LECTURE 13

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FOR TODAY

- Entrance game
- Why does Backwards Induction make sense?
- Regulation as a barrier to entry.

MOTIVATION

- Until now, the number of producers is given
- But firms enter and exit industries every day
- Today I present the existence of equilibria with non-credible threats
- The game is the “Entrance Deterrence Model”

ENVIRONMENT

- Players: An incumbent and an entrant
- Actions:

i. Entrant: enter the market (E) or not (N)

ii. Incumbent: Accommodate (A) (compete in a Cournot model), Price War (W) (Bertrand Competition)

PAYOFF MATRIX $(0 < \eta < \pi_C < \pi_M)$

(Incumbent, Entrant)		Entrant	
		E	N
Incumbent	A	$(\pi_C, \pi_C - \eta)$	$(\pi_M, 0)$
	W	$(0, -\eta)$	$(\pi_M, 0)$

STRATEGY

- Incumbent: an action $\sigma_I \in \{A, W\}$
- Entrant: an action $\sigma_E \in \{E, N\}$
- Strategy profile is a pair $\sigma = (\sigma_I, \sigma_E)$

ENTRANT'S PROBLEM

- Assuming an incumbent action σ_I, entrant solves

$$(1)\ \pi_E(\sigma_I) = \max_{a \in \{E,N\}} 1_{a=E}\left(1_{\sigma_I=A}(\pi_C - \eta) - \eta 1_{\sigma_I=W}\right)$$

INCUMBENT'S PROBLEM

- Assuming an entrant action σ_E, the Incumbent solve

$$(2)\ \pi_I(\sigma_E) = \max_{a \in \{W,A\}} 1_{\sigma_E = N}\pi_M + 1_{\sigma_E = A}\, 1_{a=A}\pi_C$$

EQUILIBRIUM

- An Equilibrium is a strategy profile $\sigma = (\sigma_E, \sigma_I)$ such that

i. Given σ_I, σ_E solves (1)

ii. Given σ_E, σ_I solves (2)

CHARACTERIZATION 1

- There exists 2 equilibria.
- Equilibrium 1: Suppose that the Incumbent expects the entrant to enter the market, then he faces the problem

$$(3)\ \pi_I(E) = \max_{a \in \{W,A\}} 1_{a=A}\pi_C$$

- Since $\pi_C > 0$, the incumbent chooses $\sigma_I = A$

CHARACTERIZATION 2

- Suppose that the entrant expects that incumbent plays A, then he faces the problem

$$(4)\ \pi_E(A) = \max_{a \in \{E,N\}} 1_{a=E}(\pi_C - \eta)$$

- Since $\pi_C > \eta$, then the incumbent chooses $\sigma_E = E$
- These two problems show that $\sigma = (E, A)$ is an equilibrium as each player does as described in the tuple when they expect their peers to also follow what it's stated in the tuple

CHARACTERIZATION 3

- Q: Is this the only equilibrium?
- A: No.
- Suppose that incumbent expects $\sigma_E = N$, the he faces the problem

$$(5)\ \pi_I(N) = \max_{a \in \{W,A\}} 1_{a=A}\pi_M + 1_{a=W}\pi_M$$

- Observe that the incumbent is indifferent between either action, so he could choose $\sigma_I = W$

CHARACTERIZATION 4

- Suppose that the entrant expects the seller to play W, then his problem becomes

$$(6)\ \pi_E(W) = \max_{a \in \{E,N\}} -1_{a=E}\eta$$

- Since $\eta > 0$, the entrant prefers not entering, thus $\sigma_E = N$
- Therefore, $\sigma = (N, W)$ is ALSO AN EQUILIBRIUM.

PUNCHLINE

- When we do not model the timing in this game, we have two equilibrium
- (E, A) makes sense, but (N, W) seems weird
- The first equilibrium states that the entrant Enters and the incumbent prefers to accommodate rather than lose profits in order to punish the entrant
- The second states that the entrant stays away expecting the incumbent to start a price war and the incumbent keeps his promise.

ADDING A TIMING

- Suppose that the timing is the following:

1. Entrant makes his decision and the Incumbent observes his action
2. Incumbent makes his choice.

STRATEGIES

- An entrant strategy is $\sigma_E \in \{E, N\}$
- An incumbent strategy is a function $\sigma_I : \{E, N\} \to \{A, W\}$

EQUILIBRIUM

- An equilibrium is a strategy profile $\sigma = (\sigma_E, \sigma_I)$ such that

i. Conjecturing an incumbent strategy σ_I, σ_E solves (1)

ii. For each observed action $a \in \{E, N\}$, choice $\sigma_I(a)$ solves (2)

CHARACTERIZATION 1

- This equilibrium can be characterized via Backwards Induction
- First, the incumbent’s strategy solves the same problems as before and his optimal strategy is

$$(7)\ \sigma_I(a) = \begin{cases} \text{i}A \ if\ a = E \\ \tilde{\sigma} \in \{A, W\}\ if\ a = N \end{cases}$$

CHARACTERIZATION 2

- The entrant rightly conjecturing potential incumbent strategies expects to be accommodated provided that he enters the market, so he picks $\sigma_E = E$.
- All equilibrium are then payoff equivalent to $\sigma = \left(E, (\sigma_I(E) = A, \sigma_I(N) = W)\right)$

PUNCHLINE

- When one adds a timing of play, we can eliminate a “weird” equilibrium
- Q: Can one change the game in play such that the sole equilibrium is the ”weird” equilibrium?
- A: Yes!

ENTRY GAME WITH STACKELBERG OR COURNOT COMPETITION

- Players: An incumbent and an entrant
- Actions:

i. Entrant: enter the market (E) or not (N)

ii. Incumbent: Wait (W), Stackelberg quantity (S)

PAYOFF MATRIX $(0 < \pi_2^S \leq \eta < \pi_C < \pi_1^S < \pi_M)$

(Incumbent, Entrant)		Entrant	
		E	N
Incumbent	W	$(\pi_C, \pi_C - \eta)$	$(\pi_M, 0)$
	S	$(\pi_1^S, \pi_2^S - \eta)$	$(\pi_M, 0)$

TIMING

- We can define strategies and equilibrium for this game
- Characterizing these equilibria leads us to 2 equilibria: (S, N)
- Next, assume that the timing is the following

1. Incumbent decides to pick his Stackelberg quantity or to wait for the entrant
2. Entrant either stays away or enters and picks a quantity to produce

EQUILIBRIUM AND INSIGHT

- The equilibrium can be defined and characterized but the only equilibrium we get is $\sigma = \left(S, (\sigma_E(S) = N, \sigma_E(W) = N)\right)$
- Therefore, we learn several things

1. Who makes a choice first matters
2. Changing the threat, changes the prediction
3. The cost of entrance matter: large entrance cost ($\eta > 0$), the less likely one gets entry
4. Real world ways to get higher entrance costs includes increasing regulatory costs.