PORTFOLIO MANAGEMENT

INTERNATIONAL INVESTMENTS AND VALUE AT RISK

PORTFOLIO MANAGEMENT

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1. International Investments

Our aim in this chapter is to outline the facts and theories about international portfolio investments. Cross-border trading is more and more frequent. The globalisation of financial markets is favourable to both lenders (savers, investors...) and borrowers (firms, governments...). In this sub-module, we shall mainly consider the investors' point of view. International corporate finance issues are not discussed here.

We shall start assessing the benefits of **international diversification**. As in the domestic setting, diversification enables investors to reduce the risk of their portfolio. We discuss the issue of cross-correlation between different financial markets and aspects of country risks and specifics of emerging markets.

The last section focuses on **foreign exchange risk hedging**. We present the possible means of currency risk hedging. In addition, the relevance of full hedging using both theoretical arguments and empirical evidence is discussed.

1.1 International diversification

A basic principle in portfolio management is that **diversification reduces risk** in terms of the variability of returns. The reason for that is quite intuitive: the greater the number of securities in a portfolio, the less the portfolio is likely to lose value as the result of a company's misfortune. In general, the total risk of a portfolio will depend on:

- the number of securities included in the portfolio;
- the riskiness of each individual security;
- the degree to which risks are independent of each other.

Clearly, the possibility of including foreign securities allows further diversification of the portfolio. As a result, the number of potential securities increases and, moreover, risks in several countries are less likely to be perfectly correlated.

When planning an investment in foreign securities, a manager faces problems in estimating risks and returns of selected instruments, as well as their cross correlation. In fact, for the estimations of the first two components he can apply a standard procedure as for domestic securities. Since these issues were well studied earlier, we will not address them in this section. However, the cross-correlation factor plays an import role for international investments, and we will study it in more detail.

1.1.1 Computing foreign currency return and variance

The typical investor is primarily interested in the return on investment expressed in his **reference currency**. This is usually the currency of the country in which he lives (i.e. the currency he uses in order to purchase consumption goods).

We are going to denote by R_{Dt} the domestic currency return on an asset and R_{Ft} the foreign currency return on the same asset. The rate of return in foreign currency is defined in the usual way. For a single investment, like a bond or a share, it is equal to:

$$R_{Ft} = \frac{P_{Ft} - P_{Ft-1}}{P_{Ft-1}} + \frac{C_{Ft}}{P_{Ft-1}}$$

where:

P_{Ft} and P_{Ft-1} Price (denominated in foreign currency) of the asset at the beginning and respectively at the end of the period

C_{Ft} Eventual cash flow paid at time t.

Converted into national currency, a foreign investment yields:

$$1 + R_{Dt} = (1 + R_{Ft}) \cdot (1 + s_t)$$

where:

R_{Dt} Rate of return denominated in domestic currency

R_{Ft} Rate of return of the foreign investment (computed as stated above)

s_t Relative change in the value of the foreign currency[1].

Developing the above expression, we find that:

$$R_{Dt} = R_{Ft} + s_t + R_{Ft} \cdot s_t \cong R_{Ft} + s_t$$

The last expression is only an approximation, because the cross-product term $R_{Ft} \cdot s_t$, which is small, has been ignored. However, the equality holds exactly if we consider continuous compounded rates of return and depreciation[2]:

$$\ln(1 + R_{Dt}) = \ln[(1 + R_{Ft}) \cdot (1 + s_t)] = \ln(1 + R_{Ft}) + \ln(1 + s_t)$$

$$R_{Dt}^{inst} = R_{Ft}^{inst} + s_t^{inst}$$

Hence, the expected return on a foreign investment has two components: the expected return of the investment in foreign currency and the expected change in exchange rate. From now on, we shall always consider continuous compounded rates of return in order to simplify the analysis.

The expected return for period t, based on information available at period t – 1, is equal to:

$$E_{t-1}[R_{Dt}] = E_{t-1}[R_{Ft}] + E_{t-1}[s_t]$$

where:

$E_{t-1}[\cdot]$ Conditional expectation operator, conditioned upon information at time t–1.

1 The rate of appreciation of the foreign currency can also be seen as the rate of depreciation of the domestic currency. When the CHF depreciates, foreign currencies appreciate and foreign investments perform better.

2 See in "Modern portfolio theory I": the continuous compounded rate of return is equal to ln (1 + r), where r is the simple rate of return over the holding period

A similar decomposition can be derived for the variance. The variance of the return in domestic currency, $\mathrm{Var}[R_{Dt}]$, is given by:

$$\mathrm{Var}[R_{Dt}] \cong \mathrm{Var}[R_{Ft}] + \mathrm{Var}[s_t] + 2 \cdot \mathrm{Cov}[R_{Ft}, s_t]$$

where $\mathrm{Cov}[\cdot]$ is the covariance operator.

The above expression is an approximation if one considers discrete rates of return; it holds exactly if continuous compounded rates of return are used.

If, instead of a single investment, we focus on a portfolio of international securities, the computation of its expected return (R_P^e) and variance with proportion x_i of asset i is similar to the one of a domestic portfolio.

$$R_P^e = \sum_{i=1}^{N} x_i \cdot R_i^e$$

$$\sigma_P^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i \cdot x_j \cdot \sigma_{ij}$$

where $\sigma_{ij} = \mathrm{Cov}[R_i, R_j]$ and $\sigma_{ii} = \mathrm{Var}[R_i]$.

These formulae are standard. The only difference is that the return R_i is expressed in the reference currency and has therefore two components as discussed above. Let us now study portfolio returns in detail.

Assume that a proportion x_i is invested in currency i. Under this assumption, the domestic currency return (R_D) on a portfolio including N assets denominated in N different currencies is given by:

$$R_{PDt} = x_1 \cdot R_{1Dt} + x_2 \cdot R_{2Dt} + ... + x_N \cdot R_{NDt}$$

or, using the definition of returns in domestic currency,

$$R_{PDt} = x_1 \cdot R_{1Ft} + ... + x_N \cdot R_{NFt} + x_1 \cdot s_{1t} + ... + x_N \cdot s_{Nt}$$

To compute the expected return on such a portfolio, investors need forecasts of returns in foreign currency as well as predictions of relative changes in exchange rates:

$$E_{t-1}[R_{PDt}] = x_1 \cdot E_{t-1}[R_{1Ft}] + ... + x_N \cdot E_{t-1}[R_{NFt}] + x_1 \cdot E_{t-1}[s_{1t}] + ... + x_N \cdot E_{t-1}[s_{Nt}]$$

The variance of the portfolio return in domestic currency is much more difficult to decompose than in the single foreign currency context, because it contains a large number of covariance terms:

$$\begin{aligned}\mathrm{Var}[R_{PDt}] = {} & x_1^2 \cdot \mathrm{Var}[R_{1F}] + ... + x_N^2 \cdot \mathrm{Var}[R_{NF}] + 2 \cdot x_1 \cdot x_2 \cdot \mathrm{Cov}[R_{1F}, R_{2F}] + ... \\ & + x_1^2 \cdot \mathrm{Var}[s_1] + ... + x_N^2 \cdot \mathrm{Var}[s_N] + 2 \cdot x_1 \cdot x_2 \cdot \mathrm{Cov}[s_1, s_2] + ... \\ & + 2 \cdot x_1^2 \cdot \mathrm{Cov}[R_{1F}, s_1] + 2 \cdot x_1 \cdot x_2 \cdot \mathrm{Cov}[R_{1F}, s_2] + ...\end{aligned}$$

Table 1-1 shows the types and numbers of terms included in the total variance of a portfolio diversified over N currencies. It shows the complexity of the variance of an internationally diversified portfolio. It shows that the variance not only depends on the variance of individual securities and the variance of exchange rates but also on many covariances.

Term	Explanation	Number of terms
$\mathrm{Var}(R_{iF})$	Variances of return in foreign currency	N
$\mathrm{Cov}(R_{iF};R_{jF})$	Covariances of returns in foreign currency	$N\cdot(N-1)$
$\mathrm{Var}(s_i)$	Variances of relative changes in exchange rates	N
$\mathrm{Cov}(s_i;s_j)$	Covariances of relative changes in exchange rates	$N\cdot(N-1)$
$\mathrm{Cov}(R_{iF};s_i)$	Covariances of returns in foreign currency with relative changes in exchange rates of the same country	$2\cdot N$
$\mathrm{Cov}(R_{iF};s_j)$	Covariances of returns in foreign currency with relative changes in exchange rates of other countries	$2\cdot N\cdot(N-1)$
Total		$4\cdot N^2$

Table 1-1: Types and numbers of items included in the total variance

1.1.2 Cross-correlation

To clarify the analysis, we are going to consider a portfolio with only two assets. The variance of this portfolio is then equal to:

$$\mathrm{Var}[R_P]=x_1^2\cdot\mathrm{Var}[R_1]+x_2^2\cdot\mathrm{Var}[R_2]+2\cdot x_1\cdot x_2\cdot\mathrm{Cov}[R_1,R_2]$$

Note that the covariance of two assets returns is equal to the product of the correlation coefficient and respective standard deviations:

$$\rho_{x,y}=\frac{\mathrm{Cov}[x,y]}{\sigma_x\cdot\sigma_y}\quad\leftrightarrow\quad\mathrm{Cov}[x,y]=\sigma_x\cdot\sigma_y\cdot\rho_{x,y}$$

Therefore, the variance of the portfolio can be written as:

$$\mathrm{Var}[R_P]=x_1^2\cdot\mathrm{Var}[R_1]+x_2^2\cdot\mathrm{Var}[R_2]+2\cdot x_1\cdot x_2\cdot\rho_{R_1,R_2}\cdot\sqrt{\mathrm{Var}[R_1]\cdot\mathrm{Var}[R_2]}$$

Provided that the correlation between the assets is not perfect ($\rho \neq 1$), the volatility of the portfolio will be less than the weighted sum of the individual volatilities:

$$\text{Gain from diversification: } \sigma_{R_P}<x_1\cdot\sigma_{R_1}+x_2\cdot\sigma_{R_2}\quad\leftrightarrow\quad\rho\neq1$$
$$\text{No gain from diversification: } \sigma_{R_P}=x_1\cdot\sigma_{R_1}+x_2\cdot\sigma_{R_2}\quad\leftrightarrow\quad\rho=1$$

Diversification is beneficial to the extent that stock returns are not perfectly positively correlated. Moreover, the lower the correlation the lower is the variance of the portfolio.

The example above was presented for two abstract stocks. Now, assume we have chosen these stocks from the same, say domestic, market. Clearly, the domestic stock market is sensitive to any local (domestic) macroeconomic or microeconomic shocks. During such shock period the correlation between securities tends to increase. For example, if the shock is negative (political crises in the country), the whole stock market is likely to be down. Therefore, there is a high probability that correlation ρ_{R_1,R_2} will increase, and hence the diversification effect

will be reduced. On the other hand, an internationally diversified portfolio is not that sensitive to such local shocks.

Therefore, if the portfolio is constructed of many assets from different countries, it is relevant to study the various correlations embodied in the total variance. Correlation coefficients between various stock indices are provided in Table 1-2.

These figures show that stock markets are not independent of each other. Stock markets around the world tend to move in the same direction. Yet, the positive correlation is far from perfect. Thus, there is a gain from international diversification.

Country	Germany	Japan	Switzerland	UK	USA
Germany	1				
Japan	0.46	1			
Switzerland	0.79	0.40	1		
UK	0.81	0.44	0.83	1	
USA	0.74	0.45	0.71	0.72	1

Table 1-2: Stock market indices correlation coefficients (February 1999-March 2003)

The decomposition of the total variance shows that other kinds of correlations play a role in the total risk of a portfolio: the correlations between currency changes and the correlations between currencies and stock markets. Table 1-3 shows the correlation matrix of exchange rate changes, from the EUR point of view. Notice that the correlations are positive and somewhat higher than the ones between stock market indices. This result implies that exchange rate risk cannot be totally eliminated by diversifying across currencies.

Currency	EUR	GBP	JPY	USD
EUR	1			
GBP	0.33	1		
JPY	0.05	0.44	1	
USD	0.13	0.54	0.53	1

Table 1-3: Currency spot rates correlation coefficients (February 1999-March 2003)

Finally, it is worthwhile examining the correlations between stock markets and currencies. Table 1-4 provides these correlation coefficients, also computed from the EUR point of view. We observe that most of the correlation coefficients are positive and rather low. A positive correlation means that an increase in the foreign stock index is associated with an appreciation of the foreign currency (i.e. a depreciation of the domestic currency). Conversely, a negative correlation implies that an increase in the foreign stock index is associated with a depreciation of the foreign currency. In the latter situation, exchange rate changes tend to offset stock index fluctuations, thus providing a **natural hedge**. A similar matrix has also been computed from the US perspective, which found out negative correlations. Thus, **the results crucially depend on the reference currency.**

Country	EUR	JPY	GBP	USD
Germany	0.19	0.09	0.09	0.27
Japan	0.05	0.06	0.06	0.12
UK	0.10	0.07	0.05	0.28
USA	0.20	0.04	0.08	0.22
Switzerland	0.13	0.10	0.11	0.26

Table 1-4: Currency spot rates - Market indices correlation coefficients (February 1999-March 2003)

These correlation structures help to assess the benefit of diversification. However, if an investor wants to use historical data in order to determine the efficient set, he or she does not need to determine all these covariance/correlation terms.

1.1.3 Country risk

Country risk can be defined as a risk encountered by investors entering into business relationships in foreign countries. Such relationships may include investments in the foreign financial assets as well as direct business activities. In other words, country risk may be associated with some events, which affect the value of the investor's assets. There are several major sources of risk, namely:

- **Political risk.** This risk is associated with the stability of the political system in the country. Changes in the ruling party may result in major policy changes or certain financial instability. These may result in the loss of assets or termination of operations, loss of assets value, local currency inconvertibility, higher taxes and tariffs, etc. There are many countries that still display a certain political uncertainty, for example, Pakistan, and almost all post-USSR countries. Even countries with very strong political institutions can be subject to political risk. For instance, the last presidential elections in the US had an impact on the volatility of the financial markets, which in turn could affect (and perhaps affected), in particular, investors holding short-term securities.
- **Monetary Policy.** Governments may pursue unsound monetary and fiscal policies which can lead to higher inflation, higher interest rates and, as a result, higher borrowing costs, and finally to a recession.
- **Entire economic situation.** Such factors as high unemployment rate, high inflation and low industrial productivity may lead to a social instability and strikes, which in turn can substantially worsen the investment climate.
- **Other:** probability for the country to enter a war, economic sanctions from other countries, etc.

Therefore, when deciding to invest in foreign assets one should be aware of these risks, in particular when the investment is considered to be made in so-called emerging markets.

1.1.4 Emerging markets

As we have already mentioned, international diversification is beneficial for investors because it allows risk reduction and increases expected return on the investment. So far, we were talking about international investments without any classification of the countries the investments go to. There are basically two types of markets investors are concerned about. The first one consists of developed countries, and it is self-explained by definition. The second type of markets – these are so called *Emerging Markets* which we are going to describe in this section.

There is enormous literature on different aspects of investment in emerging markets. In order to explain this interest in emerging markets we will try to answer the following questions: What are they? Why are they attractive for investors? And what are the problems when investing in them?

1.1.4.1 Definitions

The International Finance Corporation adopted the following segmentation to distinguish developed markets from emerging ones. Namely, the market is assumed to be emerging if a GNI (gross national income) per capita is below USD 9266[3]. Obviously, around 155 countries will fit this definition. In the financial world there are some additional criteria to define whether the particular market is emerging. Those are:

- The capital market must be relatively well developed (size and turnover matter) and sufficiently liquid. Nevertheless, liquidity still remains an issue for investments in emerging markets, and we will discuss this below.
- The growth rate of emerging economies is higher when compared to developed countries.
- The political and economic situation must be relatively stable and the economy is assumed to be market oriented.

Having presented the definitions of emerging economies, now we are going to address the issue of their attractiveness for investment.

1.1.4.2 Benefits from investing in Emerging Markets

By definition, emerging economies are assumed to grow faster than their developed counterparts, and this obviously makes them attractive for investment. But there is also a trade off between high returns and high risks, as shown in Table 1-5.

The second point of attractiveness, documented by many studies, is that the correlation of emerging markets with a world market is very low (see Table 1-5). As we have mentioned before, low correlation is beneficial for diversification effect and allows an investor to gain in the portfolio risk reduction.

3 This level was defined in 2002.

	Annual Return %	Total Risk %	Domestic Risk %	Correlation with World
World	**11.5**	**14.4**	14.4	**1.00**
U.S.A	**13.4**	**15.3**	15.3	**0.83**
Argentina	**33.2**	**87.2**	155.5	**0.02**
Brazil	**13.3**	**62.3**	93.8	**0.11**
Chile	**32.9**	**27.7**	26.8	**0.12**
Columbia	**31.0**	**31.7**	32.1	**0.05**
Greece	**17.7**	**42.3**	41.9	**0.21**
India	**6.0**	**33.3**	35.6	**-0.10**
Korea	**5.2**	**28.4**	27.2	**0.27**
Malaysia	**17.1**	**25.2**	25.6	**0.53**
Mexico	**24.7**	**46.0**	43.5	**0.36**
Nigeria	**17.6**	**53.9**	47.4	**0.06**
Pakistan	**10.4**	**26.6**	26.6	**0.03**
Philippines	**22.6**	**33.9**	33.9	**0.32**
Portugal	**15.7**	**40.7**	40.3	**0.39**
Taiwan	**21.6**	**52.1**	51.0	**0.25**
Thailand	**20.3**	**32.7**	32.8	**0.39**
Turkey	**19.4**	**68.0**	66.4	**0.06**
Venezuela	**19.2**	**46.5**	43.2	**-0.06**

Table 1-5. Return and Risk of Emerging Stock Markets (Dec. 1986-Dec.1996, in USD)[4]

1.1.4.3 Risks and constraints when investing in emerging markets

When thinking about the investment in emerging markets the investor must be aware of the possible risks and restrictions. In fact, those can be considered as a price of attractiveness.

The first important source of risk is liquidity risk. Sometimes, it might be difficult for an investor to sell the stock for its fair price. Liquidity issue can be considered as one of the factors that contribute to the high volatility of emerging markets.

When we are talking about fair price, we assume that the investor is familiar with the accounting system and has an easy access to different sources of information, such that the fair price can be estimated. Unfortunately, this is not always the case when dealing with emerging markets. It can be difficult for the investor to get some information about a particular company, which he easily gets in his home or developed country. The complicated or unknown taxation schemes can also add some difficulties to the assessment.

Another source of possible risk is political risk. For example, the statements of politicians about possible changes in fiscal policy or restrictions on foreign ownership will immediately affect financial market (in a negative sense).

Some countries impose certain restrictions on the foreign participation in their capital markets and the investor might not be able to purchase the desired amount of shares. But this restriction does not affect him much, since this information can be obtained before the investment is realised.

4 Source: B.Solnik, “International Investments”, 4th ed., Addison-Wesley Publishing Company, Inc., 2000, p.308.

And the last, but not the least, problem when investing in emerging markets is that transaction costs are substantially higher then in developed markets.

Now, we assume that the reader is familiar with major positive and negative sides of the investment in emerging markets. The question where to invest and how much, should be studied by applying different investment techniques and is out of scope of this subsection.

1.2 Hedging foreign exchange risk

1.2.1 Effective management of currency risk

The purpose of hedging is to reduce risk exposure. Hedging a particular currency implies establishing a currency position such that any loss or gain on the original currency exposure is exactly or partially offset by a corresponding foreign exchange gain or loss on the currency hedge position. Currency hedging enables investors to protect themselves against unforeseen currency movements.

There is a wide variety of hedging techniques. Various financial instruments can be used for hedging purposes. Some common ones are described below.

1.2.1.1 Forward market

The forward currency market has been described briefly. The pricing and the use of forward contracts for hedging purposes are also studied in module “Derivatives Valuation and Analysis”.

In the forward market, agents sell and purchase an underlying currency at a specified exchange rate. The settlement occurs later, at a specified date. If the contract calls for the purchase of the underlying asset, the trader is said to hold a long position in the contract. On the contrary, a short position implies an obligation to sell.

The forward market is one of the most natural tools to hedge against currency exposure. A forward market hedge simply involves taking an opposite (offsetting) position on the forward market:

- an original long position can be hedged by taking a short position on the forward market; this creates a **short hedge**;
- an original short position can be hedged by taking a long position on the forward market; this creates a **long hedge**.

The delivery date that is specified on the forward contract should match the date at which the original position is closed. If the amount purchased or sold forward is equal to the amount involved by the original position, the hedge is said to be a **full hedge**.

Example:
Suppose that a Swiss investor expects to receive 20 Mio. USD after one year. Converted into EUR, the amount is uncertain. However, the investor can sell 20 Mio. USD forward so that the EUR value of the expected cash-flow is fixed. The initial long position in USD is offset by a short position on the forward market. Let us consider a forward exchange rate of 1.15 EUR/USD with delivery after one year. Table 1-6 shows different possible outcomes for the forward market hedge.

Spot exchange rate at maturity	Value of original cash flow	Gain (Loss) on forward contract	Total cash flow
1.12 CHF/USD	22'400'000 CHF	600'000 CHF	23'000'000 CHF
1.15 CHF/USD	23'000'000 CHF	0 CHF	23'000'000 CHF
1.17 CHF/USD	23'400'000 CHF	–400'000 CHF	23'000'000 CHF

Table 1-6: different possible outcomes for the forward market hedge

Note that, irrespective of the future spot exchange rate after one year, the Swiss investor receives the same amount denominated in CHF. Any exchange gain or loss on the original position is offset by a corresponding exchange gain or loss on the forward contract.
A Swiss borrower who will have to redeem a USD debt could implement the opposite strategy: his original short position in USD implies buying USD forward.

The price of a forward contract can be determined using the **covered interest parity**. No-arbitrage condition tells us that:

$$\frac{{}_{t-j}F_t}{S_{t-j}} = \frac{1+R_{Dt-j}}{1+R_{Ft-j}}$$

Where:

${}_{t-j}F_t$	Forward price at time t – j for delivery at time t
S_{t-j}	Spot exchange rate at time t – j
R_{Dt-j}	Domestic interest rate at time t – j for deposits expiring at time t
R_{Ft-j}	Foreign interest rate at time t – j for deposits expiring at time t

The above formula must hold in order to prevent arbitrage opportunities. It also shows that the forward price is closely related to money market conditions, suggesting that a forward market hedge can be replicated using money market transactions.

1.2.1.2 Futures versus forward

The distinction between currency forward and currency futures contracts is similar to the one between futures and forward contracts on any other underlying asset. Table 1-7 provides a summary of the main differences between forward and futures contracts.

Feature	Forward contract	Futures contract
Contract size (amount)	Tailored to customer needs	Standardised
Delivery date	Tailored to customer needs	Standardised
Transactions	Established by the bank or broker via phone contact with limited number of buyers and sellers	Open auction among many buyers and sellers
Participants	Banks, brokers and multinational corporations. Public speculation not encouraged	Banks, brokers and multinational corporations. Qualified public speculation encouraged
Commissions	Set by "spread" between bank's buy and sell price, not easily negotiated by customer	Published small brokerage fees and negotiated rates on block trades
Security deposit	None as such, but compensating bank balances required	Published small security deposit required
Clearing operation	Handling contingent on individual banks and brokers. No separate clearinghouse function	Handled by exchange clearing-house. Daily settlements to the market.
Frequency of delivery	More than 90% settled by actual delivery	Theoretically, no deliveries in a perfect market. In reality, less than 1%

Table 1-7: Summary of the main differences between forward and futures contracts[5]

Compared with futures contracts, forward contracts offer more flexibility. A customer can ask for a particular contract size and a particular settlement date that exactly match his needs. On the other hand, futures contracts are standardised. Among other characteristics, the customer cannot choose the delivery date and the exact contract size.

Futures contracts also differ from forward contracts in that a deposit (initial margin) is required in order to cover the customer credit risk. Usually, the initial margin only represents a small fraction of the underlying currency's total value. This is attributable to the procedure of **daily resettlement (or marking to the market).** If, at the end of a trading day, the price variation is such that a loss occurs, there is a **margin call**: the trader is required to replenish the margin in order to resume the contract the following day. In general, the trader must deposit funds in order to restore the so-called **maintenance margin**. The effect of this procedure is to create a safer futures market. In the forward market, no daily resettlement occurs so that the only cash-flow takes place during settlement of the forward contract. Thus, forward contracts exhibit more risks than futures contracts. As a result, only large and creditworthy multinational corporations or safe financial institutions can take part in the currency forward market under reasonable conditions.

The use of futures contracts for hedging purpose is similar to the one of forward contracts. It involves creating an offsetting position. In order to implement a full hedge, an original long position requires selling futures contracts whose size and delivery date match, as closely as possible, the position to be hedged. Of course, an original short position requires purchasing futures contracts. The fact that the hedge will in general not be perfect stems from the existence of basis risk or even correlation risk (e.g. when one hedges a currency position using futures contract whose underlying currency is not the same).

5 Source: TUCKER A.L., MADURA J. and CHIANG T.C., 1991, "International Financial Markets", West Publishing Company

1.2.1.3 Money market hedge

The uncovered interest parity suggests that an alternative to the forward market hedge is to take specific positions on the money market. A money market hedge can be implemented by simultaneously borrowing and lending in two different currencies.

Example (continued):
Let us go back to the above example: a Swiss investor will receive 20 Mio. USD in one year. Suppose that CHF and USD annual interest rates are respectively 5% and 10%, and the spot exchange rate is 1.2048 CHF/USD. In order to implement a money market hedge, the Swiss investor borrows 20 Mio. USD / 1.10 = 18.18 Mio. USD. Then, he converts this sum into 21.90 Mio. CHF (18.18 Mio. USD million · 1.2048 CHF/USD) and invests it for one year. At maturity, the investor will receive 21.90 Mio. CHF · 1.05 = 23.00 Mio. CHF for sure and will use the 20 Mio. USD accruing from the original position to pay back the 1.10 · 18.18 Mio. USD = 20.00 Mio. USD. Table 1-8 shows that the gain or loss generated by the money market hedge offsets the gain or loss on the original position.

Spot exchange rate at maturity	Value of original cash flow	Gain (Loss) on money market hedge	Total cash flow
1.12 CHF/USD	22'400'000 CHF	600'000 CHF	23'000'000 CHF
1.15 CHF/USD	23'000'000 CHF	0 CHF	23'000'000 CHF
1.17 CHF/USD	23'400'000 CHF	–400'000 CHF	23'000'000 CHF
1.2048 CHF/USD	24'096'000 CHF	–1'096'000 CHF	23'000'000 CHF

Table 1-8: Gain or loss generated by a money market hedge

This result is exactly similar to the one obtained with a forward market hedge. The gain or loss generated by the money market hedge exactly offsets the exchange gain or loss on the original cash-flow. For instance, in the case of an end-of-year spot rate of 1.17 CHF/USD, the principal and interest of 20 Mio. USD will cost 23.4 Mio. CHF to repay. As the return on the CHF investment is 23 Mio. CHF, the hedge generates a loss of 400'000 CHF.

Notice that the equality between the total cash flows from the money market and the forward market hedges is not coincidental. It simply results from the covered interest parity. In the previous example, we used an initial spot rate of 1.2048 and a forward rate of 1.15 with a Swiss interest rate of 5% and a US interest rate of 10%. These figures are compatible with the covered interest parity:

$$\frac{1.15}{1.2048} = \frac{1.05}{1.10}$$

Note that, empirically, this relation holds most of the time; if this were not the case, there would be arbitrage opportunities. Therefore, the above example is quite realistic. As soon as the covered interest parity holds, money market transactions enable investors to replicate (or synthesise) forward contracts.

1.2.1.4 Currency options

Currency option contract is another financial product that allows investors to hedge against currency exposure. Compared with forward or futures contract, options on foreign exchange give the right, but not the obligation, to purchase or sell a specified currency, at a specified exchange rate, at or before a specified expiration date.

Currency options have the same characteristics as options on other underlying assets. Notice however that a call option on a foreign currency is equivalent to a put option on the domestic currency.

Currency options are particularly interesting if an investor is uncertain whether the hedged foreign currency cash flow will materialise.

Example:
For instance, consider a firm that submits a bid on a contract on the 1st of March and for which it would be paid in foreign currency at the end of the year; however, let us assume that the announcement of the winning bid will not occur before the 1st of June. For three months, the firm will not know if it will receive the payment that should occur later on. Suppose that the firm wants to guarantee that the exchange does not move against it between the time it bids and the payment date. Being unhedged can be dangerous if, while the foreign institution accepts the firm's bid, the foreign currency depreciates.
An obvious solution would be to sell the currency forward. However, if the firm looses the bid on the contract, it still must sell the currency. A big loss can result if the currency has appreciated. The solution to manage such foreign exchange risk is to purchase a currency options contract which entitles the owner to the right (but not the obligation) to sell the foreign currency at a specified exchange rate.

The above example not only applies to firms but also to any investor who is uncertain about future payoffs. Notice also that the non-linearity in the option payoffs allows a profit to be made when the currency moves favourably and to be protected when the currency moves to the investor's disadvantage. Of course, this feature implies a cost: the premium that the investor has to pay in order to purchase the currency option.

1.2.2 Behaviour of currency returns

In this section, some examples of foreign currency returns are illustrated. The aim is to illustrate the computational aspects discussed in the previous section. Table 1-9 shows the decomposition of average continuous compounded returns on various foreign stock markets from the Swiss investor's point of view:

Country	Total return (Swiss point of view) (a) = (b) + (c)	Market return (b)	Currency return (c)
Switzerland	10.0%	10.0%	-
France	10.3%	11.7%	–1.4%
Germany	5.4%	6.8%	–1.4%
Japan	4.0%	2.4%	+ 1.6%
United Kingdom	6.8%	8.6%	–1.8%
United States	7.7%	9.5%	–1.8%

Table 1-9: Returns on stock market indices (Dec. 1982-Dec. 2002)[6]

One observes that the Swiss currency has appreciated against every currency apart from the Japanese yen. This implies that foreign stock portfolios seem to under perform from the Swiss point of view.

Table 1-10 illustrates several features of multi-currency rates of return. It provides statistical measures of the return on a 1-month Eurodollar deposit. The return is given in terms of USD and CHF. The lower part of the table provides the same statistics for the rate of return on the Dow Jones industrial index. 1-month periods are considered. For a Swiss investor, most of the volatility on Eurodollar investments stems from exchange rate fluctuations that appear to be mostly unpredictable. This result is partially the consequence of the short holding period

6 Source: Datastream.

considered. We shall see further in this module that exchange rate shifts can provide a natural hedge against asset fluctuations, especially for long holding periods.

Measure	Monthly return in USD	Monthly relative change in CHF/USD	Monthly return in CHF
1-month Euro USD			
Mean	0.52%	–0.15%	0.37%
Standard deviation	0.29%	3.45%	3.46%
Autocorrelation lag 1	0.99	0.09	0.10
Autocorrelation lag 2	0.97	0.01	0.02
Correlation with relative change in CHF/USD	0.04		
Correlation with return in CHF	0.10	0.999	
Dow Jones industrial index			
Mean	0.86%	–0.15%	0.71%
Standard deviation	4.66%	3.45%	6.29%
Autocorrelation lag 1	-0.02	0.09	0.08
Autocorrelation lag 2	–0.03	0.01	–0.03
Correlation with relative change in CHF/USD	0.18		
Correlation with return in CHF	0.84	0.68	

Table 1-10: Monthly data from December 1982 to December 2002[7]

Figure 1-1 shows the return on a 1-month Euro USD investment in terms of USD and CHF. The higher volatility of CHF returns is particularly obvious.

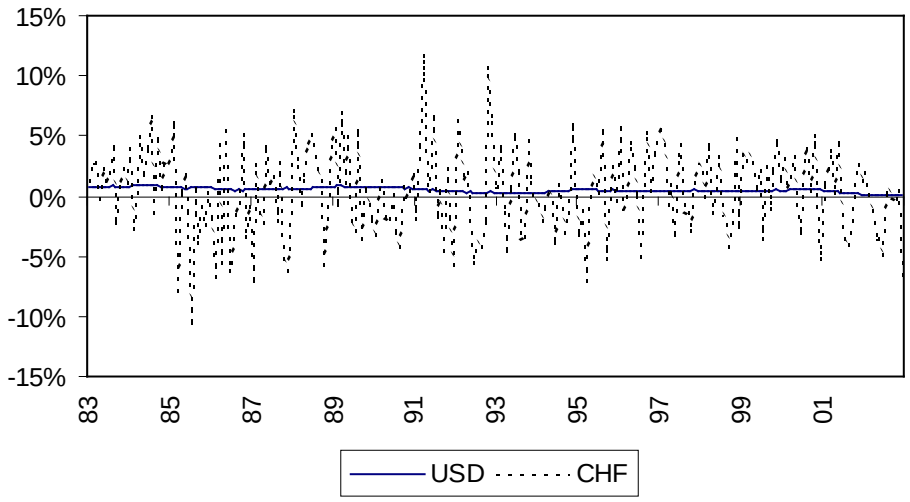


Figure 1-1: Monthly returns on 1-month Euro USD[8]

Figure 1-2 illustrates the same phenomenon for stock returns. Again, exchange rate fluctuations add volatility. However, the volatility of CHF returns is much smaller than the sum of the volatility of the asset and the volatility of the exchange rate. This is due to imperfect correlation between the change in exchange rate and the change in asset return.

7 Source: Datastream.

8 Source: Datastream.

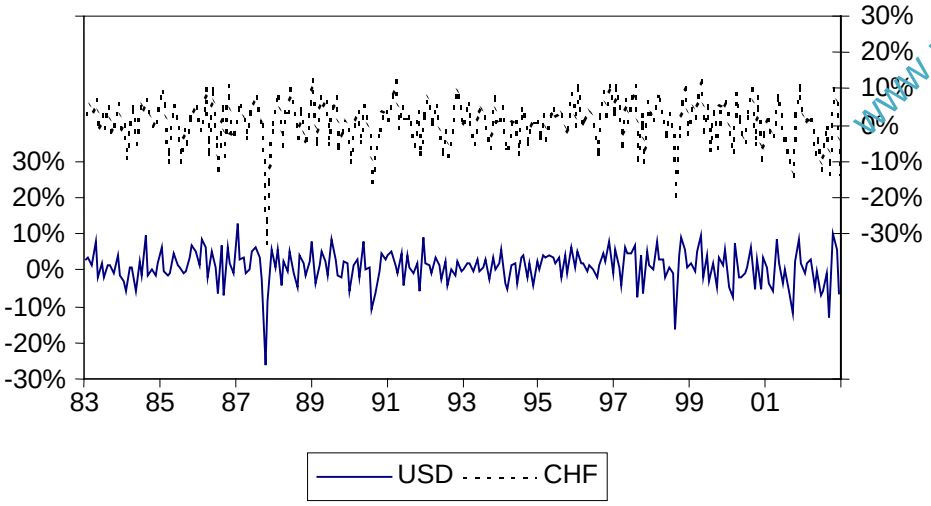


Figure 1-2: Monthly returns on a stock portfolio (Dow Jones industrial index)

1.2.3 Is it a separate asset class / zero sum game?

In section 1.2.1, we studied briefly the most common financial instruments which can be used to hedge against currency risk. Up to this point, we did not say anything about the relevance of hedging. Now, we come to the question: **is hedging worthwhile?**

The traditional answer to this question is yes. However, we shall see that this rule is not universal and does not apply to every case. Full hedging is not always optimal. Then, why is it so often recommended to implement a currency hedge? This conclusion results from the following reasoning: both cost and benefits of hedging are estimated.

The benefit lies in the risk reduction. The uncertainty about the future outcome is reduced; risk-averse investors are therefore better off if they implement a hedge.

What about the cost? What is the cost of a forward hedge? A fallacious way of determining the cost is to measure it as the forward discount or premium. Note that the latter is defined as:

$$\frac{S_{t-1} - {}_{t-1}F_t}{S_{t-1}}$$

This approach is misleading because the relevant comparison must be between the domestic currency per unit of foreign currency amount received with hedging, ${}_{t-1}F_t$, and the domestic currency amount received in the absence of hedging, S_t, where S_t is the future unknown spot rate at the date of settlement. If the investor had not implemented a hedge, the realised value of each unit of foreign currency would have been S_t. As usual in economics; the "true" cost of hedging is an **opportunity cost**. Therefore, the cost of hedging is equal to:

$$\frac{S_t - {}_{t-1}F_t}{S_{t-1}}$$

When the investor takes the decision to hedge (fully or only partially), he cannot determine the cost of hedging because the future spot exchange rate S_t is unknown at time t – 1. Thus, investors should base their decision on the **expected cost of hedging**. The expected cost is simply equal to:

$$E_{t-1}\left[\frac{S_t - {}_{t-1}F_t}{S_{t-1}}\right] = \frac{E_{t-1}[S_t] - {}_{t-1}F_t}{S_{t-1}}$$

The expected cost depends on the relation between the forward exchange rate and the expected future spot rate. One can write this relation as:

$${}_{t-1}F_t = E_{t-1}[S_t] + \Pi$$

where Π is a risk premium term.

Combining this expression with the expected cost of hedging yields:

$$E_{t-1}\left[\frac{S_t - {}_{t-1}F_t}{S_{t-1}}\right] = \frac{E_{t-1}[S_t] - {}_{t-1}F_t}{S_{t-1}} = -\frac{\Pi}{S_{t-1}}$$

The cost of hedging depends on the unbiasedness hypothesis of the forward exchange rate. Note that the unbiased forward parity says that ${}_{t-1}F_t = E_{t-1}[S_t]$. If the latter relation is valid, the premium Π is equal to zero and therefore, the expected cost of hedging is also equal to zero.

In conclusion, if the forward rate is an unbiased estimate of the future spot exchange rate, currency hedging has zero expected cost and it provides a risk reduction benefit. In such a case, it is always optimal to hedge currency exposures. This is the traditional **free lunch argument** for currency hedging.

Unfortunately, the forward rate seems to be a biased estimate of the future spot exchange rate ($\Pi \neq 0$). Hence, hedging may be costly. We saw that the premium term is non-zero as soon as the markets participants are risk-averse. The expected cost of hedging depends on the magnitude of the premium. Perold and Schulman[9] published a study in line with the free lunch argument. They agree on the existence of a risk premium but they say:

" (...) there is little in the theory that directly predicts, in either real or nominal terms, who gets the premia, whether they are large or small, and whether they are stable or unstable. (...) Numerous studies have looked for evidence of currency premia. While the more recent ones tend to reject the simple hypothesis that the premia are zero in nominal terms, the departure from zero is not large. They can be explained by time varying premia but, importantly, not by stationary premia. (...) There are good grounds for believing that, over relatively short periods, the expected return from currency hedging (equivalently currency exposure) will be non-zero. However, there are no good grounds for believing that these premia will be consistently positive or negative (...). From the perspective of long-run policy, there appears to be little basis for believing that not hedging currency risk enhances long-run returns. Because there is such a large risk reduction from currency hedging, the long-run (or "normal") portfolio should be one that is hedged against currency risk."

9 PEROLD A. and SCHULMAN E., 1988, "The Free Lunch in Currency Hedging: Implications for Investment Policy and Performance Standards", Financial Analysts Journal, pp.45-50

In order to illustrate their point, Perold and Schulman provide various examples of the benefit of currency hedging. They present a comparison between the volatility of a portfolio fully hedged (hedge ratio = 1) against currency risk and unhedged portfolios.

The hedged return (using a money market hedge) is computed using the following formula:

$$1+R_D^{hedged} = \underbrace{(1+R_F)\cdot(1+S)}_{\text{investment return}} + \underbrace{(1+R_D)-(1+R_F)\cdot(1+S)}_{\text{hedge return}}$$

The return of a hedged investment is equal to the return on the initial investment plus the return on the money market hedge. This formula holds for fully hedged investments. This means that the hedge ratio is equal to one: the additional investment must be of the same size as the investment being hedged against currency fluctuations. As soon as changes occur in the exchange rate or/and in the value of the initial investment, the hedge should be rebalanced in order to keep the hedge ratio equal to one. The above formula does not take rebalancing into account, it is correct only for a buy-and-hold hedging strategy (meaning that the hedge is not perfect).

Table 1-11 shows some of Perold and Schulman's results. Hedged return is computed according to the above formula, assuming quarterly rebalancing.

	Unhedged	Hedged	Percentage risk reduction
Stocks			
US	17.4%	17.4%	-
Japan	24.9%	16.7%	32.8%
UK	22.6%	18.6%	17.6%
Germany	24.3%	20.3%	16.4%
Bonds			
US	14.4%	14.4%	-
Japan	20.9%	8.9%	57.5%
UK	18.9%	12.4%	34.6%
Germany	18.3%	8.3%	55.6%

Table 1-11: Volatility of quarterly real returns, 1978-87, US perspective

Notice that the reduction in risk is significant. From the US point of view, foreign stock and bond markets appear much riskier than the respective domestic markets. However, if foreign investments are hedged, foreign markets may be less risky than their US counterpart. The risk reduction benefit seems relatively larger for bonds than for stocks.

Another point in support of hedging lies in the risk reduction of internationally diversified portfolios. In section 1.1, we showed that international diversification offers large risk reduction benefits. Perold and Schulman computed the incremental gain of currency hedging. Their results are shown in Table 1-12.

	100% US	75% US / 25% non-US				
	Volatility	Volatility Unhedged	Risk reduction	Volatility Hedged	Risk reduction	Incremental risk reduction
Stocks	17.42%	16.71%	4.1%	15.64%	10.30%	6.4%
Bonds	14.38%	14.10%	1.9%	12.53%	13.00%	11.4%
65% / 35%	14.14%	13.87%	1.9%	12.48%	11.30%	9.6%

Table 1-12: Results of incremental gain of currency hedging

In the above example, hedging once again appears to be beneficial. For instance, consider the stock portfolio: adding 25% of unhedged foreign stocks reduces the volatility by 4.1%. Hedging the non-US component of the portfolio leads to an incremental risk reduction of 6.4%, even more than the risk reduction achieved by diversifying internationally.

In the same line as Perold and Schulman, Eun and Resnick[10] analysed the benefit of international diversification with particular emphasis on the currency hedging problem. Their framework is the modern portfolio theory (mean-variance analysis of Markowitz). Unlike Solnik[11], they do not simply look at the in-the-sample performance of various portfolios. First, they build portfolios on the basis of historical data: average returns and variance-covariance matrix. This means that only data known at the time of portfolio selection is used. The performance is estimated at the end of the period, using realised returns.

To sum up, portfolio selection takes place at the beginning of each period (ex-ante) and performance is measured at the end of each period (ex-post). Clearly, this approach is more realistic than the sole measurement of in-the-sample performance. It also provides guidance to portfolio managers by considering the issue of **estimation risk**.

Eun and Resnick considered weekly rates of return during the period 1980-1985. Seven countries are taken into account: Canada, France, Germany, Japan, Switzerland, the United Kingdom and the United States. Various portfolios are constructed: EQW is an equally-weighted portfolio (each country has the same weight), CET is the certainty-equivalent tangency portfolio[12], MVP is the minimum variance portfolio. Table 1-13 shows the out-of-sample performance of the various ex-ante investment strategies.

Strategy	Mean	Standard Deviation	Sharpe index ($R_F = 0$)
EQW unhedged	0.315%	1.515%	0.214
CET unhedged	0.198%	3.862%	0.084
MVP unhedged	0.336%	1.545%	0.210
EQW hedged	0.393%	1.054%	0.423
CET hedged	0.466%	1.266%	0.399
MVP hedged	0.500%	1.202%	0.429
Pure US portfolio	0.189%	1.744%	0.104

Table 1-13: Performance of various ex-ante investment strategies[13]

From Table 1-13, one can observe that:

- The domestic strategy (passive) is dominated by every international strategy with the exception of the unhedged CET. This tends to confirm the benefit of international diversification;
- Strategies using past returns as predictors for future returns are outperformed;
- Strategies with currency hedging dominate unhedged strategies.

For Eun and Resnick, the latter point is another illustration of the “free lunch” in currency hedging.

10 EUN C. and RESNICK B., 1988, “Exchange Rate Uncertainty, Forward Contracts, and International Portfolio Selection”, Journal of Finance, Vol. 43, pp.197-215

11 SOLNIK B., 1974, “Why not diversify internationally rather than domestically?”, Financial Analyst Journal, pp.48-54

12 The CET strategy consists in assuming that past returns are the best estimators of future returns.

13 In percentage per week

These illustrations clearly show that hedging can be beneficial. However, one should not conclude that full hedging is always optimal. The previous examples are not sufficient to prove the optimality of full hedging. In the following section, several particular cases are considered.

1.2.4 Treatment of currency within a global portfolio/optimal level of hedge

In this section, we shall study the impact of international diversification as well as hedging on bonds and stocks. One way of doing so is to compute various statistics on six classes of assets: domestic stocks and bonds, foreign stocks and bonds unhedged against currency risk, foreign stocks and bonds hedged.

Jorion[14] presented such an analysis from the US point of view. He used standard indices: the S&P 500, the Salomon Brothers US Government Index, the Morgan Stanley Capital International EAFE (Europe, Australia, Far East) Index, and the Salomon Brothers Non-USD Bond Index. For hedged asset classes, no index is available, thus Jorion had to construct them specially for his analysis. He did so by going back to sub-indices (national indices). He computed hedged foreign returns using a 1-month rolling hedge for each sub-index[15]; then, the international index was constructed using sub-indices. These results are presented in Table 1-14.

	US		**Unhedged foreign**		**Hedged foreign**	
	Stocks	**Bonds**	**Stocks**	**Bonds**	**Stocks**	**Bonds**
Average return	15.8%	9.7%	22.9%	12.6%	20.9%	11.3%
Volatility	16.5%	11.2%	17.2%	13.7%	13.1%	6.8%
Correlation with:						
US stocks	1					
US bonds	0.29	1				
Foreign stocks	0.43	0.23	1			
Foreign bonds	0.05	0.42	0.66	1		
Hedged stocks	0.59	0.12	0.76	0.09	1	
Hedged bonds	0.19	0.53	0.34	0.58	0.24	1
60/40 US mix	0.93	0.62	0.44	0.20	0.53	0.35
Beta with:						
60/40 US Mix	1.28	0.58	0.63	0.22	0.58	0.20

Table 1-14: Annualised from monthly data, January 1978-December 1988

Notice the relative good performance of foreign stocks and bonds. Foreign stocks outperform US stocks by 7.1% per year without much increase in volatility. Again, this tends to show that there are strong diversification effects across foreign markets and currencies. Hedged foreign stocks also outperformed US stocks, by 5.1%, and they provided a lower risk level. However, hedging reduces the average return by 2%. This means that hedging is costly even if, in this particular situation, the cost is quite modest when compared to the risk reduction.

14 JORION P., 1989, "Asset Allocation with Hedged and Unhedged Foreign Stocks and Bonds", Journal of Portfolio Management, pp.49-54

15 At the beginning of each month, the foreign currency exposed amount is sold 1-month forward. At the end of the month, the position is closed. This strategy eliminates most of the exchange rate risk but it is imperfect because the exact amount to be hedged is unknown. Practically, the remaining currency exposure is small over short period intervals.

Let us now compare bonds and stocks. In both cases, currency hedging appears beneficial. The volatility of unhedged stocks is equal to 17.2% while the volatility of hedged stocks is equal to 13.1%. Hedging leads to a 24% reduction of the volatility. For bonds, the reduction appears relatively higher: bonds volatility is reduced from 13.7% to 6.8%. This implies a 50% decrease.

Hedging has a stronger impact on bonds' risk than on stocks' risk. This observation is typical and not surprising: it results from the specific risk composition of bonds and stocks. Let us go back to Table 1-10 in section 1.2.2. In this table, the distinction between debt and equity is quite obvious. Expressed in their own currency, stocks are much riskier than bonds. Actually, the standard deviation of the returns on the Dow Jones industrial is 16 times higher than the standard deviation of the returns on 1-month Euro USD. However, when they are converted into another currency, the stock returns standard deviation is only 1.5 times higher than the 1-month Euro USD standard deviation.

Most of the risk of a foreign bond is due to exchange rate fluctuations. Thus, there is much more room for risk reduction and currency hedging appears very beneficial. On the other hand, exchange rate fluctuations do not add much risk to foreign stocks. This results from the stocks' standard deviation which is high, even when it is measured in the original currency. Moreover, stock returns and relative changes in exchange rates are almost uncorrelated. This characteristic implies that hedging is not as beneficial for foreign stocks as it is for foreign bonds.

This result shows that hedging foreign bonds is quite interesting. Is this always so? Not necessarily. The following section further discusses this issue by considering the proportion of wealth invested in foreign currency.

1.2.4.1 Proportion of wealth invested in foreign markets

In reality, portfolio managers are often constrained. They cannot invest more than a certain amount in foreign assets. Even when they are not constrained, one usually observes some kind of home currency preference (home bias). What about the currency risk of an internationally diversified portfolio when only a small part of it is invested in foreign securities?

Note that investors are mainly interested in the risk of their portfolio. Most of the time, the risk of an individual security is not relevant because part of it can be diversified away. What is important is the contribution of a security to the portfolio's total risk. Such a contribution can be measured by the security's beta coefficient.

Table 1-14 above contains beta coefficients with respect to a pure US portfolio with weights 60% stocks and 40% bonds. The beta can be interpreted as a measure of the local change in total portfolio volatility when a small amount of foreign assets is added. The lower the beta of an asset, the lower the contribution of this asset to the portfolio risk.

The beta coefficient of an asset is measured as:

$$\beta_{asset} = \frac{Cov[R_{asset}, R_{portfolio}]}{Var[R_{portfolio}]} = \frac{Corr(R_{asset}, R_{portfolio}) \cdot Std\ dev.(R_{asset})}{Std\ dev.(R_{portfolio})}$$

Thus, the beta coefficient depends on volatilities and correlations. In general, low correlations suggest the existence of diversification benefits. Jorion[16] observes that there is a subtle side effect of hedging: hedging increases the correlations of foreign assets with US assets. This occurs because most exchange rate movements are unrelated to changes in US asset prices and are thus diversifiable. Both a lower volatility and a higher correlation imply that hedging hardly reduces the systematic risk (i.e. the beta).

For instance, consider the foreign bonds in Table 1-14 above. The decrease in volatility is accompanied by an increase in the correlation with the 60/40 US portfolio from 0.20 to 0.35. Together, these contradictory effects only lead to a decrease in the beta coefficient from 0.22 to 0.20.

The implication of this phenomenon is that hedging may have a limited impact on the risk of a portfolio. Jorion provides an illustration to this point reproduced in Figure 1-3.

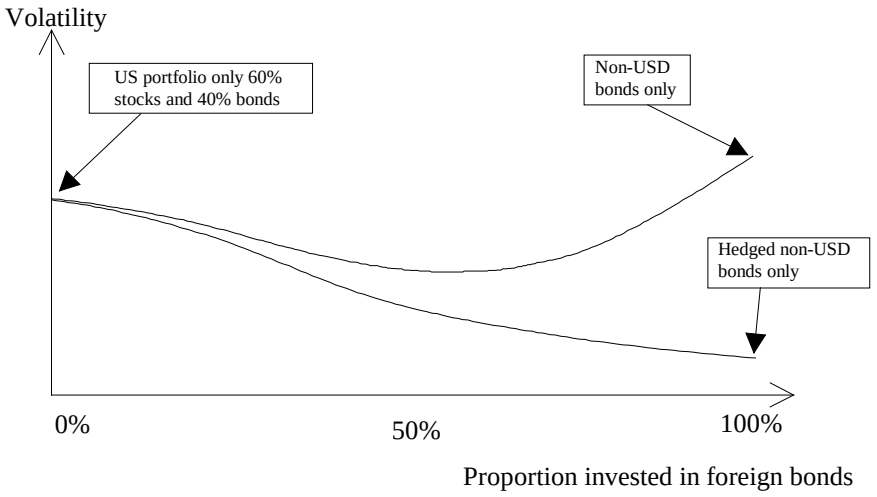


Figure 1-3: Increase of the correlations of foreign with US assets caused by hedging

The "starting point" is the pure US portfolio including 60% of stocks and 40% of bonds; this mix seems classical for US pension funds. Then, foreign bonds are added. The upper line corresponds to the volatility of the portfolio if the bonds being included are not hedged. The lower line corresponds to the volatility of hedged portfolios. Notice that portfolios containing less than one third of foreign bonds are almost unaffected by currency hedging: the risk reduction is not significant.

In fact, US investors only invest a small proportion of their portfolio in foreign securities. Jorion provides a striking example: he considers a portfolio with 10% invested in foreign bonds. The total portfolio risk is 11.2% with currency exposure, versus 11.1% with currency hedging.

16 JORION P., 1989, "Asset Allocation with Hedged and Unhedged Foreign Stocks and Bonds", Journal of Portfolio Management, pp.49-54

When viewed in the context of an overall portfolio with only few foreign securities, hedging does not appear to be so beneficial. To the extent that hedging is costly (and thus reduces the expected return of the portfolio), investors should not hedge the foreign component of their portfolios if the latter represents only a small portion of total wealth.

1.2.4.2 Time dependency

Another question about currency hedging that deserves attention is: "I**s currency hedging time-sensitive?"**

The answer seems to be yes. The main reason for that is that the premium Π in the expression

$$_{t-1}F_t = E_{t-1}[S_t] + \Pi$$

is time varying. The Perold and Schulman[17] argument was that Π is more or less equal to zero. It is sometimes positive, sometimes negative and the deviations from zero are small in magnitude. In the long run, Π seems to have zero mean. However, if the deviations had consistently the same sign, hedging would be either costly or profitable (depending on the investor's position).

In Table 1-14, we observed that currency hedging implied a cost. Over the period 1978-1988, the average return of hedged stocks is reduced by 2% while the average return of hedged bonds is reduced by 1.3%. One could argue that the cost was small with respect to the significant risk reduction. However, if one considers sub-periods, conclusions are radically altered. For instance, Jorion[18] presents the expected return of various strategies over several sub-periods. Table 1-15 reproduces some of his results.

	Only	US	Normal	foreign	Hedged	foreign
Sub-periods	**Stocks**	**Bonds**	**Stocks**	**Bonds**	**Stocks**	**Bonds**
70-80 weak USD	18.5	6.6	19.9	9.3	15.9	6.0
81-84 strong USD	11.2	6.0	8.5	2.8	21.2	16.5
85-88 weak USD	18.3	13.2	39.4	24.9	24.4	10.2

Table 1-15: Average return, percent per annum

Observe that currency hedging can strongly affect the average return. Moreover, the effect on the average return depends on the period considered. When the USD tends to appreciate against foreign currencies, hedging appears highly profitable by preventing currency losses on foreign assets. On the other hand, when the USD depreciates, hedging reduces the average return (by 15% for foreign stocks over the period 1985-1988!).

These differences between hedged and unhedged strategies would not exist if the forward rate were an unbiased predictor of the future spot exchange rate. The fact that large discrepancies are observed between hedged returns and unhedged return is another indication that the unbiased forward hypothesis is unrealistic. It also shows that the uncovered interest parity (or Fisher international parity) does not hold.

17 PEROLD A. and SCHULMAN E., 1988, "The Free Lunch in Currency Hedging: Implications for Investment Policy and Performance Standards", Financial Analysts Journal, pp.45-50

18 JORION P., 1989, "Asset Allocation with Hedged and Unhedged Foreign Stocks and Bonds", Journal of Portfolio Management, pp.49-54

From the previous observations, one can also conclude that hedging generates a return which can be either positive or negative. Therefore, it may be seen as a classical asset that can be included in the mean-variance analysis.

This also suggests that currency speculation may be profitable. The following section discusses the use of forward contract as a speculative tool.

1.2.4.3 A speculative strategy using forward contracts

In reality, one observes that the forward exchange rate tends to overestimate the rate of depreciation or appreciation of the foreign currency. Note that, most of the time, the estimation of the regression

$$\ln(S_t) - \ln(S_{t-1}) = \alpha + \beta \cdot [\ln({}_{t-1}F_t) - \ln(S_{t-1})] + \varepsilon_t$$

yields an estimated β smaller than 1 (and even 0, see Froot and Thaler 90[19]). This suggests that a simple "speculative" strategy can be implemented:

- the forward contract is sold each time we observe a premium (${}_{t-1}F_t > S_t$);
- the forward contract is bought when there is a discount ($S_t > {}_{t-1}F_t$).

If the foreign exchange market is efficient and investors do not require any risk premium for open positions in foreign currencies, the return of such a strategy should be zero. On the contrary, if the forward rate contains a risk premium, this strategy should yield positive return. To illustrate this point, let us assume the existence of a premium which, to simplify, will be set constant and positive. In this case, we may write:

$${}_{t-1}F_t = E_{t-1}[S_t] + \Pi$$

where $\Pi > 0$ is the forward risk premium.

If we now enter in the "speculative" strategy by selling the forward rate, the return will be equal to:

$${}_{t-1}F_t - S_t = E_{t-1}[S_t] + \Pi - S_t$$

Taking the expected return yields:

$$E_{t-1}[{}_{t-1}F_t - S_t] = E_{t-1}[E_{t-1}[S_t] - S_t] + \Pi = \Pi > 0$$

On the other hand, if the risk premium is negative ($\Pi' < 0$), the previous argument needs simply to be reversed by buying the forward contract. Multiplying the previous equation by minus one gives:

$$E_{t-1}[S_t - {}_{t-1}F_t] = E_{t-1}[S_t - E_{t-1}[S_t]] - \Pi' = -\Pi' > 0$$

19 FROOT K.A. and THALER R.H., 1990, "Anomalies : Foreign Exchange", Journal of Economic Perspectives, Vol. 4, pp.179-192

Adjaouté and Tuchschmid[20] computed average returns and volatilities generated by this "speculative" strategy. Table 1-16 reproduces some of their results.

	BEF	CAD	DKK	FRF	NLG	DEM	ITL	USD	GBP	JPY
Return	0.28%	0.35%	0.34%	0.17%	0.26%	0.20%	0.30%	0.12%	0.17%	0.64%
Std. dev.	1.76%	4.07%	1.74%	1.80%	1.59%	1.48%	2.36%	3.98%	2.99%	2.88%
Sharpe	0.16	0.09	0.19	0.09	0.16	0.14	0.13	0.03	0.06	0.22

Table 1-16: Monthly returns and other data of a Swiss investor, 1976-1994

We can observe that the mean return is never negative even if the volatility is quite high. Notice also that the Sharpe ratios are similar to those reported on equity investments. Accounting for positive speculative returns has mainly relied on two explanations: the first one puts forward market inefficiency or investors' irrationality. The second one, more appealing, uses the risk premium argument.

Ajaouté and Tuchschmid also show that the performance of this strategy coupled with an internationally diversified portfolio is better than the one of an international portfolio being fully hedged or unhedged. This means that both systematic hedging and not hedging are costly. Again, this suggests that **forward exchange rates have to be viewed as assets by themselves and should be included in the optimisation problem during asset allocation.**

1.2.5 Black's paper on universal currency hedge

Solnik (1974)[21] extended the national (one-market) CAPM in an international framework integrating both market(s) risks and currency risks. Similar to the original model, his model provides equilibrium expected returns for stocks and currencies, leading to optimal positions that are consistent across investors all over the world. In particular, he shows that there exists a universal portfolio that contains optimally currency-hedged stocks.

Adding several assumptions, Black (1989)[22] developed a hedging formula that is consistent with Solnik's international version of the equilibrium CAPM. Black's model indicates that the proportion of currency exposure that should be hedged depends on two components: the expected excess return on the world market portfolio and the exchange rate volatility averaged across all investors and all countries. Consequently, according to Black, **there should exist one universal optimal hedging ratio that applies to all investors**[23].

Black's approach, however, has been criticized on several grounds. His model relies on two unrealistic assumptions: (i) all investors should have the same risk tolerance, and (ii) each country's national wealth should be exactly equal to the value of its stock market. As evidenced by Adler and Prasad (1992)[24], the universality of Black's hedge ratio is not a general result, but it follows directly from the initial assumptions that impose homogeneity on

20 ADJAOUTÉ K. and TUCHSCHMID N., 1995, "The Relevance of Hedging Currency Risk in Internationally Diversified Stock Portfolios", HEC-University of Lausanne, Working Paper #9506

21 SOLNIK Bruno, 1974, "An equilibrium model of the international capital market", Journal of Economic Theory, vol. 8, pp. 500-524

22 BLACK Fisher, 1989, "Equilibrium Exchage Rate Hedging", NBER Working Paper #2947

23 Remember that one standard assumption of the CAPM is that all investors have the same expectations about return, variance and covariance of the available investment opportunities.

24 ADLER and PRASAD (1992), "On universal currency hedges", Journal of Financial and Quantitative Analysis, vol. 27, pp. 19-38.

world investors. In addition, one difficulty in applying the technique is that the universal hedge ratio is very sensitive to changes in a number of unstable variables. When tested on historical data, Black's model indicates that the proportion of currency hedged ranges between 30 to 77 percent, depending on the expected return to the world market portfolio.

These reasons explain why Black's model, although interesting from a theoretical point of view, had limited implications in practice.

1.2.6 Use of overlay strategies

There are basically two different and controversial solutions for the management of currency risk within a portfolio: the integrated management of currency risk, and the currency overlay. The choice between them is mostly driven by the answer to the following question: should the currency management be undertaken jointly or separately from asset management?

In the **integrated solution**, the investment optimisation integrates currency exposures within the country allocation. Black's model was a typical example of an integrated solution. In this line of thought, bond or equity managers should deliver at the same time high returns from asset selection and from currency management. Although this is theoretically feasible, in practice, foreign exchange markets have their own dynamics and their own risk-reward profiles, very distinct from those of equities or bonds. It is therefore hard to find managers that are able to be consistently successful in both aspects of the investment process. In addition, the problem becomes more complex with the trend towards sector investing, where several currencies are mixed within a sector.

The **currency overlay** approach takes a fundamentally different point of view. With a currency overlay, the optimisation process is carried out separately on currencies, which are considered as a distinct asset class. Optimal regional/sector weightings are decided first by traditional managers. Next, third party managers - to avoid potential conflicts of interest – optimise only foreign exchange exposures.

The currency overlay market started in the 1990s, initially in the US pension fund universe, and expanded abroad, particularly in the Netherlands, Australia, Japan and the United Kingdom. Three reasons contributed to the rapid expansion of this market. First, a larger number of pension funds started expanding their international equity holdings during that period. Second, pension funds are very likely to hire external managers on specialized mandates, such as currency management. Finally, performance reports by companies such as Frank Russel, InterSec or WM Company provided evidence that traditional fund managers had historically destroyed value when they were managing the currency risk themselves.

Advocates of currency overlays claim they can add value by either reducing the overall currency risk exposure of the portfolio, or through return enhancement. Stated differently, they aim at redistributing the currency risk from a normal to a somehow skewed distribution, limiting the large losses due to strong currency swings and slightly shifting the overall distribution to the right (towards higher returns).

The currency overlay process is generally structured as follows. At the beginning of the reference period, the currency exposures that are going to be managed are announced. A committee designated by the pension fund fixes some benchmark in terms of hedge ratio, and then delegates the overlay implementation to in-house or external managers. The proportion to be hedged is often called the **strategic hedge ratio**. It corresponds to the desired long-term

exposure, and should be seen as a neutral stance. It can range from a non-hedging strategy (zero percent hedged) to a defined, fixed hedge ratio partially or fully covering (hundred percent hedged) the exposures at risk throughout the currency risk[25]. Now, come the distinctions between the active and the passive overlay approaches.

Traditionally, the currency overlay policies can be categorised between "passive" and "active" approaches.

In the **passive approach**, the implementation consists simply in monitoring currency exposures and readjusting them regularly if necessary so that the effective hedge ratio corresponds to the strategic hedge ratio. The process is not necessarily as simple as it looks. For instance, some investments can take the form of derivative instruments, which can complicate the assessment of currency risk exposure by their non-linear variations.

In the **active approach**, the currency manager has typically a **tactical hedge ratio** that may differ from the strategic hedge ratio whenever his currency market expectations suggest attractive opportunities. The various steps of an active currency overlay management are very similar in nature to the steps used when managing another asset class portfolio. They consist of:

- **Forecasting returns for each currency**. The process often combines both fundamental and technical indicators to provide a comprehensive forecast. Fundamental approach typically relies on the analysis of interest rate differentials across countries to determine their respective attractiveness, the comparison of purchasing power parity to provide a measure of the fair value of each currency, and the assessment of economic and government creditworthiness by looking at the stock market and public deficit. Technical analysis is often used as a complement. Looking at past currency returns provides technical forecasts that may be useful to signal upcoming changes or levels of speculative activity.
- **Building an optimised and risk-controlled portfolio**. The currency portfolio construction process relies on optimisation and on active position limits. Optimisation builds the currency portfolio with the highest expected return for a given level of risk, while position limits are initially defined to ensure that the portfolio's composition is representative of the benchmark.
- **Implementing the portfolio**. The implementation is then performed, often using futures and forward contracts for their high liquidity, low transaction costs, and ease of cash-flow management.

It is important to realize that when implementing a currency overlay, investors are not losing control on a part of their portfolio to benefit from active management. The benchmark (strategic hedge ratio) represents the risk control, while the management process (tactical hedge ratio) represents the value added. The choice of an adequate benchmark is therefore an essential part of the currency overlay decision. Several alternatives are available. One can use:

- A fully hedged benchmark. The advantage is that some fully hedged indices are publicly available for portfolio construction and monitoring (e.g. MSCI indices for USD investors). The drawback is that the active manager is limited in his decisions, as he can only reduce the hedge ratio, but not go above a hundred percent hedge.

25 Most empirical studies have shown evidence that in the long run, neither a zero percent nor a hundred percent hedge were efficient. As a rule of thumb a forty to sixty percent hedge is recommended.

- A non-hedged benchmark. The advantages and drawbacks are similar to the fully hedge case (managers cannot go below a zero percent hedge).
- A 50% hedge ratio, which has the advantage of allowing hedge ratio deviations on both sides.
- A benchmark that is totally independent of the underlying portfolio. This allows the currency manager to take bets that are totally detached from the base assets. The drawback is that there is an important loss of control, particularly in terms of ex-ante risk.

Another important aspect of currency overlays is the management of the cash flows they generate. These cash flows can be positive or negative; they typically occur when future and forward contracts are rolled over or closed, or when options are purchased, sold or exercised. Should these cash flows be included in the traditional investment process, or should they remain isolated with the overlay managers? Invasive overlay programs implement the first solution, at the expense of the portfolio manager's performance[26], while non-invasive overlay programs prefer the second variant, sacrificing a pool of cash for the overlay manager's operations.

1.3 International equities

The United States is the world's largest stock market by far, but it accounts for only 47% of the world stock market capitalization. This implies that a U.S. investor holding only U.S. equities would miss about half, if not more, of the world's investment opportunities. Despite this, some years ago, various forms of capital and currency controls constrained international investing, few asset managers offered global services, and the absence of U.S. investors on the international scene was significant. The situation was somehow different elsewhere. European banks and private investors have long been international investors by cultural heritage as well as necessity (given the small size of each country's stock market). European stock markets altogether represent about 30% of the world stock market capitalization, Pacific stock markets about 16%, and emerging markets about 5%.

Fortunately, today, the investment scene has changed drastically, thanks to the deregulation and globalisation of financial markets throughout the world. A trend toward international equity investing can now be seen in all countries.

Two arguments are often presented as evidence to support the benefits of international equity investment: higher return potential abroad, and better diversification benefits due to the low correlations among national equity markets.

The higher return potential abroad is essentially based on historical considerations. For instance, let us consider the case of a USD-based investor. It is well known that the U.S. stock market has roared in the 1990s. Nevertheless, if one considers the relative performance of other markets (represented by MSCI market indices), the U.S. market has only been two times among the world's top-performing developed markets in the past 12 years. Therefore, a globally diversified portfolio may help increase the return of a domestic equity portfolio.

26 The portfolio manager has to maintain some cash in his portfolio and to buy and sell securities to face deposits and withdrawals from the overlay manager.

1992		1993		1994	
Hong Kong	32.39%	Hong Kong	116.70%	Finland	52.47%
Switzerland	18.13%	Luxemburg	98.41%	Norway	24.07%
USA	7.36%	Finland	83.16%	Japan	21.62%
Singapore	4.50%	New Zealand	69.97%	Sweden	18.80%

1995		1996		1997	
Switzerland	45.05%	Spain	41.27%	Portugal	47.54%
USA	38.19%	Sweden	38.00%	Switzerland	44.84%
Sweden	34.07%	Finland	34.72%	Italy	36.38%
Spain	31.15%	Hong Kong	33.08%	Denmark	35.01%

1998		1999		2000	
Finland	122.63%	Finland	153.33%	Switzerland	6.38%
Belgium	68.73%	Sweden	80.60%	Canada	5.64%
Italy	53.20%	Japan	61.77%	Denmark	3.71%
Spain	50.58%	Singapore	60.17%	Norway	-0.38%

2001		2002		2003	
New Zealand	9.50%	New Zealand	26.09%	Greece	69.52%
Australia	2.66%	Austria	17.28%	Sweden	66.08%
Ireland	-2.70%	Australia	-0.28%	Germany	64.79%
Austria	-5.05%	Italy	-6.32%	Spain	59.21%

Source: MSCI data

Table 1-17: Annual return of top four performing equity markets

Refusing to invest abroad may lead to missing important rewards, particularly over the long run. For instance, over the 10-year period ending at the end of 2003, the average annual returns for the international stock markets were ranging from -2.94% for Singapore (the worst case) to 20.52% for Finland (the best case). All other countries are somewhere in between. Which markets should investors have put their funds in over the past 10 years? Of course, in Finland. But the problem now is to forecast the next winner, i.e., the winner ten years from now. For those who prefer not to rely on luck, the answer is to diversify.

Of course, one may argue that foreign equity investments are more risky than domestic equity, due to currency risk. This is where the second argument – the one about diversification – comes in.

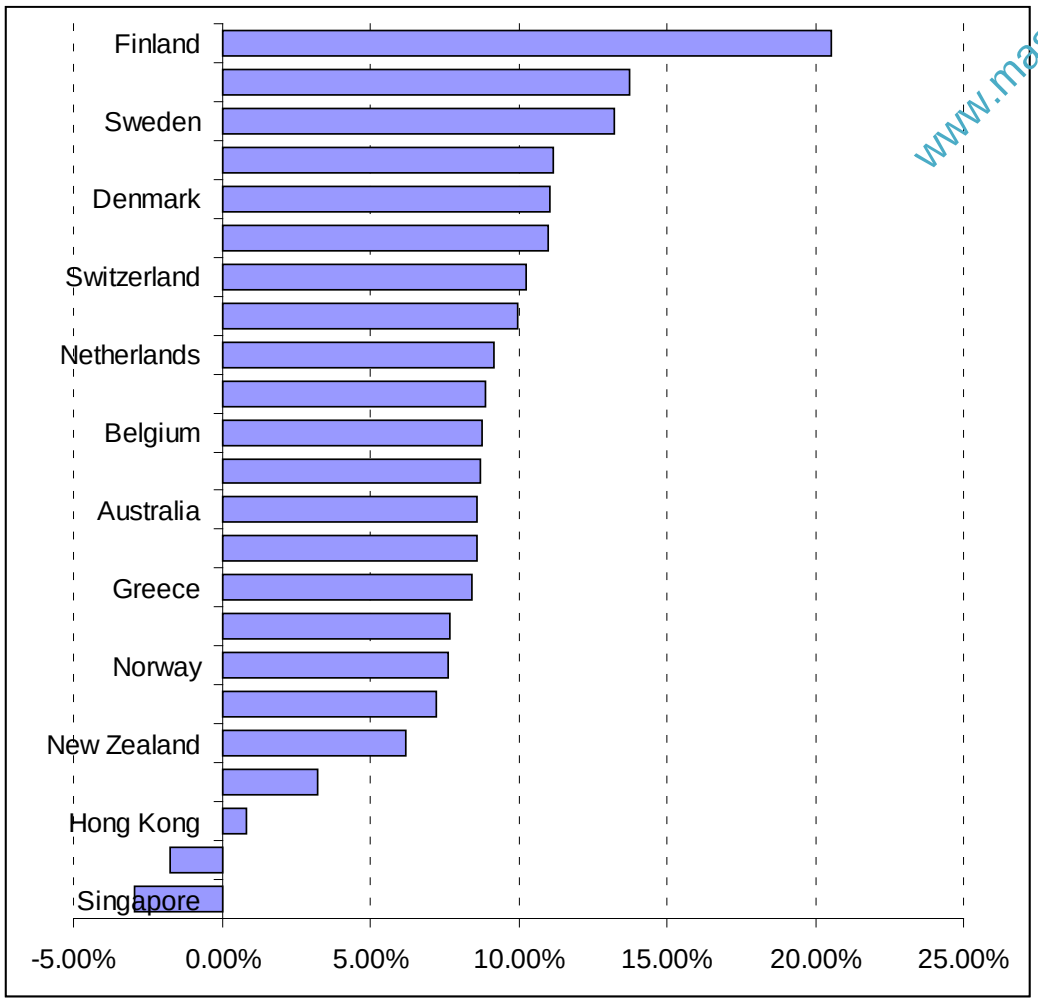


Figure 1-4: Average annual returns (1993-2003)

The low correlation between national equity markets was also verified historically. Since trends in foreign stock markets generally do not correlate perfectly with bull or bear market cycles in any domestic stock market, diversifying beyond the single home market should reduce the overall volatility of a stock portfolio over time.

In today's world economy, international stock markets are becoming increasingly integrated, capital flows are liberated and national protectionist regulations are reduced. Consequently, an event that impacts one market or group of markets has repercussions that carryover into others, and the odds become more likely that equity markets' correlations will increase. So, if this is the case (there is still some debate over), why bother about international equity diversification?

The answers lie in the magnitude, rather than the direction, of market movement. Even if the general tendency is to move together, some stock markets have historically outperformed others during certain periods, and underperformed during other periods. Though past performance doesn't indicate anything about the future, an ongoing strategy of diversification between domestic and foreign equities may help provide exposure to the better-performing class and potentially reduces overall portfolio volatility.

Indeed, one should not oversell the benefits of geography: the answers also lie in diversification across economic sectors and industries. These will become more important

than the nationality of those industries. Note that the goal of international equity is to locate good companies spread across the global economy, but the flag they fly is secondary.

Now, let us recall that there are several particular risks that should be considered when forming a portfolio of international equities:

- **Political risks.** Political actions, changes in governments, events or instability, changes of tax law, currency or market regulations, all of these can affect the value or the liquidity of an investment.
- **Liquidity risk.** Liquidity is the ease with which one can sell an investment without any loss of value. In smaller foreign stock exchanges, liquidity risk increases for thinly traded shares.
- **Regulatory risk.** Many overseas securities markets are less regulated than those of the G21 countries and may permit trading practices that are either more strictly regulated or prohibited elsewhere. In particular, foreign audit requirements may be less stringent and insider-trading rules may be weaker or inadequately enforced.
- **Information risk.** The information released by foreign companies to their shareholders may also be more difficult to access by non-local investors, and may not always be available in English. Thus, investors may find it difficult to obtain timely information needed to locate and invest in the under-valued stocks of foreign companies offering the greatest discounts to their long-term values, or to adequately monitor their investments in such companies.
- **Trading costs.** Traditional brokerage costs - as well as exchange fees, custodial fees, taxes, and other charges - considerably increase the cost of buying and selling foreign securities. Investing in foreign markets also involves higher portfolio management costs (greater cost of research, etc.). This can have a negatively impact on returns.
- **Currency risk.** International diversification automatically brings with it currency risk and requires expertise to manage this risk.

While most investors recognize the benefits of global diversification, they also need to be aware of the challenges of trading directly on local markets. These include for instance inefficient trade settlements, uncertain custody services and costly currency conversions. In addition, in several foreign markets, it is not possible or procedurally almost impossible for foreign individual investors to purchase ordinary shares. Foreign access to shares is only granted to expatriate nationals or institutional investors. This explains why several investors prefer to invest abroad by indirect means, such as depositary receipts, WEBS, or mutual funds.

Depositary Receipts were developed as a method of enabling domestic investors to trade in certain international securities within their domestic market in the most efficient manner possible. Simply stated, depositary receipts are listed securities that represent ownership in the shares of a foreign company. Each depositary receipt may be equivalent to one or more foreign shares or a fraction of a share. Depositary Receipts are created when a foreign broker or a foreign bank purchases some company's shares on its home stock market and delivers those to the depositary's local custodian bank, which then instructs the depositary bank to issue depositary receipts in another country. These represent and are backed by the deposited

securities, but they may trade freely, just like any other security, either on an exchange or in the over-the-counter market and can be used to raise capital[27].

American Depositary Receipts (ADRs) are the investment of choice for U.S. investors seeking direct participation in international markets. Although in substance they represent ownership of foreign shares, they are U.S. registered and traded securities, they are quoted in dollar terms and their dividends are paid in dollars. ADRs started in 1927 and were originally issued by Morgan Stanley. Today, there are over two thousand ADRs from over 50 countries available for purchase by U.S. investors. Global Depositary Receipts (GDRs) are similar except they are issued by non-U.S. banks and are traded in the global markets (e.g., Luxembourg).

World Equity Benchmark Shares (WEBS) are interests in SEC registered and traded funds that track different MSCI country indices (Australia, Austria, Belgium, Canada, France, Germany, Hong-Kong, Italy, Japan, Malaysia, Mexico, Netherlands, Singapore, Spain, Sweden, Switzerland and the United Kingdom). While WEBS do not necessarily include every stock in the relevant MSCI country index, the tracking error is expected to be low. WEBS offer several advantages over the direct purchase of individual equities in the foreign market, such as cost efficiency (they are easily available on the American Stock exchange at "normal" commission rates and are denominated and settled in USD), liquidity (they can be purchased and sold as any other U.S. listed security) and market adaptability (limit orders, stop losses, selling short and margins are all available on WEBS securities). The major drawback of WEBS is that they are designed primarily for US investors and are therefore not necessarily eligible investment or tax efficient ones for non-U.S. persons.

The professional management and wide diversification of **equity mutual funds** also provide a good solution to invest in distant and often very dissimilar markets. Some of the basic decisions here are whether to choose a global fund, whose investments include domestic as well as foreign stocks, or an international fund, whose holdings are all foreign equity, and opting for an actively or a passively managed fund. Each approach has its advantages and disadvantages.

Finally, last but not the least, another easy way for investors to obtain some international exposure for their portfolios is to simply purchase securities of **multinational corporations** who have operations in and derive significant revenues from foreign markets. Coca-Cola, Nestle or IBM are popular examples of such firms.

1.4 International fixed income

With the increasing globalisation of financial markets, issuers started offering their debt not only in their home country, but also abroad. For example, since the 1970s, the Canadian provinces used the U.S. bond market as a major source of funding. Later on, the euromarket (coupled with the tremendous liquidity provided by the swap markets) started being considered as a major playfield for international issuers.

International bonds have very different risk and return profiles than domestic bonds. Not only is their price affected by movements in a foreign country's interest rate, they also change in

27 Companies frequently establish a depositary receipt program to enlarge the market for their shares through a broadened and a more diversified investor exposure, to enhance their image in a marketplace outside its home country, or to enable employees to invest easily in a parent company.

value depending on the foreign exchange rates. As a consequence, similar to what we have seen for equities, exposure to international fixed-income increases the set of investment opportunities. For instance, while the USD bond market is still by far the largest, other currency bond markets represent more than 66% of the total world market in publicly traded fixed-income securities and this percentage is increasing every year. By remaining in its domestic currency bond market, a USD investor would lose the investment opportunities that may exist in other bond markets and the potential for risk diversification. The economies of individual countries are typically at different stages of the business cycle, which leads to wide variance in annual investments. For example, by comparing the performance of major bond markets, one would note that no single market has been the best performer for s long time. Therefore the advantage of international bonds over domestic ones.

Year	Best Market	U.S. Rank
2002	South Africa	10
2001	Czech Republic	9
2000	U. S.	1
1999	Japan	3
1998	France	9
1997	U. K.	2
1996	Australia	6
1995	Sweden	7
1994	Belgium	9
1993	Japan	8
1992	Japan	4
1991	Australia	4
1990	U. K.	10
1989	Canada	2
1988	Australia	3
1987	U. K.	10
1986	Belgium	9

Source: Lehman Brothers, JP Morgan

Table 1-18: Top performing bond markets annually since 1986.

Potential returns (and losses) from a high quality international bond portfolio have three sources: income advantage/disadvantage[28], expected relative domestic price movements, and prospective currency changes. A thorough understanding of each of these components and their interrelationships is essential to successfully manage an international bond portfolio, since achieving investment performance typically involves building upon fundamental valuations of global and local economic factors, as well as of the individual securities, capturing return opportunities based on the differences in interest rate cycles throughout the world, actively managing currencies, and last, but not least, using diversification to control risk!

Very often, a key decision for an international bond portfolio is to choose between individual bonds and bond funds. The former have no expense ratio, and they provide a specific maturity when the investor knows he'll get his principal back. The latter offer diversification (an important issue for corporate bonds), professional management, lower transaction costs (bond funds can trade more efficiently because of their size), monthly dividends (for some funds) and easy income reinvestment.

28 This is the only element which is expressed in domestic currency terms and known ex-ante.

Note that:

- the tax rules applicable to investments in corporate bonds may be much more complicated than the rules that apply to corporate stocks, particularly in the case of U.S. citizens and residents. As a general rule, the least expensive and complicated way for such investors to invest in international bonds is to buy them through a U.S. mutual fund or to buy bonds that are registered in the U.S. and are listed on one of the U.S. securities exchanges.
- The attraction for international bonds has also been increased by the introduction of the EUR currency in January 1999. This has implicitly converted all public traded debt denominated in the national currencies of the eleven countries participating in the EMU to EUR. The result was the creation of a new government bond market with a size equivalent to the US market. Simultaneously, several countries have cancelled the restrictions on the portfolio holdings of institutional investors, allowing them to diversify out of their home market throughout the EMU zone. This case is somehow specific, because currency risk does not exist anymore.

1.5 Managing a portfolio of international assets

Managing a portfolio of international assets may appear at a first glance as a simple extension of managing a portfolio of domestic assets. Although this is theoretically true, the international character creates numerous implementation challenges, particularly on the research, execution, monitoring, and global custody aspects.

Integrated portfolio managers often utilize the information and analysis from various committees to determine the policy at each stage of the investment process, with a mix of top-down and bottom-up approaches.

Some managers of very large portfolios also adopt a **core/satellites portfolio investment approach**, that is, a portion of the portfolio is put in lowest cost, index replicator funds (“the core”) while the rest can then be managed in a more aggressive way, in search of higher returns (“satellites”). By using this approach, investors benefit from lower management fees (as the core component is managed at lower cost), limited duplicate shareholdings (as satellite funds are only selected after evaluating the composition of the core fund) and opportunities to invest in current hotspots.

2. Value at Risk

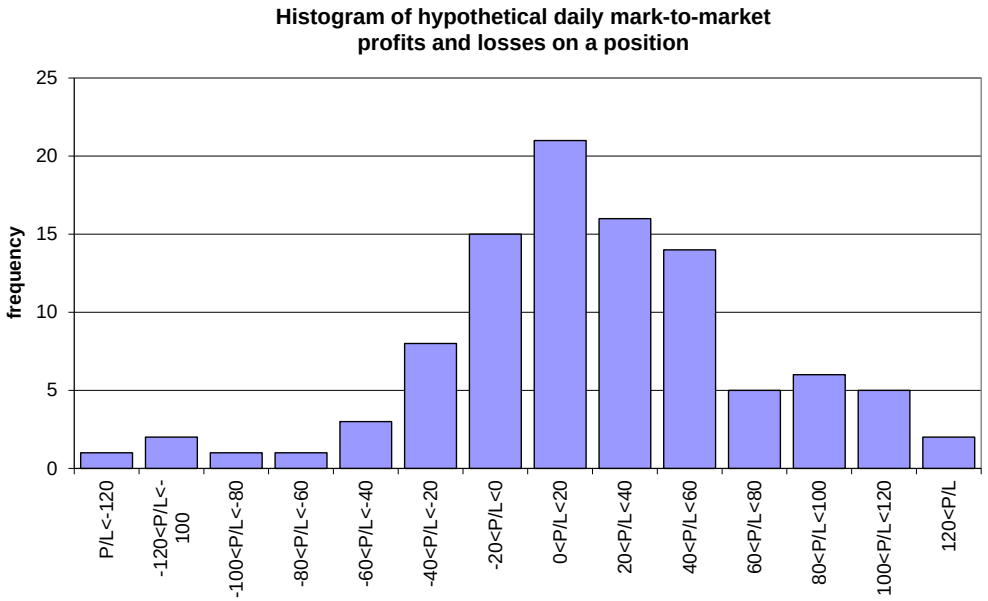
Modern Portfolio Theory uses the standard deviation to describe a portfolio's risk. It assumes that this risk measure captures all information about risk that is relevant, and that the knowledge of a portfolio's standard deviation alone allows the construction of optimal risk management.

But the standard deviation measures the risk in terms of deviations, either above or below, an expectation, whereas risk managers are only concerned about losses, i.e., deviations below the expected return. Furthermore, the use of the standard deviation as a risk measure assumes a symmetrical distribution of returns, i.e., that the probability of having a return higher than expected is the same as the probability of achieving a lower return. This is not always the case, especially when we add options and other derivative instruments.

To overcome these shortcomings of standard deviation, Value at Risk was created as a risk measure which kept the benefits of the standard deviation: It is a single, summary, statistical measure of portfolio risk, here defined as possible portfolio losses. Specifically, Value at Risk is a measure of losses due to 'normal' market movements. Losses greater than Value at Risk are suffered only with a low specified probability, and are considered to be due to 'abnormal' market movements.

Let us first look at an example, and then have a more formal definition of Value at Risk.

2.1 Example



The figure shows a distribution of possible one-day changes in the value of a position. As we can see, we have 1% probability that losses will be higher than USD 120. The probability of losses higher than USD 100, but lower than USD 120 is 2%, while the probability of a loss between USD 80 and USD100 is 1%. The probability of a loss between USD 80 and USD 60 is 1 percent as well. Summing these probabilities, there is a 5% probability that the loss will be higher than USD 60. If we considered a loss that happens less than 5% of the time as a loss due to 'abnormal' market movements, then the USD 60 divides the losses due to 'normal'

markets from the losses due to 'abnormal' markets. We could then say that with this position we cannot lose more than USD 60 if market movements stay 'normal'. This worst loss under 'normal' conditions is called the Value at Risk of the position.

Of course, a distinction between 'normal' and 'abnormal' market movements cannot be made such that everybody agrees, so we might choose a different cut off level than 5%. For example, if we chose to say that only movements that happen less than 3% of the time are 'abnormal', we would find a Value of Risk of USD 100 (1% probability of losing more than USD 120 + 2% probability of losing between USD 100 and USD 120). Most of the times however, the VaR is quoted by specifying the probability of 'normal' market moves, i.e., the 95% VaR would be USD 60, and the 97% VaR would be USD 100.

Implicit in the specification of the VaR measure is the choice of a holding period. We examined daily losses. We might just as well also consider losses over a week, or even a month.

2.2 Definition

Value at Risk summarizes the expected maximum loss (or worst loss) over a target horizon within a given confidence interval. For example, we can define a 1-day 99%-VaR, as follows:

"Value at Risk (VaR) is the amount of money such that a portfolio isexpected to lose less than that amount of money 99 days out of 100."

For example, if the 1-day 99%-VaR of a stock portfolio is 5 million CHF, the probability of loosing more than 5 million CHF in one day is 1 percent.

VaR can be defined as the loss relative to the expected return of the portfolio (in dollar or percentage terms), or as the absolute dollar loss. In the terms of statistics, VaR is a quantile of a distribution.

The VaR of a portfolio is determined by 3 factors: The portfolio's profit and loss (P/L) distribution, the confidence level and the target horizon (or holding period).

2.2.1 Confidence Level

The confidence level tells us with what probability the portfolio's losses will be higher than VaR. There are no guidelines to choose the confidence level. 99%, 97.5% and 95% are the most commonly used confidence levels. Higher confidence levels lead to higher VaR figures. Under the assumption that asset returns are normally distributed, it is possible to convert between VaR figures with different confidence level[29].

2.2.2 Target Horizon

The target horizon enters the VaR calculation through the P/L-distribution. If this distribution was designed to depict changes in portfolio values and their probabilities over the next *n* days, the VaR tells us what maximum loss to expect over the next *n* days. The choice of *n* depends on the nature of the portfolio. For a portfolio with constantly changing positions it would be advisable to choose a short horizon, while a long-term buy-and-hold strategy is better reflected in a longer target horizon. Often a 10-trading day horizon is used as a compromise.

Some VaR systems assume that the VaR is proportional to the square root of the target horizon, i.e., a 10-day VaR will be $\sqrt{10}$ times higher than the 1 day VaR.

2.2.3 Main assumptions of Value at Risk

Value at Risk makes two crucial assumptions:

- No change in portfolio composition: We used today's portfolio composition to estimate profits and losses over the next 10 trading days. Of course, if we would change the portfolio's composition afterwards, the new P/L-distribution after 10 trading days is not the original anymore. Hence our VaR estimate today is only valid for today's portfolio composition.
- No changes in expected market behavior: For the estimation of the P/L-distribution we forecasted the market's, i.e., the risk factors', behavior over the target horizon. However, if there would be an unexpected shock during the VaR-horizon, the actual P/L-distribution would differ from the forecasted distribution, invalidating our VaR estimate.

2.3 Interpretation of Value at Risk

While interpreting Value at Risk figures, it is important to always keep in mind the choice of the confidence level and target horizon. If two companies hold the same portfolios, but use differing confidence levels and target horizons, they will not come up with the same Value at Risk figure. Obviously, the loss that can happen with a probability of only 1% is higher than the loss which can happen with a probability of 5%. And similarly, the probability of big losses gets higher the longer one holds the position. Using the rules given in the sections on

29 With normally distributed asset returns, VaR is a multiple of the standard deviation. For example, a 95% VaR is 1.645 times the standard deviation, and a 99% VaR is 2.326 times the standard deviation. So the 99% VaR will be 2.326/1.645 = 1.414 times bigger than the 95% VaR.

the choice of the confidence level and the target horizon, it is possible to compare VaR figures with differing specifications. But these rules are only valid under a set of assumptions, which normally do not hold.

2.4 Calculation of Value at Risk

To calculate the Value at Risk of a portfolio, we need to estimate the portfolio's profit and loss distribution over the target horizon. Once we have identified this distribution, we derive the VaR directly as a cutoff value such that the probability of exceeding this value is the confidence level[30]. So the difficult part of calculating a portfolio's VaR is to come up with the portfolio's P/L distribution. One could take several approaches. We will summarize the most widely used, and also discuss their strengths and weaknesses.

2.4.1 VaR of normally distributed asset returns (parametric approach)

If we assume that asset returns are normally distributed, we look for a quantile of the standard normal distribution. Since the quantiles are constant for a given level of confidence, the VaR of a portfolio is just a multiple of its standard deviation. This allows us to use standard portfolio risk aggregation techniques to calculate the total portfolio standard deviation, and then multiply by the value of the standard normal distribution implied by the confidence level to get the portfolio's VaR. For example, if we choose a confidence level of 95%, we have to multiply the portfolio's standard deviation by 1.65. However, this is only allowed if asset returns are normal.

2.4.2 Local-Valuation Approaches

Calculating the VaR for a single position is straightforward. For a portfolio we need a suitable way to aggregate the single positions.

The local valuation approaches gives an easy method by assuming that the risk factors influencing the portfolio value are normally distributed, and that changes in portfolio value are a linear combination of changes in the underlying risk factors, weighted by the sensitivity of a single position against changes in a risk factor. Hence the resulting portfolio P/L-distribution will be normal as well.

The portfolio VaR is again a multiple of the portfolio's standard deviation, since the portfolio's returns are normally distributed.

30 In mathematical terms, we are looking for a cutoff value V^* such that the area under the density function $f(V)$ of the portfolio P/L is equal to the confidence level c. This amounts to finding a value of the inverse cumulative density function of the portfolio P/L-distribution:

$$c = \int_{V^*}^{\infty} f(V)dV \quad c = \int_{\infty}^{V^*} f(V)dV = F(V^*) \quad V^* = F^{1}(1 \quad c)$$

2.4.2.1 Delta-Normal Approach

For a position in the underlying risk factor itself the sensitivity is 1. However, the relation between options and the underlying risk factor is nonlinear, and we have to use approximations to capture the option's reaction to changes in the price of the underlying.

The simplest approximation is the first order approximation, or in terms of option pricing, the *delta* of an option. Hence the most simple local-valuation method is called *Delta-Normal approach*.

It is possible to improve on the Delta-Normal approach by incorporating higher order sensitivities such as Gamma and Vega.

2.4.3 Full-Valuation Approaches

The full-valuation approach copes with the non-linearity of options by doing a full valuation of the position. For that it uses a given set of parameters as input into a valuation model. This of course implies that the full valuation method is only as good as the valuation model used. But how should one choose the parameters determining the option's price?

2.4.3.1 Historical-Simulation Method

The Historical-Simulation Method is the simplest full-valuation approach. It consists of going back in time and using past combinations of parameters as input into the valuation model. For instance, one might look at the last 100 trading days, and valuate the option for each of these trading days using the underlying price, volatilities, yield curves etc. of that particular day. This gives a distribution of possible option prices that we can use to calculate the VaR of the position.

The main problem of this approach is the assumption that the movements of financial variables over the target horizon will behave exactly like they did over the past period used in the historical simulation. Especially this approach does not consider the possibility of extreme events, e.g. a stock market crash, unless these events are included in the sample.

2.4.3.2 Stress Testing

Stress Testing or scenario analysis consists of subjectively establishing possible scenarios of future movements of risk factors over the target horizon. These scenarios are used to value the option. If we assign probabilities to these scenarios we can derive a probability distribution of the profits and losses in the option position, yielding a VaR estimate.

The drawback of this approach is that it is very difficult to assign probabilities to the scenarios. The advantage is that one can build scenarios of market movements not observed during the past period, e.g., a bigger shock than previously experienced, or it allows one to identify a combination of events that have a strong impact on the position. This is why stress testing is often implemented as a risk management method complimenting more standard VaR estimates.

2.4.3.3 Structured Monte-Carlo

Structured Monte-Carlo uses Monte-Carlo methods to plot joint probability distributions of risk factors. A full valuation approach for all these parameter combinations yields a profit and loss distribution of the portfolio, thus giving us the VaR estimate.

Structured Monte-Carlo is the most comprehensive approach to estimate VaR, given that the stochastic models of the risk factors are implemented correctly. However, it requires very complex computations.

2.4.4 Comparison of Local versus Full-Valuation Approaches

Local-Valuation Approaches are easy to implement and calculate, thus allowing frequent VaR estimations. However, if the portfolio includes options with highly nonlinear features, the approximations used in this approach lead to big errors, especially for strong market movements. And since VaR is concerned about the lower tail of the distribution, these errors may lead to huge errors in the VaR estimate.

Another disadvantage of local valuation approaches is that they generally assume that asset returns are normally distributed, while we generally observe ‘fat tails’ in the distribution of returns. Again, because VaR looks at the tails of distributions, this problem cannot be ignored.

Full valuation approaches deal well with non-linearity in options’ reactions to price changes, provided that the valuation model is not correctly specified. However, unless one uses only a limited set of sample paths over the target horizon, the computational cost of this approach is huge. And even if we use the most sophisticated VaR estimation method that yields precise estimates, it is of no use if it is so cumbersome that we cannot update it frequently to reflect changes in portfolio composition and market behavior.

2.5 Dangers and Pitfalls

Value at Risk is not a panacea. It is a single, summarising, statistical measure of normal risk. It does not capture extreme market moves like crashes well, and it also does not consider liquidity differences between instruments. In addition, it measures only on one quantile of the tail of the P/L distribution, and hence fails to capture the whole information in the distribution.

A VaR estimate is only as good as the methodology with which it was calculated. So if we do not correctly estimate the volatilities and correlations of financial variables, or if we use a wrong model to value derivatives, our VaR estimates will be inaccurate as well.