.$$ 

Suppose the demand is linear,

$$D(p_i, p_j) = a - bp_i + dp_j,$$

and the marginal cost is constant ($C''_i = 0$). Then, $\Pi^i_{ij} = d$. Hence, prices are strategic complements if the goods are demand substitutes ($d > 0$); prices are strategic substitutes if the goods are demand complements ($d < 0$). More generally, if the two goods are demand substitutes with convex cost functions to produce them, it suffices that $\partial^2 D_i / \partial p_i \partial p_j \geq 0$ for prices to be strategic complements.

The bottom line is: before applying the taxonomy, one should look into the microstructure of the industry and determine the type of competition that is being waged.
8.6 Some applications using the taxonomy

Example 1 Voluntary limitation of capacity

Consider the two-firm, two-stage, capacity-price game that we discussed before. One can look at it as an example of entry accommodation games. In this game, firms accumulate non-competitive amounts of capacity (the Cournot level). What prevents a firm from accumulating a large amount of capacity is that by accumulating a small capacity, each firm signals that it will not play an aggressive price strategy, and there is no point to cutting the price if one cannot satisfied demand. Such a signal softens the pricing behavior among firms. This voluntary limitation of capacity is an example of the “puppy dog” behavior.

Example 2 Learning by doing

Consider a two-firm rivalry. Due to the learning-by-doing effect, each firm’s second-period marginal cost decreases with its first-period output. Suppose first that competition takes place in quantities in both periods. By increasing its output in period 1, a firm signals that it will produce a higher output in period 2 because of the learning effect. With strategic substitutes, this reduces the other firm’s output in the second period. Thus, playing “top dog” to accumulate experience in the early stage is optimal for the accommodation game. Note that it is also optimal for entry deterrence, because the incumbent’s lower second-period cost hurts the entrant.

Suppose now that competition takes place in prices in both periods. The “top dog” strategy is still optimal for entry deterrence: By charging a low price today, the incumbent accumulates experience, which induces it to charge a low price tomorrow. In the accommodation game, when there is only one firm in the market at date 1, experience induces a low price, which triggers a low price from the rival. Thus, the incumbent should call for the “puppy dog” strategy and underinvest in experience. This is not the case in the accommodation game when both firms are in the market at date 1. On the one hand, a lower price today increases the firm’s output and hence its experience, making the firm aggressive
tomorrow and triggering a low price from its rival; on the other hand, a lower price today also reduce the rival’s market share and, therefore, reduces its experience. The rival faces a higher second-period marginal cost, and therefore is less aggressive in that period. The first concern calls for the “puppy dog” strategy while the second one calls for the “top dog” strategy. It is not clear \textit{a priori} which effect dominates.

**Example 3 Multimarket oligopoly**

Consider a situation where firms 1 and 2 are rivals in the market 1 and firm 1 is a monopoly in market 2. Consider $K_1$ as the profitability in market 2. Note that now $K_1$ becomes exogenous. Suppose that firms compete in quantities and all quantities are chosen simultaneously. Assume further the technology exhibits decreasing returns to scale. Suppose the demand increases in market 2. This induces firm 1 to sell more in that market, which raises the marginal cost of production and output in market 1. Firm 2, observing the increase in demand in market 2, will infer that firm 1 will decrease its output in market 1, and so firm 2 will raise its output in market 1. In other words, the increased profitability in market 2 raises firm 1’s marginal cost in market 1, which puts it at a strategic disadvantage (a “puppy dog” look is not good for firm 1 under strategic substitutes in entry accommodation games). This strategic effect may offset the profitability increase of firm 1 in market 2.

Suppose firms compete in prices and firm 1’s technology exhibits increasing returns to scale. An increase in the profitability in market 2 lowers its marginal cost in market 1 and therefore makes it more aggressive in this market, which triggers a low price by firm 2 (a “top dog” look is not good for firm 1 under strategic complements in entry accommodation games). Again, this strategic effect may offset the profitability increase of firm 1 in market 2.

Both scenarios demonstrate that an increase in firm 1’s profitability in market 2 may actually reduce its total profit.
**Example 4  Systems and product compatibility**

Consider a market where two firms both produce products $X$ and $Y$ (for example, hardware and software), that constitute a system (think about computer systems). Consumers are uniformly located on a square of dimension 1, and firm 1’s system is located at $(0,0)$ and firm 2’s system is located at $(1,1)$. A consumer locates at $(x_1, y_1)$ is $tx_1 + ty_1$ away from his preferred system when she buys from firm 1 (consider $t$ as a taste parameter, the analog of the transportation cost). Let $p_i$ be the price of system $i$. The generalized price paid by this consumer for firm 1’s system is:

$$ep_1 = p_1 + t(x_1 + y_1);$$

and similarly, for firm 2’s system is:

$$\tilde{p}_2 = p_2 + t[(1 - x_1) + (1 - y_1)].$$

If the systems are not compatible, the consumer chooses the system with the lower generalized price, and the demand of consumers located at $(x_1, y_1)$ is: $q = a - b\tilde{p}$, where: $\tilde{p} = \min\{\tilde{p}_1, \tilde{p}_2\}$. If the system are compatible and the products are sold separately, the consumer can “mix and match”. For example, the consumer can buy product $X$ from firm 1 and product $Y$ from firm 2, and pays a generalized price of:

$$p_1^X + p_2^Y + t[x_1 + (1 - y_1)].$$

So by mixing, the consumer can choose among four systems. Again, the consumer chooses the one with the lowest generalized price. The demand function for each firm’s system (under incompatibility) or each firm’s product (under compatibility) can be determined as a function of prices. For simplicity, let the unit production cost be the same for both firms and for both products. Then the Nash equilibrium demands for each product are symmetric and can be shown by the following figures.

What are firms incentive to achieve compatibility? First, compatibility increases demand, because it makes product better adapted to the consumer’s taste (compatibility lowers the generalized price). Second, compatibility softens price competition. Note that
under incompatibility, when firm 1 decreases its price for good $X_1$ it enjoys the full benefit associated with the increase in demand since there is only one system that involves $X_1$. However, under compatibility, there are two systems involve product $X_1$, \{X_1,Y_1\} and \{X_1,Y_2\}. Thus, some of the benefit from increased demand due to firm 1’s price cutting accrues to firm 2. This reduces firm 1’s incentive to cut its price. Therefore, the firms price their components less aggressively than they would do if the components were bundled in an incompatible system. These two effects imply that firms have a common interest in achieving compatibility.

Note that the desire for compatibility stems from a presumption that firms accommodate each other. Incompatibility would be the prescription if the dominant firm aims to induce exit of its rivals.

8.7 Flexibility & Option Value

Strategic commitments depend on irreversibility to be credible, but especially with uncertainty about market conditions, costs, rivals’ goals, or resources, there is a value to keeping one’s options open. Flexibility gives the firm option value, which should be factored into the strategic investment decision. Consider the following example of a monopoly firm facing no threat of entry making a decision whether to build a factory or not:

\[
\begin{align*}
  t = 0 & \quad t = 1 & \quad t = 2 & \quad \cdots \\
  q & \quad p = 300 & \quad p = 300 & \quad\rightarrow \\
  \downarrow & \quad p = 200 & \quad p = 100 & \quad\rightarrow \\
  1-q & \quad p = 100 & \quad p = 100 & \quad\rightarrow 
\end{align*}
\]

The investment costs $I = 1600$ with an interest rate of 10%. Suppose $q = 0.5$. One strategy is to invest now with:

\[
NPV = -1600 + \sum_{t=0}^{\infty} \frac{200}{(1.1)^t} = -1600 + 2200 = 600.
\]
Another strategy is to wait for one year and invest if and only if the price goes up. The \( NPV \) of this strategy is:

\[
NPV = 0.5 \times 0 + 0.5 \times \left[ \frac{-1600}{1.1} + \sum_{t=1}^{\infty} \frac{300}{(1.1)^t} \right] = \frac{850}{1.1} = 773.
\]

Clearly, the firm is better off to wait than to invest right now.

**Example 5** Commitment vs. Flexibility in the CD Market

Philips’ decision in 1982:

* to build a CD plant in the U.S., or

* to delay its decision, to learn the appeal of the new recording medium.

A MES plant (minimum AC) would cost $25m, and be virtually sunk cost — no alternative uses. Building first might discourage others from investing in their own capacity, which might avoid overcapacity and possibly brutal price competition. Philips didn’t invest in 1983; Sony did in 1984.

Philips’ decision on investing in a U.S. CD plant highlights the tension between the strategic effects of commitment and the option value of waiting: by building first, Philips, in a top-dog strategy, would preempt its rivals, but would the plant be profitable? A study has calculated that, had Philips faced no competition in the CD market, it would have been better off waiting and retaining flexibility if the probability of acceptance of the CD was 0.38 or lower: some option effect. But with rivals who would learn of the market acceptance when it did, Philips should only wait if the acceptance probability was less than 0.006: a virtual green light.

With competition, delay may reduce future uncertainty, but with a risk that investment may be preempted by rivals.