Introduction to Behavioral economics

Lecture VI - **Strategic interactions**

Matej Lorko
matej.lorko@euba.sk
Student resources: www.lorko.sk

References: Camerer, C. F. (2011). *Behavioral game theory: Experiments in strategic interaction*. Princeton University Press.

Strategic interactions

- A large number of decisions in our day-to-day lives require us to engage in “strategic decision making”.

- It means that what I decide to do in a particular situation will affect the well-being of another person (or group of people) – and, in turn, what someone else does will crucially impact upon my own well-being.

- Same holds true for firms and their partners or competitors.

- Theses situations can be thought of as “games” with us as “players”, and they can be analysed using the tools of game theory. This interdependence causes each player to consider the other player’s possible decisions, or strategies, in formulating his own strategy. Players may have similar, opposed, or mixed interests. A solution to a game describes the optimal decisions of the players.

Game theory

- Developed by John von Neumann and Oskar Morgenstern (1944)
- Game theory is a set of tools used to help analyze situations where an individual's best course of action depends on what others do or are expected to do. Game theory allows us to understand how people act in situations where they are interconnected.
- Connections between people arise in all sorts of situations. Sometimes through cooperation with others, we can achieve more than we can on our own. Other times, conflict arises where an individual benefits at the expense of others. And in many situations, there are benefits to cooperation but elements of conflict also exist.
- In stressing the strategic aspects of decision making, or aspects controlled by the players rather than by pure chance, the theory both supplements and goes beyond the classical theory of probability.
- Because game theory can help analyze any environment where the person's best action depends on others' behavior, it has proven useful to analyze strategic interactions in wide variety of fields.
- Examples:
    - In economics, the decisions of firms are affected by their expectations of a competitor's choice of product, price and advetising.
    - In political science, a cadidate's policy reform is influences by policy announcement of their rival.
    - In biology, animals must compete for scarce resources, but can be hurt if they are too aggressive with the wrong rival.
    - In computer science, networked computers compete for bandwidth.
    - In sociology, public displays of non-conformist attitudes are influeneced by other's behavior, which is shaped by social culture.
    - In sports, it is often necessary to predict the behavior of others (e.g., footbal penalty kicks, tennis serves…)

Classification of games

- Number of players (player need not be an individual)
    - one-person - games against nature, no opponents, the player only needs to list available options and then choose the optimal outcome.
    - two-person
    - n-person (with n greater than two)
- Information
    - perfect - each player knows everything about the game at all times (chess)
    - imperfect - players do not know all of their opponents’ possibilities (poker)
- The extent to which the goals of the players coincide or conflict
    - Constant-sum games are games of total conflict (pure competition), players have completely opposed interests
    - Variable-sum games - players may all be winners or losers (labour-management dispute)
        - cooperative (players can communicate and, most important, make binding agreements)
        - noncooperative (players may communicate, but they cannot make binding agreements)
- Number of options
    - Finite - each player has a finite number of options, the number of players is finite, and the game cannot go on indefinitely
    - Infinite

Variables

- 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?
- A solution concept - "Nash equilibrium" = a profile of strategies where each player's strategy is a "best response" to the strategies of others (i.e. gives him the highest payoff among his strategies, given the others' strategies). Note that the Nash equilibrium requires players to have correct beliefs about the strategies of others. Nash equilibria can be in "pure strategies" (each player chooses one strategy with certainty) or in "mixed strategies" (players choose randomly among a set of strategies).

Descriptions

- A game can be described in one of three ways - in extensive, normal, or characteristic-function form.
- Extensive
    - most parlour games, which progress step by step, one move at a time
    - can be described by a “game tree,” in which each turn is a vertex of the tree, with each branch indicating the players’ successive choices
- Normal (strategic) form
    - primarily used to describe two-person games
    - game is represented by a payoff matrix, wherein each row describes the strategy of one player and each column describes the strategy of the other player.
    - The matrix entry at the intersection of each row and column gives the outcome of each player choosing the corresponding strategy
    - The payoffs to each player associated with this outcome are the basis for determining whether the strategies are “in equilibrium,” or stable.
- The characteristic-function form
    - generally used to analyze games with more than two players
    - indicates the minimum value that each coalition of players—including single-player coalitions—can guarantee for itself when playing against a coalition made up of all the other players.

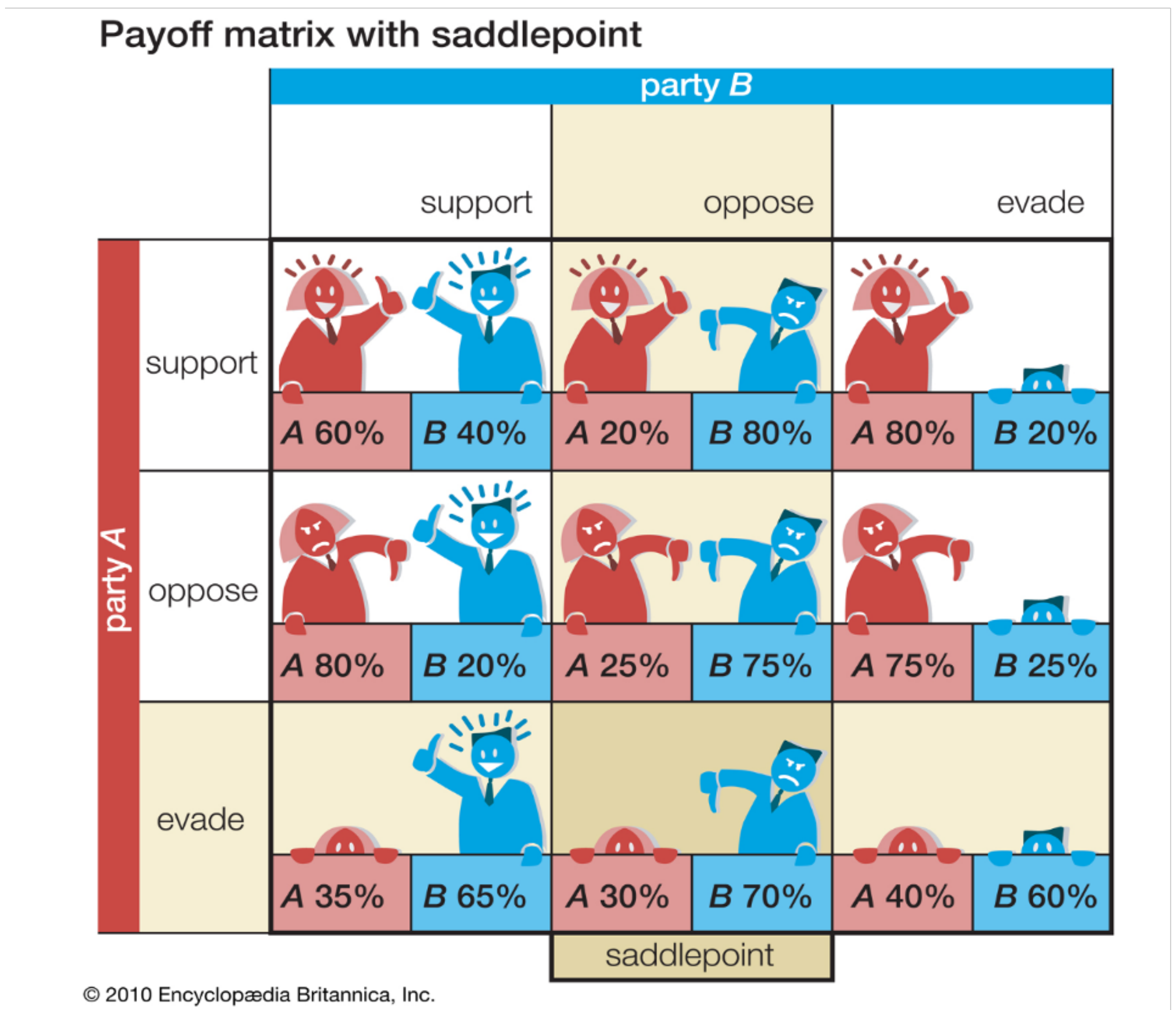
One-person games

- Games against nature
- With no opponents, the player only needs to list available options and then choose the optimal outcome.
- For example, a person deciding whether to carry an umbrella weighs the costs and benefits of carrying or not carrying it. While this person may make the wrong decision, there does not exist a conscious opponent.
- Nature is presumed to be completely indifferent to the player's decision, and the person can base his decision on simple probabilities.

Two-Person Constant-Sum Games

- Games of perfect information - chess, checkers, go...
- such games are strictly determined; by making use of all available information, the players can deduce strategies that are optimal, which makes the outcome strictly determined
- chess - exactly one of three outcomes must occur if the players make optimal choices
- For a simple game like crosses and noughts, any match between humans should end in a draw,
- Chess is much more complicated, but in principle, a sufficiently powerful supercomputer could determine which of the three outcomes will occur.
- However, considering that there are some 1043 distinct 40-move games of chess possible, there seems no possibility that such a computer will be developed now or in the foreseeable future.
- Therefore, while chess is of only minor interest in game theory, it is likely to remain a game of enduring intellectual interest.

Saddlepoint



- A “saddlepoint” in a two-person constant-sum game is the outcome that rational players would choose.
- A saddlepoint always exists in games of perfect information but may or may not exist in games of imperfect information.
- By choosing a strategy associated with this outcome, each player obtains an amount at least equal to his payoff at that outcome, no matter what the other player does.
- This payoff is called the value of the game; as in perfect-information games, it is determined by the players’ choices of strategies associated with the saddlepoint, making such games strictly determined.

Constant vs. Variable sum games

- Constant-sum games are win-lose games. Whatever you win in those situations, the other party has to lose. The players in constant-sum games games have diametrically opposed interests, and there is a consensus about what constitutes a solution (=everybody plays their dominant strategy). Theoretically, the outcome of the game (the Nash equillibrium) is predictable.

- Most games that arise in practice, however, are variable-sum games; the players have both common and opposed interests. For example, a buyer and a seller are engaged in a variable-sum game (the buyer wants a low price and the seller a high one, but both want to make a deal).

- Some “obvious” properties of two-person constant-sum games are not valid in variable-sum games. In constant-sum games, for example, both players cannot gain (they may or may not lose, but they cannot both gain) if they are deprived of some of their strategies. In variable-sum games, however, players may gain if some of their strategies are no longer available.

- The effect of communication is particularly revealing of the difference between constant-sum and variable-sum games. Communication is pointless in constant-sum games because there is no possibility of mutual gain from cooperating.

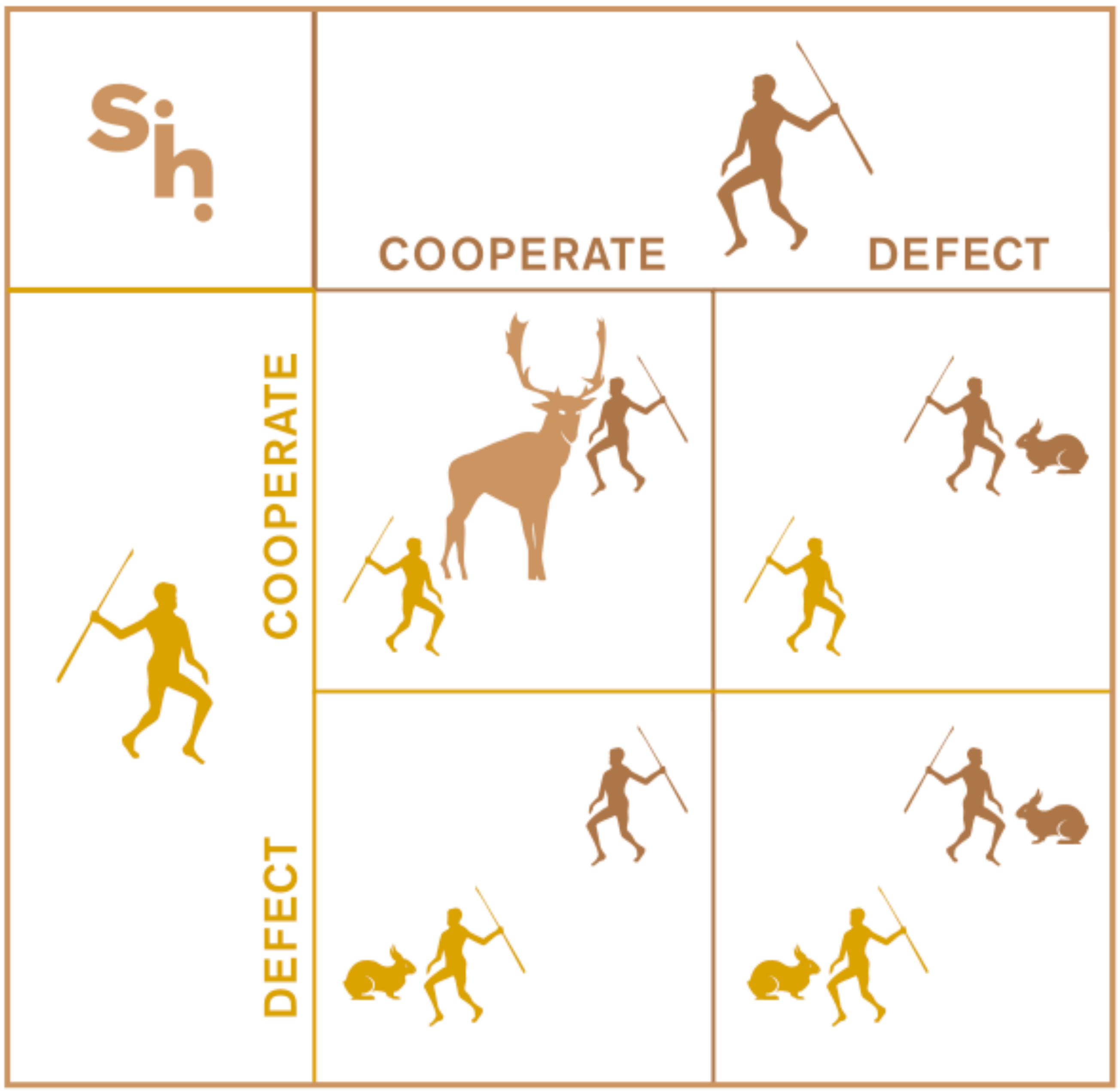
- In variable-sum games, on the other hand, the ability to communicate, the degree of communication, and even the order in which players communicate can have a profound influence on the outcome. A player may want an opponent to be well-informed. This can be advantageous for both parties (strikes) or only for some (competition, blackmailing)

- Generally, the more two players’ interests coincide, the more important and advantageous communication becomes.

Coordination

- Many situations in social life require the coordination of activities.
- At an abstract level, any game with multiple equilibria is a coordination game.
- Which equilibrium, if any, will people play?
- Important issues concern the role of saliency or communication as coordination devices.
- “Stag-hunt” game – 2 equilibria - “payoff-dominant” and “risk-dominant”
- The stag hunt, sometimes referred to as the assurance game, trust dilemma or common interest game, describes a conflict between safety and social cooperation.
- Two hunters must decide separately, and without the other knowing, whether to hunt a stag or a rabbit. However, both hunters know the only way to successfully hunt a stag is with the other's help. One hunter can catch a rabbit alone with less effort and less time, but it is worth far less than a stag and has much less meat.
- Therefore, it would be much better for each hunter, acting individually, to give up total autonomy which brings only the small reward of the rabbit. Instead, each hunter should separately choose the more ambitious and far more rewarding goal of getting the stag, thereby giving up some autonomy in exchange for the other hunter's cooperation and added might.
- Commentators have seen the situation as a useful analogy for many kinds of social cooperation, such as international agreements on climate change.
- Experiments show that, after some initial miscoordination, play converges to an equilibrium. Yet, unless the players can communicate, they almost invariably end up playing the risk-dominant instead of the payoff-dominant equilibrium.

Stag Hunt Game



Stag hunt game

	Stag	Rabbit
Stag	(2, 2)	(0, 1)
Rabbit	(1, 0)	(1, 1)

Figure 7.2 Example stag hunt and mini

Stag hunt game

	Stag	Rabbit
Stag	(2, 2)	(0, 1)
Rabbit	(1, 0)	(1, 1)

Minimum effort game

Own action	Minimum action in group						
	7	**6**	**5**	**4**	**3**	**2**	**1**
7	130	110	900	70	50	30	10
6		120	100	80	60	40	20
5			110	90	70	50	30
4				100	80	60	40
3					90	70	50
2						80	60
1							70

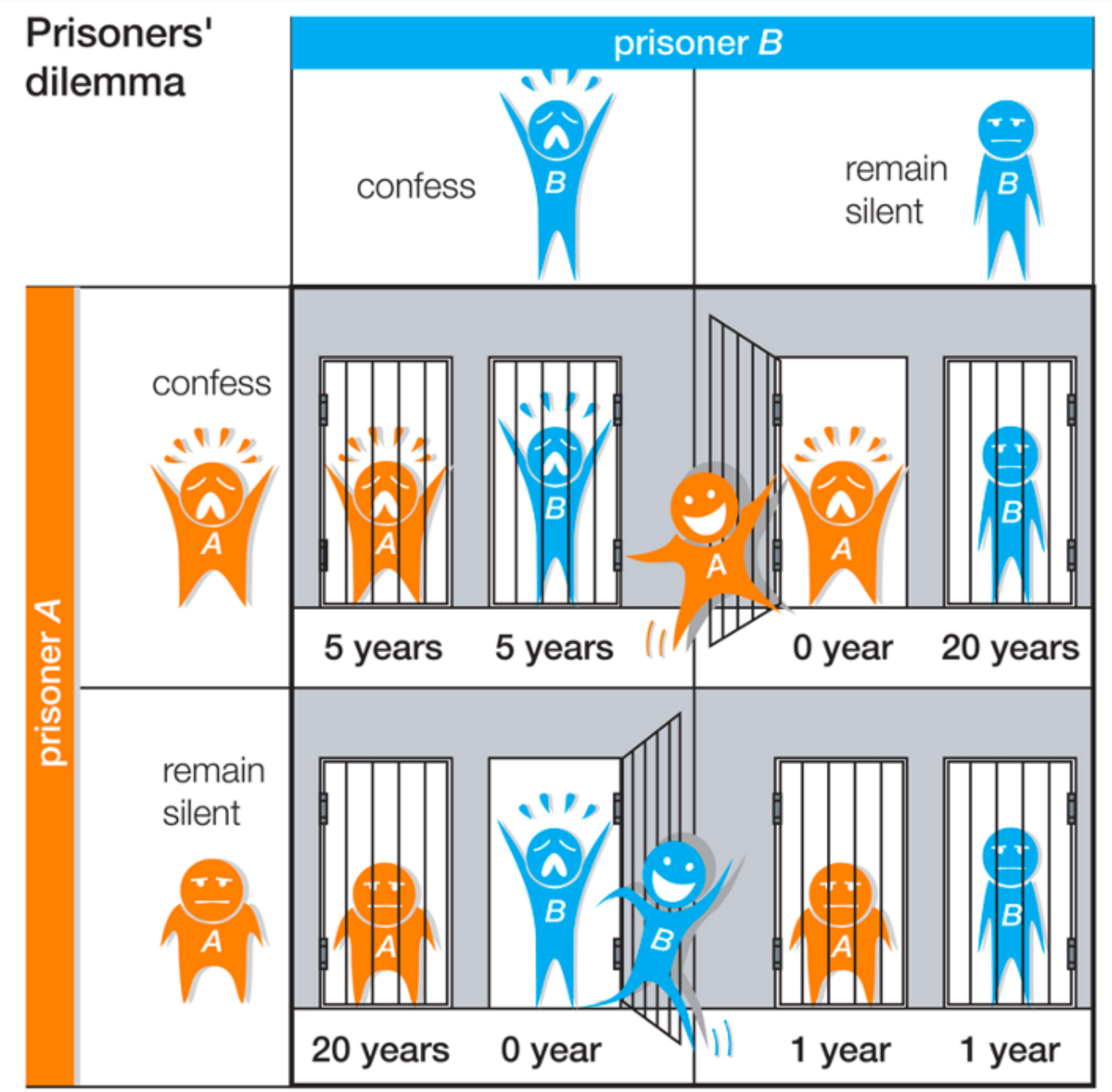
Figure 7.2 Example stag hunt and minimum effort coordination games.

- From the past experiments, it seems that in a basic stag hunt game, the risk dominant rabbit equilibrium is chosen overwhelmingly. However, subjects are attracted to the payoff dominant stag equilibrium and will coordinate on it if they are able to communicate before the game.

- Coordination of the form captured by the stag hunt and minimum effort games (also known as weakest link games, which is basically a stag hunt with many participants) is also important in organizational settings, where the disparate parts of a production or service system all need to complete their tasks in a timely fashion. Similarly, a project with multiple critical paths can be delayed by any one path going over schedule. For example, an airplane can only take off if all the preparations are finished: passengers boarded, flight crew prepped, luggage loaded, etc. Any work group falling behind delays the whole flight. A natural question is then what kind of institutional features best support coordination, and what kind of managerial interventions can lead to coordination improvements.

- Large coordinating groups can emerge by taking small groups that are coordinating well and slowing growing them. Other managerial and institutional interventions can also improve coordination. Requiring players to pay an up-front fee increases coordination on higher actions. They argue this behavior is consistent with forward induction and loss aversion: Subjects are reluctant to enter the game intending to play an equilibrium that would yield negative payoffs. Brandts and Cooper (2007) add a subject in a managerial role that can both communicate with the coordinating employees and give them financial incentives. While financial incentives are helpful, communication is even more effective. Indeed, the most effective communication strategy is simple: Ask for high effort, emphasize the mutual benefits of high effort, and suggest employees are well paid.

Prisoners’ dilemma



- To illustrate the kinds of difficulties that arise in two-person noncooperative variable-sum games, consider the celebrated prisoner’s dilemma (PD)
- Two prisoners, A and B, suspected of committing a robbery together, are isolated and urged to confess.
- Each is concerned only with getting the shortest possible prison sentence for himself; each must decide whether to confess without knowing his partner’s decision.
- Both prisoners, however, know the consequences of their decisions:
  - (1) if both confess, both go to jail for five years;
  - (2) if neither confesses, both go to jail for one year (for carrying concealed weapons);
  - (3) if one confesses while the other does not, the confessor goes free (for turning state’s evidence) and the silent one goes to jail for 20 years.

Prisoners’ dilemma (cooperation)

- Although A cannot be sure what B will do, he knows that he does best to confess when B confesses (he gets five years rather than 20) and also when B remains silent (he serves no time rather than a year); analogously, B will reach the same conclusion.
- So the solution would seem to be that each prisoner does best to confess and go to jail for five years.
- Paradoxically, however, the two robbers would do better if they both adopted the apparently irrational strategy of remaining silent; each would then serve only one year in jail.
- The irony of PD is that when each of two (or more) parties acts selfishly and does not cooperate with the other (that is, when he confesses), they do worse than when they act unselfishly and cooperate together (that is, when they remain silent).
- PD is not just an intriguing hypothetical problem; real-life situations with similar characteristics have often been observed.
- For example, two shopkeepers engaged in a price war may well be caught up in a PD.
- Similarly, nations competing in an arms race and farmers increasing crop production can also be seen as manifestations of PD.

One-shot vs. repeated game

- People often interact in ongoing relationships. For example, most employment relationships last a long time. Countries competing over tariff levels know that they will be affected by each others' policies far into the future. Firms in an industry know that they are not playing a static game but one in which they compete everyday over time.

- In all of these dynamic situations, the way in which a party behaves at any given time is influenced by what this party and others did in the past. In other words, players "condition" their decisions on the history of their relationship. An employee may choose to work hard only if his employer gave him a good bonus in the preceding month. One country may set a low import tariff only if its trading partners had maintained low tariffs in the past. Repeated games help explain why ongoing economic phenomena produce behavior very different from those observed in a one-time interaction.

- If players believe that future behavior will be affected by the nature of current interaction, they may behave in ways that they would not otherwise. The prospect of reciprocity, either by way of rewards or punishments, is what separates a repeated game from a one-shot game. Rewards or punishments have to be credible in the sense that players will only believe them if they are part of a subgame perfect equilibrium.If a player believes that

    - "no good deed today will go unrewarded tomorrow", then he will have a greater reason to do a good deed

    - "no bad deed today will go unpunished tomorrow", he may be less inclined to do a bad deed today.

Oligopoly market structure

- The petrol/service station market structure is usually that of an oligopoly. An oligopoly has a small number of firms supplying the market, so there is some competition. In an oligopoly, a firm is concerned with how their rivals will react to any action it takes.
- Let's assume the following: The monopoly price is $2 and the quantity traded is 50,000 litres. The competitive price is $1 and the quantity traded is 100,000 litres. If there is only one petrol station, so it produces the monopoly outcome, and makes positive economic profits of $50,000.
- What happens if another petrol station enters the market? Either they collude on monopoly price, or the price war begins…
-

Station 1 Output	Station 2 Output	Total Output	Price	Station 1 Profit	Station 2 Profit
25000	25000	50000	$2	25000	25000
25000	35000	60000	$1.80	20000	28000
35000	35000	70000	$1.60	21000	21000
35000	45000	80000	$1.40	14000	18000

Oligopoly market structure

- At the monopoly outcome in duopoly market structure, each firm has an incentive to increase its output in order to obtain a larger share of the total profit.

- However, when total market output increases, the price must fall. This process continues until output increases are outweighed by price falls and profit would decline. Hence, firms that act in their own self interest produce an outcome where output is above the monopoly level but below the competitive one.

- The two petrol stations would in fact be better to cooperate. They could both make more money in total if they moved to the monopoly outcome. However there is the tension that then exists to break the deal, and profit by supplying a greater output, it the other one held to the deal. This is why these sorts of agreements - known as a cartel - are typically unstable. They are also generally illegal.

- For firms that decide to collude, there usually must be some way of punishing those who cheat. Such threats of punishment must be credible.

- If another service station joins the market, the incentives remain the same but push the market outcome further towards the competitive outcome. The addition of many petrol stations pushes the market all the way to the competitive outcome. Collusion type agreements become much more difficult and even more unstable.

The Market for Lemons

- When a consumer buys a used car it may be very difficult for him to determine whether or not it is a good car or a lemon. By contrast, the seller of the used car probably has a pretty good idea of the quality of the car.

- Such asymmetric information may cause significant problems with the efficient functioning of a market.

- Consider a market with 100 people who want to sell their used cars and 100 people who want to buy a used car. Everyone knows that 50 of the cars are “plums” and 50 are “lemons.” The current owner of each car knows its quality, but the prospective purchasers don’t know whether any given car is a plum or a lemon.

- The owner of a lemon is willing to part with it for $1000 and the owner of a plum is willing to part with it for $2000. The buyers of the car are willing to pay $2400 for a plum and $1200 for a lemon. In this case the buyers have to guess about how much each car is worth. If a car is equally likely to be a plum as a lemon, then a typical buyer would be willing to pay the expected value of the car = $1800.

- But who would be willing to sell their car at that price? At a price of $1800 only lemons would be offered for sale. Buyers would therefore (correctly) expect to get a lemon. In this market, none of the plums ever get sold! Even though the price at which buyers are willing to buy plums exceeds the price at which sellers are willing to sell them, no such transactions will take place.

- The problem is that there is an externality between the sellers of good cars and bad cars; when an individual decides to try to sell a bad car, he affects the purchasers’ perceptions of the quality of the average car on the market. This lowers the price that they are willing to pay for the average car, and thus hurts the people who are trying to sell good cars. It is this externality that creates the market failure.

Asymmetric information

- Basic economic theories assume that buyers and sellers are both perfectly informed about the quality of the goods being sold in the market. This assumption can be defended if it is easy to verify the quality of an item. If it is not costly to tell which goods are high-quality goods and which are low-quality goods, then the prices of the goods will simply adjust to reflect the quality differences.

- However, if the information about quality is costly to obtain, then it is no longer plausible that buyers and sellers have the same information about goods involved in transactions. Thus, a key feature of the real world is asymmetric information.

- In economics asymmetric information arises when the two sides of the market have different information about the goods and services being traded. In particular, sellers typically know more about what they are selling than buyers do.

- While information asymmetries inevitably arise, the extent to which they do so and their consequences depend on how the market is organized, and the anticipation that they will arise affects market behavior.

Hidden knowledge vs. hidden action

- There are two basic forms of asymmetric information that can be distinguished.
  - Hidden knowledge refers to a situation in which one party has more information than the other party on the quality (or "type") of a traded good or contract variable. Hidden knowledge leads to the adverse selection problem. Can be fixed by transferring information from more informed to less informed party (signalling) or from less informed to more informed party (screening)
  - Hidden action is when one party can affect the "quality" of a traded good or contract variable by some action and this action cannot be observed by the other party. From hidden actions arises the moral hazard problem. This refers to the inefficiency that arises due to the difficulties in designing incentive schemes that ensure the right actions are taken. For instance, the price charged for insurance must take into account of the fact that an insured person may become more careless once they have the safety net of insurance cover.

Hawk vs. Dove (Chicken)

- The story is that two teenagers drive home on a narrow road with their bikes, and in opposite directions.

- None of them wants to go out of the way

    - whoever 'chickens' out loses his pride, while the tough guy wins.

    - if both stay tough, then they break their bones!!

    - if both go out of the way, then only their pride is damaged slightly.

		Player 2: Tough	Player 2: Chicken
Player 1	Tough	-10,-10	1,-1
	Chicken	-1,1	0,0