Andreas Krause

# Arbitrage Pricing Theory

- The Capital Asset Pricing Model (CAPM) is not the only model of determining expected returns.
- The CAPM is often criticised for only considering systematic risk with respect to the market as the driver of expected asset returns.
- We will therefore here look at a model in which a number of factors influencing asset returns are considered.

# Determinants of asset returns

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→ We will now look what factors might drive the returns of assets.

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  - The possible factor affecting assets returns are numerous, but they include inflation. Higher inflation might increase the (nominal) return of assets; for example stocks might increase their returns if the company is able to maintain real profits through price increases. On the other hand, bonds might reduce in value as higher inflation usually is followed by higher interest rates (the risk-free rate), which are the basis of the discounting and future value.
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# Linear dependence on factors

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→ How various factors influence asset returns can take many different forms. We will focus here on the most simple possible dependence, a linear relationship.

- We assume now we have identified a number of factors that can affect asset returns
- and we combine the influence of these factors in a linear way

- *Formula*
- 
  - Firstly, we can consider the risk-free asset, which is not affected by any of the possible factors considered, thus $\beta_{ik} = 0$.
  - The return of this asset is then the risk-free rate.
- [⇒] *Formula*

→ We can now continue considering special cases and make use of the result that $\beta_i 0 = r$.

# Linear dependence on factors

- We now assume that each factor has an influence on the expected asset return
- $\mu_i = \beta_{i0} \qquad \beta_{ik} F_k$

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- Consider an asset that is not affected by any of the factors

$\Rightarrow \mu_i = \beta_{i0}$

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- The return of this asset is then the risk-free rate.

▶ [⇒] *Formula*

→ We can now continue considering special cases and make use of the result that $\beta_i 0 = r$.

# Deriving the APT equation

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- This asset is as close to the factor itself as it can be, it essentially is the factor.
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→ When estimating the coefficients $\beta_{ik}$ this can be interpreted as a multivariate linear regression and the coefficients will be the ration of the covariance of the asset with the factor portfolio, divided by the variance of the factor portfolio. This is the same structure as the $\beta_i$ in the CAPM, it represents the covariance risk with respect to the factor portfolio.

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# Factor portfolios

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→ A problem in practical applications of Arbitrage Pricing Theory is the determination of the expected return of the asset that mimics the factor, $\mu_k$. The factor itself cannot be used for this purpose as it has no asset return.

- We have to create an asset that has the desired property, only being affected by the factor. This would be a portfolio of assets that are specifically put together to have these properties and we can then determine the return on this portfolio.
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  - In reality obtaining such a pure portfolio is difficult; the portfolio needs to be well diversified to have no systematic risk.
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  - In addition to determining the appropriate portfolio, identifying the factors itself can also be difficult.
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→ While there are some practical problems when implementing APT, it is possible to use statistical methods to obtain a good approximation of the factor portfolios and then use these to determine asset returns.

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# CAPM vs. APT

# CAPM vs. APT

→ The Capital Asset Pricing Model and Arbitrage Pricing Theory are the most widely used models to determine the returns of individual stocks, where the CAPM is by far the more dominant models that is used. We will now compare these two models to see what relationship they have with each other.

- We will argue that the CAPM is nothing more than a special case of the APT.
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  - We will consider a case where we only identify a single factor.
  - This factor is the market.
- [⇒] Using the expected the APT in this case gives this *formula*.
- In this case the factor portfolio will be the market portfolio and can be more readily identified than most other factor portfolios.

→ We thus see that the CAPM is a special case of a one-factor APT. Given the difficulties in identifying factors and then determining the factor portfolios to determine the expected returns, APT is not a widely used approach in determining assets returns. It is often, however, that the factors are directly applied to the asset return; this is not consistent with the APT as no expected returns of this factor are determined.

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  - This factor is the market.
- [⇒] Using the expected the APT in this case gives this *formula*.
- In this case the factor portfolio will be the market portfolio and can be more readily identified than most other factor portfolios.

→ We thus see that the CAPM is a special case of a one-factor APT. Given the difficulties in identifying factors and then determining the factor portfolios to determine the expected returns, APT is not a widely used approach in determining assets returns. It is often, however, that the factors are directly applied to the asset return; this is not consistent with the APT as no expected returns of this factor are determined.



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