CHAPTER 10: RETURN AND RISK: THE CAPITAL ASSET PRICING MODEL

Assigned problems: 3, 5, 6, 12, 15, 16, 17, 19, 23, 25, 26, 30, 33 and 34. Read Appendix 10A.

I. Expected (*ex ante)* Return, Variance, and Covariance

This analysis on pages 1 and 2 looks at future possible states "s" of the economy and a stock's return in each of the future economic states. Several important formulas are listed below.

Note: p_s is the probability of state "s" occurring:

R_s is the return on the security if state "s" occurs.

Expected Return of a Security = E(R) = $\bar{R} = \sum_{s=1}^{K} p_s R_s$

Variance of a Single Security = $\sigma^2 = \sum_{s=1}^{K} p_s \left(R_s - \bar{R}\right)^2$

Standard Deviation of a Single Security = $\sqrt{\text{Variance}} = \sigma$

Covariance Between any Two Securities = $\sigma_{AB} = \sum_{s=1}^{K} p_s \left(R_{s,A} - \overline{R_A}\right)\left(R_{s,B} - \overline{R_B}\right)$

Correlation Coefficient Between any Two Securities = $\rho_{AB} = \sigma_{AB}/(\sigma_A\sigma_B)$

Risk and Return of a two stock portfolio:

We use the following example to illustrate the calculation of return and risk statistics depending on various future economic *states of the world*:

Outcomes	Probability (p_s)	R_A	R_B
Boom	0.25	20%	5%
Normal	0.50	10%	10%
Bust	0.25	0%	15%

Expected Return

$\bar{R}_A$ or $E(R_A)$ = (0.25)(0.20) + (0.5)(0.10) + (0.25)(0.00) = 0.10, just a weighted average across the three future states

$\bar{R}_B$ or $E(R_B)$ = (0.25)(0.05) + (0.5)(0.10) + (0.25)(0.15) = 0.10

Variance (a measure of dispersion of returns around the mean or expected return)

$\sigma_A^2 = (0.25)(0.20\text{-}0.10)^2 + (0.5)(0.10\text{-}0.10)^2 + (0.25)(0.00\text{-}0.10)^2 = 0.00500$

$\sigma_B^2 = (0.25)(0.05\text{-}0.10)^2 + (0.5)(0.10\text{-}0.10)^2 + (0.25)(0.15\text{-}0.10)^2 = 0.00125$

Standard Deviation (always the square root of the variance)

$\sigma_A = (0.00500)^{0.5} = 0.07071 = 7.071\%$

$\sigma_B = (0.00125)^{0.5} = 0.03536 = 3.536\%$

Covariance

$\sigma_{AB} = (.25)[(.20\text{-}.10)(.05\text{-}.10)]+(.5)[(.10\text{-}.10)(.10\text{-}.10)]+(.25)[(.00\text{-}.10)(.15\text{-}.10)] = -0.0025$

Correlation coefficient

$\rho_{AB} = \sigma_{AB}/(\sigma_A\sigma_B)$ **DON'T FORGET ABOUT THIS EQUATION!!!**

$\rho_{AB} = -0.0025 / (0.07071)(0.03536) = -1.0$

Security B is a very unusual investment because it has its highest returns in economic downturns and its lowest returns during boom times. We use this extreme example to demonstrate the concept of *diversification*.

Diversification, using a two asset portfolio

Suppose in the previous example we invest $100 in security A and $200 in B. Dollar returns under each possible outcome are:

Outcome	Probability	CF on $100 in A	CF on $200 in B	Total CF	%Return on $300 in A&B
Boom	.25	$120	$210	$330	10%
Normal	.50	$110	$220	$330	10%
Bust	.25	$100	$230	$330	10%
				Expected Return	10%
				Variance	0.00
				Standard Deviation	0.00% (no risk)

In economic upturns, we would do well in security A but poorly in B. In downturns, higher returns to B would offset lower returns to A. Combining securities A and B together, we can form a portfolio with a certain return of $330. Many are often surprised to find that a portfolio of risky assets can have no risk or variability of return. Since security B is an extreme example, it is important to point out that *diversification* works in many cases. 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 $\rho_{AB} = 0$

As long as two securities are not perfectly positively correlated ($\rho_{AB} = +1.0$), diversification will work. Most pairs of common stocks will have correlation coefficients between 0.2 and 0.6. We examine the effects of diversification in more detail in the following sections.

II. Return and Risk for Portfolios

Expected Return of a Portfolio = $E(R_p) = \bar{R}_p = \sum_{i=1}^{N} X_i \bar{R}_i$

Variance of a Portfolio = $\sigma_p^2 = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + 2\sum_{i=1}^{N} \sum_{j=1, i\neq j}^{N} X_i X_j \sigma_{ij}$

where X_i is the percentage (or weight) of the portfolio in security "i" and "N" is the number of securities in the portfolio. **The sum of the weights must always add up to 1.0.**

The above formulas apply to portfolios with many securities. We next utilize the formula version for the expected return and risk for a 2-asset portfolio:

(1) $\mathbf{E(R_p) = X_A E(R_A) + X_B E(R_B)}$ (always a weighted average across the stocks)

(2) $\mathbf{\sigma_p^2 = X_A^2 \sigma_A^2 + X_B^2 \sigma_B^2 + 2X_A X_B \sigma_{AB}}$ (portfolio risk is never a weighted average)

Applying the portfolio formulas to the previous example of Section I:

$X_A = \$100/\$300 = 1/3$

$X_B = 1 - X_A = 2/3$

$E(R_P) = (1/3)(0.10) + (2/3)(0.10) = 0.10$

$\sigma_p^2 = X_A^2\sigma_A^2 + X_B^2\sigma_B^2 + 2X_A X_B \sigma_{AB}$

$= (1/3)^2(0.00500) + (2/3)^2(0.00125) + (2)(1/3)(2/3)(-0.0025) = 0$, a riskless portfolio

III. Efficient Sets And Diversification

The example here uses two stocks: **IBM** and **Homestake Mining** (HM). Assume that the correlation $\rho=0$ and covariance $\sigma_{IBM,HM} = 0$ and each stock has the following characteristics:

Stock	X_i	E (Ri)	σ_i^2	σ_i
IBM	X_{IBM}	0.09	0.01	10%
HM	X_{HM}	0.13	0.04	20%
Total	100%			

The following Tables illustrate portfolios comprised of **IBM** and **Homestake**. The weights in each security are allowed to vary from 0.0 to 1.0. Figure 1 shows the portfolio possibilities for $\rho=0$. Figure 2 expands the result to illustrate the three correlations of 0, +1.0, and -1.0 in order to demonstrate the differences. The equations for calculating the portfolio expected return and variance were given earlier and are:

$E(R_p) = X_{IBM}E(R)_{IBM} + X_{HM}E(R)_{HM}$

$\sigma_p^2 = X_{IBM}^2\sigma_{IBM}^2 + X_{HM}^2\sigma_{HM}^2 + 2X_{IBM}X_{HM}\sigma_{IBM,HM}$

Remember that covariance is defined as: $\sigma_{IBM,HM} = \rho_{IBM,HM}\sigma_{IBM}\sigma_{HM}$

	IBM	**Homestake**
Exp. Return	0.09	0.13
Std. Deviation	0.10	0.20
Variance	0.01	0.04
Correlation	As listed in Table below	

Weight in IBM	Weight in Homestake	Portfolio Expected Return	Port. Standard Deviation, **Correlation equals 0.0**	Port. Standard Deviation, **Correlation equals +1.0**	Port. Standard Deviation, **Correlation equals -1.0**
1.00	0.00	9.00%	10.00%	10.00%	10.00%
0.95	0.05	9.20%	9.55%	10.50%	8.50%
0.90	0.10	9.40%	9.22%	11.00%	7.00%
0.85	0.15	9.60%	9.01%	11.50%	5.50%
***0.80**	**0.20**	**9.80%**	**8.94%**	12.00%	4.00%
0.75	0.25	10.00%	9.01%	12.50%	2.50%
0.70	0.30	10.20%	9.22%	13.00%	1.00%
0.65	0.35	10.40%	9.55%	13.50%	0.50%
****0.60**	**0.40**	**10.60%**	**10.00%**	14.00%	2.00%
0.55	0.45	10.80%	10.55%	14.50%	3.50%
0.50	0.50	11.00%	11.18%	15.00%	5.00%
0.45	0.55	11.20%	11.88%	15.50%	6.50%
0.40	0.60	11.40%	12.65%	16.00%	8.00%
0.35	0.65	11.60%	13.46%	16.50%	9.50%
0.30	0.70	11.80%	14.32%	17.00%	11.00%
0.25	0.75	12.00%	15.21%	17.50%	12.50%
0.20	0.80	12.20%	16.12%	18.00%	14.00%
0.15	0.85	12.40%	17.07%	18.50%	15.50%
0.10	0.90	12.60%	18.03%	19.00%	17.00%
0.05	0.95	12.80%	19.01%	19.50%	18.50%
0.00	1.00	13.00%	20.00%	20.00%	20.00%

* The portfolio that is 80% and 20% invested in IBM and HM, respectively, represents the minimum variance portfolio for **Figure 1**, the ZERO correlation or covariance case.

** Also in **Figure 1**, the portfolio that is 60% and 40% invested in IBM and HM, respectively, has the same risk or standard deviation (10%) as a portfolio 100% invested in IBM, while having a higher expected return (10.6% versus 9%) than being 100% in IBM.

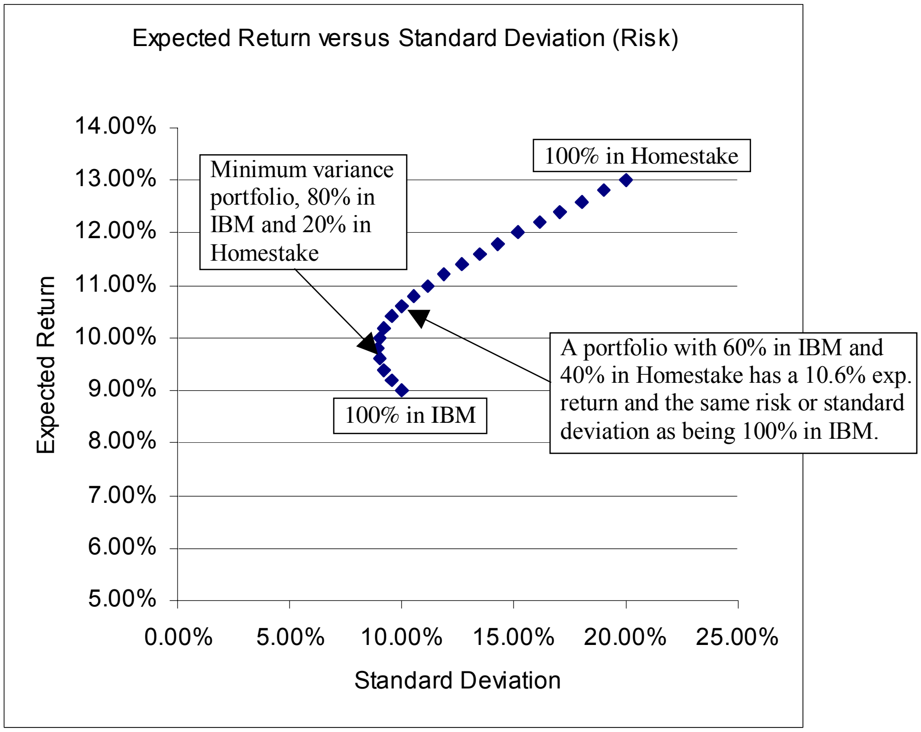


Figure 1

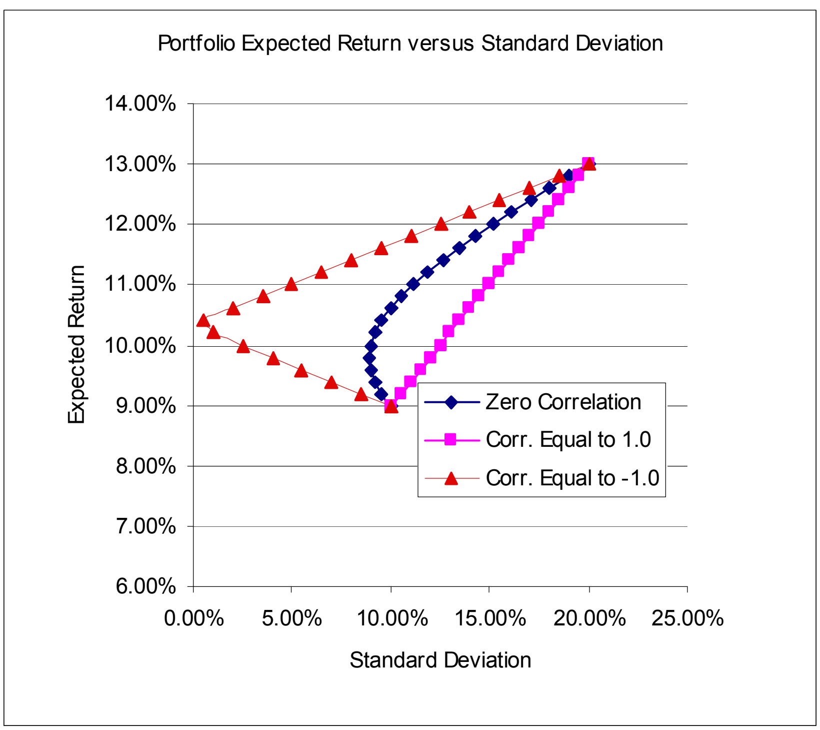


Figure 2

As long as $\rho<1$, the standard deviation of a portfolio of two securities is *less* than the weighted average of the standard deviations of the individual securities (again, this is why diversification works). When $\rho=1$ the standard deviation of a portfolio of two securities is the weighted average of the standard deviations of the individual securities.

The **efficient set** includes portfolios within the investment opportunity set that represent the **best** return-risk combinations. To be included in the efficient set, a portfolio must have the highest expected return at a given standard deviation relative to all other portfolios in the investment opportunity set

Note that in Figure 1 above, the rational investor will only choose a portfolio that is weighted 80% or less in IBM. Any portfolio *below* the Minimum Variance Portfolio (weighted more than 80% in IBM) is inferior since there is always some portfolio having higher expected return with the same standard deviation.

IV. Portfolios With Many Securities

As the number of securities increases in a portfolio, the covariance terms outnumber the variance terms. For example, a portfolio with N=3 securities has $N^2 = 9$ terms; consisting of 6 covariance terms and 3 variance terms. In general, there are $N^2 - N$ covariance terms and N variance terms in a portfolio. Consequently, the variance of return on a portfolio with many securities is more dependent on the covariances between the individual securities than on the variances of the individual securities. This concept is central to the Modern Portfolio Theory or MPT.

The **Variance-Covariance matrix** below is an ideal tool to both calculate and understand portfolio variance or standard deviation. The two stock IBM and Homestake example from Section III is extended to include a third stock -- Home Depot. The matrix contains $N^2=9$ terms; 3 are variance terms and 6 are covariance terms. Sum up all nine cells and you have just computed the portfolio variance for a three asset portfolio.[1]

	IBM	**Homestake**	**Home Depot**
IBM	$X_{IBM}^2\sigma_{IBM}^2$	$X_{IBM}X_{HM}\sigma_{IBM,HM}$	$X_{IBM}X_{HD}\sigma_{IBM,HD}$
Homestake	$X_{HM}X_{IBM}\sigma_{HM,IBM}$	$X_{HM}^2\sigma_{HM}^2$	$X_{HM}X_{HD}\sigma_{HM,HD}$
Home Depot	$X_{HD}X_{IBM}\sigma_{HD,IBM}$	$X_{HD}X_{HM}\sigma_{HD,HM}$	$X_{HD}^2\sigma_{HD}^2$

To extend this example, a portfolio with N=100 securities has $N^2=10{,}000$ boxes or elements in the matrix; 9900 covariance terms and 100 variance terms. Sum up the terms of each of the 10,000 boxes, take the square root, and you have the portfolio standard deviation.

If you then add a one additional stock (a 101st stock to this portfolio); the portfolio with N=101 securities has $N^2=10{,}201$ boxes or elements in the variance/covariance matrix. The one additional stock has added 1 new *variance* term and 200 new *covariance* terms. The change to

[1] If you add together just the four cells associated with a two asset portfolio of IBM and Homestake, then you obtain the two-asset variance equation presented earlier.

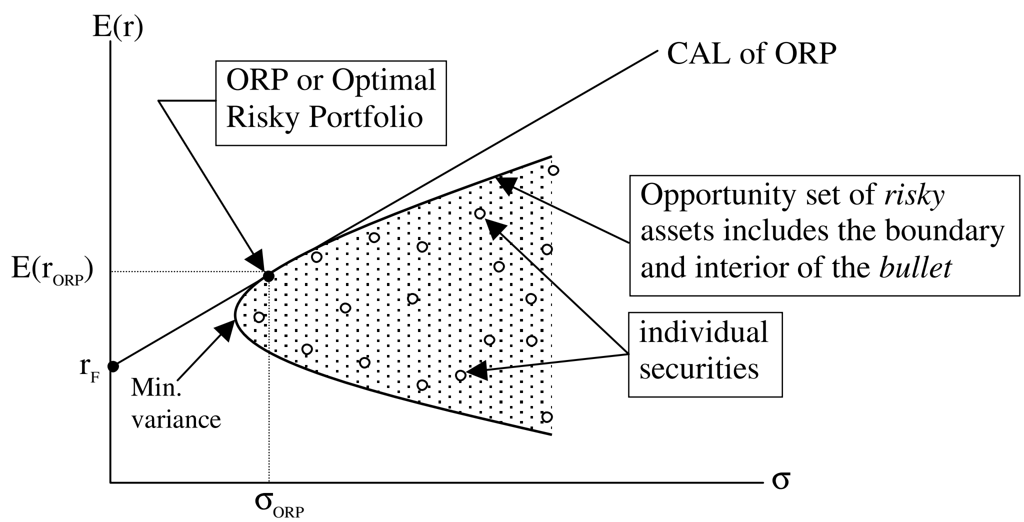
the portfolio risk depends on how the new 101st security is correlated with each of the other 100 different securities. The variance of the new security (generally considered a stock's "stand alone" risk) is irrelevant, and only the *portfolio* risk is relevant.

The Efficient Set for many securities

The intuition behind the 2-asset case applies to the case with *many* securities. However, the investment opportunity set for many securities is an *area*, rather than the curve of Figure 1. The **Efficient Set** is the upper boundary of the curve above the minimum variance portfolio. Since most common stocks have a correlation coefficient between 0.2 and 0.5, the variance of a well-diversified portfolio is less than the weighted average of the variance of individual stocks. The efficient set is composed mostly of well-diversified portfolios.

There are an infinite number of risky portfolios that can be created. However, we will eventually discover that only *one* of these risky portfolios is relevant to a *rational* investor. We assume that rational investors are *risk averse* and *mean-variance optimizers*.

For portfolios of many securities, computer software will generate the *bullet* or *portfolio frontier* shown in the **Figure** below. The top boundary or curve of the bullet (above Minimum Variance point) is the **efficient set**. A rational investor will only care about risky portfolios that exist on the efficient set! Note that for any given Expected Return, the "bullet" or portfolio frontier represents the point of minimum attainable risk or standard deviations.



Now, let us introduce one new type of asset; the **riskless asset**, having no risk (zero standard deviation) and yielding the risk-free rate of return r_F, e.g., something like 3-month U.S. T-bills.

Now, allow the investor to combine the riskless investment with a portfolio of risky assets (calculation examples will soon follow in Section V). Once the riskless asset is introduced, a rational investor now only cares about one portfolio risky portfolio on the efficient set, called the **Optimal Risky Portfolio** or **ORP**. All other risky portfolios on the efficient set (or anywhere on or within the bullet) become *inferior*.

The **Capital Allocation Line** or **CAL** represents the *linear* combination of the riskless asset and a portfolio of risky assets. The investor's ORP is found where the CAL is *tangent* to the efficient set of the bullet. The ORP is the only portfolio of risky assets that the investor will hold.

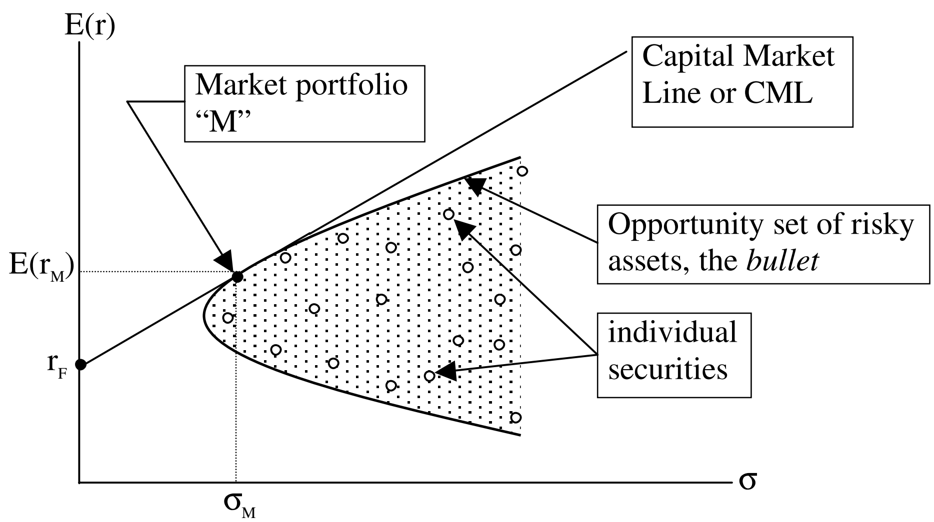
The investor can create an infinite number of CALs, by combining the riskless asset with various points on the efficient frontier (and even inferior portfolios within the bullet). However, the *optimal* CAL is always the one that is *tangent* to the **efficient set**. This line has the highest slope or expected reward to risk ratio.

We now have a tool that the individual investor or portfolio manager can employ. First, the investor must identify the portfolio bullet. Next, given the riskless asset's rate of return r_F, the investor must identify the ORP on the efficient set. Finally, the investor will hold some combination of the riskless asset and the ORP, according to his/her tolerance for risk.

In any case, the CAL identified in the Figure above represents the highest *expected* reward to risk ratio that is available to the investor.

V. Capital Market Equilibrium and CAPM Model

In a world with *homogeneous expectations*, normally distributed asset returns, and rational investors, all will identify the same bullet or portfolio frontier, efficient set, Optimal Risky Portfolio (ORP), and Capital Allocation Line (CAL). Everyone then holds some combination of the ORP and riskless asset. Since everyone holds the same ORP, we now refer to this risky portfolio as the **Market portfolio**. The CAL now becomes the **Capital Market Line** or **CML**. The CML is *identical* for *all* rational investors.



Let us now construct portfolios, called **P**, by combining the Market portfolio **M** with the riskless asset **F**. All portfolios **P** will lie exactly on the Capital Market Line or CML.

$\mathbf{E(R_P) = X_M R_M + (1-X_M)R_F}$, and $\boldsymbol{\sigma_P = X_M \sigma_M}$, since $\sigma_{RF} = 0$

Let $R_M = 10\%$, $R_F = 5\%$, and $\sigma_M = 20\%$

<u>Portfolio No. 1:</u>

Let $X_M = 1$ and $X_F = 0$ (100% is held in the market portfolio)

$E(R_P) = X_M R_M + (1-X_M)R_F = (1.0)(0.10) + (1-1)(0.05) = 0.10$ or 10%

$\sigma_P = X_M \sigma_M = (1.0)(0.20) = 0.20$ or 20%

<u>Portfolio No. 2:</u>

Let $X_M = 0.5$ and $X_F = 0.5$ (50% is held in both the market portfolio and riskless asset)

$E(R_P) = X_M R_M + (1-X_M)R_F = (0.5)(0.10) + (1-0.5)(0.05) = 0.075$ or 7.5%

$\sigma_P = X_M \sigma_M = (0.5)(0.20) = 0.10$ or 10%

<u>Portfolio No. 3:</u>

Let $X_M = 1.5$ and $X_F = -0.5$ (take $1 of your money and then *borrow* $0.50 at the riskless rate, and invest all $1.50 in the market portfolio). This is like buying stock "on margin", as there is a negative weight on the riskless asset.

$E(R_P) = X_M R_M + (1-X_M)R_F = (1.5)(0.10) + (1-1.5)(0.05) = 0.125$ or 12.5%

$\sigma_P = X_M \sigma_M = (1.5)(0.20) = 0.30$ or 30%

<u>Systematic versus Unsystematic Risk</u>

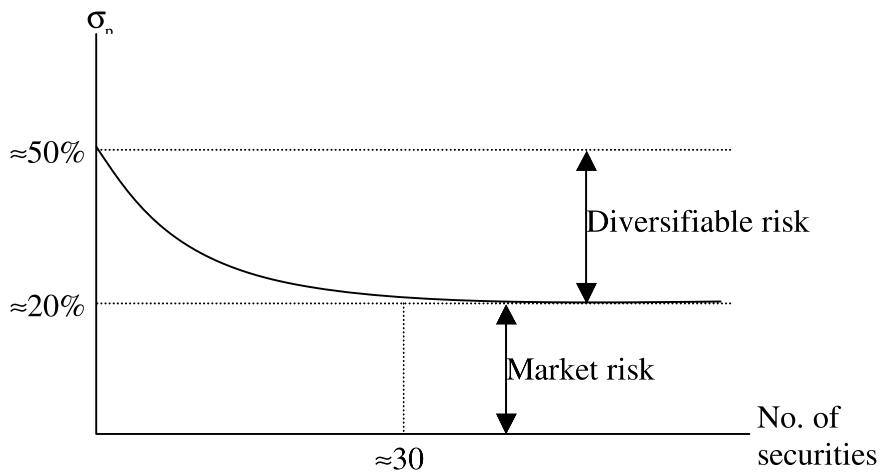
Since a *rational* investor will only hold the well-diversified Market portfolio as the risky asset, the standard deviation of his portfolio is less than the weighted average standard deviation of the underlying securities. For this investor, diversification eliminates part of the risk of an individual security. Therefore, the only relevant risk is a security's contribution towards the standard deviation or risk of the well-diversified portfolio. Any security's risk is comprised as follows:

Total risk of individual security = systematic risk + unsystematic (diversifiable) risk

For the *typical* stock, about 25% and 75% of its total return variance is driven by systematic and unsystematic risk, respectively. Thus for a typical stock, about 75% of its return variance is attributed to risk that is specific or unique to the firm. This risk is also referred to as nonsystematic, diversifiable, or firm-specific risk.

For a *well diversified* or *market* portfolio of stocks, then about 100% of your return variance is due to risk that is macroeconomic or market in nature, often referred to as systematic risk or nondiversifiable risk. While the *individual* securities are all certainly affected by risks that are specific to the individual firms (or industries), nearly all of this risk is diversified away in a well-diversified portfolio. Since firm-specific risk is diversifiable, it should be irrelevant. Only the market or systematic risk is now relevant as it affects all stocks to some degree.

The following graph illustrates the typical relation between portfolio risk and number of securities in a portfolio. Note that the typical stock has an annual standard deviation of around 50%, while for the market portfolio the standard deviation is around 20%. Market or macroeconomic risk cannot be diversified away, and therefore it is the only relevant risk.



The Capital Asset Pricing Model (CAPM)

All rational investors identify the exact same ORP portfolio of risky assets. The only ORP of risky assets that investors will choose to own is the **Market** portfolio.

Since rational investors hold the **Market** portfolio, the relevant risk of any security is its contribution towards the risk of the **Market** portfolio, also known as **Beta** (β). Beta is the measure of a stock's *systematic* or *macroeconomic* risk. The **market** portfolio has a Beta of 1.0 by definition.[2] Systematic risk cannot be diversified away in a portfolio and therefore, rational risk averse investors require a *risk premium* for incurring this type of risk. Therefore, Beta or systematic risk is the only risk factor that concerns rational investors. Beta is defined as:

$$\beta_i = \sigma_{i,M}/\sigma^2_M$$

Remember that: $\sigma_{i,M} = \rho_{i,M}(\sigma_i\sigma_M)$ and σ_M is the standard deviation of the Market Portfolio.[3] The *linear* relationship between required return and Beta for an individual security *i* under CAPM is:

$$R_i = R_F + \beta_i\,[R_M - R_F]$$

EXAMPLE: Apple Computer has a Beta of 0.80. The required return on the market portfolio (think of the market portfolio as something akin to the Standard and Poors 500 or S&P 500 index) is R_M=10%. The Risk Free rate of interest is R_F=5%.

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[2] Stocks with Betas of 0.5 and 1.5 will move with the market portfolio but by 50% and 150% as much, respectively. Zero and even negative Beta stocks are theoretically possible. A well-diversified portfolio of zero Beta stocks will have both zero systematic and unsystematic risk and therefore should earn the riskless rate R_F. A zero Beta stock may have considerable firm-specific or unsystematic risk, however it has no market or systematic risk.

[3] What is a "market portfolio"? Ideally, this is a global wealth portfolio of all assets. However, such a portfolio is certainly unobservable. A stock market index, such as the Standard and Poors 500 index, is usually used.

R_{AAPL} = 0.05 + 0.80[0.10 - 0.05] = 0.05 + 0.80[0.05] = 0.05 + 0.04 = 0.09 or 9.0%

NOTE: The 0.05 or **5%** term within the brackets is known as the *Market Risk Premium*. This refers to the extra compensation for risk that risk averse investors require for holding the market portfolio **M** of all stocks.[4] The (0.80)(0.05) = 0.04 or **4%** term is known as the *risk premium* for Apple Computer stock.

Security Market Line (SML):

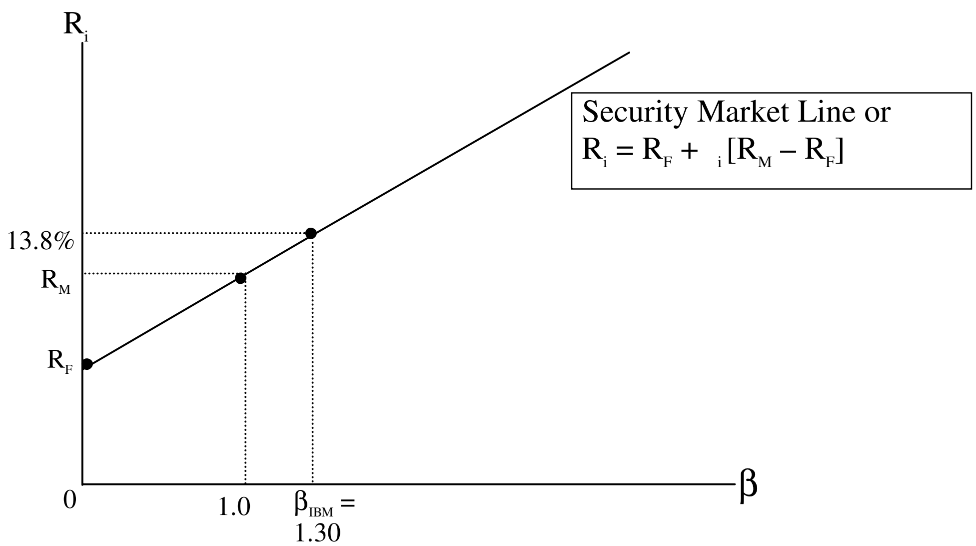
The CAL and CML refer to the relation between well-diversified portfolios and their standard deviations. The CML specifically refers to combinations of the Market portfolio and riskless asset. The SML is very different in that it refers to the relationship of the required return of an *individual* asset to its *Beta*. The SML is nothing more than a graphical depiction of the linear **CAPM** equation.

Example: Let R_M = 12% and R_F = 6%. Let IBM have a *true* β = 1.30.

$E(r_{IBM}) = R_F + \beta_{IBM}[R_M - R_F]$

R_{IBM} = 0.06 + (1.30)[0.12 – 0.06] = 0.06 + (1.30)[0.06] = 0.06 + 0.078 = 0.138

The required return of IBM is thus 13.8%, which is comprised of the 6% riskless rate and the 7.8% risk premium of IBM. The risk premium of the Market portfolio is [12% - 6%] = 6%.



[4] If *marginal* investors (those driving stock prices) are *risk averse*, they will certainly demand a risk premium for stocks, so that stocks are attractive when compared to low risk investments such as T-bills.

CAPM, the Security Market Line, and mispricing of stocks:

Under the **CAPM**, any asset's required return should be a function of its Beta and its return should fall exactly on the **SML** line. If not on the SML, then the stock is *mispriced*.

Let the Beta of the common stock of MLH Corporation be $\beta_{MLH} = 2.0$, the required return on the market portfolio is $R_M = 10\%$, and the riskless rate of interest is $R_F = 6\%$.

The required return of MLH stock is thus:

$$\mathbf{R_{MLH} = R_F + \beta_{MLH}(R_M - R_F) = 0.06 + 2.0[0.10 - 0.06] = 0.06 + 0.08 = 0.14 \text{ or } 14.0\%}$$

For the sake of this example, assume that you are an analyst and you know that the TRUE Beta of MLH is 2.0. In this case, MLH's TRUE required rate of return is 14% per year. If this stock is properly priced in the market, it should be priced to yield an expected return of 14% per year. MLH is mature and everyone expects it to pay out a total Free Cash Flow to Equity of $FCFE_1$ = $1.00 per share exactly one year from today and the permanent growth rate g = 6% per year. Using the constant growth model, you estimate that the stock should be worth:

$\mathbf{P_0 = FCFE_1/(r - g)} = 1.00/(0.14 - 0.06) =$ **$12.50 per share.**

Assume that you are correct in this analysis. If the <u>current</u> market price of this stock is actually **$12.50** then the stock is properly priced to yield a *normal* or *fair* return. However, what if you are right but the market has priced the stock incorrectly (perhaps the market has estimated the risk incorrectly)?

<u>**Scenario 1**</u>: Assume the stock is priced by the market to yield an expected return of r = 16% per year. Then the stock is **mispriced** and selling at:

$P_0 = FCFE_1/(r - g) = 1.00/(0.16 - 0.06) =$ **$10.00 per share**. The stock is priced to yield 16% per year at this price, which is too high of a rate of return. The stock is **Undervalued** at $10.00 and you would recommend that this stock be **purchased**.

<u>**Scenario 2:**</u> Assume the stock is priced by the market to yield an expected return of r = 12% per year. Then the stock is **mispriced** and selling at:

$P_0 = FCFE_1/(r - g) = 1.00/(0.12 - 0.06) =$ **$16.67 per share**. The stock is priced to yield 12% per year at this price, which is too low of a rate of return. The stock is **Overvalued** at $16.67 and you would recommend that this stock be **sold** or perhaps even **shorted**.

In either **Scenario 1** or **2** above, the mispricing should eventually be corrected.

The stock should be priced exactly on the SML to yield R_{MLH} = 14% for a Beta of 2.0.

<u>**In Scenario 1**</u>, the stock lies <u>above</u> the SML: while the true Beta is 2.0, the stock is priced at a return of 16%, when it should be 14%. Any stock that lies *above* the SML is **Undervalued**.

<u>**In Scenario 2**</u>, the stock lies <u>below</u> the SML: while the true Beta is 2.0, the stock is priced at a return of 12%, when it should be 14%. Any stock that lies *below* the SML is **Overvalued**.