# Risk & Return

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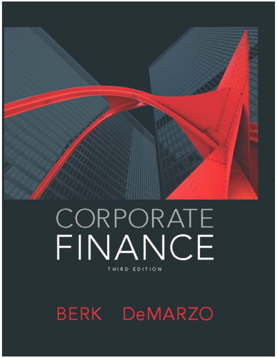
# Sommaire

# Readings

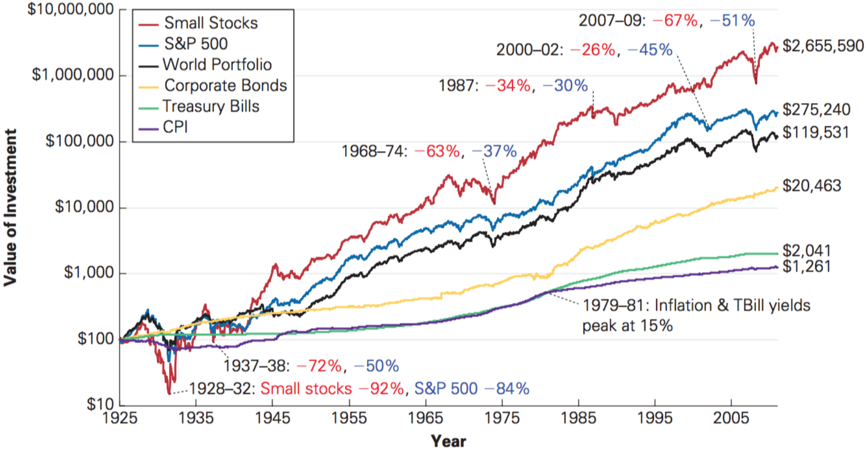
- Jonathan Berk (Stanford University) & Peter DeMarzo (Stanford University) - *Corporate Finance* (3rd edition)



# 1.1 Risk and return: some insights


- What is the return on Berkshire Hathaway ?
  - If you had invested in 1964, your $1,000 would be $10.5 million.

- Result of investing $100 at the end of 1925 in five financial products

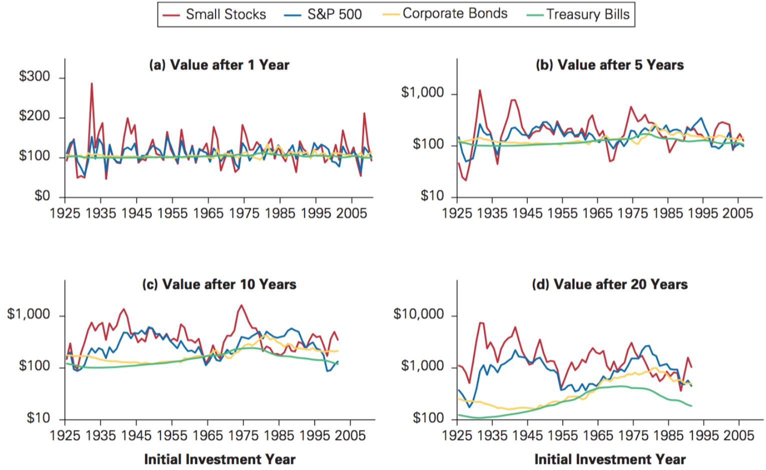



Source: Chicago Center for Research in Security Prices, Standard and Poors, MSCI, and Global Financial Data

# 1.1 Risk, return: first impressions

- **Small stocks experienced the highest long-term return, followed by the large stocks in the S&P 500**
  - Then international stocks in the world portfolio, corporate bonds, and finally Treasury bills.
  - All of the investments grew faster than inflation (CPI).
- **What can explain those differences ?**
  - Stocks had the best performance over this 86-year period, however that performance came at a cost: *the risk of large losses in a downturn*;
  - On the other hand, T-bill - regarded as safe assets by the market - enjoyed steady gains each year.

- For 1 year: Which is the most variable ? Which is the least variable




Source: Chicago Center for Research in Security Prices, Standard and Poors, MSCI, and Global Financial Data

### 1.2.1 Expected return

- What is the *return* ?
  - It is the increase - usually expressed in percentage - in the value of an investment per dollar initially invested in the security
- If an asset is risky: its future is not known for sure... but you can assign a probability to possible outcomes !
  - We summarize this information with a probability distribution

Example: LVMH share price today $(t-1)$ is 150$. In one year $t$, 3 possible outcomes:

| Scenarios | Share price | Return | Probability |
|---|---|---|---|
| Optimist | 160$ | 10$ | 40% |
| Neutral | 155$ | 5$ | 50% |
| Pessimist | 145$ | -5$ | 10% |

- **What is the expected return ?**

### 1.2.2 Variance and standard deviation

- The expected return is the return we would earn on average if we were to iterate the same investment multiple times, with the same distribution
  - However, at each point of time, the share price is not always equal to the expected value
  - Thus we can calculate the *deviation* from the mean (= expected return)
- The variance is squared to amplify the "*spread-out*" of the probability distribution
  - We refer to the variance with the notation $Var(r_j)$ or $V(r_j)$
- The standard deviation is simply the square root of the variance
  - In finance, the standard deviation is referred to as the *volatility* of a stock and is noted $\sigma_{r_j}$
  - We usually use volatility to assert the risk as it is in the same unit as the returns

# 1.2 Metrics for risks and returns

Back to LVMH share example: we know that $E[R] = 4.5\$$

| **Sce.** | $P_{LVMH}$ | $R$ | $P_R$ | **Sqrd dev.** $(R - E[R])^2$ |
|---|---|---|---|---|
| O | 160$ | 10$ | 40% | $(4.5\$)^2 = 20.25$ |
| N | 155$ | 5$ | 50% | $(0.5\$)^2 = 0.25$ |
| P | 145$ | -5$ | 10% | $(-9.5\$)^2 = 90.25$ |

- What is the variance of LVMH ?
- What is the standard deviation of LVMH ?

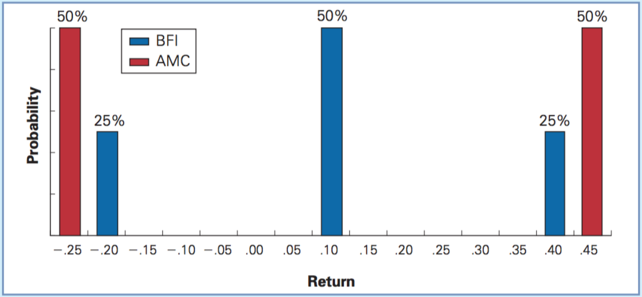
Concretely, the **expected return** is what **we can earn on average**, whereas the **standard deviation** measures **how much we could be wrong**...

## Getting a graphic look at expected return, variance and standard deviation

**FIGURE 10.4**

**Probability Distribution for BFI and AMC Returns**

While both stocks have the same expected return, AMC's return has a higher variance and standard deviation.



# 1.2 Metrics for risks and returns

## Expected (or *mean*) return

$$Expected\ \ return = E[R] = \sum_R p_R \times R$$

## Variance

$$Variance = Var[R] = \sum_R p_R \times (R - E[R])^2$$

## Standard deviation, volatility

$$Standard\ \ deviation = \sigma_R = \sqrt{Var[R]}$$

### 1.2.3 Historical return

- In order to assign probabilities of future outcomes, we need to have an idea of how the stock has moved in the past
  - In order to do that we need to compute the **historical return** of a stock
  - It corresponds to the return that actually occurred on a certain period

Between $t$ and $t+1$ the realized return is given by the formula

**Historical return, realized return**

$$\begin{aligned} R_{t+1} &= \frac{Div_{t+1}}{P_t} + \frac{P_{t+1} - P_t}{P_t} \\ &= Dividend\ yield + Capital\ gain \end{aligned}$$

A look at historical returns between 2002 and 2011...

| Year End | S&P 500 Index | Dividends Paid* | S&P 500 Realized Return | Microsoft Realized Return | 1-Month T-Bill Return |
|---|---|---|---|---|---|
| 2001 | 1148.08 | | | | |
| 2002 | 879.82 | 14.53 | −22.1% | −22.0% | 1.6% |
| 2003 | 1111.92 | 20.80 | 28.7% | 6.8% | 1.0% |
| 2004 | 1211.92 | 20.98 | 10.9% | 8.9% | 1.2% |
| 2005 | 1248.29 | 23.15 | 4.9% | −0.9% | 3.0% |
| 2006 | 1418.30 | 27.16 | 15.8% | 15.8% | 4.8% |
| 2007 | 1468.36 | 27.86 | 5.5% | 20.8% | 4.7% |
| 2008 | 903.25 | 21.85 | −37.0% | −44.4% | 1.5% |
| 2009 | 1115.10 | 27.19 | 26.5% | 60.5% | 0.1% |
| 2010 | 1257.64 | 25.44 | 15.1% | −6.5% | 0.1% |
| 2011 | 1257.60 | 26.59 | 2.1% | −4.5% | 0.0% |

*Total dividends paid by the 500 stocks in the portfolio, based on the number of shares of each stock in the index, adjusted until the end of the year, assuming they were reinvested when paid.

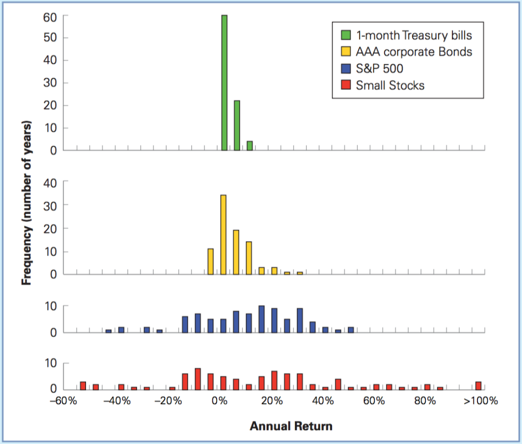
*Source*: Standard & Poor's, Microsoft and U.S. Treasury Data

... Which can yield a useful probability distribution !

FIGURE 10.5

**The Empirical Distribution of Annual Returns for U.S. Large Stocks (S&P 500), Small Stocks, Corporate Bonds, and Treasury Bills, 1926–2011.**

The height of each bar represents the number of years that the annual returns were in each 5% range. Note the greater variability of stock returns (especially small stocks) compared to the returns of corporate bonds or Treasury bills.



# 1.2 Metrics for risks and returns

**How to compute average historical returns and variance with realized returns:**

## Average annual return of a security

$$\overline{R} = \frac{1}{T}\sum_{t=1}^{T} R_t$$

## Variance with realized return

$$Var[R] = \frac{1}{T-1}\sum_{t=1}^{T}(R_t - E[\overline{R}])^2$$

Why do we divide by $T-1$ ? In essence it is because we "use up" one degree of freedom by not knowing the exact expected return.

# 1.3 Typology of risks and diversification

**Overall typology of risks...**

- **Common risk**: Risk that is perfectly correlated and affects all securities (e.g.: Earthquake)
- **Independent risk**: Risk that is uncorrelated and affects a particular security (e.g: life insurance)

**... At a firm-scale**

- **Systematic risk**: news about the economy as a whole and therefore affects all stocks. (e.g: FED increases interest rates)
- **Idiosyncratic (or firm-specific) risk**: a good or bad news about the company (e.g: growth of sales)

When risks are *independent*, some individual homeowners are unlucky and others are lucky, but overall the number of claims is quite predictable. The averaging out of independent risks in a large portfolio is called **diversification**.

# 1.3 Typology of risks and diversification

**Example (Diversifiable Versus Systematic Risk)**

Which of the following risks of a stock are likely to be firm-specific, diversifiable risks, and which are likely to be systematic risks? Which risks will affect the risk premium that investors will demand?

1. The risk that the founder and CEO retires
2. The risk that oil prices rise, increasing production costs
3. The risk that a product design is faulty and the product must be recalled
4. The risk that the economy slows, reducing demand for the firms products

# 2.1 Constructing a portfolio

After estimating the expected return and volatility of a single stock, we can now turn to the construction of a **portfolio**, which bundles together a collection of financial assets

The first attempt to formalize the role of diversification in forming an optimal stock market portfolio was made by Harry Markowitz, Portfolio Selection, *Journal of Finance* (1952)

# 2.2 Returns of a portfolio

## 2.2.1 - Portfolio weights

- It is the fraction of the total investment in the portfolio held in each individual investment in the portfolio
  - When you add up all weights, you should get 1 !

**Portfolio weights**

$$Weight\ of\ security\ i\ (in\ \%) = w_i = \frac{Value\ of\ investment\ in\ i}{Total\ value\ of\ the\ portfolio} \times 100$$

**Example (Portfolio Automotive industry (1))**

Consider a portfolio with 100 shares of Renault worth \$80 per share and 200 shares of Peugeot worth \$20 per share.

- What is the total value of the portfolio ?
- What are the weights $w_{Renault}$ and $w_{Peugeot}$ ?

## 2.2.1 - Portfolio returns

- Given the portfolio weights, we can calculate the return on the portfolio, by weighting firms' returns in the portfolio

### Portfolio return and expected return

1. $\textit{Return of portfolio} = R_P = \sum_i w_i \times R_i$
2. $\textit{Expected return of portfolio} = E[R_P] = \sum_i w_i \times E[R_i]$

### Example (Portfolio Automotive industry (2))

We go back to the previous portfolio. Imagine the price of Renault's share goes up to 85$ and Peugeot's share to 30$

- What is the return of the portfolio, $R_P$ ?
- What are the new weights $\tilde{w}_{Renault}$ and $\tilde{w}_{Peugeot}$ ?

# 2.3 Diversification of a portfolio

**2.3.1 - Why diversify ?**

In the previous part, we have made a distinction between **common risk** and **independent risk**. In a large portfolio, independent risk can be eliminated by diversification, whereas common risks cannot be eliminated...

In a competitive market, **The risk premium for diversifiable risk is zero**, so investors are not compensated for holding firm-specific risk. This implies that **the risk premium of a security is determined by its systematic risk** and does not depend on its diversifiable risk.

Consequently we need to estimate a securitys expected return, a measure of a securitys systematic risk. This is the goal of the **CAPM** (*Capital Asset Pricing Model*). In particular, risk-averse investors will demand a premium to invest in securities that will do poorly in bad times

### 2.3.2 - Identify the systematic risk

In exchange for bearing systematic risk, investors want to be compensated by earning a higher return.

- The first step is to build an efficient portfolio: changes in the price of this portfolio should correspond to systematic shocks to the economy (i.e. it cannot be further diversified)
- An ideal candidate: the market portfolio which contains all stocks and securities traded in the capital markets. E.g.: S&P500
- Finally, we can then measure the systematic risk of a security by calculating the sensitivity of the securitys return to the return of the market portfolio, known as the beta ($\beta$) of the security

**The beta of a security is the expected % change in its return given a 1% change in the return of the market portfolio.**

# 2.3 Diversification of a portfolio

**TABLE 10.6** Betas with Respect to the S&P 500 for Individual Stocks (based on monthly data for 2007–2012)

| Company | Ticker | Industry | Equity Beta |
|---|---|---|---|
| General Mills | GIS | Packaged Foods | 0.20 |
| Consolidated Edison | ED | Utilities | 0.28 |
| The Hershey Company | HSY | Packaged Foods | 0.28 |
| Abbott Laboratories | ABT | Pharmaceuticals | 0.31 |
| Newmont Mining | NEM | Gold | 0.32 |
| Wal-Mart Stores | WMT | Superstores | 0.35 |
| Clorox | CLX | Household Products | 0.39 |
| Kroger | KR | Food Retail | 0.42 |
| Altria Group | MO | Tobacco | 0.43 |
| Amgen | AMGN | Biotechnology | 0.44 |
| McDonald's | MCD | Restaurants | 0.47 |
| Procter & Gamble | PG | Household Products | 0.47 |
| Pepsico | PEP | Soft Drinks | 0.51 |
| Coca-Cola | KO | Soft Drinks | 0.54 |
| Johnson & Johnson | JNJ | Pharmaceuticals | 0.59 |
| PetSmart | PETM | Specialty Stores | 0.75 |
| Molson Coors Brewing | TAP | Brewers | 0.78 |
| Nike | NKE | Footwear | 0.91 |
| Microsoft | MSFT | Systems Software | 1.01 |
| Southwest Airlines | LUV | Airlines | 1.09 |
| Intel | INTC | Semiconductors | 1.09 |
| Whole Foods Market | WFM | Food Retail | 1.10 |
| Foot Locker | FL | Apparel Retail | 1.11 |
| Oracle | ORCL | Systems Software | 1.12 |
| Amazon.com | AMZN | Internet Retail | 1.13 |
| Google | GOOG | Internet Software and Services | 1.14 |
| Starbucks | SBUX | Restaurants | 1.20 |
| Walt Disney | DIS | Movies and Entertainment | 1.21 |
| Cisco Systems | CSCO | Communications Equipment | 1.23 |
| Apple | AAPL | Computer Hardware | 1.26 |
| PulteGroup | PHM | Homebuilding | 1.28 |
| Dell | DELL | Computer Hardware | 1.41 |
| salesforce.com | CRM | Application Software | 1.47 |
| Marriott International | MAR | Hotels and Resorts | 1.48 |
| eBay | EBAY | Internet Software and Services | 1.48 |

### 2.3.3 - Measuring the volatility

To find the risk of a portfolio, we need to know more than the risk and return: to which degree do stocks face common risks?

- **Covariance** is the expected product of the deviations of two returns from their means. Intuitively it gives an idea whether 2 stocks move along or in opposite ways

**Covariance formula**

$$Cov(R_i, R_j) = E[(R_i - E[R_i])(R_j - E[R_j])]$$

- While the sign of the covariance is easy to interpret, its magnitude is not. This is why we can introduce a **correlation coefficient**
  - The correlation is always between -1 and +1

**Correlation coefficient formula**

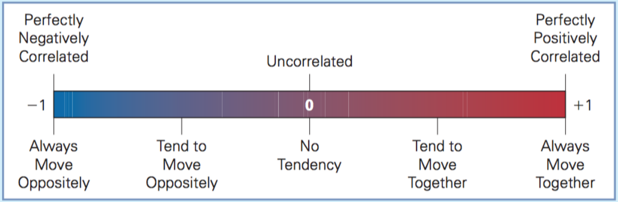
$$Corr(R_i, R_j) = \rho_{R_i,R_j} = \frac{Cov(R_i, R_j)}{\sigma_{R_i} \times \sigma_{R_j}}$$

# 2.3 Diversification of a portfolio

Interpreting the correlation coefficient

**FIGURE 11.1** **Correlation**

Correlation measures how returns move in relation to each other. It is between +1 (returns always move together) and −1 (returns always move oppositely). Independent risks have no tendency to move together and have zero correlation.



# 2.3 Diversification of a portfolio

Now we have every tool to calculate the variance of a portfolio $P$, which return is given by: $R_P = (w_1 \times R_1) + (w_2 \times R_2)$

$$\begin{aligned} Var(R_P) &= Cov(R_P, R_P) \\ &= Cov((w_1 \times R_1) + (w_2 \times R_2), (w_1 \times R_1) + (w_2 \times R_2)) \\ &= w_1^2 V(R_1) + w_2^2 V(R_2) + 2 w_1 w_2 Cov(R_1, R_2) \end{aligned}$$

We can generalize this to:

**Variance of a large portfolio**

$$V(R_P) = \sum_i \sum_j w_i w_j Cov(R_i, R_j)$$
$$V(R_P) = \sum_i \sum_j w_i w_j \rho_{R_i, R_j} \sigma_{R_i} \sigma_{R_j}$$

# 2.4 Choosing an efficient portfolio

Now that we understand how what ere the expected return and volatility of a portfolio, we can return to the main goal of the chapter: **Determine how an investor can create an efficient portfolio between two stocks**

## Example (Intel vs. Coca)

Consider a portfolio of Intel and Coca-Cola stock. Suppose an investor believes these stocks are uncorrelated and will perform as follows:

| Stock | Expected return | Volatility |
|---|---|---|
| Intel | 26% | 50% |
| Coca-Cola | 6% | 25% |

- What are the expected return and volatility of a portfolio with a $w_{Intel}$ of 40% and $w_{Coca}$ of 60% ?

# 2.4 Choosing an efficient portfolio

Expected return and volatility with different weights

**TABLE 11.4** **Expected Returns and Volatility for Different Portfolios of Two Stocks**

| Portfolio Weights | | Expected Return (%) | Volatility (%) |
|---|---|---|---|
| $x_I$ | $x_C$ | $E[R_P]$ | $SD[R_P]$ |
| 1.00 | 0.00 | 26.0 | 50.0 |
| 0.80 | 0.20 | 22.0 | 40.3 |
| 0.60 | 0.40 | 18.0 | 31.6 |
| 0.40 | 0.60 | 14.0 | 25.0 |
| 0.20 | 0.80 | 10.0 | 22.4 |
| 0.00 | 1.00 | 6.0 | 25.0 |

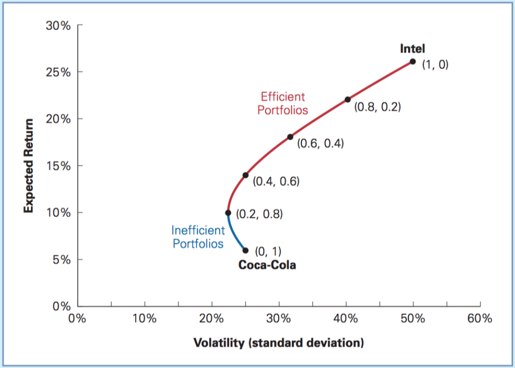
# 2.4 Choosing an efficient portfolio

Then we can draw a graph to summarize every information

**FIGURE 11.3**

**Volatility Versus Expected Return for Portfolios of Intel and Coca-Cola Stock**

Labels indicate portfolio weights ($x_I$, $x_C$) for Intel and Coca-Cola stocks. Portfolios on the red portion of the curve, with at least 20% invested in Intel stock, are efficient. Those on the blue portion of the curve, with less than 20% invested in Intel stock, are inefficient—an investor can earn a higher expected return with lower risk by choosing an alternative portfolio.




**Why are portfolio on the blue line inefficient ?** For the same risk, we can find an alternative composition of the portfolio that can yield a higher expected return

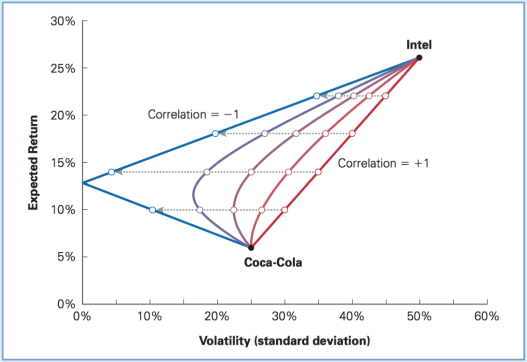
# 2.4 Choosing an efficient portfolio

What would be the difference if Intel and Coca were correlated ?

FIGURE 11.4

**Effect on Volatility and Expected Return of Changing the Correlation between Intel and Coca-Cola Stock**

This figure illustrates correlations of 1, 0.5, 0, −0.5, and −1. The lower the correlation, the lower the risk of the portfolios.




**It is easy to remember this graph**: if $\rho = -1$ you know that stocks move in opposite direction in exactly the same amount. Then you can find a portfolio with 0% voltility !

# 2.5 Choosing an efficient portfolio with short-sales

Thus far we have only considered *long* position. However, on markets it is possible to *short-sell* stocks and stay long on others.

- Short-sell: you sell the stock today and buy it after
  - You bet on a fall of prices !
- If you short sell a stock, the weight in your portfolio will be negative
  - Think of your short-sale as a negative investment

**Example (Intel vs. Coca 2)**

Suppose you have $20,000 in cash to invest. You decide to short sell $10,000 worth of Coca- Cola stock and invest the proceeds from your short sale, plus your $20,000, in Intel. What is the expected return and volatility of your portfolio?

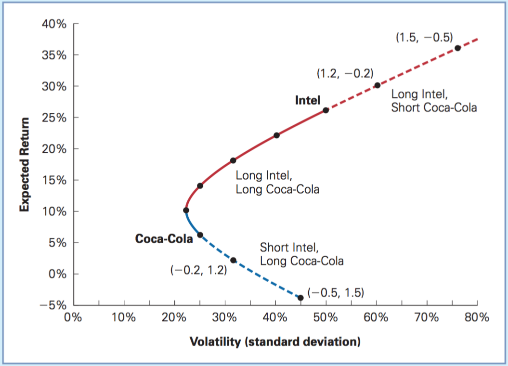
# 2.5 Choosing an efficient portfolio with short-sales

If we draw the new possibilities, we now have:

FIGURE 11.5

**Portfolios of Intel and Coca-Cola Allowing for Short Sales**

Labels indicate portfolio weights ($x_I$, $x_C$) for Intel and Coca-Cola stocks. Red indicates efficient portfolios, blue indicates inefficient portfolios. The dashed curves indicate positions that require shorting either Coca-Cola (red) or Intel (blue). Shorting Intel to invest in Coca-Cola is inefficient. Shorting Coca-Cola to invest in Intel is efficient and might be attractive to an aggressive investor who is seeking high expected returns.




**It is also easy to remember this graph**: if you go further beyond the point of Intel, it means that you are actually investing more in Intel than what you have. Hence, you are long intel and short Coca-Cola

# 2.6 Portfolio and risk-free asset

### 2.6.1 - What is a risk-free asset ?

- Financial assets that do not bear any risks over a given period of time
  - Usually we take risk-free government bonds
  - US T-bill, German *Bund*
- Is the US T-bill realy risk free ?
  - In 1933, President F. D. Roosevelt suspended bondholders right to be paid in gold rather than currency.
  - Mid-2011: Debt ceiling..

That being said, what is the variance of a risk-free asset ($r_f$) ?

### 2.6.2 - Investing in risk-free securities

**Example (Portfolio with a risk-free asset)**

Consider an arbitrary risky portfolio with returns $r_P$. What is the expected return of $\tilde{P}$ if we put a fraction $w_P$ of our money in the portfolio, while leaving the remaining fraction $(1 - w_P)$ in risk-free Treasury bills with a yield of $r_f$?

## Example (Portfolio with a risk-free asset - Solution)

$$
\begin{aligned}
E[r_{\tilde{P}}] &= E[((1 - w_P) \times r_f) + (w_P \times r_P)] \\
&= r_f - (w_P \times r_f) + (w_P \times E[r_P]) \\
&= r_f + w_P \times (E[r_P] - r_f))
\end{aligned}
$$

Now what is the volatility of $\tilde{P}$ ?

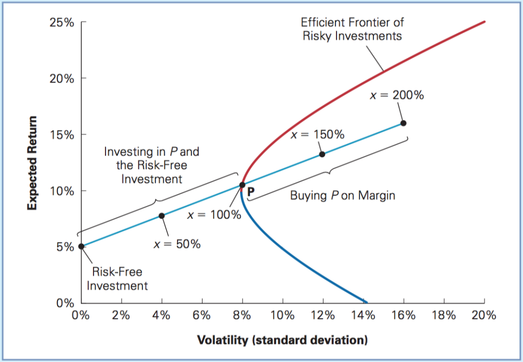
$$
\begin{aligned}
\sigma_{\tilde{P}} &= \sqrt[2]{(1 - w_P)^2 V(r_f) + w_P^2 V(r_P) + 2(1 - w_P) Cov(r_f, r_P)} \\
&= \sqrt[2]{w_P^2 V(r_P)} \\
&= w_P \sigma_{r_P}
\end{aligned}
$$

The blue line illustrates combinations of volatility and expected return for different choices of $x = w_P$

FIGURE 11.9

**The Risk–Return Combinations from Combining a Risk-Free Investment and a Risky Portfolio**

Given a risk-free rate of 5%, the point with 0% volatility and an expected return of 5% represents the risk-free investment. The blue line shows the portfolios we obtained by investing $x$ in portfolio $P$ and $(1 - x)$ in the risk-free investment. Investments with weight $x > 100\%$ in portfolio $P$ require borrowing at the risk-free interest rate.



# 2.7 Identifying the tangency portfolio

## 2.7.1 - First approach

- The blue line is not *optimal*
  - By combining the risk-free asset with a portfolio some- what higher on the efficient frontier than portfolio P, we will get a line that is steeper than the line through P
  - If the line is steeper, then for any level of volatility, we will earn a higher expected return.
- Two questions raises: (1) What is the optimal portfolio ? (2) What is the slope of the curve ?

## 2.7.2 - The Sharpe ratio

- Hence to find the optimal portfolio we need to work on the slope of the curve, which is referred to as the **Sharpe ratio**

**Sharpe ratio**

$$Sharpe\ ratio = \frac{Excess\ return}{Volatility} = \frac{E[r_P] - r_P}{\sigma_{r_P}}$$

# 2.7 Identifying the tangency portfolio

## Demonstration - Sharpe ratio = slope of CML

We know that $E[\tilde{r_P}] = r_f + w_P \times (E[r_P] - r_f))$.
We also know that $\sigma_{\tilde{P}} = w_P \times \sigma_{r_P}$.
Now:

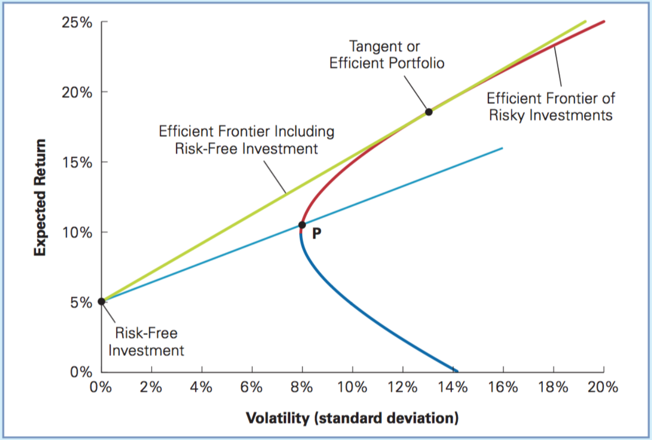
$$\begin{aligned} E[\tilde{r_P}] &= r_f + w_P \times (E[r_P] - r_f)) \\ &= r_f + \frac{\sigma_{\tilde{P}}}{\sigma_{r_P}} \times ((E[r_P] - r_f)) \\ &= r_f + \underbrace{\frac{(E[r_P] - r_f)}{\sigma_{r_P}}}_{\text{Sharpe Ratio}} \times \sigma_{\tilde{P}} \end{aligned}$$

## 2.7.3 - Concretely, what does that fuss mean ?

**FIGURE 11.10**

**The Tangent or Efficient Portfolio**

The tangent portfolio is the portfolio with the highest Sharpe ratio. Investments on the green line connecting the risk-free investment and the tangent portfolio provide the best risk and return trade-off available to an investor. As a result, we also refer to the tangent portfolio as *the* efficient portfolio.




N.B: The Sharpe ratio measures the **ratio of reward-to-volatility provided by a portfolio**

### 2.8.1 - Being an investor

Imagine you are an investor: under which condition are you going to increase the weight of your investment in a company $i$ within your portfolio ?
Only if:

$$E[r_i] - r_f > \sigma_{r_i} \times \rho_{(r_P),(r_i)} \times \frac{E[r_P] - r_f}{\sigma_{r_P}}$$
$$> \beta \times [E[r_P] - r_P]$$

With $\beta \equiv \frac{\sigma_{r_i} \times \rho_{(r_P),(r_i)}}{\sigma_{r_P}}$

## 2.8.2 - So what is the beta in the CAPM?

### Beta

$$\beta = \frac{Cov(R_i, R_{Mkt})}{V(R_{Mkt})}$$

The **beta of a security measures its volatility due to market risk relative to the market as a whole**, and thus captures the securitys sensitivity to market risk.

Turning to CAPM we have:

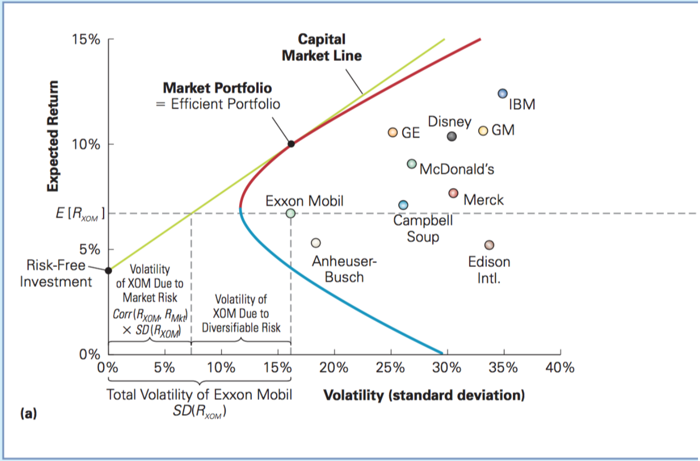
### CAPM equation

$$E[R_i] = r_f + \beta_i \times \underbrace{(E[r_{Mkt}] - r_f)}_{\text{Risk premium for security } i}$$

## 2.8.3 - On a graph...

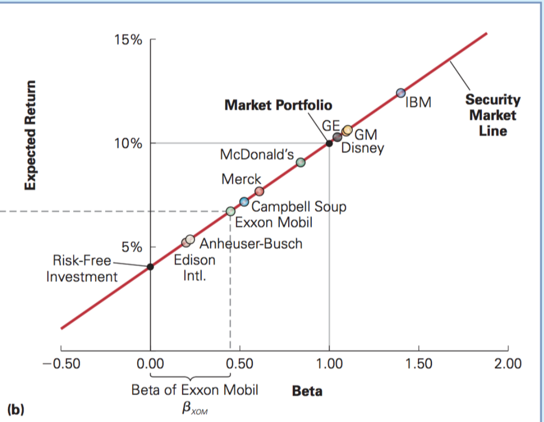
**FIGURE 11.12** **The Capital Market Line and the Security Market Line**

(a) The CML depicts portfolios combining the risk-free investment and the efficient portfolio, and shows the highest expected return that we can attain for each level of volatility. According to the CAPM, the market portfolio is on the CML and all other stocks and portfolios contain diversifiable risk and lie to the right of the CML, as illustrated for Exxon Mobil (XOM).



# 2.8 Capital Asset Pricing Model

## 2.8.3 - Security Market Line




(b) The SML shows the expected return for each security as a function of its beta with the market. According to the CAPM, the market portfolio is efficient, so all stocks and portfolios should lie on the SML.