Andreas Krause

Performance evaluation

Outline

- Exploiting market inefficiencies
- Sharpe ratio
- Jensen's α
- Portfolio return decomposition
- Summary

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- Investors seek to exploit their perceived informational advantage over other investors and make a profits from this information.
- While they might generate returns that are higher than other investments, this return needs to put into context of the risk the investor is taking.
- As a higher risk implies that higher returns should be achieved to compensate for this additional risk, we need to consider the risks investors are taking.
- We will here see how the performance of investors can be measured and the performance can be assessed against relevant benchmarks.

- We will look art the two most common performance measures, the Sharpe ratio and Jensen's α, but then also look at ways to decompose portfolio returns into different component to give a more comprehensive view of the performance of investors, taking elements of both performance measures into account.

- Exploiting market inefficiencies
- Sharpe ratio
- Jensen's α
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- We can now briefly outline the way investors seek to exploit any market inefficiencies and point out the different risks they are taking.

Trading on information

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- → Information is obtained with the aim of using it in order to make profits from trading.
- ▶
  - Investors might have obtained information which they seek to trade on to make profits.
  - This implies that they belief that this information is not yet included into the price and hence markets are inefficient.
- ▶ If the information suggests that the future price will be higher than the current price the investor would buy the asset. If we assume that the market will be efficient in the future, the future price will equal the value of the asset and hence we often talk of 'undervalued' assets.
- ▶ If the information suggests that the future price will be lower than the current price the investor would sell the asset. If we assume that the market will be efficient in the future, the future price will equal the value of the asset and hence we often talk of 'overvalued' assets.
- → Hence in order for an investor to belief he can make profits, he must belief that the market is inefficient and the information he has received is not included into the price yet, but that it will be included into the price in the future. If the information were never included into the price, ithe price woiuld not move and there are profits the investor could make.

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- The consequence of trading on information is that the return on investment will change compared to the investor not trading.
- Another consequence of trading on information is that the portfolio the investor holds will deviate from his long-term optimal portfolio.
- This will also mean that the risks of the portfolio the investor holds will change. We have to take into account the different risk such a portfolio is exposed to and how this affects the utility derived from it/.

→ We thus cannot rely only on returns to assess the performance of an investor, but have to consider the risks as well.

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Risk types

Risk types

- → Depending on the context of our assessment of the investor's performance, different types of risks are relevant and need to be considered.
- The first type of risk is systematic risk, which is the risk arising from the co-movement with the market (the β-risk from the Capital Asset Pricing Model) and which cannot be diversified.
- The other risk is the unsystematic or idiosyncratic risk, which is the risk relevant only to a single asset; this risk can be diversified. The total risk of a portfolio will consist of the combinations of all the systematic and unsystematic risks. The total risk of a single asset is the combination of systematic and unsystematic risk.
- A good performance measure will take into the risks the investor is taking and the performance measures will adjust returns accordingly.
- How such adjustments are made will depend on the risks we have to consider. And which risks are relevant will in turn depend on the objectives and concerns of the person assessing the performance, which do not necessarily coincide with that of the investor.
- → We will now consider two of the most common such performance measures. Although many other performance measures have been developed, often for use in specific contexts, these are the most widely used measures and illustrate the idea of adjusting returns for risk.

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- **Sharpe ratio**
- Jensen's α
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- We first consider the Sharpe ratio, which uses the total risk of an asset or portfolio as the relevant risk for adjusting the return.
- Using the Sharpe ratio allows us to compare the performance of two portfolios, such as a benchmark portfolio.

Considering total risk

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→ We consider the total risk of a portfolio as the relevant risk, thus we use the combination of systematic and unsystematic risk.

- If we are concerned about the total risk of a portfolio, we can use the variance of the return on the portfolio as our risk measure.
- Portfolio theory tells us that investment decisions are based on the expected return and the variance of this return, in addition to the covariances in a portfolio. If we only consider a portfolio and interpret this as a single asset, covariances can be ignored. The actually realised return of a given period of time can then be used to estimate the expected return and variance.
- The idea of the Sharpe ratio is to assess the risk-return relationship using portfolio theory.

→ We will see how the Sharpe ratio relates to portfolio theory

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Portfolio selection

- → We now briefly recap the basics of portfolio theory, which then allows us to derive the performance measure.
- We consider decisions using the mean (expected return) and the risk (standard deviation).
- We then know that the efficient frontier, that is the collection of all portfolios that cannot be ranked without use of more then the assumption of risk aversion, is this hyperbolic curve.
- If we now introduce a risk-free asset, which we know gives us the straight security market line, which is tangential to the efficient frontier and crosses the vertical axis at the risk-free rate.
- The tangential point is the location of the Optimal Risky Portfolio (ORP), representing the portfolio of risky assets that all risk-averse investors hold, as long as they agree on the mean, variances, and covariances of the assets in the portfolio. This portfolio is independent of the specifics of the preferences, we only need investors to be risk-averse.
- With a higher mean increasing the utility of investors, but a higher risk reducing the utility, the indifference curve will be positively sloped.
- The optimal portfolio (OP) will then the a combination of the ORP and the risk-free asset and it is located where the indifference curve is tangential to the security market line.
- Let us now consider a portfolio that is located above the security market line; it will have a higher return and/or a lower risk than the OP.
- We can draw a straight line, similar to the security market line through this portfolio. This line will have a higher slope than the security market line.
- We can now find the indifference curve at this portfolio. We see that the indifference curve is to the upper left of the indifference curve giving us the OP. This implies a higher utility level.
- Let us now consider a portfolio that is located below the security market line; it will have a lower return and/or a higher risk than the OP.
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- We can now find the indifference curve at this portfolio. We see that the indifference curve is to the lower right of the indifference curve giving us the OP. This implies a lower utility level.
- → We can now develop a performance measure based on the slope of this straight like through the portfolio. We have seen that a higher slope corresponds to a higher utility level, which indicates a better performance.

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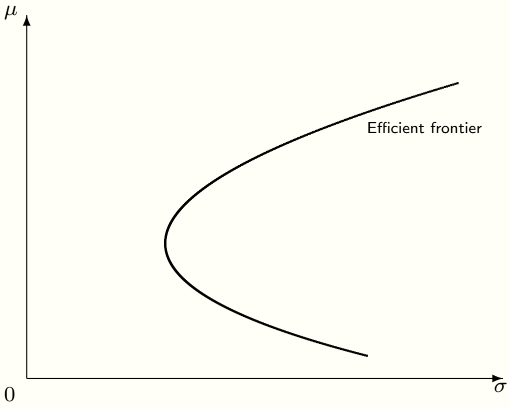

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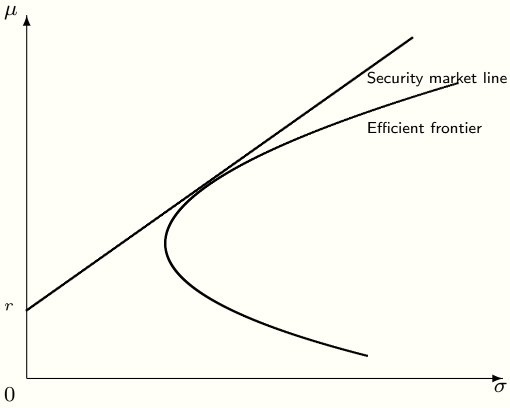

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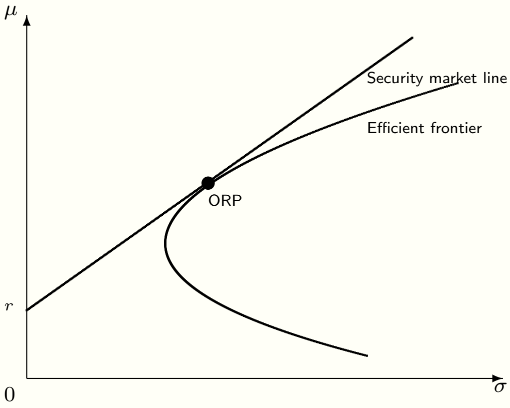

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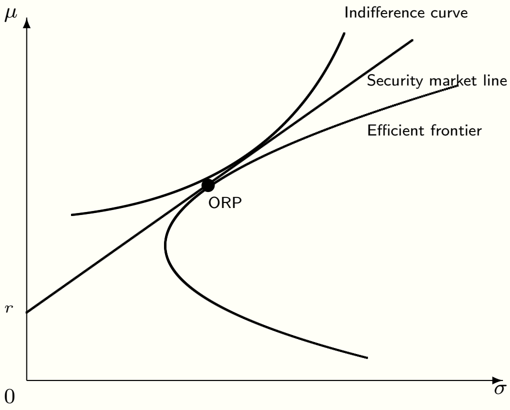

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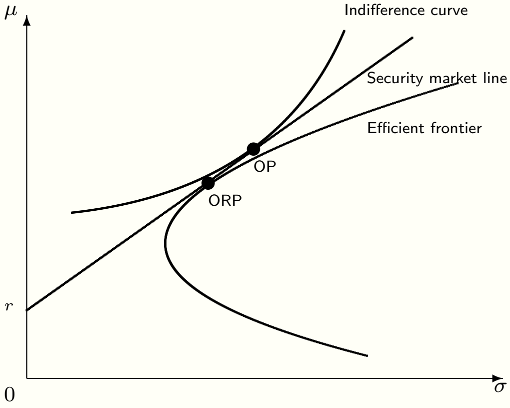

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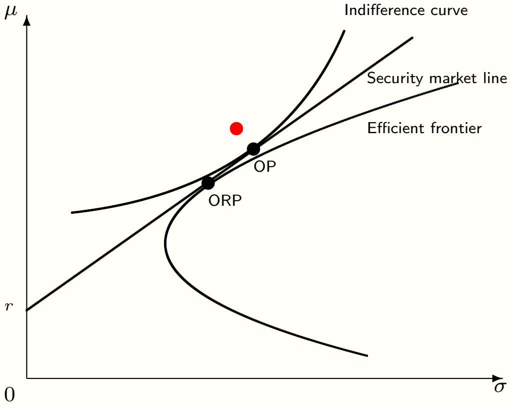

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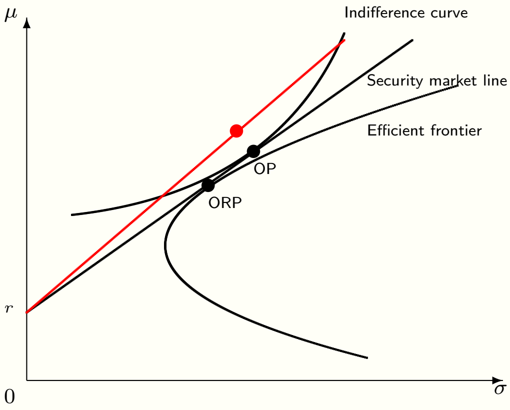

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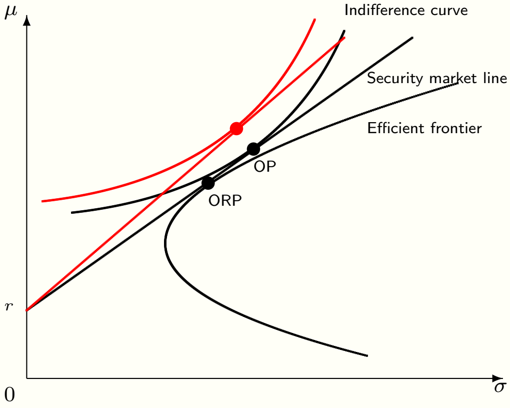

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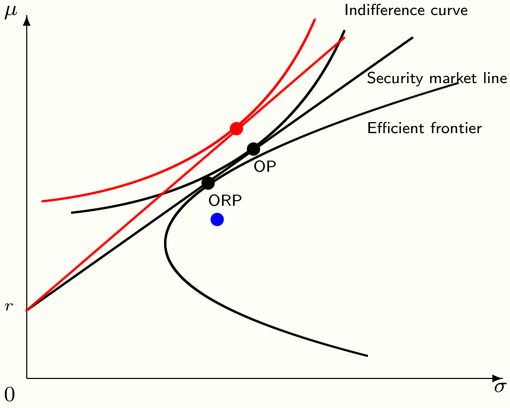

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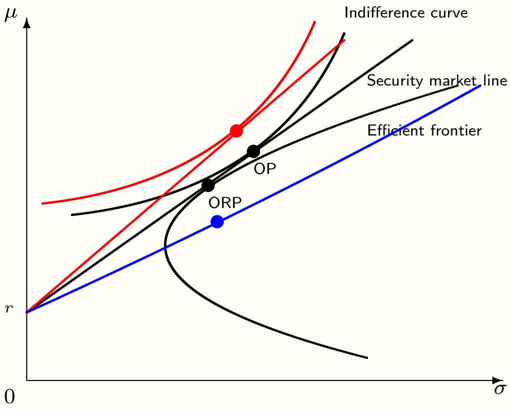

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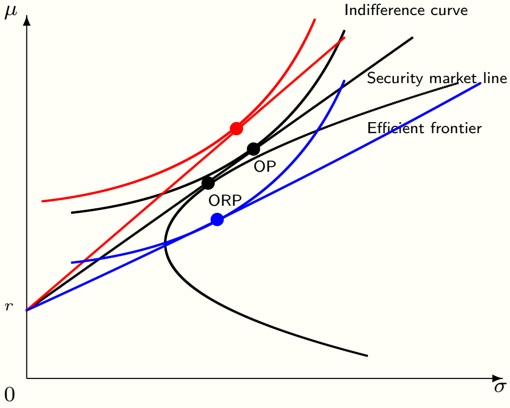

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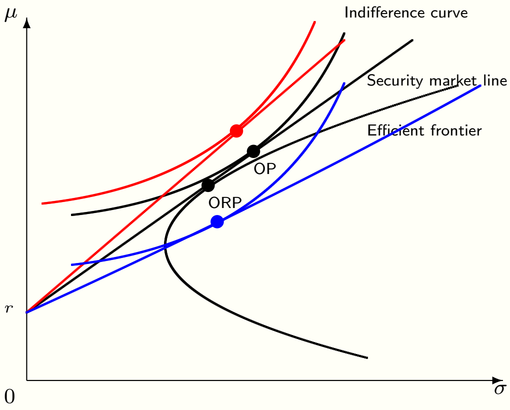

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Slope as performance measure

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→ Using the intuition of exploiting the slope as an indicator which portfolio is referred, we can now proceed to define this slope more formally as a performance measure.

- We have seen that a higher slope of the line from the risk-free asset to the portfolio corresponds to a higher utility level
- We therefore use this slope as out performance measure, a higher value will indicate a higher performance.
- The length of the vertical direction is the difference between the expected return of the portfolio, μ_i and the risk-free rate, r. This is often referred to as the excess return the investor generates over the risk-free rate.
- The length of the horizontal direction is the risk (standard deviation) of the portfolio, given that the risk of the risk-free asset is nil.
- *Formula*
- The Sharpe ratio is simply the excess return divided by the standard deviation.

→ The Sharpe ratio itself is not meaningful, it always needs to be compared with another portfolio; this might be a benchmark portfolio for the investors, such as the market portfolio. As we use the standard deviation of returns, the risks considered are the total risks of both portfolios.

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- We use the slope as a performance measure
- The vertical direction gives the excess return of the investor over the risk-free rate

- $SR_i = \frac{\mu_i - r}{}$

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→ The Sharpe ratio itself is not meaningful, it always needs to be compared with another portfolio; this might be a benchmark portfolio for the investors, such as the market portfolio. As we use the standard deviation of returns, the risks considered are the total risks of both portfolios.

Slope as performance measure

- A higher slope corresponds to a higher utility level
- We use the slope as a performance measure
- The vertical direction gives the excess return of the investor over the risk-free rate
- The horizontal direction represents the risk
- $SR_i = \frac{\mu_i - r}{\sigma_i}$

→ Using the intuition of exploiting the slope as an indicator which portfolio is referred, we can now proceed to define this slope more formally as a performance measure.

- We have seen that a higher slope of the line from the risk-free asset to the portfolio corresponds to a higher utility level
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- Exploiting market inefficiencies
- Sharpe ratio
- Jensen's α
- Portfolio return decomposition
- Summary

- We can now look at an alternative performance measure that takes into account only systematic risk.

Using asset pricing benchmark

Using asset pricing benchmark

→ We will consider the reasons for focussing on systematic risk first.

- An investor who holds a well-diversified portfolio will have diversified away unsystematic risk and will therefore not be much concerned about such risk. This might not be the case for the investor directly, but, for example, for a client is the investor is an asset manager; even if the portfolio itself is not well-diversified, the client might be through holding other investments besides those considered here. In this case they would want to use a performance measure that excludes unsystematic risk as they are not concerned about it.
- If we exclude unsystematic risk, we only have to be concerned about systematic risk.
- With the Capital Asset Pricing Model serving as a benchmark for the return that should be generated for a given level of systematic risk, we can compare the return of the portfolio with that implied by the CAPM.

→ We can now develop a performance measure intuitively based on these ideas.

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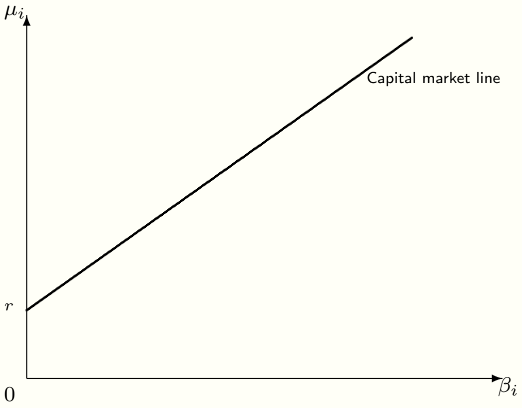

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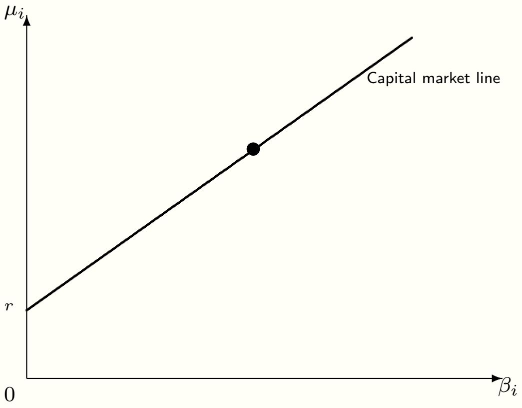

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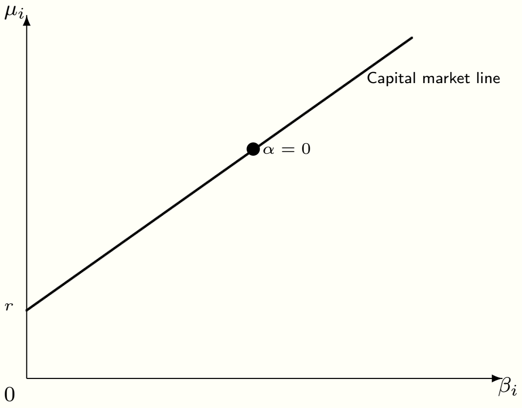

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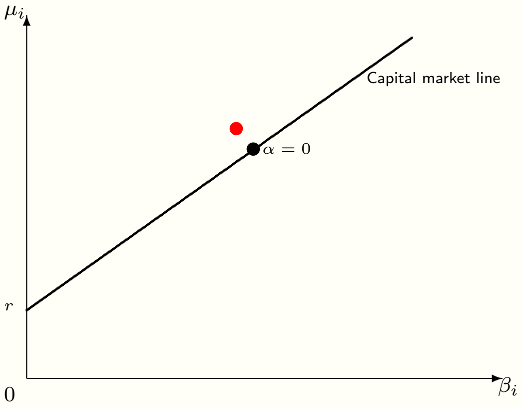

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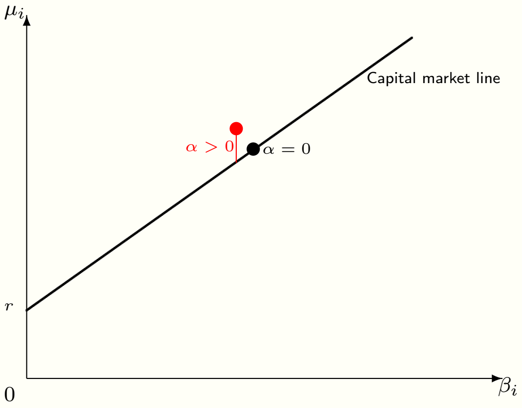

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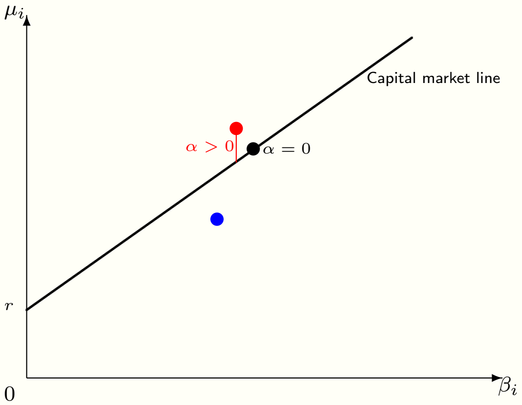

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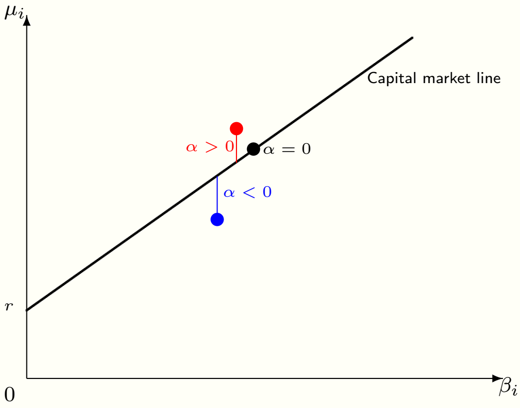

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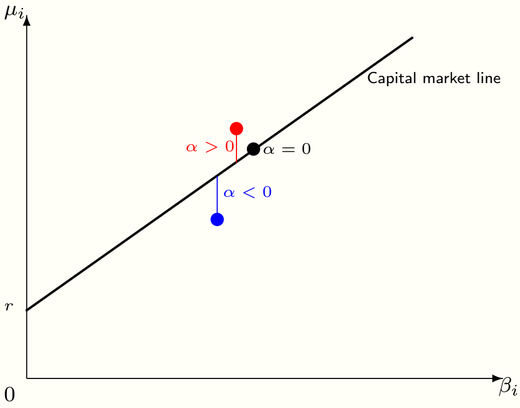

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→ Using the intuition of using the difference between the return and its CAPM benchmark, we can now define this performance measure more formally.

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  - The CAPM gives us the return an asset, or any portfolio, should achieve over and above the risk-free rate.
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  - This performance measure, known as Jensen's α uses the return of the portfolio, adjusted with an expression including β_i, which represents the systematic risk of the portfolio. Hence the return is adjusted only for systematic risk.
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Differences in returns

- The CAPM gives the excess return of an asset as the excess return of the market, adjusted for systematic risk
- $\hat{\mu}_i - r = \beta_i \left(\mu_M - r\right)$
- The performance measure is the difference of the actual return and the return implied by the CAPM
- $\alpha = \mu_i - \hat{\mu}_i$

Differences in returns

→ Using the intuition of using the difference between the return and its CAPM benchmark, we can now define this performance measure more formally.

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  - The CAPM gives us the return an asset, or any portfolio, should achieve over and above the risk-free rate.
  - This excess return of the asset or portfolio is determined by the excess return of the market portfolio,
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- Exploiting market inefficiencies
- Sharpe ratio
- Jensen's α
- **Portfolio return decomposition**
- Summary

- We will now address the lack of concern for unsystematic risk when using Jensen's α.
- Ignoring unsystematic risk can give incentives to portfolio managers to choose portfolios that have low systematic risk, but high unsystematic risk, as long as such risk is rewarded in the market through a higher return. This would imply that the CAPM does not hold.

Adjusting performance for idiosyncratic risk

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→ We seek to make an adjustment to Jensen's α that takes into account unsystematic (idiosyncratic) risk.

- - We have seen that the Sharpe ratio takes into account unsystematic and systematic risk,
  - and Jensen's α only takes into account systematic risk.
- The benefit of using Jensen's α is that it is more intuitively interpreted as the additional return the portfolio generates, while the Sharpe ratio is a slope which lacks any direct interpretation. However, when using Jensen's α, we cannot consider unsystematic risk, which in some portfolios can be substantial. This might be particularly the case if we were to assess the strategy of using information on an individual asset; in this case unsystematic risk is not diversified at all.
- Let us assume that actual returns follow the CAPM perfectly, thus the actual return (and not only the expected return) will be determined by the actual return of the market (rather than only its expected value) in line with the CAPM equation.

⇒ We can now take the variance of the returns of the portfolio. Taking into account that the risk-free rate is constant, the variance will depend on the variance of the market and $beta_i$ of the portfolio.

- The variance, or standard deviation, was used as a measure of the total risk of the portfolio. If we know the total risk of the portfolio (standard deviation), we can determine the amount of systematic risk that would generate the same amount of risk. by solving for β_i. A portfolio with systematic risk β_i^* has the same amount of systematic risk as the total risk of a portfolio with standard deviation σ_i.

→ We can now intuitively determine an adjustment to Jensen's α that takes unsystematic risk into account.

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Determining net selectivity

Determining net selectivity

→ We will now take into account the unsystematic risk in a portfolio and adjust Jensen's α accordingly.

- We consider the expected return (μ_i) and the systematic risk β_i of a portfolio.
- The CAPM gives us the market line as a straight line crossing the vertical axis at the risk-free rate.
- We consider some portfolio with given characteristics.
- We can determine the return and systematic risk.
- Given the systematic risk, we can determine the benchmark return using the CAPM.
- We can now divide the total return in three components. The first component represents compensation for giving up liquidity by making the investment. This is often referred to as 'time value' and would accrue from investing into a risk-free asset.
- The return to the benchmark return is now the compensation for the portfolio being exposed to systematic risk.
- The final element is now the additional value added by from managing the portfolio, usually attributed to selecting investment profitably and is referred to as 'selectivity'. This is exactly Jensen's α.
- We now take into account the unsystematic risk and determine the equivalent amount of systematic risk required such that it would be equal to the total risk of the portfolio. Note that this value is always higher than the actual systematic risk as unsystematic risk cannot be negative.
- We can use the CAPM again to determine the return that is required in a portfolio that exhibits this amount of systematic risk.
- We can now attribute the difference between the two CAPM benchmarks as the compensation for risks the portfolio incurs by not diversifying fully; equivalent this part of the return would not be incurred if the portfolio was properly diversified.
- The performance measure is here called 'net selectivity' and represents the return made in excess of the return required from taking the equivalent systematic risk.

→ Note that even if selectivity positive, net selectivity may be negative; net selectivity is always lower than selectivity as the equivalent systemic risk is always higher than the actual systemic risk.

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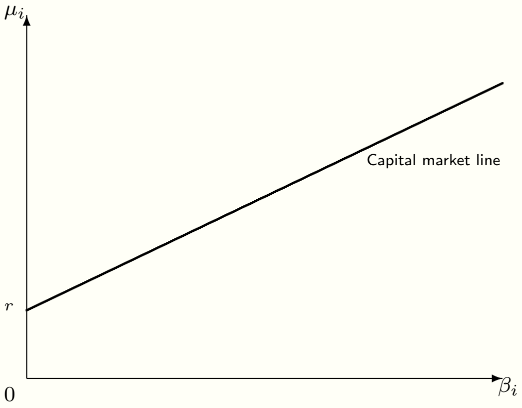

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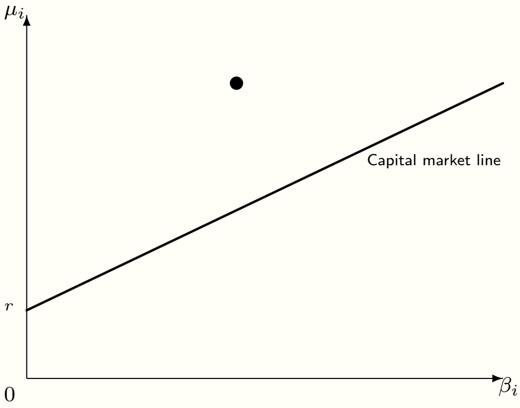

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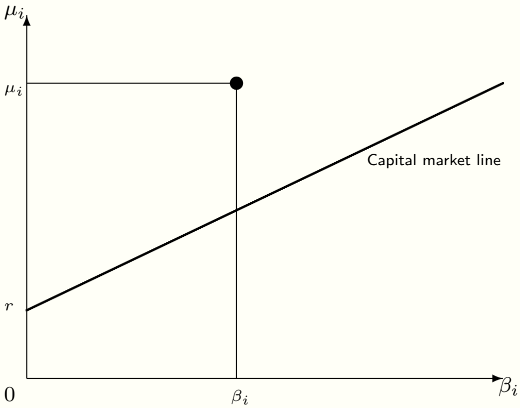

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- We now take into account the unsystematic risk and determine the equivalent amount of systematic risk required such that it would be equal to the total risk of the portfolio. Note that this value is always higher than the actual systematic risk as unsystematic risk cannot be negative.
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- The performance measure is here called 'net selectivity' and represents the return made in excess of the return required from taking the equivalent systematic risk.
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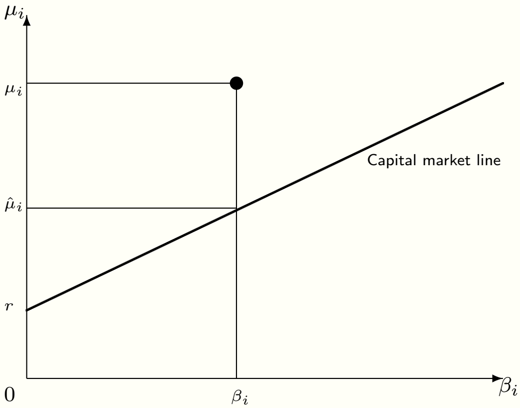

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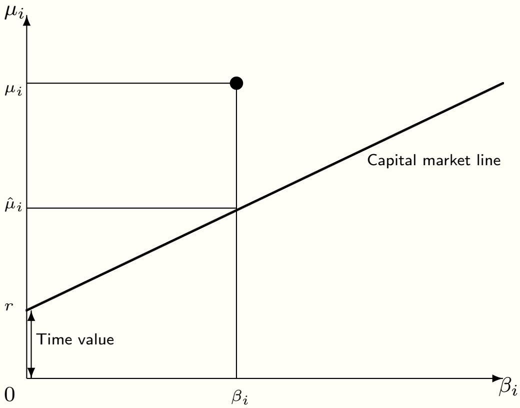

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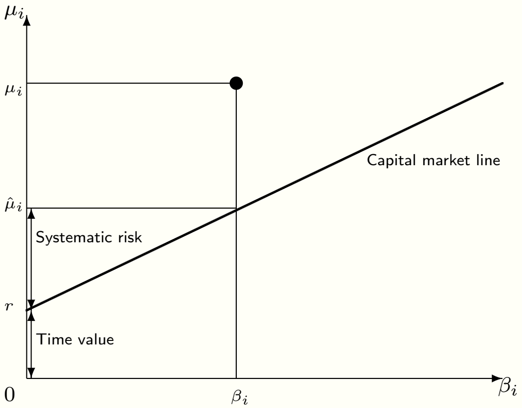

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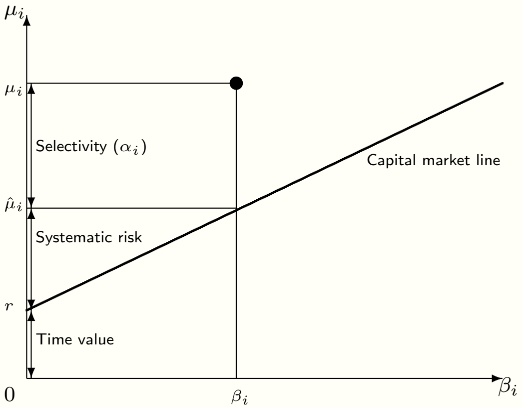

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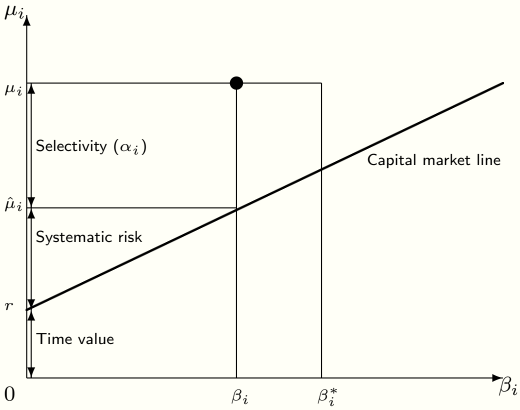

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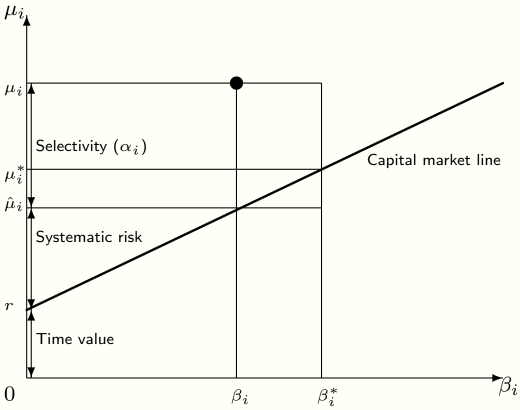

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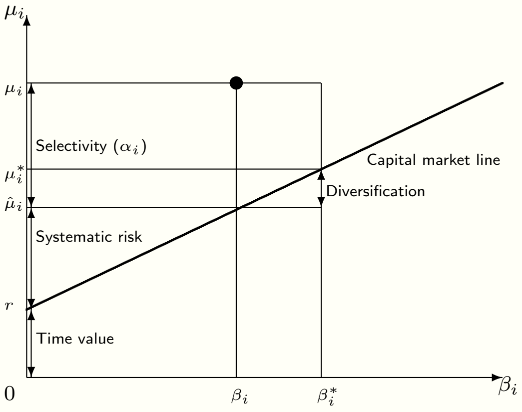

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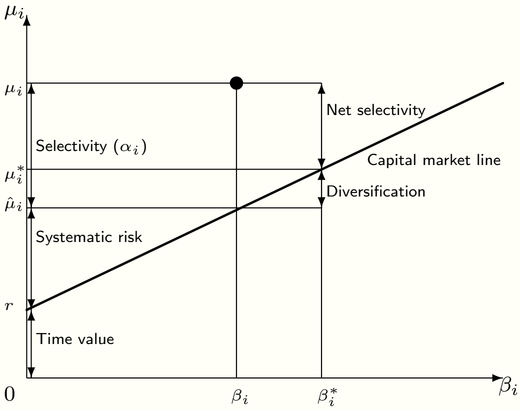

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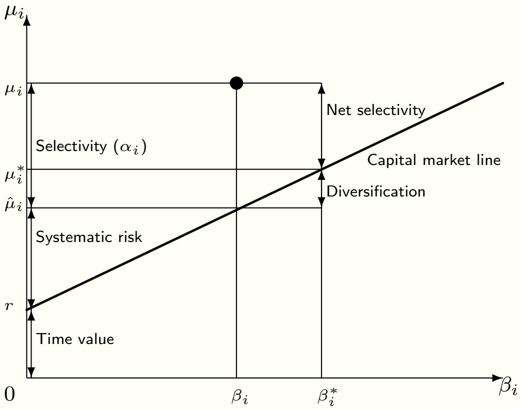

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- What in this context is termed selectivity is identical to Jensen's α. We will now adjust this value to take into account the unsystematic risk incurred in the portfolio.
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  - A portfolio that is not fully diversified will be exposed to unsystematic (idiosyncratic) risk.
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- We can now summarise the key ideas about the performance evaluation of portfolios.

Importance of risk adjustments

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→ Investors might have additional information and if the market is not fully efficient, they will seek to exploit their knowledge by trading on the information they hold. As information is not perfect, investors are exposed to risks and when determining whether the information was used effectively, the risks have to be taken into account.

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Choice of performance measure

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→ The choice of an appropriate risk measure can affect the assessment of the performance, thus it is important to be aware of the type of risks the different risk measures include and how the performance is determined.

- Using different risk measures can give different results in the performance assessment. It might be that portfolio A is performing better than portfolio B using one performance measure, but will perform worse when using another performance measure.
- Let us assume we have portfolio A which generates a high Jensen's α as the investors makes use of the information he holds, while the original portfolio B generates a much lower Jensen's α.
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    - However, portfolio A might have a high unsystematic risk as a result of the portfolio becoming much less well diversified as the investor sought to trade on his information.
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- We need to select the performance measure accordingly and take into account which risks have to be considered in the performance assessment.

→ There is no general answer to which risk should be considered as it depends on the specific circumstances of the evaluator. The risks considered have to be those that are relevant to the person making (or receiving) the performance evaluation.

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