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Utility theory

- We will introduce some basic concepts about utility theory and decision-making that are common in finance and banking.
- The themes introduced here will either be used in many models in finance and banking or are general settings that are commonly encountered in these areas.

Expected utility

- Decisions in finance and banking are characterised by uncertainty about the outcome of decisions
- The utility a decision gives cannot be determined ex-ante, instead we form expectations about the utility that is obtained
- This expected utility is then used as the basis for decision-making
- The uncertainty about the outcome of decisions, the risk, plays an important part in many models

Expected utility

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- Economic theory is often about choices between alternatives that generate a specific outcome. In finance and banking, however, the outcomes of a decision are often not known, there are only probabilities known that a specific outcome may be realised.
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  - As the realised outcomes are not known in advance with certainty, we cannot assign a specific utility to a decision.
  - Instead we know the probability of each outcome and hence the probability with which the utility associated with this outcome emerges; this allows us to form expectations about the utility of the decision-maker.
- This expected utility is the objective function in our optimisations in such cases.
- What distinguishes this assessment of actions from that of conventional economic theory is the risk associated with the decision. A decision might yield a high or a low utility, it is not known which one is realised. This introduces a risk into the decision-making which is an important factor in the decision-making process.

→ Will look in more detail at the preferences of decision-makers, how risk affects decisions, and the way the attitude of decision-makers towards risk can be measured. These risk-preferences will often be used when assessing optimal choices, but in many cases we will for convenience also assume that risk preferences are not relevant in the decision-making process. This will often be for convenience of the mathematical derivation of results, but also because they often do not impact the results significantly.

Asymmetric information

- Another characteristic in finance and banking in many models is that market participants do not have the same level of information
- Such asymmetric information between market participants can have profound impact on decision-making and market outcomes
- We will briefly discuss how asymmetric information affect decisions and markets

Asymmetric information

→ One key topic that is present in finance of banking a lot is that of information. Having information (or not) about possible outcomes is a fundamental concern in modelling decisions.

- Given the uncertainty of outcomes, information about possible outcomes is important and it is realistic to assume that decision-makers do not all have the same information. Some market participants might have better information than other market participants, where better here means more precise information.
- We will see here, and in many other examples that such asymmetric information can have significant impact on the decisions taken and subsequently on market outcomes.
- We will here briefly outline the key issue, the implications it will have, but leave manifestation of specific circumstances and their solutions to more specific settings.

→ Having different precision of information between market participants is referred to as asymmetric information and the resulting potential implications often as adverse selection.

Risk-taking behaviour

- Companies and managers, as well as investors, make decisions that maximize their own utility, but these decisions will also affect other market participants
- In finance and banking the risk-taking is of specific concern and frequently there is an incentive to take more risk than would be socially optimal
- We will briefly discuss how risk-taking is affected and what consequences there might be

Risk-taking behaviour

→ Given the importance of risk in the decision-making process, we will briefly look at the incentives for risk-taking and what consequences this might have.

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- Decision-makers seek to maximize their own utility and this is what drives their decision to make a specific choice.
- Their choice often will affect other market participants as well and if the decision of all market participants need to be considered for an outcome, this can lead to complex interactions between them.

▶ A specific concern given the uncertainty of outcomes in banking and finance is the amount of risk a decision-maker is taking. It is often that there are incentives to take more risks than is socially optimal in what is a called a moral hazard.

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- We will here point out why higher risks are taken than is optimal.
- We will also look at the consequences such incentives to take high risks has for the market outcome. The results can be more severe than a mere increase in the overall risk.

→ Decisions taken by market participants will affect others and this can set off a chain of results that lead to a significantly different market outcomes if the economy changes only marginally. We will look how such situations can arise and suggest some ways of addressing these.

Assessing risk-preferences

- Individuals do not like taking risks and utility functions have properties that exhibit such properties
- Measuring risk-preferences is not possible without the knowledge of the specific utility function
- We will discuss the most common measure of risk preferences, called risk aversion

Assessing risk-preferences

→ We will start by looking at the preferences for risk that individuals might have and how we can include this into the decision-making process.

- It is generally accepted and empirically confirmed that individuals seek to avoid risks.
- We will see that the common properties of utility functions implies exactly such a dislike for taking risk.

- Assessing risk preferences exactly is not possible without the knowledge of the utility function. However, the utility function is generally not known, even not to the decision-maker itself.
- We will therefore seek a measure of risk aversion that can be applied without the knowledge of the specific utility function. While the resulting risk aversion would be derived from the utility function, it can be used as a concept to assess the impact of risk on decisions.

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Risk aversion

→ We will now discuss how to derive risk aversion and how utility functions can be re-written to take this property into account.

Maximizing expected utility with knowing the utility function

- Risk aversion can be used as a measure of the attitude towards risk
- By using risk aversion we can maximize expected utility without the need to know the utility function
- Often it is more convenient to consider only expected returns and ignore risks
- In this case we assume implicitly that individuals are risk neutral

Maximizing expected utility with knowing the utility function

→ Now that we have derived the main results of the model, as far as relevant for us, we will briefly discuss some implications as well as limitations of this model. This will allow us to interpret the model in its context of the initial problem and enables us to apply it appropriately in a realistic context.

- We can use risk aversion to determine how much risk affects the utility of decision-makers. Risk aversion captures the key properties of the attitude individuals have to wards risk: how much they dislike risk.
- Using risk aversion, we do not need to know the specific utility function, but we only need the expected outcome and the risk of a decision. While this is only an approximation of the optimal decision, given that in reality there will be many other factor affection the decision which have not been included, this can be seen as a good approximation in most cases and allows us to derive meaningful conclusions form such models.
- In many cases, models only consider the expected outcomes and ignore the risks associated with it. This is not because risks are irrelevant, but in many such cases, the risks are either not affecting the decision significantly, or they are so closely related with the expected outcome (the positive risk-return relationship), the one can serve as the proxy of the other and including both doe snot add much information to the outcome of the model.
- Ignoring the risk in a model implies that we assume decision-makers are risk-neutral as they are not concerned about risk. This is equivalent to a risk aversion of zero and a linear utility function.

→ Having established how we might model the risks of decisions, we can now address a problem that arises from decisions being risky: that of information.

Asymmetric information

- Market participants often have different information about possible outcomes of decisions or the risks involved
- Of particular concern is if some market participants have better information than others, allowing them to make additional profits
- We will investigate how in such a situation markets may not be able to function properly

Asymmetric information

→ With outcomes of decisions not known in advance, there is scope for individuals to acquire knowledge about possible outcomes. This knowledge is commonly referred to as information.

- With market participants collecting information on possible outcomes, they might have different information from each other.
  - Our focus with respect to information will be on the risks of outcomes in most cases.
- Decision-makers will not only have different information, but some decision-makers will have better information, that is information which reduces the risks as it is more precise and allows them to reduce the range of possible outcomes.
  - As many models will show, being better informed allows a decision-maker to make additional profits at the expense of decision-makers who are less-well informed.
- We will outline here under conditions a market might not be able to function properly given the differences in the quality of information market participants have.

→ Such differences between market participants in the quality of information, not merely having different information, is called asymmetric information.


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Adverse selection

→ We can now look at a simple model to illustrate the problem of symmetric information.

The need to identify the types of market participants

- If the risk of market participants to make a loss is too high, markets may not function
- Such adverse selection can only be overcome if the type of market participants can be identified
- Many theories in corporate finance and banking evolve around the identification of different types of market participants

The need to identify the types of market participants

→ Now that we have derived the main results of the model, as far as relevant for us, we will briefly discuss some implications as well as limitations of this model. This will allow us to interpret the model in its context of the initial problem and enables us to apply it appropriately in a realistic context.

- We have seen that if the losses from asymmetric information for one market participant are too high, here the bank, then this market participant will not enter the market and the market breaks down, allowing no one make profits.
- To ensure that markets do not breakdown in such situations, we need to find a mechanism that allows to identify the information market participants hold. Such identification of market participants will only be possible through incentives that induce specific decisions and these decisions can be observed; from the decision we can then infer the information the market participant holds.
- Asymmetric information and adverse selection are a recurring theme in corporate finance, banking, but also when analysing trading in financial markets.

→ Asymmetric information is not the only possible problem that can emerge in markets; we will now address the decision-making process itself.

Socially sub-optimal decisions

- Decision-makers can make decisions about which type of investment to pursue, it could be low-risk or high-risk
- Often the consequences of a decision do not have to be borne fully by the decision-maker, costs might be imposed on others
- The benefits of their decisions are often accruing only to the decision-maker
- This can distort incentives in decision-making sway from the socially optimal decision

Socially sub-optimal decisions

→ Decisions are made by individuals and while these may be individually rational, the impact of such decisions can be detrimental to everyone, including the decision-maker. One example of such individually rational decisions that are detrimental is the Prisoner's dilemma in game theory.

▶
- In the banking an finance context, a common decision is about which type of investment a company should make, whether bank should give a loan, or whether to purchase a security.
- The investment could be low-risk (safe), or high risk (risky); it is often convenient to assume that there are only two investment opportunities and assess the decision which one is chosen.

▶
- One feature of many decisions is that consequence of a decision is not always fully borne by the decision-maker. For example if a loan is taken for an investment, the loan might not be repaid if the investment fails. Thus the losses of a failing investment might be limited, while the benefits of a successful investment fully accrue to the decision-maker.
- It is not only that the decision-maker does not have to bear the full costs of their decision, but they impose costs on other market participants. Here the bank faces a loss as the loan is not repaid.

▶ It is common that the benefits fully accrue to the decision-maker, while the costs are shared.

▶ Such a situation can distort the decision-making process and the resulting outcome will not reflect the social optimum that could otherwise be achieved.

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Moral hazard

→ We will now look at a simple model that shows the implications such moral hazard, as it is called, can have on the market outcome.

Incentives to align decisions

- Moral hazard can lead to markets not being able to function properly
- Contractual arrangements need to be found that align the interests of the decision-maker with the social optimum
- The development of arrangements that align incentives is an important topic in corporate finance and banking

Incentives to align decisions

→ Now that we have derived the main results of the model, as far as relevant for us, we will briefly discuss some implications as well as limitations of this model. This will allow us to interpret the model in its context of the initial problem and enables us to apply it appropriately in a realistic context.

- As adverse selection, moral hazard can lead to the breakdown of the market and no market participant can make a profit.
- What is needed to overcome such a market breakdown is to align the incentives of all market participants, such that the decisions they are taking are consistent with each other.
- Together with contractual arrangements to overcome the problems arising from adverse selection, designing mechanisms to align incentives over coming moral hazard are a large part of the literature in banking and corporate finance. Moral hazard is less of a concern in financial markets.

→ Moral hazard and adverse selection seem very similar on first sight; therefore we will now frienfly point out the key differences between these two concepts.

Comparing adverse selection and moral hazard

- In adverse selection, companies are of different types
- Ex-ante banks do not know which type a company is
- In moral hazard, companies make a decision on which type they are
- Banks can infer which decision a company will make

Comparing adverse selection and moral hazard

→ The models of adverse selection and moral hazard seem very similar. In both cases there were two possible investments, high-risk and low-risk. In both cases the result was a market breakdown. There are, however, substantial conceptual differences between these.

- For adverse selection to emerge we had companies that were one of two types, high-risk or low-risk. These types were exogenously given the companies themselves could not change their properties. Companies were assumed to know which type they were.
- In contrast to companies, banks do not know which type the company is; this leads to adverse selection.
- In moral hazard, the company decides on its type, it is a decision by the company. Thus the type is no longer given, but can be changed by the company.
- Banks have the knowledge to infer how the company will decide, while in adverse selection the bank had no way of knowing their type, unless specific mechanisms are put into place.

→ Adverse selection and moral hazard seem to look similar, but their key assumptions are different.

Key problems in finance and banking

- Corporate finance, banking, and insurance are exposed to the problems of adverse selection and moral hazard
- Adverse selection is also a concern when trading in financial markets
- Risk preferences are of concern when making investment decisions, while in corporate finance and banking these are often ignored

Key problems in finance and banking

→ We can now summarize the key results we have obtained about decision-making under uncertainty.

- The problems of adverse selection and moral hazard are ever present in corporate finance and banking. Many of the practices in these areas can be traced back as an attempt to overcome either or both of these concerns.
- Moral hazard can be mostly ignored for trading in financial markets, but adverse selection is an ever-present concern for any trader.
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  - With the importance of risk in finance and banking, modelling risk preferences adequately is essential to obtain meaningful and insightful results. Risk preferences are a main concern in financial markets where risk aversion is an ever-present concept that drives investment decision. This is not least to establish a positive relationship between risk and return.
  - In contrast to that in corporate finance and banking risk aversion is often ignored as it does not add significantly to the validity of the outcome, but complicates the analysis. Given the positive relationship between risks and returns established in financial markets, the addition of risks to the expected outcome would largely be a duplication of the relationship arising from the expected outcome.

→ We have established some of the key concepts that are important in finance and banking and can now use these in specific applications to address specific problems.

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