Portfolio Management

2018年6月CFA一级培训

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Portfolio Management

1. Portfolio Risk and Return: Part Ⅰ
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Portfolio Risk and Return: Part I

Holding Period Return (HPR):

- *Financial assets normally generate two types of return for investors.*

  --Provide periodic income through cash dividends or interest payments.

  --The price of a financial asset can increase or decrease, leading to a capital gain or loss.

- ***A holding period return (HPR):*** *the return earned from holding an asset for a single specified period of time.*

$$R = \frac{P_t - P_{t-1} + D_t}{P_{t-1}} = \frac{P_t - P_{t-1}}{P_{t-1}} + \frac{D_t}{P_{t-1}} = \text{Capital gain} + \text{Dividend yield}$$

$$= \frac{P_T + D_T}{P_0} - 1$$

- *HPR for more than one year: R=(1+R1) (1+R2) … (1+Rn) -1*

  Ri is the annual return for year i

Arithmetic mean and Geometric mean Return

- *The arithmetic mean return*

$$\bar{R}_i = \frac{R_{i1} + R_{i2} + \ldots + R_{i,T-1} + R_{iT}}{T} = \frac{1}{T}\sum_{t=1}^{T} R_{it}$$

- *A geometric mean return*

$$\bar{R}_{Gi} = \sqrt[T]{(1 + R_{i1}) \times (1 + R_{i2}) \times \ldots \times (1 + R_{i,T-1}) \times (1 + R_{iT})} - 1$$

$$= \sqrt[T]{\prod_{t=1}^{T}(1 + R_{it})} - 1$$

where R_{it} is the return in period t and T is the total number of periods.

- *The arithmetic mean return is the average of the returns earned on a unit of investment at the beginning of each holding period. A geometric mean return provides a more accurate representation of the growth in portfolio value over a given time period than does an arithmetic mean.*

The Money-Weighted Return

- *The money-weighted return: an accurate measure of what the investor actually earned on the money invested.*
- *The money-weighted return and its calculation are similar to the* ***internal rate of return****.*

Comparison of Returns- Examples

The money-weighted return does not allow for return comparison between different individuals or different investment opportunities. Two investors in the same mutual fund may have different money-weighted returns because they invested different amounts in different years.

Exhibit 2

Year	1	2	3
Balance from previous year	€0	€50	€1,000
New investment by the investor (cash inflow for the mutual fund) at the start of the year	100	950	0
Net balance at the beginning of year	100	1,000	1,000
Investment return for the year	–50%	35%	27%
Investment gain (loss)	–50	350	270
Withdrawal by the investor (cash outflow for the mutual fund) at the end of the year	0	–350	0
Balance at the end of year	€50	€1,000	€1,270

EXAMPLE 1

Computation of Returns

Ulli Lohrmann and his wife, Suzanne Lohrmann, are planning for retirement and want to compare the past performance of a few mutual funds they are considering for investment. They believe that a comparison over a five-year period would be appropriate. They are given the following information about the Rhein Valley Superior Fund that they are considering.

Year	Assets Under Management at the Beginning of Year (€)	Net Return (%)
1	30 million	15
2	45 million	–5
3	20 million	10
4	25 million	15
5	35 million	3

The Lohrmanns are interested in aggregating this information for ease of comparison with other funds.

1. Compute the holding period return for the five-year period.
2. Compute the arithmetic mean annual return.
3. Compute the geometric mean annual return. How does it compare with the arithmetic mean annual return?
4. The Lohrmanns want to earn a minimum annual return of 5 percent. Is the money-weighted annual return greater than 5 percent?

Solution to 1:

B is correct. The definition of risk management includes both defining the level of risk desired and measuring the level of risk taken. Risk management means taking risks actively and in the best, most value-added way possible and is not about minimizing risks.

Solution to 2:

A is correct. Governance is the element of the risk management framework that is the top-level foundation for risk management. Although policies, procedures, and infrastructure are necessary to implement a risk management framework, it is governance that provides the overall context for an organization's risk management.

Solution to 3:

C is correct. Risk identification and measurement is the quantitative part of the process. It involves identifying the risks and summarizing their potential quantitative impact. Communication and risk governance are largely qualitative.

Solution to 4:

C is correct. Risk monitoring, mitigation, and management require recognizing and taking action when these (risk exposure and risk tolerance) are not in line, as shown in the middle of Exhibit 1. Risk governance involves setting the risk tolerance. Risk identification and measurement involves identifying and measuring the risk exposures.

EXAMPLE 2

London Arbitrageurs, PLC employs many analysts who devise and implement trading strategies. Mr. Brown is trying to evaluate three trading strategies that have been used for different periods of time.

- **Keith believes that he can predict share price movements based on earnings announcements. In the last 100 days he has earned a return of 6.2 percent.**

- **Thomas has been very successful in predicting daily movements of the Australian dollar and the Japanese yen based on the carry trade. In the last 4 weeks, he has earned 2 percent after accounting for all transactions costs.**

- **Lisa follows the fashion industry and luxury retailers. She has been investing in these companies for the last 3 months. Her return is 5 percent.**

Mr. Brown wants to give a prize to the best performer but is somewhat confused by the returns earned over different periods. Annualize returns in all three cases and advise Mr. Brown.

Solution to 1:

B is correct. The enterprise view is characterized by a focus on the organization as a whole—its goals, value, and risk tolerance. It is not about strategies or risks at the individual business line level.

Solution to 2:

C is correct. Risk tolerance identifies the extent to which the organization is willing to experience losses or opportunity costs and fail in meeting its objectives. It is best discussed before a crisis and is primarily a risk governance or oversight issue at the board level, not a management or tactical one.

Solution to 3:

C is correct. Risk budgeting is any means of allocating a portfolio by some risk characteristics of the investments. This approach could be a strict limit on beta or some other risk measure or an approach that uses risk classes or factors to allocate investments. Risk budgeting does not require nor prohibit hedging, although hedging is available as an implementation tool to support risk budgeting and overall risk governance.

Solution to 4:

B is correct. A chief risk officer or a risk management committee is an individual or group that specializes in risk management. A chief financial officer may have considerable knowledge of risk management, may supervise a CRO, and would likely have some involvement in a risk management committee, but a CFO has broader responsibilities and cannot provide the specialization and attention to risk management that is necessary in a large organization.

Annualized Return

- *If the weekly return is 0.2 percent, then the compound annual return is computed as shown because there are 52 weeks in a year:*

$$r_{annual} = \left(1 + r_{weekly}\right)^{52} - 1 = \left(1 + 0.2\%\right)^{52} - 1$$
$$= \left(1.002\right)^{52} - 1 = 0.1095 = 10.95\%$$

- *A general equation to annualize returns is given, where c is the number of periods in a year. For a quarter, c = 4 and for a month, c = 12:*

$$r_{annual} = \left(1 + r_{period}\right)^{c} - 1$$

- *Similar expressions can be constructed when quarterly or weekly returns are needed for comparison instead of annual returns.*

$$r_{weekly} = \left(1 + r_{daily}\right)^{5} - 1; \quad r_{weekly} = \left(1 + r_{annual}\right)^{1/52} - 1$$

Other Major Return Measures and their Applications

- ***Gross and Net Return***

--A gross return is the return earned by an asset manager prior to deductions for expenses that are not directly related to the generation of returns but rather related to the management and administrationof an investment.

--Gross return is an appropriate measure for evaluating and comparing the investment skill of asset managers.

--Net return accounts for all managerial and administrative expenses that reduce an investor's return.

- ***Pre-tax and After-tax Nominal Return***

--All return measures discussed previously are pre-tax nominal returns— that is, no adjustment has been made for taxes or inflation. In general, all returns are pre-tax nominal returns unless they are otherwise designated.

Other Major Return Measures and their Applications

- ***Real Returns***

--A nominal return (r) consists of three components: a real risk-free return (r_{rF}), inflation (π), and a risk premium for assuming risk (RP). Thus, nominal return and real return can be expressed as:

$$(1+r) = (1+r_{rF}) \times (1+\pi) \times (1+RP)$$

$$(1+r_{real}) = (1+r_{rF}) \times (1+RP) \text{ or}$$

$$(1+r_{real}) = (1+r) \div (1+\pi)$$

- ***Leveraged Return***

-- an investor may trade futures contracts in which the money required to take a position may be as little as 10 percent of the notional value of the asset.

-- Investors can also invest more than their own money by borrowing money to purchase the asset.

EXAMPLE 3

Computation of Special Returns

Let's return to Example 1. After reading this section, Mr. Lohrmann decided that he was not being fair to the fund manager by including the asset management fee and other expenses because the small size of the fund would put it at a competitive disadvantage. He learns that the fund spends a fixed amount of €500,000 every year on expenses that are unrelated to the manager's performance.

Mr. Lohrmann has become concerned that both taxes and inflation may reduce his return. Based on the current tax code, he expects to pay 20 percent tax on the return he earns from his investment. Historically, inflation has been around 2 percent and he expects the same rate of inflation to be maintained.

1. Estimate the annual gross return for the first year by adding back the fixed expenses.
2. What is the net return that investors in the Rhein Valley Superior Fund earned during the five-year period?
3. What is the after-tax net return for the first year that investors earned from the Rhein Valley Superior Fund? Assume that all gains are realized at the end of the year and the taxes are paid immediately at that time.
4. What is the anticipated after-tax real return that investors would have earned in the fifth year?

Solution to 1:

The gross return for the first year is higher by 1.67 percent (= €500,000/€30,000,000) than the investor return reported by the fund. Thus, the gross return is 16.67 percent (= 15% + 1.67%).

Solution to 2:

The investor return reported by the mutual fund is the net return of the fund after accounting for all direct and indirect expenses. The net return is also the pre-tax nominal return because it has not been adjusted for taxes or inflation. The net return for the five-year holding period was 42.35 percent.

Solution to 3:

The net return earned by investors during the first year was 15 percent. Applying a 20 percent tax rate, the after-tax return that accrues to the investors is 12 percent [= 15% – (0.20 × 15%)].

Solution to 4:

As in Part 3, the after-tax return earned by investors in the fifth year is 2.4 percent [= 3% – (0.20 × 3%)]. Inflation reduces the return by 2 percent so the after-tax real return earned by investors in the fifth year is 0.39 percent, as shown:

$$\frac{(1+2.40\%)}{(1+2.00\%)}-1=\frac{(1+0.0240)}{(1+0.0200)}-1=1.0039-1=0.0039=0.39\%$$

Note that taxes are paid before adjusting for inflation.

Variance of a Single Asset

- *Variance, or risk, is a measure of the volatility or the dispersion of returns. Variance is measured as the average squared deviation from the mean.*

$$\sigma^2 = \frac{\sum_{t=1}^{T}(R_t - \mu)^2}{T}$$

- *where R_t is the return for period t, T is the total number of periods, and μ is the mean of T returns, assuming T is the population of returns.*
- *If only a sample of returns is available instead of the population of returns (as is usually the case in the investment world), the correction for sample variance is made by replacing the denominator with (T - 1), as shown next, where R is the m ean return of the sample observations and s^2 is the sample variance:*

$$s^2 = \frac{\sum_{t=1}^{T}(R_t - \overline{R})^2}{T - 1}$$

Standard Deviation of an Asset

- *The standard deviation of returns of an asset is the square root of the variance of returns. The population standard deviation (a) and the sample standard deviation (s)are given below.*

$$\sigma = \sqrt{\frac{\sum_{t=1}^{T}(R_t - \mu)^2}{T}}; \quad s = \sqrt{\frac{\sum_{t=1}^{T}(R_t - \overline{R})^2}{T-1}}$$

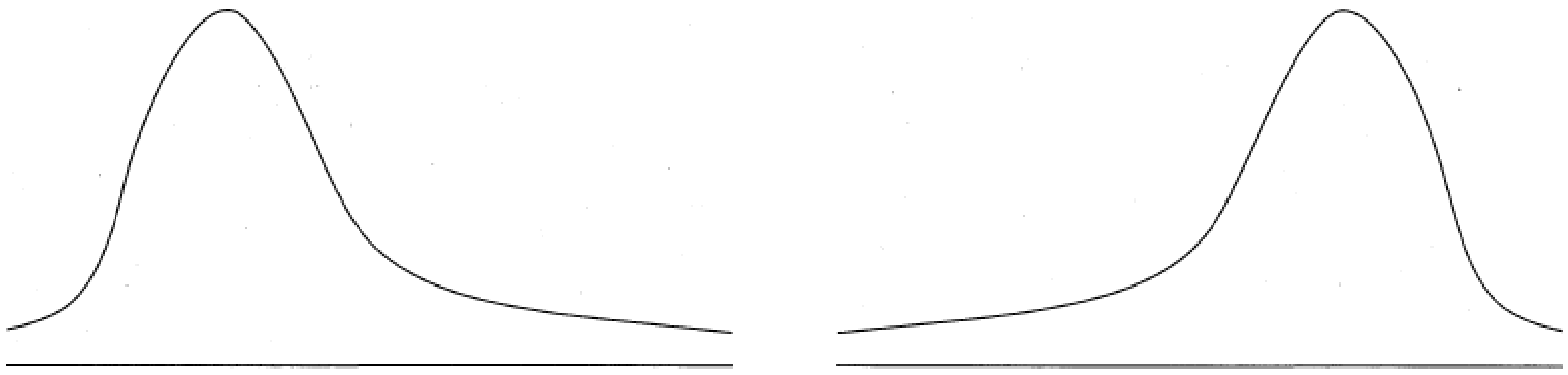
- *Standard deviation is another measure of the risk of an asset, which may also be referred to as its volatility.*

Other Investment Characteristics

- *Distributional Characteristics*

  -- Skewness: Skewness refers to asymmetry of the return distribution, that is, returns are not symmetric around the mean.

Exhibit 8 Skewness



Distribution Skewed to the Right (Positively Skewed)   Distribution Skewed to the Left (Negatively Skewed)

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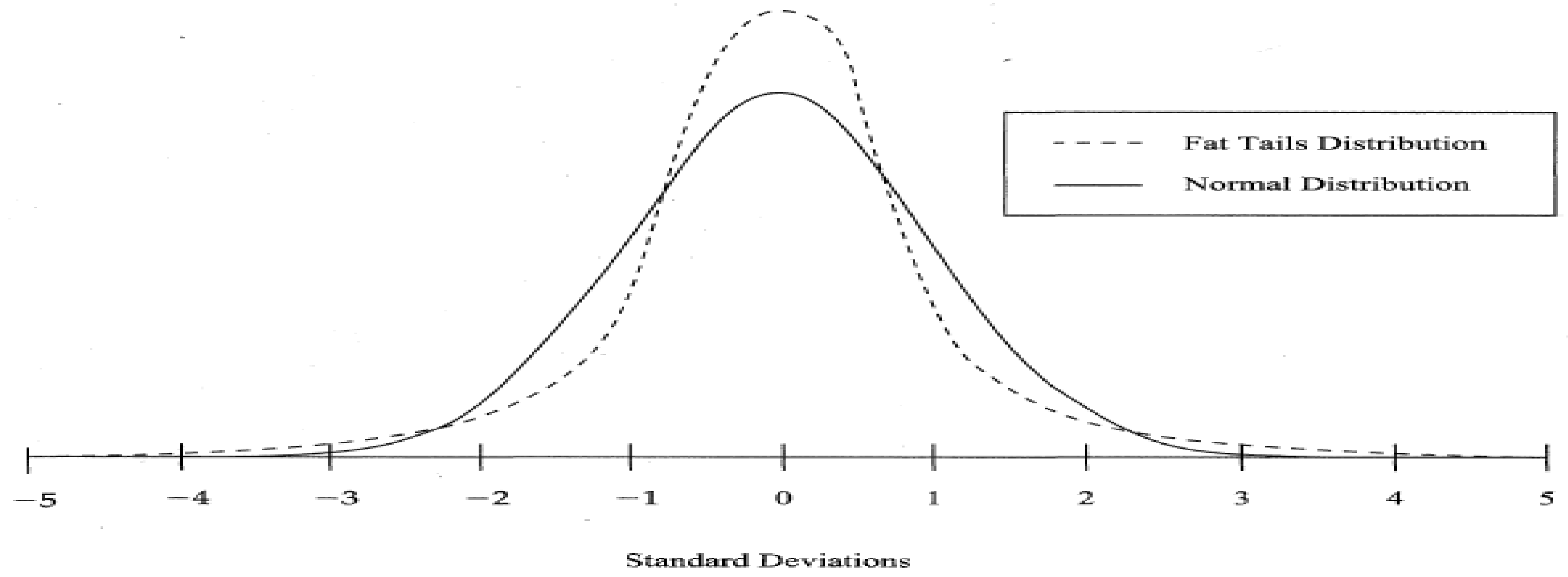
Other Investment Characteristics

--Kurtosis: refers to fat tails or higher than normal probabilities for extreme returns and has the effect of increasing an asset's risk that is not captured in a mean-variance framework.

Exhibit 10 Kurtosis



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Return & Risk

Risk aversion:

1. *Risk seeking: gamble*
2. *Risk neutral: indifferent about the gamble or the guaranteed outcome*
3. *Risk averse: guaranteed outcome*
4. *Risk tolerance: the amount of risk an investor is willing to tolerate*

Utility Theory and Indifference Curve

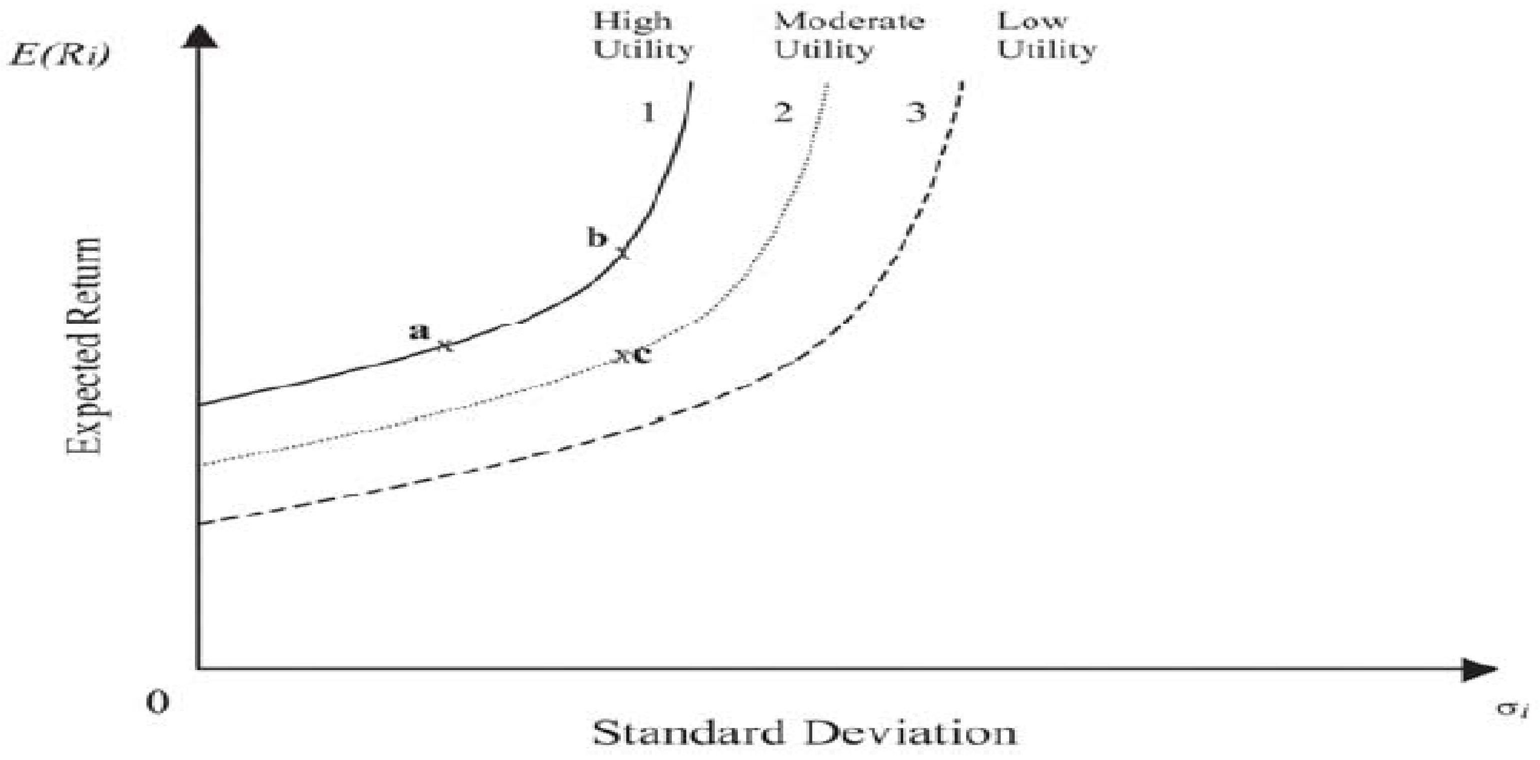
- ✓ $U=E(r)-0.5*A*\delta^2$
- ✓ *A is a measure of risk aversion.*
- ✓ *Great than 0 for a risk-averse investor, negative for a risk-lover investor.*

Return & Risk

Risk aversion

Indifference curves

Exhibit 11 Indifference Curves for Risk-Averse Investors

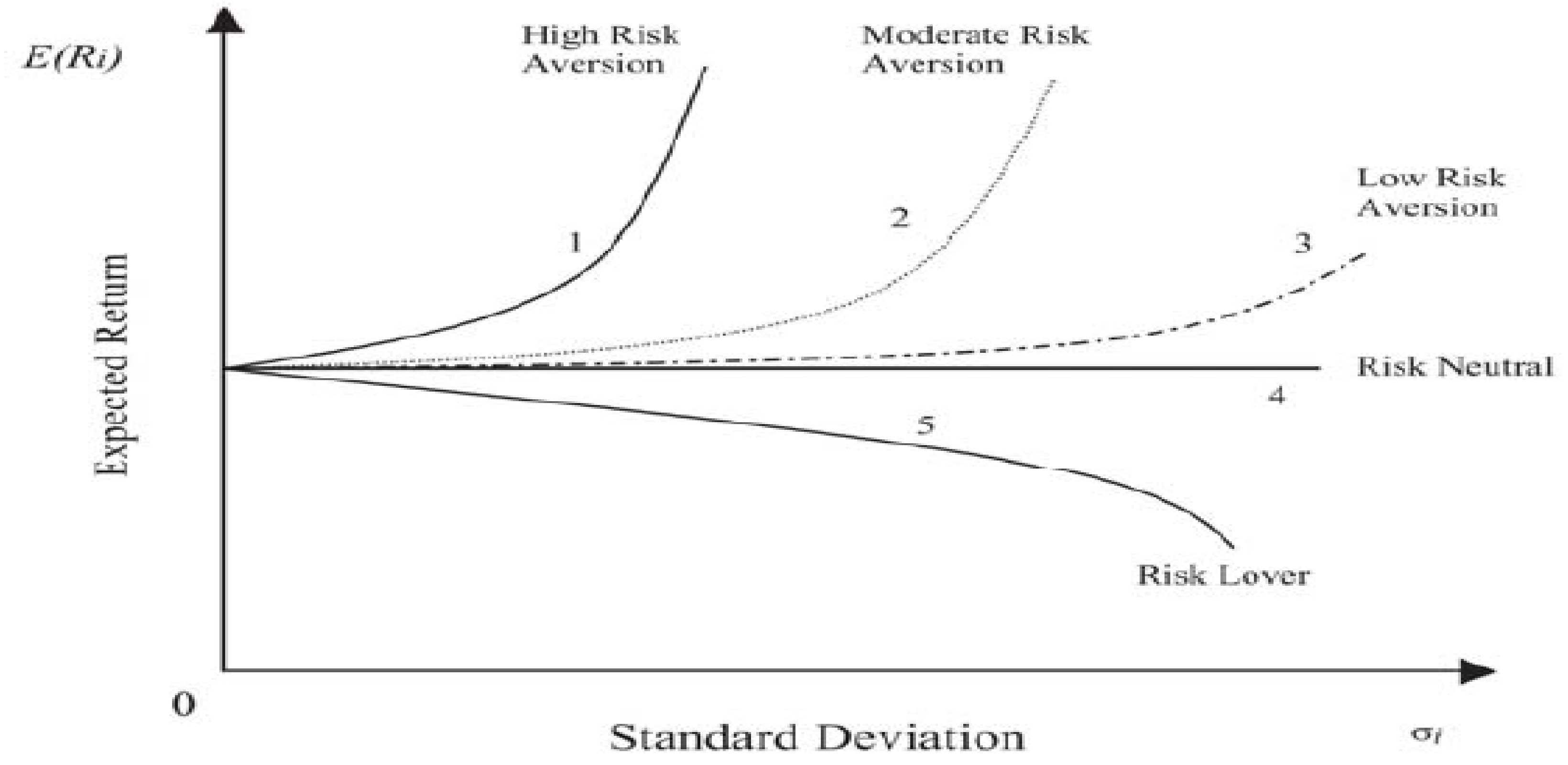


Return & Risk

Risk aversion

Indifference curves

Exhibit 12 Indifference Curves for Various Types of Investors



EXAMPLE 6

Computation of Utility

Based on investment information given below and the utility formula $U = E(r) - 0.5A\sigma^2$, answer the following questions. Returns and standard deviations are both expressed as percent per year. When using the utility formula, however, returns and standard deviations must be expressed in decimals.

Investment	Expected Return $E(r)$	Standard Deviation σ
1	12%	30%
2	15	35
3	21	40
4	24	45

1. Which investment will a risk-averse investor with a risk aversion coefficient of 4 choose?
2. Which investment will a risk-averse investor with a risk aversion coefficient of 2 choose?
3. Which investment will a risk-neutral investor choose?
4. Which investment will a risk-loving investor choose?

Solutions to 1 and 2:

The utility for risk-averse investors with $A = 4$ and $A = 2$ for each of the four investments are shown in the following table. Complete calculations for Investment 1 with $A = 4$ are as follows: $U = 0.12 - 0.5 \times 4 \times 0.30^2 = -0.06$.

Investment	Expected Return $E(r)$	Standard Deviation σ	Utility $A = 4$	Utility $A = 2$
1	12%	30%	–0.0600	0.0300
2	15	35	–0.0950	0.0275
3	21	40	–0.1100	0.0500
4	24	45	–0.1650	0.0375

The risk-averse investor with a risk aversion coefficient of 4 should choose Investment 1. The risk-averse investor with a risk aversion coefficient of 2 should choose Investment 3.

Solution to 3:

A risk-neutral investor cares only about return. In other words, his risk aversion coefficient is 0. Therefore, a risk-neutral investor will choose Investment 4 because it has the highest return.

Solution to 4:

A risk-loving investor likes both higher risk and higher return. In other words, his risk aversion coefficient is negative. Therefore, a risk-loving investor will choose Investment 4 because it has the highest return and highest risk among the four investments.

Expected value, Variance of returns on a portfolio

The weight of portfolio asset i is

$$w_i = \frac{market\ value\ of\ investmen\ in\ asset\ i}{market\ value\ of\ the\ portfolio}$$

- **Portfolio expected value:**

$$E(R_P) = \sum_{i=1}^{N} w_i E(R_i) = w_1 E(R_1) + w_2 E(R_2) + \ldots + w_N E(R_N)$$

- **Portfolio variance:**

$$Var(R_P) = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j Cov_{i,j} \qquad Cov_{i,j} = \rho_{i,j} \cdot \sigma_i \cdot \sigma_j$$

Variance of a Portfolio of Assets

- *Portfolio's variance*

$$\sigma_P^2 = \sum_{i,j=1}^{N} w_i w_j Cov(R_i, R_j)$$

$$Cov(R_i, R_j) = \rho_{ij}\sigma_i\sigma_j.$$

$$\sigma_P^2 = \sum_{i=1}^{N} w_i^2 Var(R_i) + \sum_{i,j=1, i\neq j}^{N} w_i w_j Cov(R_i, R_j)$$

- *For a two assets portfolio, the expression for portfolio variance simplifies to the following using covariance and then using correlation:*

$$\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2Cov(R_1, R_2)$$

$$\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2$$

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2Cov(R_1, R_2)}$$

or,

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2}$$

Portfolio of two Risky Assets

- ***Covariance and Correlation***

--The covariance in the formula for portfolio standard deviation can be expanded as $Cov(R_1, R_2) = \rho_{12}\sigma_1\sigma_2$ *where* ρ_{12} *is the correlation between* R_1 *and* R_2.

--Correlation is a measure of the consistency or tendency for two investments to act in a similar way. ρ_{12} *can be positive or negative and ranges from -1 to +1.*

--ρ_{12} *=+1: Returns of the two assets are perfectly positively correlated. Assets 1 and 2 move together 100 percent of the time.*

--ρ_{12} *= -1: Returns of the two assets are perfectly negatively correlated. Assets 1and 2 move in opposite directions 100 percent of the time.*

--ρ_{12} *= 0: Returns of the two assets are uncorrelated. Movement of Asset 1 provides no prediction regarding the movement of Asset 2.*

Example :

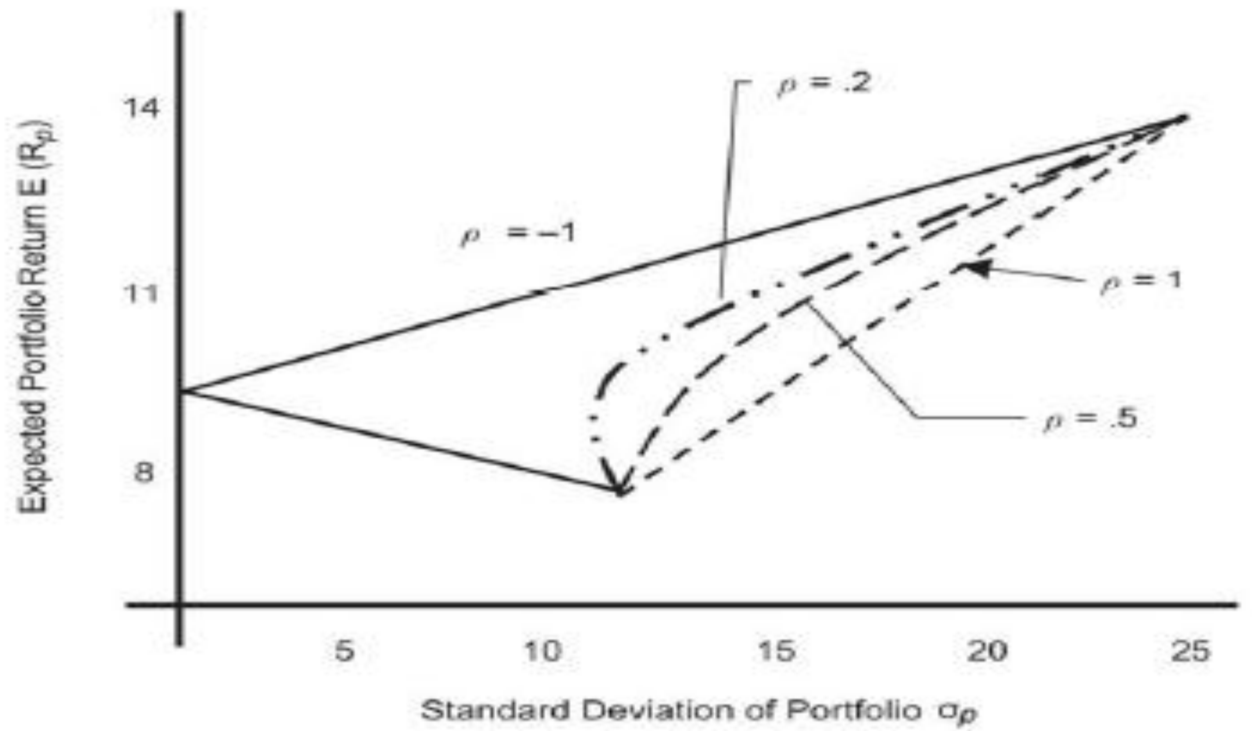
For two assets, Asset 1 and Asset 2, the risk and return characteristics:

	Asset1	Asset2
Expected return	7%	15%
Standard deviation	12%	25%
Correlation	1.0 0.5 0.2 -1.0	

Weight %			Correlation			
Asset1	Asset2	Portfolio Return	1	0.5	0.2	-1
0	100	15	25	25	25	25
10	90	14.2	23.7	23.1	22.8	21.3
20	80	13.4	22.4	21.3	20.6	17.6
30	70	12.6	21.1	19.6	18.6	13.9
40	60	11.8	19.8	17.9	16.6	10.2
50	50	11	18.5	16.3	14.9	6.5
60	40	10.2	17.2	15	13.4	2.8
70	30	9.4	15.9	13.8	12.3	0.9
80	20	8.6	14.6	12.9	11.7	4.6
90	10	7.8	13.3	12.2	11.6	8.3
100	0	7	12	12	12	12

Relationship between Risk and Return

Exhibit 17 Relationship between Risk and Return



◈ *The lower the correlation-> the greater the diversification benefits.*

Relationship between Risk and Return

If all assets in the portfolio have the same variance and then same correlation among assets, the portfolio risk can be written as:

$$\sigma_p = \sqrt{\frac{\sigma^2}{N} + \frac{(N-1)}{N}\rho\sigma^2}$$

EXAMPLE 9

Diversification with Rain and Shine

Assume a company Beachwear rents beach equipment. The annual return from the company's operations is 20 percent in years with many sunny days but falls to 0 percent in rainy years with few sunny days. The probabilities of a sunny year and a rainy year are equal at 50 percent. Thus, the average return is 10 percent, with a 50 percent chance of 20 percent return and a 50 percent chance of 0 percent return. Because Beachwear can earn a return of 20 percent or 0 percent, its average return of 10 percent is risky.

You are excited about investing in Beachwear but do not like the risk. Having heard about diversification, you decide to add another business to the portfolio to reduce your investment risk.

- There is a snack shop on the beach that sells all the healthy food you like. You estimate that the annual return from the Snackshop is also 20 percent in years with many sunny days and 0 percent in other years. As with the Beachwear shop, the average return is 10 percent.

You decide to invest 50 percent each in Snackshop and Beachwear. The average return is still 10 percent, with 50 percent of 10 percent from Snackshop and 50 percent of 10 percent from Beachwear. In a sunny year, you would earn 20 percent (= 50% of 20% from Beachwear + 50% of 20% from Snackshop). In a rainy year, you would earn 0 percent (=50% of 0% from Beachwear + 50% of 0% from Snackshop). The results are tabulated in Exhibit 18.

Exhibit 18

Type	Company	Percent Invested	Return in Sunny Year (%)	Return in Rainy Year (%)	Average Return (%)
Single stock	Beachwear	100	20	0	10
Single stock	Snackshop	100	20	0	10
Portfolio of two stocks	Beachwear	50	20	0	10
	Snackshop	50	20	0	10
	Total	100	20	0	10

These results seem counterintuitive. You thought that by adding another business you would be able to diversify and reduce your risk, but the risk is exactly the same as before. What went wrong? Note that both businesses do well when it is sunny and both businesses do poorly when it rains. The correlation between the two businesses is +1.0. No reduction in risk occurs when the correlation is +1.0.

- To reduce risk, you must consider a business that does well in a rainy year. You find a company that rents DVDs. DVDrental company is similar to the Beachwear company, except that its annual return is 20 percent in a rainy year and 0 percent in a sunny year, with an average return of 10 percent. DVDrental's 10 percent return is also risky just like Beachwear's return.

If you invest 50 percent each in DVDrental and Beachwear, then the average return is still 10 percent, with 50 percent of 10 percent from DVDrental and 50 percent of 10 percent from Beachwear. In a sunny year, you would earn 10 percent (= 50% of 20% from Beachwear + 50% of 0% from DVDrental). In a rainy year also, you would earn 10 percent (=50% of 0% from Beachwear + 50% of 20% from DVDrental). You have no risk because you earn 10 percent in both sunny and rainy years. Thus, by adding DVDrental to Beachwear, you have reduced (eliminated) your risk without affecting your return. The results are tabulated in Exhibit 19.

Exhibit 19

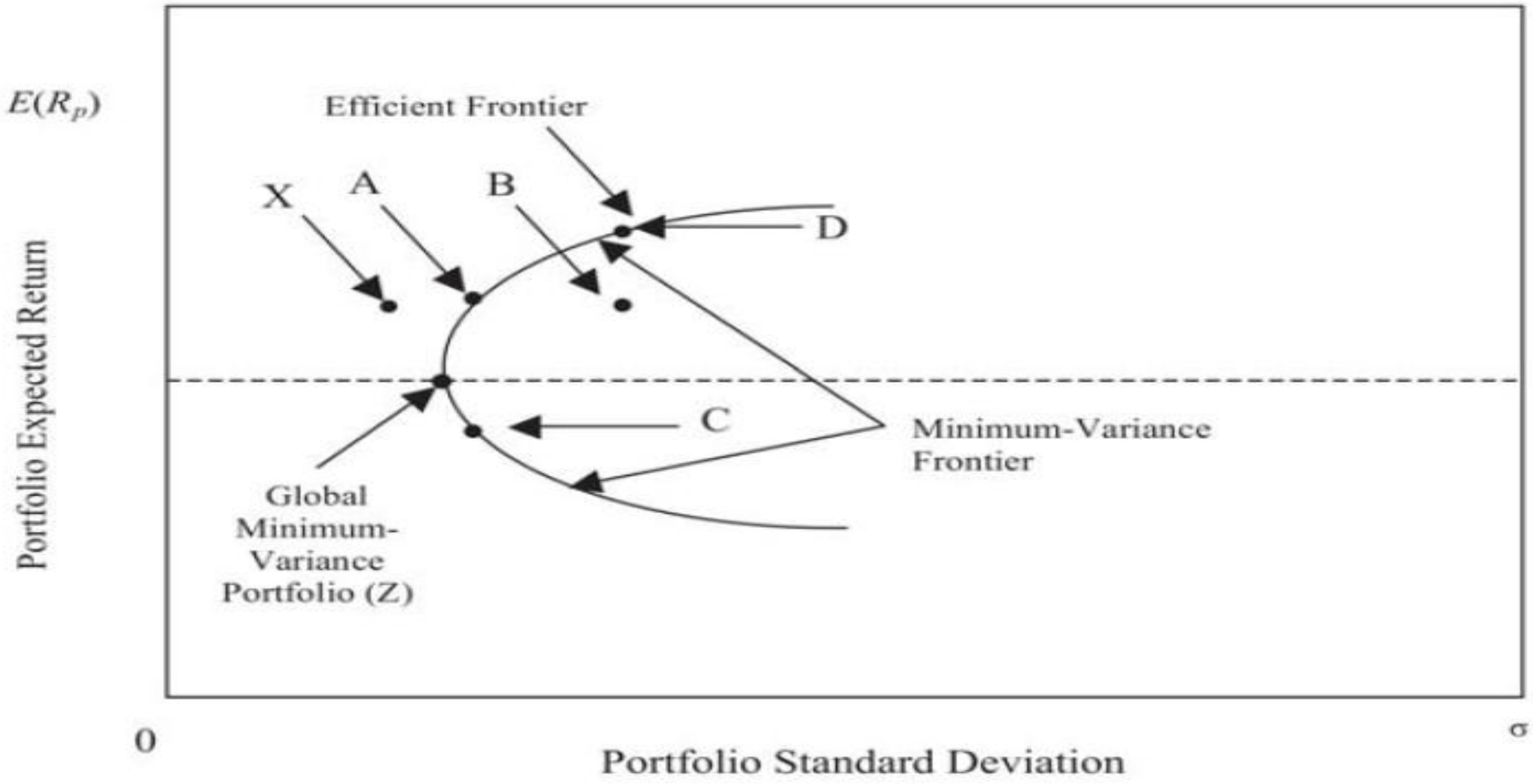
Type	Company	Percent Invested	Return in Sunny Year (%)	Return in Rainy Year (%)	Average Return (%)
Single stock	Beachwear	100	20	0	10
Single stock	DVDrental	100	0	20	10
Portfolio of two stocks	Beachwear	50	20	0	10
	DVDrental	50	0	20	10
	Total	100	10	10	10

In this case, the two businesses have a correlation of –1.0. When two businesses with a correlation of –1.0 are combined, risk can always be reduced to zero.

Minimum-Variance Portfolio

The portfolios with the lowest risk for each level of return.

Exhibit 22 **Minimum-Variance Frontier**



EXAMPLE 11

Comprehensive Example on Portfolio Selection

This comprehensive example reviews many concepts learned in this reading. The example begins with simple information about available assets and builds an optimal investor portfolio for the Lohrmanns.

Suppose the Lohrmanns can invest in only two risky assets, A and B. The expected return and standard deviation for asset A are 20 percent and 50 percent, and the expected return and standard deviation for asset B are 15 percent and 33 percent. The two assets have zero correlation with one another.

1. Calculate portfolio expected return and portfolio risk (standard deviation) if an investor invests 10 percent in A and the remaining 90 percent in B.

Solution to 1:

The subscript "*rp*" means risky portfolio.

$$R_{rp} = [0.10 \times 20\%] + [(1 - 0.10) \times 15\%] = 0.155 = 15.50\%$$

$$\sigma_{rp} = \sqrt{w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2w_A w_B \rho_{AB}\sigma_A\sigma_B}$$

$$= \sqrt{(0.10^2 \times 0.50^2) + (0.90^2 \times 0.33^2) + (2 \times 0.10 \times 0.90 \times 0.0 \times 0.50 \times 0.33)}$$

$$= 0.3012 = 30.12\%$$

Note that the correlation coefficient is 0, so the last term for standard deviation is zero.

2. Generalize the above calculations for portfolio return and risk by assuming an investment of w_A in Asset A and an investment of $(1 - w_A)$ in Asset B.

Solution to 2:

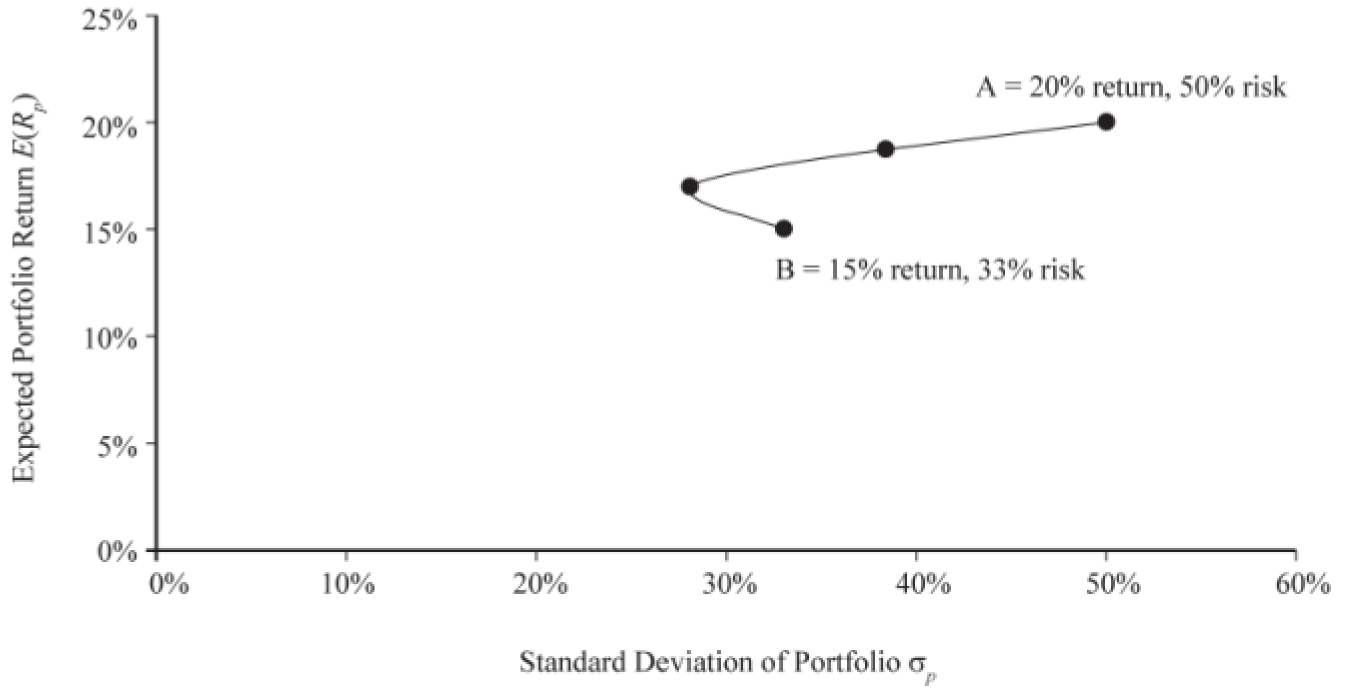
$$R_{rp} = w_A \times 20\% + (1 - w_A) \times 15\% = 0.05w_A + 0.15$$

$$\sigma_{rp} = \sqrt{w_A^2 \times 0.5^2 + (1 - w_A)^2 \times 0.33^2} = \sqrt{0.25w_A^2 + 0.1089\,(1 - 2w_A + w_A^2)}$$

$$= \sqrt{0.3589w_A^2 - 0.2178w_A + 0.1089}$$

The investment opportunity set can be constructed by using different weights in the expressions for $E(R_{rp})$ and σ_{rp} in Part 1 of this example. Exhibit 26 shows the combination of Assets A and B.

Exhibit 26



3. Now introduce a risk-free asset with a return of 3 percent. Write an equation for the capital allocation line in terms of w_A that will connect the risk-free asset to the portfolio of risky assets. (Hint: use the equation in Section 3.3 and substitute the expressions for a risky portfolio's risk and return from Part 2 above).

Solution to 3:

The equation of the line connecting the risk-free asset to the portfolio of risky assets is given below (see Section 3.3), where the subscript "*rp*" refers to the risky portfolio instead of "*i*," and the subscript "*p*" refers to the new portfolio of two risky assets and one risk-free asset.

$$E(R_p) = R_f + \frac{E(R_i) - R_f}{\sigma_i}\sigma_p,$$

Rewritten as

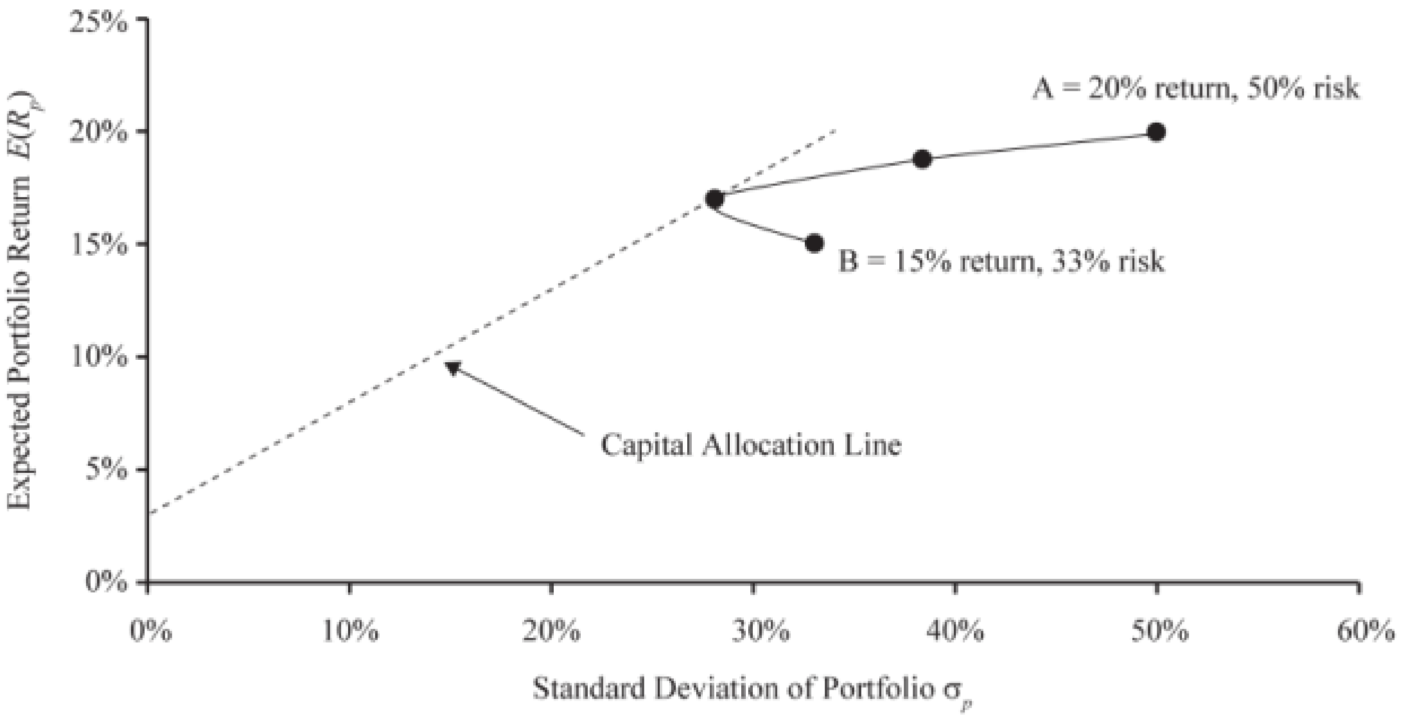
$$E(R_p) = R_f + \frac{E(R_{rp}) - R_f}{\sigma_{rp}}\sigma_p$$

$$= 0.03 + \frac{0.05w_A + 0.15 - 0.03}{\sqrt{0.3589w_A^2 - 0.2178w_A + 0.1089}}\sigma_p$$

$$= 0.03 + \frac{0.05w_A + 0.12}{\sqrt{0.3589w_A^2 - 0.2178w_A + 0.1089}}\sigma_p$$

The capital allocation line is the line that has the maximum slope because it is tangent to the curve formed by portfolios of the two risky assets. Exhibit 27 shows the capital allocation line based on a risk-free asset added to the group of assets.

Exhibit 27



4. The slope of the capital allocation line is maximized when the weight in Asset A is 38.20 percent.[10] What is the equation for the capital allocation line using w_A of 38.20 percent?

Solution to 4:

By substituting 38.20 percent for w_A in the equation in Part 3, we get $E(R_p) = 0.03 + 0.4978\sigma_p$ as the capital allocation line.

5. Having created the capital allocation line, we turn to the Lohrmanns. What is the standard deviation of a portfolio that gives a 20 percent return and is on the capital allocation line? How does this portfolio compare with asset A?

Solution to 5:

Solve the equation for the capital allocation line to get the standard deviation: $0.20 = 0.03 + 0.4978\sigma_p$. $\sigma_p = 34.2\%$. The portfolio with a 20 percent return has the same return as Asset A but a lower standard deviation, 34.2 percent instead of 50.0 percent.

6. What is the risk of portfolios with returns of 3 percent, 9 percent, 15 percent, and 20 percent?

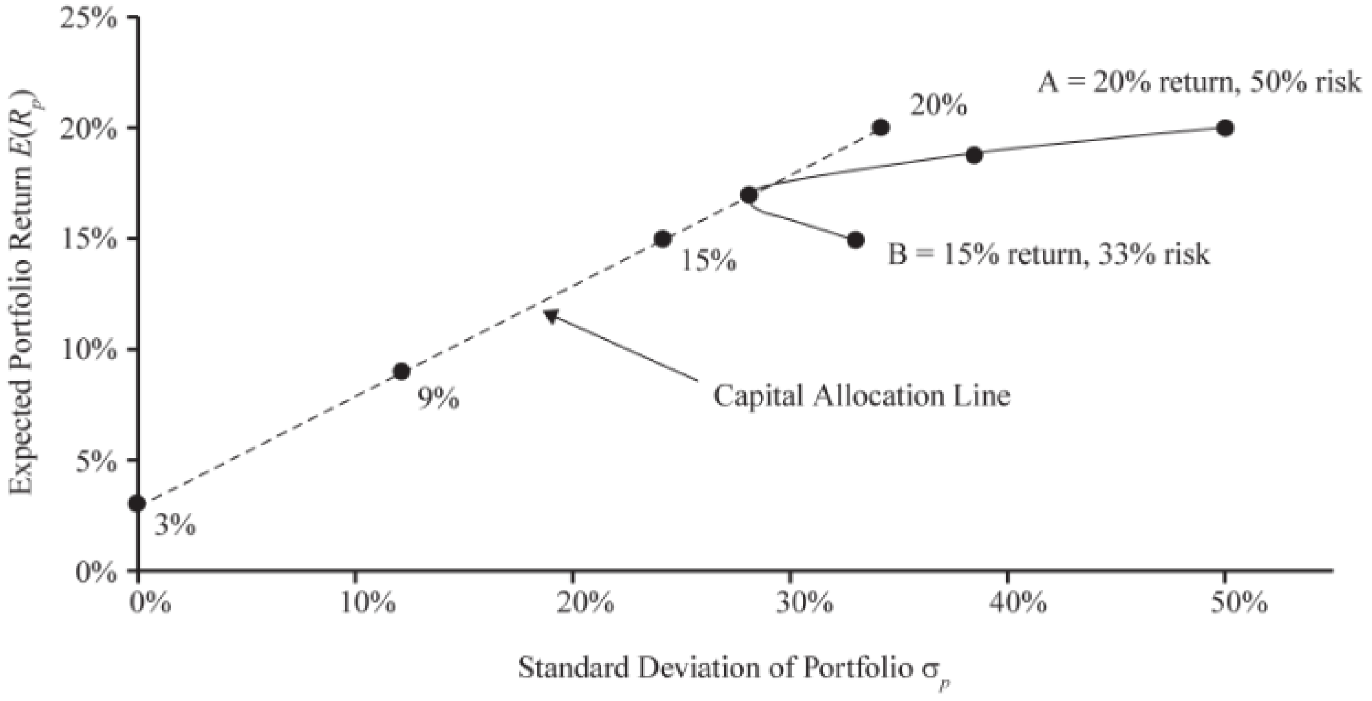
Solution to 6:

You can find the risk of the portfolio using the equation for the capital allocation line: $E(R_p) = 0.03 + 0.4978\sigma_p$.

For a portfolio with a return of 15 percent, write $0.15 = 0.03 + 0.4978\sigma_p$. Solving for σ_p gives 24.1 percent. You can similarly calculate risks of other portfolios with the given returns.

The risk of the portfolio for a return of 3 percent is 0.0 percent, for a return of 9 percent is 12.1 percent, for a return of 15 percent is 24.1 percent, and for a return of 20 percent is 34.2 percent. The points are plotted in Exhibit 28.

Exhibit 28



7. What is the utility that the Lohrmanns derive from a portfolio with a return of 3 percent, 9 percent, 15 percent, and 20 percent? The risk aversion coefficient for the Lohrmanns is 2.5.

Solution to 7:

To find the utility, use the utility formula with a risk aversion coefficient of 2.5:

$$\text{Utility} = E(R_p) - 0.5 \times 2.5\sigma_p^2$$

$$\text{Utility}\ \ (3\,\%) = 0.0300$$

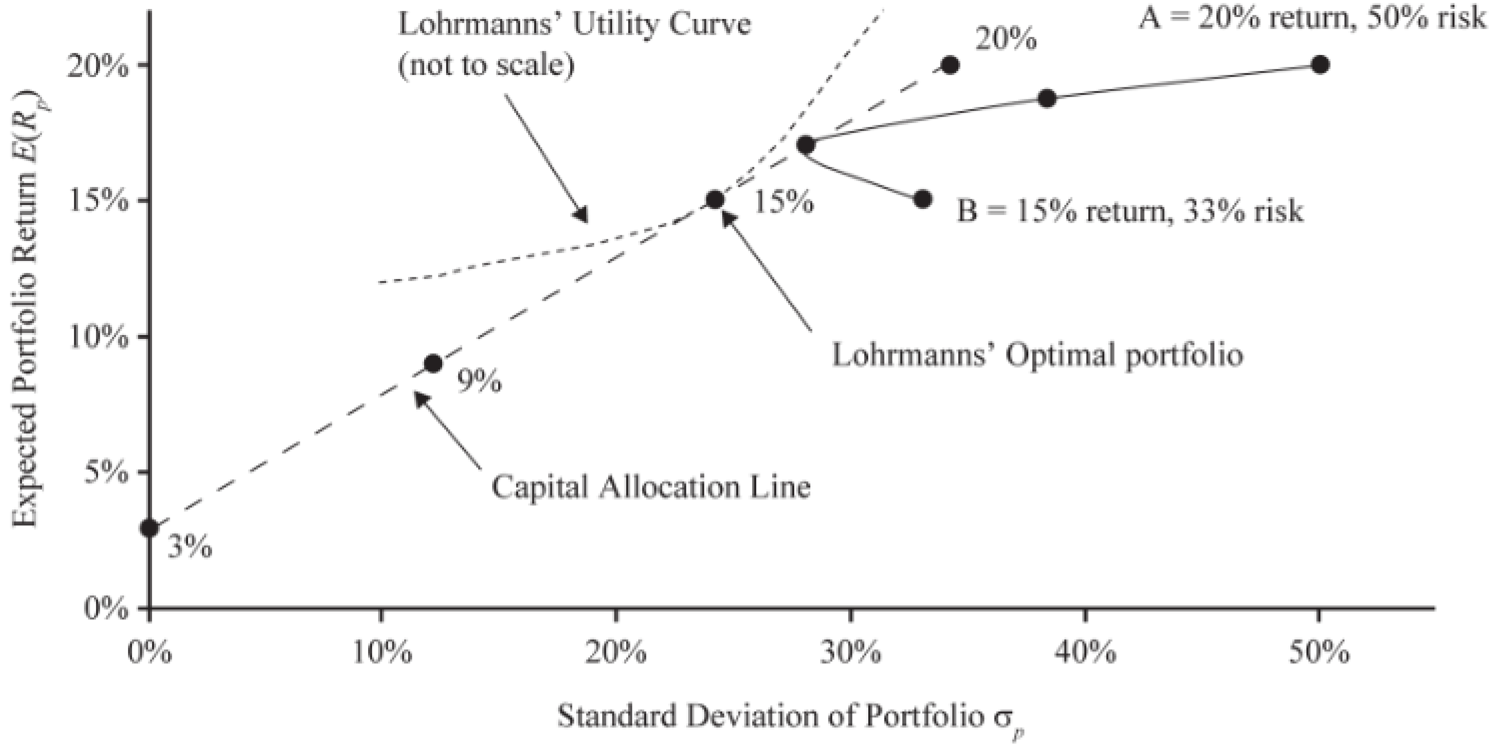
$$\text{Utility}\ \ (9\,\%) = 0.09 - 0.5 \times 2.5 \times 0.121^2 = +0.0717$$

$$\text{Utility}\ \ (15\,\%) = 0.15 - 0.5 \times 2.5 \times 0.241^2 = +0.0774$$

$$\text{Utility}\ \ (20\,\%) = 0.20 - 0.5 \times 2.5 \times 0.341^2 = +0.0546$$

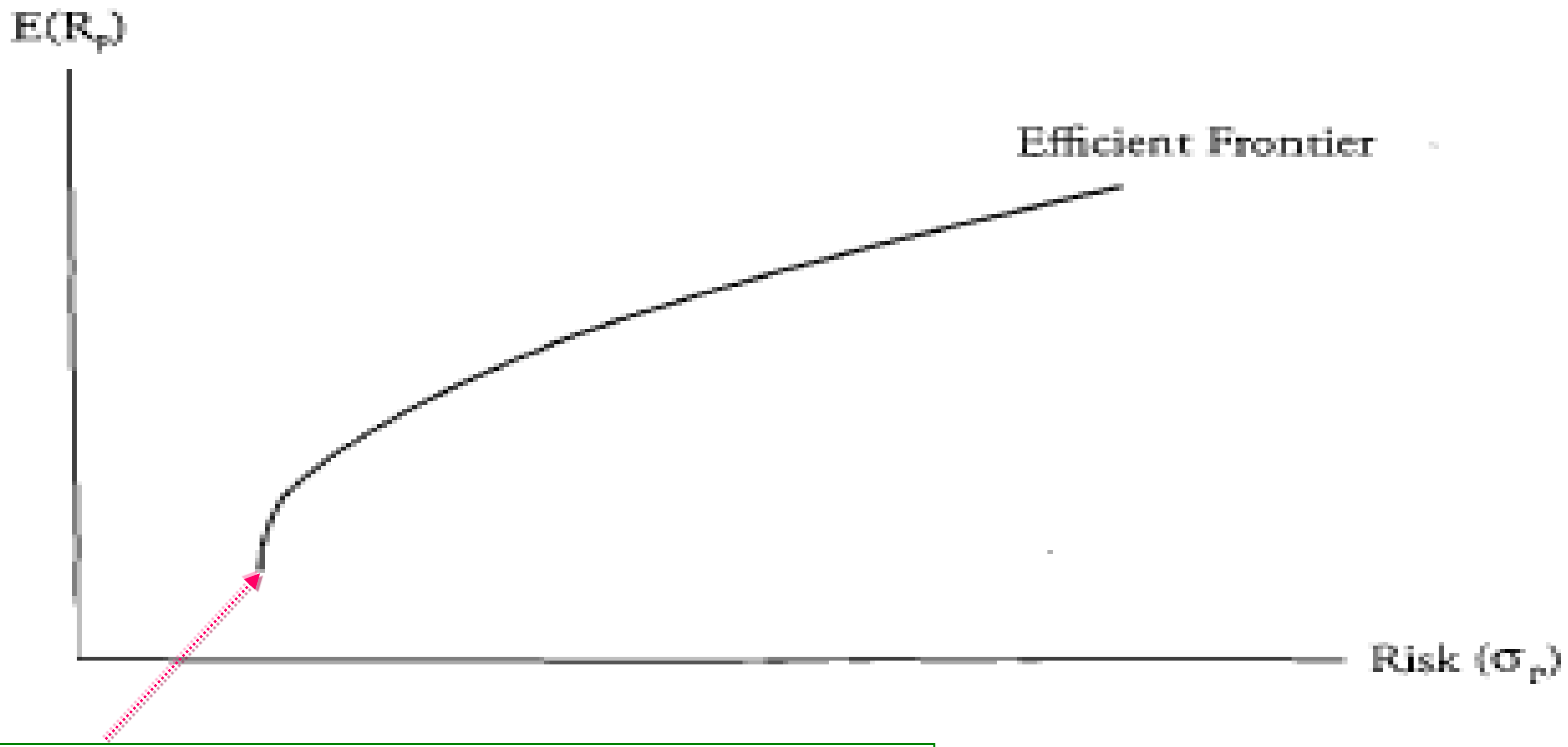
Based on the above information, the Lohrmanns choose a portfolio with a return of 15 percent and a standard deviation of 24.1 percent because it has the highest utility: 0.0774. Finally, Exhibit 29 shows the indifference curve that is tangent to the capital allocation line to generate Lohrmanns' optimal investor portfolio.

Exhibit 29


Lohrmanns' Utility Curve
(not to scale)
A = 20% return, 50% risk
20%
15%
B = 15% return, 33% risk
Lohrmanns' Optimal portfolio
9%
Capital Allocation Line
3%
Expected Portfolio Return $E(R_p)$
20%
15%
10%
5%
0%
0%
10%
20%
30%
40%
50%
Standard Deviation of Portfolio σ_p

Markowitz Efficient frontier

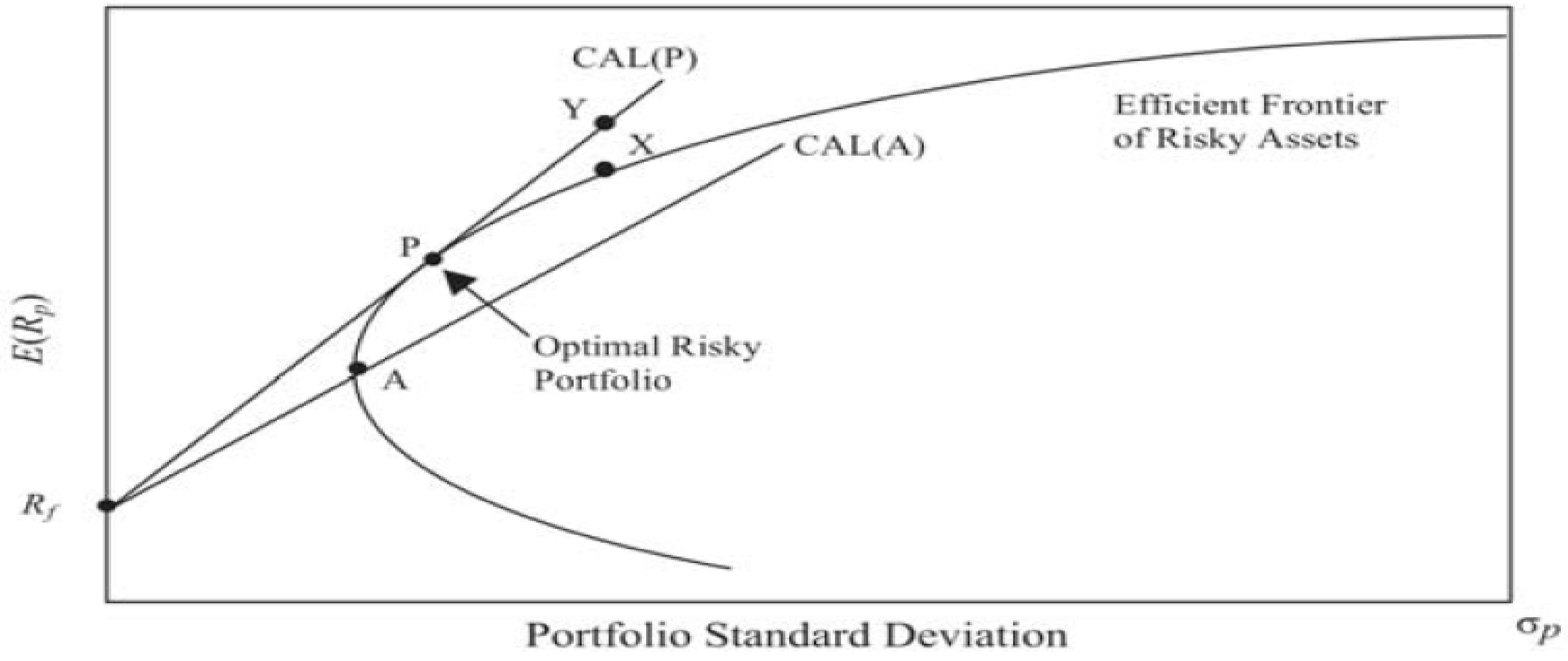
The set of portfolios that will give you the highest return at each level of risk (or, alternatively, the lowest risk for each level of return).



Global minimum-variance portfolio

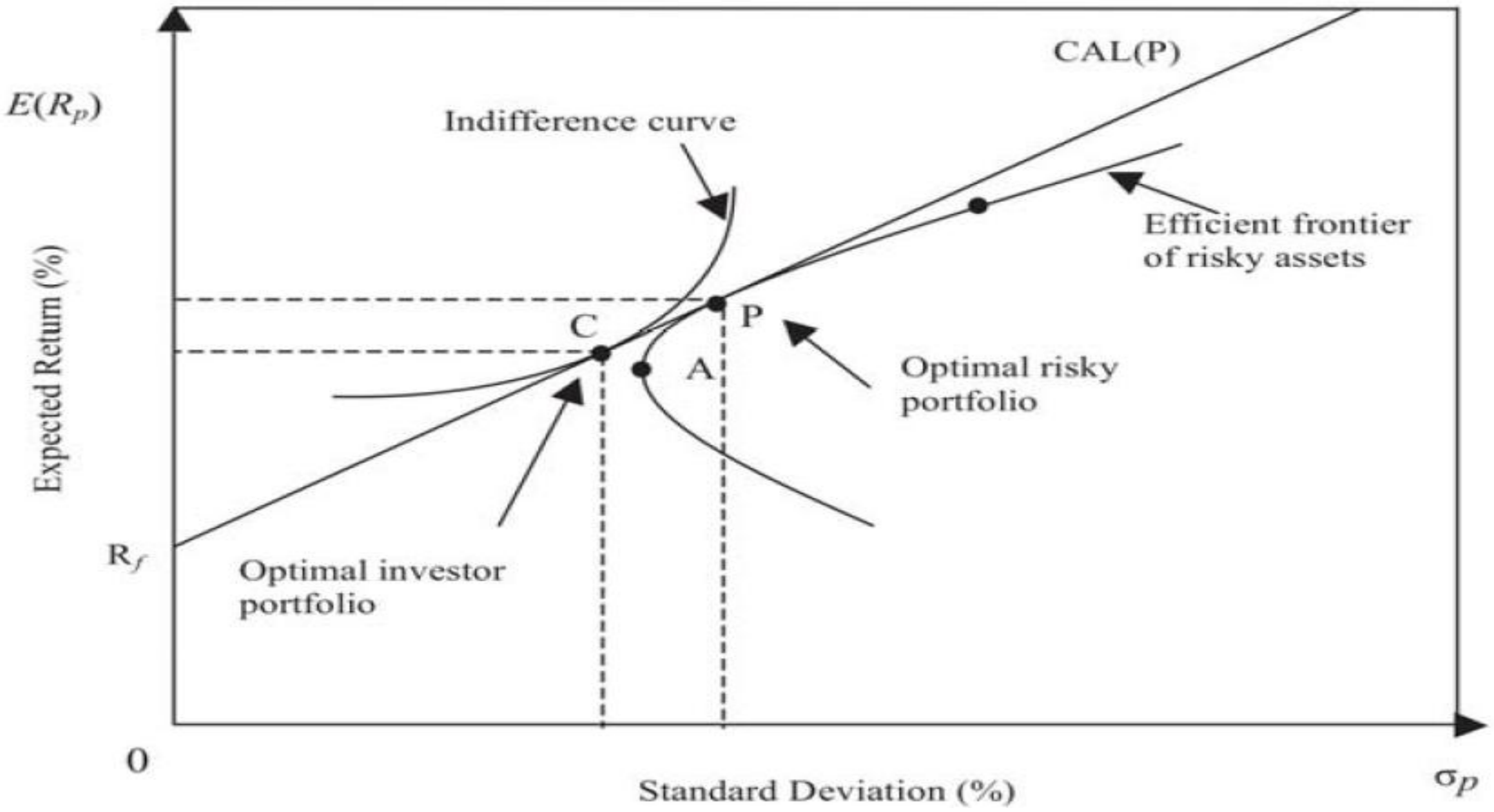
Risk –Free Asset and Many Risky Assets

Exhibit 23 Optimal Risky Portfolio



Optimal Investor Portfolio

Exhibit 25 Optimal Investor Portfolio

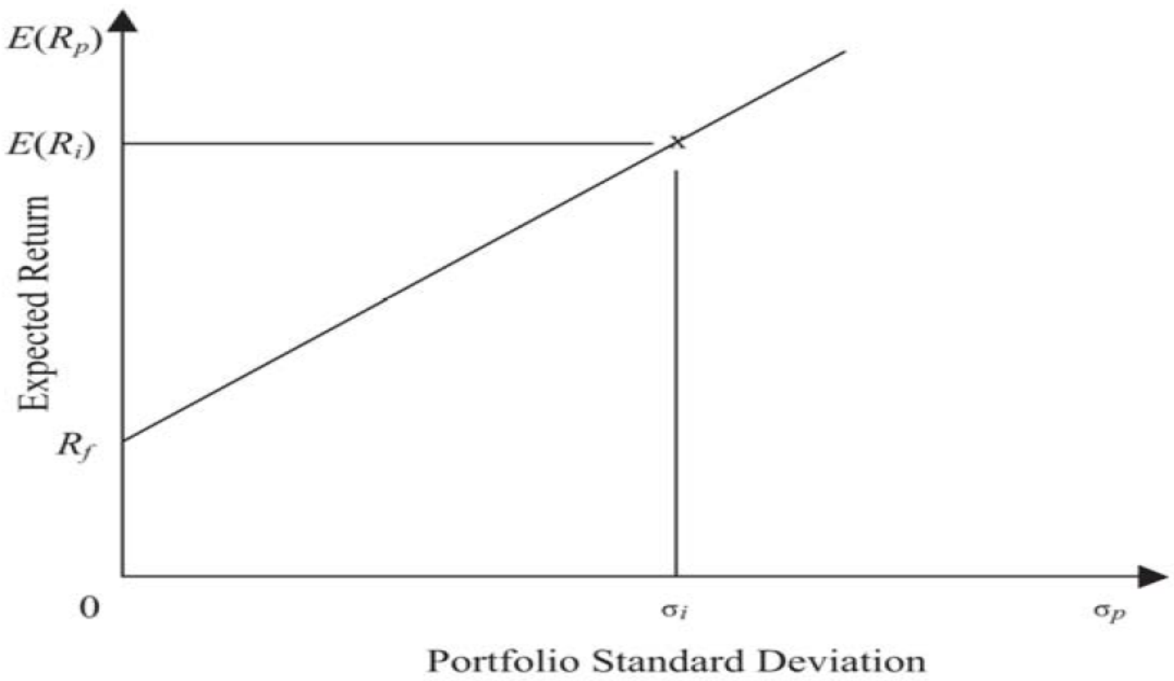


Capital market theory

Markowitz efficient frontier* + *A risk-free asset

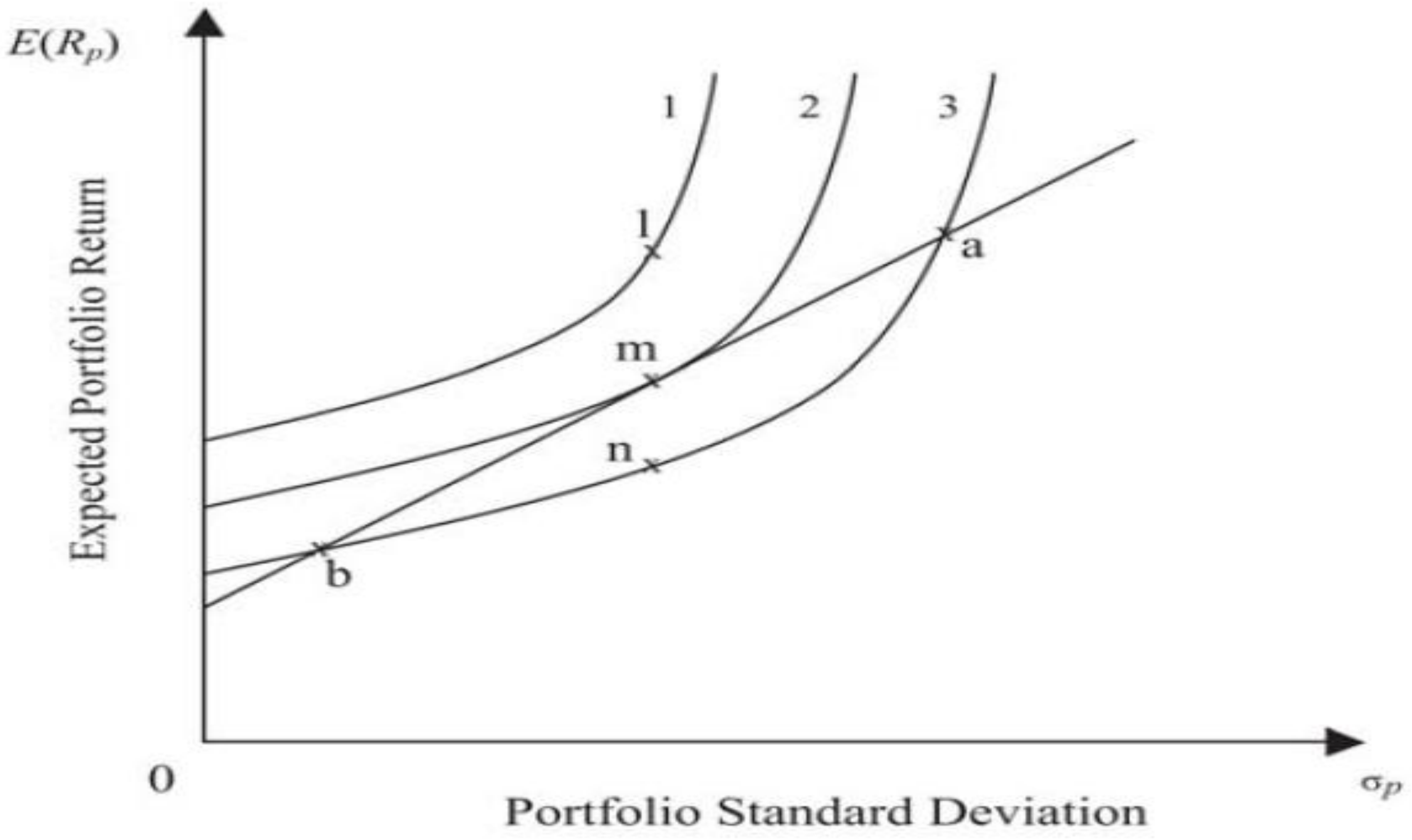
Capital Allocation Line:
The combinations of risk-free assets and the risky asset portfolio.

Exhibit 13 Capital Allocation Line with Two Assets



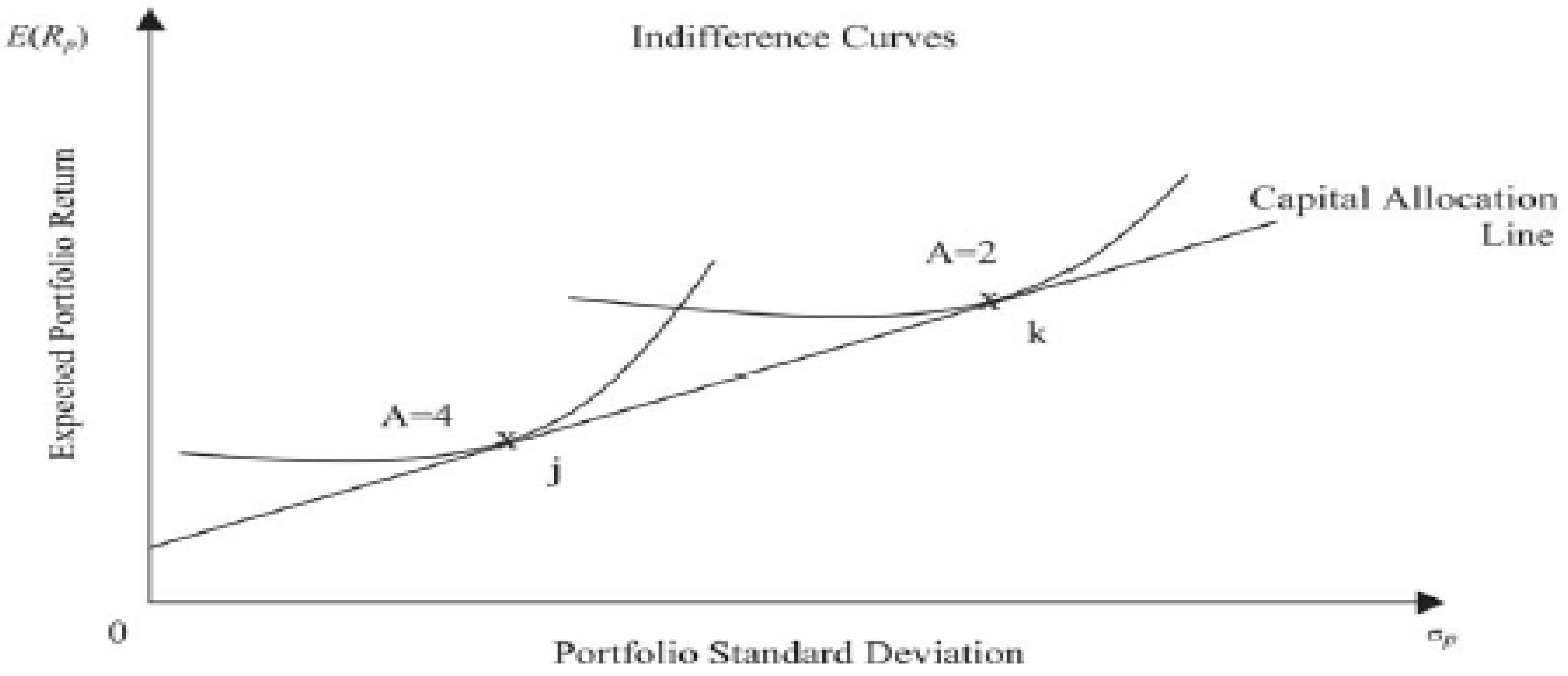
Portfolio Selection

Exhibit 14 Portfolio Selection



Portfolio Selection

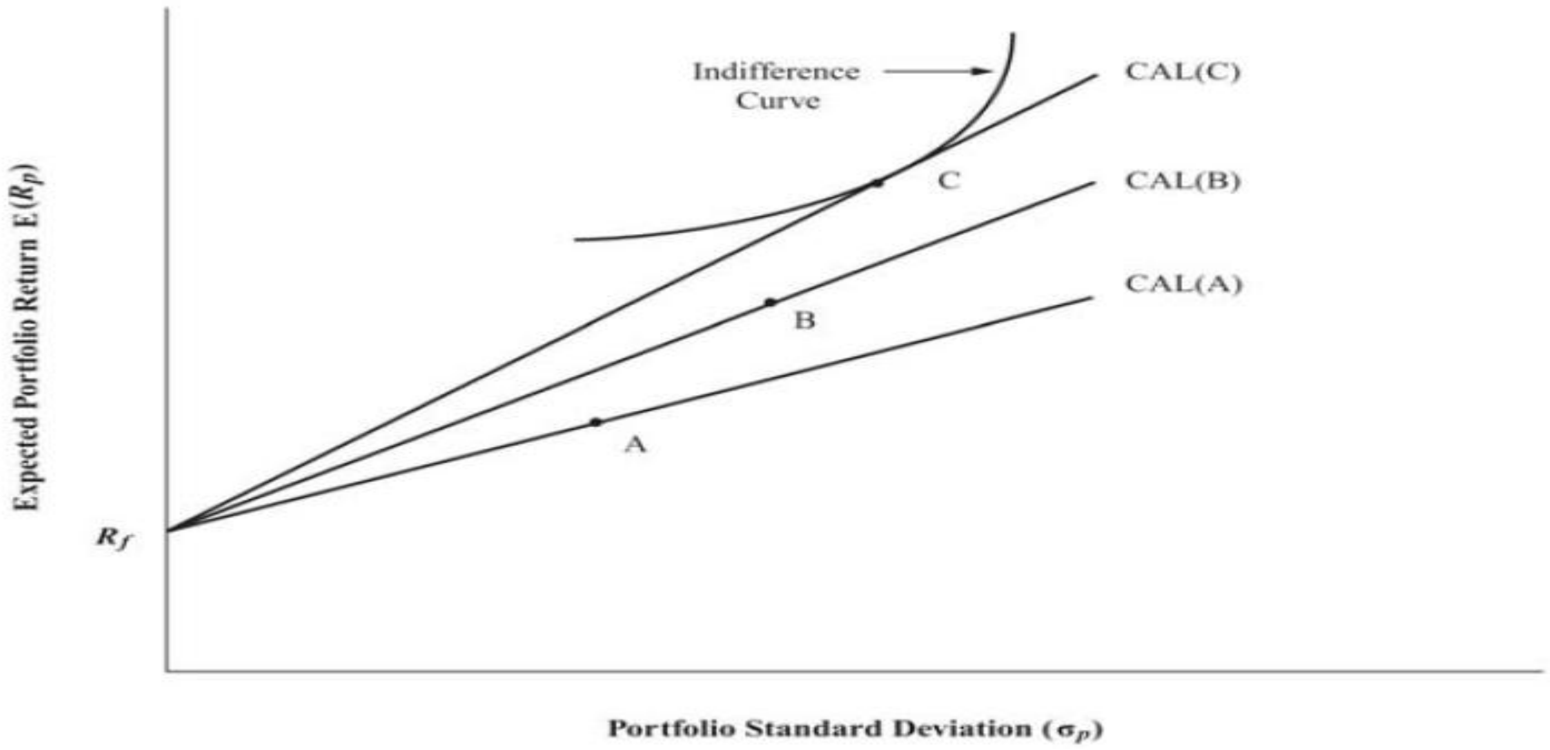
Exhibit 15 Portfolio Selection for Two Investors with Various Levels of Risk Aversion



Portfolio Risk and Return: Part Ⅱ

Portfolio Selection

Exhibit 2 Risk-Free Asset and Portfolio of Risky Assets



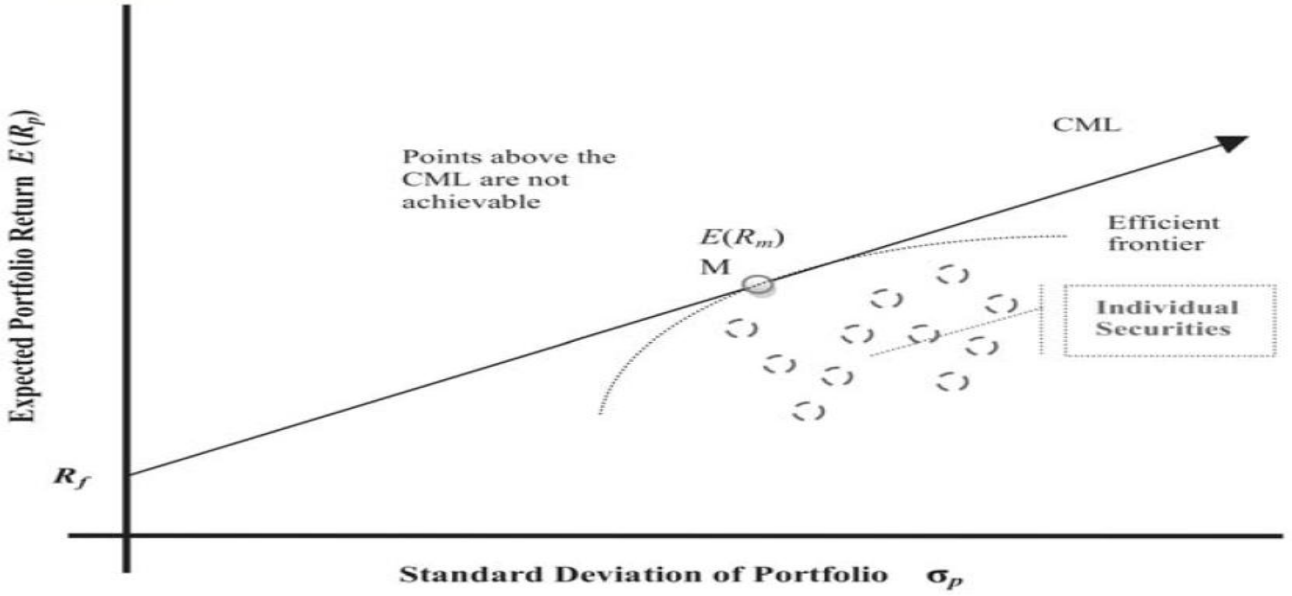
- *the optimal risky portfolio：Portfolio C*
- *the most preferred set of possible portfolio：the greatest expected utility*

Capital Market Line (CML)

◈ *The capital market line is special case of capital allocation line, where the risky portfolio is the market portfolio, the S&P 500 Index as the market's proxy.*

◈ *The risk-free asset is a debt security with no default risk, no inflation risk, no liquidity risk, no interest rate risk, and no risk of any other kind. US Treasury bills as the proxy.*

Exhibit 3 Capital Market Line



$$E(R_P) = RFR + \sigma_P \cdot \left(\frac{E(R_M) - RFR}{\sigma_M} \right)$$

EXAMPLE 1

Mr. Miles is a first time investor and wants to build a portfolio using only US T-bills and an index fund that closely tracks the S&P 500 Index. The T-bills have a return of 5 percent. The S&P 500 has a standard deviation of 20 percent and an expected return of 15 percent.

1. Draw the CML and mark the points where the investment in the market is 0 percent, 25 percent, 75 percent, and 100 percent.

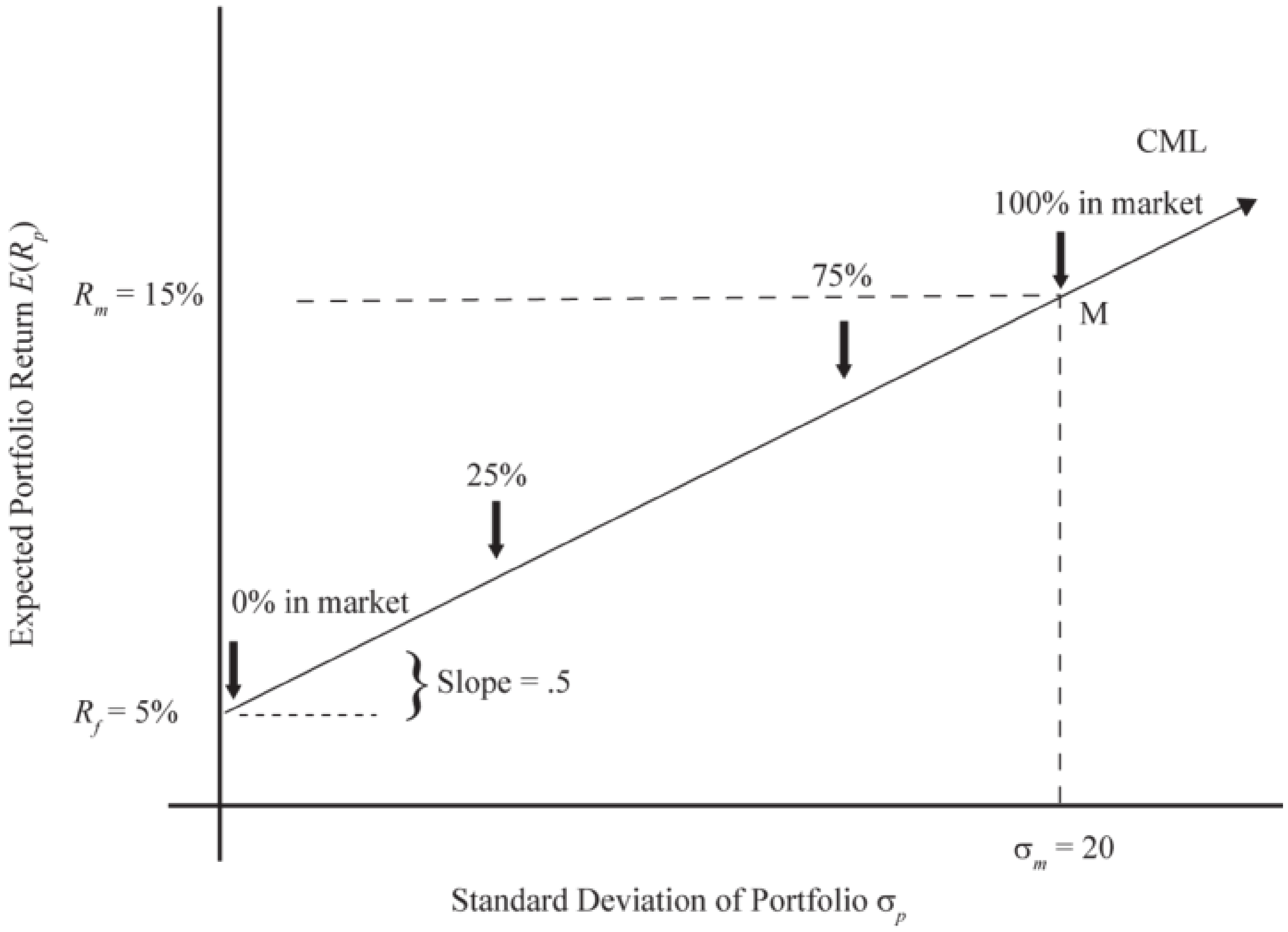
2. Mr. Miles is also interested in determining the exact risk and return at each point.

Solution to 1:

We calculate the equation for the CML as $E(R_p) = 5\% + 0.50 \times \sigma_p$ by substituting the given information into the general CML equation. The intercept of the line is 5 percent, and its slope is 0.50. We can draw the CML by arbitrarily taking any two points on the line that satisfy the above equation.

Alternatively, the CML can be drawn by connecting the risk-free return of 5 percent on the *y*-axis with the market portfolio at (20 percent, 15 percent). The CML is shown in Exhibit 4.

Exhibit 4. Risk and Return on the CML



Solution to 2:

Return with 0 percent invested in the market = 5 percent, which is the risk-free return.

Standard deviation with 0 percent invested in the market = 0 percent because T-bills are not risky.

Return with 25 percent invested in the market = (0.75 × 5%) + (0.25 × 15%) = 7.5%.

Standard deviation with 25 percent invested in the market = 0.25 × 20% = 5%.

Return with 75 percent invested in the market = (0.25 × 5%) + (0.75 × 15%) = 12.50%.

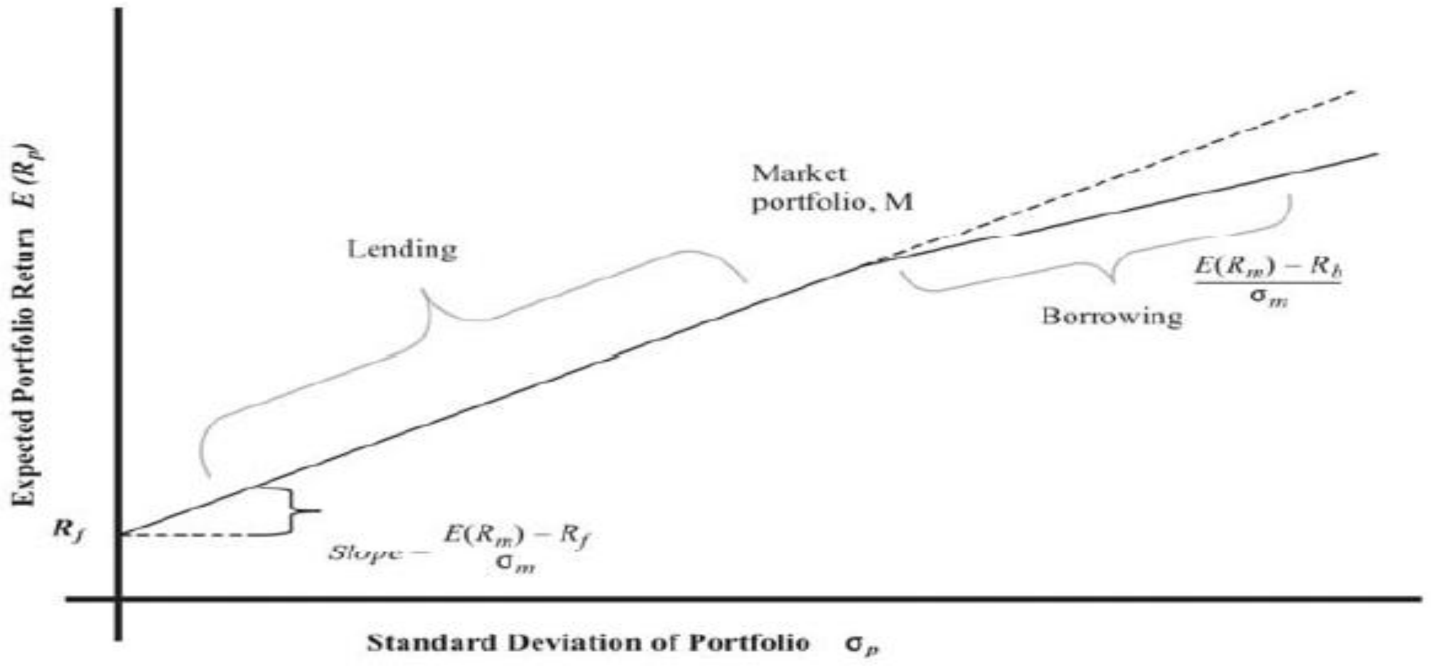
Standard deviation with 75 percent invested in the market = 0.75 × 20% = 15%.

Return with 100 percent invested in the market = 15 percent, which is the return on the S&P 500.

Standard deviation with 100 percent invested in the market = 20 percent, which is the risk of the S&P 500.

Capital Market Line (CML)

Exhibit 5 CML with Different Lending and Borrowing Rates



$$E(R_P) = RFR + \sigma_P \cdot \left(\frac{E(R_M) - RFR}{\sigma_M} \right)$$

◈ *All investors will hold：Combination of the risk-free asset and Market portfolio*

EXAMPLE 2

Mr. Miles decides to set aside a small part of his wealth for investment in a portfolio that has greater risk than his previous investments because he anticipates that the overall market will generate attractive returns in the future. He assumes that he can borrow money at 5 percent and achieve the same return on the S&P 500 as before: an expected return of 15 percent with a standard deviation of 20 percent.

Calculate his expected risk and return if he borrows 25 percent, 50 percent, and 100 percent of his initial investment amount.

Solution:

The leveraged portfolio's standard deviation and return can be calculated in the same manner as before with the following equations:

$$E(R_p) = w_1 R_f + (1 - w_1) E(R_m)$$

and

$$\sigma_p = (1 - w_1)\sigma_m$$

The proportion invested in T-bills becomes negative instead of positive because Mr. Miles is borrowing money. If 25 percent of the initial investment is borrowed, w_1 = –0.25, and $(1 - w_1)$ = 1.25, etc.

Return with –25 percent invested in T-bills = (–0.25 × 5%) + (1.25 × 15%) = 17.5%.

Standard deviation with –25 percent invested in T-bills = 1.25 × 20% = 25%.

Return with –50 percent invested in T-bills = (–0.50 × 5%) + (1.50 × 15%) = 20.0%.

Standard deviation with –50 percent invested in T-bills = 1.50 × 20% = 30%.

Return with –100 percent invested in T-bills = (–1.00 × 5%) + (2.00 × 15%) = 25.0%.

Standard deviation with –100 percent invested in T-bills = 2.00 × 20% = 40%.

Note that negative investment (borrowing) in the risk-free asset provides a higher expected return for the portfolio but that higher return is also associated with higher risk.

EXAMPLE 3

Mr. Miles approaches his broker to borrow money against securities held in his portfolio. Even though Mr. Miles' loan will be secured by the securities in his portfolio, the broker's rate for lending to customers is 7 percent. Assuming a risk-free rate of 5 percent and a market return of 15 percent with a standard deviation of 20 percent, estimate Mr. Miles' expected return and risk if he invests 25 percent and 75 percent in the risk-free asset and if he decides to borrow 25 percent and 75 percent of his initial investment and invest the money in the market.

Solution:

The unleveraged portfolio's standard deviation and return are calculated using the same equations as before:

$$E(R_p) = w_1 R_f + (1 - w_1)E(R_m),$$

and

$$\sigma_p = (1 - w_1)\sigma_m$$

The results are unchanged. The slope of the line for the unleveraged portfolio is 0.50, just as before:

Return with 25 percent invested in the market = (0.75 × 5%) + (0.25 × 15%) = 7.5%.

Standard deviation with 25 percent invested in the market = 0.25 × 20% = 5%.

Return with 75 percent invested in the market = (0.25 × 5%) + (0.75 × 15%) = 12.5%.

Standard deviation with 75 percent invested in the market = 0.75 × 20% = 15%.

For the leveraged portfolio, everything remains the same except that R_f is replaced with R_b.

$$E(R_p) = w_1 R_b + (1 - w_1)E(R_m),$$

and

$$\sigma_p = (1 - w_1)\sigma_m.$$

Return with –25 percent invested in T-bills = (–0.25 × 7%) + (1.25 × 15%) = 17.0%.

Standard deviation with –25 percent invested in T-bills = 1.25 × 20% = 25%.

Return with –75 percent invested in T-bills = (–0.75 × 7%) + (1.75 × 15%) = 21.0%.

Standard deviation with –75 percent invested in T-bills = 1.75 × 20% = 35%.

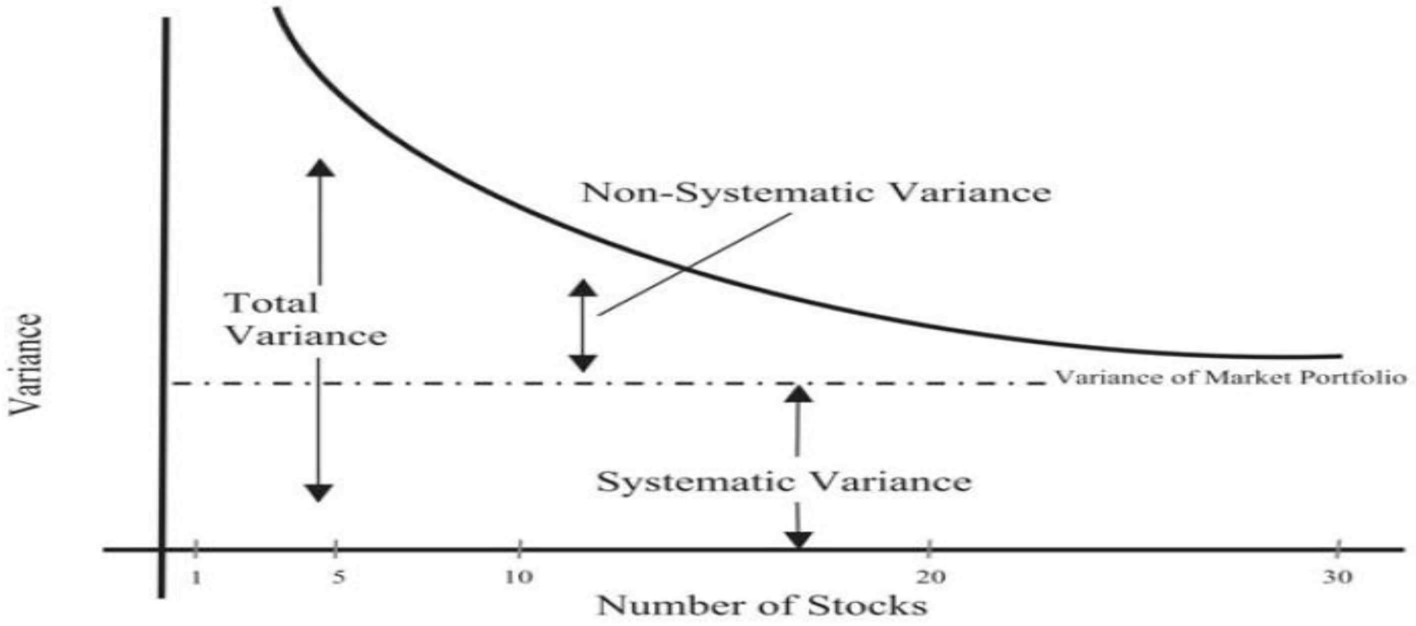
Systematic Risk and Nonsystematic Risk

unsystematic risk (unique, diversifiable, or firm-specific risk)

systematic risk (non-diversifiable risk or market risk)

Total risk = systematic risk + unsystematic risk

Exhibit 13 Diversification with Number of Stocks



EXAMPLE 4

1 Describe the systematic and nonsystematic risk components of the following assets:
A A risk-free asset, such as a three-month Treasury bill

B The market portfolio, such as the S&P 500, with total risk of 20 percent

2 Consider two assets, A and B. Asset A has total risk of 30 percent, half of which is nonsystematic risk. Asset B has total risk of 17 percent, all of which is systematic risk. Which asset should have a higher expected rate of return?

Solution to 1A:

By definition, a risk-free asset has no risk. Therefore, a risk-free asset has zero systematic risk and zero nonsystematic risk.

Solution to 1B:

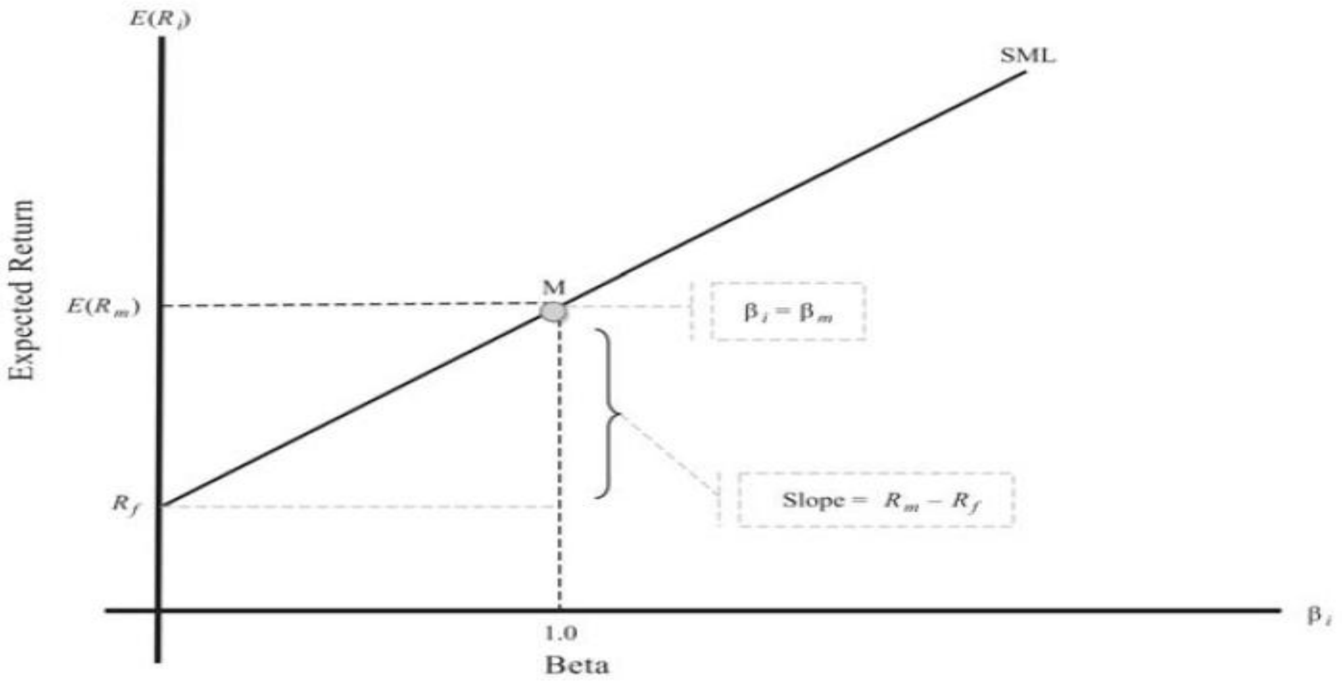
As we mentioned earlier, a market portfolio is a diversified portfolio, one in which no more risk can be diversified away. We have also described it as an efficient portfolio. Therefore, a market portfolio does not contain any nonsystematic risk. All of its total risk, 20 percent, is systematic risk.

Solution to 2:

The amount of systematic risk in Asset A is 15 percent, and the amount of systematic risk in Asset B is 17 percent. Because only systematic risk is priced or receives a return, the expected rate of return must be higher for Asset B.

Capital asset pricing model (CAPM)

Exhibit 7 The Security Market Line



Security market line (SML)

$$\beta_i = \frac{Cov_{i,mkt}}{\sigma^2_{mkt}}$$

- E(R) = Rf + β(Rm-Rf)

Return-Generating Model

- *Return-Generating Model*

$$E(R_i) - R_f = \sum_{j=1}^{k} \beta_{ij} E(F_j) = \beta_{i1}\left[E(R_m) - R_f\right] + \sum_{j=2}^{k} \beta_{ij} E(F_j)$$

- *Three - Factor and Four - Factor Models*
- *The Single-Index Model:*

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f].$$

- *Although the single-index model is simple, it fits nicely with the capital market line.*

$$E(R_i) - R_f = \left(\frac{\sigma_i}{\sigma_m}\right)\left[E(R_m) - R_f\right]$$

Decomposition of Total Risk for a Single-Index Model

- *Decompose total variance into systematic and nonsystematic variancesThe difference between expected returns and realized returns is attributable to non-market changes, as an error term, e_i in the second equation below:*

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f] \qquad R_i - R_f = \beta_i(R_m - R_f) + e_i$$

- *The variance of realized returns can be expressed in the equation below*

$$\sigma_i^2 = \beta_i^2\sigma_m^2 + \sigma_e^2 + 2\mathrm{Cov}(R_m, e_i)$$

$$\sigma_i^2 = \beta_i^2\sigma_m^2 + \sigma_e^2 \qquad \sigma_i = \sqrt{\beta_i^2\sigma_m^2 + \sigma_e^2}$$

$$E(R_i) - R_f = \left(\frac{\sigma_i}{\sigma_m}\right) \times \left[E(R_m) - R_f\right] = \left(\frac{\beta_i\sigma_m}{\sigma_m}\right) \times \left[E(R_m) - R_f\right],$$

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f]$$

Calculation and Interpretation of Beta

- *We begin with the single-index model*

$$R_i = (1 - \beta_i)R_f + \beta_i \times R_m + e_i$$

- *Because systematic risk depends on the correlation between the asset and the market,we can arrive at a measure of systematic risk from the covariance between Rt and Rm*

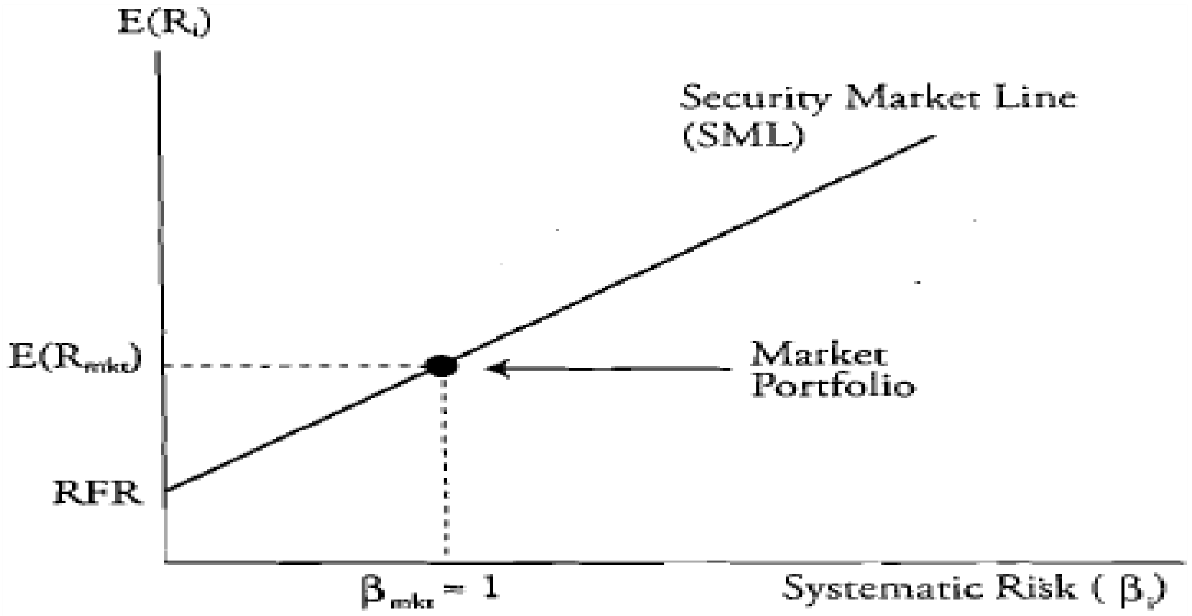
$$\begin{aligned} \text{Cov}(R_i, R_m) &= \text{Cov}(\beta_i \times R_m + e_i, R_m) \\ &= \beta_i \text{Cov}(R_m, R_m) + \text{Cov}(e_i, R_m) \\ &= \beta_i \sigma_m^2 + 0 \end{aligned}$$

- *Rewrite the equation in terms of beta as follows:*

$$\beta_i = \frac{\text{Cov}(R_i, R_m)}{\sigma_m^2} = \frac{\rho_{i,m}\sigma_i\sigma_m}{\sigma_m^2} = \frac{\rho_{i,m}\sigma_i}{\sigma_m}$$

The Capital Asset Pricing Model

- *Given that the only relevant systematic risk for an individual asset i is the covariance between the asset's returns and the return on the market portfolio.*



$$E(R_i) = RFR + \beta_i \cdot [E(R_{mkt}) - RFR]$$

$$\beta_i = \frac{Cov_{i,mkt}}{\sigma^2_{mkt}}$$

◈ *Beta (standardized systematic risk) measures the sensitivity of a security's returns to changes in the market return.*

EXAMPLE 5

Assuming that the risk (standard deviation) of the market is 25 percent, calculate the beta for the following assets:

1 A short-term US Treasury bill.

2 Gold, which has a standard deviation equal to the standard deviation of the market but a zero correlation with the market.

3 A new emerging market that is not currently included in the definition of "market"—the emerging market's standard deviation is 60 percent, and the correlation with the market is –0.1.

4 An initial public offering or new issue of stock with a standard deviation of 40 percent and a correlation with the market of 0.7 (IPOs are usually very risky but have a relatively low correlation with the market).

We use the formula for beta in answering the above questions:

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m}$$

Solution to 1:

By definition, a short-term US Treasury bill has zero risk. Therefore, its beta is zero.

Solution to 2:

Because the correlation of gold with the market is zero, its beta is zero.

Solution to 3:

Beta of the emerging market is $-0.1 \times 0.60 \div 0.25 = -0.24$.

Solution to 4:

Beta of the initial public offering is $0.7 \times 0.40 \div 0.25 = 1.12$.

EXAMPLE 7

1 Suppose the risk-free rate is 3 percent, the expected return on the market portfolio is 13 percent, and its standard deviation is 23 percent. An Indian company, Bajaj Auto, has a standard deviation of 50 percent but is uncorrelated with the market.Calculate Bajaj Auto’s beta and expected return.

2 Suppose the risk-free rate is 3 percent, the expected return on the market portfolio is 13 percent, and its standard deviation is 23 percent. A German company, Mueller Metals, has a standard deviation of 50 percent and a correlation of 0.65 with the market. Calculate Mueller Metal’s beta and expected return.

Solution to 1:

Using the formula for β_i, we can calculate β_i and then the return.

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{0.0 \times 0.50}{0.23} = 0$$

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 0 \times (0.13 - 0.03) = 0.03 = 3.0\%$$

Because of its zero correlation with the market portfolio, Bajaj Auto’s beta is zero. Because the beta is zero, the expected return for Bajaj Auto is the risk-free rate, which is 3 percent.

Solution to 2:

Using the formula for β_i, we can calculate β_i and then the return.

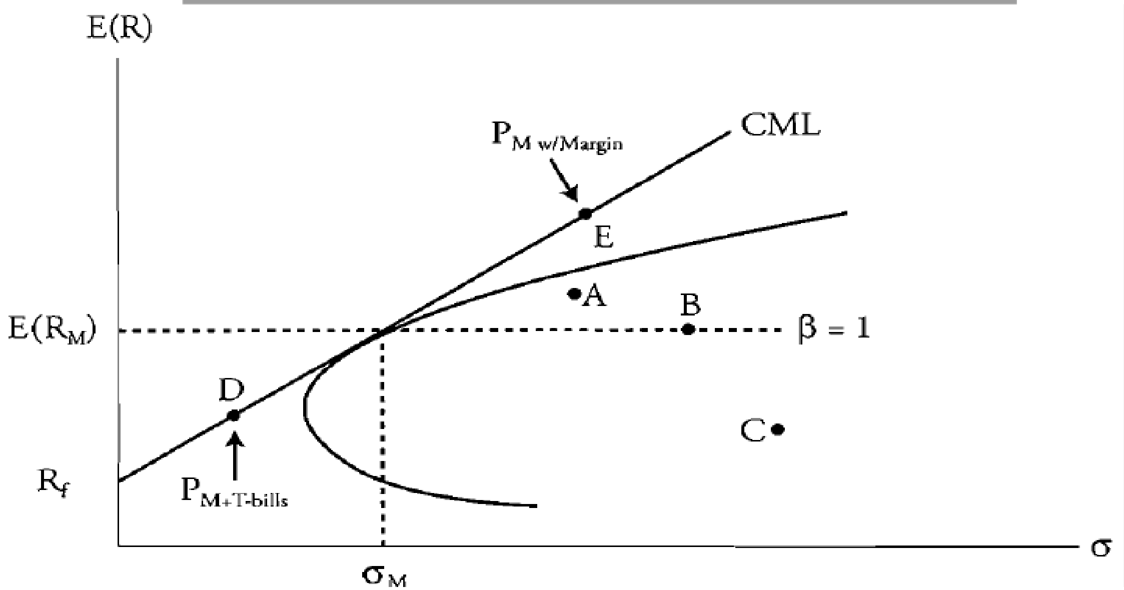
$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{0.65 \times 0.50}{0.23} = 1.41$$

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 1.41 \times (0.13 - 0.03) = 0.171 = 17.1\%$$

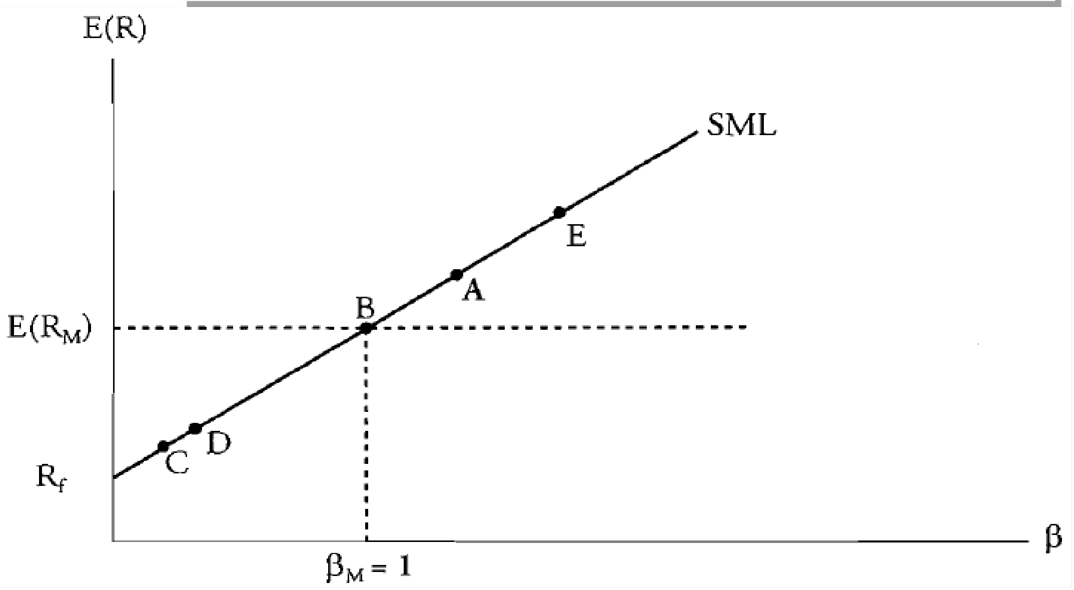
Because of the high degree of correlation with the market, the beta for Mueller Metals is 1.41 and the expected return is 17.1 percent. Because Mueller Metals has systematic risk that is greater than that of the market, it has an expected return that exceeds the expected return of the market.

CML and SML

- ***The CML : Total risk!   Efficient***



- ***The SML : Systematic risk!   Properly priced***



•Point A represents a high-beta stock or portfolio,
•Point B represents a stock or portfolio with a beta of one.
•Point C represents a low-beta stock or portfolio (not necessarily low-risk).

- *The CML uses total risk on the X-axis. Hence, only efficient portfolios will plot on the CML.*

- *The SML uses beta (systematic risk) on the X-axis. So in a CAPM world, all properly priced securities and portfolios of securities will plot on the SML.*

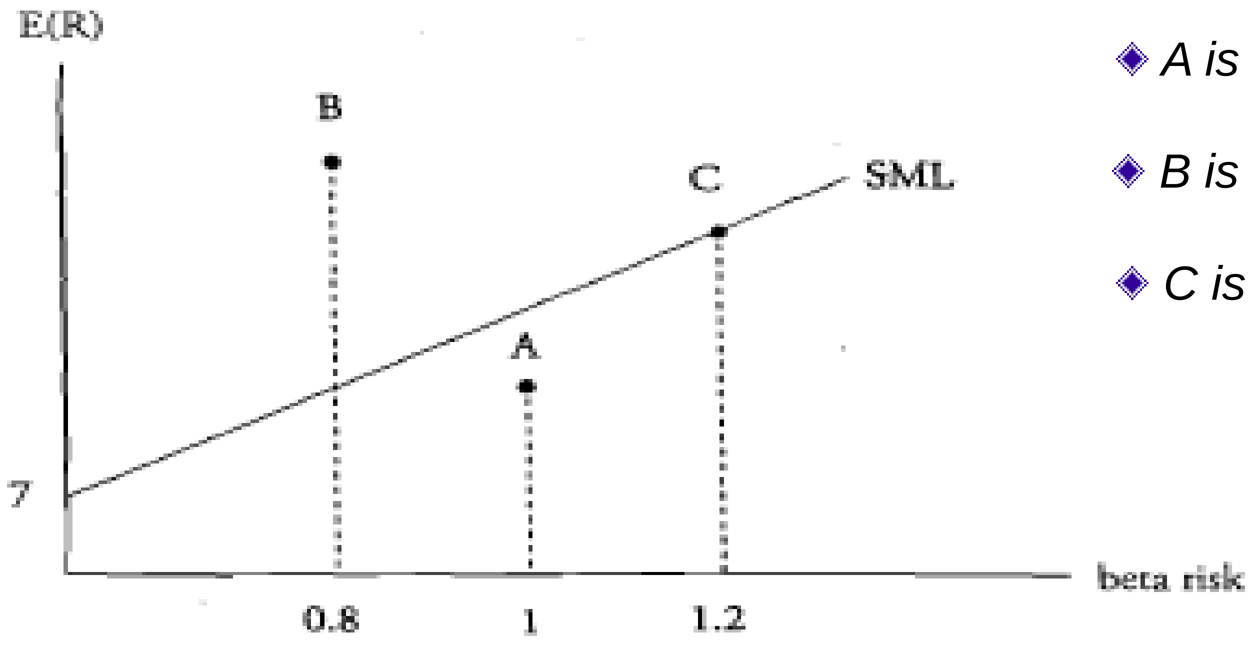
Identify mispriced securities

Estimated or Forecast return

the expected return based on opinions of the returns that can be earned on the stock given our future price and dividend forecasts.

Required return

the expected return based on the theory of the CAPM.



- *A is overvalued. Short sell stock A.*
- *B is undervalued. Buy stock B.*
- *C is properly valued. Do nothing.*

EXAMPLE 8

You invest 20 percent of your money in the risk-free asset, 30 percent in the market portfolio, and 50 percent in RedHat, a US stock that has a beta of 2.0. Given that the risk-free rate is 4 percent and the market return is 16 percent, what are the portfolio's beta and expected return?

EXAMPLE 9

GlaxoSmithKline Plc is examining the economic feasibility of developing a new medicine. The initial investment in Year 1 is $500 million. The investment in Year 2 is $200 million. There is a 50 percent chance that the medicine will be developed and will be successful. If that happens, GlaxoSmithKline must spend another $100 million in Year 3, but its income from the project in Year 3 will be $500 million, not including the third-year investment. In Years 4, 5, and 6, it will earn $400 million a year if the medicine is successful. At the end of Year 6, it intends to sell all rights to the medicine for $600 million. If the medicine is unsuccessful, none of GlaxoSmithKline's investments can be salvaged. Assume that the market return is 12 percent, the risk-free rate is 2 percent, and the beta risk of the project is 2.3. All cash flows occur at the end of each year.

1 Calculate the expected annual cash flows using the probability of success.

2 Calculate the expected return.

3 Calculate the net present value.

Solution:

The beta of the risk-free asset = 0, the beta of the market = 1, and the beta of RedHat is 2.0. The portfolio beta is

$$\beta_p = w_1\beta_1 + w_2\beta_2 + w_3\beta_3 = (0.20 \times 0.0) + (0.30 \times 1.0) + (0.50 \times 2.0) = 1.30$$

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.04 + 1.30 \times (0.16 - 0.04) = 0.196 = 19.6\%$$

The portfolio beta is 1.30, and its expected return is 19.6 percent.

Alternate Method:

Another method for calculating the portfolio's return is to calculate individual security returns and then use the portfolio return formula (i.e., weighted average of security returns) to calculate the overall portfolio return.

Return of the risk-free asset = 4 percent; return of the market = 16 percent

RedHat's return based on its beta = $0.04 + 2.0 \times (0.16 - 0.04) = 0.28$

Portfolio return = $(0.20 \times 0.04) + (0.30 \times 0.16) + (0.50 \times 0.28) = 0.196 = 19.6\%$

Not surprisingly, the portfolio return is 19.6 percent, as calculated in the first method.

EXAMPLE 9

Application of the CAPM to Capital Budgeting

GlaxoSmithKline Plc is examining the economic feasibility of developing a new medicine. The initial investment in Year 1 is $500 million. The investment in Year 2 is $200 million. There is a 50 percent chance that the medicine will be developed and will be successful. If that happens, GlaxoSmithKline must spend another $100 million in Year 3, but its income from the project in Year 3 will be $500 million, not including the third-year investment. In Years 4, 5, and 6, it will earn $400 million a year if the medicine is successful. At the end of Year 6, it intends to sell all rights to the medicine for $600 million. If the medicine is unsuccessful, none of GlaxoSmithKline's investments can be salvaged. Assume that the market return is 12 percent, the risk-free rate is 2 percent, and the beta risk of the project is 2.3. All cash flows occur at the end of each year.

1. Calculate the expected annual cash flows using the probability of success.
2. Calculate the expected return.
3. Calculate the net present value.

Solution to 1:

There is a 50 percent chance that the cash flows in Years 3–6 will occur. Taking that into account, the expected annual cash flows are:

Year 1: –$500 million (outflow)

Year 2: –$200 million (outflow)

Year 3: 50% of –$100 million (outflow) + 50% of $500 million = $200 million

Year 4: 50% of $400 million = $200 million

Year 5: 50% of $400 million = $200 million

Year 6: 50% of $400 million + 50% of $600 million = $500 million

Solution to 2:

The expected or required return for the project can be calculated using the CAPM, which is = 0.02 + 2.3 × (0.12 – 0.02) = 0.25.

Solution to 2:

The expected or required return for the project can be calculated using the CAPM, which is = 0.02 + 2.3 × (0.12 – 0.02) = 0.25.

Solution to 3:

The net present value is the discounted value of all cash flows:

$$NPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + r_t)^t}$$

$$= \frac{-500}{(1+0.25)} + \frac{-200}{(1+0.25)^2} + \frac{200}{(1+0.25)^3} + \frac{200}{(1+0.25)^4} + \frac{200}{(1+0.25)^5} + \frac{500}{(1+0.25)^6}$$

$$= -400 - 128 + 102.40 + 81.92 + 65.54 + 131.07 = -147.07.$$

Because the net present value is negative (–$147.07 million), the project should not be accepted by GlaxoSmithKline.

Measures of risk-adjusted returns

Evaluate the relative performance of a portfolio with risk that differs from that of a benchmark.

- **Sharpe Ratio:** $$\frac{R_P - R_f}{\sigma_P}.$$
- **M-squared (M²):** $$(R_P - R_f)\frac{\sigma_M}{\sigma_P} - (R_M - R_f).$$
- **Treynor measure:** $$\frac{R_P - R_f}{\beta_P}.$$
- **Jensen's alpha:** $$(R_P - R_f) - \beta_P(R_M - R_f).$$

Whether risk adjustment should be based on total risk or systematic risk depends on whether a fund bears the nonsystematic risk of a manager's portfolio.

The assumptions of the CAPM:

- *Investors are risk-averse, utility-maximizing, rational individuals.*
- *Markets are frictionless, including no transaction costs and no taxes.*
- *Investors plan for the same single holding period.*
- *Investors have homogeneous expectations or beliefs.*
- *All investments are infinitely divisible.*
- *Investors are price takers.*

Limitations of the CAPM:

Theoretical Limitations of the CAPM

1. *Single-factor model, only systematic risk or beta risk is priced in the CAPM.*
2. *Single-period model: the CAPM is a single-period model that does not consider multi-period implications or investment objectives of future periods.*

Practical Limitations of the CAPM

1. *The true market portfolio includes all assets, also includes many assets that are not investable.*
2. *Proxy for a market portfolio vary among analysts.*
3. *A long history of returns is required to estimate beta risk.*
4. *Empirical support for the CAPM is weak.*
5. *Homogeneity in investor expectations.*

Portfolio Management: An Overview

Investment Management Clients

Investment Management Clients

- Individual investors
  - Defined Contribution pension plans
- Institutions
  - Defined Benefit pension plans
  - Endowments & Foundations
  - Bank
  - Insurance companies
  - Sovereign wealth funds
  - Investment companies
    - Mutual fund
    - Hedge fund
    - Venture capital

Institutions

Defined benefit pension plan(DB plan): *an employer has an obligation to pay a certain annual amount to its employees when they retire.*

- ✓*Need to invest the assets that will provide cash flows that match the timing of the future pension payments(liabilities)*
- ✓*Plans are committed to paying pensions to members, and the assets of these plans are there to fund those payments. Plan managers need to ensure that sufficient assets will be available to pay pension benefits as they come due.*
- ✓*The plan may have an indefinitely long time horizon if new plan members are being admitted or a finite time horizon if the plan has been closed to new members.*

Institutions

Endowments and foundations

- ✓*University endowments are established to provide continuing financial support to a university and its students.*
- ✓*Charitable foundations invest donations made to them for the purpose of funding grants that are consistent with the charitable foundation's objectives.*

Institutions

Banks

✓*In some cases, banks need to invest their excess reserves.*

✓*The investments of excess reserves need to be conservative, emphasizing fixed-income and money market instruments rather than equities and other riskier assets.*

✓*The investments need to be relatively liquid.*

Institutions

Insurance companies

✓*Need to invest premiums in a manner that will allow them to pay claims*

✓*Life insurance companies and non-life insurance companies differ in their purpose and objectives and hence in their investment time horizons.*

Sovereign wealth funds: *Government-owned investment funds.*

Investment companies

Portfolio management process

Step 1: Planning step

- *Understanding the client's needs*
- *Write a Investment Policy Statement (IPS).*

- *Description of Client.*
- *Investment objectives must be stated in terms of Risk tolerance and Return.*

✓ *Absolute return objective*

✓ *Relative return objectives*

✓ *Ability to bear risk*

✓ *Willingness to bear risk*

- *Investment constraints of Liquidity, Time horizon, Tax concerns, Legal and regulatory factors, and Unique circumstances must be stated.*

- *It should also specify an objective benchmark (such as an index return) for evaluating investment performance.*

Portfolio management process

Step 2: Execution step

- *Asset Allocation.*

Top down analysis

Bottom up analysis.

- *Security Analysis*

Identifying attractive investments in particular market sectors.

- *Portfolio Construction*

Risk management is an important part of the portfolio construction process.

Step 3: Feedback step

- *Portfolio Monitor and Rebalancing.*
- *Performance Measurement and Reporting.*

Pooled Investment

Mutual Funds

Mutual funds are one of the most important investment vehicles for individuals and institutions.

Open-end fund VS Close-end fund

Open-end fund: -- accept new investment. Issue or withdraw at the net asset value.
-- Easy to grow in size, but should keep some cash to meet redemption.
Closed-end fund: --No new investment is accepted. New investors invest by buying existing shares. Trade at a premium or discount to net asset value.
--Limited ability to grow. Do not have to keep cash position.

Types of Mutual Funds

- Money Market Funds

- Bond Mutual Funds

- Stock Mutual Funds

- Hybrid/Balanced Funds

Other Investment products

- ***Exchange Traded Funds***

ETFs combine features of closed-end and open-end mutual funds.

  - *Trade like closed-end funds.*
  - *ETFs' price track net asset value like open-end funds.*

- ***Separately Managed Accounts(SMA)***

- A fund management service for institutions or individual investors with substantial assets is the separately managed account (SMA), which is also commonly referred to as a "managed account," "wrap account," or "individually managed account".The key difference between an SMA and a mutual fund is that the assets are owned directly by the individual.

Risk Management: An introduction

Basic Concept

Risk: *is exposure to uncertainty, is used to describe all of the uncertain environmental variables that lead to variation in and unpredictability of outcomes.*

Risk management: *is the process by which an organization or individual defines the level of risk to be taken, measures the level of risk being taken, and adjusts the latter toward the former, with the goal of maximizing the company's or portfolio's value or the individual's overall satisfaction, or utility.*

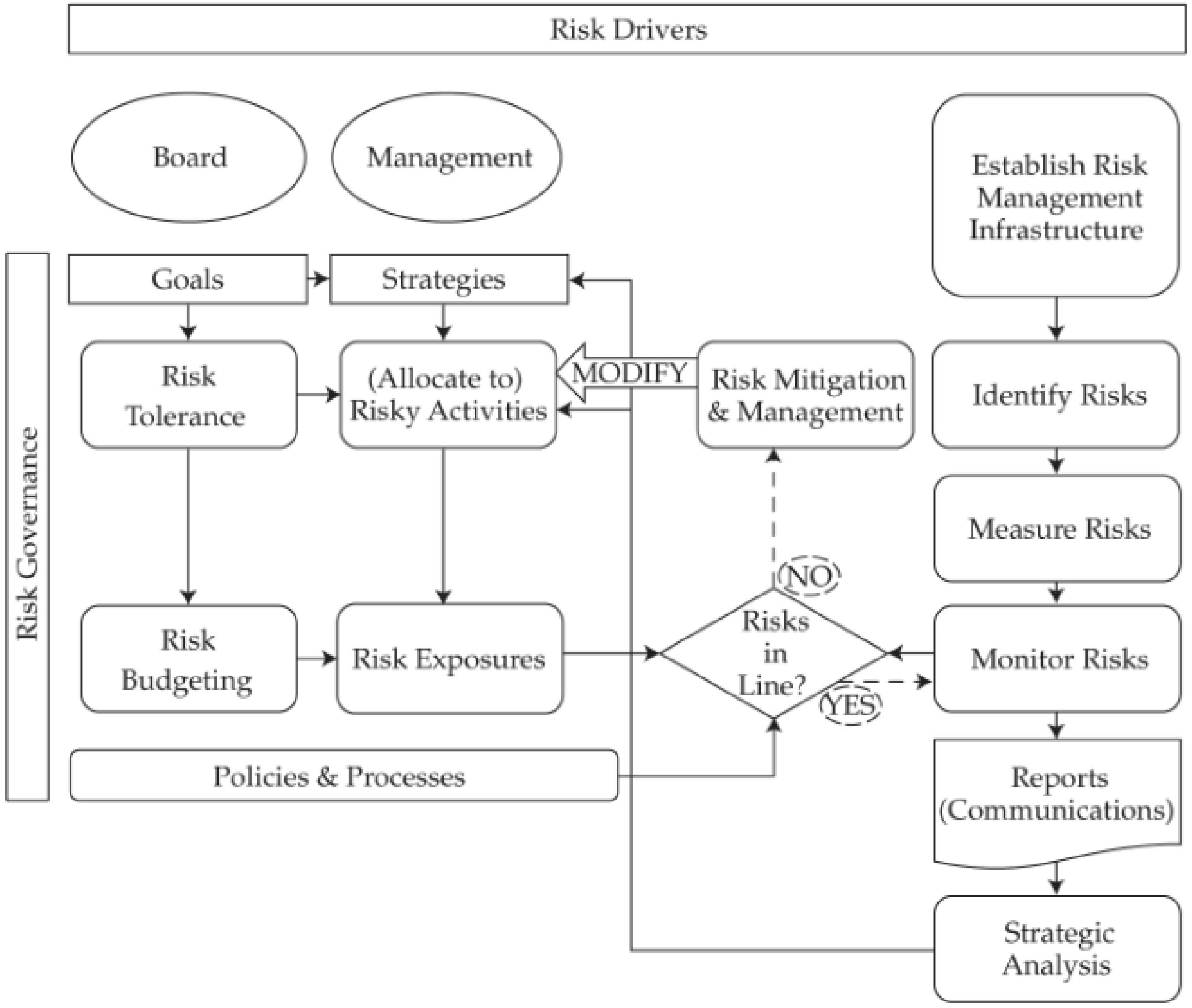
Risk exposure: *is the extent to which the underlying environmental or market risks result in actual risk borne by a business or investor who has assets or liabilities that are sensitive to those risks, the risk exposure is simply the risk position multiplied by he risk driver.*

Risk Governance

It is the top-down process and guidance that directs risk management activities to align with and support the goals of the overall enterprise.

- *An enterprise view of risk governance: drives the risk framework.*
- *Risk tolerance: identifies the extent to which the entity is willing to experience losses or opportunity costs and to fail in meeting its objectives.*
- *Risk budgeting: how one risk is taken; quantifies and allocates the tolerable risk by specific metrics.*

Exhibit 1. The Risk Management Framework in an Enterprise Context



Identification of risks

-- Financial risks: *mainly include* ***market risk, credit risk and liquidity risk.***

- *Market risk: arises from movements in interest rates, stock price, exchange rates and commodity prices.*
- *Credit risk: one party fails to pay an amount owed on an obligation.*
- *Liquidity risk: significant downward valuation adjustment when selling a financial asset.*

Identification of risks

-- Non-financial risks

- *Settlement risk: related closely to default risk.*
- *Compliance risk: Regulatory risk, accounting risk and tax risk. Matters of conforming to laws, policies and regulations.*
- *Model risk& tail risk: according to the model, it may never occur but actually, it occurred! (even more than once!!)*
- *Operational risk*
- *Solvency risk: the entity does not survive or succeed because it runs out of cash.*
- *Mortality & longevity risk: individual risk*

Measuring Risks

-- Beta

-- Duration

Convexity

-- Delta

Gamma

-- Value at risk (VaR)

- *Contains: amount, time and a probability.*
- *a minimum extreme loss metric.*

Scenario analysis& stress testing

Modifying Risks

Risk Prevention and Avoidance

Risk Acceptance: Self-insurance and Diversification

Risk Transfer

Risk Shifting

Basics of Portfolio Planning and Construction

Major Components of an IPS

- *Introduction.*
- *Statement of Purpose.*
- *Statement of Duties and Responsibilities.*
- *Procedures.*
- *Investment Objectives.*
- *Investment Constraints*
- *Investment Guidelines.*
- *Evaluation and Review.*
- *Appendices.*

Investment Objectives

Risk Objectives

- *Risk objectives are specifications for portfolio risk that reflect the risk tolerance of the client. Quantitative risk objectives can be absolute or relative or a combination of the two.*
- *Willingness to take risk: a more subjective factor.*
- *Ability to take risk: time horizon, expected income, level of wealth relative to liabilities.*

Return Objectives

- *absolute or relative.*

EXAMPLE 1

Types of Risk Objectives

A Japanese institutional investor has a portfolio valued at ¥10 billion. The investor expresses his first risk objective as a desire not to lose more than ¥1 billion in the coming 12-month period. The investor specifies a second risk objective of achieving returns within 4 percent of the return to the TOPIX stock market index, which is the investor's benchmark. Based on this information, address the following:

1.

A. Characterize the first risk objective as absolute or relative.

B. Give an example of how the risk objective could be restated in a practical manner.

2.

A. Characterize the second risk objective as absolute or relative.

B. Identify a measure for quantifying the risk objective.

Solutions to 1:

A. This is an absolute risk objective.

B. This risk objective could be restated in a practical manner by specifying that the 12-month 95 percent value at risk of the portfolio must not be more than ¥1 billion.

Solutions to 2:

A. This is a relative risk objective.

B. This risk objective could be quantified using the tracking risk as a measure. For example, assuming returns follow a normal distribution, an expected tracking risk of 2 percent would imply a return within 4 percent of the index return approximately 95 percent of the time. Remember that tracking risk is stated as a one standard deviation measure.

EXAMPLE 2

The Case of Henri Gascon: Risk Tolerance

Henri Gascon is an energy trader who works for a major French oil company based in Paris. He is 30-years old and married with one son, aged 5. Gascon has decided that it is time to review his financial situation and consults a financial adviser. The financial adviser notes the following aspects of Gascon's situation:

- Gascon's annual salary of €250,000 is more than sufficient to cover the family's outgoings.
- Gascon owns his apartment outright and has €1,000,000 of savings.
- Gascon perceives that his job is reasonably secure.
- Gascon has a good knowledge of financial matters and is confident that equity markets will deliver positive returns over the longer term.
- In the risk tolerance questionnaire, Gascon strongly disagrees with the statements that "making money in stocks and bonds is based on luck" and that "in terms of investing, safety is more important than returns."
- Gascon expects that most of his savings will be used to fund his retirement, which he hopes to start at age 50.

Based only on the information given, which of the following statements is *most* accurate?

A. Gascon has a low ability to take risk, but a high willingness to take risk.

B. Gascon has a high ability to take risk, but a low willingness to take risk.

C. Gascon has a high ability to take risk, and a high willingness to take risk.

Solution:

C is correct. Gascon has a high income relative to outgoings, a high level of assets, a secure job, and a time horizon of 20 years. This information suggests a high *ability* to take risk. At the same time, Gascon is knowledgeable and confident about financial markets and responds to the questionnaire with answers that suggest risk tolerance. This result suggests he also has a high *willingness* to take risk.

EXAMPLE 3

Henri Gascon is so pleased with the services provided by the financial adviser, that he suggests to his brother Jacques that he should also consult the adviser. Jacques thinks it is a good idea. Jacques is a self-employed computer consultant also based in Paris. He is 40-years old and divorced with four children, aged between 12 and 16. The financial adviser notes the following aspects of Jacques' situation:

- ☐ **Jacques' consultancy earnings average €40,000 per annum, but are quite volatile.**

- ☐ **Jacques is required to pay €10,000 per year to his ex-wife and children.**

- ☐ **Jacques has a mortgage on his apartment of €100,000 and €10,000 of savings.**

- ☐ **Jacques has a good knowledge of financial matters and expects that equity markets will deliver very high returns over the longer term.**

- ☐ **In the risk tolerance questionnaire, Jacques strongly disagrees with the statements "I am more comfortable putting my money in a bank account than in the stock market" and "When I think of the word "risk" the term "loss" comes to mind immediately."**

- ☐ **Jacques expects that most of his savings will be required to support his children at university.**

Based on the above information, which statement is correct?

A Jacques has a low ability to take risk, but a high willingness to take risk.

B Jacques has a high ability to take risk, but a low willingness to take risk.

C Jacques has a high ability to take risk, and a high willingness to take risk.

Solution:

A is correct. Jacques does not have a particularly high income, his income is unstable, and he has reasonably high outgoings for his mortgage and maintenance payments. His investment time horizon is approximately two to six years given the ages of his children and his desire to support them at university. This finely balanced financial situation and short time horizon suggests a low ability to take risk. In contrast, his expectations for financial market returns and risk tolerance questionnaire answers suggest a high willingness to take risk. The financial adviser may wish to explain to Jacques how finely balanced his financial situation is and suggest that, despite his desire to take more risk, a relatively cautious portfolio might be the most appropriate approach to take.

EXAMPLE 4

The Case of Henri Gascon: Return Objectives

Having assessed his risk tolerance, Henri Gascon now begins to discuss his retirement income needs with the financial adviser. He wishes to retire at age 50, which is 20 years from now. His salary meets current and expected future expenditure requirements, but he does not expect to be able to make any additional pension contributions to his fund. Gascon sets aside €100,000 of his savings as an emergency fund to be held in cash. The remaining €900,000 is invested for his retirement.

Gascon estimates that a before-tax amount of €2,000,000 in today's money will be sufficient to fund his retirement income needs. The financial adviser expects inflation to average 2 percent per year over the next 20 years. Pension fund contributions and pension fund returns in France are exempt from tax, but pension fund distributions are taxable upon retirement.

1. Which of the following is closest to the amount of money Gascon will have to accumulate in nominal terms by his retirement date to meet his retirement income objective (i.e., expressed in money of the day in 20 years)?

   A. €900,000.

   B. €2,000,000.

   C. €3,000,000.

2. Which of the following is closest to the annual rate of return that Gascon must earn on his pension portfolio to meet his retirement income objective?

   A. 2.0%.

   B. 6.2%.

   C. 8.1%.

Solution to 1:

C is correct. At 2 percent annual inflation, €2,000,000 in today's money equates to €2,971,895 in 20 years measured in money of the day [2m × $(1 + 2\%)^{20}$].

Solution to 2:

B is correct. €900,000 growing at 6.2 percent per year for 20 years will accumulate to €2,997,318, which is just above the required amount. [The solution of 6.2 percent comes from €2,997,318/€900,000 = $(1 + X)^{20}$, where X is the required rate of return.]

Investment Constrains

- *Liquidity*
- *Time Horizon*
- *Tax Concerns*
- *Legal and Regulatory Factors*
- *Unique Circumstances*

EXAMPLE 7

Henri Gascon: Description of Constraints

Henri Gascon continues to discuss his investment requirements with the financial adviser. The financial adviser begins to draft the constraints section of the IPS.

Gascon expects that he will continue to work for the oil company and that his relatively high income will continue for the foreseeable future. Gascon and his wife do not plan to have any additional children, but expect that their son will go to a university at age 18. They expect that their son's education costs can be met out of their salary income.

Gascon's emergency reserve of €100,000 is considered to be sufficient as a reserve for unforeseen expenditures and emergencies. His retirement savings of €900,000 has been contributed to his defined-contribution pension plan account to fund his retirement. Under French regulation, pension fund contributions are paid from gross income (i.e., income prior to deduction of tax) and pension fund returns are exempt from tax, but pension payments from a fund to retirees are taxed as income to the retiree.

With respect to Gascon's retirement savings portfolio, refer back to Example 2 as needed and address the following:

1. As concerns liquidity,

    A. a maximum of 50 percent of the portfolio should be invested in liquid assets.

    B. the portfolio should be invested entirely in liquid assets because of high spending needs.

C. the portfolio has no need for liquidity because there are no short-term spending requirements.

2. The investment time horizon is *closest* to:

   A. 5 years.

   B. 20 years.

   C. 40 years.

3. As concerns taxation, the portfolio:

   A. should emphasize capital gains because income is taxable.

   B. should emphasize income because capital gains are taxable.

   C. is tax exempt and thus indifferent between income and capital gains.

4. The principle legal and regulatory factors applying to the portfolio are:

   A. US Securities laws.

   B. European banking laws.

   C. French pension fund regulations.

5. As concerns unique needs, the portfolio should:

   A. have a high weighting in oil and other commodity stocks.

   B. be invested only in responsible and sustainable investments.

   C. not have significant exposure to oil and other commodity stocks.

Solution to 1:

C is correct. The assets are for retirement use, which is 20 years away. Any short-term spending needs will be met from other assets or income.

Solution to 2:

B is correct. The relevant time horizon is to the retirement date, which is 20 years away. The assets may not be liquidated at that point, but a restructuring of the portfolio is to be expected as Gascon starts to draw an income from it.

Solution to 3:

C is correct. Because no tax is paid in the pension fund, it does not matter whether returns come in the form of income or capital gains.

Solution to 4:

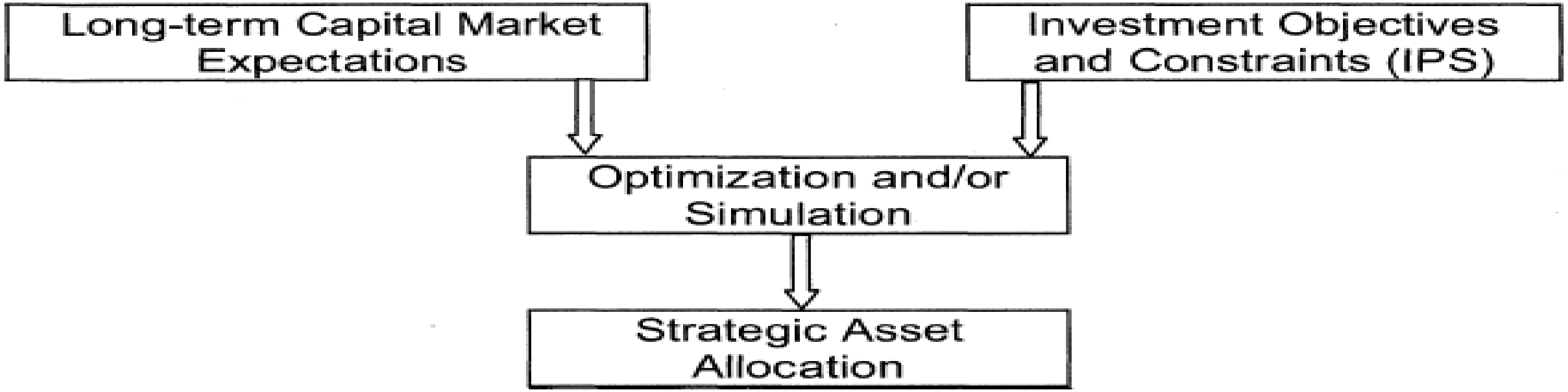
C is correct. The management of the portfolio will have to comply with any rules relating the French pension funds.

Solution to 5:

C is correct. Gascon's human capital (i.e., future labour income) is affected by the prospects of the oil industry. If his portfolio has significant exposure to oil stocks, he would be increasing a risk exposure he already has.

The Strategic Asset Allocation

Exhibit 6 Strategic Asset Allocation Process



Asset class: high paired correlation and low correlation with other asset class.

Tactical asset allocation

Security selection

Additional Portfolio Organizing Principles

- *Traditional top-down oriented framework*
- *Core-satellite approach*

EXAMPLE 11

Approaching a SAA for a Private Investor

Rainer Gottschalk recently sold his local home construction company in the south of Germany to a large homebuilder with a nationwide reach. Upon selling his company, he accepted a job as regional manager for that nationwide homebuilder. He is now considering his and his family's financial future. He looks forward to his new job, where he likes his new role, and which provides him with income to fulfill his family's short-term and medium-term liquidity needs. He feels strongly that he should not invest the proceeds of the sale of his company in real estate because his income already depends on the state of the real estate market. He consults a financial adviser from his bank about how to invest his money to retire in good wealth in 20 years.

The IPS they develop suggests a return objective of 6 percent, with a standard deviation of 12 percent. The bank's asset management division provides Gottschalk and his adviser with the following data (Exhibit 8) on market expectations.

Exhibit 8. Risk, Return, and Correlation Estimates

	Expected Return (%)	Standard Deviation (%)	Correlation Matrix		
			European Equities	Emerging Mkt. Equities	European Govt. Bonds
European equities	8.40	24	1.00	0.86	–0.07
Emerging market equities	9.20	28	0.86	1.00	–0.07
European government bonds	3.50	7	–0.07	–0.07	1.00

Note: Standard deviation and correlation calculated over the period March 1999–December 2008. All data in unhedged euros.

Sources: Barclay's, MSCI, Bloomberg.

To illustrate the possibilities, the adviser presents Gottschalk with the following plot (Exhibit 9), in which the points forming the shaded curve outline the risk–return characteristics of the portfolios that can be constructed out of the three assets. An imaginary line linking the points with the lowest standard deviation for each attainable level of return would be the efficient frontier. The two straight lines show the risk and return objectives. Gottschalk should aim for portfolios that offer an expected return of at least 6 percent (the straight horizontal line or above) and a standard deviation of return of 12 percent or lower (the straight vertical line to the left).

Exhibit 9. Efficient Frontier

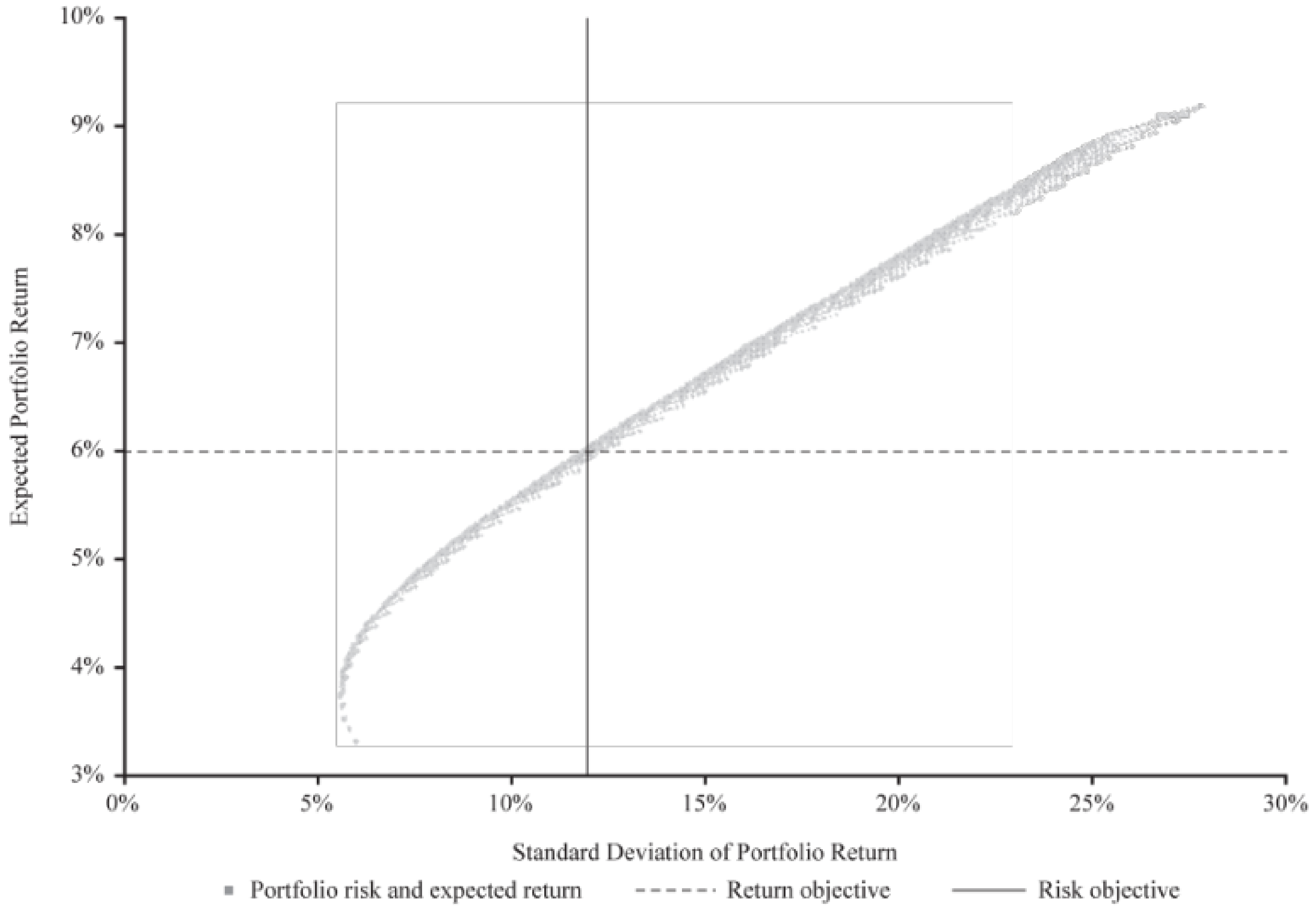


Exhibit 9 shows that a portfolio on the efficient frontier satisfies the two objectives. This portfolio consists of 28 percent European stocks, 20 percent emerging market equities, and 52 percent government bonds and gives a 6 percent expected return and a 12 percent standard deviation. This combination is what the adviser recommends to Gottschalk as his strategic asset allocation.

EXAMPLE 12

Strategic Asset Allocation for a European Charity

A European charity has an asset allocation at the beginning of the year consisting of the asset classes and weights shown in Exhibit 10:

Exhibit 10. Asset Allocation of a European Charity (Beginning of Year)

Asset Class	Policy Weight	Corridor (+/–)	Upper Limit	Lower Limit
European equities	30.0%	2.0%	32.0%	28.0%
International equities	15.0	2.0	17.0	13.0
European government bonds	20.0	2.0	22.0	18.0
Corporate bonds	20.0	2.0	22.0	18.0
Cash and money market instruments	15.0	2.0	17.0	13.0
Total	100.0			

As Exhibit 10 reveals, the charity has a policy that the asset class weights cannot deviate from the policy weights by more than 2 percent (the corridor). The resulting upper and lower limits for the asset class weights are shown in the rightmost columns of the table. There are two reasons for asset class actual weights to deviate from policy weights: by deliberate choice (tactical asset allocation or market timing) and as a result of divergence of the returns of the different asset classes (drift). In this example, the asset class weights start the year exactly in line with policy weights.

After half a year, the investment portfolio is as shown in Exhibit 11.

Exhibit 11. Asset Allocation for a European Charity (6 Months Later)

Asset Class	Policy Weight	Corridor (+/–)	Upper Limit	Lower Limit	Period Return	Ending Weight
European equities	30.0%	2.0%	32.0%	28.0%	15.0%	32.4%
International equities	15.0	2.0	17.0	13.0	10.0	15.5
European government bonds	20.0	2.0	22.0	18.0	0.5	18.9
Corporate bonds	20.0	2.0	22.0	18.0	1.5	19.1
Cash and money market instruments	15.0	2.0	17.0	13.0	1.0	14.2
Total	100.0%				6.6%	100.0%

1. Discuss the returns of the portfolio and comment on the main asset weight changes.

Solution to 1:

The investment portfolio generated a return calculated on beginning (policy) weights of 6.55 percent or 6.6 percent (= 0.30 × 15% + 0.15 × 10% + 0.20 × 0.5% + 0.20 × 1.5% + 0.15 × 1.0%), mainly driven by a strong equity market. Bond returns were more subdued, leading to considerable drift in asset class weights. In particular, the European equity weight breached the upper limit of its allowed actual weight.

The investment committee decides against reducing European equities back to policy weight and adding to the fixed income and cash investments toward policy weights. Although this rebalancing would be prudent, the committee decides to engage in tactical asset allocation based on the view that this market will continue to be strong over the course of the year. It decides to just bring European equities back to within its bandwidth (a 32 percent portfolio weight) and add the proceeds to cash. Exhibit 12 shows the outcome after another half year.

Exhibit 12. Asset Allocation for a European Charity (an Additional 6 Months Later)

Asset Class	Policy Weight	Starting Weight	Corridor (+/–)	Upper Limit	Lower Limit	Period Return	Ending Weight
European equities	30.0%	32.0%	2.0%	32.0%	28.0%	–9.0%	29.7%
International equities	15.0	15.5	2.0	17.0	13.0	–6.0	14.9
European government bonds	20.0	18.9	2.0	22.0	18.0	4.0	20.0
Corporate bonds	20.0	19.1	2.0	22.0	18.0	4.0	20.2
Cash and money market instruments	15.0	14.6	2.0	17.0	13.0	2.0	15.2
Total	100.0%					–2.0%	100.0%

The prior decision not to rebalance to policy weights did not have a positive result. Contrary to the expectations of the investment committee, both European and international equities performed poorly while bonds recovered. The return of the portfolio was −2.0 percent.

2. How much of this return can be attributed to tactical asset allocation?

Solution to 2:

Because tactical asset allocation is the deliberate decision to deviate from policy weights, the return contribution from tactical asset allocation is equal to the difference between the actual return, and the return that would have been made if the asset class weights were equal to the policy weights. Exhibit 13 shows the difference to be −0.30 percent.

Exhibit 13. Returns to Tactical Asset Allocation

Asset Class	Policy Weight I	Starting Weight II	Weights Difference III (= II – I)	Period Return IV	TAA Contribution V (= III × IV)
European equities	30.0%	32.0%	2.0%	–9.0%	–0.18%
International equities	15.0	15.5	0.5	–6.0	–0.03
European government bonds	20.0	18.9	–1.1	4.0	–0.05
Corporate bonds	20.0	19.1	–0.9	4.0	–0.04
Cash and money market instruments	15.0	14.6	–0.4	2.0	–0.01
Total	100.0%			–2.0%	–0.30%

THANKS