

Game theory and applications

ECON 201 - Winter 2026

Week 7: February 18th

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Today's Agenda

1. What is a game?
2. Nash equilibrium
3. Common types of static games

Motivation

- Perfect competition and pure monopoly are extremes
- In many markets, there are a few dominant players
 - Apple, Samsung, Huawei
 - Boeing and Airbus
 - Meta, Google, Microsoft
 - Walgreens, CVS
 - Disney, Warner Brothers, Paramount

Motivation

- These players watch each other closely since they affect each other
 - Samsung offers a discount → Apple's sales are hurt
 - Walgreens opens a new store in town → Local pharmacy goes under
 - Airbus slows down R&D investment → Boeing's returns to R&D goes up
- **Our goal this week:** Learn a tool that explains and predicts how these players end up behaving, in situations where their choices affect other players

Definition of a game

Definition

A game has 3 components:

1. Set of players $i \in \{1, \dots, I\}$
2. For each player i , set of available actions $A_i = \{a_1^i, \dots, a_N^i\}$
3. For each player i , payoffs they are getting from all possible profiles of actions $U_i(a^1, \dots, a^I)$

A simple 2-player example

1. Two players $i \in \{1, 2\}$.
2. Each player can either say *Yes* or *No*.

$$A_1 = A_2 = \{\text{Yes}, \text{No}\}.$$

3. Each player prefers when both say *Yes*, but is embarrassed when they say *Yes* non-mutually. It's safe to play *No*, but no fun.

$$U_1(\text{Yes}, \text{Yes}) > U_1(\text{No}, \text{No}) > U_1(\text{No}, \text{Yes}) > U_1(\text{Yes}, \text{No})$$

		Player 2	
		Yes	No
Player 1	Yes	10, 10	0, 3
	No	3, 0	5, 5

What do we expect to happen?

Nash equilibrium

Definition

Nash equilibrium: A profile of actions $a = (a^1, \dots, a^I)$ such that none of the players would prefer to do something else conditional on everyone else sticking to a :

$$U_i(a^1, \dots, a^i, \dots, a^I) \geq U_i(a^1, \dots, \tilde{a}^i, \dots, a^I), \quad \forall \tilde{a}^i \neq a^i, \quad \forall i \in I$$

Scenarios:

- Unique equilibrium
- Multiple equilibria
- No equilibrium

Types of strategies

Pure strategy: One of the actions $a_i \in A_i$.

Mixed strategy: A probability distribution $(p_1, \dots, p_N)$ over A_i .

Interpretations of a mixed strategy:

- *Literal:* Players randomize before taking an action.
- *Statistical:* Reflects the frequency with which we see actions taken
- *Epistemic:* Reflects a player's beliefs about the other player

Recap of efficiency terms

Pareto-dominance: Profile of actions (a_1, a_2) Pareto-dominates profile of actions (a'_1, a'_2) if $a_1 \geq a'_1$, $a_2 \geq a'_2$, and for some i : $a_i > a'_i$.

Pareto-efficiency: Profile of actions (a_1, a_2) is Pareto-efficient if there is no other profile of actions that Pareto-dominates it.

The zoo of games

Comparison among equilibria

<i>Comparison b/t equilibria & non-eqa</i>	Unique equilibrium	One eqm Pareto-dominates other eqa	No eqm Pareto-dominates any other eqm
			Bach or Stravinsky
			Hawks & Doves
		Arm's race	
	Prisoner's dilemma		

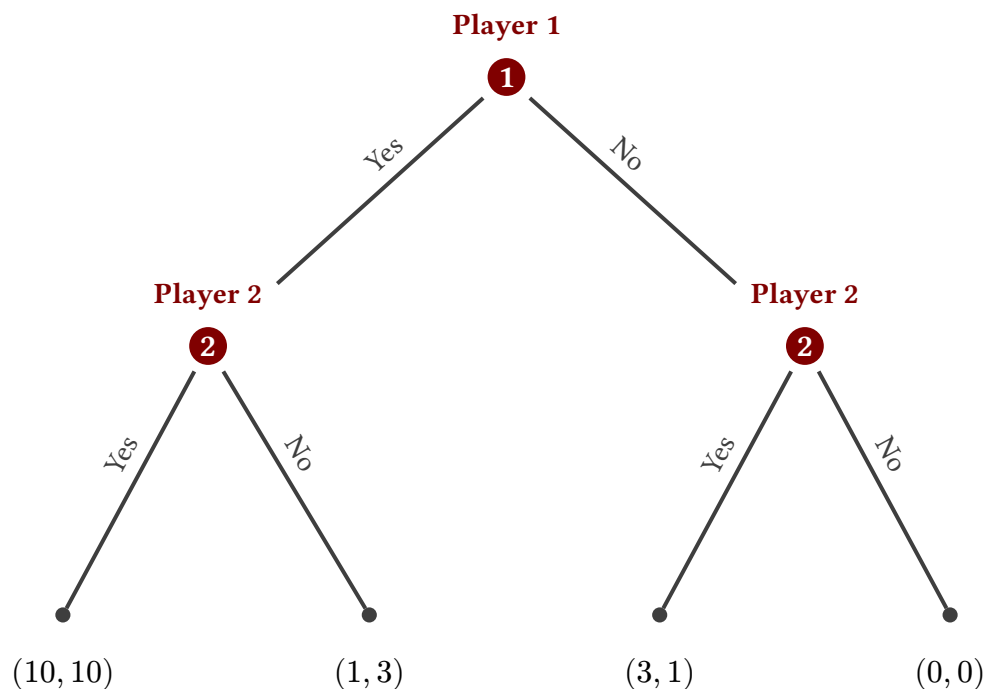
Sequential games

Yes/No example

- Before, we assumed that Players say Yes or No simultaneously
- What if one of them did it first and let the other one respond?

Yes/No example

- Before, we assumed that Players say Yes or No simultaneously
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Extensive game

1. Set of players $i \in \{1, \dots, I\}$
2. Set of possible **histories** $(a^1, \dots, a^t) \in H$.
 - A history is **terminal** if $t = T$, where T is the last period.
3. Player function $P(h)$ that maps histories to a player that is supposed to make the decision at that point.
4. Payoffs of players from terminal histories

Yes/No example formalized

1. Players $i \in \{1, 2\}$
2. Set of possible histories:

$$H = \left\{ (\text{Yes}), (\text{No}), \underbrace{\{(\text{Yes}, \text{Yes}), (\text{Yes}, \text{No}), (\text{No}, \text{Yes}), (\text{No}, \text{No})\}}_{\text{Terminal}} \right\}$$

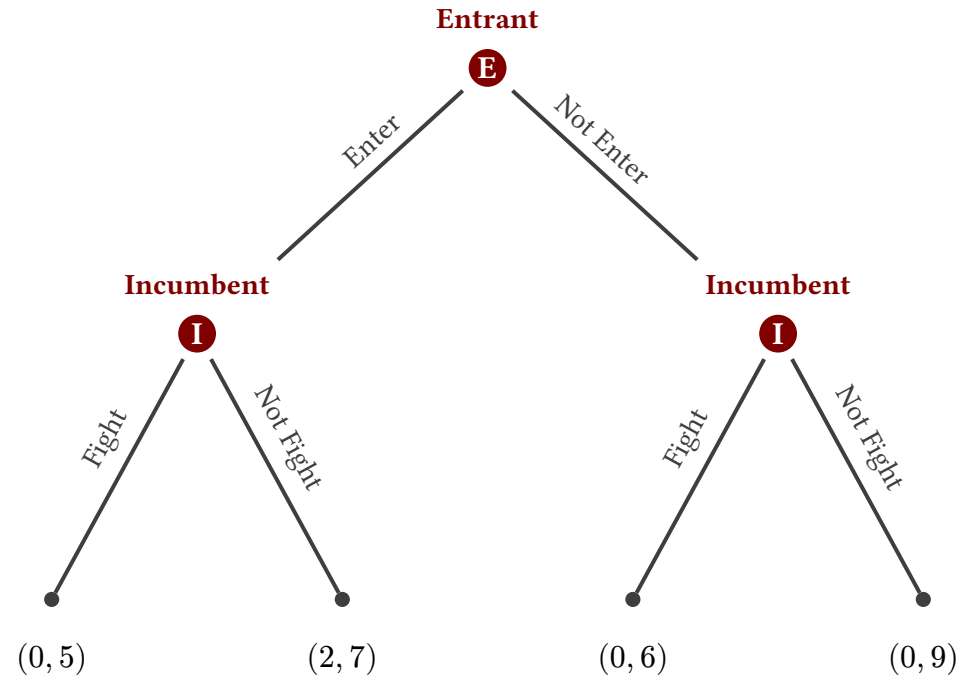
3. Player function:

$$P(\emptyset) = 1 \quad P(\text{Yes}) = P(\text{No}) = 2$$

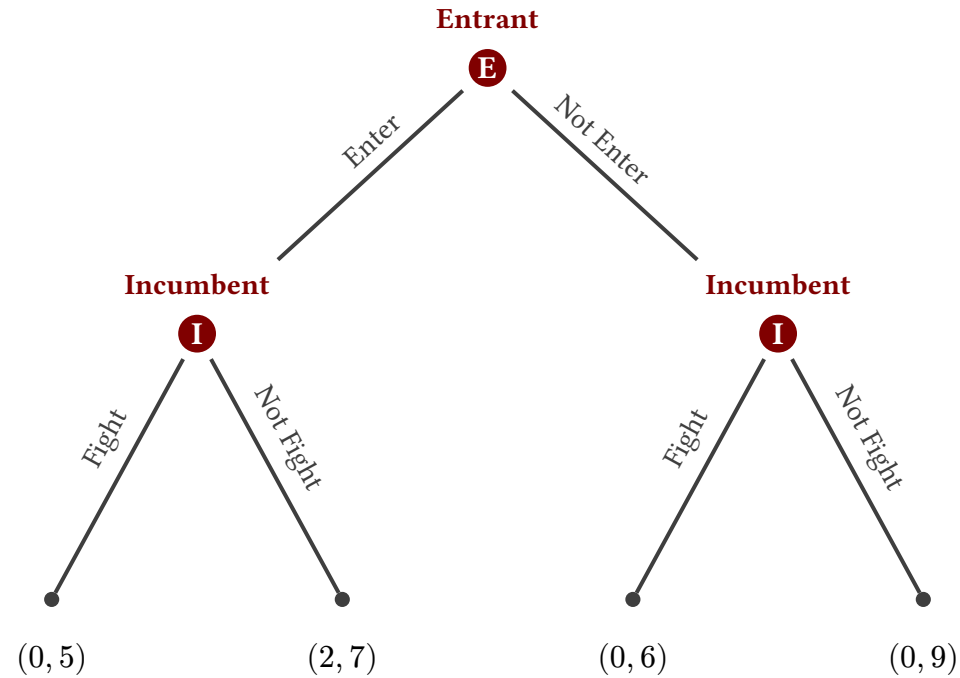
4. Payoff functions

$$\begin{aligned} U_1((\text{Yes}, \text{Yes})) &= U_2((\text{Yes}, \text{Yes})) = 10, & U_1((\text{No}, \text{No})) &= U_2((\text{No}, \text{No})) = 0, \\ U_1((\text{Yes}, \text{No})) &= U_2((\text{No}, \text{Yes})) = 1, & U_2((\text{Yes}, \text{No})) &= U_1((\text{No}, \text{Yes})) = 3 \end{aligned}$$

Commitment problem

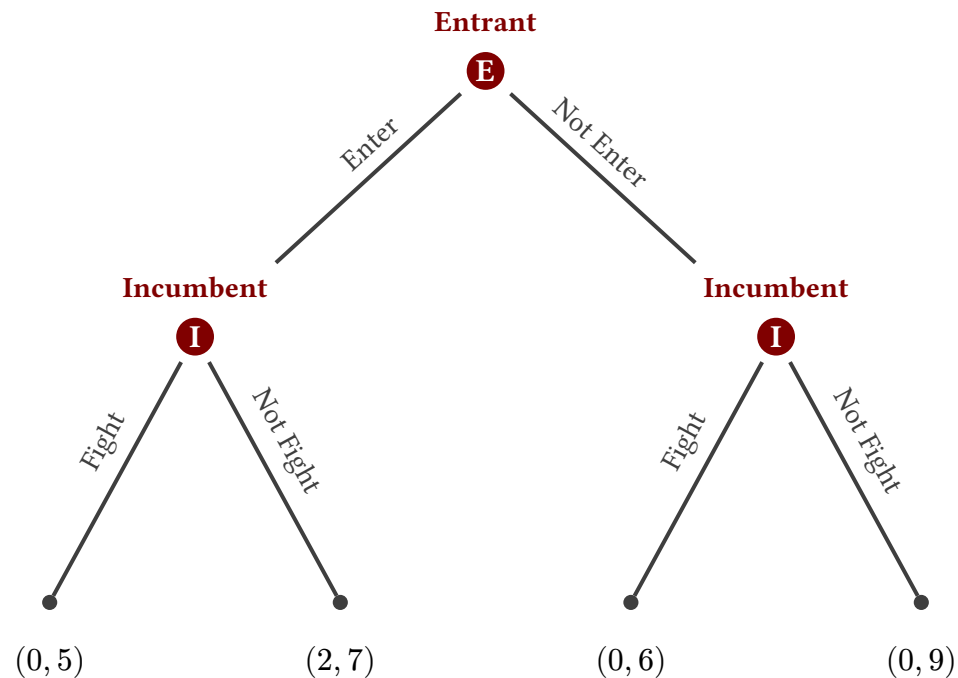


Commitment problem



Equilibrium: (Enter, $\underbrace{(\text{Not Fight}, \text{Not Fight})}_{\substack{\text{What Incumbent} \\ \text{plays after Enter}}}$)

Commitment problem

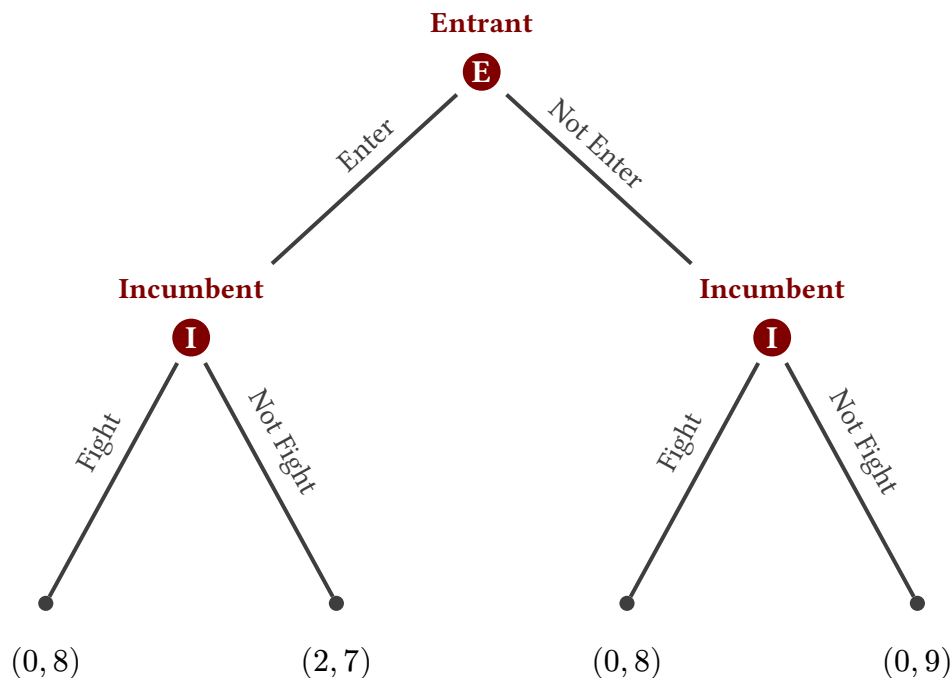


Equilibrium: $(\text{Enter}, \underbrace{(\text{Not Fight}, \text{Not Fight})}_{\substack{\text{What Incumbent} \\ \text{plays after Enter}}})$

Equilibrium history: $(\text{Enter}, \text{Not Fight})$

Preemptive investment as a commitment device

Principle: Increase the payoff from the 'wanted' action.



- Incumbent invests in additional production capacities in advance

⇒ Fighting becomes more effective

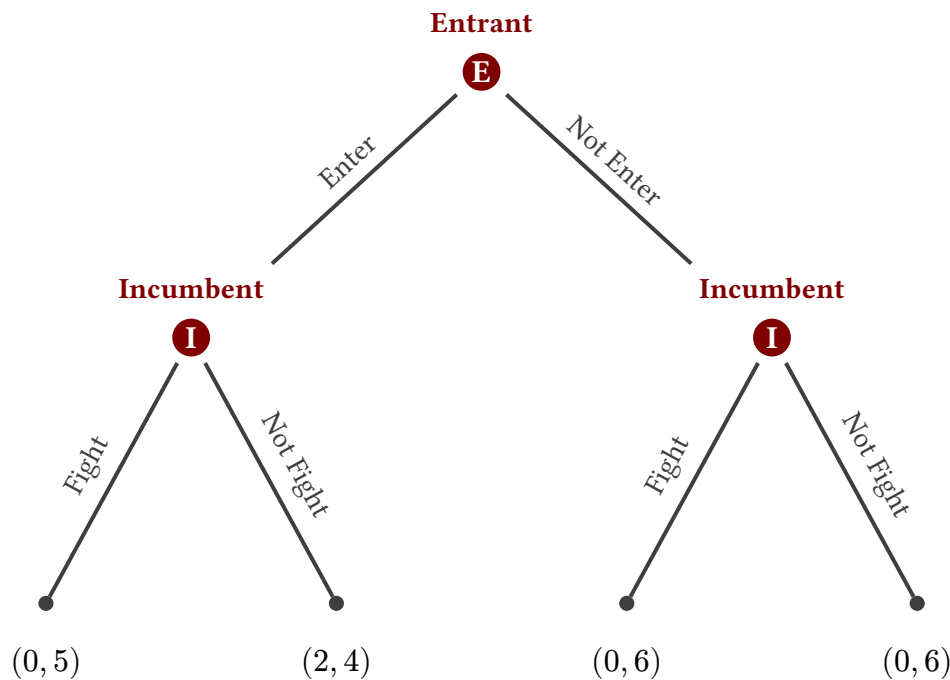
⇒ Payoff increases from 5 to 8.

Equilibrium: (Not Enter, $\underbrace{(\text{Fight}, \text{Not Fight})}_{\substack{\text{What Incumbent} \\ \text{plays after Enter}}}$)

Equilibrium history: (Not Enter, Not Fight)

“Bridge burning” as a commitment device

Principle: Reduce the payoff from the ‘unwanted’ action.



- Incumbent destroys some of its production capacity

⇒ Baseline payoff decreases from 9 to 6

⇒ Payoff from not fighting decreases from 7 to 4.

Equilibrium: (Not Enter, $\underbrace{\text{Fight, Not Fight}}_{\substack{\text{What Incumbent} \\ \text{plays after Enter}}}$)

Equilibrium history: (Not Enter, Not Fight)