Competitive strategies in commodity oligopolies

L 07: The emergence of cooperation

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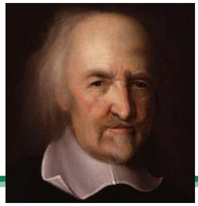
Non est potestas Super Terram quæ Comparetur ei. Iob. 41. 24.

Thomas Hobbes: The origin of social order (I)



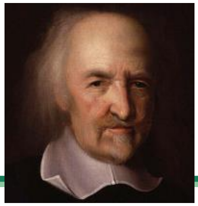
The initial situation is a state of nature which is characterized in the following way:

- there are no internalized norms,
- all individuals are pure egoists,
- individuals are in a conflict situation, i.e., there is competition for goods;
- this leads to hostility and the attempt to subjugate others;
- there is no organization or state that prevents violence or issues laws;
- individuals behave "rationally," i.e., they try to maximize their utility by enhancing their material welfare

The consequence is a war of all against all ("where every man is enemy to every man").

Source: Thomas Hobbes: Leviathan Or the Matter, Forme and Power of a Commonwealth Ecclesiasticall and Civil (1651)

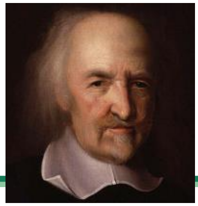
Thomas Hobbes: The origin of social order (II)



„In such condition, there is no place for industry; because the fruit thereof is uncertain: and consequently no culture of the earth; no navigation, nor use of the commodities that may be imported by sea; no commodious building; no instruments of moving, and removing, such things as require much force; no knowledge of the face of the earth; no account of time; no arts; no letters; no society; and which is worst of all, continual fear, and danger of violent death; **and the life of man, solitary, poor, nasty, brutish, and short**“

Source: Thomas Hobbes: Leviathan Or the Matter, Forme and Power of a Commonwealth Ecclesiasticall and Civil (1651)

Thomas Hobbes: The origin of social order (III)



How does “social order” originate in such a situation?

The basic idea is that a “Leviathan” ("sea monster"), i.e., a state, is created. How does the state originate? Hobbes’s argument can be reconstructed in the following way:

1) Men love (their own) liberty and dominion over others (which is a condition for the war of all against all)
2) Men want their own “preservation” and a “more contented life”
3) There is a belief ("foresight") that (only?) "restraint“ (= state) leads to realizing the second motive by imposing fear of punishment for pursuing the first motive
4) Individuals are willing to transfer rights to a central authority
5) Establishing order is not possible by covenants without a sword, by "the joining together of a small number of men," and being "governed, and directed by one judgment, for a limited time“
6) Consequence: A “Leviathan” originates

However, cooperation between self-interested individuals does exist without central authority (examples?)

Source: Thomas Hobbes: Leviathan Or the Matter, Forme and Power of a Commonwealth Ecclesiasticall and Civil (1651)

Our key question for this session

Under what conditions

will cooperation emerge

in a world of egoists

<u>without</u> central authority?

Agenda

Strategies for the repeated prisoner's dilemma

The evolution of cooperation

Examples and conclusions

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The Prisoner's Dilemma

Player A \ Player B	Cooperate	Defect
Cooperate	R=3, R=3	S=0, T=5
Defect	T=5, S=0	P=1, P=1

R = Reward

P = Punishment

S = Sucker's payoff

T = Temptation

Conditions:

- T > R > P > S
- 2 R > T + S

The Repeated Prisoner's Dilemma

If the game is played once, two egoist players will choose their dominant strategy: defection.

If the game is played a known finite number of times, the players still have no incentive to cooperate:

- Both players will defect in the last move because there is no future to influence
- On the next-to-last move neither player will have an incentive to cooperate because they can both anticipate a defection by the other player on the very last move
- Such a reasoning implies that the game will unravel all the way back to mutual defection on the first move

However, this reasoning does not apply if the players will interact an indefinite number of times or – more realistically – cannot be sure when the last interaction between them will occur. In such a situation cooperation can emerge.

But how?

And under which conditions?

The rules of the original repeated prisoner's dilemma model

Restrictions:

- There is no mechanism available to the players to make enforceable threats or commitments
- There is no way to be sure what the other player will do on a given move
- There is no way to eliminate the other player or run away from the interaction
- There is no way to change the other player's payoffs
- The players can communicate only through the sequence of their own behavior

No restrictions:

- The payoffs of the players need not be comparable at all
- The payoffs need not be symmetric
- The payoffs need not be measured on an absolute scale
- Cooperation need not be considered desirable from the point of view of the rest of the world
- There is no need to assume that the players are rational
- The actions that players take are not necessarily even conscious choices

The shadow of the future

However, cooperation can emerge because the players

- might meet again,
- recognize each other, and
- remember how they have interacted so far.

The future can therefore cast a shadow back upon the present and thereby affect the current strategic situation.

The future is, however, less important than the present. The *weight* of the next move relative to the present move will be called ***w*** (discount parameter).

The higher the discount parameter ***w*** the more important are future interactions for the total payout of a game (and the higher is the incentive to collaborate).

Axelrod's first computer tournament

Rules

- Round robin: each entry played against each other entry
- Each entry also played against its own twin and against RANDOM (a program that randomly cooperates and defects with equal probability)
- Each game consisted of exactly 200 moves
- Payoffs: R=3, P=1, T=5, S=0
- The tournament was run five times to get a more stable estimate of the scores for each pair of players

Entries:

- Strategies (or decision rules) that specify what to do (cooperate or defect) in any situation that might arise
- 14 entries from five disciplines (psychology, economics, mathematics, political science, sociology)

Which strategy would you submit?

Examples of submitted strategies in the first tournament

TIT FOR TAT:

- Start with a cooperative move and thereafter do what the other player did on the previous move

JOSS:

- Start with a cooperative move, always defect if the other player defects, usually cooperate if the other player cooperates, but in 10% of the cases defect after the other player cooperates

FRIEDMAN:

- Never defect first, but if the other defects even once, always defect for the rest of the game

DOWNING:

- Estimate the probability that the other player cooperates after you cooperate, and also the probability that the other cooperates after you defect. Update these estimates after each move and select the choice that will maximize the long-term payoff

Results of the first computer tournament

TIT FOR TAT won the tournament (with an average of 504 points per game), without winning a single game (!)

The eight top-ranking entries were all nice i.e., they did not defect first (and achieved scores between 472 and 504)

All other seven entries were not nice (and achieved scores < 402)

Each of the nice rules received about 600 points with each of the other seven nice rules and with its twin

The relative ranking of the top eight entries was largely determined by two kingmakers: DOWNING and FRIEDMAN (strategies that tried to get away with occasional defections performed worse against these two strategies)

TIT FOR TWO TATS (defect only if the other player defected on the previous two moves) would have won the tournament if it had been submitted (TIT FOR TAT lost many points due to the echo effect in case of one (accidental or planned) defection)

Axelrod's second computer tournament

Adjusted rules

- The length of the game was determined probabilistically with a 0.00346 chance of ending with each given move (equivalent to w=0.99654)

Entries:

- 62 entries from six countries
- Every participant had received an analysis of the results of the first tournament
- More than half of the entries were nice

Which strategy would you submit?

Examples of additional strategies in the second tournament

TIT FOR TWO TATS:

- Start with a cooperative move, defect only if the other player defected on the previous two moves

TESTER:

- Defect on the first move to test the other player. If the other player ever defects, apologize by cooperating and playing tit for tat for the rest of the game. Otherwise cooperate on the second and third moves but defect every other move after that.

TRANQUILIZER:

- Cooperate for the first dozen or two dozens moves if the other player also cooperates. Only then throw in an unprovoked defection. If the other player continues to cooperate, increase the frequency of defections

Results of the second computer tournament

TIT FOR TAT won again (!)

Of the top 15 rules all but one were nice, of the bottom 15 rules all but one were not nice

Strategies that tried to exploit the exploitable (like TESTER, TRANQUILIZER) paid too high a price when playing against strategies that were not exploitable

The ranking of the nice rules was largely determined by how promptly and reliably they responded to a challenge by the other player

- Retaliatory rules that immediately defected after an "uncalled for " defection from the other (like TIT FOR TAT) performed better than more tolerant rules (like TIT FOR TWO TATS).

Also check the website: **http://ncase.me/trust/**

Properties of successful rules

Niceness

- Never be the first to defect

Provokability

- Defect immediately after an uncalled-for defection by the other

Forgiveness

- Cooperate if the other player returns to cooperation after your response to a provocation

Clarity

- Have a simple, transparent strategy that allows the others to adapt to your pattern of action

TIT FOR TAT perfectly reflects these properties

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An evolutionary approach to cooperation

John Maynard Smith, evolutionary biologist (1974)

Imagine the existence of a population of individuals employing a certain strategy in the repeated prisoner's dilemma, and a single mutant individual employing a different strategy

A new strategy is said to <u>invade</u> a native strategy if the newcomer gets a higher score with a native than a native gets with another native

A strategy is <u>collectively stable</u> if no strategy can invade it

Collectively stable strategies are important because they are the only ones that an entire population can maintain in the long run in the face of any potential mutant

What can we say about collectively stable strategies?

Propositions on the evolution of cooperation

Proposition 1: TIT FOR TAT is collectively stable if and only if, w is large enough. The critical value of w is a function of the four payoff parameters T, R, P, and S

Proof of proposition 1

TIT FOR TAT has a memory of only one, so we only have to prove that neither DC nor DD can beat TIT FOR TAT if w is large enough

Proof for DD: The payoffs are equal if $R + wR + w^2R + ... = T + wP + w^2P + ...$

This is equivalent to saying $R / (1-w) = T + wP / (1-w)$ or $w = (T-R) / (T-P)$

So, if $w \geq (T-R) / (T-P)$ TIT FOR TAT cannot be invaded by DD

Proof for DC: The payoffs are equal if $R + wR + w^2R + ... = T + wS + w^2T + w^3S + ...$

This is equivalent to saying $R / (1-w) = (T + wS) / (1-w^2)$ or $w = (T-R) / (R-S)$

So, if $w \geq (T-R) / (R-S)$ TIT FOR TAT cannot be invaded by DC

Conclusion: If T=5, R=3, P=1, S=0 this means that TIT FOR TAT cannot be invaded by DD if $w \geq 1/2$ and by DC if $w \geq 2/3$

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The live-and-let-live system in trench warfare in World War I

A British staff officer on a tour of the trenches remarked that he was

> *astonished to observe German soldiers walking about within rifle range behind their own line. Our men appeared to take no notice ... These people evidently did not know there was a war on. Both sides apparently believed in the policy of "live and let live"*

G. Dugdale: Langemarck and Cambrai (1932)

Trench warfare as a repeated prisoner's dilemma

In a given locality the <u>two players</u> can be taken to be the small units facing each other

At any time, the <u>choices</u> are to shoot to kill or deliberately to shoot to avoid causing damage

For both sides, weakening the enemy is an important <u>value</u> because it will promote own survival

Therefore, in the <u>short run</u> it is better to do damage now whether the enemy is shooting back or not

This means that

- Mutual defection is preferred to unilateral restraint (P > S)
- Unilateral restraint by the other side is even better than mutual cooperation (T > R)
- Mutual restraint is preferred by the local units to the outcome of mutual punishment (R > P)
- Taken together this establishes the first PD condition: T > R > P > S
- Moreover, both sides would prefer mutual restraint to the random alternation of serious hostilities, establishing the second PD condition: R > (T + S) / 2

Understanding cooperation in trench warfare

How could the live-and-let-live system have gotten started?

- Similarities in basic needs and activities e.g., fire pause during mealtimes, Christmas
- Miserable weather preventing troops from fighting
- Spreading mutual restraint for longer periods of time and into neighboring sectors
- Routines of ritualized aggressions (e.g., precise and predictable artillery attacks)

How was it sustained?

- Demonstration of retaliatory capabilities
- Provocable strategies: significant retaliation in case of defection (two or three for one)
- Avoidance of echo effects: defecting side would understand retaliation and not escalate
- Forgiving strategies: no further escalation after significant retaliation
- Hand-over: familiarization of the incoming unit by the outgoing unit
- Artillery (less vulnerable, more powerful) was strongly governed by the infantry

Why did it break down toward the end of the war?

- More direct monitoring and influence by the headquarters
- Institution of the raid: carefully prepared attacks on enemy trenches by small groups
- Ordered by the headquarter, unpredictable, provoking retaliation and echo effects

How to promote cooperation?

Conclusions for policy makers

1. Enlarge the shadow of the future
- Make the interactions more durable (wedding, trench warfare, corporate organizations)
- Make the interactions more frequent (clusters, decomposition of interactions, corporate processes)

2. Change the payoffs
- Change payoffs (T,R,S,P) such that a given w is large enough to encourage cooperation (p.22)
- Increase the punishment for defection to an extent that cooperation becomes the dominant strategy

3. Teach people to care about each other
- Altruism: one person's utility is positively affected by another person's welfare
- Genetical kinship theory, socialization (but: risk of exploitation)

4. Teach reciprocity
- Golden rule ("Do unto others as you would have them do unto you!") spoils and tempts the other players
- Reciprocity needed to police the community (but: risk of echo effect, feud)

5. Improve recognition abilities
- Players' ability to recognize each other from the past
- Transparency on players' moves and underlying strategies

**The same strategies (with an opposite sign)
can be used to prevent cooperation**

How to choose an effective strategy?

Conclusions for players

1. Don't be envious

- Wrong question: How well am I doing compared to the other players?
- Good question: How well am I doing compared to how well someone else could be doing in my shoes?
- TIT FOR TAT never once scored better in a game than the other player!

2. Don't be the first to defect

- It pays to cooperate as long as the other player is cooperating
- However, cooperation doesn't pay in non-recurring interactions ...
- ... or if cooperation will not be reciprocated

3. Reciprocate both cooperation and defection

- Extracting more than one defection for each defection of the other player risks escalation
- On the other hand, extracting less than one-for-one risks exploitation
- The precise level of forgiveness that is optimal depends upon the environment (e.g., level of noise)

4. Don't be too clever

- Consider that your own behavior will change the behavior of the other players
- Hiding your intentions is useful in a zero-sum setting, but not if you benefit from cooperation
- Be transparent and make it easy for the other player to comprehend your intentions

What do these conclusions mean for your strategy in the commopoly game?