

**BUILDING ON OPTIMAL PORTFOLIO  
CHOICE...  
CAPITAL ASSET PRICING MODEL (CAPM)**

**WHAT WILL YOU LEARN?**

- ▶ Capital asset pricing model (CAPM)
  - ▶ Main workhorse model
  - ▶ Key insight: Risk of an asset is not its total volatility but how assets move in relation to each other.
  - ▶ There should be no premium for bearing risks that can be diversified away.
  - ▶ What is the relationship between risk and reward?

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- ▶ CAPM developed in the 1960s by Jack Treynor, William Sharpe, John Lintner and Jan Mossin.
- ▶ Sharpe shared the 1990 Nobel Prize in Economics with Markowitz.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- ▶ Revolutionary in its day because it changed the way practitioners thought about risk.
- ▶ Relevant measure of risk is how the asset covaries with the market portfolio – the beta of an asset.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- ▶ CAPM is an equilibrium model that characterizes risk-return combinations of securities that occur when investors are mean-variance optimizers.
- ▶ Equilibrium refers to a situation where no investor wants to do anything differently.
  - ▶ Prices set such that supply = demand.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- ▶ If everybody in the economy holds an efficient portfolio, what do the asset prices need to be so that markets clear?

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- What if, for example, based on the prices/expected returns our model comes up with, we find that IBM does not enter into any maximizing investor's portfolio?

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- It must be that IBM is priced too high.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- For equilibrium – for supply to equal demand – then the price will have to fall to a point such that the aggregate demand of investors equals the number of shares outstanding.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

- CAPM tells us how assets should be priced in equilibrium.

## **SUMMARY**

- Capital asset pricing model (CAPM) is an equilibrium model that characterizes the risk-return trade-off.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

### **WHAT WILL YOU LEARN?**

- ▶ Capital asset pricing model (CAPM) Lesson #1
  - ▶ All investors hold the market portfolio.

## REMEMBER THE EFFICIENT FRONTIER?

## CAPM ASSUMPTIONS

- ▶ Single-period investment horizon
  - ▶ Individual investors are price takers
  - ▶ Investments are limited to traded financial assets
  - ▶ Investors can borrow and lend at a known risk-free rate.
  - ▶ No taxes and transaction costs
  - ▶ Information is costless and available to all investors
  - ▶ Investors are risk-averse and seek to maximize  $E[U]$
  - ▶ Investors are rational mean-variance optimizers
  - ▶ Homogeneous expectations
- ✓ If everyone is mean-variance optimizing investor facing the same frontier, what must the tangency portfolio be for there to be *no excess demand* or *supply* for any security?



## **CAPM EQUILIBRIUM**

- ▶ The MVE on the frontier of all risky assets is the market portfolio!
  - ▶ Since everyone holds the same MVE, and this is the best portfolio that can be held by all investors, the MVE portfolio becomes the market portfolio in equilibrium.

## **CAPM EQUILIBRIUM**

- ▶ The capital allocation line going through the market portfolio is called the CAPITAL MARKET LINE.
  - ▶ Passive investing is efficient!

## SUMMARY

- ▶ In a CAPM world, the market portfolio is mean-variance efficient.
- ▶ All investors hold the market portfolio, just in different proportions.
- ▶ The efficient frontier consists of all portfolios that consist of mixing the risk-free asset and the market portfolio.

## **CAPITAL ASSET PRICING MODEL (CAPM)**

### **WHAT WILL YOU LEARN?**

- ▶ Capital asset pricing model (CAPM) Lesson #2
  - ▶ The market risk premium depends on the risk aversion of the average investor.

## **CAPM EQUILIBRIUM**

- ▶ The capital allocation line going through the market portfolio is called the CAPITAL MARKET LINE.
  - ▶ Passive investing is efficient!

## **CAPM EQUILIBRIUM**

- ▶ The market risk premium depends on the risk aversion of the average investor.

## SUMMARY

- ▶ In a CAPM world, the market portfolio is mean-variance efficient.
- ▶ All investors hold the market portfolio, just in different proportions.
- ▶ The efficient frontier consists of all portfolios that consist of mixing the risk-free asset and the market portfolio.
- ▶ The market risk premium is determined by the average risk aversion and the variance of the market portfolio – the amount of market risk that cannot be diversified away.

## **BETA AND SYSTEMATIC RISK**

### **WHAT WILL YOU LEARN?**

- ▶ Systematic (market) risk vs. non-systematic risk
- ▶ How do you measure the systematic risk of an individual asset?
- ▶ What is beta?

## **SYSTEMATIC RISK VS NON-SYSTEMATIC RISK**

- ▶ Systematic (market) risk is the proportion of the risk of the security that is related to moves of the market portfolio.
- ▶ Non-systematic (idiosyncratic) risk is the proportion of the risk of the security that is unrelated to moves of the market portfolio. It is the risk that disappears when that security is held in the market portfolio.

## **CAPM BETA**

- ▶ Beta is the numerical description of systematic risk.
- ▶ It is a measure of how an asset co-moves with the market portfolio.

## **HOW DO YOU MEASURE BETA?**

## **SUMMARY: CAPM LESSONS**

- ▶ Beta is a measure of systematic risk.
- ▶ Beta of the market portfolio is one.



## **CAPITAL ASSET PRICING MODEL (CAPM)**

### **WHAT WILL YOU LEARN?**

- ▶ Capital asset pricing model (CAPM) Lesson #3
  - ▶ What determines the risk and return relation for individual securities?

## **SYSTEMATIC RISK VS NON-SYSTEMATIC RISK**

- ▶ Systematic risk (Market) risk is the proportion of the risk of the security that is priced.
- ▶ Idiosyncratic risk is the proportion of the risk of the security that is not priced.

## **CAPM: EXPECTED RETURN-BETA RELATIONSHIP**

## SECURITY MARKET LINE

## CAPM BETA

- ▶ You can also think of beta as a measure of the lack of diversification potential.
  - ▶ High betas → high market risk → low diversification benefits

## SUMMARY

- ▶ The risk premium on an individual asset is determined by its beta.
- ▶ Bad time = low (negative) market return
  - ▶ Assets paying off in bad times (assets with low betas) have low risk premiums.
  - ▶ Losses during bad times are more likely with high beta assets.
  - ▶ High beta assets are risky and require high expected returns to be held in equilibrium.