Andreas Krause

Asset pricing

- We will look at the two most prominent theories of asset pricing, the Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT).
- Especially the CAPM is the cornerstone of modern finance and universally used in finance as well as other fields of economics.

Assets pricing and valuation

Assets pricing and valuation

→ The topic is called asset pricing, so it is reasonable to assume that we will discuss theories about the valuation of assets, but this is not the case.
- Rather than discussing the value of assets directly, asset pricing is concerned about the expected return of these assets.
- Valuation models are then taking these expected returns as given and with additional factors, such as dividends for stocks, obtain the value of the asset.
- This topic will therefore focus on determining what the returns on assets should be.

→

Assets pricing and valuation

- Asset pricing is mainly concerned with determining appropriate expected returns for assets

Assets pricing and valuation

→ The topic is called asset pricing, so it is reasonable to assume that we will discuss theories about the valuation of assets, but this is not the case.
- Rather than discussing the value of assets directly, asset pricing is concerned about the expected return of these assets.
- Valuation models are then taking these expected returns as given and with additional factors, such as dividends for stocks, obtain the value of the asset.
- This topic will therefore focus on determining what the returns on assets should be.

→

Assets pricing and valuation

- Asset pricing is mainly concerned with determining appropriate expected returns for assets
- How such expected returns are then translated into actual prices is subject of valuation models

Assets pricing and valuation

→ The topic is called asset pricing, so it is reasonable to assume that we will discuss theories about the valuation of assets, but this is not the case.
- Rather than discussing the value of assets directly, asset pricing is concerned about the expected return of these assets.
- Valuation models are then taking these expected returns as given and with additional factors, such as dividends for stocks, obtain the value of the asset.
- This topic will therefore focus on determining what the returns on assets should be.

→

Assets pricing and valuation

- Asset pricing is mainly concerned with determining appropriate expected returns for assets
- How such expected returns are then translated into actual prices is subject of valuation models
- In this topic we will therefore focus on the determinants of expected asset returns

Assets pricing and valuation

→ The topic is called asset pricing, so it is reasonable to assume that we will discuss theories about the valuation of assets, but this is not the case.
- Rather than discussing the value of assets directly, asset pricing is concerned about the expected return of these assets.
- Valuation models are then taking these expected returns as given and with additional factors, such as dividends for stocks, obtain the value of the asset.
- This topic will therefore focus on determining what the returns on assets should be.

→

Assets pricing and valuation

- Asset pricing is mainly concerned with determining appropriate expected returns for assets
- How such expected returns are then translated into actual prices is subject of valuation models
- In this topic we will therefore focus on the determinants of expected asset returns

Assets pricing and valuation

→ The topic is called asset pricing, so it is reasonable to assume that we will discuss theories about the valuation of assets, but this is not the case.
- Rather than discussing the value of assets directly, asset pricing is concerned about the expected return of these assets.
- Valuation models are then taking these expected returns as given and with additional factors, such as dividends for stocks, obtain the value of the asset.
- This topic will therefore focus on determining what the returns on assets should be.

→

The importance of asset pricing

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

▶
- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

▶
- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

▶
- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

▶
- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

▶
- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

▶
- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

▶
- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

▶
- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models and therefore the investment decisions of individuals

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models and therefore the investment decisions of individuals
- Most models of asset pricing take the risks of assets as given

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

▶
- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

▶
- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

▶
- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

▶
- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models and therefore the investment decisions of individuals
- Most models of asset pricing take the risks of assets as given and based on these risks determine the expected returns

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

▶
- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

▶
- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

▶
- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

▶
- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models and therefore the investment decisions of individuals
- Most models of asset pricing take the risks of assets as given and based on these risks determine the expected returns
- Asset pricing forms the basis of the valuation of assets

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models and therefore the investment decisions of individuals
- Most models of asset pricing take the risks of assets as given and based on these risks determine the expected returns
- Asset pricing forms the basis of the valuation of assets, but also affects investment decisions by companies

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

The importance of asset pricing

- A large number of asset pricing models have been developed, some based on theoretical considerations, others based on empirical evidence, especially in the stock market
- Expected returns are a key ingredient into portfolio selection models and therefore the investment decisions of individuals
- Most models of asset pricing take the risks of assets as given and based on these risks determine the expected returns
- Asset pricing forms the basis of the valuation of assets, but also affects investment decisions by companies

The importance of asset pricing

→ Asset pricing is one of the most important area in finance. A large amount of effort is spent by traders, banks, insurance companies, and other market participants on determining appropriate asset pricing models.

▶
- Many asset pricing models have been developed over time, many based on theoretical considerations of what and how asset returns should be affected.
- Other approaches have taken a more empirical approach and sought to determine what actually affects asset returns and then have developed a rationale for their findings.
- Most asset pricing models have been developed for stocks, with other asset classes gaining much less attention. Some attention has been paid to real estate and more recently also cryptoassets. The valuation of derivatives is usually accomplished differently through arbitrage relationships.

▶
- When considering investment decisions, for example from portfolio selection theory, asset returns were one of the key elements that are required, in addition to the risk.
- Hence investment decisions rely on having appropriate asset returns.

▶
- In most cases, the risks of assets are taken as exogenously given rather than determined endogenously.
- Asset pricing models then use these risks as the bases on which to determine the asset returns.

▶
- Asset pricing theories with its returns are then the basis on which the actual value of assets can be determined.
- Determining the appropriate asset return will, through its effect on the asset value, affect not only the investment decision of individuals, but also that of companies.

→ We can now turn to explore the two key asset pricing theories.

Analysing further portfolio selection theory

Analysing further portfolio selection theory

→ The starting point for the Capital Asset Pricing Model (CAPM) is portfolio selection theory. It determines an equilibrium outcome to ensure the market for assets clears.

- We can interpret asset returns as the price of a good, the good here being the asset. And this 'price' will be determined in a market such that supply and demand are balanced.
- The demand side arises from the investment decisions of investors as determined by portfolio selection theory.
- Given that we assume investors to make decisions based on portfolios selection theory, this will be the starting point for our analysis of asset returns.

→ We can now derive the Capital Asset Pricing Model.

Analysing further portfolio selection theory

- Asset returns are determined through the demand and supply of assets in markets

Analysing further portfolio selection theory

→ The starting point for the Capital Asset Pricing Model (CAPM) is portfolio selection theory. It determines an equilibrium outcome to ensure the market for assets clears.

- We can interpret asset returns as the price of a good, the good here being the asset. And this 'price' will be determined in a market such that supply and demand are balanced.
- The demand side arises from the investment decisions of investors as determined by portfolio selection theory.
- Given that we assume investors to make decisions based on portfolios selection theory, this will be the starting point for our analysis of asset returns.

→ We can now derive the Capital Asset Pricing Model.

Analysing further portfolio selection theory

- Asset returns are determined through the demand and supply of assets in markets
- The demand is affected by investment decisions of individuals

Analysing further portfolio selection theory

→ The starting point for the Capital Asset Pricing Model (CAPM) is portfolio selection theory. It determines an equilibrium outcome to ensure the market for assets clears.

- We can interpret asset returns as the price of a good, the good here being the asset. And this 'price' will be determined in a market such that supply and demand are balanced.
- The demand side arises from the investment decisions of investors as determined by portfolio selection theory.
- Given that we assume investors to make decisions based on portfolios selection theory, this will be the starting point for our analysis of asset returns.

→ We can now derive the Capital Asset Pricing Model.

Analysing further portfolio selection theory

- Asset returns are determined through the demand and supply of assets in markets
- The demand is affected by investment decisions of individuals
- As investment decisions are the consequence of portfolio selection, this theory will serve as the starting point for asset pricing

Analysing further portfolio selection theory

→ The starting point for the Capital Asset Pricing Model (CAPM) is portfolio selection theory. It determines an equilibrium outcome to ensure the market for assets clears.

- We can interpret asset returns as the price of a good, the good here being the asset. And this 'price' will be determined in a market such that supply and demand are balanced.
- The demand side arises from the investment decisions of investors as determined by portfolio selection theory.
- Given that we assume investors to make decisions based on portfolios selection theory, this will be the starting point for our analysis of asset returns.

→ We can now derive the Capital Asset Pricing Model.

Analysing further portfolio selection theory

- Asset returns are determined through the demand and supply of assets in markets
- The demand is affected by investment decisions of individuals
- As investment decisions are the consequence of portfolio selection, this theory will serve as the starting point for asset pricing

Analysing further portfolio selection theory

→ The starting point for the Capital Asset Pricing Model (CAPM) is portfolio selection theory. It determines an equilibrium outcome to ensure the market for assets clears.

- We can interpret asset returns as the price of a good, the good here being the asset. And this 'price' will be determined in a market such that supply and demand are balanced.
- The demand side arises from the investment decisions of investors as determined by portfolio selection theory.
- Given that we assume investors to make decisions based on portfolios selection theory, this will be the starting point for our analysis of asset returns.

→ We can now derive the Capital Asset Pricing Model.


Andreas Krause
Capital Asset Pricing Model

→ The Capital Asset Pricing model is probably the most widely known and most widely used model in finance.

Rewarding systematic risk only

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Rewarding systematic risk only

- The CAPM suggests that expected returns are determined by the systematic risk of assets only

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Rewarding systematic risk only

- The CAPM suggests that expected returns are determined by the systematic risk of assets only
- The expected returns are proportional to the covariance of the asset with a market portfolio

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Rewarding systematic risk only

- The CAPM suggests that expected returns are determined by the systematic risk of assets only
- The expected returns are proportional to the covariance of the asset with a market portfolio

? If investors have different opinions about asset characteristics, will they have different expected returns from the CAPM?

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Rewarding systematic risk only

- The CAPM suggests that expected returns are determined by the systematic risk of assets only
- The expected returns are proportional to the covariance of the asset with a market portfolio

? If investors have different opinions about asset characteristics, will they have different expected returns from the CAPM?

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Rewarding systematic risk only

- The CAPM suggests that expected returns are determined by the systematic risk of assets only
- The expected returns are proportional to the covariance of the asset with a market portfolio

? If investors have different opinions about asset characteristics, will they have different expected returns from the CAPM?

! Different opinions will lead to different optimal risky portfolios, but all assets still need to be held in equilibrium, this is unlikely to be fulfilled and the CAPM becomes unsustainable as a theory

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Rewarding systematic risk only

- The CAPM suggests that expected returns are determined by the systematic risk of assets only
- The expected returns are proportional to the covariance of the asset with a market portfolio

? If investors have different opinions about asset characteristics, will they have different expected returns from the CAPM?

! Different opinions will lead to different optimal risky portfolios, but all assets still need to be held in equilibrium, this is unlikely to be fulfilled and the CAPM becomes unsustainable as a theory

Rewarding systematic risk only

→ 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 derived that asset returns should only be determined by the systematic risk of the asset, not its total risk.
- This systematic risk was determined as the covariance of the asset with the market portfolio and the asset returns, more precisely the excess returns over the risk-free rate, are proportional to this risk measure.
- [?] We assumed that all investors agreed on the characteristics of all assets to derive the CAPM. Assume now investors do not agree on these characteristics, would this then mean they would simply have different expected returns for the assets?
- [!] The issue will be much more complicated as with different characteristics, the optimal risky portfolio would be different for each investor. As we still need to determine an equilibrium, we would need to determine different asset returns such that nevertheless all assets are held. That would make the CAPM easily not sustainable in its current form. The assumption of homogenous beliefs in the characteristics is essential when deriving the CAPM?

→ One aspect that has been important in portfolio theory is that of diversification. We will therefore look at the connection between diversification and the CAPM to see what the connection between these is.

Diversification and systematic risk

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors
- We will assess how effective diversification is in reducing risks

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors
- We will assess how effective diversification is in reducing risks
- The CAPM suggests investors are only rewarded for some elements of the risk they are facing

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors
- We will assess how effective diversification is in reducing risks
- The CAPM suggests investors are only rewarded for some elements of the risk they are facing, the covariance with the market

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors
- We will assess how effective diversification is in reducing risks
- The CAPM suggests investors are only rewarded for some elements of the risk they are facing, the covariance with the market (systematic risk)

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors
- We will assess how effective diversification is in reducing risks
- The CAPM suggests investors are only rewarded for some elements of the risk they are facing, the covariance with the market (systematic risk)
- We will explore how this covariance is related to diversification

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.

Diversification and systematic risk

- Portfolio theory suggests that diversification is beneficial to investors
- We will assess how effective diversification is in reducing risks
- The CAPM suggests investors are only rewarded for some elements of the risk they are facing, the covariance with the market (systematic risk)
- We will explore how this covariance is related to diversification

Diversification and systematic risk

→

- We know from portfolio theory that diversification, holding more assets, increases the opportunity set and hence potentially reduces the risk of a portfolio; it is therefore beneficial to diversity.
- We will look into the effectiveness of diversifcation, namely by how much risks would reduce if more assets are held.
-
  - From the CAPM we have obtained that not all types of risks are rewarded, but only for some aspect of risk.
  - This risk that was rewarded with a higher return, was the covariance of the asset with the market.
  - We called this risk the systematic risk.
- We will now explore how covariance and diversification are related to make additional connections between portfolio selection theory and the CAPM.

→ We will look at diversification also from a practical perspective, considering the costs of diversification.


Andreas Krause
Limits to diversification

→ We will now see that diversification will reduce risks, but it will not be able eliminate risks.

Summary of key results

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.

▶
- We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
- Thus, diversification allows to reduce risks, but it will not eliminate it.

▶ [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?

▶ [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases
- Diversification can reduce the risk at most towards the systematic risk

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases
- Diversification can reduce the risk at most towards the systematic risk, a further reduction is not possible

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases
- Diversification can reduce the risk at most towards the systematic risk, a further reduction is not possible

? Will investing into more assets always result in lower risk than investing in a few assets only?

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases
- Diversification can reduce the risk at most towards the systematic risk, a further reduction is not possible

? Will investing into more assets always result in lower risk than investing in a few assets only?

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases
- Diversification can reduce the risk at most towards the systematic risk, a further reduction is not possible

? Will investing into more assets always result in lower risk than investing in a few assets only?

! Investing into few assets with low correlations may be more effective as the average covariance will be lower.

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Summary of key results

- We see that increasing the number of assets to invest into becomes less and less effective as the number of assets increases
- Diversification can reduce the risk at most towards the systematic risk, a further reduction is not possible

? Will investing into more assets always result in lower risk than investing in a few assets only?

! Investing into few assets with low correlations may be more effective as the average covariance will be lower.

Summary of key results

→ 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 as the number of assets included in the portfolio increases, the benefits of increasing the number of assets even further will reduce; the reduction in the unsystematic risk of the portfolio becomes smaller and smaller.
-
  - We can reduce the risk through diversification, but this will affect only the unsystematic risk; the systematic risk remains.
  - Thus, diversification allows to reduce risks, but it will not eliminate it.
- [?] If we just increase the number of assets, does this mean the risk of our portfolio reduces always?
- [!] This is not necessarily the case; it depends on the average covariance of assets, thus adding an asset with a high covariance to existing assets will increase the systematic risk and this might have a larger effect than the reduction in the unsystematic risk. We might be able to achieve a lower overall risk by holding only a few assets with low covariances (correlations); this will result in low systematic risk, but we are also exposed to some unsystematic risk.

→ For the stock market, such low correlations can often be achieved by selection stocks from different industries.

Shortcomings of the CAPM

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
  - As such it only allows for a single factor to affect asset returns, the market portfolio.
- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→

Shortcomings of the CAPM

- The CAPM is obtained from on the theory of portfolio selection

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
  - As such it only allows for a single factor to affect asset returns, the market portfolio.
- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→

Shortcomings of the CAPM

- The CAPM is obtained from on the theory of portfolio selection and identifies a single risk factor, the market

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
- As such it only allows for a single factor to affect asset returns, the market portfolio.

- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→

Shortcomings of the CAPM

- The CAPM is obtained from on the theory of portfolio selection and identifies a single risk factor, the market
- How the market return and risk is determined is not explained

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
- As such it only allows for a single factor to affect asset returns, the market portfolio.

- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→

Shortcomings of the CAPM

- The CAPM is obtained from on the theory of portfolio selection and identifies a single risk factor, the market
- How the market return and risk is determined is not explained
- With all influences obtained through the market, the ultimate driving forces behind returns cannot be identified

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
- As such it only allows for a single factor to affect asset returns, the market portfolio.

- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→

Shortcomings of the CAPM

- The CAPM is obtained from on the theory of portfolio selection and identifies a single risk factor, the market
- How the market return and risk is determined is not explained
- With all influences obtained through the market, the ultimate driving forces behind returns cannot be identified
- We will look at Arbitrage Pricing Theory to obtain a tool allowing us to determine the influence of different factors on asset returns

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
  - As such it only allows for a single factor to affect asset returns, the market portfolio.
- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→

Shortcomings of the CAPM

- The CAPM is obtained from on the theory of portfolio selection and identifies a single risk factor, the market
- How the market return and risk is determined is not explained
- With all influences obtained through the market, the ultimate driving forces behind returns cannot be identified
- We will look at Arbitrage Pricing Theory to obtain a tool allowing us to determine the influence of different factors on asset returns

Shortcomings of the CAPM

→ The CAPM does not perform very well empirically, for this reason many models seek to improve on this model.

- One concern is that the CAPM is only based on investor decisions through portfolio selection theory.
- As such it only allows for a single factor to affect asset returns, the market portfolio.

- The model takes the market return and the risks as given, but does not explain how they are determined. This is especially true for the market return, which is the weighted average of the asset returns and hence not a truly exogenous variable.
- While the market will be influenced by a range of factors, we cannot identify the strength of influence these factors have individually, not on the market and not on individual assets.
- Arbitrage Pricing Theory seeks to overcome this shortfall in the CAPM by allowing for multiple factors to influence asset returns.

→


Andreas Krause
Arbitrage Pricing Theory

→ We can now derive the key results of the Arbitrage Pricing Theory.

Limits in the practical use of APT

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor
- It gives no hint how these factors are to be found

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor
- It gives no hint how these factors are to be found, nor how these factor portfolios are to be constructed

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor
- It gives no hint how these factors are to be found, nor how these factor portfolios are to be constructed

? As the CAPM is a special case of APT, is using the APT better?

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor
- It gives no hint how these factors are to be found, nor how these factor portfolios are to be constructed

? As the CAPM is a special case of APT, is using the APT better?

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor
- It gives no hint how these factors are to be found, nor how these factor portfolios are to be constructed

? As the CAPM is a special case of APT, is using the APT better?

! The APT suffers from factors having no sound theoretical basis and difficulties in identifying and using any such factors; this makes the use of APT more challenging

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Limits in the practical use of APT

- APT suggests that asset prices are proportional to the returns of portfolios which are only affected by a single factor
- It gives no hint how these factors are to be found, nor how these factor portfolios are to be constructed

? As the CAPM is a special case of APT, is using the APT better?

! The APT suffers from factors having no sound theoretical basis and difficulties in identifying and using any such factors; this makes the use of APT more challenging

Limits in the practical use of APT

→ 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.

- Arbitrage Pricing Theory requires us to identify factor portfolios and we then can identify the influence these factors have on the asset return.
-
  - The problem with APT is that it does not give us any information which factors are to be selected, it merely assumes that there are such factors. Even the number of factors is not determined.
  - The construction of the factor portfolios, combinations of assets that are perfectly correlated with only a single factor, is also not developed with that theory.
- [?] APT can be seen as a generalisation of the CAPM, we just introduce more factors in addition to the single factor of the market portfolio. Does this make APT a better theory?
- [!] There is not theoretical foundation for APT, we just assumed that there are factors which influence asset returns and that they do so linearly; in CAPM the use of the market portfolio was mandated by the theory originating in portfolio selection theory, but in APT even the use of the market portfolio is justified theoretically. All this makes the use of APT more difficult as the choice of factors is subject to challenge and any factor cannot be rebuffed as the result of theoretical considerations.

→ While APT seems to be generalisation of the CAPM, it has no sound theoretical foundation and suffers from empirical problems regarding the identification of factors and then the formation of factor portfolios.

Summary

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Summary

- Asset pricing theory suggests that investors are only rewarded for being exposed to systematic risk

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Summary

- Asset pricing theory suggests that investors are only rewarded for being exposed to systematic risk
- Risks that can be diversified, unsystematic risk, is not rewarded

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Summary

- Asset pricing theory suggests that investors are only rewarded for being exposed to systematic risk
- Risks that can be diversified, unsystematic risk, is not rewarded
- While diversification reduces unsystematic risk, its impact is small once a larger number of assets are held

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Summary

- Asset pricing theory suggests that investors are only rewarded for being exposed to systematic risk
- Risks that can be diversified, unsystematic risk, is not rewarded
- While diversification reduces unsystematic risk, its impact is small once a larger number of assets are held
- Using a small number of assets with low correlations can give low total risk

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Summary

- Asset pricing theory suggests that investors are only rewarded for being exposed to systematic risk
- Risks that can be diversified, unsystematic risk, is not rewarded
- While diversification reduces unsystematic risk, its impact is small once a larger number of assets are held
- Using a small number of assets with low correlations can give low total risk, even though it includes unsystematic risk

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Summary

- Asset pricing theory suggests that investors are only rewarded for being exposed to systematic risk
- Risks that can be diversified, unsystematic risk, is not rewarded
- While diversification reduces unsystematic risk, its impact is small once a larger number of assets are held
- Using a small number of assets with low correlations can give low total risk, even though it includes unsystematic risk

Summary

→ We can now summarize the key results we have obtained about two key asset pricing models.

- Both, the CAPM and APT, suggest that investors are only rewarded with a higher return for taking on additional risk, if the risk is systematic risk.
- If risks can be diversified, they are not rewarded when taken by an investor, as he could eliminate this risk through holding more assets.
- Diversification reduced and eventually eliminates unsystematic risk, once a large number of assets are held, the effect of increasing the number of assets further is reduced significantly.
-
  - It might be better to use a small number of assets with a low correlation and a hence low systematic risk as the costs of doing so will be lower than holding many assets.
  - The small number so carefully selected assets might involve smaller overall risks, despite the unsystematic risk investors are exposed to. This is if the average covariance of the assets selected is smaller than the average covariance of a larger portfolio.

→ We have thus seen that not all risk-taking is rewarded by higher asset returns, it is only systematic risk, which is the determined as the covariance of the asset with a benchmark portfolio.

Andreas Krause
Department of Economics
University of Bath
Claverton Down
Bath BA2 7AY
United Kingdom

E-mail: mnsak@bath.ac.uk