

Game Theory and Oligopoly

Week 13

Econ 1101 – section 40

Announcements

- No recitation TODAY (Thanksgiving week)

Final Exam is cumulative

- See Final Exam info page at the very bottom of Moodle at Week 15. Has links to the practice midterms all in one place

Plan for today (Lec 13)

- Introduction to Game theory
 1. The Prisoner's Dilemma
 2. Simple Version of the Battle of the Sexes
 3. The Battle of the Sexes with Some Strategic Moves
 4. Application: Debt Negotiations, Debt Ceiling, Government Shutdown
- Duopoly
- When is cooperation likely?
 - Competition Policy in the U.S. and Europe
- Application1: Game show game theory
- Application2 of Game Theory: An Arms Race for Nuclear Weapons [We won't finish this in class, see Ch 17 of textbook]
- Evaluations

Outline of what I will cover

- Introduction to Game theory
 1. We study game theory in the context of oligopoly
 - Definition of oligopoly, cooperation and cartels
 2. Definition of a Game
 - Payoff matrix (example prisoner dilemma)
 - Strategies (optimal and dominant)
 3. Equilibrium (Nash)
 - Example prisoner dilemma
 - Efficiency of equilibrium
 4. Battle of Sexes (game with more than one NE)
 - Static game
 - Sequential games and first mover advantage
 - Commitment devices
 5. Chicken game and reputation: debt ceiling and crisis

Outline of what I will cover

- Oligopoly (duopoly) and applications of Game Theory
 1. Duopoly:
 - Cooperation (cartel) vs market outcome
 - how to get the equilibrium and using the payoff matrix
 2. Cooperation (duopoly)
 - Repeated games
 - Cartels are more likely to be sustainable if...
 - Note US' current law is not favorable for cartels
 3. Application #1: Game Show
 4. Application #2: Arm Race for Nuclear Weapons

Notes:

- The following slides are just complementary material of what I will cover in class
- They are not self-contained since we will work mainly on the whiteboard
- For self contained slides refer to lec 12(iii) and 13(i) in moodle
- Its mandatory to read and understand chapter 17 of the textbook

Example of cartel:

Take OPEC (the cartel of oil producing nations).

- **Gains for the group** if each country holds back oil production to keep up the price. So each country in cartel gets a production quota.
- **Gain for an individual decision maker** (country) to deviate from the agreement and secretly sell more than the quota amount at the high price.

How does it all work out?

- Game Theory is a useful tool

Commitment devices

- In Battle of Sexes, anticipating how girl will respond to pact with friends, guy will make the pact.
- This move on the guy's part is something like the famous example of Cortez burning his ships after landing in Mexico in 1519. He was playing a game with his soldiers. Fighting the Aztec Indians then became a better option for the soldiers than retreating back to the ships.

This is a taste of game theory.

- More than being fun and interesting, it is a powerful tool for social scientists to study important strategic interactions.
- This is a **Social Science Core Class**, and game theory relevant for other social sciences
- Congress and frequent debt ceiling 'crises'

Debt Negotiations, Debt Ceiling, Government Shutdown

The Chicken Game

Government Shutdown and Debt Ceiling 'Crisis'

- Now game of **Chicken**

| | | SWERVE | | STRAIGHT | |
|----------|------|---------|-------|-----------|-----------|
| SWERVE | Blue | Neutral | Sad | Sad | Happy |
| | Red | Happy | Sad | Sad | Happy |
| STRAIGHT | Blue | Happy | Sad | Starburst | Starburst |
| STRAIGHT | Red | Sad | Happy | Starburst | Starburst |

- Suppose red person can convince blue person that he is totally OK with both players playing "straight" and smashing into each other. Then blue will play "swerve," seeing that red will play "straight." **In a game of chicken, reputation for being crazy helps you win.**

Debt Ceiling

- When the government runs a **deficit**, the national debt grows. There is a ceiling on the debt that periodically needs to be changed by Congress. The Republican majority in the house (influenced by the "Tea Party" faction), decided to pay tough and demand cuts to ObamaCare as a price of the debt extension. Obama and the Democrats didn't want that...
- The result was like a **game of chicken**. If the debt ceiling was not raised, then bills would come due, and the government wouldn't be able to pay them. If the government defaulted on its debt, it would do great damage to the U.S. credit rating, and would be analogous in the game of chicken, to the two cars smashing.

- Many of the **Tea-Party** Republicans claimed that they would hold firm, and that if the government hit the debt ceiling, it wouldn't be that big of a problem. Perhaps the majority of Republican believed it would be a disaster to default. However, having some radicals in the group saying it would just be fine had the potential to enhance the Republicans' bargaining power.
- Another way to look at it is that if you really hate government spending, like the Tea Party claims, you are not going to be that upset if the government loses its credit card.
- In the end, the Republicans that believed it would be a disaster to default supported raising the debt ceiling, despite the outcry from the Tea-party. In the analogy of the game of chicken, red guy "swerved," before it was too late.

Now we are coming up to the next battle. Three things:

1. A committee needs to reach an agreement on the budget in December.
2. If not, government funding runs out in January and there could be another shutdown (and the second round of the sequester could kick in)
3. In February the debt ceiling needs to be raised again and we get another debt ceiling rumble.

When is cooperation more likely?

Cartels more likely to work if:

(1) Interaction is frequently repeated and participants care about the future.

(2) The fewer players, the better

(3) If other players can more quickly react. (If information about what each other is doing goes back and forth quickly.)

(4) Cooperation more likely with a more favorable legal environment.

When is cooperation more likely, competition policy US

Current law is not favorable for cartels

U.S. Antitrust Law:

- 1890 Sherman Act outlaws price fixing
- If you are found to be part of a conspiracy to fix price, you can go to jail.

Europe: Regulated by the European Commission.

- If interested, you can see these webpages for more info
 - http://ec.europa.eu/competition/index_en.html
- We can see some examples of cartel cases that have been prosecuted
 - http://ec.europa.eu/competition/cartels/overview/index_en.html

Application1: Game show game theory

Lets try it in class....

Golden Balls – Split or Steal

- Let's apply what we know about game theory to analyze behavior of people on a British game show – Golden Balls.
- After a series of elimination rounds, four players are eliminated down to two.
- The two remaining players must now play a game of “split or steal” to determine how much money they each go home with.
- If both pick split, they split the total winnings. If one picks split and the other picks steal, the person who steals gets all of the winnings. If both pick steal, the both leave with nothing.

First, let's try it in the class. Volunteers?

Split or Steal?

| | | Person A | |
|----------|-------|--|----------------------|
| | | Split | Steal |
| Person B | Split | $\frac{1}{2}$ of winnings $\frac{1}{2}$ of winnings | All of winnings 0 |
| | Steal | 0 All of winnings | 0 0 |

- We see that if Person A picks “Steal”, Person B is indifferent, technically, between “Split” or “Steal”.
- However, we might assume that the payout for Person B is negative if he picks “Split” when Person A picks “Steal,” since he will also have a psychologically negative experience being cheated on

Split or Steal? (minor edit)

Assumption: Negative psychological impact of picking split when the other picks steal

| | | Person A | |
|----------|-------|--|-------------------------|
| | | Split | Steal |
| Person B | Split | $\frac{1}{2}$ of winnings $\frac{1}{2}$ of winnings | All of winnings <0 |
| | Steal | <0 All of winnings | 0 0 |

A Game of Split or Steal

| | | Richard | |
|-------|-------|------------------|--------------|
| | | Split | Steal |
| Carol | Split | 14,087 14,087 | <0 28,175 |
| | Steal | <0 28,175 | 0 0 |

Another Game of Split or Steal

| | | Abraham | |
|------|-------|--------------|-------------|
| | | Split | Steal |
| Nick | Split | 6800 6800 | 0 13,600 |
| | Steal | 13,600 0 | 0 0 |

| | | Abraham | |
|------|-------|--------------|--------------|
| | | Split | Steal |
| Nick | Split | 6800 6800 | <0 13,600 |
| | Steal | 13,600 >0 | 0 0 |

Kind of like a first mover advantage (but not quite, since player could do something different than what he said he would do). Call this **cheap talk**

Abraham

| | | Split | Steal |
|------|-------|--------------|--------------|
| Nick | Split | 6800 6800 | <0 13,600 |
| | Steal | 13,600 >0 | 0 0 |

Links:

Richard vs Carol

<http://www.youtube.com/watch?v=wewk06udkNo>

Abraham vs Nick

<https://www.youtube.com/watch?v=S0qjK3TWZE8>

What about the cases where you don't see Steal/Steal?

- In life, it's not just the monetary payout that matters, as payouts should also take into account someone's morals or beliefs about the other player – so we really need to look at total utility
- For example, someone's utility from picking “steal” over a poor old lady might be a **lot** lower than the utility of the money they could win by picking it, thus making steal not the best option.

An Application of Game Theory: An Arms Race for Nuclear Weapons

Application: Cold War & Arms Race

[See Ch 17 in text]

Potential Prisoner's Dilemma Situation for a first strike nuclear Attack.

The unique Nash equilibrium is _____ (Prisoner's dilemma again.)

Soviet Union

| | | First Strike | Don't Attack |
|------|--------------|----------------------------------|----------------------------------|
| U.S. | First Strike | USSR gets -100 U.S. gets -100 | USSR. gets -1000 US. gets 200 |
| | Don't Attack | USSR gets 200 U.S. gets -1000 | USSR gets 0 U.S. gets 0 |

Application: Cold War & Arms Race

[See Ch 17 in text]

Potential Prisoner's Dilemma Situation for a first strike nuclear Attack.

The unique Nash equilibrium is us first strike, su first strike (Prisoner's dilemma again.)

Soviet Union

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|------|--------------|----------------------------------|----------------------------------|
| | | First Strike | Don't Attack |
| U.S. | First Strike | USSR gets -100 U.S. gets -100 | USSR. gets -1000 US. gets 200 |
| | Don't Attack | USSR gets 200 U.S. gets -1000 | USSR gets 0 U.S. gets 0 |

Suppose instead, each party can **credibly** commit to launch a massive retaliatory attack on warning. So if one party launches a first strike, nuclear winter results. The payoffs now look like: (where $-\infty$ means “minus infinity”)

Soviet Union

| | | Soviet Union | |
|------|--------------|--|--|
| | | First Strike | Don't Attack |
| U.S. | First Strike | USSR gets $-\infty$ U.S. gets $-\infty$ | USSR. gets $-\infty$ US. gets $-\infty$ |
| | Don't Attack | USSR gets $-\infty$ U.S. gets $-\infty$ | USSR gets 0 U.S. gets 0 |

The unique Nash equilibrium is now

- This is the concept of mutually-assured destruction, (MAD) which results in a kind of stability.
- Requires both to keep up in an arms race (if one is more powerful than the other then MAD can break down).
- Requires rationality on both parts.

A useful theory for thinking about Soviet/U.S. Cold War interactions.

Not a useful theory for thinking about North Korea and Iran....

The unique Nash equilibrium is now

U,S do not attack, S.U do not attack

- This is the concept of mutually-assured destruction, (MAD) which results in a kind of stability.
- Requires both to keep up in an arms race (if one is more powerful than the other then MAD can break down).
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Arms Control (Chp. 17 in Mankiw)

- Model of an “Arms Race”

| | | Soviet Union | |
|-------------|---------------|---|--|
| | | Arm | Disarm |
| U.S. | Arm | USSR at risk U.S. at risk | USSR at risk, weak US. safe, powerful |
| | Disarm | USSR safe, powerful U.S. at risk, weak | USSR safe U.S. safe |

- Again, we see the usual Prisoner's Dilemma, where unique equilibrium is both chose "Arm"
- Again, if the two countries could cooperate, both would be better off if both disarm.
- Try an arms control agreement. Both parties can be better off. **But it is crucial for both sides to be able to verify compliance of the other party.**