Lesson 1: Introduction to CAPM

Introduction

- Assumptions with CAPM
- Capital market line (CML)
- Security market line (SML)
- Fallings of CAPM
- Summary and concluding remarks

Assumptions with CAPM

Capital Asset Pricing Model (CAPM)

The standard form of CAPM equilibrium relation is first shown by Sharpe, Lintner, and Mossin. Hence, it is also referred to as the Sharpe–Lintner–Mossin model of CAPM (1960s)

- It is the simplest and most widely employed model of asset pricing
- It has been documented to be extremely efficient in explaining the observed prices
- It involves some important assumptions

CAPM: Assumptions

No transaction costs: what are these transaction costs?

Securities are infinitely divisible: one can take as small a position as INR 1.

Prices are given: traders cannot affect prices

Investors are rational: they understand the return distributions and risk and also process all the available information

CAPM: Assumptions

Unlimited short sales are allowed

Unlimited lending and borrowing is allowed

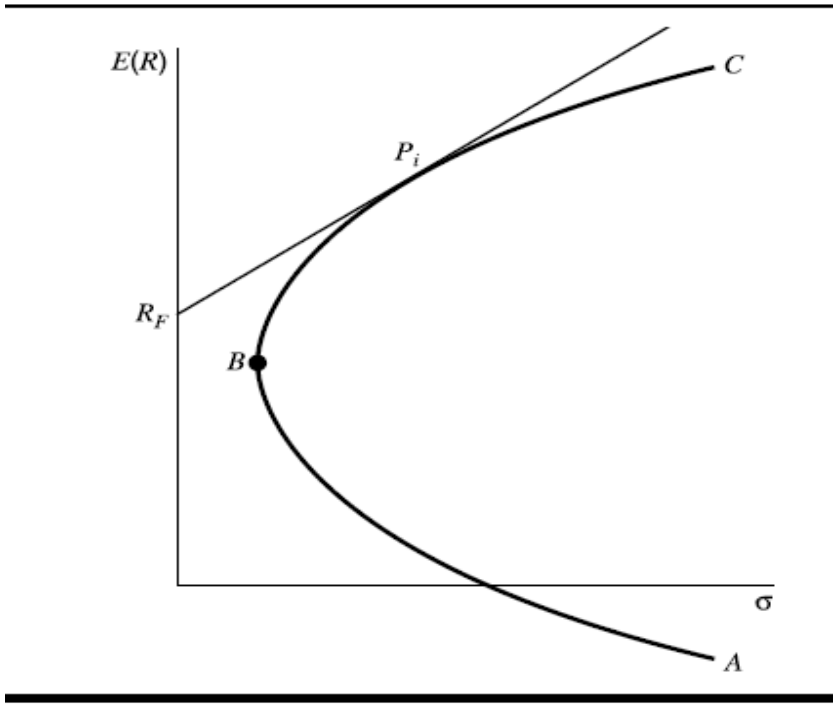
Uniform expectations: At equilibrium, all the investors have the same expectation of a security's return distribution (i.e., expected return, risk, and correlation structure across securities); they define the period of equilibrium in a similar manner

All the assets are marketable

A Simple Approach to Understand the CAPM I: Capital Market Line (CML)

A Simple Approach to Understand the CAPM: CML

Our old story of one risky asset (market portfolio) in the presence of risk-free lending and borrowing

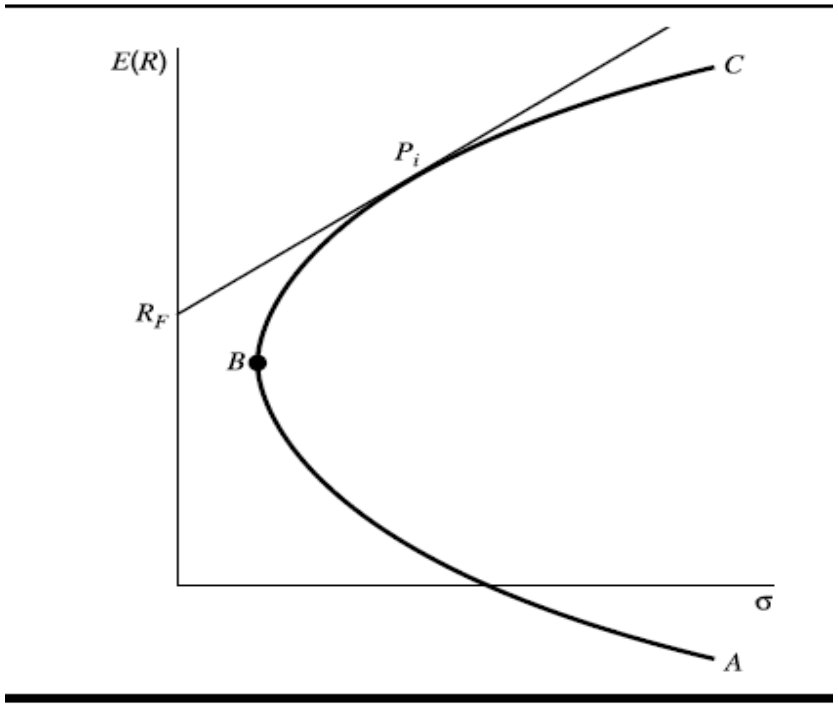


The efficient frontier with lending and borrowing.

Elton, Gruber, Brown, and Goetzmann; Modern Portfolio Theory and Investment Analysis. 9th edition. Chapter 13

Capital Market Line (CML)

- We said (under the assumptions specified) that all the investors will hold this portfolio along with the risk-free asset (investing or borrowing)
- This line is called the capital market line (CML)



The efficient frontier with lending and borrowing.

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Capital Market Line (CML)

The equation of this line is as follows

- $\bar{R}_e = R_F + \frac{(\bar{R}_M - R_F)}{\sigma_M}\sigma_e$ where subscript "e" denotes an efficient portfolio
- The term $\frac{(\bar{R}_M - R_F)}{\sigma_M}$ indicates the price of risk, i.e., excess returns per unit of risk

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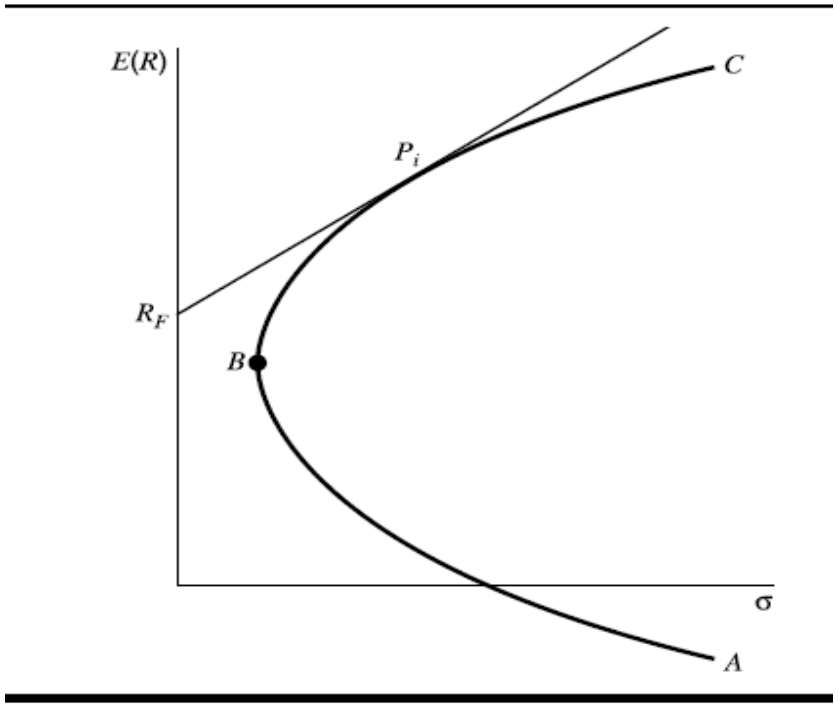
Capital Market Line (CML)

- The combined term $[\frac{(\bar{R}_M - R_F)}{\sigma_M}\sigma_e]$ is the total reward for taking on σ_e risk
- R_F is simply the risk-free rate that is the price of time, which is delaying the consumption (time value of money)



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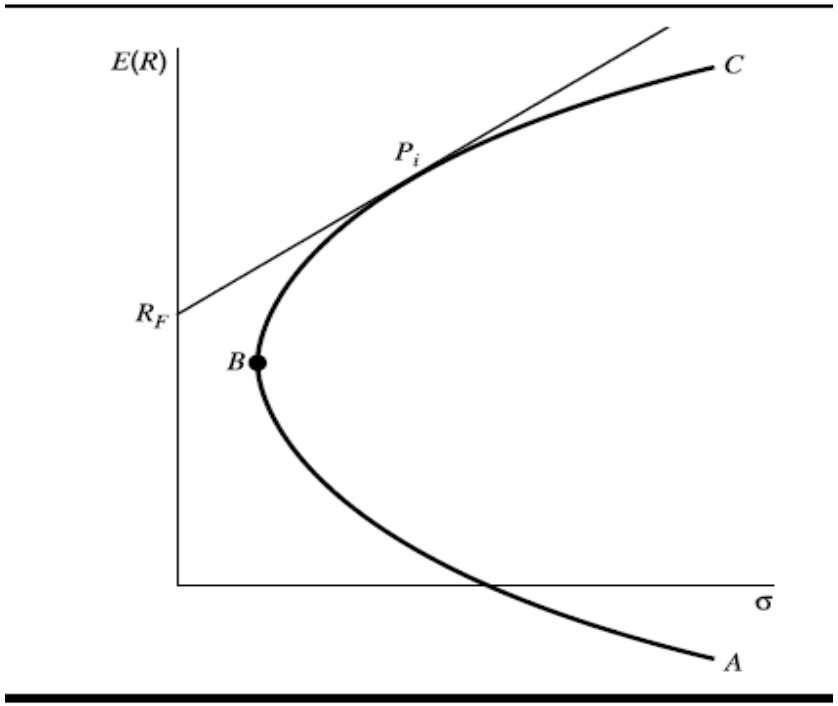
Capital Market Line (CML)

- Therefore, the equation can be simply written as follows:
  Expected return = Price of time + Price of risk × Risk



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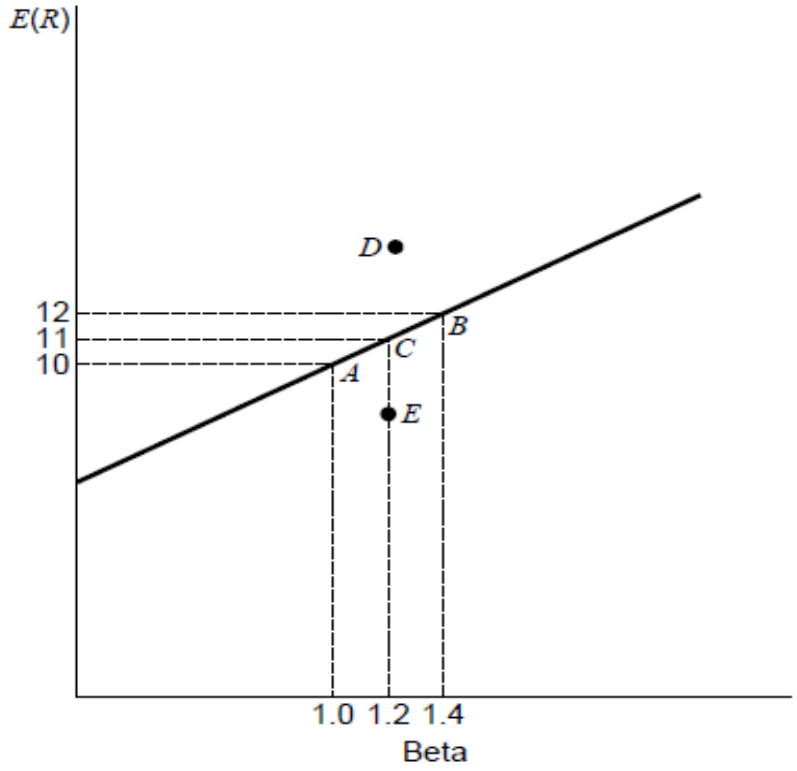
A Simple Approach to Understanding the CAPM II: Security Market Line (SML)

Security Market Line (SML)

- Security market line carries all the securities available in the market
- If all the investors hold well-diversified portfolios, then only risk that matters for a security is beta or market risk
- Imagine five portfolios, i.e., A, B, C, D, and E, on SML



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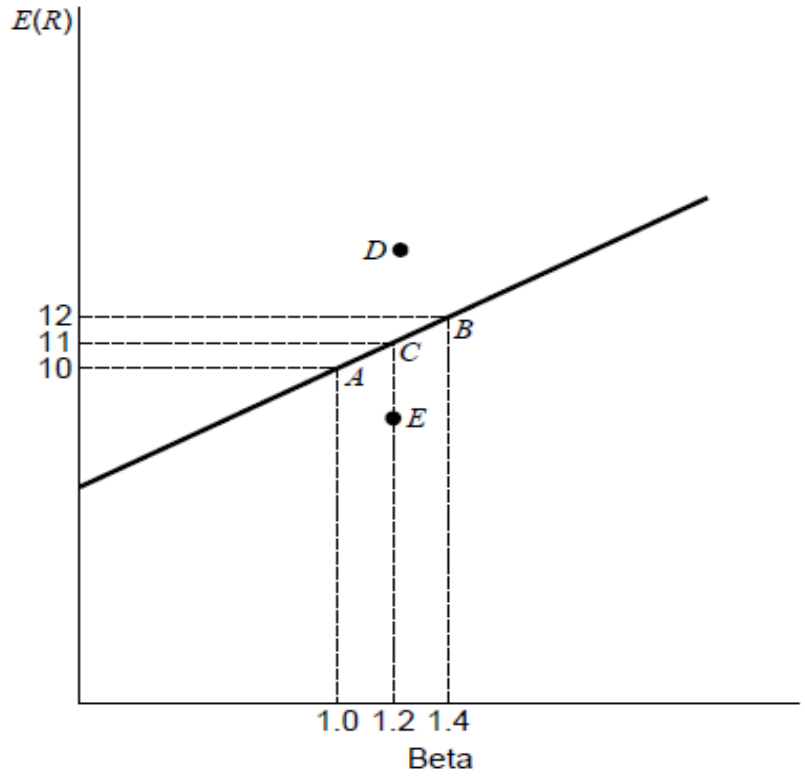
SML: Arbitrage Portfolio

Investment	Expected Return	Beta	Portfolio
A	10%	1	Efficient
B	12%	1.4	Efficient
D	13%	1.2	Inefficient
E	8%	1.2	Inefficient
C (average of A and B)	11%	1.2	Efficient
Arbitrage portfolio			
Sell C	−11%	−1.2	
Buy D	13%	1.2	
Expected return	2%	0	
Arbitrage portfolio			
Buy C	11%	1.2	
Sell E	−8%	−1.2	
Expected return	3%	0	

Security Market Line (SML)

For a well-diversified portfolio, non-systematic risk tends to go to zero

- Market risk is the only relevant risk measured by beta
- The SML shown here plots five portfolios (A, B, C, D, and E)
- Here, portfolios D and E are anomalous, i.e., their expected return is not aligned to the systematic-risk (beta)



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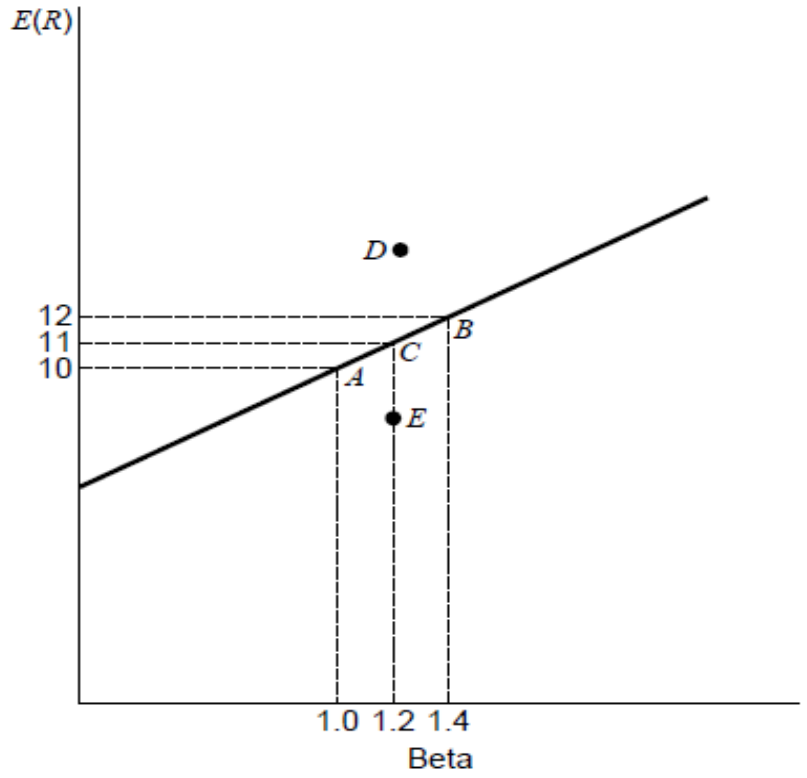
Security Market Line (SML)

For a well-diversified portfolio, non-systematic risk tends to go to zero

- E is overpriced and, therefore, offers a lower expected return
- D is underpriced and, therefore, offers a higher expected return



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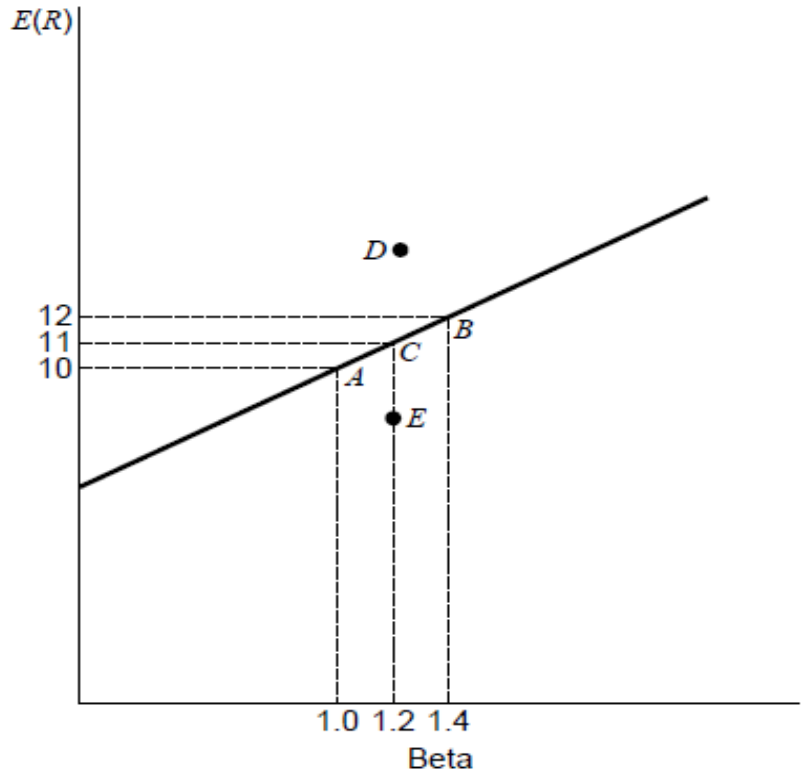
Security Market Line (SML)

For a well-diversified portfolio, non-systematic risk tends to go to zero

- There is a (partially) riskless arbitrage opportunity by selling E and buying D and makes profits
- This will bring securities back to the SML



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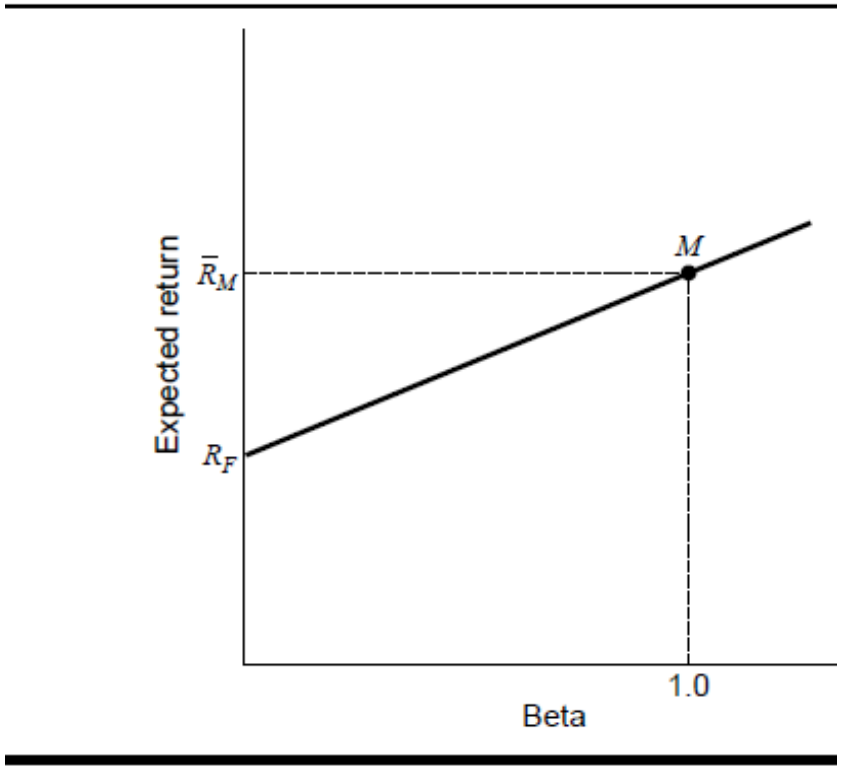
Security Market Line (SML)

- SML can be identified using the two points through which it passes
- One, the risk-free investment (beta = 0 and interest rate of R_F) and market portfolio (beta = 1 and interest rate of $\bar{R}_M$)



The security market line.

Elton, Gruber, Brown, and Goetzmann; Modern Portfolio Theory and Investment Analysis. 9th edition. Chapter 13

Security Market Line (SML)

Using these points, we can write down the equation of SML as

- $\bar{R}_i = R_F + \beta_i(\bar{R}_M - R_F)$ → CAPM
- Here, $\beta_i = \frac{\sigma_{im}}{\sigma_m^2}$

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Fallings of CAPM

CAPM Assumption Violations

- No transaction costs
- Securities are infinitely divisible
- Prices are given
- Investors are rational

CAPM Assumption Violations

- Unlimited short sales are allowed
- Unlimited lending and borrowing is allowed
- Uniform expectations
- All the assets are marketable

Few Last Words on CAPM

- CAPM appears to hold at an aggregate level
- However, individual investors do hold smaller portfolios, not similar to market portfolios
- Many CAPM assumptions violate the real-world conditions
- However, there are certain assumptions that can be relaxed and alternative variants can be derived

Few Last Words on CAPM

- Under the assumptions of CAPM, the only portfolio of risky assets that investors will hold will be the market portfolio
- In this market portfolio, any security has a proportion that is the same as the ratio of the market capitalization of that security to the total market capitalization of that market

Few Last Words on CAPM

- Investors depending upon their risk tolerance will adjust the proportions of the market portfolio and risk-free asset
- However, we know that individual investors do hold non-market, smaller portfolios

Summary and Concluding Remarks

Summary and Concluding Remarks

- CAPM is a very simple yet powerful model of equilibrium asset pricing
- CAPM is based on certain assumptions that violate real-life situations
- However, its efficacy lies in its ability to describe the real observed prices
- All the efficient portfolios lie on the capital market line (CML)
- The CML describes equilibrium prices in terms of price of time and price of risk

Summary and Concluding Remarks

- Security market line (SML) describes the behavior of all the securities available in the market at equilibrium
- Essentially, this SML is the equation of CAPM
- It passes through the market portfolio and risk-free security

Summary and Concluding Remarks

- Various assumptions of CAPM violate the real-world scenarios
- CAPM postulates that all individuals should hold the market portfolio
- However, individual investors hold various small portfolios that are different from the market portfolio
- The violation of a few assumptions individually may not necessarily invalidate CAPM

Thanks!