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Microeconomics

微观经济学

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Table of contents

Fairness and social preferences

Let's play some games!

- Game 1: CNY20 to divide between you and another person in the classroom.

  https://gsm.syd1.qualtrics.com/jfe/form/SV_0dq86HNZaPwhLlI

Let's play some games!

- Game 2: CNY20 to divide between you and another person in the classroom, however, the person can reject if she or he is "unhappy".

https://gsm.syd1.qualtrics.com/jfe/form/SV_3g8XVG3zn6rXIgK

Fairness and social preferences

- So far we have discussed economics under the assumption that people only cares about their own interest: selfishness assumption.
- Do you think this assumption is realistic?
- Can you give some examples that people violate selfishness assumption?
  - giving to charity
  - donating organs
  - voluntary unpaid work
  - voting

Game 1: Dictator game

- two players： a propose (P) and a responder (R).
- P has dictator power over R.

What is the best strategy as a proposer?
What is your prediction of our results?

Let's see our results!

Game 1: Dictator game

Empirical findings: dictators offered an average about 20%

- The offer is purely based on “altruism” **利他**.

Game 2: Ultimatum game

- two players： a propose (P) and a responder (R)
- R can either accept the offer, or reject
- In case of rejection, both players receive nothing.

What is the best strategy as a proposer?
What is the best strategy as a responder?

What is your prediction of our results?

Let's see our results!

Game 2: Ultimatum game

Empirical findings: even when stakes are big, people still do not play according to selfishness assumption. In countries with low disposable income where the stake was equivalent to 3 months' income (Camerer 1995).

- Between 60% and 80% of the offers are between 0.4 and 0.5 of the pie.
- Almost no offers below 0.2.
- Low offers are frequently rejected.

The responders are angered by proposals that they regard as unfair, and prepared to punish such unfair behavior at a cost to themselves.

Game theory

Game 1: The Grade Game

Imagine that the following procedure will determine your final score:

- If you put α and your pair puts β, then you will get grade A, and your pair grade C.
- If both you and your pair put α, then you both will get grade B-.
- If you put β and your pair puts α, then you will get grade C, and your pair grade A.
- If both you and your pair put β, then you will both get grade B+.

What is game theory?

Game theory is a method to study strategic interactions **策略性互动**.

What is a strategy?

- Not strategic: Firms in perfect competition are price takers (Do not have to worry about competitors). Monopolists do not have competitors to worry about (They just take the demand curve).
- Strategic: Everything in between. For example, Huawei has to worry about Apple and Xiaomi.

Strategy is a plan for playing a game where the outcomes that affect you depend on actions of others.

Elements of a game

Make a table to describe The Grade Game: [write on the white board]

		pair	
		α	β
me	α	B-, B-	A, C
	β	C, A	B+, B+

How many chose α? How many chose β?
What's your reason?

Elements of a game

We still do not have payoffs...

- We may only care about our own grade
- We may also care about other's grade

We will deal with both cases.

Possible payoffs 1

Numbers represent utilities.

			pair	
			α	β
me	α		0,0	3,-1
	β		-1,3	1,1

- $(A, C) \rightarrow\ 3$
- $(B+, B+) \rightarrow\ 1$
- $(B-, B-) \rightarrow\ 0$
- $(C, A) \rightarrow\ -1$

It may represent people who only care about their only payoffs.
What should you do as a player?

Strictly dominant vs. strictly dominated strategies

As a person who maximizes own utilities, you should always choose α.
Why? Can't I choose β? If my pair also agrees to choose β, we both got 1!
Is the argument right?

Strictly dominant vs. strictly dominated strategies

As a person who maximizes own utilities, you should always choose α.
Why? Can't I choose β? If my pair also agrees to choose β, we both got 1!
Is the argument right?

- I cannot convince/trust my pair.
- Even if my pair is convinced and will choose β, it is still in my best interest to choose α.

Strictly dominant vs. strictly dominated strategies

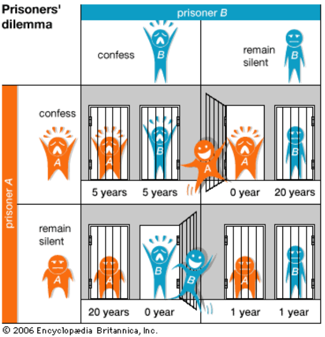
strictly dominant 严格占优

We say that my strategy α **strictly dominates 严格占优于** my strategy β if my payoff from α is strictly greater than that from β, regardless of what others do.

strictly dominated 严格被占优 is the opposite: my strategy β is **strictly dominated** by my strategy α if my payoff from α is strictly greater than that from β, regardless of what others do.

- A rational person should never choose the dominated strategy.
- Rational choice can lead to outcomes that is Pareto inefficient.

Prisoner's dilemma 囚徒困境



Firms competing prices, bringing guns, cleaning your dormitory, etc.

- Adam Smith and the invisible hand: best results come from everyone in the group doing what's best for himself (competitive market equilibrium is Pareto optimal).
- Prisoner's dilemma is an example of conflict between individual rationality and group rationality.

Solving prisoner's dilemma

What could be the solutions?

- Communication and even collusion: drawing a "contract" (mafias substitute the law and enforce the contract).
- Repeated interaction (reputation concern)

Possible payoffs 2

Numbers represent utilities.

		pair α	pair β
me	α	0,0	-1,-3
	β	-3,-1	1,1

- $(A, C) \rightarrow \; 3 - 4 = -1$
- $(B+, B+) \rightarrow \; 1$
- $(B-, B-) \rightarrow \; 0$
- $(C, A) \rightarrow \; -1 - 2 = -3$

It may represent people who are inequality averse.

What do you do as a player?

Possible payoffs 2

Numbers represent utilities.

		pair	
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It may represent people who are inequality averse.
What do you do as a player? No dominant strategy.

- choose α: minimize loss, or minimize variation
- choose β: maximize gain.

The game is a coordination problem.

Possible payoffs 3

What if you are self-interested (like in payoff table 1) and your pair is inequality averse (like in payoff table 2).

		pair	
		α	β
me	α	0,0	3,-3
	β	-1,-1	1,1

What should you do as a player?

Possible payoffs 3

What if you are self-interested (like in payoff table 1) and your pair is inequality averse (like in payoff table 2).

		pair	
		α	β
me	α	0,0	3,-3
	β	-1,-1	1,1

What should you do as a player?
α is still the dominant strategy (like in payoff table 1).
Because from the definition of dominant strategy (regardless of what others do), changing your pair's payoff should not affect your dominant strategy.

Possible payoffs 4

What if you are inequality averse (like in payoff table 2) and your pair is self-interested (like in payoff table 1)?

		pair α	pair β
me	α	0,0	-1,-1
me	β	-3,3	1,1

What should you do as a player?

Possible payoffs 4

What if you are inequality averse (like in payoff table 2) and your pair is self-interested (like in payoff table 1)?

		pair	
		α	β
me	α	0,0	-1,-1
	β	-3,3	1,1

What should you do as a player?

- I don't have a dominant strategy.
- My pair has a dominant strategy α, like the self-interested player in payoff table 3.
- I'd better choose α.

It is important to put yourself in other's shoes **换位思考** and try to figure out what they will do.

Game 2: Beauty Contest

No discussion. Do not show your answers to your neighbors.

- write down a whole number between 1 and 100
- calculate the average number in our class
- the winner is the person whose number is closest to 2/3 times the average number of the class
- The winner will get CNY10 in cash!
- In case of a tie, you will split the reward.

Ingredients of a game

- **players** i, j: say, the class
- **strategies**
  - s_i: a particular strategy of player i, say choosing number 14.
  - S_i: the set of possible strategies of player i, say $\{1, 2, 3, ..., 100\}$
  - s: a strategy profile/list: a particular play of the game, say one number for each person in the class (our data set).
- **payoffs** $u_i(s_1, ..., s_i, ..., s_n)$ or $u_i(s)$

Assume **complete information 完全信息**: everyone knows the structure of the game and the payoff functions of the players.
An example of incomplete information: auction where each player only knows their own utility (private information).

Results of Game 2

What is your guess?

Let's see the results!

Results of Game 2

What is your guess?

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Reason for choosing 33...

- If everybody is choosing randomly, the average will be 50
- Then 2/3 of 50 is about 33

Anything wrong?

Results of Game 2

What is your guess?

Let's see the results!

Reason for choosing 33...

- If everybody is choosing randomly, the average will be 50
- Then 2/3 of 50 is about 33

Anything wrong?

- $s_i > 67$: weakly dominated by 67. (rationality, R)
- $67 \geq s_i > 45$: not weakly dominated in original game, but weakly dominated once we delete 68 to 100. (rationality + knowledge that others are rational, R+KR)
- $45 \geq s_i > 30$: weakly dominated once we delete 46 to 100. (R+KR+KKR)
- ... go all the way to 1. (KK...KR)

Why isn't 1 the winning answer?

Common knowledge

Common knowledge 共同知识

a special kind of knowledge for a group of agents. There is common knowledge of p in a group of agents G when all the agents in G know p, they all know that they know p, they all know that they all know that they know p, and so on *ad infinitum*.

An example: two people with blue eyes living on a island. If there is no reflective surface, they can only know each other's eye color but not their owns. Then "at least one person has blue eyes", although known by each person, is not a common knowledge.

Best response 最优反应

Best response: an example

		player 2: l	player 2: r
player 1	U	5,1	0,2
	M	1,3	4,1
	D	4,2	2,3

- Neither player has a dominated strategy.

What would you do as player 1?

- U is the best response to l.
- M is the best response to r.
- Can you rationalize choosing D?

Best response: an example

			l	r
			player 2	
player 1	U		5,1	0,2
	M		1,3	4,1
	D		4,2	2,3

- Neither player has a dominated strategy.

What would you do as player 1?

- U is the best response to l.
- M is the best response to r.
- Can you rationalize choosing D?
  - Assume my belief is that my opponent is equally likely to choose l and r, then D gives the highest expected utility.

Best response: another example

Penalties in soccer game 点球

		Goal keeper	
		l	r
	L	4,-4	9,-9
Shooter	M	6,-6	6,-6
	R	9,-9	4,-4

- Neither player has a dominated strategy.

What should the shooter do?

- L is the best response to r.
- R is the best response to l.
- How about M?
  - Is M the best response if the shooter's belief for the goal keeper is equally likely to go l and r?

Best response: another example

- M is not a best response to any belief.
- How to see that?

Best response (BR)

1. Player i's strategy $\hat{s}_i$ is a best response to the strategy s_{-i} of other players if $u_i(\hat{s}_i, s_{-i}) \geq u_i(s_i^{'}, s_{-i})$ for all $s_i^{'}$ is S_i.
   - or $\hat{s}_i$ solves $\max_{s_i} u_i(s_i, s_{-i})$.
2. Player $i's$ strategy $\hat{s}_i$ is a best response to the belief p about the other player's choices if $Eu_i(\hat{s}_i, p) \geq Eu_i(s_i^{'}, p)$ for all $s_i^{'}$ is S_i.
   - or $\hat{s}_i$ solves $\max_{s_i} Eu_i(s_i, p)$.

Do not choose the strategy that is never a best response to any belief.

Best response: an application

Partnership game:

- 2 agents own firm jointly
- share profits equally
- each agent choose her <u>effort level</u> to put into this firm: $S_i = [0, 4]$.
- profit of the firm is given by $4[s_1 + s_2 + bs_1 s_2]$ where $0 \leq b \leq \frac{1}{4}$
- payoffs: $u_i(s_i, s_{-i}) = \frac{1}{2} \times 4[s_i + s_{-i} + bs_i s_{-i}] - s_i^2$ where s_i^2 is the cost of the effort.

We are interested in: what is player 1's BR to each possible choice of player 2?

$$\max_{s_1}\ 2[s_1 + s_2 + bs_1 s_2] - s_1^2$$

F.O.C.,

$$2(1 + bs_2) - 2\hat{s}_1 = 0$$

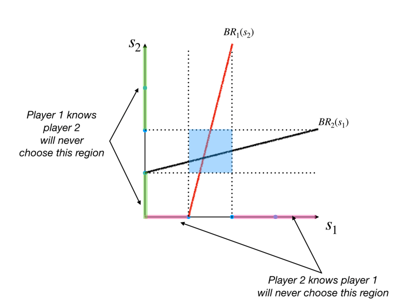
$$\Rightarrow \hat{s}_1 = 1 + bs_2 = BR_1(s_2)$$

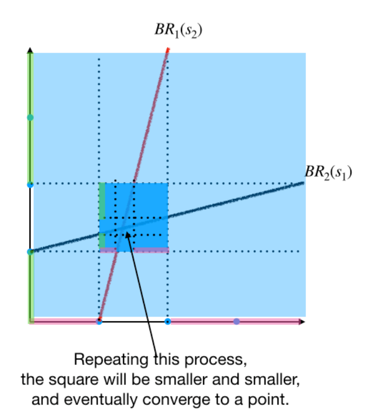
[S.O.C., $-2 < 0$]

The same analysis will give

$$\hat{s}_2 = 1 + bs_1 = BR_2(s_1)$$

Remember that "never choose a strategy that is not best response to any strategy of your opponent". If this is a common knowledge, what will happen?





Note that the right figure is an enlarge of the shaded area in the left figure.

Players' strategies will converge to a point $BR_1 = BR_2$:

$$BR_1 = \hat{s_1} = 1 + b\hat{s_2}$$

$$BR_2 = \hat{s_2} = 1 + b\hat{s_1}$$

$$\Rightarrow \hat{s_1} = \hat{s_2} = \frac{1}{1-b}$$

Nash equilibrium 纳什均衡

Nash equilibrium

A strategy profile $(s_1^*, s_2^*, ..., s_N^*)$ is a Nash equilibrium (NE) if for each i, her choice s_i^* is a best response to other player's choices s_{-1}^*.

- Everyone is playing a best response to everyone else.
- By far the most commonly used solution set in game theory.
- It does not mean that people (or rational people) will play the NE.

Nash equilibrium

Why we should care about NE?

1. No individual can do strictly better by *deviating*, holding others fixed.
2. **self-fulfilling 自我实现 beliefs**： If everyone believes that everyone else is going to playing their part of NE, then everyone will actually play their part of NE.

Those points stand by definition of NE.

Nash equilibrium

An example:

player 2

		l	c	r
	U	0,4	4,0	5,3
player 1	M	4,0	0,4	5,3
	D	3,5	3,5	6,6

Nash equilibrium

An example:

		player 2		
		l	c	r
player 1	U	0,<u>4</u>	<u>4</u>,0	5,3
	M	<u>4</u>,0	0,<u>4</u>	5,3
	D	3,5	3,5	<u>6</u>,<u>6</u>

Find the place where the best responses coincide.
$BR_1(l) = M$, $BR_1(c) = U$, $BR_1(r) = D$
$BR_2(U) = l$, $BR_2(M) = c$, $BR_2(D) = r$
So NE is (D, r).

Note again that a rational person may not choose NE for good reason.

Relate NE to Dominance

		player 2 α	player 2 β
player 1	α	0,0	3,-1
player 1	β	-1,3	1,1

- α strictly dominates β for both players
- "Never choose the dominated strategy"
- NE is (α, α).

Strictly dominated strategy could not be a best response.
No strictly dominated strategy could ever be played in NE.

Relate NE to Dominance

		player 2	
		l	r
player 1	U	$\underline{1},\underline{1}$	$\underline{0}$,0
	D	0,$\underline{0}$	$\underline{0},\underline{0}$

- For player 1, U weakly dominates D, and for player 2, l weakly dominates r.
- (U, l) is a NE, (D, r) is also a NE.
- So weakly dominated strategies could be played in NE.

Remember that at NE no player can be *strictly* better by deviating.

NE: An example

Multi-player game: An example

The investment game:

- players: the class
- strategies: invest 0 or **1 point** of your final grade.
- payoffs:
  - If you invest nothing, then you get 0.
  - If you invest 1, then
    - 2 net profit if $\geq 90\%$ of the class invest
    - -1 net profit if $< 90\%$ of the class invest

Multi-player game: An example

The investment game:
NE: all invest and no one invest.

- Everyone invest is a better NE than no one invest.
- What happens if we repeat the game for several times? It is highly possible that we will converge to a “bad” NE.
- Self-fulfilling prediction that if you predict others will not invest, you will not invest. The opposite also holds.

Multi-player game: An example

The investment game:
What is the difference between this game and Prisoner's dilemma?

- There is no dominant strategy.
- This is a coordination game, where Pareto improvement is possible.
- Examples: which side of the road to go, bank runs, etc.
- Unlike in Prisoner's dilemma, communication might help.

Multi-player game: a true story

Since he started teaching at Johns Hopkins University in 2005, Professor Peter Fröhlich has maintained a grading curve in which each class's highest grade on the final counts as an A, with all other scores adjusted accordingly. So if a midterm is worth 40 points, and the highest actual score is 36 points, "that person gets 100 percent and everybody else gets a percentage relative to it," said Fröhlich.

This approach, Fröhlich said, is the "most predictable and consistent way" of comparing students' work to their peers', and it worked well.

Multi-player game: a true story

Two NEs:

- No one takes the test.
- Everyone takes the test.

Multi-player game: a true story

Two NEs:

- No one takes the test.
- Everyone takes the test.

Questions?