Chapter 21
RISK AND RETURN

The spice of finance

Investors who buy financial securities face risks because they do not know with certainty the future selling price of their securities, nor the cash flows they will receive in the meantime. This chapter will try to understand and measure this risk, and also examine its repercussions.

Section 21.1
SOURCES OF RISK

First, it is useful to begin by explaining the difference between **risk** and **uncertainty**. This example, adapted from Bodie and Merton (2000), describes it quite nicely:

RISK AND UNCERTAINTY

Suppose you would like to give a party, to which you decide to invite a dozen friends. You think that 10 of the 12 invitees will come, but there is some *uncertainty* about the real number of people who will eventually show up – 8. However, this is only *risky* if the uncertainty affects your plans.

For example, in providing for your guests, suppose you have to decide how much food to prepare. If you know for sure that 10 people will show up, then you would prepare exactly enough for 10 – no more and no less. If 12 actually show up, there will not be enough food, and you will be cross because some guests will be hungry and dissatisfied. If 8 actually show up, there will be too much food, and you will be cross about that too, because you will have wasted some of your limited resources on surplus food. Thus the uncertainty matters and, therefore, there is risk in this situation.

On the other hand, suppose that you have told your guests that each person is to bring enough food for a single guest. Then it might not matter whether more or fewer than 10 people come. In this case, there is uncertainty but no risk.

There are various risks involved in financial securities, including:

➢ **Industrial, commercial and labour risks, etc.**

There are so many types of risks in this category that we cannot list them all here. They include: lack of competitiveness, emergence of new competitors, technological

breakthroughs, an inadequate sales network, strikes and so on. These risks tend to lower cash flow expectations and thus have an immediate impact on the value of the stock.

➢ **Liquidity risk**

This is the risk of not being able to sell a security at its fair value, as a result either of a liquidity discount or the complete absence of a market or buyers.

➢ **Solvency risk**

This is the risk that a creditor will lose his entire investment if a debtor cannot repay him in full, even if the debtor's assets are liquidated. Traders call this **counterparty risk**.

➢ **Currency risk**

Fluctuations in exchange rates can lead to a loss of value of assets denominated in foreign currencies. Similarly, higher exchange rates can increase the value of debt denominated in foreign currencies when translated into the company's reporting currency base.

➢ **Interest rate risk**

The holder of financial securities is exposed to the risk of interest rate fluctuations. Even if the issuer fulfils his commitments entirely, there is still the risk of a capital loss or, at the very least, an opportunity loss.

➢ **Political risk**

This includes risks created by a particular political situation or decisions by political authorities, such as nationalisation without sufficient compensation, revolution, exclusion from certain markets, discriminatory tax policies, inability to repatriate capital, etc.

➢ **Regulatory risk**

A change in the law or in regulations can directly affect the return expected in a particular sector. Pharmaceuticals, banks and insurance companies, among others, tend to be on the front lines here.

➢ **Inflation risk**

This is the risk that the investor will recover his investment with a depreciated currency, i.e. that he will receive a return below the inflation rate. A flagrant historical example is the hyperinflation in Germany in the 1920s.

➢ **The risk of a fraud**

This is the risk that some parties to an investment will lie or cheat, i.e. by exploiting asymmetries of information in order to gain unfair advantage over other investors. The most common example is insider trading.

➢ **Natural disaster risks**

These include storms, earthquakes, volcanic eruptions, cyclones, tidal waves, etc. which destroy assets.

➢ **Economic risk**

This type of risk is characterised by bull or bear markets, anticipation of an acceleration, a slowdown in business activity, or changes in labour productivity.

The list is nearly endless; however, at this point it is important to highlight two points:

- most financial analysis mentioned and developed in this book tends to generalise the concept of risk rather than analysing it in depth. So, given the extent to which markets are efficient and evaluate risk correctly, it is not necessary to redo what others have already done; and
- risk is always present. The so-called risk-free rate, to be discussed later, is simply a manner of speaking. **Risk is always present, and to say that risk can be eliminated is either to be excessively confident or be unable to think about the future – both very serious faults for an investor.**

Obviously, any serious investment study should begin with a precise analysis of the risks involved.

The knowledge gleaned from analysts with extensive experience in the business, mixed with common sense, allow us to classify risks into two categories:

- economic risks (political, natural, inflation, swindle and other risks), which threaten cash flows from investments and which come from the "real economy"; and
- financial risks (liquidity, currency, interest rate and other risks), which do not directly affect cash flow, but nonetheless do come into the financial sphere. These risks are due to external financial events, and not to the nature of the issuer.

Section 21.2
RISK AND FLUCTUATION IN THE VALUE OF A SECURITY

All of the aforementioned risks can penalise the financial performances of companies and their future cash flows. Obviously, if a risk materialises that seriously hurts company cash flows, investors will seek to sell their securities. Consequently the value of the security falls.

Moreover, if a company is exposed to significant risk, some investors will be reluctant to buy its securities. Even before risk materialises, investors' perceptions that a company's future cash flows are uncertain or volatile will serve to reduce the value of its securities.

Most modern finance is based on the premise that investors seek to reduce the uncertainty of their future cash flows. By its very nature, risk increases the uncertainty of an asset's future cash flow, and it therefore follows that such uncertainty will be priced into the market value of a security.

Investors consider risk only to the extent that it affects the value of the security. Risks can affect value by changing anticipations of cash flows or the rate at which these cash flows are discounted.

To begin with, it is important to realise that in corporate finance no fundamental distinction is made between the risk of asset revaluation and the risk of asset devaluation. That is to say, whether investors expect the value of an asset to rise or decrease is immaterial. It is the fact that risk exists in the first place that is of significance and affects how investors behave.

All risks, regardless of their nature, lead to fluctuations in the value of a financial security.

Consider, for example, a security with the following cash flows expected for years 1 to 4:

Year	1	2	3	4
Cash flow (in €)	100	120	150	190

Imagine the value of this security is estimated to be €2000 in 5 years. Assuming a 9% discounting rate, its value today would be:

$$\frac{100}{1.09} + \frac{120}{1.09^2} + \frac{150}{1.09^3} + \frac{190}{1.09^4} + \frac{2000}{1.09^5} = €1743$$

If a sudden sharp rise in interest rates raises the discounting rate to 13%, the value of the security becomes:

$$\frac{100}{1.13} + \frac{120}{1.13^2} + \frac{150}{1.13^3} + \frac{190}{1.13^4} + \frac{2000}{1.13^4} = €1488$$

The security's value has fallen by 15%. However, if the company comes out with a new product that raises projected cash flow by 20%, with no further change in the discounting rate, the security's value then becomes:

$$\frac{100 \times 1.20}{1.13} + \frac{120 \times 1.20}{1.13^2} + \frac{150 \times 1.20}{1.13^3} + \frac{190 \times 1.20}{1.13^4} + \frac{2000 \times 1.20}{1.13^5} = €1786$$

The security's value increases for reasons specific to the company, not because of a rise of interest rates in the market.

Now, suppose that there is an improvement in the overall economic outlook that lowers the discounting rate to 10%. If there is no change in expected cash flows, the stock's value would be:

$$\frac{120}{1.10} + \frac{144}{1.10^2} + \frac{180}{1.10^3} + \frac{228}{1.10^4} + \frac{2400}{1.10^5} = €2009$$

Again, there has been no change in the stock's intrinsic characteristics and yet its value has risen by 12.5%.

If there is stiff price competition, then previous cash flow projections will have to be adjusted downward by 10%. If all cash flows fall by the same percentage and the discounting rate remains constant, the value of the company becomes:

$$2009 \times (1 - 10\%) = €1808$$

Once again, the security's value increases for reasons specific to the company, not because of a rise in the market.

In the previous example, a European investor would have lost 10% of his investment (from €2009 to €1808). If, in the interim, the euro had fallen from $1 to $0.86, a US investor would have lost 23% (from $2009 to $1555).

A closer analysis shows that some securities are more volatile than others, i.e. their price fluctuates more widely. We say that these stocks are "riskier". **The riskier a stock is, the more volatile its price, and vice versa.** Conversely, the less risky a security is, the less volatile its price, and vice versa.

> In a market economy, a security's risk is measured in terms of the volatility of its price (or of its rate of return). The greater the volatility, the greater the risk, and vice versa.

Volatility can be measured mathematically by **variance** and **standard deviation**.

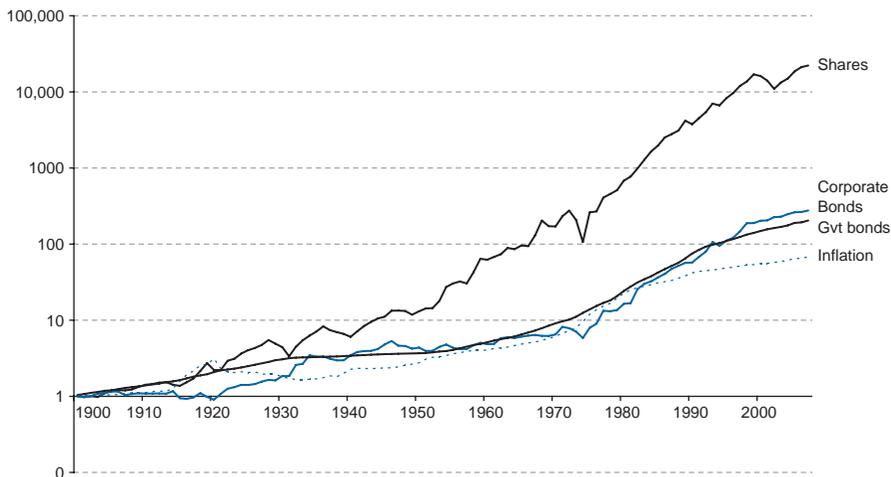### RETURN OF SOME FINANCIAL SECURITIES OVER 13 YEARS
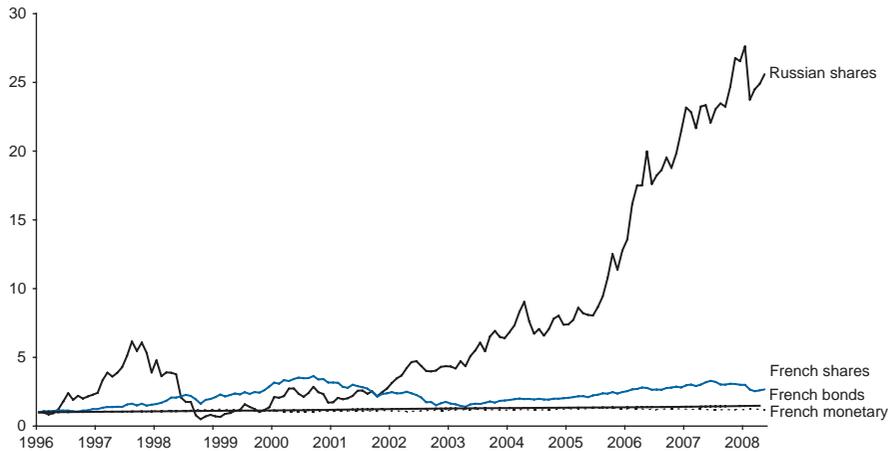
Price trends of some financial assets since 1996 shows very different levels of volatility!

Source: Datastream.

Typically, it is safe to assume that risk dissipates over the long term. The erratic fluctuations in the short term give way to the clear outperformance of equities over bonds, and bonds over money-market investments. The chart below tends to back up this point of view. It presents data on the **path of wealth** (POW) for the three asset classes. The POW measures the growth of 1€ invested in any given asset, assuming that all proceeds are reinvested in the same asset.

NOMINAL RETURNS IN UK SINCE 1900

Since 1900, UK stocks have risen 22,252-fold, hence an average annual return of 9.7% vs. 5.3% for bonds, 5.0% for money-market funds and average inflation of just 4.0%.

Source: Based on Dimson, Marsh, Staunton (2008).

As is easily seen from the chart, risk does dissipate, but only over the long term. In other words, an investor must be able to invest his funds and then do without them during this long-term timeframe. It sometimes requires strong nerves not to give in to the temptation to sell when prices collapse, as happened with stock markets in 1929, 1974, September 2001 and October–November 2008.

Since 1900, UK stocks have delivered an average annual return of 9.7%. Yet during 37 of those years the returns were negative, in particular in 1974, when investors lost 57% on a representative portfolio of UK stocks.

If you are statistically inclined, you will recognise the "Gaussian" or "normal" distribution in this chart, showing the random walk of share prices underlying the theory of efficient markets.

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                                        2007
        30 –                            2004
                                        1998
                                        1992
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                                        1988
        25 –                       1987 2006
                                   1985 2005
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                              1994 1965 1999
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        20 –                  1979 1961 1996
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                              1964 1945 1984
        15 –                  1960 1944 1983
                              1952 1927 1982
                              1948 1926 1980
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                              1940 1923 1963
        10 –                  1939 1917 1950
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                         2001 1921 1912 1943
                         2000 1915 1910 1942 1993
                         1957 1913 1909 1941 1971
         5 –        2002 1949 1911 1908 1936 1953
                    1990 1937 1907 1906 1935 1933 1977
                    1969 1930 1903 1905 1934 1922 1967 1968
                    1931 1929 1901 1904 1928 1919 1958 1959
    1974        1973 1920 1914 1900 1902 1924 1918 1932 1954              1975
         –60  –50  –40  –30  –20  –10   0   10   20   30   40   50   60  //  >100
                                       Per cent
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Source: based on Dimson, Marsh et Staunton (2008).

And in worst case scenarios, it must not be overlooked that some financial markets vanished entirely, including the Russian equity market after the First World War and 1917 revolution, the German bond market with the hyperinflation of 1921–23, and the Japanese and German equity markets in 1945. Over the stretch of one century, these may be exceptional events, but they have enormous repercussions when they do occur.

The degree of risk depends on the investment timeframe and tends to diminish over the long term. Yet rarely do investors have the means and stamina to think only of the long term and ignore short- to medium-term needs. Investors are only human, and there is definitely risk in the short and medium terms!

Section 21.3
TOOLS FOR MEASURING RETURN AND RISK

1/ EXPECTED RETURN

To begin, it must be realised that a security's rate of return and the value of a financial security are actually two sides of the same coin. The rate of return will be considered first.

The holding-period return is calculated from the sum total of cash flows for a given investment, i.e. income, in the form of interest or dividends earned on the funds invested and the resulting capital gain or loss when the security is sold.

If just one period is examined, the return on a financial security can be expressed as follows:

$$F_1/V_0 + (V_1 - V_0)/V_0 = \text{Income} + \text{Capital gain or loss}$$

Here F_1 is the income received by the investor during the period, V_0 is the value of the security at the beginning of the period, and V_1 is the value of the security at the end of the period.

In an uncertain world, investors cannot calculate their returns in advance, as the value of the security is unknown at the end of the period. In some cases, the same is true for the income to be received during the period.

Therefore, investors use the concept of **expected return**, which is the average of possible returns weighted by their likelihood of occurring. Familiarity with the science of statistics should aid in understanding the notion of expected outcome.

Given security A with 12 chances out of 100 of showing a return of -22%, 74 chances out of 100 of showing a return of 6% and 14 chances out of 100 of showing a return of 16%, its expected return would then be:

$$-22\% \times \frac{12}{100} + 6\% \times \frac{74}{100} + 16\% \times \frac{14}{100}, \text{ or about } 4\%$$

More generally, expected return or expected outcome is equal to:

$$E(r) = \sum_{t=1}^{n} r_t \times p_t = \bar{r}$$

Expected return formula

where r_t is a possible return and p_t the probability of it occurring.

2/ VARIANCE, A RISK-ANALYSIS TOOL

Intuitively, the greater the risk on an investment, the wider the variations in its return, and the more uncertain that return is. While the holder of a government bond is sure to receive his coupons (unless the government goes bankrupt!), this is far from true for the shareholder of an offshore oil drilling company. He could either lose everything, show a decent return, or hit the jackpot.

Therefore, the risk carried by a security can be looked at in terms of the dispersion of its possible returns around an average return. Consequently, risk can be measured

mathematically by the variance of its return, i.e. by the sum of the squares of the deviation of each return from expected outcome, weighted by the likelihood of each of the possible returns occurring, or:

Risk formula

$$V(r) = \sum_{t=1}^{n} p_t \times (r_t - \bar{r})^2$$

Standard deviation in returns is the most often used measure to evaluate the risk of an investment. Standard deviation is expressed as the square root of the variance:

$$\sigma(r) = \sqrt{V(r)}$$

The variance of investment A above is therefore:

$$\frac{12}{100} \times (-22\% - 4\%)^2 + \frac{74}{100} \times (6\% - 4\%)^2 + \frac{14}{100} \times (16\% - 4\%)^2$$

where $V(r) = 1\%$, which corresponds to a standard deviation of 10%.

In sum, to formalise the concepts of risk and return:

- expected outcome $E(r)$, is a measure of expected return; and
- standard deviation $\sigma(r)$ measures the average dispersion of returns around expected outcome, in other words, risk.

Section 21.4
HOW DIVERSIFICATION REDUCES RISK

Typically, investors do not concentrate their entire wealth in only one financial asset, because they prefer to hold well-diversified portfolios. We can liken this behaviour to the old saying "Do not put all your eggs in one basket".

The following table contains evidence of an interesting phenomenon, which gives the standard deviation for the daily returns of 13 European companies and the EuroStoxx50 index from February 2003 to February 2008 (% values):

Arcelor Mittal	37.70	Sanofi Aventis	19.05
Banco Santander	18.16	Siemens	21.09
ENI	15.53	Telefonica	16.07
E.ON	18.81	Total	16.76
France Telecom	20.81	Unilever	16.61
Intesa San Paolo	20.21	Unicred	17.90
Nokia	26.91	EuroStoxx	14.42

The standard deviation of single assets is higher than the standard deviation of the entire market (as given by the market index)! If investors buy portfolios of assets, instead of

single assets, they can reduce the overall risk of their entire portfolio because asset prices move independently. They are influenced differently by macroeconomic conditions.

This suggests that adding securities to a portfolio makes it possible to reduce the idiosyncratic influence that single securities have on the total return of the portfolio. This "diversification effect" is due to:

- the reduced weighting of single securities on the portfolio performance; and
- the higher balance that occurs between favourable and unfavourable securities.

When choosing securities, investors should evaluate the *marginal contribution* that each additional asset brings to the variance of the entire portfolio.

Fluctuations in the value of a security can be due to:

- fluctuations in the entire market. The market could rise as a whole after an unexpected cut in interest rates, stronger than expected economic growth figures, etc. All stocks will then rise, although some will move more than others (see the figure below). The same thing can occur when the entire market moves downward; or
- factors specific to the company that do not affect the market as a whole, such as a major order, the bankruptcy of a competitor, a new regulation affecting the company's products, etc.

These two sources of fluctuation produce two types of risk: market risk and specific risk.

- **Market, systematic or undiversifiable risk** is due to trends in the entire economy, tax policy, interest rates, inflation, etc., and affects all securities. Remember, this is **the risk of the security correlated to market risk**. To varying degrees, market risk affects all securities. For example, if a nation switches to a 35-hour working week with no cut in wages, all companies will be affected. However, in such a case, it stands to reason that textile makers will be affected more than cement companies.
- **Specific, intrinsic, or idiosyncratic risk** is independent of market-wide phenomena and is due to factors affecting just the one company, such as mismanagement, a factory fire, an invention that renders a company's main product line obsolete, etc. (In the next chapter, it will be shown how this risk can be eliminated by diversification.)

Market volatility can be economic or financial in origin, but it can also result from anticipations of flows (dividends, capital gains, etc.) or a variation in the cost of equity. For example, an overheating of the economy could raise the cost of equity (i.e. after an increase in the central bank rate) and reduce anticipated cash flows due to weaker demand. Together, these two factors could exert a double downward pressure on financial securities.

WHAT DIVERSIFICATION DOES
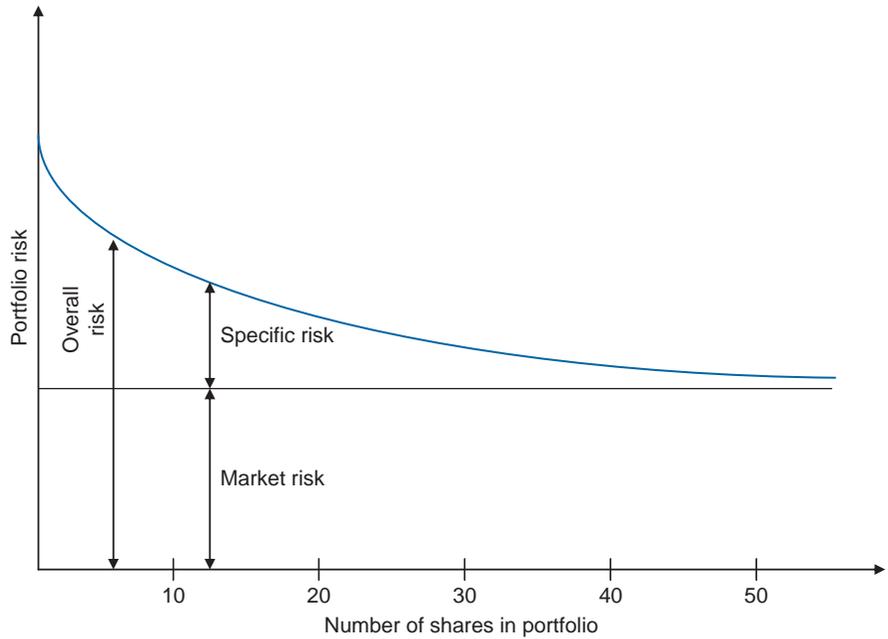
It is now possible to partition risk typologies according to their nature. There are some risks that only impact a small number of companies, e.g. project risk, competitive risk and industry risk. The latter refers to the impact that industrial policy can have on the performance of a specific industry.

Conversely, there are other risks that impact a much larger number of companies, e.g. interest rate risk, inflation risk and external shock risks. By their nature, these types of risk influence almost all companies in a country. Consider interest rate risk. It is reasonable to assume that an increase in interest rates will diminish the investments in fixed assets of *all* companies, because it affects different sectors and companies with varying levels of intensity.

Finally, there are some risks that lie between the two extremes. Their impact differs substantially among industries. A good example is currency risk, which is important for companies who have a significant proportion of their sales in foreign currencies.
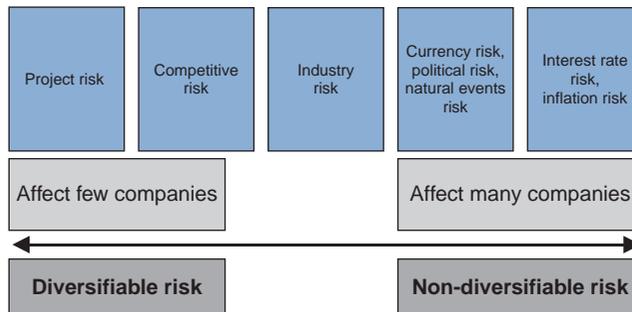
When an investor wants to know the contribution of risk to the portfolio rather than the total risk of an asset, what is the appropriate risk measure he should use? The standard deviation of a single asset is not the correct measure, because standard deviation measures the risk in isolation without considering the correlation with other assets. A better measure would be the **covariance** between the returns of the assets included in the portfolio.

Section 21.5
PORTFOLIO RISK

1/ THE FORMULA APPROACH

Consider the following two stocks, Heineken and Ericsson, which have the following characteristics:

	Heineken %	Ericsson %
Expected return: $E(r)$	6	13
Risk: $\sigma(r)$	10	17

As is clear from this table, Ericsson offers a higher expected return while presenting a greater risk than Heineken. Inversely, Heineken offers a lower expected return but also presents less risk.

These two investments are not directly comparable. Investing in Ericsson means accepting more risk in exchange for a higher return, whereas investing in Heineken means playing it safe.

Therefore, there is no clear-cut basis by which to choose between Ericsson and Heineken. However, the problem can be looked at in another way: **would buying a combination of Ericsson and Heineken shares be preferable to buying just one or the other?**

It is likely that the investor will seek to diversify and create a **portfolio** made up of Ericsson shares (in a proportion of X_E) and Heineken shares (in a proportion of X_H). This way, he will expect a return equal to the weighted average return of each of these two stocks, or:

$$E(r_{E,H}) = X_E \times E(r_E) + X_H \times E(r_H)$$

where $X_A + X_E = 1$

Depending on the proportion of Ericsson shares in the portfolio (X_E), the portfolio would look like this:

X_E (%)	0	25	33.3	50	66.7	75	100
$E(r_{E,H})$(%)	6	7.8	8.3	9.5	10.7	11.3	13

The portfolio's variance is determined as follows:

$$\sigma^2(r_{E,H}) = X_E^2 \times \sigma^2(r_E) + X_H^2 \times \sigma^2(r_H) + 2X_E \times X_H \times \text{cov}(r_E, r_H)$$

$\text{Cov}(r_E, r_H)$ is the covariance. It measures the degree to which Ericsson and Heineken fluctuate together. It is equal to:

$$Cov(r_E, r_H) = E\left[(r_E - E(r_E)) \times (r_H - E(r_H))\right]$$

$$= \sum_{i=1}^{n}\sum_{j=1}^{m} p_{i,j} \times (r_E - \overline{r_E}) \times (r_H - \overline{r_H})$$

$$= \rho_{E,H} \times \sigma(r_E) \times \sigma(r_H)$$

$p_{i,j}$ is the probability of joint occurrence and $\rho_{A,E}$ is the correlation coefficient of returns offered by Ericsson and Heineken. The correlation coefficient is a number between -1 (returns 100% inversely proportional to each other) and 1 (returns 100% proportional to each other). Correlation coefficients are usually positive, as most stocks rise together in a bullish market and fall together in a bearish market.

By plugging the variables back into our variance equation above, we obtain:

$$\sigma^2(r_{E,H}) = X_E^2 \times \sigma^2(r_E) + X_H^2 \times \sigma^2(r_H) + 2X_E \times X_H \times \rho_{E,H} \times \sigma(r_E) \times \sigma(r_H)$$

Given that:

$$-1 \le \rho_{E,H} \le 1$$

it is therefore possible to say:

$$\sigma^2(r_{E,H}) \le X_E^2 \times \sigma^2(r_E) + X_H^2 \times \sigma^2(r_H) + 2X_E \times X_H \times \sigma(r_E) \times \sigma(r_H)$$

or:

$$\sigma^2(r_{E,H}) \le (X_E \times \sigma(r_E) + X_H \times \sigma(r_H))^2$$

As the above calculations show, the overall risk of a portfolio consisting of Ericsson and Heineken shares is less than the weighted average of the risks of the two stocks.

Assuming that $\rho_{E,H}$ is equal to 0.5 (from the figures in the above example), we obtain the following:

X (%)	0	25	33.3	50	66.7	75	100
$\sigma(r_{E,H})$ (%)	10.0	10.3	10.7	11.8	13.3	14.2	17.0

Hence, a portfolio consisting of 50% Ericsson and 50% Heineken has a standard deviation of 11.8% or less than the average of Ericsson and Heineken, which is ($50\% \times 17\%) + (50\% \times 10\%) = 13.5\%$.

On a chart, it looks like this:
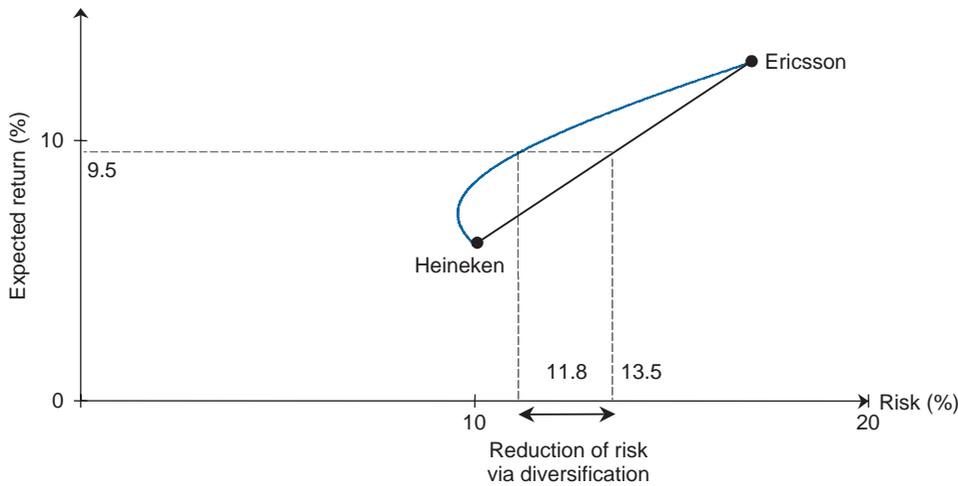
Although fluctuations in Ericsson and Heineken stocks are positively correlated with each other, having both together in a portfolio creates a less risky profile than investing in them individually.

Only a correlation coefficient of 1 creates a portfolio risk that is equal to the average of its component risks.

CORRELATION BETWEEN DIFFERENT MARKETS

	France	Germany	Italy	Netherlands	Spain	Switzerland	UK	USA
France	1.00	0.97	0.99	1.00	0.96	0.99	0.99	0.97
Germany	0.97	1.00	0.94	0.98	0.98	0.96	0.96	0.97
Italy	0.99	0.94	1.00	0.97	0.90	0.96	0.94	0.96
Netherlands	1.00	0.98	0.99	1.00	0.96	0.99	0.99	0.96
Spain	0.98	0.98	0.96	0.96	1.00	0.95	0.98	0.98
Switzerland	0.99	0.96	0.96	0.99	0.95	1.00	0.97	0.94
UK	0.99	0.96	0.96	0.99	0.98	0.97	1.00	0.96
USA	0.98	0.97	0.94	0.96	0.98	0.96	0.96	1.00

Source: Datastream.

Globalisation has increased correlation among Western markets (Period: March 2003–March 2008).

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However, sector diversification is still highly efficient thanks to the low correlation coefficients among different industries:

CORRELATION BETWEEN EUROPEAN STOCKS IN DIFFERENT SECTORS

Source: Datastream.
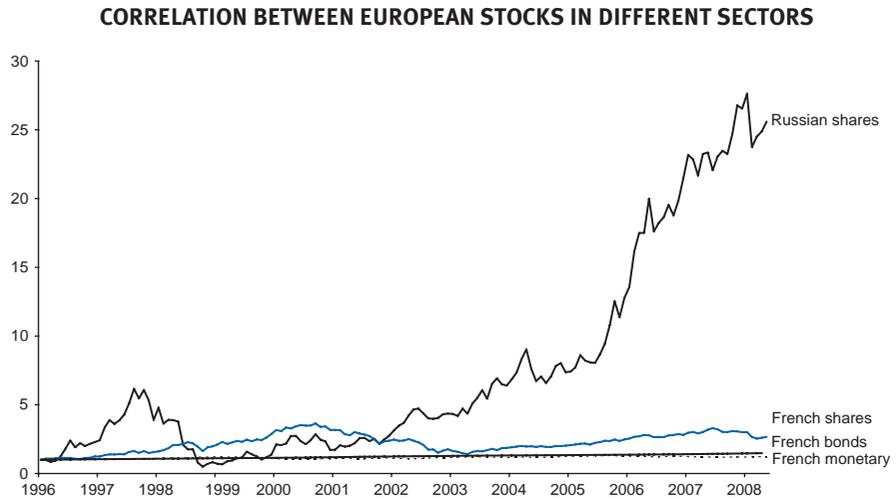
Diversification can:

- either reduce risk for a given level of return; and/or
- improve return for a given level of risk.

2/ THE MATRIX APPROACH

It is possible to use matrices that contain all the elements of the variance of a portfolio in order to visually assess the elements of variance. The previous example yields the following table:

	E	H
E	$X_E^2 \times \sigma_E^2$	$X_E \times X_H \times \sigma_{E,H}$
H	$X_E \times X_H \times \sigma_{H,E}$	$X_H^2 \times \sigma_H^2$

The variance of a two-asset portfolio is the sum of the 4 elements contained in the matrix. Since the order in which we sum the assets is irrelevant, we may simply double the cell that contains the covariance, because they are exactly the same.

The matrix approach is a useful tool when the investor manages a portfolio of many assets. Consider the following example, with N assets that result in the following matrix:

Assets	A	B	C	...	N
A	$X_A^2 \times \sigma_A^2$	$X_A \times X_B \times \sigma_{A,B}$	$X_A \times X_C \times \sigma_{A,C}$	...	$X_A \times X_N \times \sigma_{A,N}$
B	$X_B \times X_A \times \sigma_{B,A}$	$X_B^2 \times \sigma_B^2$	$X_B \times X_C \times \sigma_{B,C}$	...	$X_B \times X_N \times \sigma_{B,N}$
C	$X_C \times X_A \times \sigma_{C,A}$	$X_C \times X_B \times \sigma_{C,B}$	$X_C^2 \times \sigma_C^2$	...	$X_C \times X_N \times \sigma_{C,N}$
...	...	...	...	...	...
N	$X_N \times X_A \times \sigma_{N,A}$	$X_N \times X_B \times \sigma_{N,B}$	$X_N \times X_C \times \sigma_{N,C}$	...	$X_N^2 \times \sigma_N^2$

Following the diagonal cells from the top left to the bottom right, it should be noted that the number of terms in the diagonal is always identical to the number of assets included in the portfolio. Consequently, the "group" of variances that can have an impact on the risk of the portfolio equals the number of assets included in the portfolio. The number of covariances is much more numerous, which rapidly increases as we add assets to the portfolio.

What exactly does this result mean?

As with a portfolio of two assets, the variance of a portfolio of N assets is the sum of all the cells of the matrix. Thus, the variance of the portfolio is mostly influenced by covariances because their higher number exceeds that of variances.

Suppose that there is an equal weight for each asset included in the portfolio, i.e. each asset has a weight of $1/N$. Then there will be N elements on the diagonal of variances and $N(N - 1)$ – or $N^2 - N$ – terms in the other cells. The portfolio variance will then be given by:

$$\sigma_P^2 = N \times \left(\frac{1}{N}\right)^2 \overline{\text{var}} + (N^2 - N) \times \left(\frac{1}{N}\right)^2 \overline{\text{cov}}$$

where $\overline{\text{var}}$ and $\overline{\text{cov}}$ indicate the average variance and covariance, respectively. It can then be simplified to:

$$\sigma_P^2 = \left(\frac{1}{N}\right) \overline{\text{var}} + \left(\frac{N^2 - N}{N}\right) \overline{\text{cov}}$$

$$\sigma_P^2 = \left(\frac{1}{N}\right) \overline{\text{var}} + \left(1 - \frac{1}{N}\right) \overline{\text{cov}}$$

This equation highlights the importance of the matrix approach because, if we increase the number of assets included in the portfolio, the variance of the portfolio converges towards the average covariance of the assets.

Ideally, if the covariance were zero we could eliminate all risk from our portfolio. Unfortunately, financial assets tend to move together, thus the average covariance is positive.

Yet it is now possible to understand the real meaning of what was previously defined as "market risk". This is the risk measured by the covariance, and it represents the portion of risk that cannot be eliminated even after having taken advantage of diversification.

<div align="right">**Section 21.6**</div>

MEASURING HOW INDIVIDUAL SECURITIES AFFECT PORTFOLIO RISK: THE BETA COEFFICIENT

1/ THE BETA AS A MEASURE OF THE MARKET RISK OF A SINGLE SECURITY

Below is a brief summary of topics covered so far in this chapter:

- the risk of a well diversified portfolio is solely a function of the market risk of the securities it contains; and
- the contribution of a single asset to the risk of portfolio is measured by its covariance with the returns of the portfolio. This sensitivity measure is called the **beta** (β) of a financial asset.

Since market risk and specific risk are independent, they can be measured independently and we can apply the Pythagorean theorem (in more mathematical terms, the two risk vectors are orthogonal) to the overall risk of a single security:

$$(\textbf{Overall risk})^2 = (\textbf{Market risk})^2 + (\textbf{Specific risk})^2 \qquad (21.1)$$

The systematic risk presented by a financial security is frequently expressed in terms of its sensitivity to market fluctuations. This is done via a linear regression between periodic market returns (r_{Mt}) and the periodic returns of each security J: (r_{Jt}). This yields the regression line expressed in the following equation:

$$r_{J_t} = \alpha_J + \beta_J \times r_{M_t} + \varepsilon_{J_t}$$

β_J is a parameter specific to each investment J and it expresses the relationship between fluctuations in the value of J and the market. It is thus a coefficient of volatility or of sensitivity. **We call it the beta or the beta coefficient.**

A security's total risk is reflected in the standard deviation of its return $\sigma(r_J)$.

A security's **market risk** is therefore equal to $\beta_J \times \sigma(r_M)$, where $\sigma(r_M)$ is the standard deviation of the market return. Therefore it is also proportional to the beta, i.e. the security's market-linked volatility. The higher the beta, the greater the market risk borne by the security. If $\beta > 1$, the security magnifies market fluctuations. Conversely, securities whose beta is below 1 are less affected by market fluctuations.

**COMPARED EVOLUTION OF EUROSTOXX 50 INDEX, HEINEKEN AND ERICSSON
(INDEX = 100)**
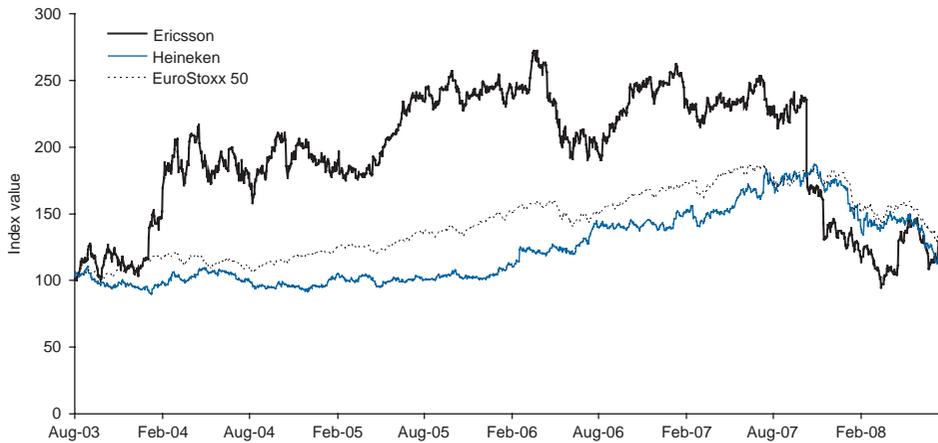
Source: Datastream.

The chart shows that the β of Ericsson is higher than that of Heineken.

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The **specific risk** of security J is equal to the standard deviation of the different residues ε_{Jt} of the regression line, expressed as $\sigma(\varepsilon_J)$, i.e. the variations in the stock that are not tied to market variations.

In summation, proposition (1) can be expressed mathematically as follows:

$$\sigma^2(r_J) = \beta_J{}^2 \times \sigma^2(r_M) + \sigma^2(\varepsilon_J)$$

2/ CALCULATING BETA

β measures a security's sensitivity to market risk. For security J, it is mathematically obtained by performing a regression analysis of security returns vs. market returns.
Hence:

$$\beta_J = \frac{Cov(r_J, r_M)}{V(r_M)}$$

Here $Cov(r_J, r_M)$ is the covariance of the return of security J with that of the market, and $V(r_M)$ is the variance of the market return. This can be represented as:

$$\beta_J = \frac{\sum_{i=1}^{n}\sum_{k=1}^{n} p_{i,k} \times (r_{J_i} - \overline{r_J}) \times (r_{M_k} - \overline{r_M})}{\sum_{i=1}^{n} p_i \times (r_{M_i} - \overline{r_M})^2}$$

More intuitively, β corresponds to the slope of the regression of the security's return vs. that of the market. The line we obtain is defined as the **characteristic line** of a security. As an example, we have calculated the β for Ericsson. It is 1.36, thus confirming the conclusion that might be drawn from a glance at the previous chart.

BETA OF ERICSSON
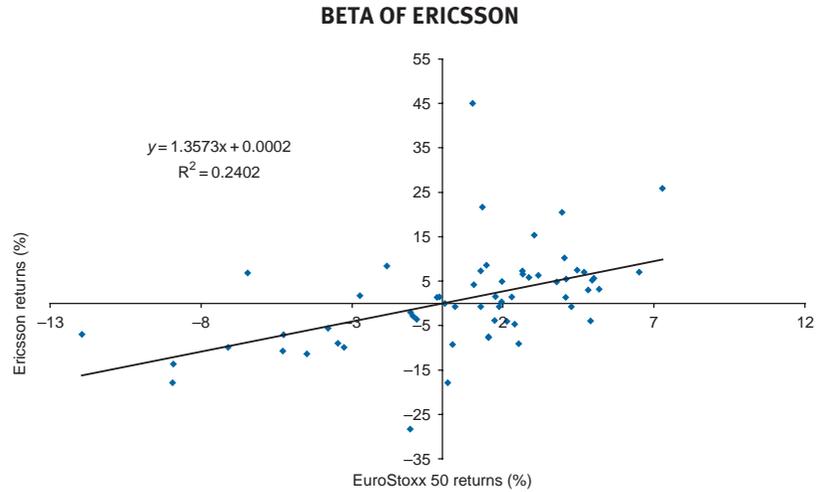
The interpretation of beta from the figure is readily apparent. The graph tells us that Ericsson's are magnified 1.36 times over those of the market. When the market does well, Ericsson is expected to do even better. When the market does poorly, Ericsson is expected to do even worse. As Ericsson's β is over 1, it is more volatile than the market and thus riskier.
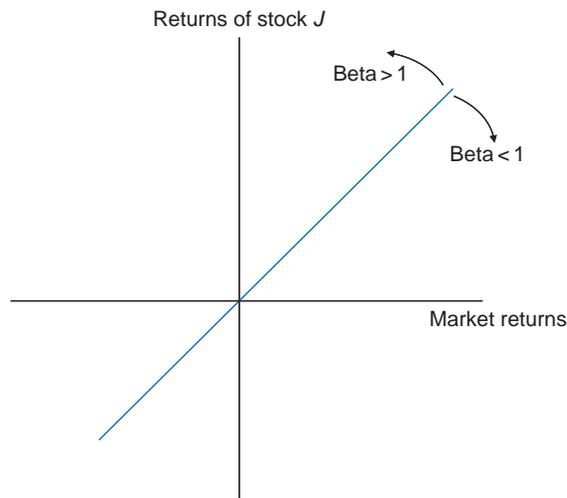
Now consider an investor who is debating whether or not to add Ericsson to his portfolio. Given that Ericsson has a magnification effect of 1.36, his reasoning will be affected by the fact that this stock will increase the risk of the portfolio.

3/ PARAMETERS BEHIND BETA

By definition, the market β is equal to 1. β of fixed-income securities ranges from about 0 to 0.5. The β of equities is usually higher than 0.5, and normally between 0.5 and 1.5. Very few companies have negative β and a β greater than 2 is quite exceptional.

To illustrate, the table below presents betas, as of mid 2008, of the EuroSTOXX 50 component stocks:

Sanofi-Aventis	0.32	BASF	0.84	Volkswagen	1.05	Philips	1.37
EON	0.50	Enel	0.84	Deutsche Bank	1.07	ING	1.48
Total	0.51	Deutsche Telekom	0.86	Intesa SanPaolo	1.09	Vivendi	1.50
Vinci	0.59	Telefonica	0.86	Banco Santander	1.10	Siemens	1.53
L'Oréal	0.63	Repsol YPF	0.92	Fortis	1.15	Aegon	1.56
Air Liquide	0.65	Generali	0.94	Renault	1.16	Saint Gobain	1.64
Unilever	0.65	ENI	0.94	BNP Paribas	1.17	Münich Re	1.65
RWE	0.71	Telecom Italia	0.96	France Télécom	1.24	Suez	1.66
Carrefour	0.73	Daimler	0.99	LVMH	1.25	SAP	1.73
Deutsche Boerse	0.83	BBVA	1.01	Bayer	1.31	Allianz	1.78
Schneider	0.83	Iberdrola	1.01	Société Générale	1.31	Alcatel Lucent	1.79
Unicredit	0.83	Crédit Agricole	1.04	Nokia	1.32	AXA	1.87

For a given security, the following parameters explain the value of beta:

(a) Sensitivity of the stock's sector to the state of the economy

The greater the effect of the state of the economy on a business sector, the higher is its β – temporary work is one such highly exposed sector. Another example is auto-makers, which tend to have a β close to 1. There is an old saying in North America, "As General Motors goes, so goes the economy". This serves to highlight how GM's financial health is to some extent a reflection of the health of the entire economy. Thus, beta analysis can show how GM will be directly affected by macroeconomic shifts in the economy.

(b) Cost structure

The greater the proportion of fixed costs to total costs, the higher the breakeven point, and the more volatile the cash flows. Companies that have high ratio of fixed costs (such as cement makers) have a high β, while those with a low ratio of fixed costs (like mass-market service retailers) have a low β.

(c) Financial structure

The greater a company's debt, the greater its financing costs. Financing costs are fixed costs which increase a company's breakeven point and, hence, its earnings volatility. The heavier a company's debt or the more heavily leveraged the company is, the higher is the β of its shares.

(d) Visibility on company performance

The quality of management and the clarity and quantity of information the market has about a company will all have a direct influence on its beta. All other factors being equal, if a company gives out little or low quality information, the β of its stock will be higher as the market will factor the lack of visibility into the share price.

(e) Earnings growth

The higher the forecasted rate of earnings growth, the higher the ß. Most of a company's value in cash flows are far down the road and thus highly sensitive to any change in assumptions.

<div align="right">

Section 21.7

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CHOOSING AMONG SEVERAL RISKY ASSETS AND THE

EFFICIENT FRONTIER

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This section will address the following questions: why is it correct to say that the beta of an asset should be measured in relation to the market portfolio? Above all, what is the market portfolio?

To begin, it is useful to study the impact of the correlation coefficient on diversification. Again, the same two securities will be analysed: Ericsson (E) and Heineken (H). By varying $\rho_{E,H}$, between -1 and $+1$, we obtain:

Proportion of E shares in portfolio (X_E) (%)		0	25	33.3	50	66.7	75	100
Return on the portfolio: $E(r_{E,H})$ (%)		6.0	7.8	8.3	9.5	10.7	11.3	13.0
Portfolio risk $\sigma(r_{E,H})$ (%)	$\rho_E, H = -1$	10.0	3.3	1.0	3.5	8.0	10.3	17.0
	$\rho_E, H = -0.5$	10.0	6.5	6.2	7.4	10.1	11.7	17.0
	$\rho_E, H = 0$	10.0	8.6	8.7	9.9	11.8	13.0	17.0
	$\rho_E, H = 0.3$	10.0	9.7	10.0	11.1	12.7	13.7	17.0
	$\rho_E, H = 0.5$	10.0	10.3	10.7	11.8	13.3	14.2	17.0
	$\rho_E, H = 1$	10.0	11.8	12.3	13.5	14.7	15.3	17.0

Note the following caveats:

- If Ericsson and Heineken were perfectly correlated (i.e. the correlation coefficient is 1), diversification would have no effect. All possible portfolios would lie on a line linking the risk/return point of Ericsson with that of Heineken. Risk would increase in direct proportion to Ericsson's stock added.

- If the two stocks were perfectly inversely correlated (correlation coefficient -1), diversification would be total. However, there is little chance of this occurring, as both companies are exposed to the same economic conditions.
- Generally speaking, Ericsson and Heineken are positively, but imperfectly, correlated and diversification is based on the desired amount of risk.

With a fixed correlation coefficient of 0.3, there are portfolios that offer different returns at the same level of risk. Thus, a portfolio consisting of two-thirds Heineken and one-third Ericsson shows the same risk (10%) as a portfolio consisting of just Heineken, but returns 8.3% vs. only 6% for Heineken.

IMPACT OF THE CORRELATION COEFFICIENT ON RISK AND RETURN
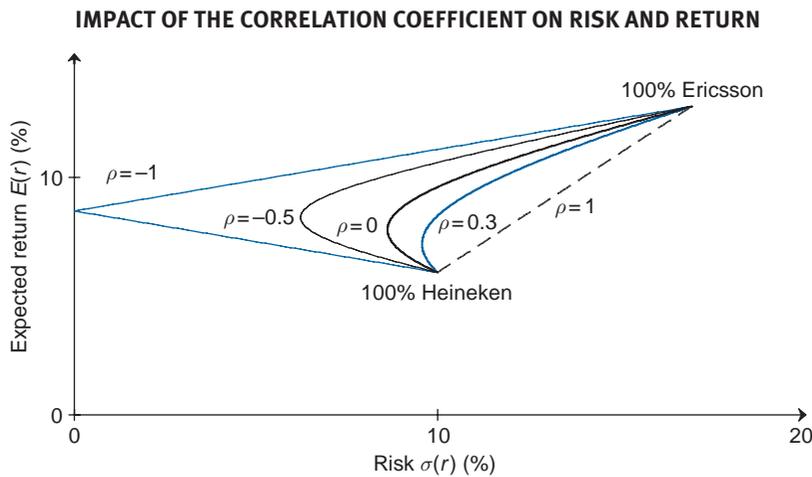
As long as the correlation coefficient is below 1, diversification will be efficient.

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There is no reason for an investor to choose a given combination if another offers a better (efficient) return at the same level of risk.

Efficient portfolios (such as a combination of Ericsson and Heineken shares) offer investors the best risk-return ratio (i.e. minimal risk for a given return).

EFFICIENT FRONTIER
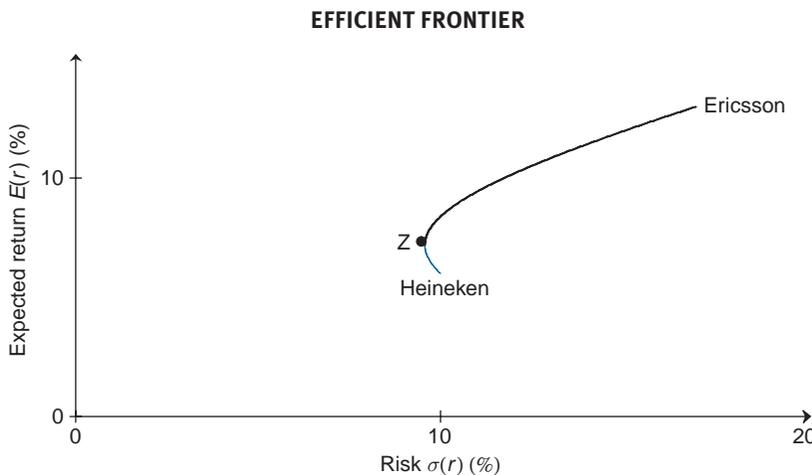
Efficient portfolios fall between *Z* and Ericsson. The portion of the curve between *Z* and Heineken is called the efficient frontier.

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For any portfolio that does not lie on the **efficient frontier**, another can be found that, given the level of risk, offers a greater return or that, at the same return, entails less risk.

All subjective elements aside, it is impossible to choose between portfolios that have different levels of risk. There is no universally optimum portfolio and therefore it is up to the investor to decide, based upon his appetite for risk. However, given the same level of risk, some portfolios are better than others. These are the efficient portfolios.

With a larger number of stocks, i.e. more than just two, the investor can improve his efficient frontier, as shown in the chart below.

EFFICIENT FRONTIER
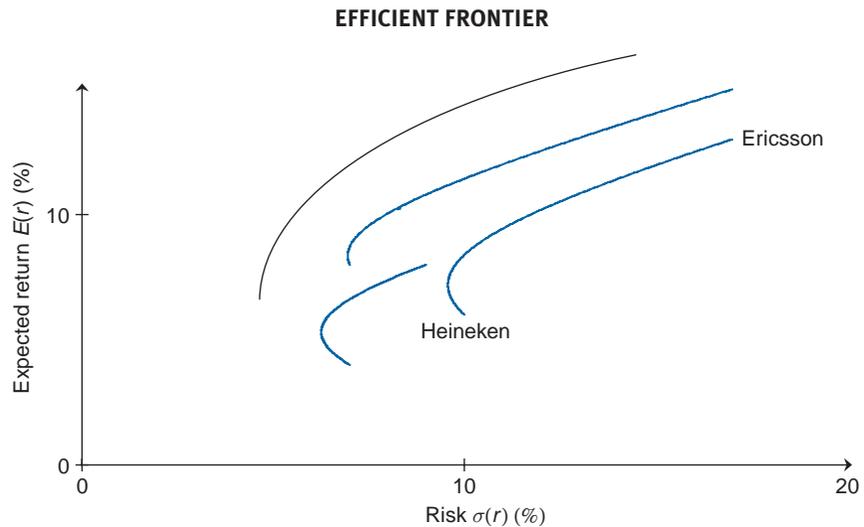
Section 21.8

CHOOSING BETWEEN SEVERAL RISKY ASSETS AND A RISK-FREE
ASSET: THE CAPITAL MARKET LINE

1/ RISK-FREE ASSETS

By definition, **risk-free assets are those whose returns,** the risk-free rate (r_F), **is certain**. This is the case with a government bond, assuming of course that the government does not go bankrupt. The standard deviation of its return is thus zero.

If a portfolio has a risk-free asset F in proportion $(1 - X_H)$ and the portfolio consists exclusively of Heineken shares, then the portfolio's expected return $E(r_{H,F})$ will be equal to:

$$E(r_{H,F}) = (1 - X_H) \times r_F + X_H \times E(r_H) = r_F + (E(r_H) - r_F) \times X_H \qquad (21.2)$$

The portfolio's expected return is equal to the return of the risk-free asset, plus a risk premium, multiplied by the proportion of Heineken shares in the portfolio. The risk premium is the difference between the expected return on Heineken and the return on the risk-free asset.

How much risk does the portfolio carry? Its risk will simply be the risk of the Heineken stock, commensurate with its proportion in the portfolio, expressed as follows:

$$\sigma\left(r_{H,F}\right) = X_H \times \sigma\left(r_H\right) \tag{21.3}$$

If the investor wants to increase his expected return, he will increase X_H. He could even borrow money at the risk-free rate and use the funds to buy Heineken stock, but the risk carried by his portfolio would rise commensurately.

By combining equations (21.1) and (21.3), we can eliminate X_F, thus deriving the following equation:

$$E(r_{H,F}) = r_F + \frac{\sigma(r_{H,F})}{\sigma(r)} \times [E(r_H) - r_F]$$

This portfolio's expected return is equal to the risk-free rate, plus the difference between the expected return on Heineken and the risk-free rate. This difference is then weighted by the ratio of the portfolio's standard deviation to Heineken's standard deviation.

Continuing with the Heineken example, and assuming that r_F is 3%, with 50% of the portfolio consisting of a risk-free asset, the following is obtained:

$$E(r_{H,F}) = 3\% + (6\% - 3\%) \times 0.5 = 4.5\%$$

$$\sigma(r_{H,F}) = 0.50 \times 10\% = 5\%$$

Hence:

$$E(r_{H,F}) = 3\% + (5\%/10\%) \times (6\% - 3\%) = 4.5\%$$

For a portfolio that includes a risk-free asset, there is a linear relationship between expected return and risk. To lower a portfolio's risk, simply liquidate some of the portfolio's stock and put the proceeds into a risk-free asset. To increase risk, it is only necessary to borrow at the risk-free rate and invest in a stock with risk.

2/ RISK-FREE ASSETS AND EFFICIENT FRONTIER

The risk–return profile can be chosen by combining risk-free assets and a stock portfolio (the alpha portfolio on the chart below). This new portfolio will be on a line that connects
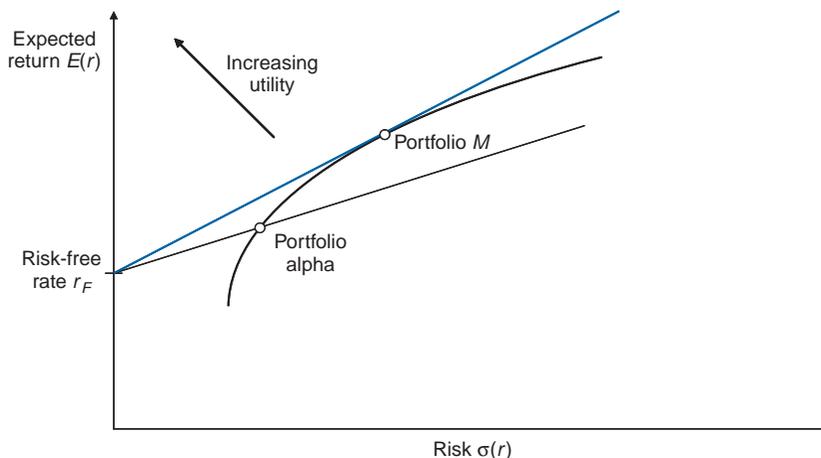
the risk-free rate to the efficient portfolio that has been chosen. In the chart below, the portfolio located on the efficient frontier, M, maximises utility. The line joining the risk-free rate to portfolio M is tangent to the efficient frontier.

Investors' taste for risk can vary, yet the above graph demonstrates that the shrewd investor should be invested in portfolio M. It is then a matter of adjusting the risk exposure by adding or subtracting risk-free assets.

If all investors acquire the same portfolio, this portfolio must contain all existing shares. To understand why, suppose that stock i was not in portfolio M. In that case, nobody would want to buy it, since all investors hold portfolio M. Consequently, there would be no market for it and it would cease to exist.

> The "market portfolio" includes all stocks at their market value. The market portfolio is thus weighted proportionally to the market capitalisation of a particular market.

The weighting of stock i in a market portfolio will necessarily be the value of the single security divided by the sum of all the assets. As we are assuming fair value, this will be the fair value of i.

3/ CAPITAL MARKET LINE

The expected return of a portfolio consisting of the market portfolio and the risk-free asset can be expressed by the following equation:

$$E(r_P) = r_F + \frac{\sigma_P}{\sigma_M} \times [E(r_M) - r_F]$$

where $E(r_P)$ is the portfolio's expected return; r_F, the risk-free rate; $E(r_M)$, the return on the market portfolio; σ_P, the portfolio's risk; and σ_M, the risk of the market portfolio.

This is the equation of the **capital market line**, which is graphically tangent to the efficient frontier containing the portfolio M. The reason is that if there was a more efficient combination of risk-free and risky assets, the weighting of the risky assets would depart from that of the market portfolio, and supply and demand for these stocks would seek a new equilibrium.

The most efficient portfolios in terms of return and risk will always be on the capital market line. The tangent point at M constitutes the optimal combination for *all* investors. If we introduce the assumption that all investors have **homogeneous expectations**, i.e. that they have the same opinions on expected returns and risk of financial assets, then the efficient frontier of risky assets will be the same for all of them. The capital market line is the same for all investors and thus each of them would hold a combination of the portfolio M and the risk-free asset.

With the assumption of homogeneous expectations, it is reasonable to say that the portfolio M includes all the assets weighted for their market capitalisation. This is defined as the **market portfolio**.[1] The market portfolio is the portfolio that all investors hold a fraction of, proportional to the market's capitalisation.

1 In practice, investors use wide-capitalisation market indexes as a proxy for the market portfolio.

> The *capital market line* links the market portfolio M to the risk-free asset. For a given level of risk, no portfolio is better than those located on this line.

These portfolios consist of two types of investments:

- an investment in the risk-free rate and in the market portfolio, between $\sigma = 0$ and $\sigma = \sigma_M$; and
- an investment in the market portfolio financed partly by debt at the risk-free rate, beyond σ_M.

A rational investor will not take a position on individual stocks in the hope of obtaining a big return, but rather on the market as a whole. He will then choose his risk level by adjusting his debt level or by investing in risk-free assets. This is the **separation theorem.** According to this theorem the financial decision of an investor requires "two steps":

1 First, collect data and information on financial assets, estimate the expected risk and return for each of them, simulate sets of combinations of assets, build the efficient frontier of risky assets, link the risk free-asset with the efficient frontier, delineate the market portfolio (*M*).
2 Then choose how to allocate wealth between *M* and the risk-free assets. This decision is a function of personal preferences and attitude toward risk.

With this understanding of what a market portfolio is, it is now possible to answer to the initial question of Section 21.7: why can we say that the beta of an asset should be measured in relation to the market portfolio? The answer is because all investors have a certain fraction of their wealth invested in the market portfolio. The additional risk of a new title should be computed measuring the covariance of that asset with the market portfolio.
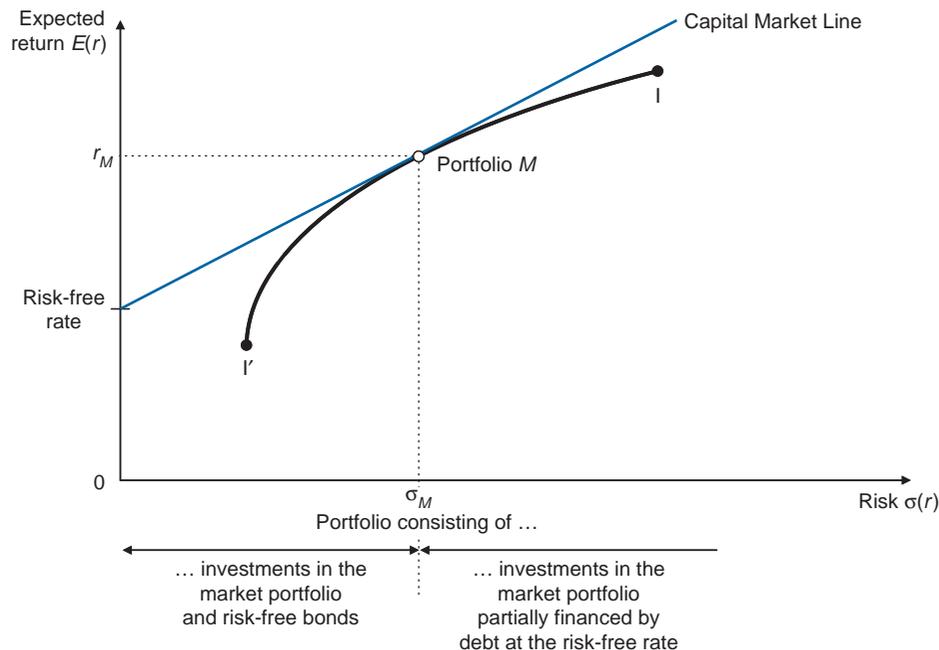
Only portfolios located on a line passing through *M* and on tangent to the efficient frontier are optimal. The others, such as portfolio *Z*, are suboptimal.

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Section 21.9
HOW PORTFOLIO MANAGEMENT WORKS

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The financial theory described so far seems to give a clear suggestion: invest only in highly diversified mutual funds and in government bonds. However, not all investors subscribe to this theory. Some take other approaches, described below. Sometimes, investors combine different approaches.

First, we shall consider the difference between a **top-down** and a **bottom-up** approach. In a top-down approach, investors focus on the asset class (shares, bonds, money-market funds) and the international markets in which they wish to invest (i.e. the individual securities chosen are of little importance). In a bottom-up approach (commonly known as stock-picking), investors choose stocks on the basis of their specific characteristics, not the sector in which they belong. The goal of the bottom-up approach is to find that rare pearl.

The strategy that is closest to portfolio theory is clearly index management, which seeks to replicate the performance of a market index. **Index trackers** seek to replicate an index as closely as possible. This is the preferred investment of those who believe in efficient markets. Index funds have developed as the general public has become more acquainted with portfolio theory. Index funds were created about 30 years ago and have since grown in value from €6m to more than €2500bn today.

There are two types of stock-pickers:

> **Investors who focus on fundamental analysis and seek to determine the intrinsic value of a stock. They believe that, sooner or later, market value will approach intrinsic value.** These investors believe that all other price changes are temporary phenomena. Intrinsic value is what financial analysts seek to measure. A fundamental investor seeks to invest over the medium or long term and like Warren Buffet, who is the most famous of them all, wait patiently for the market value to converge towards the intrinsic value, i.e. for the market to agree with them.

> **Investors who focus on technical analysis, the so-called chartists, who do not seek to determine the value of a stock. Instead, these investors conduct detailed studies of trends in a stock's market value and transaction volumes in the hope of spotting short-term trends.** Chartists prefer to analyse how the market perceives intrinsic value rather than looking at the stock's actual intrinsic value.

Chartists believe the market is predictable in the very short term, and this is often the attitude of traders and banks who take positions for very short periods, from a few hours to a few days.

Technical analysis is not based directly on any theory. It is based more on psychology than mathematics. Chartists believe that while investors are not perfectly rational, they at least are fixed in their way of reasoning, with predictable reactions to certain situations. Chartists look for these patterns of behaviour in price trends.

One method consists in calculating a moving average of prices over a certain number of days (generally 20). Chartists look for a price to break through its moving average, either upward or downward.

Another method is based on comparing a stock's prices with its highs and lows over a given period. This is used in identifying support and resistance levels:

- a support is a level that the price has very little chance of falling below; and
- a resistance is a level that the price has very little chance of rising above.

The fundamental investor believes that markets are predictable in the medium or long term, but certainly not in the short term. Chartists believe they are predictable in the short term, but not in the medium or long term. Believers in efficient markets espouse the notion that markets are never predictable.

Some fundamental investors seek out **growth stocks** (companies in sectors offering sustainable growth),[2] while others seek out **value stocks** (companies in more mature sectors that provide long-term performance). At the end of the spectrum, investors choose **income stocks** whose prices are relatively stable and provide the bulk of their returns from dividends. Asset managers have developed several types of funds targeted specifically at these types of investors: growth funds, value funds and mixed funds. These last, mixed funds, are actually a combination of the first two.

Another type of fund management has arisen recently, so-called **alternative management**, which is based on market declines, volatility, liquidity, time value and abnormal valuations, rather than on rising prices. An example of alternative management is the **hedge fund**, which is a speculative fund seeking high returns and relying heavily on derivatives, and options in particular. Hedge funds use leverage and commit capital in excess of their equity. Hedge funds offer additional diversification to "conventional" portfolios, as their results are in theory not linked to the performances of equity and bond markets. Short-seller funds, for example, bet that a stock will fall by borrowing shares at interest and selling them, then buying them back after their price falls and returning them to the borrower.

Institutional investors are taking a growing interest in hedge funds. As of end 2007, 10,000 hedge funds were active, with about €1700bn under management.

In recent years, hedge funds' risk-adjusted performance has been above that of traditional management. From 1990 to 2001, the average performance of a basket of hedge funds was 11.6%, vs. 7.9% for a basket of shares and 7.0% for bonds. It is important to note, however, that this greater return is in compensation for these funds' greater risk exposure.

Last but not least, private equity funds seek even higher returns (and thus encounter greater risks!) through leverage buy-out operations; our reader will learn more about this particular type of transaction in Chapter 44.

2 *Stocks that exhibit low price-to-book and low price-to-earnings ratios are* value stocks*, whereas those with high P/E and price-to-book ratios are called* growth stocks.

There are various risks involved in financial securities. There are economic risks (political, inflation, etc.) which threaten cash flows from financial securities and which come from the "real economy", and there are financial risks (liquidity, currency, interest rate and other risks) which do not directly affect cash flow and come under the financial sphere.

SUMMARY

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All risks, regardless of their nature, lead to fluctuations in the value of a financial security.

In a market economy, a security's risk is measured in terms of the volatility of its price (or of its rate of return). The greater the volatility, the greater the risk, and vice versa.

We can break down the total risk of a financial security into the market-related risk (market or systematic risk) and a specific risk that is independent of the market (intrinsic or diversifiable risk). These two risks are totally independent.

The market risk of a security is dependent on its β coefficient, which measures the correlation between the return on the security and the market return. Mathematically, this is the regression line of the security's return vs. that of the market.

The β coefficient depends on:

- the sensitivity of the company's business sector;
- the economic situation;
- the company's operating costs structure (the higher the fixed costs, the higher the β),
- the financial structure (the greater the group's debts, the higher the β);
- the quality and quantity of information provided to the market (the greater visibility there is over future results, the lower the β); and
- earnings growth rates (the higher the growth rate, the higher the β).

Although the return on a portfolio of shares is equal to the average return on the shares within the portfolio, the risk of a portfolio is lower than the average risk of the shares making up that portfolio. This happens because returns on shares do not all vary to exactly the same degree, since correlation coefficients are rarely equal to 1.

As a result, some portfolios will deliver better returns than others. Those portfolios that are located on the portion of the curve known as the efficient frontier will deliver better returns than those portfolios which are not. However, given portfolios located on the efficient frontier curve, it is impossible to choose an optimal portfolio objectively from among them. The choice then becomes an individual one, and every investor chooses the portfolio according to his personal appetite for (or aversion to) risk.

By including risk-free assets, i.e. assets on which the return is guaranteed such as government bonds, it is possible to obtain portfolios that are even more efficient.

The inclusion of a risk-free asset in a portfolio leads to the creation of a new efficient frontier which is the line linking the risk-free asset to the market portfolio in the risk/returns space. This new line is called the capital market line. Investors are well advised to own shares in this market portfolio and to choose the level of risk that suits them by investing in risk-free assets or by going into debt. On this line, no portfolio could perform better, i.e. no portfolio could offer a better return for a given level of risk, or a lower risk for a given return.

Portfolio theory is generally applied in varying degrees, as demonstrated by the existence of investment strategies that favour certain securities rather than market portfolios.

1/How is risk measured in a market economy?

2/What does the β coefficient measure?

3/In the graph on page 391, which is the most volatile asset? What motivates investors to enter this market?

4/The β coefficient measures the specific risk of a security. True or false?

5/Is the Heineken share more or less risky than the whole of the market? Why?

6/Upon what is the β coefficient dependent?

7/Why are market risk and specific risk totally independent?

8/Will an increase in a company's debt reduce or increase the volatility of its share price?

9/As a result of a change in the nature of its business, there is a relative rise in the proportion of fixed costs in a group A's total costs. Will this affect the risk attached to its share price? If so, how?

10/Explain why it is unhealthy for a company to invest its cash in shares.

11/Is the β of a diversified conglomerate close to 1? Why?

12/Internet companies have low fixed costs and low debt levels, yet their β coefficients are high. Why?

13/Is the β coefficient of a group necessarily stable over time? Why?

14/You buy a lottery ticket for €100 on which you could win €1,000,000, with a probability rate of 0.008%. Is this a risky investment? Could it be even riskier? How could you reduce the risk? Would this be a good investment?

15/Why is standard deviation preferable to variance?

16/What law of statistics explains that in the long term, risk disappears? State your views.

17/You receive €100,000 which you decide to save for your old age. You are now 20. What sort of investment should you go for? Perform the same analysis as if it happened when you are 55 and 80.

18/Do shares in Internet companies carry a greater or smaller risk than shares in large retail groups? Why?

19/There are some sceptics who claim that financial analysis serves no purpose. Why? State your views.

20/Why are negative β coefficients unusual?

21/What can you say about a share for which the standard deviation of the return is high, and the β is low?

22/Must the values of financial assets fluctuate in opposite directions in order to reduce risk? Why?

23/What other concept does the capital market line bring to mind?

24/Why does the market portfolio include all high risk assets in order to achieve maximum diversification?

25/Security A carries little risk and security B has great risk. Which would you choose if you wanted to take the least risk possible?

26/The correlation coefficient between French equities and European equities developed as follows:

Years	1970–1979	1980–1989	1990–1999	2000–2008
Coefficient	0.43	0.42	0.73	0.996

Are you surprised by the table above? Does it prove that there is nothing to gain by geographic diversification? Does it reduce the importance of geographic diversification?

27/Use the table on page 400 to determine which industrial sector makes the greatest contribution to reducing the risk of a portfolio.

28/What is the only asset that can be used to precisely measure the levels of risk of a portfolio?

29/What conditions are necessary for a risk-free asset to be free of risk? Provide an example. Is it really risk-free?

30/Show that the market portfolio must be on the capital market line and on the portion of the curve called the efficient frontier (see Section 21.2).

31/Why does this chapter provide an explanation of the development of mutual funds?

32/Can the risk of a portfolio be greater than the individual risk of each of the securities it contains? Under what circumstances?

33/Under which circumstances can the risk of a portfolio be less than the individual risk of each of the securities it contains?

34/The greater the number of shares in a portfolio, the less the marginal contribution to diversification of an additional security will be. True or false?

35/Will very wide diversification eliminate specific risk? And market risk?

EXERCISES

1/ Calculate the return on the ENI share and on the Italian index over 13 months until 1 July 2008. To help you, you have a record of the share price and of the general index. What is the total risk of the ENI share? What is the β coefficient of ENI? What portion of the total risk of the ENI share is explained by market risk?

Period	Jul 07	Aug 07	Sep 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08
Fiat	27.75	24.44	25.31	25.96	24.42	25.06	25.17	21.5	23.04	22.53	25.3	25.21	22.96
Italian index	3336	3081	3100	3195	3093	3023	2880	2610	2545	2573	2634	2486	2228

2/ A portfolio gives a 10% return with a standard deviation of 18%. You would like the standard deviation to drop to 14%. What should you do? What should you do if you want the standard deviation to rise to 23%?

3/ Calculate the risk and returns of portfolio Z in Section 21.2. What is the proportion of Heineken shares and Ericsson shares in this portfolio?

4/ A portfolio gives a 10% return for a standard deviation of 18%. The shares in companies C and D have the following returns and standard deviations:

	C	D
Expected return (%)	10	20
Standard deviation (%)	15	30

The Correlation between the return on these two shares is 25%.

(a) Calculate the expected return and the standard deviation for each of the following portfolios:

α : 100% C; β : 75% C+25% D; σ : 50% C+50% D; δ : 25% C+75% D; ε : 100% D

(b) Plot your results on a graph. What are your conclusions?

ANSWERS

Questions
1/ *The volatility of the value of the asset is measured by the standard deviation of its rate of return.*
2/ *The correlation between the return on the security and the market return, the market risk of the security, the line of the regression of the security's return vs. that of the market.*
3/ *The Russian shares carry the most risk, but they will also bring the highest returns.*
4/ *False, it measures the market risk of a security.*
5/ *It is difficult to give a very accurate answer, without knowing what the share's specific risk is.*
6/ *On the company's operating cost structure, its financial structure, its information policy and the growth rate of its earnings.*
7/ *One has an impact on all securities, the other on a given security.*

8/ *Yes, it will increase volatility due to the leverage effect, see Chapter 18.*

9/ *Yes, it will increase volatility due to the effect of breakeven point, see Chapter 20.*

10/ *Because cash by definition should be available at all times, and share prices are very volatile.*

11/ *Usually yes, because conglomerates are highly diversified and are a bit like "mini markets" in their own right.*

12/ *Because of the very poor visibility we currently have over what is going to happen to Internet stocks.*

13/ *No, as the group's business and financial structure can change over the course of time, which will have a knock-on effect on the β.*

14/ *Yes, very risky, because you have a 99.992% chance of losing your €100. Yes it could, if you used debt to finance the €100. If you bought all of the lottery tickets you would be sure of winning the €1,000,000, but that would cost you €100/ 0.008% = €1,250,000, which wouldn't be a very good investment.*

15/ *Because it's around 1, like returns, unlike variance which is around 2.*

16/ *The law of large numbers. The risk is never completely eliminated.*

17/ *Equities, bonds, money-market investments.*

18/ *A greater risk as the outlook is very uncertain, whereas the visibility over the earnings of large retail groups is very good.*

19/ *Financial analysis contributes very little, as it must be acted upon immediately and the results seen in the share price – financial analysis kills financial analysis. Financial analysis is necessary for market equilibrium (rationality) but can only be "disinterested".*

20/ *Because if they weren't, when markets went up, the price of most securities making up these markets would fall, which would be absurd.*

21/ *That it carries a specific risk that is very high.*

22/ *Of course not. The correlation must just not be equal to 1.*

23/ *The leverage effect.*

24/ *By definition.*

25/ *A combination of A and B, and not only security A, so that $\rho \neq 1$.*

26/ *No, because it reflects advances in European integration and globalisation, which both increase the synchronisation of economies. No, as long as correlation coefficients remain lower than 1, although they are now very close. Yes.*

27/ *The IT sector, because correlation coefficients with the other sectors are lower.*

28/ *A risk-free asset.*

29/ *There must be no doubts about the solvency of the issuer, no risk vis-à-vis the rate at which the coupons can be reinvested, and protection against inflation. A zero-coupon government bond indexed to inflation. No, because there will always be a risk that the price will fluctuate before maturity.*

30/ *By construction, on the capital market line because this line is constructed from 2 points – itself and the risk-free asset. It is on the efficient frontier in Section 21.2 because, given its high level of diversity, risk is reduced to a minimum.*

31/ *Because a mutual fund is a reduced model of market portfolio, which would be difficult to compile at an individual level.*

32/ *Yes, it is financed by debt.*

33/ *If it includes a large percentage of risk-free assets.*

34/ *True, because the portfolio is already very diversified.*

35/ *Yes, by definition. No, this would be impossible.*

Exercises

1/*Returns on the ENI share: 22.96/27.75 − 1 = −17%*
Returns on the Italian index: 2227.87/3336.47 − 1 = −33%
ENI risk σ = 7.89%
Index risk σ = 4.49%; β = 1.36; 77% = (1.36 × 4.49%) /7.89%.

2/*Add more risk-free assets until they account for 4/18 of the portfolio. Use debt to finance an increase in the size of this portfolio by 5/18.*

3/*83% of Heineken shares and 17% of Ericsson shares. E(r) = 7.19% and σ = 9.57%.*

4/

	Expected return (%)	Standard deviation (%)
α	10.00	15.00
β	12.50	15.00
σ	15.00	18.37
δ	17.50	23.72
ε	20.00	30.00

BIBLIOGRAPHY

To learn more about the history of risk analysis:

N. Barberis, Asset allocation – have investors got it wrong? *Financial Times*, 30 June 1997.

E. Dimson, P. Marsh, M. Staunton, *The Triumph of the Optimist. 101 Years of Global Investment Returns*, Princeton University Press, 2002.

E. Dimson, P. Marsh, M. Staunton, *Global Investment Returns Yearbook 2008*, ABN Amro/LBS, 2008.

P. Bernstein, *Against the Gods: The Remarkable Story of Risk*, Flammarion, 1997.

M. Kritzman, What practitioners need to know... about time diversification, *Financial Analysts Journal*, 14–18, January–February 1994.

To learn more about the theoretical analysis of risk:

N. Barberis, Investing for the long run when returns are predictable, *Journal of Finance*, **55**, 225–264, February 2000.

Z. Bodie, R. Merton, *Finance*, Prentice Hall, 2000.

E. Fama, M. Miller, *Theory of Finance*, Holt, Rinehart & Winston, 1971.

D. Hirshleifer, Investor psychology and asset pricing, *Journal of Finance*, **56**, 1533–1597, August 2001.

For more about asset management and investment strategies:

A. Damodaran, *Style Investing*, John Wiley & Sons Inc., 2003.

Index-based investing, *Financial Times Survey*, 18 July 2001.

B. Malkiel, A. Saha, Hedge funds: Risk and return, *Financial Analysts Journal*, 80–88, November–December 2005.

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