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Risk Management

- Risk is an inherent part of investing into financial markets. While risks are considered when making investment decisions, there are often needs to actively manager risks beyond portfolio selection.
- Reasons for such additional risk management might be that either risks are not adequately taken into account in the portfolio selection theory, but most prominently there might be regulatory constraints that require a lower risk than is optimal.
- Investors will then have to develop strategies to take such constraints into account. This could be taken into account when making investment decisions, but including such constraints might make the decision-making overly complex; it is therefore often that risk management is conducted after the investment decision has been made and adjustments to the initial decision are then considered.
- We will consider here how such adjustments might be conducted.

Difficulties of risk management

- Investors are exposed to risks which can cause them significant losses
- Investors may want to address such risks by taking measures to reduce them
- Risk management is a complex process that requires a detailed assessment of the risks an investor is exposed to
- Knowledge of the assets invested in, their interactions, and the factors influencing their future prices are essential
- Abstracting from these requirements, we will explore some basic principles of risk management for investors

Difficulties of risk management

→ Risk management is an extensive and highly complex field where many different aspects of risk, return, and preferences of investors need to be considered, alongside any regulatory constraints.

- Investors will make investments that expose them to risk; while taking such risk might be optimal, it will nevertheless expose them to potentially large losses.
- If these, usually unlikely but if occurring large, losses are detrimental to the investor, he might want to address them separately, without making overall changes to his investments as the investments would be optimal for all but extreme situations.
- Overall the risk management process is complex and requires a detailed analysis of the risks investors are exposed to. Such risks are not always as obvious as the credit risk of a corporate bond (there is also interest rate risk) or the risks to the value of a derivative (there is also credit risk as the contracting partner might not able to fulfill their part of the derivative contract).
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  - Therefore to fully assess risks, investors must have knowledge not only of the assets they invest in,
  - but also how they interact. Covariances between assets are frequently used, but often interactions between assets are more complex.
  - Also information on factors that affect the assets' future prices are important as they might be different to those in the past.
- We will not look at these aspects here, but instead show some basic ideas for the management of risks by investors.

→ We will focus on the assessment and management of existing risks and then on the partial elimination of risks without the use of derivatives.

Managing and eliminating risks

- The aim of risk management can be to either limit the amount of risk that is taken or prevent losses
- Limiting the exposure to risk does not prevent unexpected losses from occurring
- To eliminate risks, derivatives have been developed, but they are not always available
- We will look at the a way investors can limit the risks they are taking, but still exposing them to larger losses, and for strategies in which large losses are eliminated

Managing and eliminating risks

→ We will here consider managing (reducing) existing risk, but also how they can be eliminated completely.

- It is common for risk management to have as its ultimate goal to ensure the risks taken do not exceed a certain threshold, that is losses are accumulating with a sufficiently low probability,
- or even to eliminate risks completely; thus losses (beyond a certain threshold) should not occur at all.

- Reducing the investment into risky assets reduces the risks, but unexpected losses can still occur and unless all investment is into risk-free assets, risks will be present and need to be managed.

- Derivatives have been initially developed to eliminate specific risks and they could be used by investors as part of their risk management.
- However, derivatives are readily available only for a small amount of assets, even for stocks, options and futures are available only on a selected number of stocks. Hedging strategies like $beta$-hedging with stock index futures are reducing risks, but cannot eliminate all risks.

- We will here look at ways investors can assess risks and then subsequently reduce the amount of risks they are taking. This nevertheless does not preclude large losses, it will only make them less likely.
- We will then also look at strategies where such large losses are then completely eliminated.

→ We will therefore look at strategies to reduce risks and to eliminate risks.

Value-at-Risk is widely used

- One of the most common risk measures used in banks is Value-at-Risk due to regulatory requirements
- Regulators favour expected shortfall, a closely related concept, to which the same principles can be applied
- Many investors have also adopted Value-at-Risk, or expected shortfall, as their risk management tool
- We will look into the way Value-at-Risk can be used to manage the exposure to risks, but it will not allow to eliminate them

Value-at-Risk is widely used

→ We will firstly introduce the a risk measure that has become widely used in banks and which can be used for risk management purposes better than the volatility of returns.

- Banks have used a risk measure called Value-at-Risk since the 1990s and it briefly afterwards was a required risk measure due to the regulation of capital requirements.
- Since then, a related conspect called expected shortfall has been favoured by regulators, which is in many ways similar to Value-at-Risk, but reduces some of the shortcomings of Value-at-Risk.
- Although Value-at-Risk, and since expected shortfall, is required only by banks for their activities, it has become popular to apply in investment management as well due to its intuitive meaning. Regulatory requirements made the use of Value-at-Risk in proprietary trading of investment banks widely used.
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  - We will look at what Value-at-Risk is and how it can be used to reduce the risks taken by investors.
  - It is important to notice that using Value-at-Risk on its own cannot be used to eliminate risks, they are only reduced.

→ We will now introduce Value-at-Risk as an alternative to the use of volatility of variance as a risk measure.


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Value-at-risk
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→ We will only cover the basic idea of Value-at-Risk and its use in risk management, but do not discuss aspects like estimating it or testing the reliability of this risk measure.

Managing risks with Value-at-Risk

- Value-at-Risk focusses on potential losses and allows investors to limit the likelihood of making large losses, but such losses can still occur
- Using Value-at-Risk can give guidance on how to adjust a portfolio of assets to reduce the risks that are taken

? If you observe a loss that exceeds your Value-at-Risk, does this mean your Value-at-Risk estimate is wrong?

! Losses larger than the Value-at-Risk occur a fraction c of times and it is therefore expected that losses larger than the Value-at-Risk are observed; not observing such losses would indicate that the estimate is too high

Managing risks with Value-at-Risk

→ We have seen that Value-at-Risk can be used as an intuitive risk measure that is easily understood and can therefore much easier be used to inform investment decisions.

- value-at-Risk focusses only on the losses of investors and, unlike volatility, does not take into account any losses.
  - When using Value-at-Risk investors estimate and subsequently manage the likelihood of making losses exceeding the threshold loss,
  - It is important to note that such losses can nevertheless occur and risk management does not eliminate this possibility.
- The benefits of Value-at-Risk are that it can provide some guidance how to adjust an existing portfolio such that the risks are lower. How much risk is eliminated can be understood intuitively and it gives clear information on how the weights of assets in a portfolio should be changed to achieve a given reduction in risk.
- [?] Suppose you observe a loss that is larger than the Value-at-Risk which you have determined. As Value-at-Risk is an estimate, does this then mean that your estimate is wrong?
- [!] We would expect a fraction c of losses to be larger than the Value-at-Risk, that is how it was defined; it would indicate the the Value-at-Risk was wrong if over time no losses are observed that exceed the Value-at-Risk.

→ value-at-Risk does not allow risks to be eliminated, but only to be reduced. If we wanted to eliminate risks, we would have to use a different investment strategy.

Eliminating risks without derivatives

- Hedging with derivatives is a common way to eliminate risks, but for many investors such derivatives do not exist
- Derivatives are not readily available for small stocks, emerging markets, and most alternative investments
- Investors can still obtain protection from losses through portfolio insurance
- In portfolio insurance investments are conducted in a specific way to eliminate risks

Eliminating risks without derivatives

→ We will now consider an investment stratey that aloows us to eliminate risk, but does not involve the use of derivatives.

- Derivatives have been developed to eliminate risk for an investor and as such they could be used for this purpose.
- Most assets, however, have no derivatives that are available for them and for most investors it is not feasible to agree an Over-the-Counter agreement with a bank or other institutional investor to create such a derivative, either for lack of demand or the lack of size to make its development not cost-effective. Similarly, replicating a derivative by the investor using the derivatives pricing formulae might also not be cost-effective, either because of transaction costs or regulatory constraints on investments or short sales.

- We will have no derivatives for any but the largest stock in the major stock exchanges,
- derivatives for stock in emerging markets are rarely available,
- and most alternative investments also have no derivatives traded, for example real estate.

- In the absence of derivatives, we will look at an investment strategy that is called 'portfolio insurance'.
- Portfolio insurance develop an investment strategy that ensures losses beyond a pre-specified level cannot occur and thus risks beyond this level are eliminated.

→ We will look at one of these portolio insurance strategies, Constant Proportion Portfolio Insurance.


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→ In order for portfolio insurance to eliminate risk, we need to make an additional assumption on the maximal losses that can be incurred when investing into risky assets, which does therefore eliminate risks only if this condition is met.

Risk elimination through limited investment into risky assets

- Constant Proportion Portfolio Insurance is one way investors can eliminate risks, it allows investors to avoid losses beyond a set limit
- Investors adjust the amount of risky assets held constantly to ensure that any losses they may incur still allow the minimum value to be reached

? Using Constant Proportion Portfolio Insurance will eliminate any risk and the value of the investment in the future is known, is this correct?

! Constant Proportion Portfolio Insurance limits the losses, but there remains an uncertainty about how much the investment is worth at the end of the time horizon; there will still be volatility in the final value

Risk elimination through limited investment into risky assets

→ We have considered a specific portfolio insurance, Constant Proportion Portfolio Insurance to eliminate losses.

- We have seen that, provided the assumption on the maximal losses an investor incurs on risky assets is fulfilled, risks can be eliminated.
- We found that losses beyond a certain threshold can be ruled out, thus not all losses are eliminated and some risk is retained (unless we set the threshold at the benchmark for a loss). While some risk remains, having eliminated losses here referred to a situation in which larger losses can be ruled out.

- CPPI works by adjusting the amount of risky assets they are holding such that even in a worst-case scenario the portfolio will obtain its minimum value at the end of the time horizon.
- [?] As we have claimed that we eliminated all risks, does this then mean that we know the value of the portfolio at the end of our time horizon?
- [!] CPPI eliminates any larger losses, the outcome above this threshold loss remains uncertain and is not known. Thus here we focus on risk as loss, ignoring any profits.

→ Portfolio insurance is a tool to limit losses from risky investments without the need to use derivatives.

Summary of key results

- Measuring risk can allow investors to use their results to manage these risks, but losses beyond what is expected can nevertheless be observed
- Risk management is not primarily about eliminating risks, but about determining risk levels that are consistent with the risk-preferences of investors
- There are investment strategies, beyond the use of derivatives, that allow investors to limit any losses they make
- Such portfolio insurance will require specific investment strategies to be followed and these might not be suitable for all investors

Summary of key results

→ We can now summarize some of the key ideas developed here.

- In order to manage risks, it is essential to first now what risks an investor is exposed to and then this measurement can be used to manage risks.
- However, it is important to realise, that despite reducing risks, large losses in many cases can still occur.

- The main focus of risk management is not to eliminate risks, thus conducting hedging or other investment strategies like portfolio insurance that have a similar effect.
- The main goal of risk management is to assess the current risk level and then determine the optimal risk level for the investor and find ways to adjust the risks accordingly.

- Portfolio insurance was a way to go beyond managing risks by eliminating them without the use of derivatives and avoid large losses completely. using such strategies, apart from regulatory requirements, will usually be the result of a risk assessment and it was found that portfolio is the only way the preferences of investors with respect to risks can be met.

- Depending on the specific assumptions, there are investment strategies that need to be followed to achieve the elimination of risk.
- Such investment strategies might not always be suitable and possible for all investors; this might again be due to regulatory constraints or other preferences.

→ Thus risk management is a complex task with many aspects to consider and we have only been able to look at some of the very basic concepts here.

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