THE CAPITAL ASSET PRICING MODEL (CAPM)

Investment and Valuation of Firms
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WS 2012/2013

November 12, 2012

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1. CAPM

The capital asset pricing model, almost always referred to as the CAPM, is a centerpiece of modern financial economics. The model was introduced by Jack Treynor (1961, 1962), William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) independently, building on the earlier work of Harry Markowitz on diversification and modern portfolio theory. Sharpe, Markowitz and Merton Miller jointly received the Nobel Memorial Prize in Economics for this contribution to the field of financial economics.

The model gives us a precise prediction of the relationship that we should observe between the risk of an asset and its expected return. This relationship serves two vital functions. First, it provides a benchmark rate of return for evaluating possible investments. For example, if we are analyzing securities, we might be interested in whether the expected return we forecast for a stock is more or less than its "fair" return given its risk. Second, the model helps us to make an educated guess as to the expected return on assets that have not yet been traded in the marketplace. For example, how do we price an initial public offering of stock? How will a major new investment project affect the return investors require on a company's stock? Although the CAPM does not fully withstand empirical tests, it is widely used because of the insight it offers and because its accuracy suffices for important applications. In this chapter we first inquire about the process by which the attempts of individual investors to efficiently diversify their portfolios affect market prices. Armed with this insight, we start with the basic version of the CAPM. We also show how some assumptions of the simple version may be relaxed to allow for greater realism.

The general idea behind CAPM is that investors need to be compensated in two ways: time value of money and risk. The time value of money is represented by the risk-free (rf) rate in the formula and compensates the investors for placing money in any investment over a period of time. The other half of the formula represents risk and calculates the amount of compensation the investor needs for taking on additional risk. This is calculated by taking a risk measure (beta) that compares the returns of the asset to the market over a period of time and to the market premium (Rm-rf).

$$\bar{r}_a = r_f + \beta_a(\bar{r}_m - r_f)$$

Where:

r_f = Risk free rate

β_a = Beta of the security

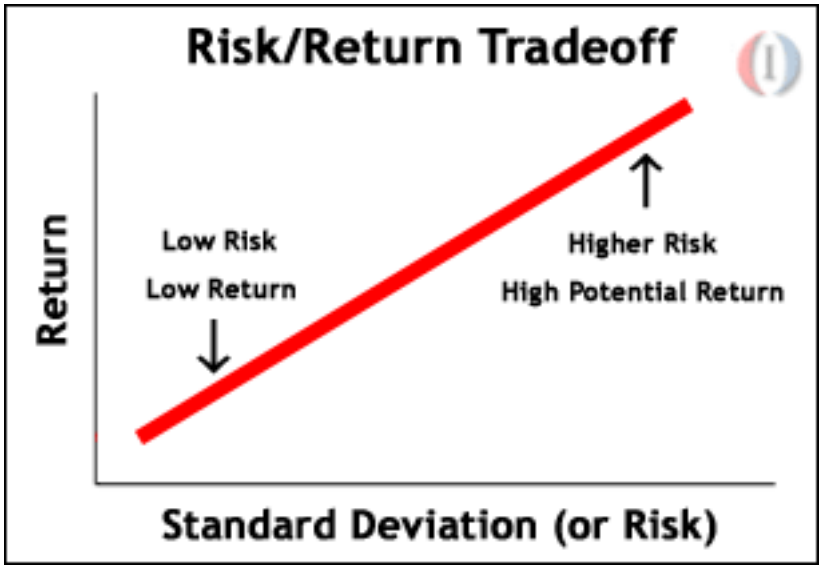
$\bar{r}_m$ = Expected market return

2. Risk and return trade off

Risk, in traditional terms, is viewed as a 'negative'. The Chinese symbols for risk, reproduced below, give a much better description of risk. The first symbol is the symbol for "danger", while the second is the symbol for "opportunity", making risk a mix of danger and opportunity.

危機

The principle that potential return rises with an increase in risk. Low levels of uncertainty (low-risk) are associated with low potential returns, whereas high levels of uncertainty (high-risk) are associated with high potential returns. According to the risk-return tradeoff, invested money can render higher profits only if it is subject to the possibility of being lost.
Because of the risk-return tradeoff, you must be aware of your personal risk tolerance when choosing investments for your portfolio. Taking on some risk is the price of achieving returns; therefore, if you want to make money, you can't cut out all risk. The goal instead is to find an appropriate balance - one that generates some profit, but still allows you to sleep at night.



Measuring return :

$$\text{return} = R = \frac{\text{change in asset value} + \text{income}}{\text{initial value}}$$

Risk

There are two types of risk:

- unsystematic risk
- systematic risk

1. **What is an unsystematic risk**?

- specific to a firm
- can be eliminated through diversification
- examples:-- Safeway and a strike
  -- Microsoft and antitrust cases

2. **What is an systematic risk?**

- market risk
- cannot be eliminated through diversification
- due to factors affecting all assets -- energy prices, interest rates, inflation, business cycles

Correlation

The correlation between two securities falls into one of the following cases:

• Positively correlated $0 < \rho AB < 1$
• Perfectly positively correlated $\rho AB = 1$
• Negatively correlated $-1 < \rho AB < 0$
• Perfectly negatively correlated $\rho AB = -1$
• Uncorrelated $\rho AB = 0$

Assumptions Underlying the CAPM

• There are many investors. They behave competitively (pricetakers).
• All investors are looking ahead over the same (one period) planning horizon.
• All investors have equal access to all securities.
• No taxes.
• No commissions.
• Each investor cares only about ErC and σC.
• All investors have the same beliefs about the investment opportunities: rf , Er1,. . .,Ern, all σi, and all correlations ("homogeneous beliefs") for the n risky assets.
• Investors can borrow and lend at the one risk free rate.
• Investors can short any asset, and hold any fraction of an asset.

3. Market portfolio

An investor might choose to invest a proportion of his or her wealth in a portfolio of risky assets with the remainder in cash—earning interest at the risk free rate (or indeed may borrow money to fund his or her purchase of risky assets in which case there is a negative cash weighting). Here, the ratio of risky assets to risk free asset does not determine overall return—this relationship is clearly linear. It is thus possible to achieve a particular return in one of two ways:

1. By investing all of one's wealth in a risky portfolio,

2. Or by investing a proportion in a risky portfolio and the remainder in cash (either borrowed or invested).

For a given level of return, however, only one of these portfolios will be optimal (in the sense of lowest risk). Since the risk free asset is, by definition, uncorrelated with any other asset, option 2 will generally have the lower variance and hence be the more efficient of the two.

This relationship also holds for portfolios along the efficient frontier: a higher return portfolio plus cash is more efficient than a lower return portfolio alone for that lower level of return. For a given risk free rate, there is only one optimal portfolio which can be combined with cash to achieve the lowest level of risk for any possible return. This is the market portfolio.

The market portfolio, M, as any other portfolio, is described by portfolio weights:

- w1,M,w2,M, . . ., wn,M.

The specific attribute of the market portfolio is that the weight on a stock is the fraction of that stock's market value relative to the total market value of all stocks:

***Stock's market value*:**

$$v_i = n_i p_i$$

where

p_i price per share of company i's stock,
n_i number of shares outstanding,
v_i the market value of i's equity.

Example:

IBM has n_{IBM}=1730 Million shares outstanding.
As of 10/6/03, the price was p_{IBM}=$91.18 per share.
So, IBM's market value is v_{IBM}=$157.7 Billion

***The total market value of all stocks*:**

$$V = v_1+v_2+...+v_n$$

The weight of stock i in the market portfolio

$$w_{i,M} = v_i / V.$$

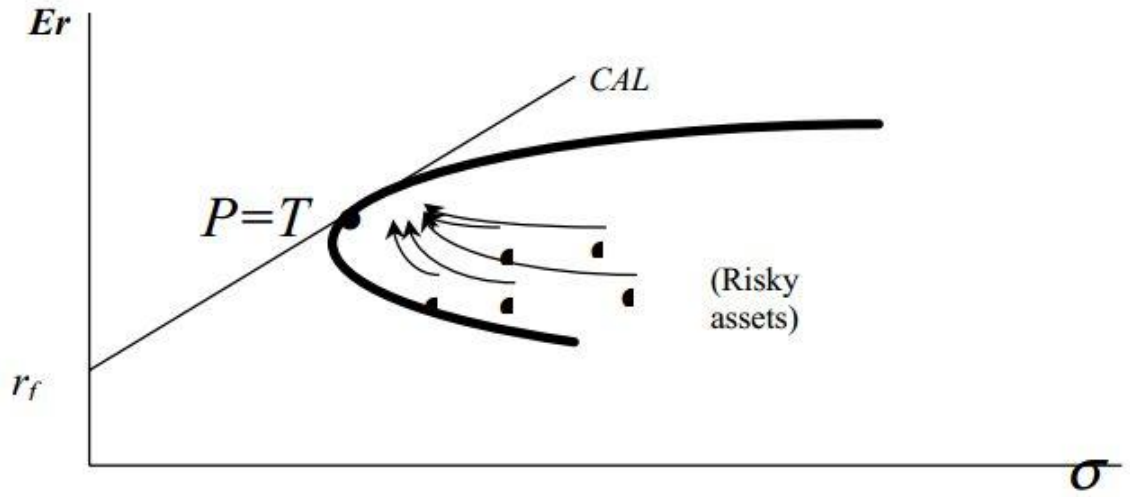
Example

Suppose the weight of IBM is: w_{IBM} = 1.5%
If we put $100,000 in the market portfolio, $1,500 should be invested in IBM.

Portfolio Choice in the CAPM World

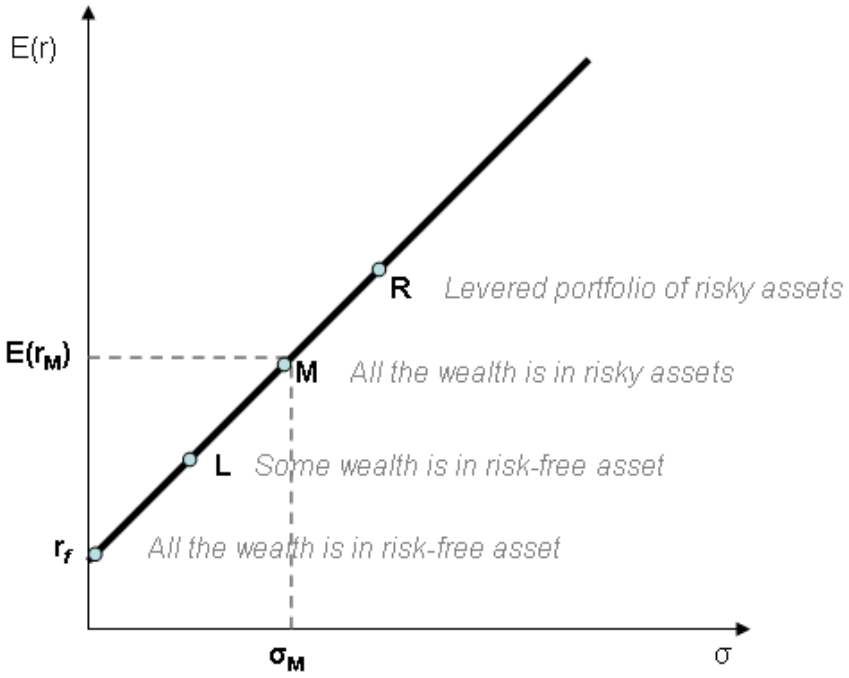
The expected return: ErC
For a given level of risk: σC

The investor's problem is to choose the "best" portfolio P.
The solution: Choose T.



4. CAPITAL MARKET LINE

Capital Market Line (CML) is a line used in the capital asset pricing model to illustrate the rates of return for efficient portfolios depending on the risk-free rate of return and the level of risk (standard deviation) for a particular portfolio.

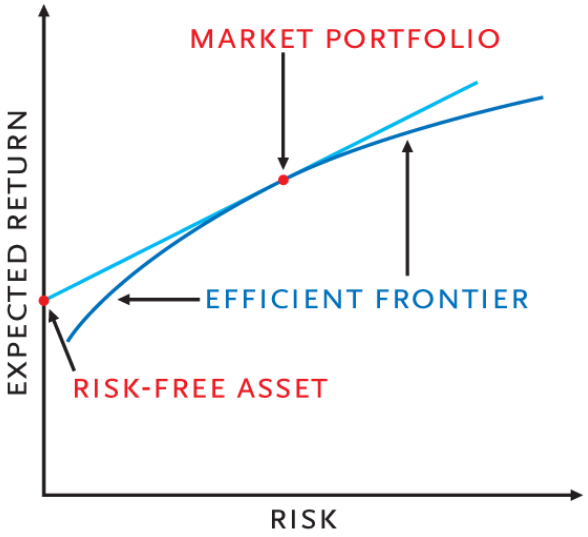


The CML is derived by drawing a tangent line from the intercept point on the efficient frontier to the point where the expected return equals the risk-free rate of return.

The CML is considered to be superior to the efficient frontier[1] since it takes into account the inclusion of a risk-free asset in the portfolio. The capital asset pricing model (CAPM) demonstrates that the market portfolio is essentially the efficient frontier. This is achieved visually through the security market line (SML).

The tangency point M represents the market portfolio, so named since all rational investors (minimum variance criterion) should hold their risky assets in the same proportions as their weights in the market portfolio.

[1] . A set of optimal portfolios that offers the highest expected return for a defined level of risk or the lowest risk for a given level of expected return.



The Formula

$$\text{CML} : E(r) = r_f + \sigma \frac{E(r_M) - r_f}{\sigma_M}.$$

Where:

$E(r_M)$=the risk premium on market portfolio

r_f = risk free rate

The Cml is the relationship between the risk and the expected return for portfolio P (Equation for CML).
The CML results from the combination of the market portfolio and the risk-free asset (point L).All points along the CML have superior risk-return profiles to any portfolio on the efficient frontier, with the exception of the Market Portfolio, the point on the efficient frontier to which the CML is the tangent. From a CML perspective, this portfolio is composed entirely of the risky asset, the market, and has no holding of the risk free asset ,i.e., money is neither invested in, nor borrowed from the money market account.

Addition of leverage[1] (the point R) creates levered portfolios that are also on the CML. The slope of the capital market line is the market price of risk for efficient portfolios, or the equilibrium price of risk in the market: $(r_m - r_f)/\sigma_M$.

[1] Leverage : 1) The use of various financial instruments or borrowed capital, such as margin, to increase the potential return of an investment. 2) The amount of debt used to finance a firm's assets. A firm with significantly more debt than equity is considered to be highly leveraged.
Leverage is most commonly used in real estate transactions through the use of mortgages to purchase a home.

Sharpe ratio & Alpha

All of the portfolios on the CML have the same Sharpe ratio as that of the market portfolio,

$$\frac{E(r) - r_f}{\sigma} = \frac{E(r_M) - r_f}{\sigma_M}.$$

In fact, the slope of the CML is the Sharpe ratio of the market portfolio.

A stock picking[1] rule of thumb is to buy assets whose Sharpe ratio is above the CML and sell those whose Sharpe ratio is below. Indeed, from the efficient market hypothesis it follows that we cannot beat the market. Therefore, all portfolios should have a Sharpe ratio less than or equal than the market's. In consequence, if there is a portfolio (or asset) whose Sharpe ratio is bigger than the market's then this portfolio (or asset) gives more return for unity of risk (i.e. the volatility σ), which contradicts the efficient market hypothesis[2].

This **abnormal** extra return over the market's return at a given level of risk is what is called the alpha.

5. SECURITY MARKET LINE

Security market line (**SML**) is the representation of the Capital asset pricing model. It displays the expected rate of return of an individual security as a function of systematic, non-diversifiable risk (its beta). Also referred to as the "**characteristic line**"[3].
The SML essentially graphs the results from the capital asset pricing model (CAPM) formula. The x-axis represents the risk (beta), and the y-axis represents the expected return. The market risk premium is determined from the slope of the SML.

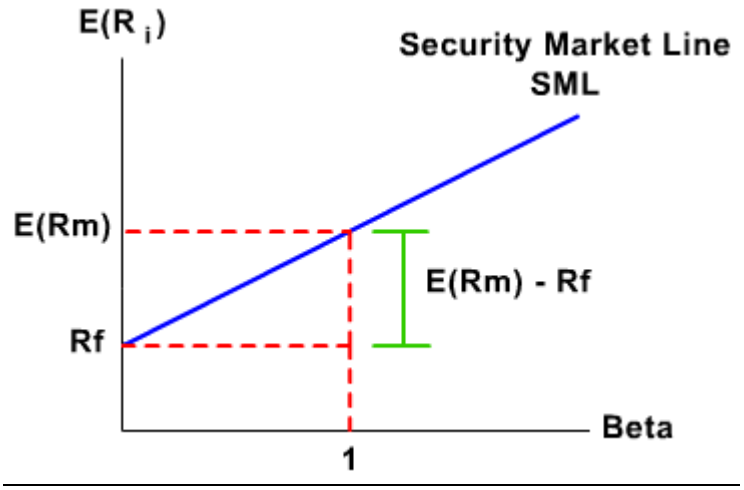
The security market line is a useful tool in determining whether an asset being considered for a portfolio offers a reasonable expected return for risk. Individual securities are plotted on the SML

[1] Stock selection criteria are methods for selecting stocks for investment. The stock investment or position can be "long" (to benefit from a stock price increase) or ''short" (to benefit from a decrease in a stock's price), depending on the investor's expectation of how the stock price is going to move. The stock selection criteria may include systematic stock picking methods that utilize computer software and/or data.

[2] Efficiente market hypothesis(EMH) asserts that financial markets are "informationally efficient", which means one cannot consistently achieve returns in excess of average market returns on a risk-adjusted basis, given the information available at the time the investment is made.

[3] Security characteristic line (SCL) is a regression line, plotting performance of a particular security or portfolio against that of the market portfolio at every point in time. The SCL is plotted on a graph where the Y-axis is the excess return on a security over the risk-free return and the X-axis is the excess return of the market in general. The slope of the SCL is the security's beta, and the intercept is its alpha.

graph. If the security's risk versus expected return is plotted above the SML, it is undervalued because the investor can expect a greater return for the inherent risk. A security plotted below the SML is overvalued because the investor would be accepting less return for the amount of risk assumed.



The Formula

The Y-intercept of the SML is equal to the risk-free interest rate. The slope of the SML is equal to the market risk premium and reflects the risk return trade off at a given time:

$$E(r)=r_f+\beta(E(r_M)-r_f)$$

Where:

r_f =Risk free rate

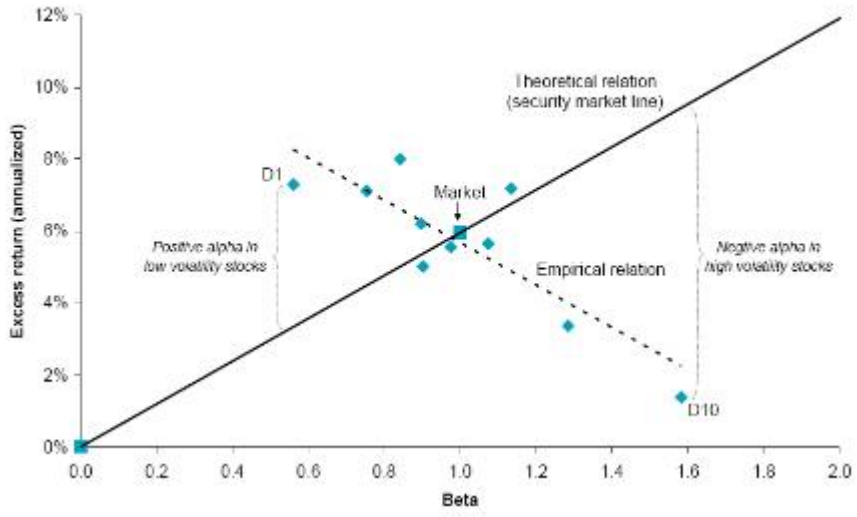
βa=Beta of security (portfolio's exposure to market risk)

r_m =Expected market return

When used in portfolio management, the SML represents the investment's opportunity cost (investing in a combination of the market portfolio and the risk-free asset). All the correctly priced securities are plotted on the SML. The assets above the line are undervalued because of a given amount of risk (beta), they yield a higher return. The assets below the line are overvalued because for a given amount of risk, they yield a lower return.

There is a question about what the SML looks like when beta is negative. A rational investor will accept these assets even though they yield sub-risk-free returns, because they will provide "recession insurance" as part of a well-diversified portfolio. Therefore, the SML continues in a straight line whether beta is positive or negative. A different way of thinking about this is that the absolute value of beta represents the amount of risk associated with the asset, while the sign explains when the risk occurs.

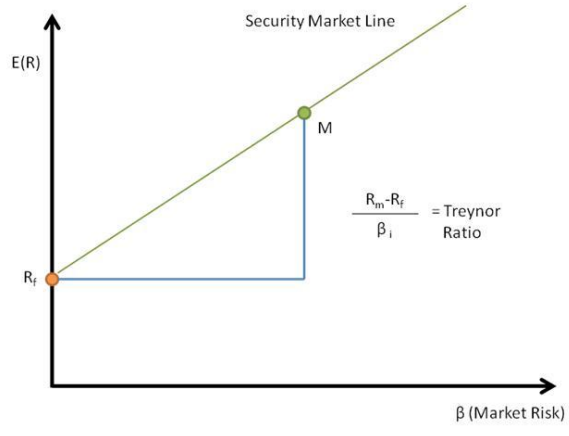
Figure 2: Empirical versus theoretical relation between beta and return



- Beta=1.0 implies as risky as markets
- Securities 1.1 till 2.0 are more risky than the market
  BETA >1.0
- Securities 0.0 till 0.9 are less risky than the market
  BETA<1.0

Treynor ratio & Alpha

All of the portfolios on the SML have the same Treynor ratio as does the market portfolio, i.e



$$\frac{E(R_i) - E_f}{\beta_i} = E(R_M) - E_f.$$

$$\Leftrightarrow$$

$$E_r = E_f + \beta i \, (E(R_M) - E_f)$$

In fact, the slope of the SML is the Treynor ratio of the market portfolio since $\beta_M = 1$

A stock picking rule of thumb for assets with positive beta is to buy if the Treynor ratio is above the SML and sell if it is below. Indeed, from the efficient market hypothesis, it follows that we cannot beat the market. Therefore, all assets should have a Treynor ratio less than or equal to that of the market. In consequence, if there is an asset whose Treynor ratio is bigger than the market's then this

asset gives more return for unity of systematic risk (i.e. beta), which contradicts the efficient market hypothesis.

This **abnormal** extra return over the market's return at a given level of risk is what is called the alpha.

Advantages & Disadvantages of SML

- ADVANTAGES
    - Explicitly adjust for systematic risk
    - Applicable to all companies as long as we compute beta
- DISADVANTAGES
    - Have to estimate the expected market risk premium, which does vary over time
    - Have to estimate beta, which also varies over time
    - We are replying on the past to predict the future, which is not always reliable.

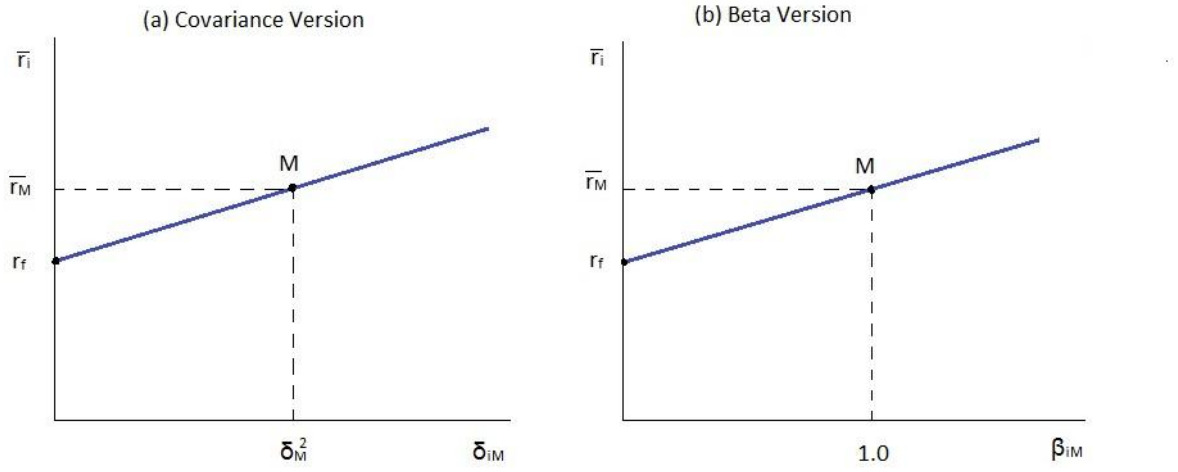
6. BETA

Beta measures a stock's volatility, the degree to which its price fluctuates in relation to the overall market. In other words, it gives a sense of the stock's market risk compared to the greater market. Beta is used also to compare a stock's market risk to that of other stocks. Investment analysts use the Greek letter 'ß' to represent beta.

This measure is calculated using regression analysis. A beta of 1 indicates that the security's price tends to move with the market. A beta greater than 1 indicates that the security's price tends to be more volatile than the market, and a beta less than 1 means it tends to be less volatile than the market. Many utility stocks have a beta of less than 1, and, conversely, many high-tech Nasdaq-listed stocks have a beta greater than 1.

For example, assume that market portfolio's expected return is 5%. If the market portfolio subsequently has an actual return of 10%, it will have returned 5% more than expected. Security A has a $\beta = 1,2$ and the expected return of 8%, but if the market has an actual return of 10%, than the security A should have the return of 14%, witch is 6% greater than initially expected. And if the market has an actual return of 3%, than the security A should have the return of 5,6%, witch is 2,4% lover than expected. Similarly, a security B has a $\beta = 0,8$ an expected return of 3%, but if the market has an actual return of 10%, than the security B should have the return of 7%, witch is 4% grater than initially expected. But if the market has an actual return of 3%, than the security B should have the return of 1,4%, witch is 1,6% lover then expected. The reason for the 2% (= 6% - 4%) and 0,8% (= 2,4% - 1,6%) difference is that the security A has a higher slope than security B – that is, security A is more sensitive then security B to returns on the market portfolio. The slope term in the CAPM is often referred as **beta coefficient** of just **beta** and is equal to: $\beta_{iM} = \delta_{iM} / \delta_M^2$ where δ_{iM} denotes the covariance of the return on stock *i* and the market portfolio, and δ_M^2 denotes the variance of returns on the market portfolio. In the Security Market Line where one of the equations expressing the SML is: $r_i = r_f + (r_M -$

r_f) β_{iM} , and the term β_{iM} is know as the beta coefficient for security *i* and it is an alternative way of representing the covariance of a security. It is actually a different version of the Security Market Line as can be seen in the panel (b) of the next Figure.
Figure 1: The Security Market Line



Source: Book: Investments, Fifth edition, Chapter 10; Written by: Sharpe, Alexander, Bailey

Some people are not prepared to take a loss on their investments therefore prefer investments with low volatility. Other people are willing to take on additional risk because with it they receive the possibility of increased reward. It is very important that investors not only have a good understanding of their risk tolerance, but also know which investments match their risk preferences.

And, by using beta to measure volatility, you can better choose those securities that meet your criteria for risk. Investors who are very risk averse should put their money into investments with low betas such as utility stocks and Treasury bills. Those investors who are willing to take on more risk may want to invest in stocks with higher betas.

In the CAPM, the beta of an investment is the risk that the investment adds to a market portfolio. In the APM and Multi-factor model, the betas of the investment relative to each factor have to be measured. There are three approaches available for estimating these parameters. The first is to use historical data on market prices for individual investments. The second is to estimate the betas from the fundamental characteristics of the investment. The third is to use accounting data.

The conventional approach for estimating the beta of an investment is a regression of the historical returns on the investment against the historical returns on a market index. For firms that have been publicly traded for a length of time, it is relatively straightforward to estimate returns that an investor would have made on investing in stock in intervals (such as a week or a month) over that period. In theory, these stock returns on the assets should be related to returns on a market portfolio, i.e. a portfolio that includes all traded assets, to estimate the betas of the assets. In practice, we tend to use a stock index as a proxy for the market portfolio, and we estimate betas for stocks against the index.

Most of us who use betas obtain them from an estimation service; Merrill Lynch, Barra, Value Line, Standard and Poor's, Morningstar and Bloomberg are some of the well known services. All these services begin with the regression beta described above and adjust them to reflect what they feel are

better estimates of future risk. Although many of these services do not reveal their estimation procedures, Bloomberg is an exception.

The Formula

The formula for the beta of an asset within a portfolio is

$$\beta_a = \frac{\mathrm{Cov}(r_a, r_p)}{\mathrm{Var}(r_p)},$$

where r_a measures the rate of return of the asset,
r_p measures the rate of return of the portfolio,
and $\mathrm{cov}(r_a, r_p)$ is the covariance between the rates of return.

The portfolio of interest in the CAPM formulation is the market portfolio that contains all risky assets, and so the r_p terms in the formula are replaced by r_m, the rate of return of the market.

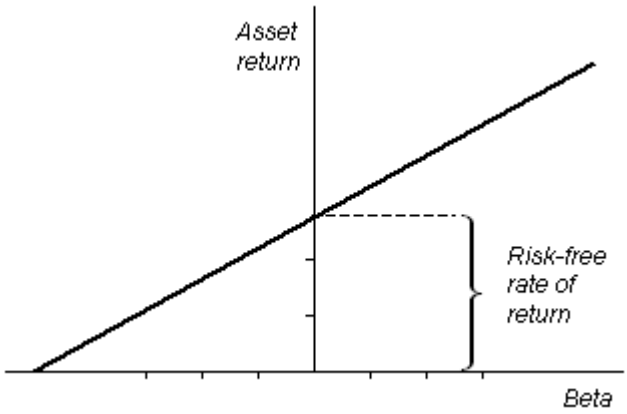
Beta is also referred to as financial elasticity or correlated relative volatility, and can be referred to as a measure of the sensitivity of the asset's returns to market returns, its non-diversifiable risk, its systematic risk, or market risk. On an individual asset level, measuring beta can give clues to volatility and liquidity in the marketplace. In fund management, measuring beta is thought to separate a manager's skill from his or her willingness to take risk.

The beta coefficient was born out of linear regression analysis. It is linked to a regression analysis of the returns of a portfolio (such as a stock index) (x-axis) in a specific period versus the returns of an individual asset (y-axis) in a specific year. The regression line is then called the Security characteristic Line (SCL).

$$\mathrm{SCL} : r_{a,t} = \alpha_a + \beta_a r_{m,t} + \epsilon_{a,t}$$

α_a is called the asset's alpha and β_a is called the asset's beta coefficient. Both coefficients have an important role in Modern portfolio theory.

Figure 2: The Security Market Line



Source: http://en.wikipedia.org/wiki/File:SecMktLine.png

The SML graphs the results from the capital asset pricing model (CAPM) formula. The *x*-axis represents the risk (beta), and the *y*-axis represents the expected return. The market risk premium is determined from the slope of the SML.

The relationship between β and required return is plotted on the *security market line* (SML) which shows expected return as a function of β. The intercept is the nominal risk-free rate available for the market, while the slope is $E(R_m) - R_f$. The security market line can be regarded as representing a single-factor model of the asset price, where Beta is exposure to changes in value of the Market. The equation of the SML is this:

$$\mathrm{SML} : E(R_i) - R_f = \beta_i (E(R_M) - R_f).$$

It is a useful tool in determining if an asset being considered for a portfolio offers a reasonable expected return for risk. Individual securities are plotted on the SML graph. If the security's risk versus expected return is plotted above the SML, it is undervalued because the investor can expect a greater return for the inherent risk. A security plotted below the SML is overvalued because the investor would be accepting a lower return for the amount of risk assumed.

Advantages of Beta

To followers of CAPM, beta is a useful measure. A stock's price variability is important to consider when assessing risk. Indeed, if you think about risk as the possibility of a stock losing its value, beta has appeal as a proxy for risk.

Intuitively, it makes plenty of sense. Think of an early-stage technology stock with a price that bounces up and down more than the market. It's hard not to think that stock will be riskier than, say, a safe-haven utility industry stock with a low beta.

Besides, beta offers a clear, quantifiable measure, which makes it easy to work with. Sure, there are variations on beta depending on things such as the market index used and the time period measured, but broadly speaking, the notion of beta is fairly straightforward to understand. It's a convenient measure that can be used to calculate the costs of equity used in a valuation method that discounts cash flows.

Disadvantages of Beta

Beta doesn't incorporate new information. Consider a utility company, let's call it Company XFor example. Company X has been considered a defensive stock with a low beta. When it entered the merchant energy business and assumed high debt levels, X's historic beta no longer captured the substantial risks the company took on. At the same time, many technology stocks are relatively new to the market and thus have insufficient price history to establish a reliable beta.

Another troubling factor is that past price movements are very poor predictors of the future. Betas are merely rear-view mirrors, reflecting very little of what lies ahead.

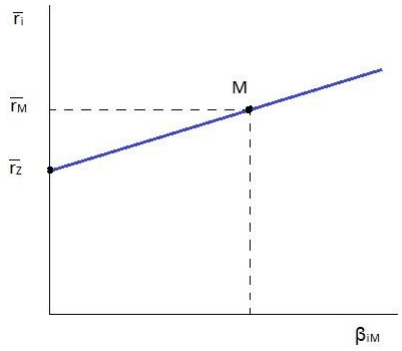
Furthermore, the beta measure on a single stock tends to flip around over time, which makes it unreliable. Granted, for traders looking to buy and sell stocks within short time periods, beta is a fairly good risk metric. However, for investors with long-term horizons, it's less useful.

Here is a basic guide to various betas:

Negative beta - A beta less than 0 - which would indicate an inverse relation to the market - is possible but highly unlikely. Some investors used to believe that gold and gold stocks should have negative betas because they tended to do better when the stock market declined, but this hasn't proved to be true over the long term.

Beta of 0 - Basically, cash has a beta of 0. In other words, regardless of which way the market moves, the value of cash remains unchanged (given no inflation). Below is the figure for zero beta.

Figure 3: The Zero-Beta Security Market Line



Source: Book: Investments, Fifth edition, Chapter 10; Written by: Sharpe, Alexander, Bailey

Beta between 0 and 1 - Companies with volatilities lower than the market have a beta of less than 1 (but more than 0). As we mentioned earlier, many utilities fall in this range.

Beta of 1 - A beta of 1 represents the volatility of the given index used to represent the overall market, against which other stocks and their betas are measured. The S&P 500 is such an index. If a stock has a beta of one, it will move the same amount and direction as the index. So, an index fund that mirrors the S&P 500 will have a beta close to 1.

Beta greater than 1 - This denotes a volatility that is greater than the broad-based index. Again, as we mentioned above, many technology companies on the Nasdaq have a beta higher than 1.

7. Equilibrium

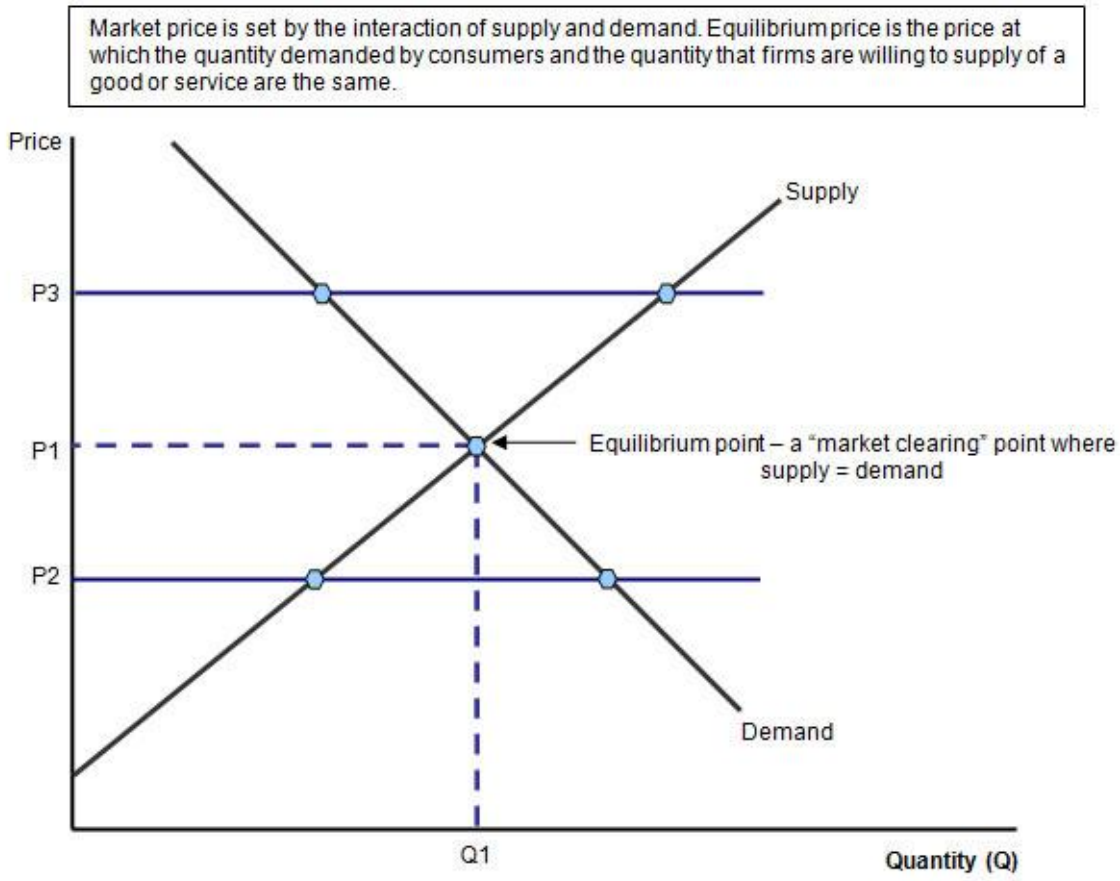
Definition

The concept of an economic equilibrium is fundamentally very complex and subtle. The goal to is to derive the outcome when the agents described in a model complete their process of maximizing behaviour. Determining when that process is complete, in the short run and in the long run, is an elusive goal as successive generations of economists rethink the strategies that agents might pursue.

At its simplest, however, we often find an equilibrium at the intersection of two or more lines. The explanation is this. Suppose line A represents the optimizing behaviour of one group of agents, and suppose line B represents the optimizing behaviour of another group of agents. Then, the intersection of lines A and B is the equilibrium where both groups of agents are optimizing.

The classic example is supply and demand. The supply curve shows the quantity supplied at a given price by profit-maximizing firms. The demand curve shows the quantity demanded at a given price

by utility-maximizing consumers. The intersection of the supply curve and the demand curve is the point that maximizes both profits and utility.



Moving from one market equilibrium to another

- Changes in equilibrium prices and quantities **do not happen instantaneously**! The shifts in supply and demand outlined in the diagrams before are reflective of changes in conditions in the market.
- So an outward shift of demand (depending upon supply conditions) leads to a short term rise in price and a fall in available stocks.
- The higher price is an incentive for suppliers to raise their output (termed as an expansion of supply) causing a movement up the short term supply curve towards the new equilibrium point.

Diagrams are a simplification of reality

- We tend to use supply and demand diagrams to illustrate movements in market prices and quantities – this is known as **comparative static analysis**
- The reality in most markets and industries is more complex. For a start, many businesses have imperfect knowledge about their demand curves – they do not know precisely how

consumer demand reacts to changes in price or the true level of demand at each and every price

- Likewise, constructing accurate supply curves requires detailed information on production costs and these may not be readily available.

A Summary of Changes in Market Equilibrium Price

Here is a summary when there is a unique change in one of the conditions of market demand or supply

Shift	Equilibrium Price	Equilibrium Quantity
Demand increases	**Higher**	**Higher**
Demand decreases	**Lower**	**Lower**
Supply increases	**Lower**	**Higher**
Supply decreases	**Higher**	**Lower**

8. Difference between Capital Market Line and Security Market Line

The Capital Market Line is a line that is used to show the rates of return, which depends on risk-free rates of return and levels of risk for a specific portfolio. Security Market Line , which is also called a Characteristic Line, is a graphical representation of the market's risk and return at a given time.

One of the differences between CML and SML is how the risk factors are measured. While standard deviation is the measure of risk for CML, Beta coefficient determines the risk factors of the SML.

The CML measures the risk through standard deviation, or through a total risk factor. On the other hand, the SML measures the risk through beta, which helps to find the security's risk contribution for the portfolio.

While the Capital Market Line graphs define efficient portfolios, the Security Market Line graphs define both efficient and non-efficient portfolios. While calculating the returns, the expected return of the portfolio for CML is shown along the Y- axis. On the contrary, for SML, the return of the securities is shown along the Y-axis. The standard deviation of the portfolio is shown along the X-axis for CML, whereas, the Beta of security is shown along the X-axis for SML.

Where the market portfolio and risk free assets are determined by the CML, all security factors are determined by the SML. Unlike the Capital Market Line, the Security Market Line shows the expected returns of individual assets. The CML determines the risk or return for efficient portfolios, and the SML demonstrates the risk or return for individual stocks.

Well, the Capital Market Line is considered to be superior when measuring the risk factors.

9. Testing Capm

We can compute expected return of a stock by using CAPM model

Ks = Krf + B (Km - Krf)
Ks = The required rate of return (or just the rate of return)
Krf = The risk free rate
B = Beta
Km = The expected return on the overall stock market

Example
If the beta (risk measure) of stock is 5, the expected market return over the period is 9% and the risk free rate is 6%, what is the expected return of the stock ?

6% + 5(9% - 6%) = 15%

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I would like to thank the project of CAPM of 2011(Slides)
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