Negotiation and Economics

Basics

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Les Regards sur la sécurité industrielle

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Editorial

Following on from the collection "Les Cahiers de la sécurité industrielle", which mainly focuses on highlighting research results, the Foundation is pleased to present "Les Regards". This is an important new collection that we're particularly excited about: the idea is to present an object, a concept or a question related to industrial safety from the point of view of a given discipline. For example, what would an economist or a sociologist have to say about feedback? What do anthropologists or engineers think about uncertainty?

What we wish to do with "Les Regards" is to build a bridge between disciplines, to foster the study of the same research topic from different and complementary points of view.

Lastly, we want "Les Regards" to be accessible to the layperson, bringing scientific content to life with overviews and examples, making it available to the public at large. There is an ever-growing demand from the public to better understand scientific issues and the stakes involved, to better grasp the complex world they live in. The Foundation wishes, with this new collection, to offer perspectives on our world, to foster the transmission of knowledge and make its modest contribution to a society in which women and men are able to make enlightened decisions.

Toulouse, April 15th, 2014
Gilles Motet, Foncsi

This document

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Since technological risk issues imply stakeholders with different preferences and objectives, they are largely submitted to negotiation. Bargaining is ubiquitous and this Regard aims to give an overview of the bargaining process from an economic point of view. In an extent, its scope is to focus on what we can grasp from theory in order to understand better how negotiation can evolve.

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About the author

Laura Concina holds a doctorate in Economics from Ca' Foscari University of Venice, Italy, in 2012 on "Leadership and Cooperation in Public Good Games". Her research examines the influence of voluntary leadership on group coordination. To address this question, she uses economic experimental methods to collect data: experimental subjects face a group coordination situation and are paid in order to mimic real world incentives. This Regard is the second published by Laura Concina, the previous one was an introduction to risk attitudes from the economic viewpoint [Concina 2014].

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Preamble

Society puts great effort into preventing, reducing, responding to and controlling risky events. Although humankind has always been subject to uncertain events (*e.g.* natural disasters), society itself has introduced new risks through industrialization and modernization. The shift – from natural hazards to risks that are a by-product of production – changes how we experience uncertainty. Not only are there immediate risks (such as the possibility of an explosion at a plant that holds dangerous materials), but there are also long-term risks (such as pollution or chronic diseases resulting from industrial activities).

Risks cannot be totally suppressed, production cannot be stopped, and stakeholders have different interests and preferences. Therefore bargains concerning potential solutions are a central issue; in particular with respect to technological risks. Although industries, administrations, other organizations (*e.g.* non-governmental and environmental) and the various components of society (*e.g.* residents living close to at-risk industries) can run into conflict, there can also be mutual benefits.

Here, we address the issue from the point of view of economics. This document provides an insight into the factors that must be taken into account in negotiations, and potential solutions that both address failure and benefit society. It does not aim to provide comprehensive solutions, nor to delve deep into economic bargaining theory; it simply presents the basic elements of bargaining viewed through the prism of economics. As this document is aimed at non-specialists, we present a simplified and informal version of standard economic theory that focuses on rational agents – selfish individuals who are only concerned about their own interests and gains.

The introduction highlights (by means of examples) the central role of bargaining in technological risk. We briefly introduce game theory (which provides the foundations for the economic study of bargaining) and present the two basic postulates of economic theory, which are used in the remainder of the document. Chapter 1 describes the elements that make up the bargaining framework and the process. Chapter 2 outlines some of the factors that have an impact on the bargaining process and outcomes. Finally, Appendix A is a short review of some of the most important economic experiments that have tested, under laboratory conditions, the bargaining theories discussed in the text. Appendix B presents some further elements of bargaining seen through the lens of utility theory.

Contents

Introduction

> *In advanced modernity, the social production of wealth is systematically accompanied by the social production of risks. Accordingly, the problems and conflicts relating to distribution in a society of scarcity overlap with the problems and conflicts that arise from the production, definition and distribution of techno-scientifically produced risks [Beck 1992].*

In his book "Risk Society - Towards a New Modernity", Beck points out that in the past few decades, production in advanced industrial society has gone hand-in-hand with new risks [Beck 1992]. While these risks have been widely accepted for a long time, there is increasing demand for environmental protection, pollution reduction and accident prevention in Western culture[1].

Heterogeneity of exposure to industrial risk

Despite our improved understanding of the causes of industrial risk, there is also an understanding that it is impossible to completely eliminate it: no matter how many precautions are taken, and how many protective barriers are put in place, an accident is always possible. Furthermore, in most cases it is impossible to stop production in order to stop risk. Thus, there are two important cases to consider when people are exposed to hazardous conditions.

On the one hand, some individuals have a **direct link** with the at-risk industry. They may be associated with production, or have an economic interest in it (*e.g.* workers at an at-risk plant). In fact, economics research has focused on compensatory wage differentials, both from the theoretical and empirical point of view. Given two workers with equal abilities (skills, experience etc.), the one involved in the at-risk activity receives a higher salary to compensate for the risk they face. In other words, risk can have certain (economic) advantages, which can be taken into account in contract negotiations. The potential negative event they are exposed to represents both a potential cost (or loss), and a potential profit in salary negotiations. Another example is a consumer of liquid petroleum or propane gas who wants to install a gas tank and who knows that it can leak or explode. In this case there is a trade-off between the advantages of the product and its risks.

On the other hand, there are adverse events that affect populations who are not directly involved in production or consumption of the product. In economics, these spill over effects on society are called **negative externalities**.

Definition

Negative externalities

Negative externalities are situations that affect a third party who did not participate in the decision that created the externality[2].

Therefore, a key question that naturally emerges is how society distributes risk between individuals (*e.g.* residents living close to a plant that produces hazardous materials). The answer to this question requires investigation of prevention measures and the compensation offered to individuals that incur risk. However, it is unlikely that these third parties will have decision-making powers regarding safety measures; these remain in the domain of the company and the legislator.

Typically, many actors are involved:

- the industry (which causes the risk, thus the potential negative externality),
- other stakeholders (the plant's workforce),
- the population (that may be affected by externalities), and
- authorities (*e.g.* state/government administrations that can legislate and enforce laws).

[1] For example, the social and psychological impact of the Chernobyl accident.
[2] Note that externalities can also be positive. For example, a bee-keeper whose bees pollinate neighbouring crops.

These actors operate at different levels and have different interests. In particular, they have different ideas about acceptable levels of investment and risk – residents demand a low accident probability, while the company has high prevention costs and would prefer to limit its investment in risk reduction.

Key issue

The importance of negotiation

As risk cannot be simply avoided, negotiation becomes crucial. It provides a mechanism for discussion, conflict resolution, and agreement on topics such as loss compensation, liability, protection levels, prevention measures, *etc.*.

Striking a bargain in the domain of technological risks

An example is the best way to introduce the idea of technological risk bargaining.

Example

A pipeline in my field

Company C wants to route a natural gas pipeline across land owned by landowner L. C asks L for a lease that grants right-of-way across the affected area.

In the simple case, the pipeline transports a perfectly safe material, and the landowner agrees to the lease in return for a payment. Here, all there is to negotiate is the price at which the deal is concluded. The bargaining process might go as follows: Company C makes an initial offer, which the landowner can accept or reject, or make a counteroffer. If a price is agreed, the process ends: the landowner receives a fee for leasing the land, and the company obtains the right to use the land. However, if there is no compromise, the landowner receives no rent, and the company is unable to route the pipeline as planned.

In fact, things are not that simple. While the usual bargaining process[3] involves two parties who are in a situation where an exchange could take place, here there is another factor to take into account: the level of risk. Gas is an inflammable material and an accident might damage L's property or create a health hazard (*e.g.* a gas leak or explosion that injures or kills the landowner).

Reaching an agreement is always a complex business (as we will see more in detail in the next chapter). If we add in a potentially risky activity, the level of complexity increases for three reasons:

1. risk perception differs between individuals;
2. parties don't have access to the same information. One party knows more about the potential damage the activity can cause; and
3. even the best-informed party may not know everything necessary to understand the real level of uncertainty regarding the occurrence and consequences of the risky event.

Negotiations in safety management

Besides negotiations with external actors, any at-risk industry must engage in negotiations with internal stakeholders. A better understanding of bargaining processes may help to improve decision making regarding safety management in these industries [Reniers and Pavlova 2013; Reniers 2010].

Negotiation as a "game"

Bargaining can be explored in terms of game theory, which has been at the forefront of a revolution in economics that began in the 1970s [Turocy and von Stengel 2001; Fudenberg and Tirole 1991].

Definition

Game theory

Game theory is the formal study of decision making, where several agents (players) make choices that potentially affect the interests of the other agents (players).

[3] For example, a seller and buyer negotiating over the price of an object (we will discuss this example in detail later).

Game theory is the formal analysis of conflict and cooperation. Its concepts apply whenever the actions of several agents are interdependent. This is very much the case for bargaining in the domains of industrial risk and safety management. Agents may be individuals, groups, firms, or any combination of these. Game theory concepts provide a language to formulate, structure, analyse, and understand strategic scenarios [Turocy and von Stengel 2001].

This document uses the vocabulary of game theory, notably in the examples that are given. Bargaining agents (players) are designated as "parties" in reference to contractual language.

Two basic postulates: rationality and complete information

In order to understand bargaining theories, we first need to introduce some of the basic concepts of **expected utility theory**[4].

In line with traditional economic theory, we assume that individuals are **rational** and **selfish**; for the sake of simplicity (and unless otherwise stated), we will also assume that information is **complete** and **perfect**.

Rational and selfish individuals: utility and preferences

First, bargaining can be seen as a way to achieve "satisfaction". Economists assume that whenever an individual consumes a good or a service, they receive satisfaction. This is represented by the concept of **utility**. As the aim of bargaining is to be better off after an agreement than before, the outcome of a bargain can be seen through the prism of utility theory (for further reading, see appendix B).

Second, individuals have **preferences** concerning the consumption of goods or services, which can be ranked depending on the level of satisfaction they provide. Ranked preferences are represented by **utility functions**, which measure the level of satisfaction (sometimes called happiness) provided by the consumption of a good (see Appendix B). A utility function does not explain why someone has a particular preference; instead it describes preferences in mathematical terms. In very brief and simple terms, the **rationality** of economic agents is described by their preferences.

Key issue

Fruit and axioms

Take an apple and a pear. If you like fruit, eating an apple gives a particular level of satisfaction. The same for the pear. We assume that it is rational to rank preferences in terms of "*I prefer apples to pears*", or "*I prefer pears to apples*", or "*I have no preferences between apples and pears*". This is one of the axioms that form the basis for expected utility theory. It is called completeness because it assumes that any comparison of two alternatives has one of the three possible solutions. Therefore, objects can always be ranked in terms of preferences.

The other three axioms are **transitivity**, **independence** and **continuity**.

Transitivity assumes that rational agents are consistent in their choices: if they prefer bananas to apples and apples to pears, then they must prefer bananas to pears.

The **independence axiom** concerns variations on a given set. For example, if rational agents prefer apples to pears, adding a banana maintains the ranking of preferences. In other words, an apple plus a banana is always preferred to a pear plus a banana.

Finally, we have the **continuity axiom**. Once again, apples are preferred to pears and bananas to apples. The continuity axiom states that there is a banana–pear combination that gives the same utility as an apple (*e.g.* a quarter of a banana and three-quarters of a pear).

We then assume that agents are totally **selfish**: their preferences only take into account their own personal benefits without accounting for the preferences of others. This assumption applies to most of the analyses that follow (although Section A.3 of appendix A describes some experiments that take into account the fact that humans can care about others' utility).

Many other factors influence choices. These require some simplifications and assumptions regarding human behaviour and, as shown in next section, information.

[4] For a more detailed –but still accessible to non-specialists– description of this theory, see [Concina 2014].

Complete and perfect information

Information is very important in a bargaining situation. Economics distinguishes two cases:

- **symmetric information**: both parties have the same level of information;
- **asymmetric information**: at least one of the parties knows something relevant that the other party does not know [Muthoo 2000].

In order to illustrate this, let us return to the pipeline example.

Example

A pipeline in my field

Company C wants to route a natural gas pipeline across land owned by landowner L. C asks for a lease that grants right-of-way across the affected area. The proposed gas transport unit is not totally safe, and C knows it. Specifically, they know more than the landowner about the risks (explosion, health consequences if there is a leak, *etc.*) and the safety measures they will adopt. Therefore, the level of information at the disposal of the parties is asymmetric.

Although in real life, levels of information are usually asymmetric, here we will assume there is symmetric and complete information. **Complete information** means that all parties know everything about the negotiation (*i.e.* all of the moves available to them, strategies and payoffs, as well as those available to the other parties). **Perfect information** occurs in a dynamic negotiation where one party, which usually has complete information, also knows all of the previous moves and strategies of the other parties and remembers all of their own moves.

Key issue

Basic framework

For the sake of simplicity, in the following chapters (and unless otherwise stated: see section 2.7 and appendix A.3), we discuss cases where **rational** and **selfish** agents have **complete** and **perfect** information. Similarly, to keep the framework simple, we only consider **two parties**, although in real life bargaining can of course involve more.

1

Bargaining: the basics

> *Any exchange situation in which a pair of individuals (or organisations) can engage in mutually beneficial trade but have conflicting interests over the terms of trade is a bargaining situation. Stated in general terms, a bargaining situation is a situation in which two or more players[1] have a common interest to co-operate, but have conflicting interests over exactly how to co-operate [Muthoo 2000].*

Many economic and social interactions consist of a process that involves two or more parties and aims to determine choices. Here, we focus on those situations in which, on the one hand, the parties have a **common interest** in making an exchange, but where, on the other hand, a **conflict** emerges concerning how this exchange takes place.

The bargaining process

Key issue

The bargaining process represents all interactions related to a proposed exchange between parties. If the trade takes place, there is a mutual benefit for everyone involved[2]. On the other hand, if the negotiation fails, there is a loss for society, in the sense that all parties miss out on potential gains.

This chapter introduces the theoretical models of the bargaining process developed by economists, and describes their predictions. We first identify the factors that must be in place at the start of a bargaining process, which can determine the outcome of the negotiation. We then use them in increasingly complex examples. Finally, we briefly illustrate the bargaining process through so-called "simple bargaining games".

1.1 The elements of bargaining

Understanding the factors that determine the outcome of an interaction involving two parties is important for two main reasons:

- ▷ it helps to disentangle the multiplicity of effects that might emerge in a complex negotiation process; and
- ▷ understanding the influence of a single variable can provide ideas for new tools or procedures that improve the distribution of gains from trade.

It is not easy to model a bargaining situation that involves firms and their stakeholders (society, residents, elected representatives, workers, *etc.*) in the context of industrial risk, as the factors that contribute to an agreement can be both complex, and include caveats that cannot be fully taken into account. Nevertheless, the motivation to reach an agreement can be investigated. With this in mind, the following sections give a flavour of the most common situations and elements that emerge in bargaining.

Specifically we introduce the following factors that provide the framework:

- ▷ the parties' objectives;
- ▷ the complexity of the bargaining object; and;
- ▷ the available information.

[1] The player, or party, or agent, can be either an individual, or an organisation (such as a firm, a political party or a country).
[2] We assume that there is no coercion; therefore if a party decides to accept a trade, it only does so because it will be better off if it accepts than if it refuses.

1.1.1 The parties' objectives: between conflict and cooperation

In the basic framework, two parties are interested in coming to an agreement on a specific subject (*e.g.* an exchange, compensation for negative externalities). Why do the two parties want to strike a bargain? What makes it so complicated to reach a decision? In this section we look at some answers to these questions.

Conflicting interests

We begin with the example of a simple trade: the exchange of an object between a buyer and a seller where a price has to be agreed.

The two parties have a common interest in trading the object. Both will gain if they reach agreement on how to proceed, *i.e.* the price of the object. **Mutual benefit** means that they both end up better off than they were before the bargain was struck. In this case, the buyer pays a price that is lower than (or equal to) the value they place on the object. Note that the buyer is satisfied, because they pay less than the value they place on the object (they would not have bought it otherwise). The seller is better off when the exchange is made at a price that is higher than (or at least equal to) their valuation of the object[3]. The respective value the buyer and the seller give to the object are their **reservation points**, namely their valuation of the object independent of whether a trade is made or not[4]. Clearly there is a potential gain for both parties, and this is why they bargain. Nevertheless, a natural antagonism emerges:

- the buyer prefers lower prices, while
- the seller prefers higher prices.

This forms the basis for a possible disagreement: a **conflict** may arise. In other words, the two parties have **conflicting interests** on the exact price.

The space of action

The **space of action** is all of the prices where agreement can be reached or not; it represents the set of all possible outcomes of the decisions taken. We assume that both parties can divide their space of action in two parts, separated by their **reservation point**:

- One side includes all of the situations where agents do not reach an agreement *i.e.* they both walk away from the bargaining game. This occurs when, for example the reservation point of the seller is higher than that of the buyer (*i.e.* the seller wants more money than the buyer is prepared to pay). These are called **disagreement points**. In this case, the "payoff" they receive is called the **disagreement outcome**. For example one disagreement outcome can be the seller's reservation point and zero for the buyer (*i.e.* the situation as it was pre-bargain)[5].
- On the other side lies a set of possible situations where both parties are better off if they agree. This part of the space of action is preferable for both parties as it is here that they judge there is something to bargain over.

It is important to note that there is a range of possible situations that the parties can agree on: this is the **zone of possible agreement (ZOPA)** or the **bargaining zone**. In this case, although both parties gain from the agreement, a higher gain for one party implies a lower gain for the other. Again, conflict can arise when there is a lack of mutually beneficial cooperative behaviour.

[3] Namely, the cost of the object and remuneration for their work.
[4] This idea will be developed later.
[5] Note that if bargaining has a cost and there is disagreement, both the buyer and seller might have negative disagreement outcomes: for example if the buyer has spent money to get to the negotiations or has spent time trying to get a good deal.

The zone of possible agreement (bargaining zone)

We illustrate this concept with a concrete example.

Example

A second-hand bike

The seller of a bike won't sell for less than 65$. A potential buyer won't pay more than 85$. They conclude the deal at 80$.

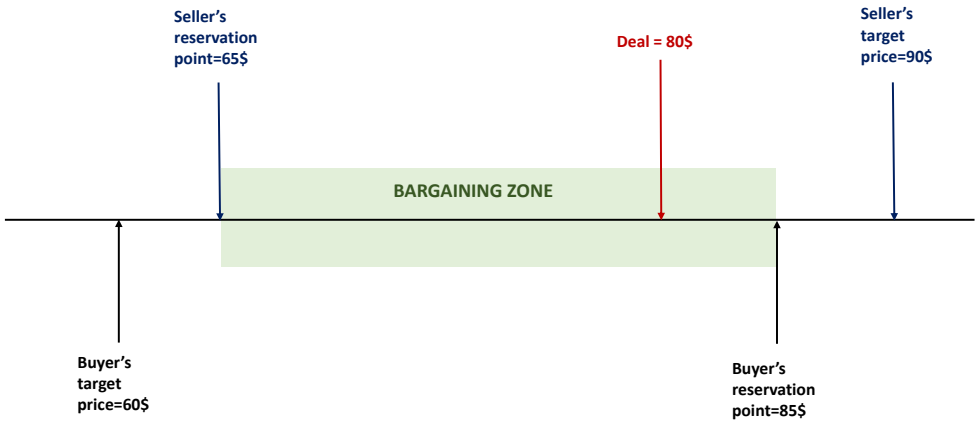

Figure 1.1 – *The zone of possible agreement (ZOPA) or bargaining zone (Source: MIT negotiation lecture)*

As described above, both parties can divide their space of action into two parts, separated by their **reservation point** (commonly known as their "bottom line"). On one side of this point are all the prices where they gain from a trade. On the other side are all those prices they would not consider buying (or selling) at.

Definition

Memo: some basic terms

Figure 1.1 shows that the **reservation point** of each party is the point beyond which they won't accept a deal. The **bargaining zone** is the area located between their respective reservation points.

Suppose now that the seller and the buyer have an ideal price, the target price, at which they wish to, respectively, sell and buy. Imagine this target price is 90$ for the seller and 60$ for the buyer.

If the lowest price the seller will accept is higher than the highest price the buyer is prepared to pay, then there can be no agreement (see the following example).

Example

The impossible deal

The seller absolutely wants to sell at their target point, here 90$. In this case, their target price is the same as their reservation price. This, in turn is higher than the buyer's reservation point, here, 85$. The parties will never agree.

However, if this is not the case, the trade can take place because there is a range of prices where both parties make gains: this is the bargaining zone (see figure 1.1).

The correct evaluation of the space of action has an important role, as an erroneous evaluation can translate into an incorrect trade. Imagine that the two parties believe that they have a common interest in trading (*i.e.* they think that the seller's reservation point < buyer's reservation point, as described in figure 1.1), but in reality, the seller's reservation point > buyer's reservation point (the seller wants more than the buyer will pay). In this case there can be no agreement and both parties will simply lose time and energy in a bargaining process that will never reach a positive conclusion.

If the reservation point of the seller is higher than the reservation point of the buyer, the bargaining zone is negative and the parties won't be able to conclude a deal.

So far we have focused on the motives for bargaining. However, most bargaining situations are less simple, due to, amongst other factors, the complexity of the bargaining object, the level of information…

1.1.2 The complexity of the bargaining object

The first question concerns the nature of the object about which the parties want to reach an agreement.

The oriental rug

Example

The object can be simple: a tourist and a merchant negotiating over the price of an oriental rug.

In this case, the object is simple, in the sense that the bargaining process only concerns the price of the goods. It is nevertheless interesting to examine how the parties reach agreement on the exact price paid by the tourist to the merchant.

However, in most contexts the parties have to agree on more complex situations and/ or multiple goods. In these cases the number of variables to be taken into account makes it more difficult to reach an agreement. Typical examples are strike negotiations, where the bargaining process deals with an increasing number of variables that are themselves complex objects. The choice of which elements are addressed can modify the way the discussion takes place and direct or redirect the issues. The individual characteristics of multiple objects can conflict or have different value for the parties, parties can agree on one particular issue, but disagree over others .... It should be noted that when the parties agree on one aspect of the negotiation, the conflict concerning that particular issue automatically disappears. This part of the problem is, in some way "erased" as it will not be a determining factor in the agreement. The focus remains on points of disagreement and relative differences that determine the outcome.

1.1.3 The available information

Even the simplest bargaining situation has an informational context.

The oriental rug

Example

The object can be simple: a tourist and a merchant negotiating over the price of an oriental rug. The seller knows how much the rug cost them and their own selling price. The tourist knows their own buying price. Usually, neither party knows the other's price.

As stated in the introduction, here we assume that both parties have the same level of information and perfect knowledge of each other's strategies. Information is complete, perfect and symmetric. Of course, in real bargaining situations, information is mostly asymmetric. This has a significant impact on the bargaining powers of parties and therefore bargaining outcomes. We will give a flavour of these impacts in chapter 2.

1.2 The bargaining process

So far we have considered the basic elements of bargaining. Next, we introduce bargaining strategies.

As Abhinay Muthoo highlights:

> *Bargaining is any process through which the players on their own[6] try to reach an agreement [Muthoo 2004].*

Bargaining is a strategic game, which means that the outcomes of one player (party) are not only affected by their own actions and choices, but also by those of other players. Many economic situations can be seen as strategic games; as an example, company profits not only depend on choices regarding price (among other parameters), but are also shaped by the prices of their competitors [Pénard 2004].

[6] In the sense that there is no requirement to agree or not.

1.2.1 Introduction to bargaining strategies

We begin with the following introductory example.

Dell *vs* Compaq[7]

Example

Imagine Dell and Compaq are the only companies producing computers. Whether their computers are compatible (or not) depends on their decision to choose the same operating system (or not). Suppose they can choose between Linux and Windows. Clearly, in addition to being beneficial for users, compatibility would also be beneficial for both firms as Dell could sell its peripheral devices to Compaq's users and vice versa. Nevertheless, for historical reasons, both companies would rather see the other make the effort to adapt. Imagine Dell prefers Windows, and Compaq prefers Linux. If both companies choose Windows, Dell makes a profit of 600M$ and Compaq 200M$. If both choose Linux, Compaq will make 600M$ and Dell 200M$. If they choose different operating systems, leading to incompatible devices, each company makes only 100M$. Suppose also that the two companies announce their decisions simultaneously, and do not know each other's choices.

If both companies choose Windows, this is interpreted as a victory for Dell as its operating system becomes the market standard. Similarly, if both choose Linux, Compaq is considered the "winner". However, regardless of the nature of the choice, it is most important to make the same choice as compatibility has greater benefits for both companies.

In 1950, John Nash showed that games have an equilibrium point where all players choose their actions with respect to their opponent's choices [Nash 1950].

Nash equilibrium

Definition

A Nash equilibrium, also called strategic equilibrium, is a list of strategies, one for each player, which has the property that no player can unilaterally change his strategy and get a better payoff [Turocy and von Stengel 2001].

The Nash Equilibrium is reached when each player's strategy is an optimal response based on the anticipated rational strategy of the other players in the game.

In the example given above, the strategies associated with a gain of 200M$ for one firm and 600M$ for the other are equilibrium strategies in the bargaining game. Why? Because if Dell thinks that Compaq will **always** choose Linux, then they will choose Linux too; this strategy would be the best response to the choice Dell expects from Compaq. This creates equilibrium because neither company has an incentive to change its strategy, given the strategy of the other. When the equilibrium is reached, there is no reason to leave it [Pénard 2004]. The same holds for Dell choosing Windows, where Compaq's best response is to also choose Windows.

The following example illustrates a case where the two parties follow extreme strategies.

House sale

Example

Imagine a seller values her house at 50 ($V_{seller} = 50$), while a buyer values it at 100 ($V_{buyer} = 100$). They both want to get as much as possible out of the trade: the seller asks for a very high price ($P_{seller} = 95$); the buyer offers a very low one ($P_{buyer} = 55$). Next, they simultaneously write down their chosen strategy, but neither can see what the other is writing. They can both record either *high price* or *low price*, but nothing in between. Then, we can look at the two pieces of paper and decide if they can trade or not and, if so, at what price.

The "payoff" (or "surplus" as it is defined in section 1.2.2) each party will receive depends on whether they agree or not and if they do, at what price:

- If both stick to extreme positions and pursue the strategy that maximises their own benefit, there will be no trade and both will receive a zero payoff.
- If they both agree on the *high price* strategy, the seller receives 45 ($P_{seller} - V_{seller} = 95 - 50 = 45$) and the buyer 5 ($V_{buyer} - P_{seller} = 100 - 95 = 5$).
- The last option is for both to choose *low price*; this results in the buyer gaining 45 ($V_{buyer} - P_{buyer} = 100 - 55 = 45$) and the seller 5 ($P_{buyer} - V_{seller} = 55 - 50 = 5$).

[7] This example is translated from [Pénard 2004].

Table 1.1 shows the strategies of the two parties in the different cases and their payoffs (the seller's gain is shown on the left and buyer's on the right).

	High price	**Low price**
High price	(45, 5)	(0, 0)
Low price	(0, 0)	(5, 45)

Table 1.1 – *Net value to (seller, buyer) of a trade based on extreme positions*

It should be noted that both parties benefit from abandoning their extreme position if the other party agrees, because they both gain at least 5.

Regardless of the strategy, it is most important that the two parties make the same choice (despite the fact that one party will receive a higher payoff than the other) because if they do not, there will be no deal and their payoff will be zero (both lose).

These two outcomes are Nash equilibria, because both parties are better off maintaining their position if the other does so too. The equilibrium concept requires that both parties anticipate the choices of the other and respond as expected. In equilibrium, there is no desire to change strategy as it is already the best response to the other's move and vice versa. In the house sale example, if the buyer thinks that the seller would make a "high price" move, they must decide to buy at the high price, otherwise there is no deal. As for the seller, if they think that the buyer would make a "high price" move, they are also better off making the same move. Since this works in both cases, neither would change strategy. This is exactly the concept of Nash equilibrium. For the same reason, the low price outcome is also equilibrium, because this is preferable for both parties to the no-deal outcome. However, it is not easy to identify which of these two equilibria will be chosen.

Based on the assumptions of rationality and complete information, we can now discuss in more detail the implications of these hypotheses, and better understand the definition of equilibrium. Assuming that they are rational, and hold all of the necessary information about available strategies, players can anticipate their behaviour, their responses to all possible combinations of other's moves. Moreover, the rational player with perfect and complete information is also able to predict what other players will do (knowing their strategies, information sets and that their behaviour is rational). This helps to clarify the equilibrium concept: as all players are able to anticipate all other player's moves, in equilibrium they know that everyone chooses the best action available and no-one will change strategy.

Next, we describe in more detail the bargaining process using more examples and some economics terminology.

1.2.2 The share of the cake

In the previous example, seller's and buyer's strategies reflect extreme positions. However, usually (as in the second-hand bike example described in section 1.1.1) there is a range of possible agreements. As both agents prefer to cooperate, the focus is on how, and how to divide the gains. In economics, the overall gain that emerges from the interaction of the two parties is called the **bargaining surplus**. It is the additional value that emerges from bargaining.

Memo: more basic terms

Definition

Figure 1.2 shows that the size of the bargaining zone represents the overall **bargaining surplus**. The bargaining surplus is negative when there is no overlap in gains. In the opposite situation, in the case of a positive surplus, each party receives a part of the total surplus.

Bargaining power is the ability of a person, group, or organization to exert influence over another party in a negotiation in order to achieve a deal which is favourable to themselves [Collins dictionnary].

For instance, in the house sale example, the seller values the house at 50 ($V_s = 50$) and the buyer at 100 ($V_b = 100$), thus the **total surplus**, if they conclude the deal, is $V_b - V_s = 100 - 50 = 50$. Given that both parties are better off by reaching a compromise, their main concern becomes getting the most out of it, *i.e.* the biggest possible share of the 50. How the surplus is distributed is linked to the bargaining power of each party: the better their bargaining power, the higher their share of the surplus (*i.e.* the higher their net gain).

Let us return to the example of the second-hand bike.

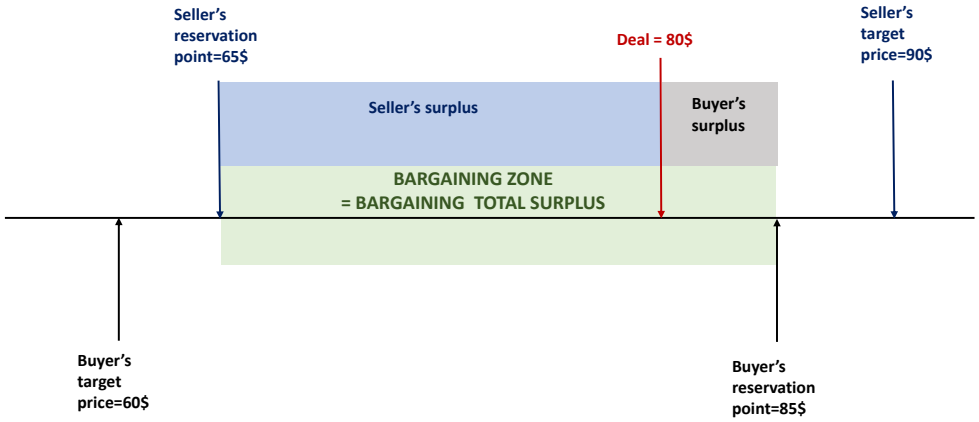

Figure 1.2 – *The zone of possible agreement (ZOPA) or bargaining zone (Source: MIT negotiation lecture)*

In this example, the seller values the bike at 65 ($V_s = 65$) and the buyer at 85 ($V_b = 85$); thus the total surplus if they conclude the deal is $V_b - V_s = 85 - 65 = 20$. If they reach an agreement at 80$, the seller's surplus is $80 - 65 = 15$\$ and the buyer's surplus is: $85 - 80 = 5$\$.

An easy way to represent the surplus of bargaining models is to think of it as a cake. Imagine two parties who need to agree on how to split a cake into two. If both have the same bargaining power, the cake is equally shared (*i.e.* fifty-fifty as in figure 1.3, left). On the other hand, if one party has better bargaining power (for example, two friends who participate in a competition but the one who puts in more effort claims a larger share) their slice will be larger (*e.g.* in 1.3, right, A has more bargaining power than B). However, it should be noted that bargaining power is always relative and never absolute: it depends on the match between the parties.

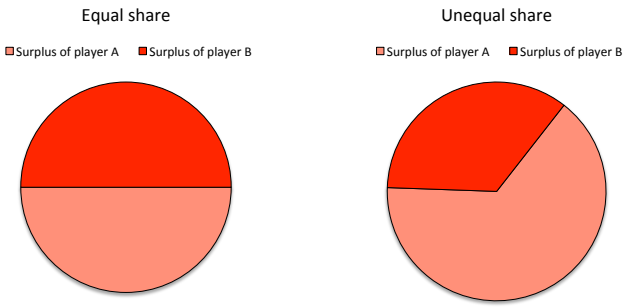

Figure 1.3 – *Sharing a surplus*

Bargaining power and surplus

Key issue

Gains are, by nature, linked to the bargaining power of the parties. The more power one party has, the larger their share of the profits, and the greater the inequality in the distribution of gains. The exploitation of bargaining power can cause significant inequalities in the redistribution of outcomes.

1.2.3 Simple static bargaining: the Nash bargaining game

One way to model the division of the surplus is given by the so-called "Nash bargaining game" [Nash 1950].

The game is simple: two agents negotiate over the distribution of a fixed surplus. They simultaneously claim a percentage of the share. If the sum of their two demands is equal to, or lower than the net gain from trade, the agreement is settled. If the sum is bigger than the cake, there is no trade. If they fail to reach an agreement, there is no surplus to share. If they reach a deal, the gain is shared according to the Nash Bargaining Solution (NBS)[8]. Given certain conditions, Nash finds that there is always a unique equilibrium that represents the agreement, and which depends on bargaining power. If two parties have the same bargaining power and the same characteristics, the surplus is split equally. In this case, the equilibrium is efficient (an agreement is reached), and symmetric (it leads to same outcome for both parties).

Although the NBS has properties that make it interesting in the bargaining analysis, it only applies to the static Nash bargaining game. In the following section we introduce the notion of dynamic bargaining.

1.2.4 Dynamic bargaining: the Rubinstein bargaining model

So far we have assumed that the game is played simultaneously; namely, strategic decisions are announced at the same time. However, in the real world, offers and counteroffers follow one another in sequence, and parties are able to accept or reject proposals. In economics, the Rubinstein model is usually used to represent real-life situations [Rubinstein 1982]. In this sequential, repeated game, parties make a series of offers and counteroffers (see 1.4) and it is a closer reflection of actual bargaining procedures than Nash's static, one-period game.

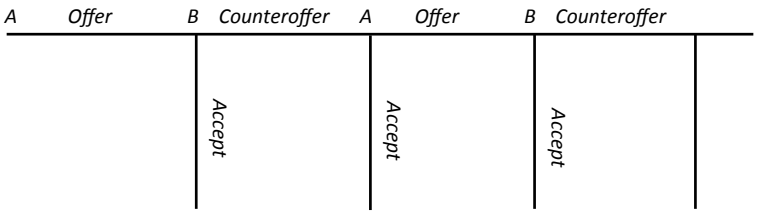

Figure 1.4 – *The Rubinstein bargaining model*

Always based on the hypotheses of perfect information and rationality described in the introduction, in that model we assume that each player knows the possible strategies of their opponent and plays in order to get the best out of the agreement. The game's dynamics are described schematically in figure 1.4. Player A starts, and makes an offer. If player B accepts the offer, the game ends; alternatively B refuses the offer, and proposes a counteroffer. A decides whether to accept the counteroffer (and end the game) or to reject it (and make a new offer). The game continues until an agreement is reached.

As the game is dynamic, the solution to the Rubinstein model is a refinement of the Nash equilibrium, the **subgame perfect (Nash) equilibrium** or **SPE**. A subgame is a part of the dynamic game. The SPE concept requires that players' strategies reach equilibrium in every subgame. To determine an SPE, we use the technique called **backward induction**:

- ▷ first, the optimal choice of the player who makes the last move in the game is identified;
- ▷ second, the optimal action in the next-to-last stage (given the optimal action in the last stage) is identified; and
- ▷ then we work backwards to the preceding stage, and so on until the first stage of the game is reached.

Despite the difference in the settings for the Nash and the Rubinstein bargaining games, there are similarities between the two models. In both cases, economists are interested in finding a solution to the bargaining situation. In other words, they want to determine the distribution of the outcome emerging from the bargaining process,

[8] We will not describe the details of the solution here because it is an abstraction from reality. It is, nevertheless, one of the most studied models and provides a benchmark for the comparison of other solutions.

and how and when the solution is reached. However, given the complexity of the process, they must make assumptions and focus on the most important factors and variables. When a solution is found in the simple context, a new element is added or, if a hypothesis is found to be too strict, it can be relaxed to increase its complexity.

1.3 Minimum required to engage in bargaining

As discussed in section 1.1.1, the **reservation point** is the starting point for the bargaining process. Parties will bargain only if they think they will benefit. They will only bargain if they expect that the outcome of the negotiation will exceed their reservation point. If there is no perceived advantage, negotiations will not even start.

A pipeline in my field

Example

To illustrate the idea of the reservation point, let us return to the example of company C that wants to construct a pipeline on the property of landowner L. If C does not make a proposal to L, the latter will continue to use the land as in the past (*e.g.* to grow wheat). As growing wheat is a low-profit activity, L's reservation point is very low. However, C has to offer at least the profit that L receives from his agricultural work, otherwise L has no incentive to conclude the contract. The higher L's profit, the more money C needs to offer in order to reach an agreement.

The reservation point only makes sense in the context of simple, static bargaining. In the dynamic case (the Rubinstein bargaining model), consisting of a sequence of offers and counteroffers, there is a similar concept, called the **impasse point**.

The impasse point

Definition

The impasse point represents the "*payoff pair obtainable through perpetual disagreement–that is, the payoff obtained by the players if each player always rejects any offer made to her* [Muthoo 1999, p52][9]."

However the two points are very similar. Multhoo shows that in general, when players have similar characteristics, the reservation point (in Nash bargaining terms), and the impasse point (in Rubinstein bargaining terms) have the same value.

[9] It should be noted that bargaining is cost-free in the Rubinstein model.

2

Factors that impact bargaining

This second chapter uses examples to give an overview of some of the important factors that influence the bargaining process and its outcomes. Most of these factors act on the bargaining powers of the parties; knowing and using them can be part of bargaining strategies.

2.1 Time

The process of reaching an agreement can take time and might consist of many stages, usually characterized by offers and counteroffers, as in the Rubinstein model.

A particular case is **frictionless bargaining**. This happens when time has no cost for the parties involved. This leads to an indeterminate outcome as parties can make offers and counteroffers to try to reach a better deal, without ever concluding an agreement. In this case, if it does not matter *when* the negotiators agree, then it will not matter *whether* they agree at all [Muthoo 2000].

However, in most real-life situations, time is precious and plays an important role in negotiations for various reasons. On the one hand, the actions taken by the two parties can be protracted, creating costly delays. On the other hand, the time that elapses between the formulation of the proposal and its acceptance or refusal may be lengthy.

2.1.1 Opportunity cost

Economists pay particular attention to **opportunity cost**. This is the cost of the time spent bargaining, rather than doing the most enjoyable alternative activity. In other words, it is the price of the next best alternative to negotiating. Although opportunity cost is of crucial importance in economics, it is not an intuitive concept. It describes the gain you might make from the best alternative option to your choice.

Example

Freelance worker

To better understand the concept, we take the example of the opportunity cost of one hour of leisure time for a freelance worker. In this hour, they could have worked; if their hourly salary is 25$, then the opportunity cost of their leisure hour is exactly 25$. In other words, it is the profit that is lost by not using the time to do something else, in this case working.

Why is it important to know the opportunity cost of time? Take the example of two parties who are negotiating over how to divide a cake (which has very low value). One is a lawyer and the other is an unskilled worker. The difference in their respective salaries means that the opportunity cost of the lawyer's time is much higher than that of the unskilled worker. Therefore the bargaining power of the lawyer is lower because they are eager to conclude the deal as quickly as possible. Thus, high opportunity costs reduce bargaining power as it is costly to spend time bargaining rather than concluding the negotiation quickly and going back to work.

2.1.2 Impatience

On the other hand, if the cake is very valuable, it is worthwhile for the lawyer to wait longer in order to get a larger share. If the value of the cake is so high that it exceeds the opportunity cost of going to work, bargaining might last for days. In this case, it is no longer opportunity cost that matters, but **relative wealth**. Suppose the lawyer is relatively rich and the unskilled worker is relatively poor. In this case, the lawyer can afford not to work. The worker, however, cannot do this and will prefer to conclude an agreement as soon as possible.

Impatience

Key issue

These types of situations determine the **level of impatience** of parties: a typical result in bargaining theory is that the higher the level of impatience, the lower the bargaining power of a party. A need to reach agreement as soon as possible reduces the gains –the part of surplus– a party can expect to get.

We can apply the concept of bargaining power to the pipeline example. In this case, the company is eager to reach an agreement: the sooner they construct the pipeline and transport gas, the sooner they make profits. The longer the bargaining process, the greater the cost of the lost opportunity. However, as we have seen in the previous example, we also need to consider relative wealth. While the firm may be impatient to conclude the deal, the landowner might also be in a disadvantageous position if, for example, he has financial problems that reduce his bargaining power.

To conclude, not only is the time spent bargaining important, but also the degree of impatience.

Discount rate and discount factor

The degree of impatience depends on economic factors and is represented by a party's **discount rate**. This measures the loss of value over time as the bargaining process evolves. The discount rate is related to the **discount factor** (the lower the discount rate, the higher the discount factor), which is a measure of future gains.

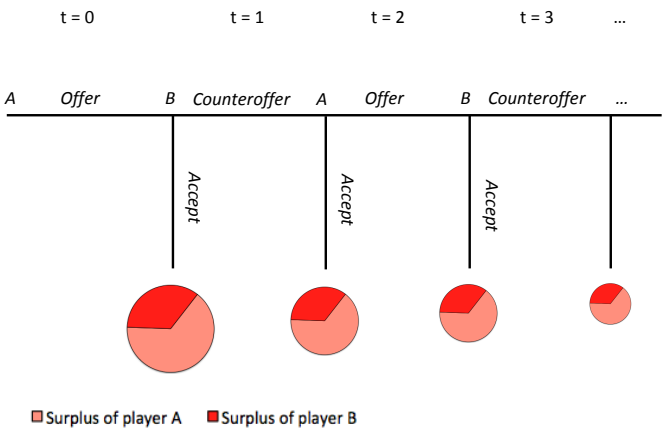

Figure 2.1 – *Timing affects the final surplus*

Taking figure 2.1 as an example, a series of offers and counteroffers are made over a certain time period. The entire cake (surplus) is represented by π. At $t = 0$, player A offers a part of it ($\pi_B^{t=0}$, the red part of the cake) to player B, such that $\pi_A^{t=0} = \pi - \pi_B^{t=0}$ (the pink part of the cake). If player B accepts the offer, an agreement is reached and the bargaining process ends. However, if player B rejects the offer, at time $t = 1$ they propose a different division of the cake ($\pi_A^{t=1} = \pi - \pi_B^{t=1}$). Meanwhile, the cake has become smaller (*e.g.* because someone else took a part of it) or has less value (*e.g.* because it is less tasty or no longer freshly baked), shown by the decrease of the disc area in figure 2.1. So, at time $t = 1$ the cake is no longer π, but a smaller amount $\delta\pi$, where δ is the **discount factor** that reduces its value ($0 < \delta < 1$).

In this example, the discount factor directly affects joint gains; however, it can also represent an individual level of impatience. Time is precious for both A and B, but the perceived decay over time can be different for the two parties. The surplus reduces at a certain rate in each time period: if A is offered a share π_A at $t = 1$ and accepts it, the gain is $\delta_A \pi_A$, where $0 < \delta_A < 1$ and represents the reduction in the surplus. If $\delta_A = 0.9$, then A's surplus is reduced by 10% compared to the previous period. Finally, B might be more or less impatient than A. Here again, what is important is the relative magnitude of impatience. Protracting bargaining is not only costly for both agents, but also for society, as gains are reduced.

Discount factor, patience and bargaining power

Key issue

An important result is that the share of the cake that is agreed depends on each player's impatience. The lower the discount factor, the more impatient the player, and the more willing they are to conclude a deal quickly as future gains diminish faster over time. On the other hand, a relatively higher level of patience confers greater bargaining power to players who reach agreement in a later period, on a smaller cake.

2.1.3 First mover advantage

In the Nash model, if the two parties have the same bargaining power, they are first compensated for their loss represented by the disagreement point, and then they divide the cake equally. The introduction of the concepts of sequencing and discount has an important effect on the division of the cake. This leads us to the notion of the so-called **first mover advantage** (found in the Rubinstein model that includes the discount factor). Imagine that the two parties are equal: they have the same discount factor and the same reservation point. We might think they will share the cake equally, but this is not true. Intuitively, if the second mover refuses the first offer, the cake will become smaller for both agents at the same rate. The second mover can only propose a division based on a smaller cake. The first mover anticipates this effect and takes it into account when making their offer.

Given the assumptions of rationality and perfect information, the share of the cake that the first mover can obtain is $\pi_{\frac{1}{1+\delta}}$, while the share of the second mover is $\pi_{\frac{\delta}{1+\delta}}$. The origin of this formula is beyond the scope of this document, but we can illustrate it with an extreme example. If the discount factor is $\delta = 1$, the cake will not change size. In this case, there is no advantage in being the first or second mover: the two have the same bargaining power and split the pie into two equal parts ($\pi_A = \pi_{\frac{1}{1+1}}$ and $\pi_B = \pi_{\frac{1}{1+1}}$). If δ is equal to zero, in second period, the pie will completely disappear and the second player has no bargaining power at all. In this case, the first mover has full bargaining power and will get all the cake ($\pi_A = \pi_{\frac{1}{1+0}}$ and $\pi_B = \pi_{\frac{0}{1+0}}$). These are extreme cases. Some more examples will help to show how the discount factor influences the division of the cake:

First mover advantage

Example

Example 1: if the cake reduces by 10% in each period (discount factor of $\delta = 90\%$), then the first mover obtains 0.53π and the second mover 0.47π.

Example 2: if the discount factor is $\delta = 50\%$ the first mover advantage is higher; the first mover obtains 0.66π and the second mover 0.33π.

Thus, everything else being equal, the first mover can ask for a greater part of a cake that will shrink in the future. Time can be an important factor because it can reduce joint gains from bargaining. It provides the first mover with an advantage even if both movers have the same discount factor. Note that the only difference between the two parties is who makes the first move.

The faster the better

Key issue

The Rubinstein model describes a dynamic game, and an agreement is usually reached in the first period, even if it can continue for an infinite number of periods. This is an important theoretical result that underlines the advantage of reaching a quick conclusion. Slow negotiations are costly: efficiency is crucial.

The following sections look in detail at other factors that can influence the division of the surplus[1].

[1] The following largely relies on the work of [Muthoo 2000].

2.2 Breakdown in negotiations

It is possible that negotiations break down due to uncontrollable factors. Exogenous factors can prevent the two parties from reaching an agreement. For example, a third party could stop or block the bargaining process, or an unexpected event might occur that means that there is no more need to reach an agreement.

A pipeline in my field

Example

If the government rejects the company's application for a permit to construct the pipeline, the bargaining process between them and the landowner automatically terminates because there is no more reason for the company to ask for the land.

There is a risk of breakdown in any bargaining process, and it can weigh differently on the bargaining power of the parties.

> *A key principle is that a player's bargaining power is higher the higher is her profit (or payoff) following the occurrence of the exogenous and uncontrollable factor that triggers a breakdown in the negotiations; and, similarly, a player's bargaining power is lower the higher is the other negotiator's payoff in that eventuality [Muthoo 2000].*

The payoff each party receives in the case of a breakdown in negotiations is termed the **breakdown payoff**.

In the context of hazardous industrial activities, the risk of the breakdown of negotiations can be significantly affected by the probability that an accident occurs. For example, in protracted negotiations over investment in safety to protect residents, the probability of an accident increases as time spent is in bargaining. Such an event will terminate any bargaining process with large losses for the parties. In this case, the risk of a breakdown in negotiations depends on an external factor that is not directly linked to the actions taken by the parties. Breakdowns can be random, and are therefore risky. Whenever there is risk, the parties' choices are affected by their preferences concerning uncertain events.

2.3 Risk preferences

In real life, most situations are unforeseeable and we need to predict future events in order to take decisions. A common problem is uncertainty related to the occurrence of a particular event. Before going any further, we need to link this uncertainty to how economists define risk. We will therefore first give the definition of risk, and risk attitudes we used[2], and then describe how the attitude of parties that face risk influences their bargaining power.

2.3.1 Risk in economics

Although in general, risk is perceived as negative because it is linked to potential accidents, loss, damage, missed opportunities, or a lack of gains, in economics it can also be associated with benefits (such as research-driven innovation). From an economic point of view, risk has more to do with uncertainty than negative effects.

Risk

Definition

In economics, the notion of risk concerns an event that is **uncertain**, *i.e.* that occurs with known or estimable probability[3], while an event that occurs with a probability of one or zero is said to be "safe" (or certain).

[2] For a more detailed presentation of these concepts, please see to [Concina 2014].

[3] Probability can be unknown, and it is therefore worth distinguishing between risk and ambiguity. When an event occurs with a probability that is not one nor zero *i.e.* it is uncertain, and there are two situations:

- in the first, the probability of the occurrence of the event is known; here we talk about **risk** (*e.g.* the probability of being killed in an airplane crash is approximately eight million to one).
- in the other, the probability of the occurrence of the event is not known; this is an example of **ambiguity**.

It is usually assumed that there is an expectation concerning uncertain events. For example, although the future salary of a worker might be unknown, it is expected to be in a certain range with a certain probability, or around a mean equal to certain amount: it has an **expected value (EV)**.

Expected value

Definition

The expected value (EV) of a random variable is the weighted average of all possible values that the variable can take. EV is a hypothetical measure: it does not reflect a real situation, instead it is the weighted mean of all possible real situations.

For example, the expected value can be calculated when the probability distribution of a continuous variable is known. To continue with the salary example, a worker believes their future salary will be between 20 000$ and 30 000$ and they expect the probability distribution to be uniform. Then, the expected value of the salary will be 25 000$.

2.3.2 Attitude to risk

People differ in their perception of uncertain events *i.e.* their perception of risk, and can be more or less reluctant to engage in a risky activity.

Expected value is a crucial element to understand attitude to risk. The following example illustrates the idea.

Attitude to risk: a lottery

Key issue

A lottery consists of events that occur with a probability. If I buy one or more tickets, each has a probability of winning a prize. Imagine a lottery L where I have a 50% probability of winning 100$, or 0$ otherwise. The expected value of L is given by $E(L) = 50\% * 100 + 50\% * 0 = 50\$$. Risk attitude is measured by the price that an individual will pay for L.

- ▷ A **risk neutral** person will buy a ticket at the same price as the expected gain, namely 50$: this person is "neutral" because they expect to receive the same amount of money they paid. For a risk neutral person, the uncertain event and the certain amount of money have the same weight.
- ▷ A **risk averse** person perceives uncertainty as negative: they prefer a certain outcome to a risky situation. Thus, they will always pay less than 50$. Risk averse people are characterized by a reluctance to engage in risky events.
- ▷ Finally, someone who is willing to pay more than the expected outcome is a **risk lover**: they perceive risk as a positive additional characteristic of the lottery.

Bargaining theory underlines how the level of risk aversion affects the bargaining power of parties. Once more, we assume that there is perfect information – namely, that agents know each other's preferences, and therefore their risk attitude. We can consider a simple case (the Nash model), where the split-the-difference rule is applied and where the two parties have the same reservation price and the same discount factor, but different attitudes to risk. In this case, the less risk-averse agent will receive a bigger share. Moreover, it is very possible that the fear of not concluding the agreement reduces the bargaining power of the party.

Similar arguments apply in the Rubinstein model. A possible breakdown in negotiations can have a large impact on the outcome depending on the parties' risk attitude.

To summarize

Key issue

The bargaining power of parties depends on their relative degree of **impatience** (see section 2.1.2) and their relative level of **risk aversion**. Less risk-averse parties have greater bargaining power and will receive a bigger share of the bargaining surplus.

2.4 Outside option

Another important factor in bargaining is **outside option**. A party can decide to terminate the negotiation and take a payoff that does not include any gains from the trade (see figure 2.2).

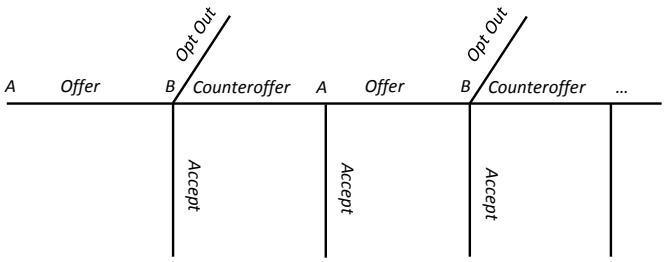

Figure 2.2 – *Outside option*

Unlike breakdown (which is a random exogenous event that has a probability of occurrence) the decision to opt out from bargaining is **endogenous** and a **strategy** that a party chooses to follow.

The oriental rug

Example

Returning to the case of the merchant and the tourist, the tourist can walk away if they see a rug at a better price in another shop. Here, the outside option consists of concluding the deal somewhere else. Both parties know that if the tourist buys from another seller, they will not buy from the merchant (it is unlikely they are interested in more than one rug!). The outside option might be an opportunity that has to be taken as soon as possible: if they find that someone else has bought the rug in the second shop, would the tourist be able to resume negotiations with the first merchant?

In most cases, the outside option has to be taken quickly and does not last forever. Another case that is frequently studied is wage negotiations.

Wage negotiations

Example

A worker is negotiating their salary with their potential future employer, but receives another offer with a non-negotiable wage. This second job offer is the outside option, and if the candidate accepts it, they can opt out of the negotiation.

However, if the outside option is less than what the party expects to gain from the trade, it will not affect the bargaining process. In the oriental carpet example, if the price of the carpet at the second shop is higher than in the first, it is not credible to threaten to leave the negotiation[4]. In the wage negotiation example, if the fixed wage is too low, the candidate will not consider it. This shows that the outside option is only interesting when it has some **power** in the negotiation.

It is important to note that the outside option does not affect the disagreement point, as it is not a payoff for ongoing disagreement, but another action that one of the parties can take. Next, we can introduce the situation where there is both an outside option and a risk of breakdown in the negotiations.

[4] Note that as we always assume perfect and complete information, we ignore bluffing as all agents anticipate that it is not a good strategy.

2.5 Outside option and risk of breakdown

Let us take the case where there is a probability that the negotiation will end for a random reason and an outside option. If the outside option is relatively unattractive (*i.e.* the expected payoff is lower than the impasse point) it is an **irrelevant outside option**. The threat of leaving the bargaining table is not credible and outcomes only depend on the breakdown point.

On the other hand, if one party has a relevant outside option (with respect to the breakdown point), then it is the only factor that counts in the outcome. Assuming the rational behaviour of all parties, the cake will be divided as follows: the party with the relevant outside option receives a share that is equal to the outside option; the other party gets the remaining share. Moreover, the former can opt out immediately if they think they will receive less than they would from the outside option. At the same time, the party with no outside option receives a share that is smaller than the one they would have received otherwise (note that their share must still be bigger than perpetual disagreement, otherwise the proposal is rejected). Returning to the carpet example.

The oriental rug

Example

If the tourist finds a cheaper rug, the merchant has to match the price (although they still make a profit that is higher than keeping the object). However, if this price is higher than the breakdown point, the bargaining process will have one of the outcomes described in previous paragraphs.

We now turn to the question of what happens when the breakdown point equals the outside option. In this case, the decision depends on the weight of discount factors relative to the probability of breakdown. If parties discount the payoffs relatively less with respect to the probability of breakdown (*i.e.* there is a high probability of breakdown with respect to the individual discount factor), then the risk that the negotiation will end as a result of exogenous factors is high. In this case, the parties will use the split-the-difference rule. On the other hand, if the probability of breakdown is relatively low, the outside option is the factor that has the greatest influence on the results.

2.6 Negotiation tactics

In this section we explore some tactics that can be put to use by the parties. The first one is to actively search for an outside option to increase their bargaining power. The second is termed "burning money" and consists in strategically destroying part of the potential gains or personal assets to threaten the other party. Finally, a party can commit to an action that increases their share.

Searching for an outside option

The previous sections have shown how another alternative can influence the outcome of bargaining. It can be advantageous to be able to threaten the other party with leaving the negotiation table. It is therefore interesting to observe what happens if one of the parties actively searches for an outside option during the bargaining process. Search theory[5] assumes that a suitable alternative cannot be found instantaneously: there is a search and many alternatives are compared until a suitable one is found. The optimal search strategy can consist, for example, in setting a value and comparing it with alternatives that are found over time. Less valuable alternatives are ignored, and the search continues until one is found that is equal to or greater in value than the one that is required. The search for an outside option is very important in bargaining theory because it increases bargaining power. However, the search may not be consistent with the bargaining process if, for example, the searcher has to leave the bargaining table (*e.g.* the tourist cannot check prices in other shops while at the same time negotiating with the merchant).

The oriental rug

Example

Suppose the tourist opts out, cannot find a better alternative and returns to the first shop. In the eyes of the merchant, the tourist's bargaining power and credibility have fallen and the seller may raise their price.

[5] Search theory studies the individual's optimal strategy in cases where the quality of the object to be acquired is uncertain, and when the search for quality is costly. Equilibrium is defined as a stopping rule: it determines when the search should end and an object bought depending on how long the search has gone on for and the distribution of the value of the objects already found.

Moreover, as time is costly, time spent searching for a better deal is costly. This is inefficient, as a loss is dissipated in the exploration of alternatives. Intuitively, the share of the cake is related to the value of the anticipated outside option, which in turn has to be compared with the risk of breakdown. Consequently, opting out is usually the last option.

Nevertheless, there are situations in which the search can be carried out during the bargaining process. In the oriental rug example, the tourist's partner can search for alternatives and report the results by mobile phone. This shows that finding an outside option in real time is a strategy that can considerably increase bargaining power.

In the pipeline example, the landowner could increase their bargaining power by searching for an alternative use for the field (*e.g.* renting the land to someone else for another purpose). On the other hand, the company could threaten to change the pipeline route if it can find other landowners who will accept a lower price. However, the threat must be credible: changing the route might be too costly, and using the land for agriculture may yield a lower rent.

2.6.1 Burning money

The idea underlying burning money is to take action that can be harmful to both parties. The principle motive of this strategy is to eliminate a potential move by either the money burner or the other party, and increase the probability of a more favourable outcome. A burning money strategy can be used to increase the time interval between an offer and a counteroffer. As parties are usually impatient (because of the cost of time), protracted bargaining is harmful for both. A simple example is striking during wage negotiations: workers can stop negotiations for few days to demonstrate their bargaining power. However, claiming that the strike will last several months is less credible. This shows that the stoppage should not be too long, but when it is credible, the strategy can have a significant impact on the outcome.

Timing is important. We illustrate this point with the following example.

Example

Workers and their employer

At time $t = 0$, the employer makes an offer, which workers can either accept or reject. If they accept it, bargaining ends; if they reject it, they make a counteroffer at time $t = 1$. If the employer accepts the counteroffer, bargaining ends; however, if they reject it, there are two potential actions:

- ▷ the employer makes another offer at time $t = 2$; or
- ▷ a series of strikes begins (say three periods), and only once they are over can the employer renew their offer.

The latter occurs at time $t = 4$. The employer's offer at time $t = 4$ is identical to that put forward at $t = 2$ with the disadvantage of a costly delay (therefore a smaller payoff to be split between the two parties). To avoid losing money, the employer may want to increase the initial offer, to compensate for any potential loss if the workers decide to strike.

In this example, the burning money technique used by the workers decreases the employer's discount factor as it increases the time (number of periods) during which the employer cannot take action. On the other hand, if workers go on strike immediately after they have rejected an offer, they decrease their own bargaining power by increasing the time available to prepare a new (potentially acceptable) counteroffer.

In general, the effect of applying the burning money strategy after an offer has been rejected is to increase the personal cost of rejection. Finally, another burning money tactic is to destroy part of the cake immediately after the other party rejects an offer. Shrinking the gains from trade has the same impact as the previous delaying tactic, but it does not affect the time span.

2.6.2 Commitment tactics

Another common tactic is to strategically commit to an action that creates an (advantageous) bargaining position. Prior to, or during the negotiation, one party indicates to the other that, as a result of its previous commitments, its hands are tied. Here, the idea is to stick to commitments no matter what.

This extract illustrates the idea:

> *If the union is going to insist on $2 and expects the management to counter with $1.60, an effort is made to persuade the membership not only that the management could pay $2 but even perhaps that the negotiators themselves are incompetent if they fail to obtain close to $2. The purpose is to make clear to the management that the negotiators could not accept less than $2 even if they wished to because they no longer control the members or because they would lose their own positions if they tried. In other words, the negotiators reduce the scope of their own authority and confront the management with the threat of a strike that the union itself cannot avert, even though it was the union's own action that eliminated its power to prevent strike [Schelling 1960, p.27].*

If the cost of reneging on the commitment is low or zero, this is not a credible threat and the other party can offer an amount that is lower than the one that was on the table when the commitment was made.

However, if the costs of backing out of the commitment are high, bargaining power is high. This can lead to aggressive bargaining. One problem is that if both parties will incur high costs in backing out of their commitments, their bargaining positions become incompatible. In this case, agreement might never be reached, with a loss of efficiency for both agents. It has been shown that incompatible bargaining positions and irrevocable commitments always end in perpetual disagreement [Muthoo 1999].

2.7 Asymmetric information

All of the examples we have looked at so far have assumed a symmetric and perfect information context, (*i.e.* both parties are fully informed about the value of the object, outside options, *etc.*). Nevertheless, this is unlikely to be the case in reality (see section 1.1.3). One party can hold fundamental information relevant to the bargaining outcome that the other party is unaware of.

In the oriental carpet example, a symmetric situation means that both parties know their own and the other party's valuation. However, while the merchant may know the "real" value of the carpet, the buyer probably does not. In most cases, the other party's estimate of the real value of the object is uncertain; this is an example of asymmetric information.

States of nature and expected value

Economic theory usually assumes that, in the asymmetric case, the less-informed party has certain "beliefs" about the quality of the object. In the oriental rug example, these beliefs are reflected in the value (*i.e.* the price) the buyer attributes to it. There are many ways buyers can express their beliefs. For example, the rug could be valued in terms of quality (high, medium or low). These possible qualities of the object are called **states of the world** or **states of nature**. Those states reflect all of the outcomes the potential buyer thinks are possible. Moreover, they can associate probabilities with them. For example, everybody knows that it is possible to find both a very good, and a very bad deal in a street market. In this case, the buyer might believe that the probabilities are as follows:

- it is unlikely they will find a high-quality carpet (say 10%),
- they may find a medium-quality carpet (35%),
- they are more likely to find a low-quality carpet (55%).

Therefore, the buyer prices the high-, medium- and low-quality carpet respectively at 200$, 150$ and 100$.

Given the uncertainty about quality, it seems natural to estimate the value as the average quality weighted by the buyer's estimate of the probability that it will occur. This weighted average is the expected value[6] (see section 2.3.1). In this case, the buyer estimates the expected value of the carpet as follows:

$$EV(rug) = V_{low} * P_{low} + V_{medium} * P_{medium} + V_{high} * P_{high}$$

[6] Another option is a frequency approach: the expected value can be seen as the average value of a carpet if we make a large number of purchases and we can, thus, infer the values of the different qualities and their probabilities to occur.

$EV(rug) = 55\% * 100 + 35\% * 150 + 10\% * 200 = 127.50\$$

Therefore, both uncertainty and beliefs determine the choices that are made. Naturally, the more complex the object or situation, the more difficult it is to gather information. In the following sections we will look at how this is important in the bargaining process. Finally, during the bargaining process, one or both parties can make a signal, or benefit from expert advice.

Asymmetric information and bargaining power

In general, having more information means more bargaining power. However, it is not always easy to transmit information to the other party. This may result in failure to reach an agreement or costly delays in acquiring the information necessary to conclude the negotiation.

Asymmetric information increases the cost of bargaining (for example, the need for external expertise or assurances) and can, in extreme cases, lead to inefficient disagreement. Once again, the oriental rug example will help to illustrate the point.

The oriental rug

Example

The merchant has private information about the rug's value, while the tourist only has beliefs about its quality. The tourist fears being ripped off by the merchant and, thus, is reluctant to make the deal. The merchant has no way to convince the tourist of the quality of the carpet and the two parties may decide to abandon the trade. This is undesirable for both parties as they would be better off by exchanging the good.

This type of inefficiency was introduced in Akerlof's paper "The Market for Lemons" [Akerlof 1970][7]. It is advantageous for a seller with low-quality good to lie about its value and ask for a high price. On the other hand, a seller of a high-quality good may not be able to demonstrate to the potential buyer the benefits of the trade. Akerlof shows that owners of high-quality used cars do not put them on the market, as they know that it would be difficult to sell them at a high price. Consequently, only low-quality cars are found on the second-hand car market: under asymmetric information, bad quality drives good quality out of the market. In some cases, the buyer can use a credible threat to gather more information about the object.

The oriental rug

Example

For example, the tourist can threaten to abandon the negotiations if the price of the rug is too high. In this case, the seller of a high-quality rug would withdraw as they have no incentive to continue. On the other hand, the seller of a low-quality rug would suggest a lower price, as they are better off selling the object even at the lower price.

This example shows that there is no market for high-quality objects and that asymmetric information creates inefficiency. However, if the seller can convince the buyer of the quality of the good, the trade can be made.

Knowledge acquisition is an important aspect of bargaining and contributions from experts or neutral third parties can limit disagreement outcomes. However, this may not be free (*e.g.* the buyer may have to pay an expert, and/or the seller may have to pay for quality certification by a credible third party), which reduces the gain from the trade.

A final important characteristic that can reduce inefficiency created by a lack of information is the **reputation** of the other party. However, building a reputation can be difficult, especially when the object in question is unusual and the two parties have not previously interacted.

[7] Akerlof won the Nobel Prize in 2001 for his research in the field of asymmetric information. His 1970 paper describes a market composed of many used car sellers and buyers, where prices are non-negotiable. As the equilibrium reflects the number of used cars sold and the price at which they are sold, the concepts are different. Nevertheless, it is interesting to compare the inefficiencies that are created by asymmetric information.

Summary

Industrial safety is a prime topic for negotiation and compromise. It is also the theme of the multidisciplinary research program launched by the Foundation for an Industrial Safety Culture entitled "Industrial risk and societal stakes, dynamics of negotiation and compromise". This introductory document, written by an economist, aims to explain the basics of bargaining theories to non-specialists, both researchers from other disciplines and anyone interested in the topic.

Using thread examples (such as a tourist trying to buy an oriental rug, or a farmer who receives an offer to lease his field to a gas pipeline company), this document provides an insight into the motives for bargaining. It presents some strategies and outcomes, and highlights the factors that increase or reduce the bargaining power of parties. Nevertheless, as the examples presented in the appendices demonstrate, theoretical predictions are not always confirmed by experiments. Furthermore, the author deliberately chose a simplified framework in order to provide an introduction to a broad audience. It must be kept in mind that real-life situations are usually much more complex, as multiple parameters and biases have to be taken into account.

A

Experiments on bargaining

This appendix briefly describes the results of experiments on bargaining behaviour in experimental settings.

Experimental economics in a nutshell

Key issue

Experimental economics is the branch of economics that studies economic phenomena through the collection of data which are deliberately created for scientific purposes under controlled conditions [Friedman and Sunder 1994, p3]. **Subjects** are the participants in the experiments that can be conducted in a lab environment or in the field. To test the effect of different parameters of interest, the design of the experiments comprises several **treatments** (particular conditions under which the experiment is conducted), chosen by the experimenter, whose results can be compared to those of the control treatment.

Economists have carried out many experiments in different settings to test theoretical predictions. Early work focused on testing the equilibrium prediction: the Nash bargaining solution (NBS) and the subgame perfect equilibrium (SPE). Other research looked at the elements that determine bargaining outcomes and the motives underlying disagreements.

A.1 Unequal bargaining power and asymmetric information

One of the most common results is that in many situations even if the theory predicts differences in bargaining power, subjects agree on an equal split of the gains. For example, Roth and Malouf asked subjects to gamble on 100 lottery tickets, each with a 1% probability of winning [Roth and Malouf 1979]. In one treatment, the prize is the same for both players (the equal condition) and different in the other (the unequal condition). To have an exact split of the cake, the two subjects should have the same expected return. For instance, 10 tickets offer a 10% of probability of winning the lottery, thus, if the value of the lottery is 10$, the expected value (EV) of 10 tickets is $10\% * 10 = 1\$$. In the equal treatment, almost all subjects agree on an equal share of tickets (fifty-fifty) and there is no disagreement. In the unequal treatment, subjects with a higher expected per-ticket payoff should receive fewer tickets to equalize the expected return. Authors find that in the unequal treatment there is greater disagreement between subjects; there is often no deal, which creates inefficiency and loss of potential gains. Those who do agree do not always follow the equilibrium prediction (equalising the expected return) but split the number of tickets in quantities that range between the SPE and equal shares. In another treatment, information about the other player's prize is not disclosed [Roth and Malouf 1979]. Introducing asymmetric information leads to an equal split of the cake and no disagreement.

Heuristic

Definition

A heuristic is a rule that is used to solve a problem based on its simplification. An individual who does not know the value of the other party's potential winnings tends to believe that they both have the same amount to gain.

If the other party's gain is unknown, individuals tend to believe that it is equal to their own. This result is important as it suggests that sometimes less information is more conducive to concluding the trade (there is less disagreement). However, it might not be fair as the subject with the high-value tickets receives a larger expected return.

A.2 Focal points

[Mehta et al. 1992] asked subjects to agree on the split of 10 pounds: if the sum of their independent offers is lower or equal to 10 pounds, then the deal is concluded, otherwise both get nothing. The NBS equilibrium predicts that each should ask for an equal share of the cake. However, to create differences between subjects, the authors introduce a preliminary stage where subjects are given cards (four aces and four deuces). Authors state that all four aces have to be pulled together to get the 10 pounds used to start the bargaining process. In general, results follow the NBS equilibrium, and the cake is equally split. However, there are significant differences with respect to the subject who is given more aces. From the theoretical point of view, the number of aces does not increase bargaining power as even with only one ace, the second subject can stop the bargaining process by refusing to share their card. From a psychological prospective, subjects frame situations around "focal points" and the introduction of differences (that are irrelevant to the negotiation) can generate substantial deviations from equilibrium predictions. This behaviour is typically termed self-serving attitude: subjects who have more aces think that their larger, self-favourable share of the cake is fair. Manipulating the bargaining framework may help to eliminate some of these self-serving biases or limit inefficient outcomes.

A.3 The role of other-regarding preferences

From the theoretical point of view, subjects are rational and selfish; they do their best to increase their personal payoff with no concern for other subjects. However, in real life, people can have preferences regarding the outcomes of others (termed by economists as other-regarding preferences). [Carpenter 2003] investigates the widely-observed equal-split result that accounts for differences in other-regarding preferences.

Using the social value orientation circle[1], Carpenter classifies subjects into altruists, co-operators, egoists and competitors.

- egoists: maximize their own outcomes regardless of others;
- altruists: consider the profits of others as a positive factor that influences their preferences;
- competitors: care about their outcomes relative to that of others; and
- co-operators: care about the total gain of the group they belong to.

Carpenter then uses this information to observe behaviour in a bargaining experiment.

Subjects are asked to play a game consisting of ten periods. Half of the time it is a one-round game (an offer followed by acceptance or rejection), otherwise it is a two-round game (an offer followed by acceptance or a counteroffer with acceptance or rejection). In all periods, for different treatments, subjects must agree on an equal share of the cake, even when in the second period there is a discount factor that dramatically shrinks (favouring the second mover) or increases (favouring the first mover) the size of the cake. Moreover, there is no difference over time: equal outcomes are required in all periods. As before, there is deviation from the equilibrium prediction in favour of fairer outcomes (fair in the sense that the first mover (dis)advantage is not exploited and all subjects gain the same amount).

However, as expected, altruists and co-operators tend to share more of the cake than competitors – but so do egoists. This is surprising as we expect them to be more selfish and exploit their advantageous position. Carpenter therefore examines if this behaviour has strategic meaning. Based on their expectations of others' behaviour, the evidence suggests that:

> *egoists must expect that other egoists will accept lower offers and therefore reduce offers when expecting to meet another egoist. But, egoists fear rejections from the other types and increase their offers when they expect to meet someone else [Carpenter 2003].*

On the one hand, co-operators and altruists split the cake equally because of their other-regarding preferences; on the other hand, there is evidence that subjects use strategic reasoning to maximize their expected payoffs according to their beliefs. The combination of these two behaviours leads to a stable agreement over the equal split, independent of the discount factor.

[1] The social value orientation circle is a way to represent individual social preferences. A series of questions about how to split incomes among individuals are put to subjects. Based on their answers, subjects are classified with respect to their other-regarding preferences.

A.4 Bargaining power and past history of negotiations

Previous history can have a significant impact on the results of future interactions between subjects. [Roth and Schoumaker 1983] allow subjects to observe the bargaining results of previous negotiations to create reputation effects. They manipulate early periods of the game by letting subjects play with computers that are programmed to give very high or very low shares of the cake. Surprisingly, although previous history *should* have no effect on the bargaining process, subjects who have obtained a large share feel they have increased bargaining power, independent of the current bargaining situation. On the other hand, subjects who receive a small share of the cake tend to be exploited.

A.5 Deadline effects

As previously described, the agreement, if it can be reached, is expected to occur at the beginning of the bargaining process to avoid costly delays. However, in both experiments and practice, deadlines have a significant effect. [Roth et al. 1988] report three experiments (where there is no discount rate) in which most agreements are reached in the last 5% of the bargaining time (a time horizon varying between 10 and 12 minutes). Subjects can continuously send anonymous proposals in a negotiation over their share of a cake. Not only do agreements occur very late, but there is also a large rate of disagreement, which creates inefficiency. Although in this case the cake does not decay, the bargaining process is not completely cost free, as subjects are assumed to incur an opportunity and/or an effort cost while bargaining. One possible explanation is that subjects with low bargaining power try to exhaust the other party and get a better outcome if they reach agreement at the very last moment. [Güth et al. 2005] investigate factors that influence the deadline effect and reduce inefficiency. They concentrate their analysis on three issues:

- ▷ length of the bargaining process (three or ten periods);
- ▷ the role of the players (*i.e.* whether only one player makes all of the proposals or if there is an alternating sequence of offers and counteroffers); and
- ▷ a small, or nonexistent discount rate.

They find that the deadline effect is reduced as the cake shrinks (and the discount rate increases), as predicted by the theory. In particular, the cost of delay increases when the time horizon is long with respect to no-cost bargaining. More time periods breaks up the decay and this may increase perceptions that the cake is shrinking. Not only is the deadline effect reduced, but more offers are accepted in the first period, in line with theoretical predictions. Finally, if only one subject is able to make proposals, inefficiency increases both in terms of disagreement rates and costly delays.

A.6 The discount rate and learning the first mover advantage

We now focus on the role of the discount rate in bargaining. In a sequential bargaining game, [Binmore et al. 1985] apply a large discount rate such that the cake shrinks to 25% of its initial amount in the second (and last) period. They find that most first movers offer half of the pie when it is the first time they play the game. However, if they repeat the game, but with reversed roles (the first mover becomes the second, and vice versa), they are more likely to make the equilibrium offer of 25% of the initial pie, as suggested by theoretical predictions. It is not clear whether this is a learning effect (which has been found in other experiments) or is due to the fact that the roles are reversed. Notwithstanding the reason, this result shows the importance of understanding that it is possible to deviate from the equal split by exploiting the first mover advantage.

A.7 Backward induction

[Neelin et al. 1988] observe initial offers in two-, three- and five-period bargaining games with high discount rates. They find that subjects tend to apply a simple heuristic: the first mover offers the second period discounted value. Instead of looking ahead to the last period, subjects exhibit limited rationality: they are not able to deduce from the future the optimal strategy to apply in the present. Similarly, [Ochs and Roth 1989] find equal splits even with different discount rates.

Definition

Bounded (limited) rationality

The idea of bounded (limited) rationality was introduced "*to focus attention upon the discrepancy between the perfect human rationality that is assumed in classical and neoclassical economic theory and the reality of human behaviour as it is observed in economic life. The point was not that people are consciously and deliberately irrational, although they sometimes are, but that neither their knowledge nor their powers of calculation allow them to achieve the high level of optimal adaptation of means to ends that is posited in economics* [Simon et al. 1992]."

An interesting additional result concerns rejection: once they have rejected an offer, the counteroffer is usually disadvantageous for the second mover, in the sense that they are asking for even less than what was offered to them (irrational behaviour). [Eckel et al. 2002] investigate the motives underlying this behaviour in depth. They find that subjects concentrate on periods close to the current period and pay little (or even no) attention to the last periods. By teaching them to observe the size of the final (discounted) cake, subjects are better able to play the SPE. However, if experienced subjects play with newcomers (who tend to prefer the equal split approach and reject offers close to the unequal SPE)[2], experienced subjects revert to more equal outcomes. In general, backward induction[3] is not computationally difficult, rather it is simply unnatural.

Key issue

Conclusion

Economic laboratory experiments on bargaining underline that theoretical models do not always predict the actual behaviour of people. Although they take into account many of the differences between agents (*e.g.* discount rates, outside options, risk attitudes, *etc.*), theoretical models do not account for heterogeneity of preferences (*e.g.* other-regarding preferences). They also do not account for the limited rationality of agents (*e.g.* their inability to predict future behaviour, or failure to understand the advantages and disadvantages of discount rates). However, experiments have provided empirical evidence for the importance of theoretical predictions in some cases, together with the importance of experience and learning. If subjects are taught equilibrium predictions, and methods such as backward induction are explained to them, they can adopt a rational strategy.

[2] Recall that, all other things being equal, different discount rates should lead to an unequal share at equilibrium.
[3] Backward induction is a way to reason about problems or situations. When a game is played over many periods, backward induction can be used to determine the sequence of actions beginning with the optimal choice in the very last period, and then working backwards through earlier periods.

B

Bargaining through the prism of utility

Economists are not particularly interested in how preferences are formed. They are more interested in how individuals make choices (their decision-making process) and whether their choices are optimal.

Utility functions are mathematical functions with "nice" properties that are used to find a solution for the decision-making process of the individual. They give a value to different choices (*e.g.* eating an apple, a pear or a banana) or to a bundle of choices (*e.g.* a basket with different types of fruits), so that choices (or bundles of choices) can be ordered from the most to the least desirable. Note once again that what is important here is not the absolute value of the utility, but the relative level of satisfaction compared to all possible choices. When we choose among different goods or bundles of goods, we **maximize utility** (*i.e.* we choose the solution that offers the highest level of utility with respect to all other feasible alternatives). Finally, we need to account for any constraints that may apply to the bargaining process. These include **budget constraints** (due to limited wealth) or **time constraints** (we cannot spend all day bargaining over an object). In the following, we look again at the bargaining process and outcomes, the share of the cake.

The utility function describes all possible combinations of outcomes that players can receive. For example, if the two parties agree on their share of the surplus, the share that they consume reflects some level of utility.

Suppose the total surplus is π (the entire cake). If the share of an agent A is equal to π_A , the share received by agent B is $\pi_B = \pi - \pi_A$

These types of game are called **zero sum games**.

An increase in the gain of one player is equivalent to a decrease of the same size in the gain of the other: agents have opposite preferences. Games where the conflict is evident and intrinsic (like zero sum games) are called competitive games. The larger my piece of the cake, the higher my utility and the lower the utility of the other party. The utility that agent A obtains is given by $u_A(\pi_A)$, while for agent B it is: given by $u_B(\pi_B) = u_B(\pi - \pi_A)$.

As we have already highlighted, in this case, there is no other-regarding preference and subjects only care about themselves. As shown above (*cf.* A.3), other-regarding preferences matter in cases where the slice of the cake given to the other subject directly influences "happiness". For example, a form of altruism requires that my utility increases as the other player's share increases.

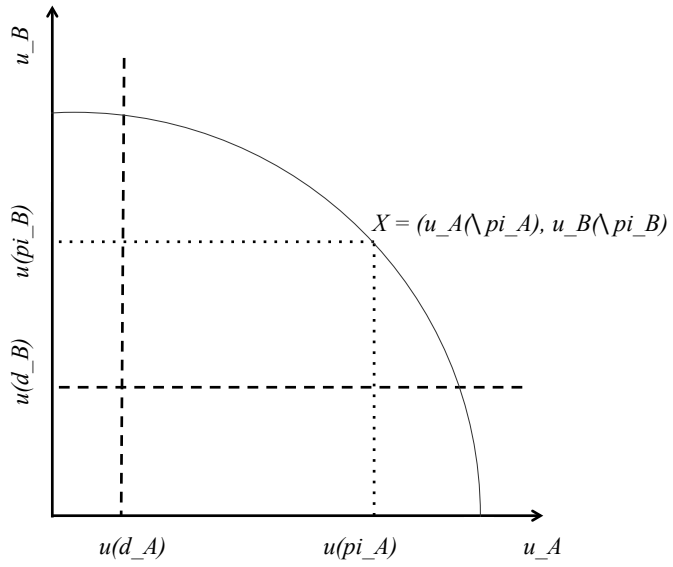

Figure B.1 – *Utilities of the two bargaining parties*

Figure B.1 represents the space of all possible combinations of two agents' utilities. Each point corresponds to a utility pair given by the consumption of the good[1]. The curve represents the utilities of the two agents for every combination of cake sharing. All points below the curve are feasible: they represent points where the sum of the two portions of the cake is less than the entire cake.

Definition

Principle of non-saturation

This principle is one of the fundamentals of microeconomics. It postulates that individuals always prefer more, rather than less, utility.

The principle of non-saturation states that "more is better" but "less is not better". Subjects always prefer to finish all the cake than throw part of it away[2]. Nevertheless, they will not accept a deal that offers them a utility that is lower than the status quo ($u_A(d_A)$ for player A and $u_B(d_B)$ for player B).

Note that utility can be different between subjects. For example, player A may love cake more than player B, so the same piece of cake has a higher utility for A than for B.

Thus, for the same piece of cake π:

$u_A(\pi) > u_B(\pi)$

represented by the dotted line in figure B.2. The utility function is monotonously increasing as, under the non-saturation principle, the higher my share, the higher my utility. This effect is marginally decreasing; for example increasing the share from 0% to 10% offers more utility than increasing from 70% to 80%. In other words, more is still better, but in a less important way.

[1] Note that this space is independent of the surplus; it only describes the many possible partitions of hypothetical utilities driven by many shares of cakes.

[2] Although there might be strategies (*e.g.* the burning money tactic) where it is preferable to throw away part of the resources, in general this is not true. This was discussed in section 2.6.1.

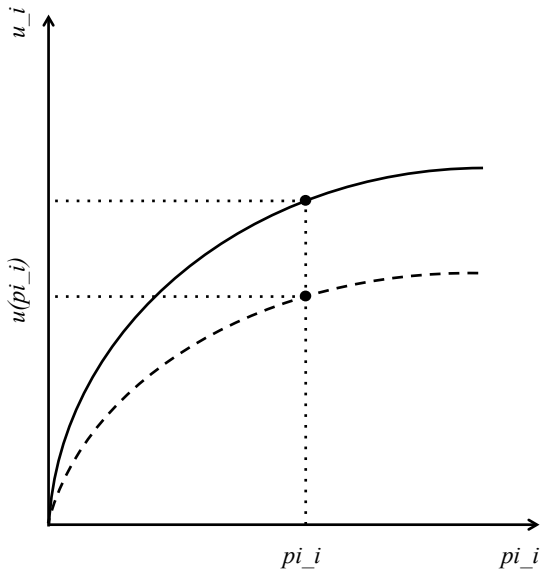

Figure B.2 – *Different utilities*

Bibliography

Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*, 84(3):488–500.

Beck, U. (1992). *Risk society: towards a new modernity*. Sage. ISBN: 0803983468.

Binmore, K., Shaked, A., and Sutton, J. (1985). Testing noncooperative bargaining theory: a preliminary study. *American Economic Review*, 75(5):1178–1180. Available at http://www.jstor.org/stable/1818658?seq=2.

Carpenter, J. P. (2003). Is fairness used instrumentally? Evidence from sequential bargaining. *Journal of Economic Psychology*, 24:467–489. Available at http://community.middlebury.edu/~jcarpent/papers/FUI%20%28JoEP%20published%20version%29.pdf.

Concina, L. (2014). Risk attitude & economics. Les Regards sur la sécurité industrielle 2014-01, Fondation pour une culture de sécurité industrielle, Toulouse, France.

Eckel, C., Johnson, M., and Wilson, R. K. (2002). Fairness and rejection in the utltimatum bargaining game. *Political Analysis*, 10(4):376–393.

Friedman, D. and Sunder, S. (1994). *Experimental Methods: A Primer for Economists*. Cambridge University Press. ISBN: 978-0521456821, 248 pages.

Fudenberg, D. and Tirole, J. (1991). *Game theory*. MIT Press. 603 pages.

Güth, W., Levati, M. V., and Maciejovsky, B. (2005). Deadline effects in sequential bargaining: an experimental study. *International Game Theory Review*, 7:117–135.

Mehta, J., Starmer, C., and Sugden, R. (1992). Chapter *An experimental investigation of focal points in coordination and bargaining: some preliminary results* in *Decision making under risk and uncertainty*, pages 211–219. Springer Netherlands.

Muthoo, A. (1999). *Bargaining theory with applications*. Cambridge University Press.

Muthoo, A. (2000). A non technical introduction to bargaining theory. *World Economics*, 1(2):145–166.

Muthoo, A. (2004). Chapter *Bargaining* in *The Social Science Encyclopedia* (Kuper, A. and Kuper, J., Ed.). Routledge, London, UK, third edition.

Nash, J. F. (1950). The bargaining problem. *Econometrica*, 18(2):155–162.

Neelin, J., Sonnenschein, H., and Spiegel, M. (1988). A further test of noncooperative bargaining theory: comment. *The American Economic Review*, 78:824–836.

Ochs, J. and Roth, A. E. (1989). An experimental study of sequential bargaining. *The American Economic Review*, 79(3):355–384. Available at http://www.ww.uni-magdeburg.de/bizecon/material/Ochs.Roth_Experimental.study.of.sequential.bargaining_AER79%283%291989_355-384.pdf.

Pénard, T. (2004). *La théorie des jeux et les outils d'analyse des comportements stratégiques*. Centre de recherche en économie et management, Université de Rennes 1, Rennes, France. Available at http://perso.univ-rennes1.fr/thierry.penard/biblio/manueljeux.pdf.

Reniers, G. (2010). Chapter *Game-Theory: A Mathematical Technique to Convince Company Top Management to Invest in Multi-Plant Safety and Security* in *Multi-Plant Safety and Security Management in the Chemical and Process Industries*. Wiley.

Reniers, G. and Pavlova, Y. (2013). *Using Game Theory to Improve Safety within Chemical Industrial Parks*. Springer Series in Reliability Engineering. Springer. ISBN 978-1-4471-5052-7.

Roth, A. E. and Malouf, M. W. (1979). Game-theoretic models and the role of information in bargaining. *Psychological Review*, 86:574–594.

Roth, A. E., Murnighan, K., and Schoumaker, F. (1988). The deadline effect in bargaining: some experimental evidence. *The American Economic Review*, 78(4):806–823.

Roth, A. E. and Schoumaker, F. (1983). Expectations and reputations in bargaining: an experimental study. *The American Economic Review*, 73:362–372. Available at http://web.stanford.edu/~alroth/papers/1983_AER_Expectations_and_Reputations.pdf.

Rubinstein, A. (1982). Perfect equilibrium in a bargaining model. *Econometrica*, 50(1):97–109. Available at http://arielrubinstein.tau.ac.il/papers/11.pdf, DOI: 10.2307/1912531.

Schelling, T. C. (1960). *The strategy of conflict*. Harvard University Press, Cambridge (MA), USA.

Simon, H. A., Egidi, M., Viale, R., and Marris, R. (1992). *Economics, bounded rationality and the cognitive revolution*. E. Elgar. ISBN: 978-1-85278-425-6, 240 pages.

Turocy, T. L. and von Stengel, B. (2001). Game theory. Research report LSE-CDAM-2001-09, Centre for discrete and applicable mathematics. Available at http://www.cdam.lse.ac.uk/Reports/Files/cdam-2001-09.pdf.

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