Game Theory and Business Strategy

Pablo Cuellar, Ph.D.

EGADE Business School

What is Game Theory?

- Game Theory is a set of tools used by economists and others to analyze strategic decision-making.

- In a strategic setting the actions of several agents are interdependent.
- Each agent's outcome depends not only on his actions, but also on the actions of other agents.
- How to predict opponents' play and respond optimally?

What is Game Theory?

- Examples of a game:
  - poker, chess, soccer, driving, stock market
  - advertising, setting prices, entering new markets, building a reputation
  - bargaining, partnerships, job market search and screening
  - designing contracts, auctions, insurance, environmental regulations
  - international relations, trade agreements, electoral campaigns

Prisoner's dilemma

		Criminal B	
		Stays silent	Betrays
Criminal A	Stays silent	$-1, -1$	$-3, 0$
	Betrays	$0, -3$	$-2, -2$

- Two alleged criminals are arrested. There is not enough evidence to convict either.
- Different cells, no communication:
  - If A and B each betray the other, each of them serves two years in prison.
  - If A betrays B but B remains silent, A will be set free and B will serve three years in prison.
  - If A remains silent but B betrays A, A will serve three years in prison and B will be set free
  - If A and B both remain silent, both of them will serve only one year in prison (on the lesser charge).

Prisoner's dilemma

- The players choose strategies that do not maximize their joint or combined profit.
- In this type of game all players have dominant strategies that lead to a payoff that is inferior to what they could achieve if they cooperated.
- The players act independently and simultaneously: their individual incentives cause them to choose strategies that do not maximize their joint profits.

Best response and Equilibrium

- Best response is the strategy (or strategies) that produces the most favorable outcome for a player, taking other players' strategies as given.

- Nash equilibrium: every player plays a best response against the other players simultaneously.

		Criminal B	
		Stays silent	Betrays
Criminal A	Stays silent	$-1, -1$	$-3, 0$
	Betrays	$0, -3$	$-2, -2$

Advertising Games

- Advertising Games:

  Prisoners' Dilemma or Joint-Profit maximizing Outcome?

- **Assumption 1:** Advertising only takes customers from rivals

		Firm B	
		Do Not Advertise	Advertise
Firm A	Do Not Advertise	$2, 2$	$0, 3$
	Advertise	$3, 0$	$1, 1$

Advertising Games (2)

- Advertising Games:

  Prisoners' Dilemma or Joint-Profit maximizing Outcome?

- **Assumption 2:** Advertising attracts new customers to the market

		Firm B	
		Do Not Advertise	Advertise
Firm A	Do Not Advertise	$2, 2$	$3, 4$
	Advertise	$4, 3$	$5, 5$

Key Elements of a Game

- Players: Who is interacting?
- Strategies: What are the options of each player? In what order do players act?
- Payoffs: How do strategies translate into outcomes? What are players' preferences over possible outcomes?

- Information/Beliefs: What do players know/believe about the situation and about one another? What actions do they observe before making decisions?
- Rationality: How do players think?

Pricing Games in Two-Sided Markets

- Two-sided market: an economic platform that has two or more user groups that provide each other with network externalities.

- A credit card, such as MasterCard or Visa, connects merchants and consumers.
  - The more consumers who use a card, the more attractive accepting that card is to merchants.
  - The more merchants who accept the card, the more likely consumers want to use it.

- Pricing Strategies:
  - Balanced pricing: merchants and consumers pay fees.
  - Unbalanced pricing: only merchants pay.

Pricing Games in Two-Sided Markets (2)

- Unbalanced Pricing

		Visa	
		Balanced	Unbalanced
MasterCard	Balanced	$7, 7$	$2, 9$
	Unbalanced	$9, 2$	$4, 4$

Pricing Games in Two-Sided Markets (3)

- Balanced Pricing

		Visa	
		Balanced	Unbalanced
MasterCard	Balanced	$7, 7$	$5, 6$
	Unbalanced	$6, 5$	$4, 4$

Prisoner's Dilemma Situations

- A Prisoner's Dilemma situation is when if each firm pursues its own self-interest, the outcome is worse than if they had cooperated.
- The incentive to *not cooperate* is so strong even though cooperation may yield the best results
- Prisoner's Dilemma is an important game theoretical example of business/economics, but it is not the only one!

Case Study - Firms' Investment in Safety

- Thousands of U.S. workers are killed on the job every year
  - 5,190 in 2016 or about 14 per day.
- A factory collapse in Bangladesh killed 1,129 workers in 2013.
- A warehouse explosion in 2015 in Tianjin, China killed over 100 workers.
- In 2017, a power plant explosion in Unchahar, India, killed 38 workers and seriously injured about 100 others.

Case Study - Firms' Investment in Safety (2)

- Managers at each firm must decide how much to invest in worker safety.
- Investments affect the firm's own reputation for safety, but also other firms in the industry.

- U.S. unions call for greater government intervention to protect workers, which would affect all firms.

Case Study - Firms' Investment in Safety (3)

- Informational issues:

- Firms have more information than workers about job safety at their plants.
- Prospective employees often do not know the injury rates at individual firms but may know the average injury rate over an entire industry.

Case Study - Firms' Investment in Safety (4)

- Injury rates vary dramatically by industry:
  - Financial services: 0.4 fatal injuries per 100,000 workers.
  - Construction: 10.1 fatal injuries per 100,000 workers.
  - Truck driving: 25.6 fatal injuries per 100,000 workers.

- Economists have found that workers receive compensating wage differentials in risky industries.

- Workers' side informational problem:

  If workers are unaware of the greater risks at certain firms within an industry, they may not receive compensating wage differentials from more dangerous employers within that industry.

Case Study - Firms' Investment in Safety (5)

Strategic Interaction:

- Workers do not know which firms are safer than others

  $\Rightarrow$ Each firm bears the full cost of its safety investments but does not get the full benefits.
- Other firms share the benefit from one firm's investment in safety.

Questions:

- Does such a situation cause firms to underinvest in safety?
- Can government intervention overcome such safety problems?

Solution

- Use game theory to solve the case.
- Who are the players?
- What are their strategies?
- What are the payoffs?

Solution (2)

		Firm 2	
		No Investment	Investment
Firm 1	No Investment	$200, 200$	$250, 100$
	Investment	$100, 250$	$225, 225$

Solution (3) - alternative

- What if the firm that invests can advertise it?

		Firm 2	
		No Investment	Investment
Firm 1	No Investment	$200, 200$	$225, 175$
	Investment	$225, 175$	$230, 230$