Session 2

Being determined

- Prisoners' Dilemma Games -

What you will learn today: Our objectives

- Why does individual rationality conflict with collective rationality? Why don't people cooperate, even if it appears that it is in their best interests to do so?
  - The classical game and its equilibrium
- How can we use these insights to explain how people behave in more complex situations?
  - Extensions
- How can we solve such dilemma situations? What are remedies to enhance mutual cooperation?
  - Strategic moves

Our path to succeed: Course outline for today

- The classical game and its equilibrium: The prisoners' dilemma
  - Tosca and the bargain with Scarpia
- Extensions: Team projects, the tragedy of the commons, and the existence of god
  - Pigs cannot fly – but are rational
- Strategic moves: Writing a contract, repeating yourself, punishing/rewarding others, and being a leader
  - Golden Balls – Split or steel?
  - Moralistic gods and supernatural punishment
  - Banning cigarette advertising on TV – US 1970

The classical story of the prisoners' dilemma

Suspect 1

- Two suspects in a major crime are held in separate cells. There is enough evidence to convict each of them of a minor offense. However, there is not enough evidence to convict either of them of a major crime unless one of them acts as an informer against the other (confesses).

Suspect 2

- If they both stay quiet (deny), each will be convicted of the minor offense and spend 1 year in prison. If only one of them confesses, he will be freed and used as a witness against the other, who will spend 10 years in prison. If both confess, each will spend 8 years in prison.

How to model the prisoners' dilemma in its strategic form

- **Players: Suspect 1 and Suspect 2**
- **Strategies: {confess, deny} for each suspect**
- **Payoffs: u_1(confess, deny) = 0, u_2(confess, deny) = -10,**
  u_1(deny, confess) = -10, u_2(deny, confess) = 0,
  u_1(confess, confess) = -8, u_2(confess, confess) = -8
  u_1(deny, deny) = -1, u_2(deny, deny) = -1

Suspect 1 \ Suspect 2	*deny*	*confess*
deny	-1,-1	-10,0
confess	0,-10	-8,-8

How to behave in prisoners' dilemma games: Always choose the dominant strategy

Suspect 2

Suspect 1

		Suspect 2: *deny*	Suspect 2: *confess*
Suspect 1	*deny*	-1,-1	-10,0
	confess	0,-10	-8,-8

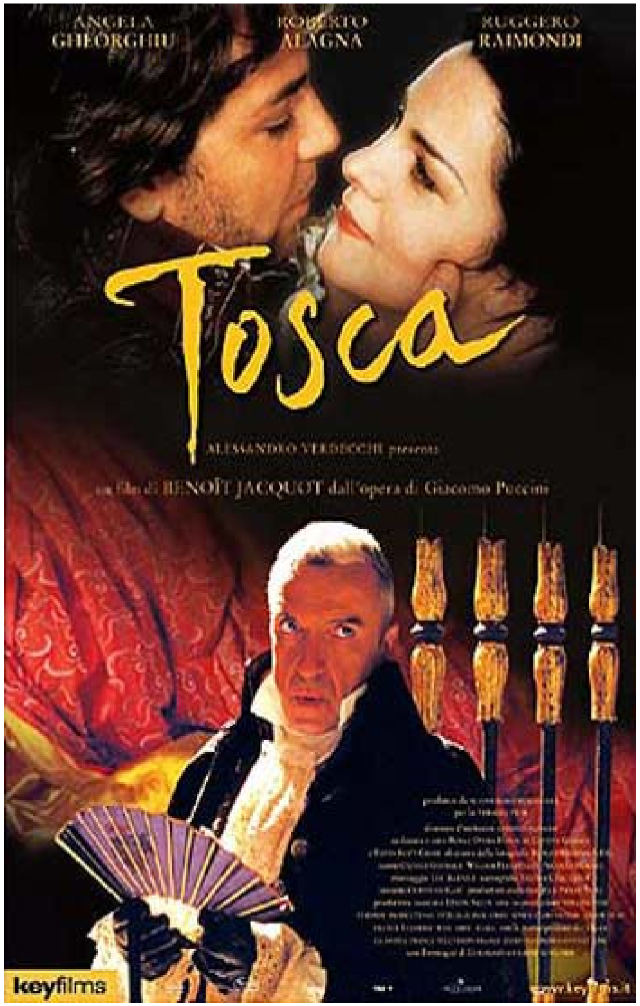
Definition:

A 2x2 **prisoners' dilemma game** is a game with one symmetric equilibrium in dominant strategies but both players mutually prefer to choose the dominated strategy.

Definition: A **dominant strategy** for a player is a strategy that leads to higher payoffs than all of his other strategies, regardless of the other players' strategies.

A (**strictly**) **dominated strategy** for a player is a strategy that always gives a (strictly) worse outcome than all of his other strategies, no matter what the other players do.

Case study: Tosca and the bargain with Scarpia



Film poster for Tosca, retrieved from en.Wikipedia.org, copyright is believed to belong to keyfilms

The previous plot:

Scarpia, chief of police, has condemned Tosca's lover Cavaradossi to death but offers her a bargain: he can order the firing squad to use real bullets – and Cavaradossi will surely die – or blanks – in which case Cavaradossi will survive – in exchange for Tosca's favors.

They meet after Scarpia has already given his orders to the squad and Tosca – without knowing what he decided – has to choose between consenting to his desires or thrusting the knife hidden in her garments….

Case study: Tosca and her bargain with Scarpia - strategic form and rational behavior

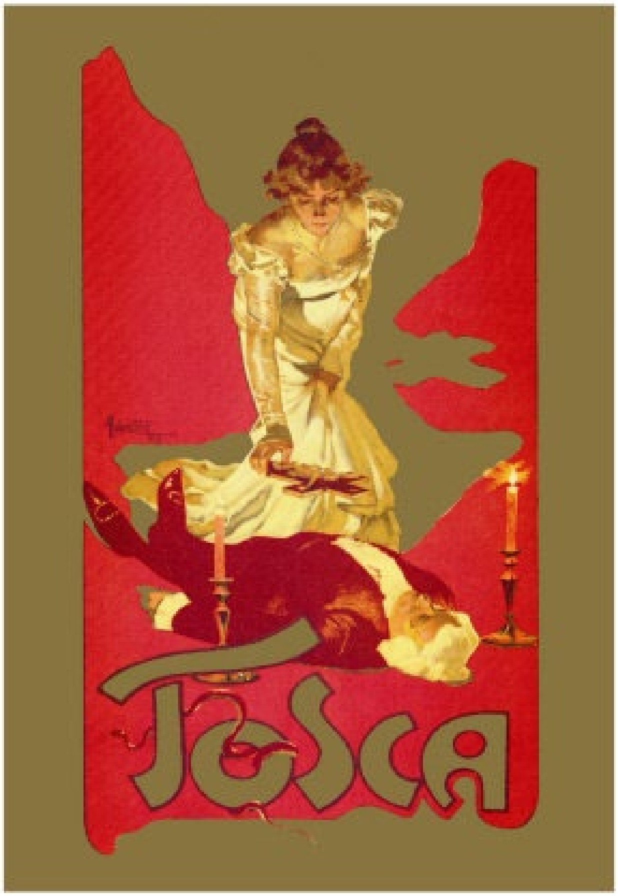
- Players: Tosca and Scarpia
- Strategies: {consent, stab} for Tosca, {real bullets, blanks} for Scarpia
- Payoffs:

Scarpia

Tosca

Tosca \ Scarpia	*real*	*blanks*
stab	2,2	4,1
consent	1,4	3,3

Case study: Tosca and her bargain with Scarpia - Puccini’s solution



Original poster for Tosca, retrieved from en.Wikipedia.org, copyright belongs to Adolfo Hohenstein

The final plot:

Tosca stabs Scarpia and Scarpia uses real bullets, so both Scarpia and Cavaradossi die.

When she learns that Cavaradossi is dead, Tosca jumps to her death.

Extending the classical game: Team projects and the problem of free riding

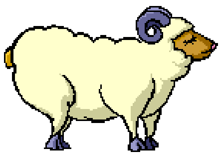
- Consider a production team with two members
- Each team member can contribute a low or high effort to the team
- A high effort, which we assume to cost 10 units, generates a productivity increase of 16 units; a low effort, costing 5 units, makes an increase of 10 units possible. Productivity increase is equally split

Team member 2

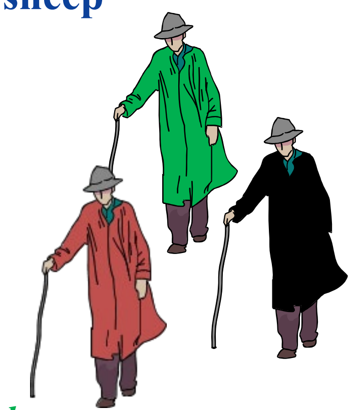
Team member 1

	low effort	*high effort*
low effort	5,5	8,3
high effort	3,8	6,6

Extending the classical game: The tragedy of the commons and the use of resources



- Suppose 3 farmers share grazing land for sheep
- Farmer simultaneously choose whether to graze 1 or 2 sheep
- Each farmer has a benefit of 2 per sheep he owns. Gazing sheep damages the land at a cost of 1 per sheep when the number of sheep is lower than 4 and at a cost of 2 otherwise. The cost of damage is shared equally by all farmers



Farmer 3

1 sheep

Farmer 1 \ Farmer 2	*1 sheep*	*2 sheep*
1 sheep	1, 1, 1	-⅔, 1⅓, - ⅔
2 sheep	1⅓, -⅔, - ⅔	⅔, ⅔, - 1⅓

2 sheep

Farmer 1 \ Farmer 2	*1 sheep*	*2 sheep*
1 sheep	-⅔, -⅔, 1⅓	-1⅓, ⅔, ⅔
2 sheep	⅔, -1⅓, ⅔	0, 0, 0

Extending the classical game: Pascal's wager, the existence of God and the one-sided prisoners' dilemma game

- Blaise Pascal's wager in Pensées: "God is, or He is not. But to which side shall we incline?... Since you must choose, let us see which interests you least. You have two things to lose, the true and the good; and two things to stake, your reason and your will,… Let us weigh the gain and the loss in wagering that God is. Let us estimate these two chances. If you gain, you gain all; if you lose, you lose nothing. Wager, then, without hesitation that He is. "

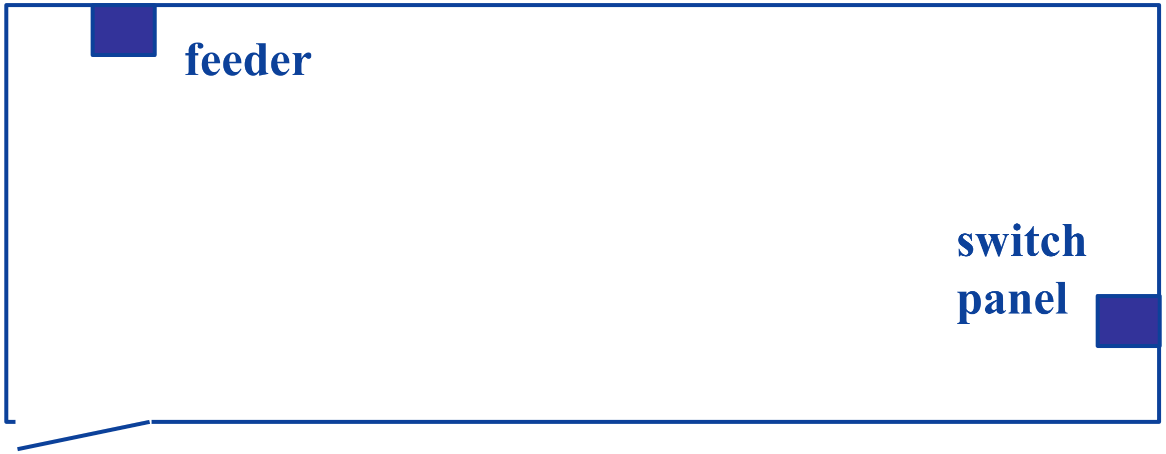
God

	believe	*don't believe*
reveal	3,4	1,1
hide	4,2	2,3

Man

Case Study: Pigs cannot fly…

- In a natural experiment, pigs were first trained to obtain food by pressing a panel with their snouts.
- Pairs of pigs were placed in a cage. At one end of the cage was a lever and at the other end a food dispenser:



- To study the relationship between social rank and panel pressing, the experiments were carried out with a large pig and a small one.

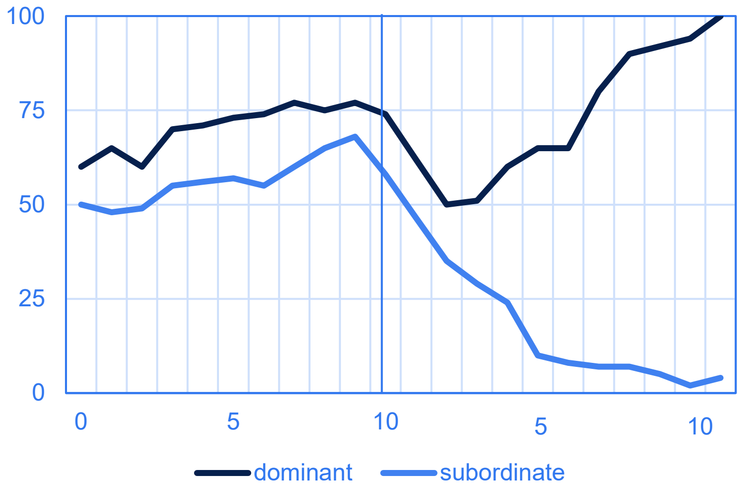
Case Study: Pigs cannot fly – but are rational

- Suppose 10 units of food are dispensed and either pig incurs a cost of 2 units from pressing the lever. The division of the 10 units of dispensed food is as follows: If the small (large) pig is there first, it gets 4 (9) units. If both pigs get there at the same time, the small one gets 3 units.

small pig

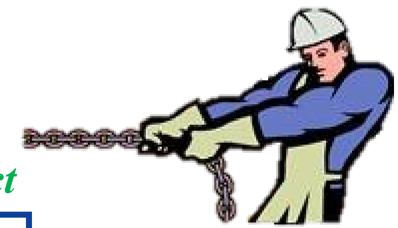
large pig	*wait at dispenser*	*press lever*
wait at dispenser	0,0	9,-1
press lever	4,4	5,1

Empirical findings:



Pre-communication and writing a contract as strategic move

- **Suppose the production team with two members has the possibility to write a contract binding both to choose high effort. If one team member does not sign the contract, they both choose low effort:**

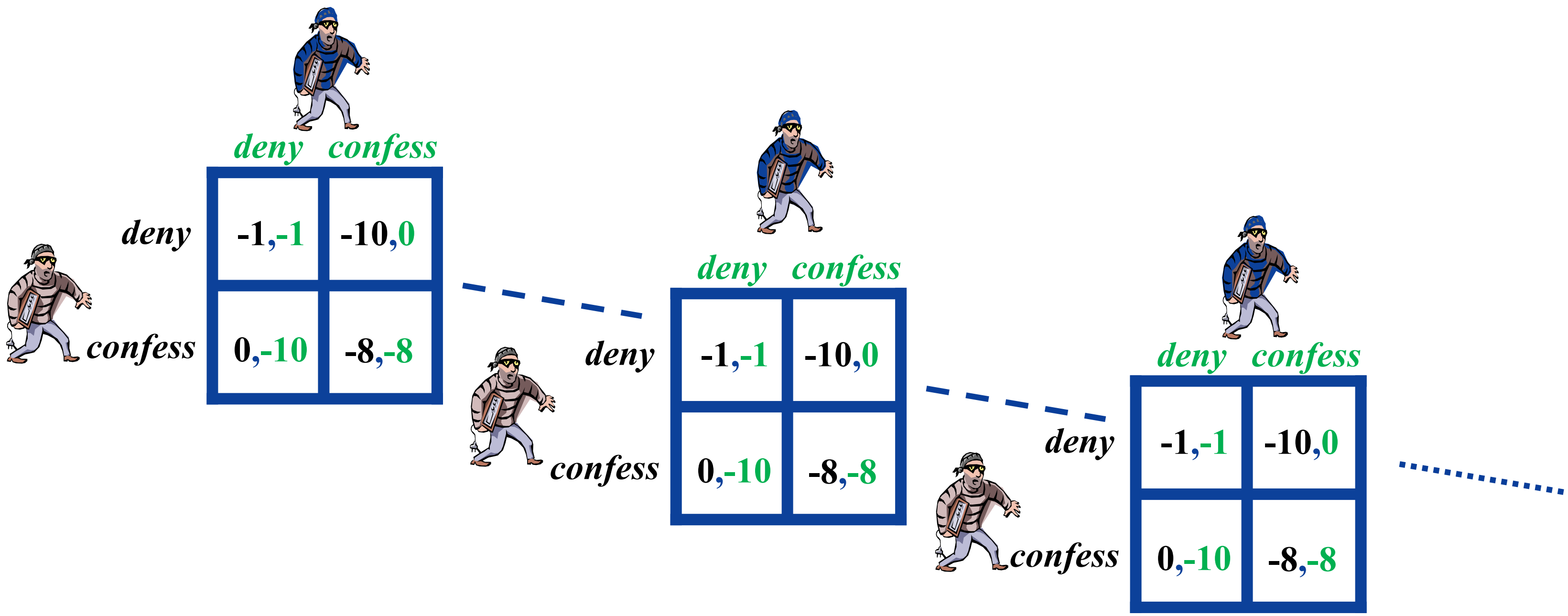


Team member 2

Team member 1

	low effort	*high effort*	*sign contract*
low effort	5,5	8,3	5,5
high effort	3,8	6,6	5,5
sign contract	5,5	5,5	6,6

Repeat yourself as strategic move, but infinitely often



Tit-for-Tat-Strategy: Cooperate if the other prisoner cooperated in the most recent play and cheat otherwise

Equilibrium: If the other plays TFT, you will play TFT if your gain from cheating today (and, hence, forever) is lower than the discounted gain from cooperation

Case study: Golden Balls – Split or steel?

The entire gameplay:

- **Round 1:** Twelve golden balls are randomly drawn from a “Golden Bank” with 100 balls, each having a cash amount inside, ranging from ₤10 to ₤75.000. Together with four additional “killer” balls, each of four contestants receives four balls at random. Each contestant places two balls visible on his front row, two hidden on the back row. After announcing the contents of the balls on the back row - later revealed – all discuss and finally vote for which of them should leave the game.

- **Round 2:** Two additional balls and one killer ball are added to the 12 remaining balls, randomly split among the three contestants, with two balls on their front row. Then the same procedure as in Round 1.

- **Round 3:** One additional killer ball is added to the 10 remaining balls, and five of them are selected randomly for the size of the final jackpot: The face value of cash balls are added, killer balls reduce the jackpot by factor 10.

- **Round 4:** The split or steel game

Contestant 1 \ Contestant 2	*split*	*steel*
split	½, ½	0,1
steel	1,0	0,0

Case study: Golden Balls – Reciprocity

Regression analysis of Round 1&2

Age	0.002 (0.387)
Gender (male = 1)	−0.249 (0.001)
Race (white = 1)	0.149 (0.079)
City (large = 1)	−0.034 (0.467)
London (London = 1)	0.041 (0.565)
Education (high = 1)	0.088 (0.068)
Student (student = 1)	0.001 (0.988)
Age × *Gender*	0.011 (0.000)
Actual stakes (log)	−0.050 (0.000)
Potential stakes (log)	0.183 (0.004)
Transmissions	−0.000 (0.660)
Potential stakes × *Transmissions*	−0.001 (0.026)
Reciprocal preferences	
Vote received from opp. (yes = 1)	−0.215 (0.019)

Findings:

- Reciprocal preferences: The likelihood of a contestant to cooperate plummets by 21% if his opponent voted against him earlier in the game
- Males are less cooperative than females
- Men become increasingly cooperative as their age increases

Punishing others as strategic move, but credibly

- Suppose that both prisoners are member of an organized crime syndicate with an honor code. If a cheater, though, is getting out of jail, his friends are waiting outside, causing him a physical harm equivalent to 20 years in jail.

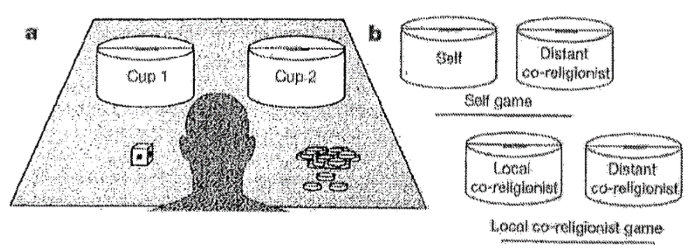
	deny	*confess*
deny	-1,-1	-10,0
confess	0,-10	-8,-8

	deny	*confess*
deny	-1,-1	-10,-20
confess	-20,-10	-28,-28

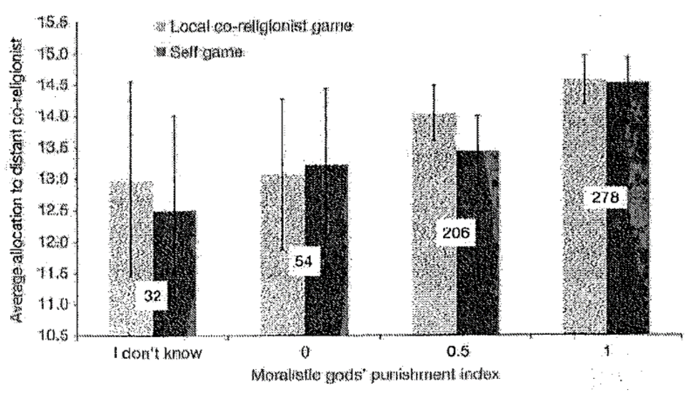
Case study: Moralistic gods and supernatural punishment

- To test the hypothesis that cognitive representations of gods as knowledgeable and punitive and who sanction violators of interpersonal social norms foster cooperation towards co-religionist strangers an allocation experiment was conducted in diverse communities around the world:

Site	Economy	Moralistic god	Local god or spirit
Coastal Tanna§	Horticulture	Christian god	Garden spirit (*Tupunus*)
Hadza	Hunting	Celestial figure (*Haine*)#	Sun (*Ishoko*)#
Inland Tanna§	Horticulture	*Kalpapan* (traditional)	Garden spirit (*Tupunus*)
Lovu	Wage labour	Hindu *Bhagwan*	None available
Mauritius	Wage labour and farming	Hindu Shiva	Spirit/soul/ghost (*Nam*)
Pesqueiro	Wage labour	Christian god	Virgin Mary
Tyva Republic	Wage labour and herding	Buddha Burgan	Spirit-masters (*Cher eezi*)
Yasawa	Fishing and farming	Christian god	Ancestor spirits (*Kalou-vu*)



Empirical findings:



Allocation to co-religionists increase as a function of moralistic gods' punishment

Purzycki et al. (2016): Moralistic gods, supernatural punishment and the expansion of human sociality, *Nature*

Case study: Banning cigarette advertising on TV – US 1970

"TV advertising was never designed to create new smokers, its main purpose was to switch people from one brand to another"

Frank Saunders, Philip Morris

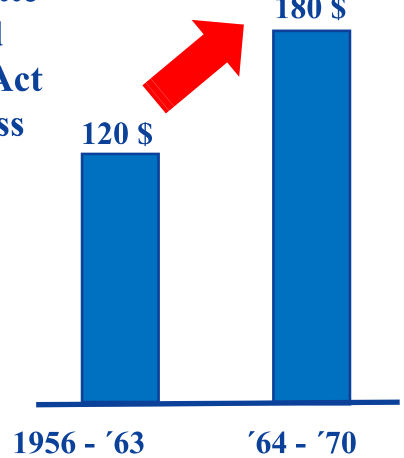
The „Advertising-Dilemma" ......

		Reynolds: *high ads*	Reynolds: *low ads*
Philip Morris	*high ads*	2,2	4,1
	low ads	1,4	3,3

ads=advertising budget

... and the actual history

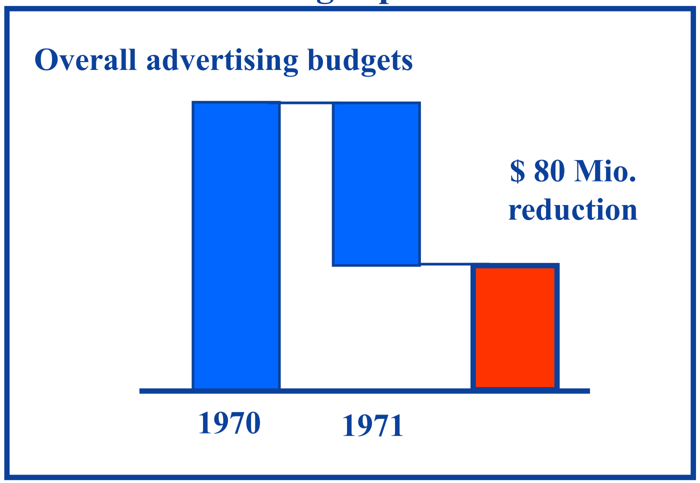
1965: Cigarette Labeling and Advertising Act
1967: Fairness Doctrine



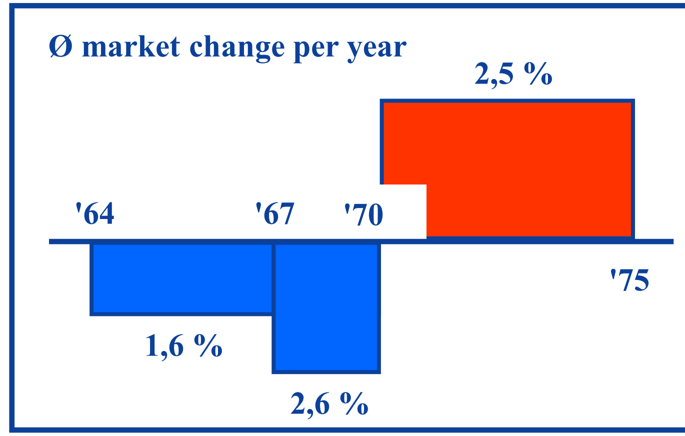
Average advertising budget per year in Mio. US $

Case study: Banning cigarette advertising on TV – The consequences

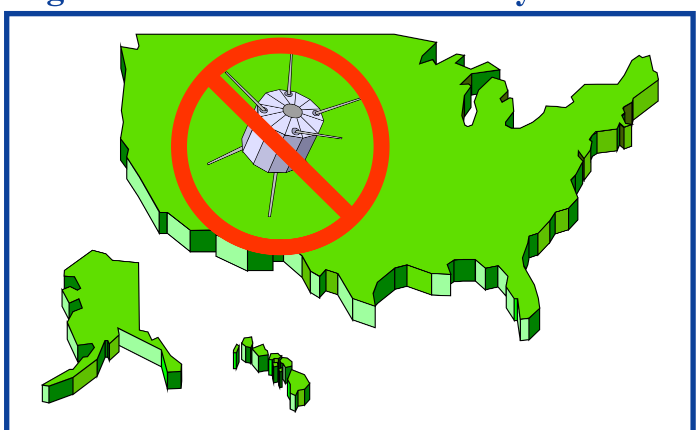
Reduced advertising expenditures



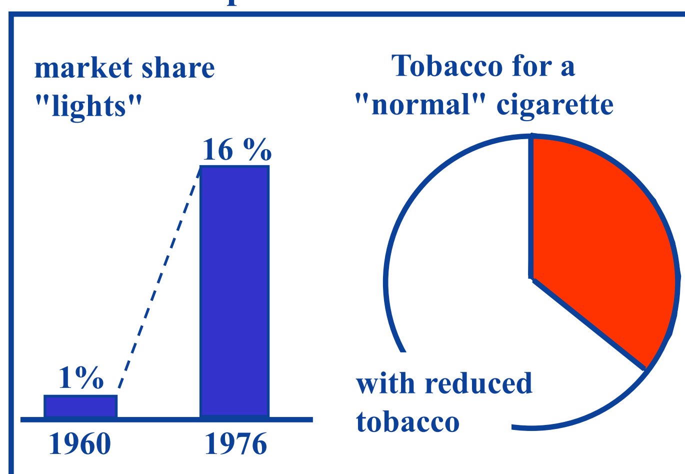
Market expansion



Higher barriers for market entry



Reduction of production costs



Being the leader as strategic move in the pizza game

- **Two pizza shops, Susi's Oven and Uncle Toms Pizza, can either choose a low or high price. Profit margins per pie are €12 for a high price, €10 for a low price.**
- **Uncle Toms Pizza store has a loyal customer base who buy 3000 pies per weak, independent of its price. There is a floating demand of 4000 pies per weak which go the store with the lowest price; if prices are identical demand will be split equally.**

- **Susi's Oven also sells 3000 pies per weak to loyal customers**

Susi's Oven \ Uncle Toms Pizza	*high*	*low*
high	60,60	36,70
low	70,36	50,50

- **Susi's Oven sells 11000 pies per weak to loyal customers**

Susi's Oven \ Uncle Toms Pizza	*high*	*low*
high	156,60	132,70
low	150,36	130,50

Being determined – Prisoners' Dilemma Games : What we learned today

- Prisoners' dilemma situations are pervasive in everyday live and arise also in team cooperation, utilization of common resources or provision of public goods.
- The optimal behavior in a prisoners' dilemma is compelling: choose your dominant strategy. However, individual rationality does not lead to the overall optimal outcome.
- Solutions to the prisoners' dilemma are, for example, contracting repetition, punishment or rewards as well as an asymmetry between the parties involved.

Further readings

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