EconS 425 - Entry Deterrence

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Industrial Organization
Now that we have characterized the oligopoly market structure, let’s look at how firms with strong market power attempt to manipulate that structure to their own ends.

- Some of it is natural market behavior, some of it is very illegal.
Barriers to Entry

Let's return to our four key assumptions of the perfectly competitive market.

- Many buyers and sellers.
- Homogeneous products.
- Perfect Information.
- No Barriers to Entry and Exit.
Barriers to Entry

- When we shifted from perfect competition to monopoly/oligopoly, we relaxed most of these assumptions.
  - Under monopoly, we have just one seller; or few sellers under oligopoly.
  - Oligopolists usually want to add some heterogeneity to their products in order to build market power.
  - Monopoly assumes complete barriers to entry, while oligopoly assumes that there are significant barriers.
Complete barriers to entry?

- This is a convenient assumption to make, but unless the government has granted a firm a natural monopoly, this doesn’t happen in the real world.
- Then why do we have this assumption in the first place?

A monopolist has many tools available to them to discourage entry into their market.

- As we observed in Stackelberg competition, first mover’s advantage is a very powerful tool that a monopolist can exploit to remain a monopolist.
Stylized Facts

- In the real world, we see the frequent entry and exit of firms into markets, even when the structure is not perfectly competitive.
- For example, consider a market that undergoes a stochastic (random) process.
  - Suppose there are 256 firms, each with a yearly revenue of $10 million.
  - With probability 0.25, revenues decline by 15 percent. With probability 0.25, revenues increase by 15 percent. And with probability 0.5, revenues stay the same.
- Let’s see what happens to those firms after a few years go by.
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## Stylized Facts

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Stylized Facts

- After just a few years, the largest firms (in terms of revenue) are now making almost three times as much as the smallest firms.
  - If we let our random process continue, the disparity between the firms gets even worse.

- In essence, a few firms are able to claim large shares of the market while many of the other firms are pushed out.
  - As revenues decline, so do profits, which induces exit from the market.
Several studies have looked at different markets and seen this process occur. They have been able to conclude on four stylized facts:

- Entry is common: Firms are always trying to enter markets when they think they can carve out a niche for themselves.
- Entry is small scale: The Stackelberg effect of large firms holding on to market share is difficult to overcome for newcomers.
- The survival rate is low: Most firms that enter the market are forced to exit shortly after.
- Industries with high entry rates also have high exit rates: Volatility tends to be a market thing, rather than entrepreneurial.
It’s interesting that the entry and exit rates of firms are strongly correlated.

What’s happening here? Firms should have the ability to project their long term profits and determine whether or not they should enter the market.

Perhaps it is truly a stochastic issue. An unforeseen change in the market (such as a significant cost increase) could cause new firms to leave.

Or perhaps the incumbent firm(s) creates a situation to encourage its new rival to exit the market?
Suppose a monopolist (firm 1) were serving a market and was threatened by entry of a new firm (firm 2) into that market.

If the entrant were to enter the market, the incumbent monopolist would become a Stackelberg leader, while the entrant would be a Stackelberg follower.

The entrant must pay a sunk cost of $F$ to enter the market. Suppose market inverse demand were

$$p = a - b(q_1 + q_2)$$

and marginal costs were constant at $c$. 
From before, we know that if the entrant to the market behaved as a Stackelberg follower, their best response function to any output level of the incumbent would be

\[ q_2(q_1) = \frac{a - c}{2b} - \frac{q_1}{2} \]

We can substitute this back into the entrant’s profit maximization problem to derive their profit level based on the incumbent’s output level,

\[ \pi_2 = pq_2 - cq_2 - F \]
\[ = a - b \left( q_1 + \frac{a - c}{2b} - \frac{q_1}{2} \right) - c \left( \frac{a - c}{2b} - \frac{q_1}{2} \right) - F \]
\[ = \frac{(a - c - bq_1)^2}{4b} - F \]
Naturally, the entrant will only want to enter this market if their profits are positive. In fact, staying out of the market would be better if

\[
\frac{(a - c - bq_1)^2}{4b} - F < 0
\]
or, solving this expression for the sunk cost,

\[
F > \frac{(a - c - bq_1)^2}{4b}
\]
Preventing Entry

\[ F > \frac{(a - c - bq_1)^2}{4b} \]

- If the sunk cost of entry is high relative to the profit level of the entrant, they will not want to enter.
- Look at what happens when I differentiate the right side of this expression with respect to the incumbent’s output level,

\[ \frac{\partial \pi_2}{\partial q_1} = -\frac{a - c - bq_1}{2} < 0 \]

as the incumbent increases their quantity, the profit level (right-hand side) of the entrant decreases.

- In fact, the monopolist may want to give the entrant a little push out of the market in this case.
Would increasing the incumbent monopolist’s output level be in their best interest?

Suppose that if the monopolist produced the Stackelberg quantity, \( \frac{a-c}{2b} \) (which is also the monopoly quantity) that the entrant would enter the market. In this case, the monopolist’s profits are the same as the Stackelberg leader’s profits we looked at before,

\[ \pi_1 = \frac{(a - c)^2}{8b} \]

Now suppose that for some quantity greater than the monopoly quantity, the profits for the entrants would become negative and cause them to not enter. This would let the incumbent remain as a monopolist.
Preventing Entry

- If the incumbent can prevent entry, their profit level as a function of their own output level is

\[ \pi_1 = pq_1 - cq_1 = (a - c - bq_1)q_1 \]

- Suppose \( \hat{q}_1 \) is the minimum output level required to keep the entrant for entering the market. The incumbent has to decide whether this profit level is more desirable than simply letting the entrant into the market. Thus, if

\[ (a - c - b\hat{q}_1)\hat{q}_1 > \frac{(a - c)^2}{8b} \]

the monopolist would prefer to increase their own quantity to keep the entrant out of the market.
Preventing Entry

\[ \frac{(a - c)^2}{2b} \]

\[ \frac{(a - c)^2}{4b} \]

\[ \pi_1 \]

\[ q_1 \]

\[ \frac{a - c}{2b} \]
Preventing Entry

\[(a - c - b\hat{q}_1)\hat{q}_1 > \frac{(a - c)^2}{8b}\]

- We can solve this expression for \(\hat{q}_1\). First, I’ll divide both sides of this expression by \(b\),

\[\left(\frac{a - c}{b} - \hat{q}_1\right)\hat{q}_1 > \frac{(a - c)^2}{8b^2}\]

and for the sake of simple algebra, let \(X \equiv \frac{a - c}{b}\),

\[(X - \hat{q}_1)\hat{q}_1 > \frac{X^2}{8}\]

- Rearranging terms,

\[8(\hat{q}_1)^2 - 8X\hat{q}_1 + X^2 < 0\]
Preventing Entry

\[ 8(\hat{q}_1)^2 - 8X\hat{q}_1 + X^2 < 0 \]

- We have to go old school here and use the quadratic equation to solve this for \( \hat{q}_1 \),

\[
\frac{8X - \sqrt{64X^2 - 4(8)X^2}}{4(8)} < \hat{q}_1 < \frac{8X + \sqrt{64X^2 - 4(8)X^2}}{4(8)}
\]

and we can discard the lower term to obtain,

\[
\hat{q}_1 < \frac{2 + \sqrt{2}}{4}X = \frac{(2 + \sqrt{2})(a - c)}{4b} = \left(1 + \frac{1}{\sqrt{2}}\right) \frac{a - c}{2b}
\]

- Thus, if the quantity that prevents entry isn’t too much higher than the monopoly (Stackelberg) quantity, the monopolist is better off increasing their output.
Preventing Entry

- It’s also possible that \( \hat{q}_1 \) is less than the monopoly quantity, \( \frac{a-c}{2b} \).
  - In this case, just producing the monopoly level is enough to deter entry from a second firm. This would not be predatory behavior at all, just a natural market process.
  - In the environmental field, firms actually lobby the government to impose new regulations (causing the sunk cost to enter to increase) in order to make this happen.

- If \( \hat{q}_1 \) is higher than the monopoly quantity, then we have predatory behavior from the incumbent.
  - The monopolist can threaten to drive the price down in the market upon observing an entrant.
  - This behavior is frowned upon.
Preventing Entry

- In the typical entry deterrence model, the game works like this,
  - In the first stage, a potential entrant decides whether or not to enter the market.
  - In the second stage, upon observing entry, the incumbent decides whether to fight (raise their output level) or to accommodate (act as a Stackelberg leader) the entrant.

- Notice that the entrant gets to move first.
Preventing Entry

Entrant

Do Not Enter

Incumbent

Enter

Incumbent

Entrant

Enter

Fight

Accomodate

Incumbent

Entrant

Incumbent

Entrant

Do Not Enter

Enter

Incumbent

Entrant

Incumbent

Entrant

Incumbent

0

\( \frac{(a - c)^2}{4b} \)

\( \frac{(a - c)^2}{8b} \)

<

\( \frac{(a - c)^2}{8b} \)

Ugly Number - \( F \)

\( \frac{(a - c)^2}{16b} \) - \( F \)
Preventing Entry

Entrant

Do Not Enter

Incumbent \( \frac{(a - c)^2}{4b} \)

Enter

Incumbent

Incumbent

Entrant

\( \frac{(a - c)^2}{4b} \)

0

Fight

\( \frac{(a - c)^2}{8b} \)

Accomodate

\( \frac{(a - c)^2}{16b} \)

Ugly Number

- \( F \)

- \( F \)
The incumbent can threaten to produce a higher quantity all they want to. If the entrant gets to move first, it knows that the incumbent’s threat isn’t credible.

Upon observing entry, the incumbent maximizes profit by producing the Stackelberg quantity, rather than $\hat{q}_1$.

Thus, it wouldn’t be rational to fight entry for the incumbent in this case.
How can the incumbent deter entry then?

Suppose we changed the model a little bit.

- In the first stage, the incumbent is able to invest in capacity, i.e., they can determine how much capital to have on hand for production.
- In the second stage, the entrant decides whether to enter or not.
- In the third stage, if the entrant enters, the firms compete in a simultaneous (Cournot) setting.
Capacity Commitment

- In the first stage of this new game, the monopolist chooses their capacity level in the form of capital investment.
  - This is feasible because capital is fixed in the short term.
  - They choose a capital level that allows them to produce a capacity $K$ at a cost of $r$ per unit of capacity. This cost is then sunk, meaning they pay it even if they don’t use all of their capacity.
  - In the third stage, they then can produce $q_1 \leq K$, while only incurring their variable cost of production, $w$. If $q_1 > K$, they must pay for the additional capacity at the time of production.

- Essentially, what the incumbent can do is invest early on, sinking some cost into capital investment that lowers their marginal cost of production later on.
  - Sunk costs do not go into their maximization decision.
Let’s use our standard Cournot model, where inverse demand is

\[ p = a - b(q_1 + q_2) \]

The incumbent’s profit maximization problem in the third stage becomes

\[ \max_{q_1} \begin{cases} (a - b(q_1 + q_2))q_1 - wq_1 - rK & \text{if } q_1 \leq K \\ (a - b(q_1 + q_2))q_1 - (w + r)q_1 & \text{if } q_1 > K \end{cases} \]

with first-order condition,

\[ \frac{\partial \pi_1}{\partial q_1} = \begin{cases} a - 2bq_1 - q_2 - w = 0 & \text{if } q_1 \leq K \\ a - 2bq_1 - q_2 - (w + r) = 0 & \text{if } q_1 > K \end{cases} \]
Capacity Commitment

\[
\frac{\partial \pi_1}{\partial q_1} = \begin{cases} 
    a - 2bq_1 - q_2 - w = 0 & \text{if } q_1 \leq K \\
    a - 2bq_1 - q_2 - (w + r) = 0 & \text{if } q_1 > K
\end{cases}
\]

- Solving these for \( q_1 \) gives us our best-response function,

\[
q_1(q_2) = \begin{cases} 
    \frac{a-w}{2b} - \frac{q_2}{2} & \text{if } q_1 \leq K \\
    \frac{a-w-r}{2b} - \frac{q_2}{2} & \text{if } q_1 > K
\end{cases}
\]

- Notice that if \( q_1 < K \), the intercept in the best response function is much higher. This corresponds to the lower marginal cost that the incumbent faces due to having pre-invested in their capacity.
  - As their output level exceeds their capacity, they lose that cost advantage.
Capacity Commitment

\[ q_1(q_2) \]

\[ \frac{a - w}{2b} \]

\[ a - w - r \]

\[ \frac{a - w - r}{2b} \]

\[ K \]

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Capacity Commitment

- Whatever level of capacity the incumbent chooses to carry determines where the break in the best response function is.
- Naturally, they lose their strategic advantage in the third stage if they set the capacity constraint too low, so investment is typically a good idea.
Capacity Commitment

- The entrant can't pre-commit to any capacity before the third stage, so their profit maximization function is

\[
\max_{q_2} \quad (a - b(q_1 + q_2))q_2 - (w + r)q_2
\]

with first-order condition,

\[
\frac{\partial \pi_2}{\partial q_2} = a - bq_1 - 2bq_2 - (w + r) = 0
\]

- Solving this expression for firm 2's quantity gives us their best response function,

\[
q_2(q_1) = \frac{a - w - r}{2b} - \frac{q_1}{2}
\]
Capacity Commitment

\[ q_1 \]

\[ q_2(q_1) \]

\[ \frac{a - w - r}{2b} \]

\[ q_2 \]
Since the value of $K$ can vary, it would benefit us to look at both best response functions for the incumbent at the same time.
Capacity Commitment

\[ q_1(\frac{a - w}{2b}) \]

\[ q_2(\frac{a - w - r}{2b}) \]
Capacity Commitment

\[ q_1(q_2) \]

\[ q_2(q_1) \]

\[ \frac{a - w}{2b} \]

\[ \frac{a - w - r}{2b} \]

Diagram showing the relationship between \( q_1 \) and \( q_2 \) with points A, B, and C.
Naturally, the incumbent is going to want to pick some value of $K$ between points $A$ and $B$.

Picking a value for $K$ that leads to point $A$ induces the Cournot outcome, where each firm produces an output level of

$$\frac{a - w - r}{3b}$$

Picking a value of $K$ that leads to point $C$ induces the monopoly/Stackelberg outcome (If $K$ is set at that level, the best response functions do cross there).

Picking a value of $K$ that exceeds point $C$ up to point $B$ describes the earlier setting where the incumbent threatens to overproduce.
What ends up happening? That depends on the sunk cost to entry and how much the entrant needs to produce to break even.

- Suppose the entrant’s break even quantity were above the Cournot output level (Point A). In this case, there is no way the entrant ever enters the market, and the incumbent sets their capacity to the monopoly level (Point C).
- Suppose the entrant can break even at the Cournot output level (Point C), but needs to produce more than their Stackelberg amount (Point B). In this case, again, the entrant does not enter the market, and the incumbent sets the monopoly level of capacity (Point C).

Neither of these outcomes are predatory.
Capacity Commitment

- Now, suppose the entrant can break even at the Stackelberg output level (Point $C$).
  - If the entrant can break even at point $B$, i.e., their fixed entry cost is very low, there’s no benefit to the monopolist to raising their capacity level, as they can’t drive the entrant out of the market. Thus, it remains at the Stackelberg level (point $C$).
  - If the entrant’s break even point lays between points $B$ and $C$, there is room for the monopolist to raise their quantity and drive them out of the market. The monopolist would be willing to set $K$ up to
    \[
    K < \hat{q}_1 = \left(1 + \frac{1}{\sqrt{2}}\right) \frac{a - w - r}{2b}
    \]
    which would induce the entrant to not enter the market. The monopolist then produces the monopoly quantity, not meeting their set capacity.

- If the incumbent drives the entrant out in this case, it would be considered predatory.
Capacity Commitment

- In essence, the monopolist can invest in capacity early on, and this serves as a signal to potential entrants.
  - It tells them that the incumbent has all of the tools it needs to drive prices down and make their entry into the market completely unprofitable.

- This is extremely anticompetitive, but it has happened several times throughout history.
  - Southern Bell Telephone
  - Safeway in Edmonton, Alberta
Sometimes, a monopolist will set their output level higher than the monopoly level if it is able to deter a potential entrant from threatening their market share.

This requires a credible threat in the form of capacity investment.
Next Time

- Predation.
- Reading: 9.3-9.5.
- Midterm on Friday.
Homework 4-4

- Study and work on those notecards.