Introduction to International Finance

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Chapter 4

Literature

Basic Literature

- **Ross/Westerfield/Jordan**: *Fundamentals of Corporate Finance*, 6th ed., Irwin McGraw-Hill
- **Eun/Resnick**: *International Financial Management*, Irwin McGraw-Hill

Additional Literature

- **Arnold**: *Corporate Financial Management*, 2nd ed., Prentice Hall
- **Günther/Schittenhelm**: *Investition und Finanzierung*, Schaeffer-Poeschel

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1. **Introduction**
2. International Accounting
3. **International Equity and Debt Financing**
4. **International Investment Strategies**
5. **Risk Management and Exchange Rates**

Learning Target International Finance

The learning target of this chapter is to understand

- ✓ **the specific aspects of international finance,**
- ✓ **the possibilities of international sources of finance,**
- ✓ **different investment strategies,**
- ✓ **how a company can deal with exchange rate risk,**
- ✓ **measures used in financial risk management.**

4. Introduction to International Finance
4.1. Introduction

General Tasks of Financial Management

- Investments
- Capital structure
- Dividend policy
- Working capital management

→ Shareholder value maximization

Particularities of International Financial Management

- Foreign exchange rate risk
- Political risk
- Imperfect markets
- Additional market opportunities

4. Introduction to International Finance
4.1. Introduction (2)

Reasons for the Necessity of International Financial Management

- Globalisation
  - Computer and telecommunication
  - Reduction of transportation costs
- Liberalisation
  - GATT (General Agreement on Tariffs and Trade)
WTO (World Trade Organisation)
  - EU (European Union), NAFTA (North American Free Trade Agreement)
- Deregulation and Privatisation
  - Financial markets (new products, cross border listings, free commission etc.)
  - Telecommunication, energy etc.
- Multinational enterprises
  - Treasurer

Characteristics of the Euro markets

Market participants

- Banks
- Governmental institutions
- Corporations with high rating

Business volume: several million

Location

- few regulations by the authorities
- London, Luxemburg, New York, Tokyo
- Off-shore centres: Bahamas, Caiman, Singapore, Hong-Kong

Syndicate of banks

- Lead manager (arranger): leading fee
- Underwriting bank (underwriters): fee for guaranty
- Placing agents (sellers)

Stock Exchanges around the World

United States

American Stock Exchange (AMEX) Arizona Stock Exchange Chicago Stock Exchange NASDAQ New York Stock Exchange Pacific Exchange (Los Angeles and San Francisco) Philadelphia Stock Exchange

World Markets

Abidjan Stock Exchange African Stock Exchange Guide Alberta Stock Exchange Athens Stock Exchange Australian Stock Exchange Bangalore Stock Exchange Barcelona Stock Exchange Bavarian Stock Exchange (Munich) Beirut Stock Exchange Berlin Stock Exchange Bermuda Stock Exchange Bilbao Stock Exchange Bogotá Stock Exchange Botswana Stock Exchange Brussels Stock Exchange Bucharest Stock Exchange Budapest Stock Exchange Buenos Aires Stock Exchange Bulgarian Stock Exchange Cairo Stock Exchange Caracas Stock Exchange Casablanca Stock Exchange Chile Electronic Stock Exchange Colombo Stock Exchange Copenhagen Stock Exchange Costa Rica National Stock Exchange Cyprus Stock Exchange German Stock Exchange Ghana Stock Exchange Guayaquil Stock Exchange Helsinki Stock Exchange Hiroshima Stock Exchange Hong Kong Stock Exchange Indian Stock Exchange (NSE) Istanbul Stock Exchange Italian Stock Exchange Jakarta Stock Exchange Jamaica Stock Exchange Johannesburg Stock Exchange Karachi Stock Exchange Korea Stock Exchange Lahore Stock Exchange Lima Stock Exchange Lisbon Stock Exchange Ljubljana Stock Exchange London Stock Exchange Lusaka Stock Exchange Luxembourg Stock Exchange Macedonian Stock Exchange Madrid Stock Exchange Mangalore Stock Exchange Mauritius Stock Exchange (SEM) Medellin Stock Exchange Mexican Stock Exchange Montreal Stock Exchange Moscow Central Stock Exchange Nagoya Stock Exchange Nairobi Stock Exchange Namibian Stock Exchange New Zealand Stock Exchange Nicaragua Stock Exchange Nigerian Stock Exchange Nijny Novgorod Stock and Currency Exchange (in Russian) Occident Stock Exchange (Cali) Oslo Stock Exchange Panama Stock Exchange Paris Stock Exchange Prague Stock Exchange Rhenish-Westphalian Stock Exchange (Dusseldorf) Santiago Stock Exchange Sao Paulo Stock Exchange Shanghai Stock Exchange Shenzhen Stock Exchange Singapore Stock Exchange St. Petersburg Stock Exchange Stockholm Stock Exchange Swaziland Stock Market Taiwan Stock Exchange Tallinn Stock Exchange Tanzanian Stock Exchange Tehran Stock Exchange Tel Aviv Stock Exchange Thailand Stock Exchange Tokyo Stock Exchange Toronto Stock Exchange Tunis Stock Exchange Ural Stock Exchange Vancouver Stock Exchange Venezuelan Electronic Stock Exchange Vienna Stock Exchange Warsaw Stock Exchange Zagreb Stock Exchange Zimbabwe Stock Exchange Zurich Stock Exchange

Reasons for Cross-border Listings

- Broaden shareholder basis
- Domestic stock exchange is too small
- Reward employees in foreign countries
- Better understanding of the firm’s strategy
- Raise awareness of the company
- Improve discipline
- Understand better the economic, social and industrial changes occurring in major markets

4.3.1. International Equity Financing (3)

CORPWATCH
Holding Corporations Accountable
www.corpwatch.org

GERMANY: Hedge Funds Accused of 'Ripping Heart out of Economy'

by Julia Kollewe and Damian Reece, Independent
May 11th, 2005

The shareholder revolt at Deutsche Börse "rips into the heart of the German economy", Rolf Breuer, the outgoing chairman of the Frankfurt stock exchange operator said yesterday. He also said Germany should look at new laws to curb hedge fund activity.

Mr Breuer was ousted as chairman of Deutsche Börse on Monday along with the chief executive, Werner Seifert, after a shareholder revolt led by hedge funds including The Children's Investment Fund (TCI) over the German company's controversial plans for a £1.3bn bid for the London Stock Exchange (LSE). The hedge funds also objected to Deutsche Börse's corporate governance standards.

In an interview with the German magazine Capital, Mr Breuer said: "It is dangerous when hedge funds take over and impose their view on stability oriented shareholders. I fear it can happen to anyone now. It heralds a new world for company boards in Germany and rips into the heart of the German economy."

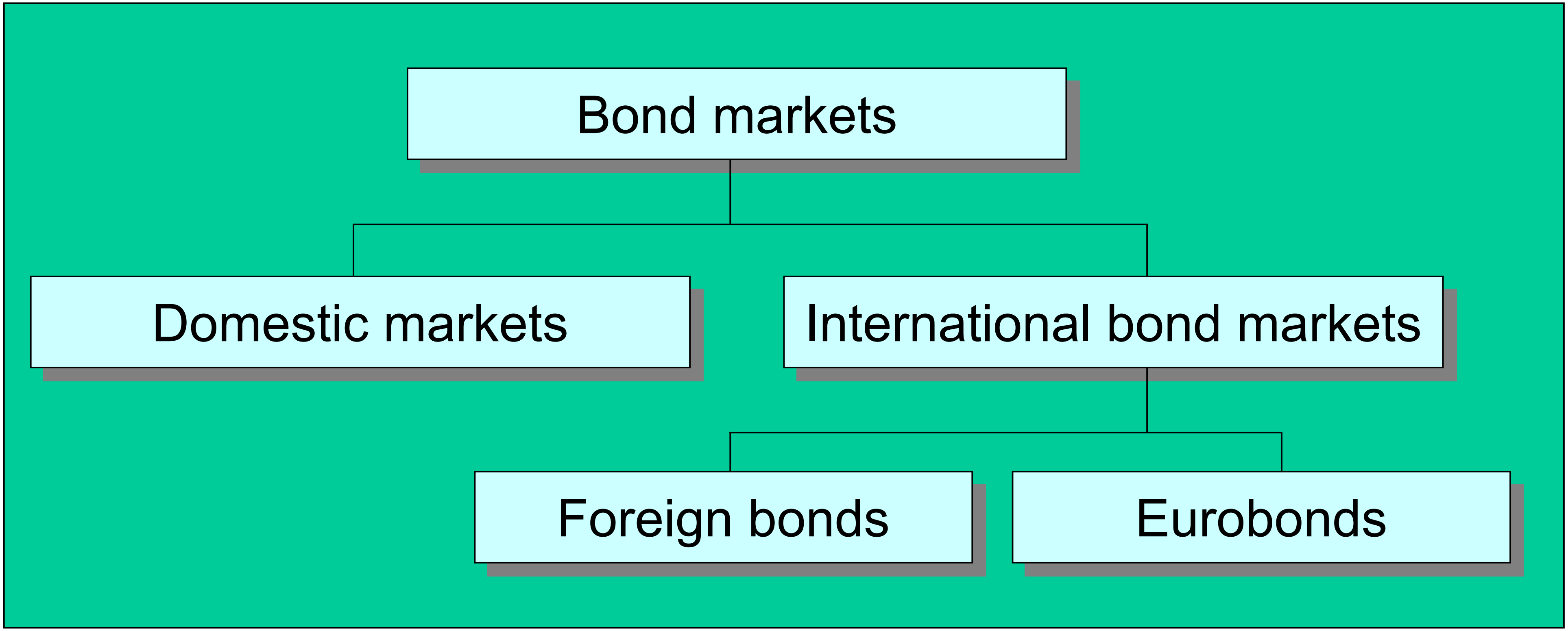
He said Germany should "seriously consider" stricter laws against hedge funds. He also criticised Christopher Hohn, TCI's managing partner, who has been engaged in increasingly bitter exchanges with Mr Seifert in recent weeks. Mr Breuer said the dispute had been conducted in a way that he thought "most unpleasant".

TCI and other hedge funds, including Atticus Capital, have accused the Deutsche Börse management of not maximising shareholder value.

4. Introduction to International Finance

4.3.2. International Bond Market

Overview



Foreign Bond

- Bond denominated in the currency of the country where it is issued.
- Issuer is a non-resident.

Eurobond

- Bonds sold outside the jurisdiction of the country of the currency in which the bond is denominated

Advantages

- Eurobonds are not subject to rules and regulations like foreign bonds.
- Eurobonds are not subject to an interest-withholding tax.
- Eurobonds are bearer bonds (holders don’t have to disclose identity)

Types of Eurobonds

Straight fixed-rate bond

- Coupon constant over time, coupon payment annually

Equity related bond

- Bonds with warrants attached:
  Option to buy some other asset (e.g. shares) at a preset price in the future. Warrants are detachable.
- Convertibles:
  Bondholder has the right to convert the bond into ordinary shares at a preset price.

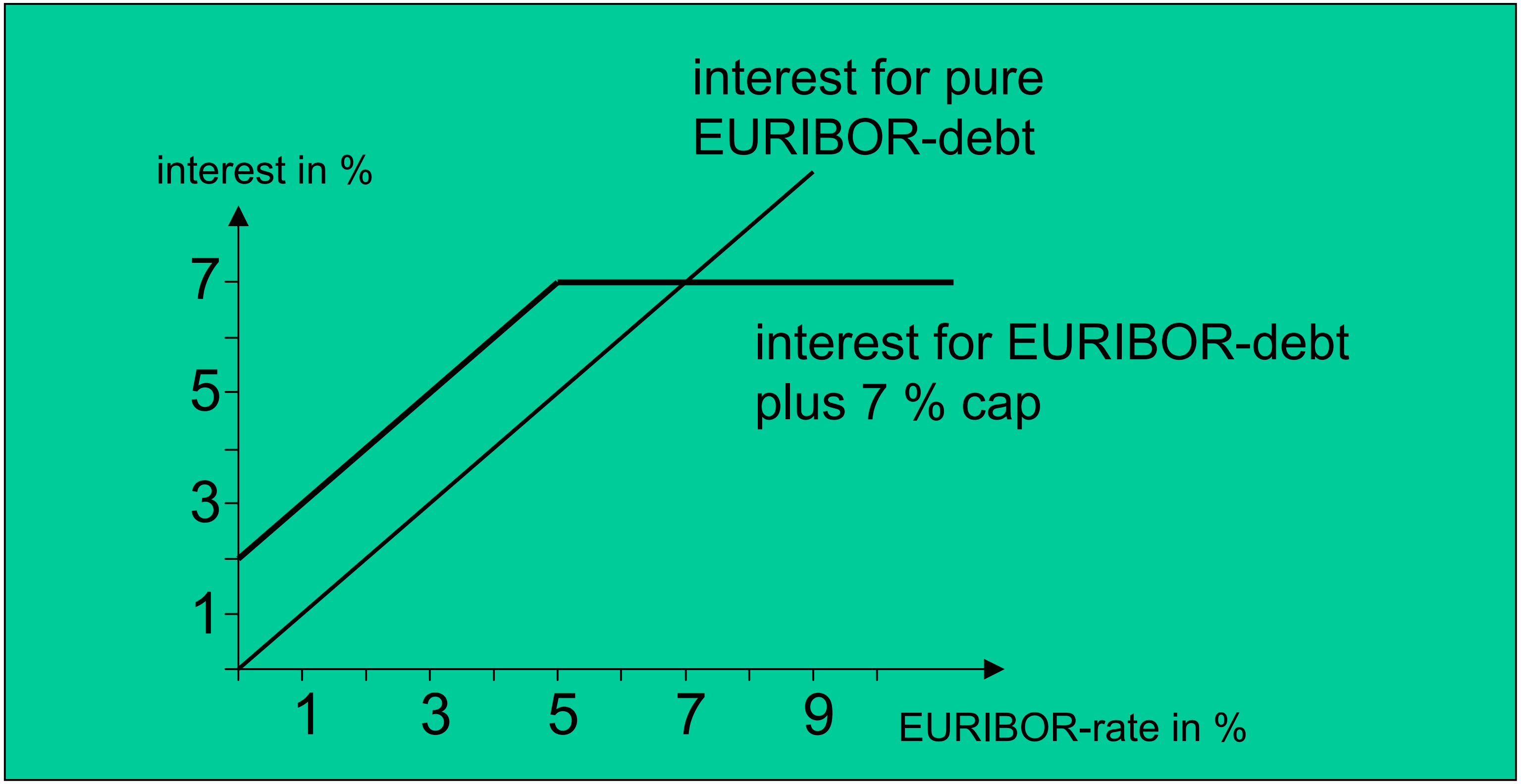
Floating-rate notes (FRN's)

- Variable coupon reset on a regular basis (e.g. every 3 / 6 months) in relation to a reference rate (e.g. LIBOR)
- Variations: Capped Note, Floor Note, Collared Note

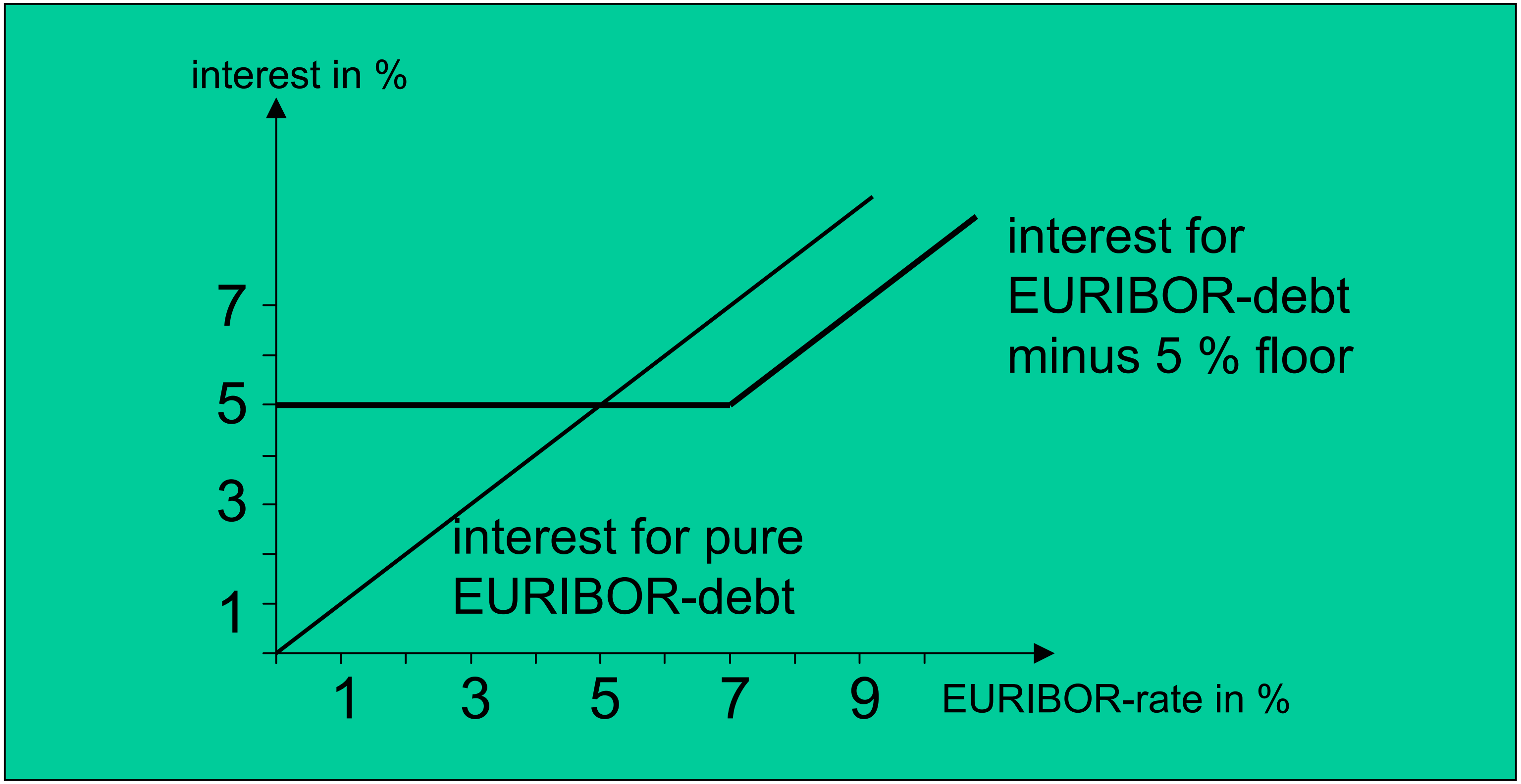
4. Introduction to International Finance

4.3.2. International Bond Market (4)

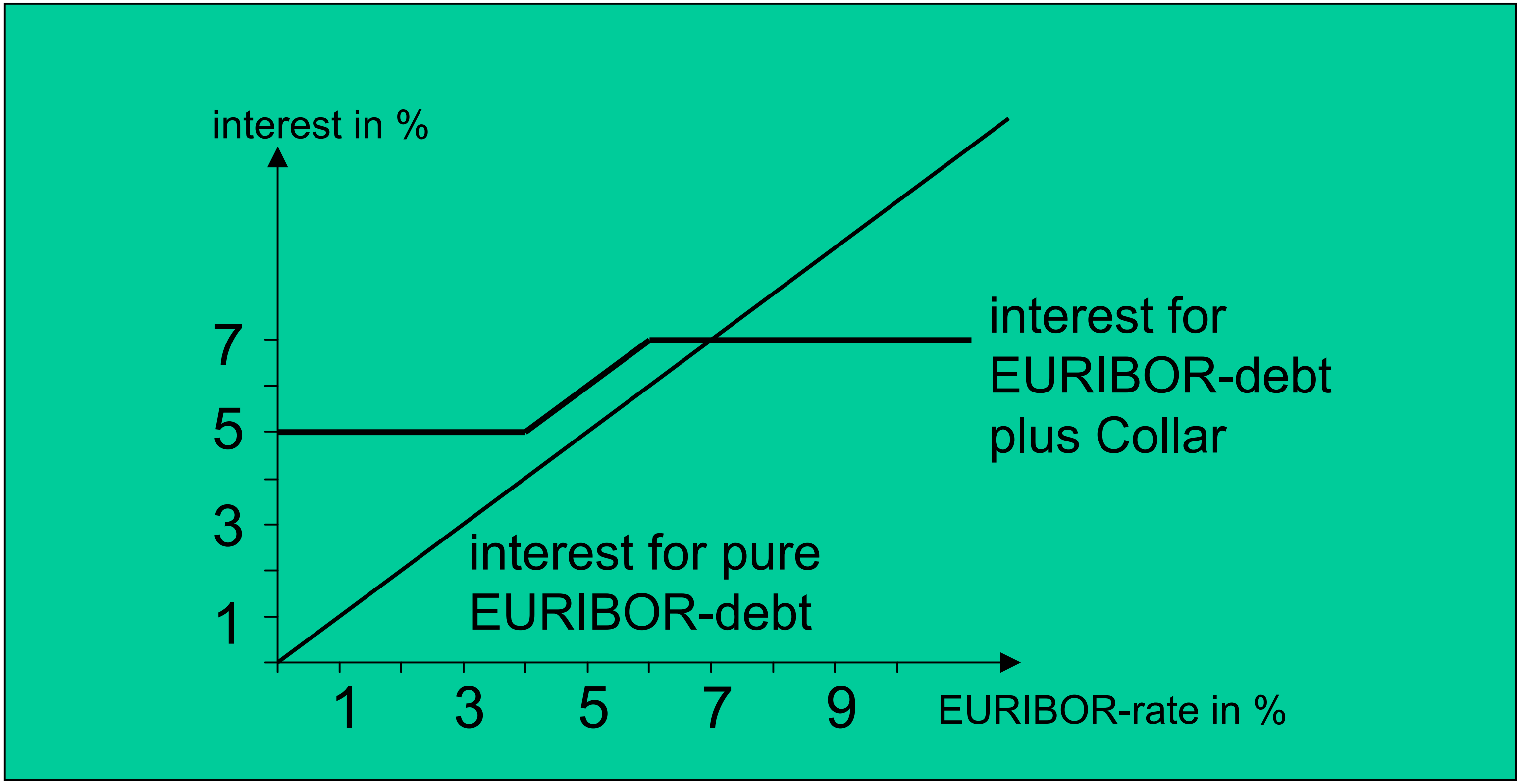
Cap: interest rate higher due to cap premium



Floor: interest rate lower due to floor premium



Collar: pay cap premium get floor premium



Advantages and Drawbacks of Eurobonds

Advantages	Drawbacks
1. Large amounts and long periods available 2. Often cheaper because of missing tax deduction, less regulations 3. Hedging: interest rates and exchange-rate risk 4. Bonds are unsecured, therefore less limitations for placement 5. Greater innovations and tailor-made financial solutions because of less regulations	1. Only for large companies 2. Safe storage is needed (bearer bonds!) 3. Exchange-rate risk might occur 4. Secondary market might be illiquid

Euro Medium-term Notes

- Issuing of notes by syndicate of banks (arranger, underwriters, placing agents)
- Unsecured lending
- Maturity 9 month and up
- Note issuance facility: Revolving Underwriting Facility, Note Standby Facility

Eurocommercial paper

- Unsecured lending, available only to corporations with highest credit ranking
- Short-term IOU, normal range 30-90 days
- Normally issued at a discount, no coupon payments
- Issued and placed outside the jurisdiction of the country in whose currency it is denominated
- Advantage for lender: higher interest rate than for depositing in bank
- Advantage for borrower: no fee must be paid to bank intermediary
- Commercial paper programme: Roll-over issue possible with bank as underwriter

General Aspects of International Investments

Advantages

- Diversification
- Product innovations
- Markets with less restrictions
- Tax advantages

Disadvantages

- Unknown markets
- Unknown regulations
- Tax disadvantages

Portfolio Theory and Diversification

Example

An investor plans to invest 1.000 €. The chosen share earns 10 % in the good case (probability 40%) and 2 % otherwise.

The function *W* describes the final wealth of the investors with W_{good} und W_{bad}.

Es gilt also:

C = 1.000 €, i_{good} = 10%, i_{bad} = 2% and p = 40%.

W_{good} = 1.000 € * (1+10%) = 1.100 € and

W_{bad} = 1.000 € * (1+2%) = 1020 €.

The expected value of the function *W* is then:

E(*W*) = 40%*1.100 € + 60% * 1020 € = 1.052 €

4.4.1. Stock markets (2)

Example (continued)

Additionally, consider a risk-free asset *F* with a fixed interest $i = 5\%$.

Suppose the investor invests $x = 80\%$ in the risky share.

- The final wealth of the investors will be then:
  $W_{good}(80\%) = 80\% * 1.000 € * (1+10\%) + 20\% * 1.000 € * (1+5\%) = 1.090 €$
  $W_{bad}(80\%) = 80\% * 1.000 € * (1+2\%) + 20\% * 1.000 € * (1+5\%) = 1.026 €$
- The expected value will be:
  $E(W(80\%)) = 40\% * 1090 € + 60\% * 1026 € = 1051{,}6 €$.

The following table shows the values for different shares *x*:

x	0%	20%	40%	60%	80%	100%
$W_{good}(x)$	1050	1060	1070	1080	1090	1100
$W_{bad}(x)$	1050	1044	1038	1032	1026	1020
$E(W(x))$	1050,0	1050,4	1050,8	1051,2	1051,6	1052,0

Risk-Return-Analysis (two risky assets)

- Basis of the analysis are three parameters:
  μ_A := Expected value of the return of asset *A* ,
  $SD(A) = \sigma_A$:= Standard deviation of the return of asset *A* ,
  $\rho_{A,B}$:= Correlation coefficient of the return of *A* and *B*.

- Consider a portfolio *P* with two risky assets *A* and *B* and shares of x_A and x_B of the total portfolio respectively, with .

$$P = x_A \cdot A + x_B \cdot B \quad , x_A + x_B = 1$$

- By definition the expected values and standard deviations are given as follows:

$$E(A) = \mu_A, E(B) = \mu_B \quad \text{and} \quad SD(A) = \sigma_A, SD(B) = \sigma_B \quad ,$$

Risk-Return-Analysis (two risky assets)

Determination of the parameters

Return of asset *i* between *t-1* and *t*:

$$R_{i,t} = \frac{W(t) - W(t-1)}{W(t-1)}$$

Empirical expected value of the return:

$$E(A_i) = \frac{1}{N} \cdot \sum_{t=1}^{N} R_{i,t} =: \overline{\mu_i}$$

Empirical standard deviation:

$$\mathrm{SD}(A_i) = \sqrt{Var(A_i)} = \sqrt{\frac{1}{N-1} \cdot \sum_{t=1}^{N} \left(R_{i,t} - \overline{\mu_i}\right)^2} =: \overline{\sigma_i}$$

Empirical covariance of two returns:

$$\mathrm{COV}(A_i, A_j) = \frac{1}{N-1} \cdot \sum_{t=1}^{N} \left(R_{i,t} - \overline{\mu_i}\right) \cdot \left(R_{j,t} - \overline{\mu_j}\right) =: \delta_{i,j}$$

Empirical correlation coefficient:

$$\overline{\rho}_{i,j} = \frac{\delta_{i,j}}{\overline{\sigma_i} \cdot \overline{\sigma_j}}$$

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4.4.1. Stock markets (5)

Risk-Return-Analysis (two risky assets)

We consider the following (see chapter 0):

$$E(P) = E(x_A \cdot A + x_B \cdot B) = x_A \cdot E(A) + x_B \cdot E(B) = x_A \cdot \mu_A + x_B \cdot \mu_B \text{ and}$$

$$SD(P) = SD(x_A \cdot A + x_B \cdot B) = \sqrt{x_A^2 \cdot SD(A)^2 + x_B^2 \cdot SD(B)^2 + 2 \cdot x_A \cdot x_B \cdot \rho_{A,B} \cdot SD(A) \cdot SD(B)}$$

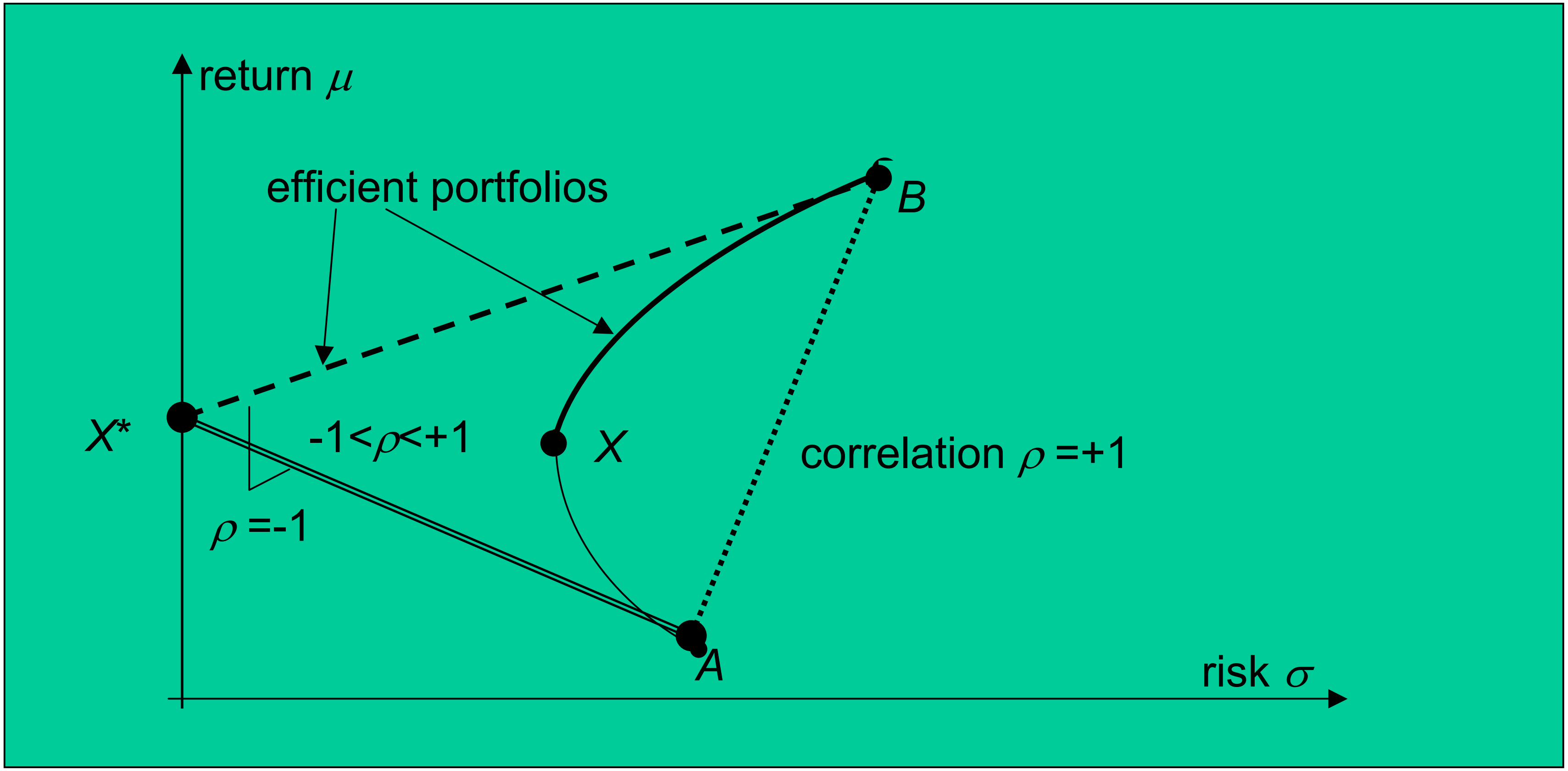
➔ $SD(P) = SD(x_A \cdot A + x_B . B) \leq x_A \cdot SD(A) + x_B . SD(B)$, since

$$\leq \sqrt{x_A^2 \cdot SD(A)^2 + x_B^2 \cdot SD(B)^2 + 2 \cdot x_A \cdot x_B \cdot SD(A) \cdot SD(B)} = x_A \cdot SD(A) + x_B \cdot SD(B)$$

$$SD(P) = \sqrt{x_A^2 \cdot SD(A)^2 + x_B^2 \cdot SD(B)^2 + 2 \cdot x_A \cdot x_B \cdot \rho_{A,B} \cdot SD(A) \cdot SD(B)}$$

The Diversification Effect

Risk-Return-Analysis (two risky assets)



Risk-Return-Analysis (for risky assets and risk-free asset)

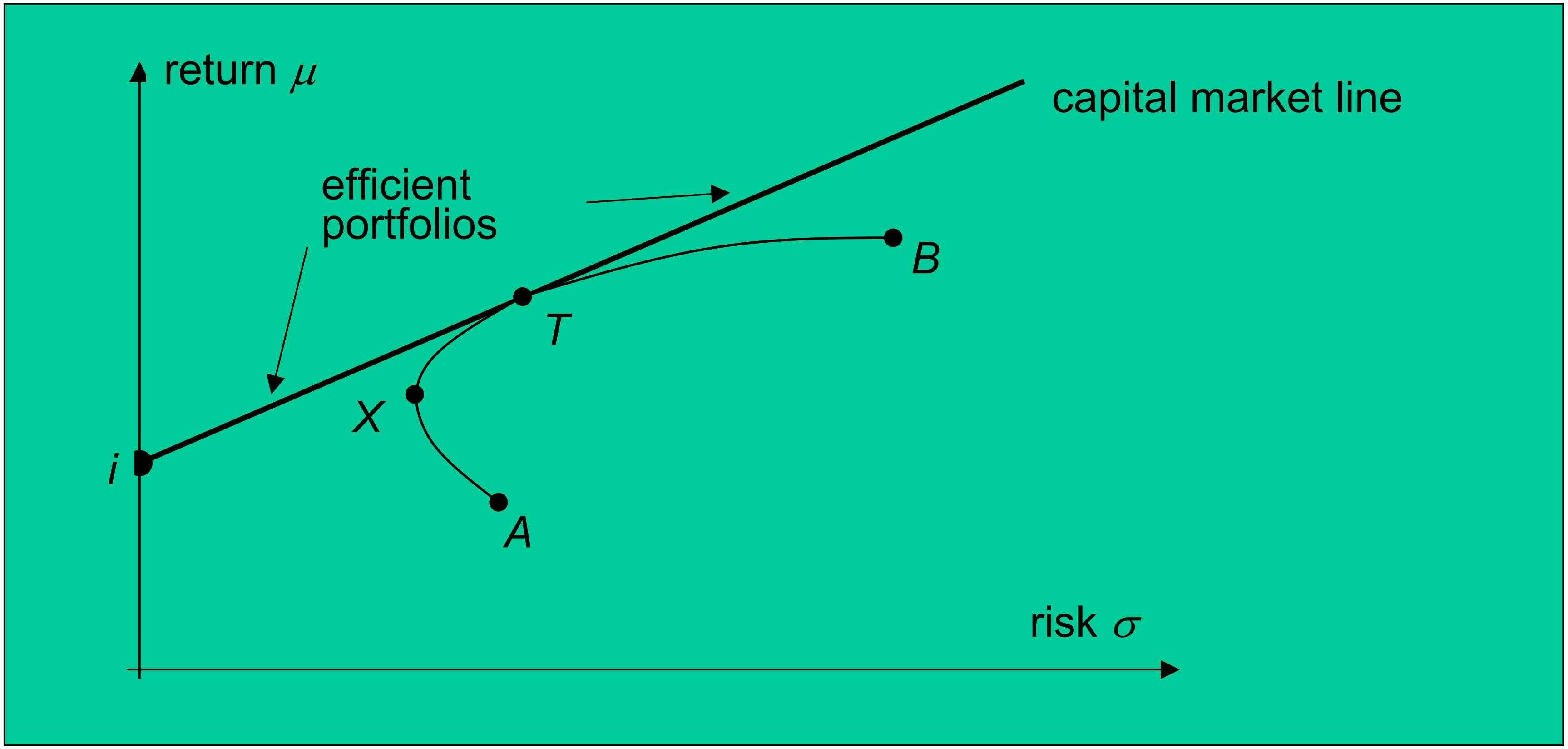
Suppose there exists a risk-free asset *F*

- Formally: The return μ_F of *F* is fixed with: $\sigma_F = 0$.
- For a combination *C* (of a risky portfolio *P* and *F*) results:
  $C = x \cdot P + (1 - x) \cdot F$
- The risk of the combination *C* can be described as follows:
  $$\sigma_C = \sqrt{(1-x)^2\sigma_F^2 + x^2\sigma_P^2 + 2x(1-x)\sigma_P\sigma_F\rho_{F,P}}$$
  with $\sigma_F = 0, \sigma_F^2 = 0$ and therefore $\sigma_C = \sqrt{x^2\sigma_P^2} = x\,\sigma_P$.

  Solving for *x*: $x = \dfrac{\sigma_C}{\sigma_P}$.
- The return of combination *C* is then: $\mu_c = \dfrac{\sigma_C}{\sigma_P}\mu_P + (1 - \dfrac{\sigma_C}{\sigma_P})\mu_F = \mu_F + (\dfrac{\mu_P - \mu_F}{\sigma_P})\sigma_C$

➔ There is a linear relation between expected value and standard deviation of *C*.

Risk-Return-Analysis (for risky assets and risk-free asset)



Minimum-variance Portfolio

In the case of two risky assets the standard deviation can be described as a function of x_A as follows (by using the equation $x_B = 1 - x_A$):

$$SD(P) = \sqrt{x_A^2 \cdot SD(A)^2 + (1 - x_A)^2 \cdot SD(B)^2 + 2 \cdot x_A \cdot (1 - x_A) \cdot \rho_{A,B} \cdot SD(A) \cdot SD(B)}$$

i.e. the variance is given by

$$\begin{aligned} VAR(P) &= x_A^2 \cdot SD(A)^2 + (1 - x_A)^2 \cdot SD(B)^2 + 2 \cdot x_A \cdot (1 - x_A) \cdot \rho_{A,B} \cdot SD(A) \cdot SD(B) \\ &= x_A^2 \sigma_A^2 + (1 - x_A)^2 \sigma_B^2 + 2 \cdot x_A \cdot (1 - x_A) \cdot \rho_{A,B} \sigma_A \sigma_B \end{aligned}$$

Then, it can be easily shown that the function does have a minimum for:

$$x_A = \frac{\sigma_B^2 - \sigma_A \sigma_B \rho_{A,B}}{\sigma_A^2 + \sigma_B^2 - 2\sigma_A \sigma_B \rho_{A,B}} \quad \text{and} \quad x_B = 1 - x_A$$

Minimum-variance Portfolio

Example

Share *A* with μ=8% ; σ=12% and share *B* with μ=13 % ; σ = 20%.

Case 1: $\rho_{A,B} = 0{,}3$

$$x_A = \frac{0{,}04 - 0{,}0072}{0{,}0144 + 0{,}04 - 2 \cdot 0{,}0072} = 82\%$$

and x_B = 18 %

with E(*P*) = 0,82 · 8 % + 0,18 · 13 % = 8,9 % and SD(*P*) = 11,4%.

Case 2: $\rho_{A,B} = -1$

x_A = 20/32 = 62,5 % and x_B = 12/32 = 37,5 %

with E(*P*) = 0,625 · 8 % + 0,375 · 13 % = 9,875 % and SD(*P*) = 0.

Example: Price (market) risk

An investor purchases a bond 1 for 100 € at time t=0.
The coupon payment is 7 €. The market return is r=7% at t=0.

The present value (or price) of the bond is therefore:

$$V(7\%) = \frac{7}{(1+7\%)^1} + \frac{7}{(1+7\%)^2} + \frac{107}{(1+7\%)^3} = 100$$

After one year the investor decides to sell the bond. The price at t=1 depends once again from the current required market return.

a) For r=5%: $V(5\%) = \frac{7}{(1+5\%)^1} + \frac{107}{(1+5\%)^2} = 103{,}72$

b) For r=7%: $V(7\%) = \frac{7}{(1+7\%)^1} + \frac{107}{(1+7\%)^2} = 100$

c) For r=9%: $V(9\%) = \frac{7}{(1+9\%)^1} + \frac{107}{(1+9\%)^2} = 96{,}48$

Example: Reinvestment risk

The investor acquires the bond from the previous example, expecting 7% interest gains over 3 years. At time T=3 the total capital is expected to be:

$$100 \cdot 1{,}07^{3} = 122{,}50$$

In fact, the investor receives coupon payments at time t = 1 and t= 2.
These payments of 7 € respectively must be reinvested at current market conditions.

Changes of the market required return cause the following consequences:
Total wealth at time T = 3:

a) For r=5%: $W(5\%) = 7 \cdot (1+5\%)^2 + 7 \cdot (1+5\%) + 107 = 122{,}07$

b) For r=7%: $W(7\%) = 7 \cdot (1+7\%)^2 + 7 \cdot (1+7\%) + 107 = 122{,}50$

c) For r=9%: $W(9\%) = 7 \cdot (1+9\%)^2 + 7 \cdot (1+9\%) + 107 = 122{,}95$

Modified Duration

Definition

The **Modified Duration** is defined by:

$$MD = -\frac{dV}{dr} \cdot \frac{1}{V} = \frac{\sum_{t=1}^{T} t \cdot c_t \cdot (1+r)^{-t-1}}{\sum_{t=1}^{T} c_t \cdot (1+r)^{-t}}$$

.

This form of duration has been developed by Hicks 1939.

Other expressions are Adjusted Duration or Volatility.

Modified Duration is used as a sensitivity measure and to estimate price changes.

Example

For our example the **modified duration** is:

$$MD = \frac{1 \cdot 7 \cdot (1+7\%)^{-2} + 2 \cdot 7 \cdot (1+7\%)^{-3} + 3 \cdot 107 \cdot (1+7\%)^{-4}}{7 \cdot (1+7\%)^{-1} + 7 \cdot (1+7\%)^{-2} + 107 \cdot (1+7\%)^{-3}} = \frac{262{,}43}{100} = 2{,}6243$$

Alternatively, for two other bonds given by

a) Bond 2, current price 118,37 €, 3 years to maturity, coupon 14 € and

b) Zero-Bond, current price 81,63 €, 3 years to maturity,

the **modified durations** result to:

a) Bond 2: $MD = \frac{295{,}99}{118{,}37} = 2{,}5006$

b) Zero-Bond: $MD = \frac{228{,}87}{81{,}63} = 2{,}8037$

Macaulay Duration

By multiplying the **modified duration** with (1 + *r*) one receives the **Macaulay Duration** *D*.

Definition

The **Macaulay Duration** is defined by:

$$D = MD \cdot (1+r) = \frac{\sum_{t=1}^{T} t \cdot c_t \cdot (1+r)^{-t}}{\sum_{t=1}^{T} c_t \cdot (1+r)^{-t}}$$

This form of duration was developed by Frederick Macaulay in 1938.

Bond Price Estimation

Example

Given our previous example of bond 1,

we receive the following bond prices if the market interest rate changes:

$$V(5\%) = \frac{7}{(1+5\%)^1} + \frac{7}{(1+5\%)^2} + \frac{107}{(1+5\%)^3} = 105{,}45$$

$$V(9\%) = \frac{7}{(1+9\%)^1} + \frac{7}{(1+9\%)^2} + \frac{107}{(1+9\%)^3} = 94{,}94$$

If we estimate the price changes with modified duration we apply:

$$V(r + \Delta r) \approx V(r) - MD \cdot \Delta r \cdot V(r)$$

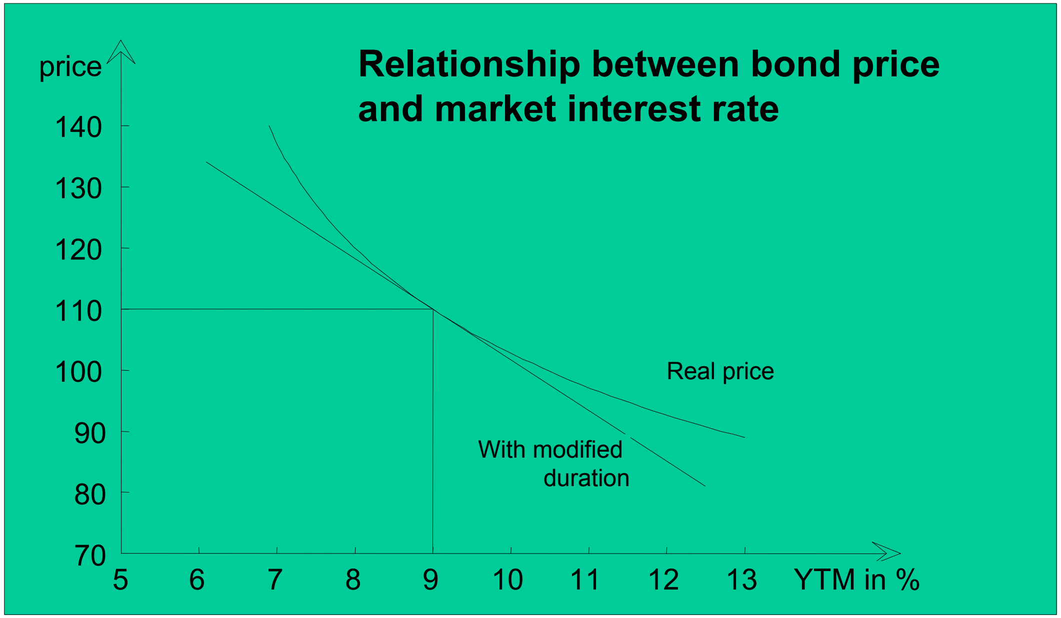
and therefore, we receive:

$$V(7\% + (-2\%)) \approx V(r) - MD \cdot \Delta r \cdot V(r) = 100 - 2{,}6243 \cdot (-2\%) \cdot 100 = 105{,}25$$

$$V(7 + 2\%) \approx V(r) - MD \cdot \Delta r \cdot V(r) = 100 - 2{,}6243 \cdot 2\% \cdot 100 = 94{,}75$$

Motivation

- Using **modified duration** to estimate price changes of a bond caused by interest rate changes assumes a linear relationship between YTM and bond price.
- Indeed, the price function is a convex function.



Convexity

Definition

The **convexity** is defined by:

$$C = \frac{d^2V}{dr^2} \cdot \frac{1}{V} = \frac{\sum_{t=1}^{T} t \cdot (t+1) \cdot c_t \cdot (1+r)^{-t-2}}{\sum_{t=1}^{T} c_t \cdot (1+r)^{-t}}$$

And we can apply the following approximation:

$$V(r+\Delta r) \approx V(r) - MD \cdot \Delta r \cdot V(r) + \frac{1}{2} \cdot C \cdot (\Delta r)^2 \cdot V(r)$$

4. Introduction to International Finance

4.4.2. Bond markets (9)

Example

We consider the following investment alternatives:

- Zero-bond 1: current price 81.6298; 3 years time to maturity
- Bond portfolio with cash flow (-81.6298; 0; 46.7290; 0; 53.5000),

Actually, the bond portfolio consists of two zero-bonds (with 40.8149 investment in each of the two bonds):

Zero-bond 2: current price 87.3439; 2 years time to maturity and

Zero-bond 3: current price 76,2895; 4 years time to maturity

- Investment (prices) of both alternatives are the same.
- The modified duration is for both alternatives is 2.8037.
- The convexity for zero-bond 1 is: C = 10,4813
- The convexity for the portfolio is: C = 11,3547

Example (continued)

An instant interest rate change will lead to the following new prices of the alternatives:

r	zero-bond 1	portfolio
5%	V(5%) = 86,3838	V(5%) = 86,3992
7%	V(7%) = 81,6298	V(7%) = 81,6298
9%	V(9%) = 77,2183	V(9%) = 77,2316

In both cases an investment in the portfolio is advantageous due to the higher convexity.

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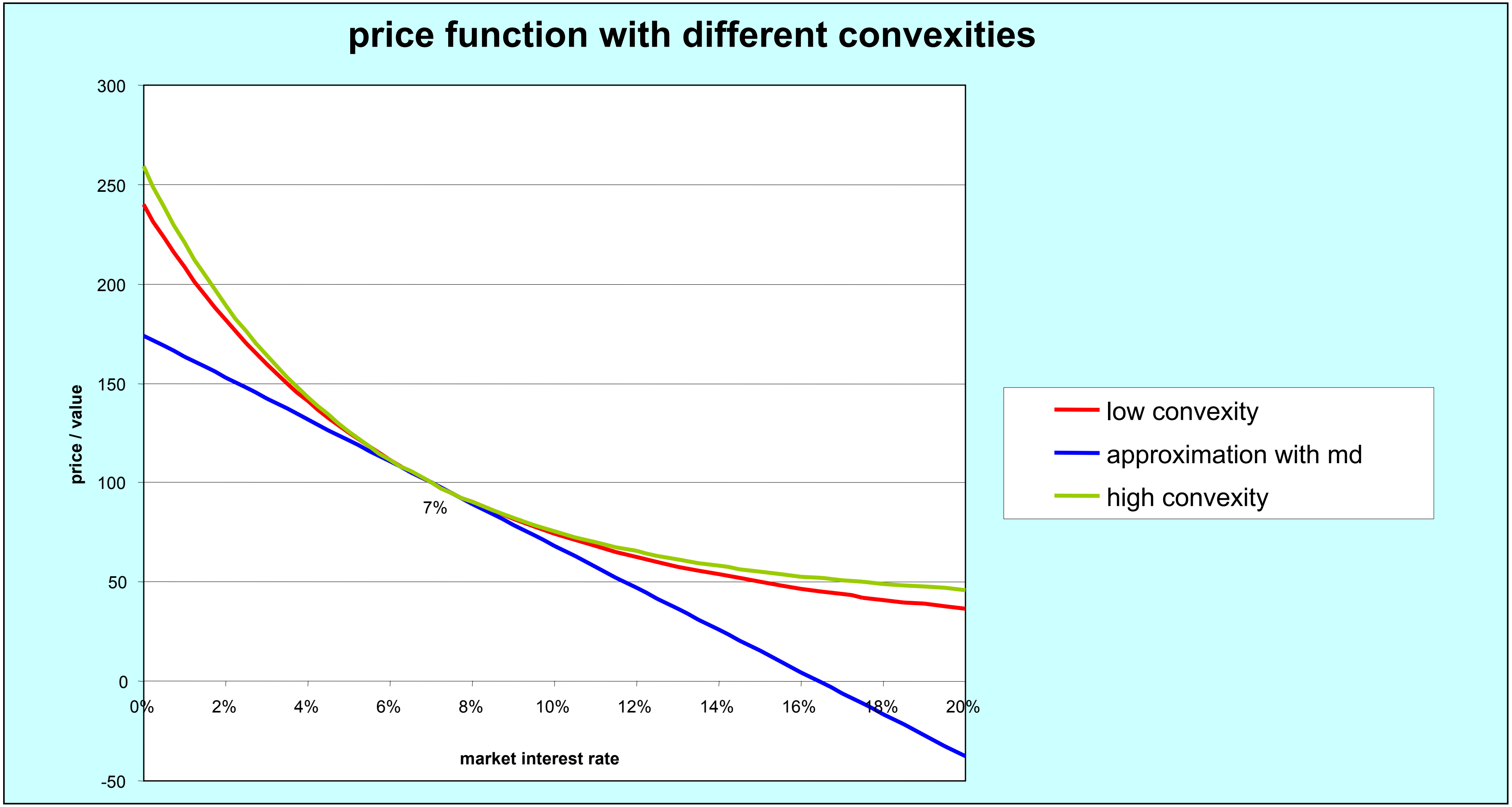
4.4.2. Bond markets (11)



Exercise

a) The current price of a zero-bond is 680,58 €; face value 1000 €; time to maturity 5 years. What is the current market interest rate?
Determine the **Macaulay duration.**

b) The current price of a bond is 100 €; face value 100 €; current market interest rate is 9%; time to maturity 3 years. What is the annual coupon payment?
Estimate the new bond prices using duration and convexity for the following yield shift: (+2.0).

Solution

Bond Investment Strategies

- **Buy and Hold Strategy**
  Bonds are kept until time to maturity.
- **Cash Flow Matching**
  Coupon and principal payments are matched to liability structure.
- **Duration Matching**
  Macaulay duration of a portfolio equals the investment horizon.
- **Immunisation**
  Structure assets and liabilities according to duration gap.
- **Riding the Yield Curve**
  Time to maturity of bonds longer than liability structure.

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4.4.2.1. Cash Flow Matching

Description of the strategy

1. **Identification of liability structure:**
   - Determination of amount and maturity of liabilities
   - Determination of fixed planning horizon
2. **Determination of relevant investment restrictions:**
   - E.g. rating, minimum and maximum investment amounts.
3. **Applying a cash flow matching strategy:**
   - Step 1: choose bond with time to maturity equal to maturity of longest liability, coupon and principal payment at time to maturity must cover total liability, earlier coupon payments reduce earlier liabilities.
   - Step 2: choose bond with time to maturity equal prior liability (consider coupon payments of bond 1).
   - Repeat for all maturities.

4.4.2.1. Cash Flow Matching (2)

Example

An investor determines the following liability structure which he wants to cover with a cash flow matching strategy:

- at time t=1, t=2, t=3, t=4: 100.000 €

The following bond are available:

- Bond 1 with (-100; 7; 7; 107),
- Bond 3 with (-102; 8; 8; 8; 108),
- Bond 4 with (-94; 5; 105),
- Bond 5 with (-95; 103).

In addition we consider:

- Zero-Bond with (-81,63; 0; 0; 100)

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4.4.2.1. Cash Flow Matching (3)

Time	t=4	t=3	t=2	t=1	t=0
Remaining liabilities	100.000	100.000	100.000	100.000	
Bond 3	926				
Revenues	**100.008**	**7.408**	**7.408**	**7.408**	-94.452
Remaining liabilities		92.592	92.592	92.592	
Bond 1		866			
Revenues		**92.662**	**6.062**	**6.062**	-86.600
Remaining liabilities			86.530	86.530	
Bond 4			825		
Revenues			**86.625**	**4.125**	-77.550
Remaining liabilities				82.405	
Bond 5				801	
Revenues				**82.503**	-76.095
Total investment					**-334.697**

4.4.2.1. Cash Flow Matching (4)

Time	t=4	t=3	t=2	t=1	t=0
Remaining liabilities	100.000	100.000	100.000	100.000	
Bond 3	926				
Revenues	100.008	7.408	7.408	7.408	-94.452
Remaining liabilities		92.592	92.592	92.592	
Zero-Bond		**926**			
Revenues		**92.600**	**0**	**0**	-75.589
Remaining liabilities			92.592	92.592	
Bond 4			882		
Revenues			**92.610**	**4.410**	-82.908
Remaining liabilities				88.182	
Bond 5				857	
Revenues				**88.271**	-81.415
Total investment					**-334.364**

4.4.2.1. Cash Flow Matching (5)

Exercise

The following liabilities are given:

at time t = 1: 1.000.000 €; at t = 2: 2.000.000 €; at t = 3: 3.000.000 €

The following bonds are available:

1. Bond 1: price: 100; coupon 8; time to maturity 3 years
2. Bond 2: price: 102; coupon 9; time to maturity 2 years
3. Bond 3: price: 104; coupon 10; time to maturity 1 year
4. Bond 4: price: 89; coupon 3; time to maturity 1 year

Apply a cash flow matching strategy and minimize the investors investment.

4. Introduction to International Finance

4.4.2.1. Cash Flow Matching (6)

Solution

Definition

A portfolio is **matched**, if the Macaulay duration of the portfolio equals the investment horizon.

Example

Given bond 1, the **Macaulay Duration** is *D*=2,8080.

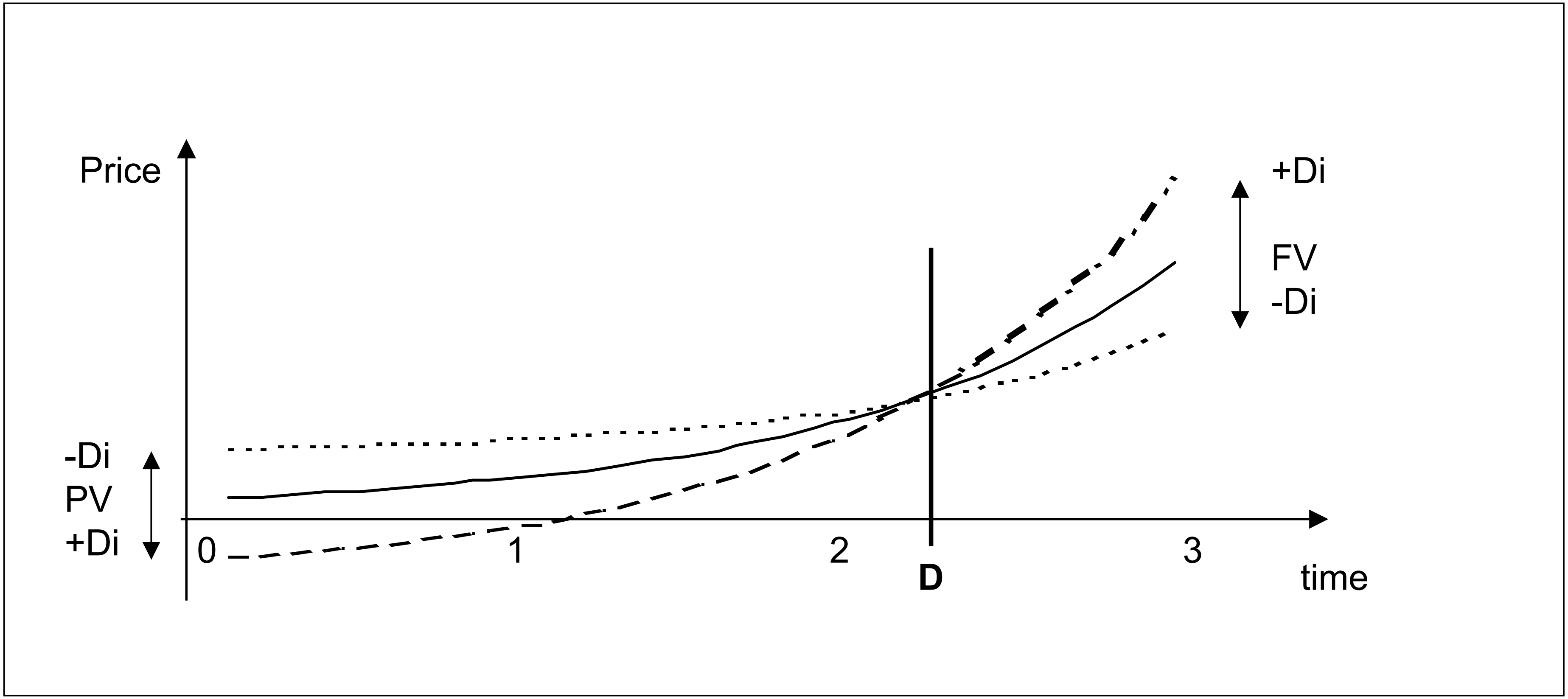
The total value of an investment for different yield scenarios at t = 2,8080 is then:

Yield r	5%	6,5%	7%	7,5%	9%
Bond price	106,0024	105,7142	105,6191	105,5247	105,2443
Reinvestment of coupons	14,9270	15,2096	15,3042	15,3991	15,6850
Total value	**120,9294**	**120.9238**	**120,9233**	**120,9238**	**120,9293**

Any interest rate change implies an increase of the portfolio value at t = 2,8080 .

4. Introduction to International Finance
4.4.2.2. Duration Matching (2)

Example



Mathematical background

To determine: minimum of the function

$$f(\Delta r) = (1 + r + \Delta r)^{\tau} \cdot \sum_{t=1}^{T} c_t \cdot (1 + r + \Delta r)^{-t}$$

We know:

$$f'(\Delta r) = \tau \cdot (1 + r + \Delta r)^{\tau - 1} \cdot \sum_{t=1}^{T} c_t \cdot (1 + r + \Delta r)^{-t} + (1 + r + \Delta r)^{\tau} \cdot \sum_{t=1}^{T} -t \cdot c_t \cdot (1 + r + \Delta r)^{-t-1}$$

$$f''(\Delta r) = \sum_{t=1}^{T} (-t + \tau) \cdot (-t + \tau - 1) \cdot c_t \cdot (1 + r + \Delta r)^{-t + \tau - 2}$$

Mathematical background

The necessary condition for a minimum is therefore .

Solve equation for τ:

$$\tau \cdot (1+r+\Delta r)^{\tau-1} \cdot \sum_{t=1}^{T} c_t \cdot (1+r+\Delta r)^{-t} \Big|_{\Delta r=0} = (1+r+\Delta r)^{\tau} \cdot \sum_{t=1}^{T} t \cdot c_t \cdot (1+r+\Delta r)^{-t-1} \Big|_{\Delta r=0}$$

$$\Rightarrow \frac{\tau \cdot (1+r+\Delta r)^{\tau-1}}{(1+r+\Delta r)^{\tau}} \Bigg|_{\Delta r=0} = \frac{\sum_{t=1}^{T} t \cdot c_t \cdot (1+r+\Delta r)^{-t-1}}{\sum_{t=1}^{T} c_t \cdot (1+r+\Delta r)^{-t}} \Bigg|_{\Delta r=0}$$

$$\Rightarrow \tau = (1+r) \cdot \frac{\sum_{t=1}^{T} t \cdot c_t \cdot (1+r)^{-t-1}}{\sum_{t=1}^{T} c_t \cdot (1+r)^{-t}} = \frac{\sum_{t=1}^{T} t \cdot c_t \cdot (1+r)^{-t}}{\sum_{t=1}^{T} c_t \cdot (1+r)^{-t}} = D$$

Check $f''(\Delta r) > 0$ for local minimum.

Assumptions

Assume unique interest rate for assets and liabilities.

- Net value of company can be calculated by:

$$N(r) = \sum_{t=1}^{T} c_t^A \cdot (1+r)^{-t} - \sum_{t=1}^{T} c_t^L \cdot (1+r)^{-t}$$

- Changes of the interest rate can be described by (r given):

$$N(\Delta r) = \sum_{t=1}^{T} c_t^A \cdot (1+r+\Delta r)^{-t} - \sum_{t=1}^{T} c_t^L \cdot (1+r+\Delta r)^{-t}$$

- Define duration gap: $MD^A - MD^L$

  where MD^A und MD^L are the modified durations of total assets and liabilities respectively.

- The net value is immunized against interest rate changes if the duration gap equals 0: $MD^A - MD^L = 0$

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4.4.2.3. Duration-gap Analysis (2)

Mathematical background

1) necessary condition:

$$\left.\frac{\partial N}{\partial \Delta r}\right|_{\Delta r=0} = 0$$

$$\Leftrightarrow \sum \left.\frac{-t \cdot c_t^A}{(1+r)^{t+1}}\right|_{\Delta r=0} = \sum \left.\frac{-t \cdot c_t^L}{(1+r)^{t+1}}\right|_{\Delta r=0}$$

$$\Leftrightarrow \left.\frac{\sum -t \cdot c_t^A \cdot (1+r)^{-t-1}}{\sum c_t^A \cdot (1+r)^{-t}}\right|_{\Delta r=0} = \left.\frac{\sum -t \cdot c_t^L \cdot (1+r)^{-t-1}}{\sum c_t^L \cdot (1+r)^{-t}}\right|_{\Delta r=0}$$

$$\Leftrightarrow MD^A = MD^L$$

Mathematical background

2) sufficient condition:

$$\left.\frac{\partial^2 N}{\partial \Delta r^2}\right|_{\Delta r=0} \geq 0$$

$$\Leftrightarrow \sum \left.\frac{-t \cdot (-t-1) \cdot c_t^A}{(1+r)^{t+2}}\right|_{\Delta r=0} \geq \sum \left.\frac{-t \cdot (-t-1) \cdot c_t^L}{(1+r)^{t+2}}\right|_{\Delta r=0}$$

$$\Leftrightarrow \left.\frac{\sum t \cdot (t+1) \cdot c_t^A \cdot (1+r)^{-t-2}}{\sum c_t^A \cdot (1+r)^{-t}}\right|_{\Delta r=0} \geq \left.\frac{\sum t \cdot (t+1) \cdot c_t^L \cdot (1+r)^{-t-2}}{\sum c_t^L \cdot (1+r)^{-t}}\right|_{\Delta r=0}$$

$$\Leftrightarrow C^A \geq C^L$$

Exercise

The liabilities of Speedy GmbH can be described by the following cash flow:
(+100.000; -7.000; -7.000; -107.000).

The current interest rate for assets and liabilities is 7%.

The responsible portfolio manager of the Speedy GmbH examines the following investment (asset) strategies:

Cash flow from investment strategy 1: (-100.000; 0; 21.980; 98985,7)

Cash flow from investment strategy 2: (-100.000; 0; 68.235; 0; 52.957,3496)

Cash flow from investment strategy 3: (-100.000; 0; 68.000; 0; 53.226,401)

Cash flow from investment strategy 4: (-100.000; 0; 68.500; 0; 52.653,951)

Calculate for all strategies modified duration and explain by applying duration-gap analysis which of the strategies are suitable.

(Hint: convexity of strategy 1: C = 9,4752; convexity of strategy 2: C = 10,1809)

4.4.2.3. Duration-gap Analysis (5)

Solution

4.4.2.4. Riding the Yield Curve

Assumptions

Necessary condition

- Normal (upward sloping) yield curve

Strategy

- investor buys bonds with time to maturity longer than maturity of liabilities.

Decreased or unchanged yield structure:

- Selling before time to maturity generates higher returns than pure cash flow matching
- Reasons:
  - Higher YTM during investment horizon.
  - Additional gains due to increase of bond prices.

Increase of yield curve:

- Bond prices fall → **risk of loss**

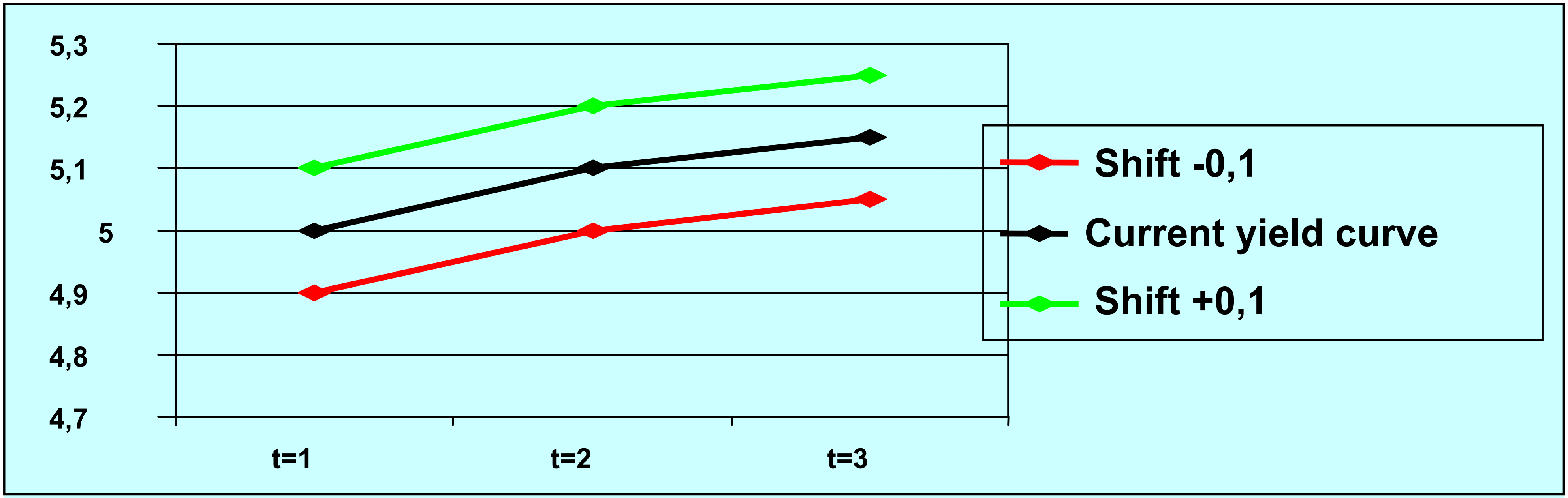
4.4.2.4. Riding the Yield Curve (2)

Example

- Zero-bond 1 (-90,53; 0; 100); Zero-bond 2 (-86,01; 0; 0; 100)
- Investor‘s liabilities at t=2: 100.000 €

Yield curve:

- 5% for 1 year; 5,1% for 2 years; 5,15% for 3 years



4.4.2.4. Riding the Yield Curve (3)

Example

- Zero-bond 1 (-90,53; 0; 100); Zero-bond 2 (-86,01; 0; 0; 100)
- investment 90.530 €:
  - ? 1000 of Zero-bond 1 or 1052,55 of Zero-bond 2

Prices for zero-bond 2 at t=2:

- shift = 0
  - bond price: 95,24; portfolio value: 100.245 €
- shift = +0,1
  - bond price: 95,15; portfolio value: 100.150 €
- shift = -0,1
  - bond price: 95,33; portfolio value: 100.340 €
- shift = +0,3
  - bond price: 94,97; portfolio value: 99.961 €

Exercise

The following liabilities are given:

t = 1: 1.000.000 €; t = 2: 1.000.000 €

An investor can choose from the following bonds:

- bond 1: (-100; 7; 107)
- bond 2: (-100; 106)

Compare the strategies 'cash-flow-matching' and 'riding-the-yield-curve'. Which one is better if you assume that the yield curve is not going to change?

Calculate the necessary investments for both strategies.

4.4.2.4. Riding the Yield Curve (5)

Solution: Cash-flow-matching

4.4.2.4. Riding the Yield Curve (6)

Solution: Riding-the-yield-curve

Hedging

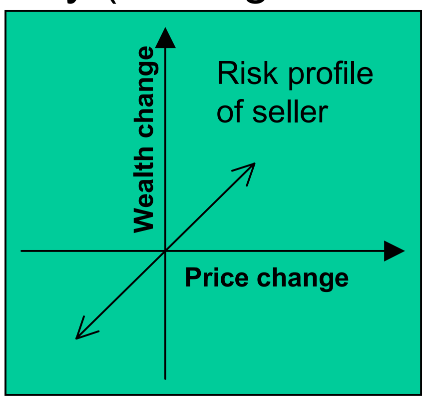
Reducing a company's exposure to price or rate fluctuations

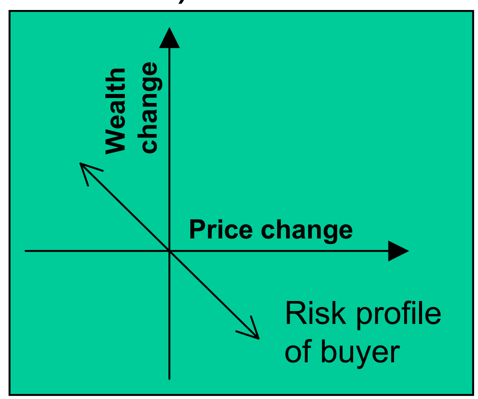
➔ Financial engineering

Volatility

- Price volatility (inflation)
- Interest rate volatility
- Exchange rate volatility
- Commodity price volatility (basic goods and material)

The Risk Profile





Terminology

An **option contract** is an agreement that gives the owner the right, but not the obligation, to buy or to sell an underlying asset at a fixed price, called the strike or exercise price, for a specified time.

Calls

A call option is an option contract that gives the owner the right to buy an asset.

Puts

A put option is an option contract that gives the owner the right to sell an asset.

American Option

Option can be exercised within a specified period.

European Option

Option can be exercised only on the expiration date.

4.5.1. Options (2)

Features of an Option

- Type of Transaction (Put or Call)
- Style of Option (American or European)
- Name of Issuer
- Underlying Asset
- Exercise Price (Strike Price)
- Expiration Date

Notation

- C = Call price
- P = Put price
- S = Current price of the underlying asset
- S_T = Price of the asset on expiration date
- X = Exercise price of the option

4.5.1. Options (3)

Advantages

- Hedging,
- High returns due to leverage,
- Possibility of portfolio insurance,
- Low capital investment necessary for an option deal.

Disadvantages

- Limited time to maturity,
- New sources of risk,
- Complexity of products ➔
  high standards requested from personnel, organisation, data processing, permanent supervision,
- Restricted range of product.

Value of an Option

Definition

An option (call or put) is said to be **at the money** if the exercise price X practically corresponds to the current price S of the underlying asset.

Definition

A call is said to be **in the money** if X is less than the current price S, correspondingly a put is in the money if X is greater than S.

Definition

A call is said to be **out of the money** if X is greater than the current price S, correspondingly a put is said to be out of the money if X is less than S.

Value of an Option at Expiration Date

(Intrinsic) Value of a Call on Expiration Date

- $S_T - X$ for $S_T > X$
- 0 for $S_T < X$

➔ i.e. value of call = max $(0, S_T – X)$

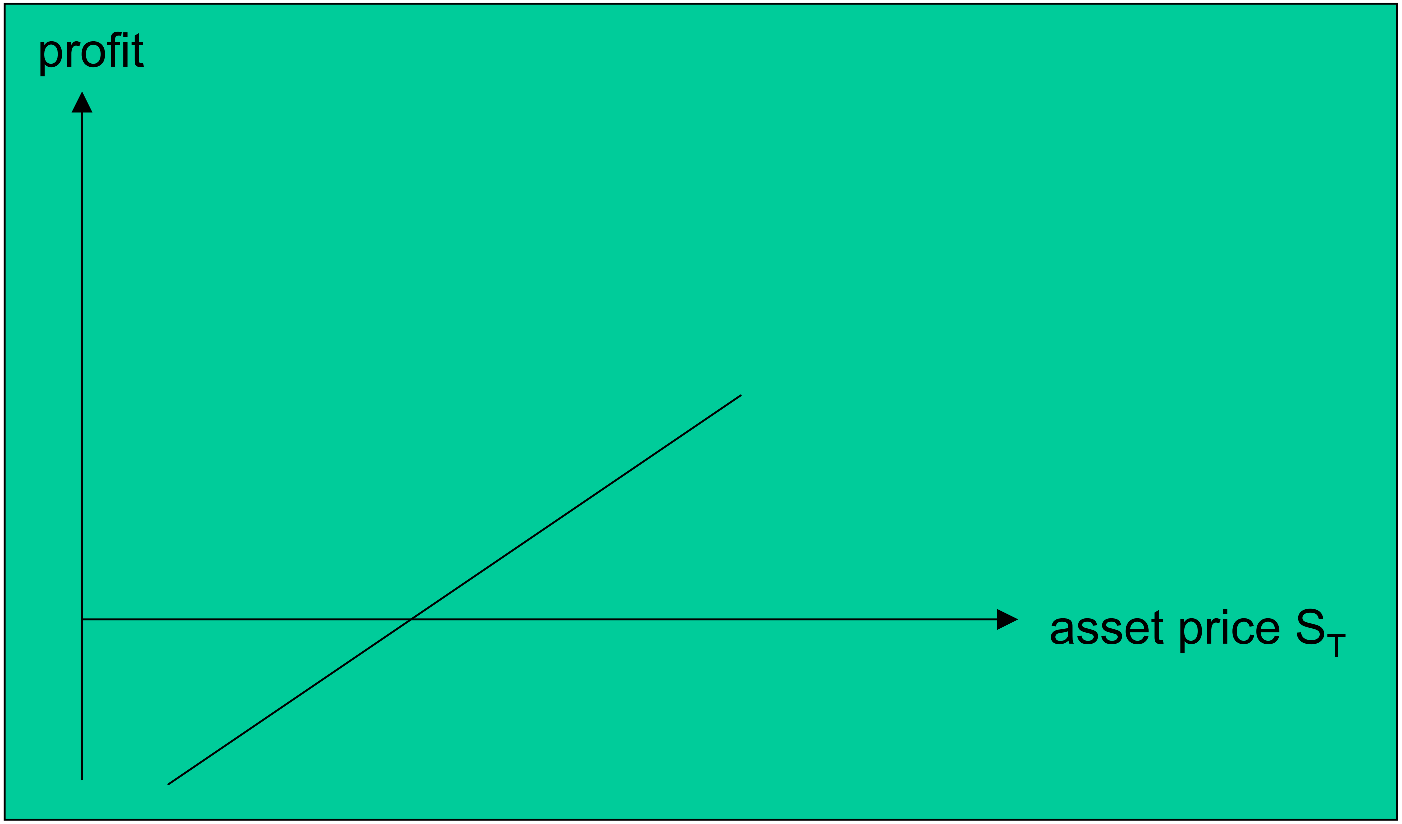
(Intrinsic) Value of a Put on Expiration Date

- 0 for $S_T > X$
- $X - S_T$ for $S_T < X$

➔ i.e. Value of put = max $(0, X – S_T)$

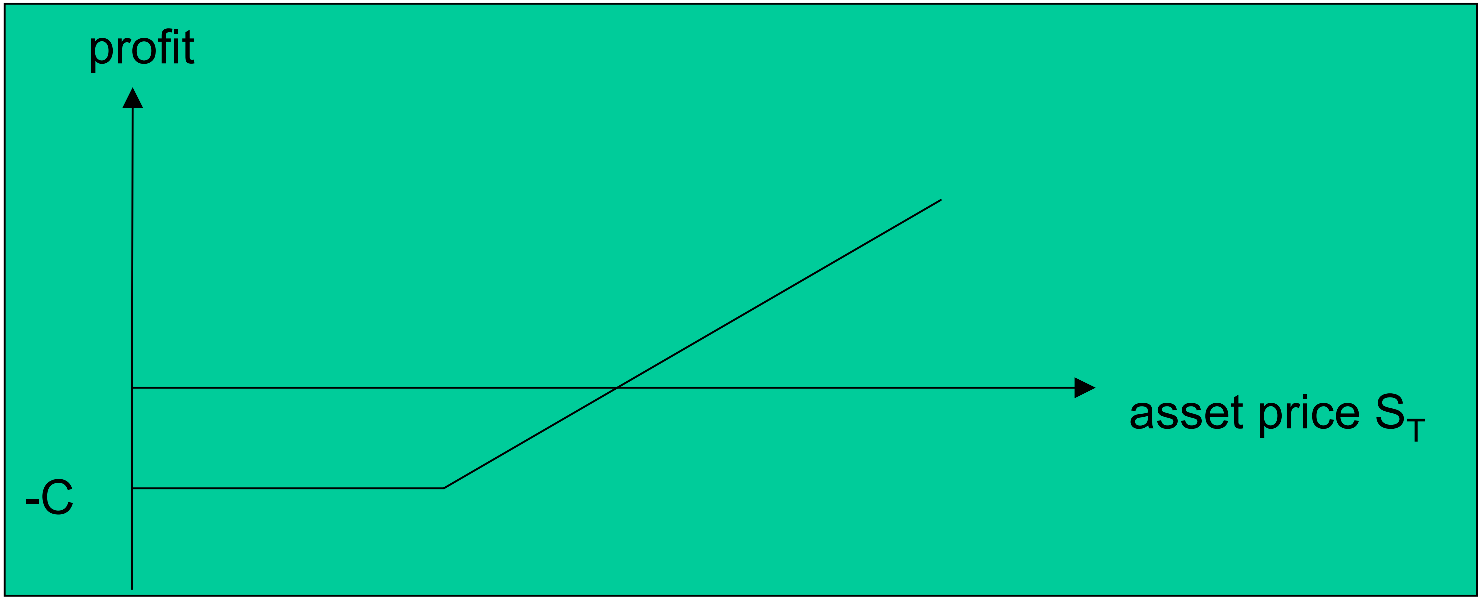
Risk Profile (Profit Loss Diagram) of a Share

- Profit on expiration date: S_T - S



Risk Profile Buying a Call

- Profit on expiration date: max (0, S_T – X) – C
- Break even for S_T = X + C
- Profit if S_T > X + C:
  - Maximum profit: unlimited   maximum loss: - C



Example

You purchase a call for C = 3 € with an exercise price of 40 €.

Then, on expiration date you profit loss situation is as follows:

Remember: profit on expiration date is: max (0, S_T – X) – C

Price Range	**Profit / Loss**
$S_T \leq 40$ €	max (0, S_T – 40 €) – 3 € = – 3 €
$S_T > 40$ €	max (0, S_T – 40 €) – 3 € = S_T – 43 €

Exercise

You sell a call for C = 3 € with an exercise price of 40 €.

Determine your profit loss situation on expiration date:

Solution

Exercise Protective Put

You purchase a share at a current price of S = 54 € and a put on that underlying for P = 2 € with an exercise price of 50 €.

Determine your profit loss situation on expiration date:

Solution

Exercise Covered Call

You purchase a share at a current price of S = 38 € and sell a call on that underlying for C = 3 € with an exercise price of 40 €.

Determine your profit loss situation on expiration date:

Solution

Other Common Strategies

Spreads

Combination of several calls or several puts respectively

- **„Money Spreads":**
  - Different exercise prices
  - Equal time to maturity
- Bullish Spread
- Bearish Spread

Straddles

Combination of call(s) and put(s)

- Long Straddle
- Straps = Bullish long Straddle
- Strips = Bearish long Straddle

Definition

Forward contracts are a legally binding agreement between two parties calling for the sale of an asset or product in the future at a price agreed upon today.

Definition

Futures are standardized forward contracts with the feature that gains and losses are realized each day rather than only on the settlement day.

Definition

Swap contracts are an agreement by two parties to exchange specified cash flows at specified intervals in the future.

Example

- The Computereinkauf GmbH must pay 200.000 US-Dollar for computers to its suppliers in 3 months.
- Suppose:
  - Exchange rate today: 1,00 US$ = 1,00 €
  - Exchange rate in 3 months (1): 1,05 € $\Rightarrow$ 210.000 €
  - Exchange rate in 3 months (2): 0,90 € $\Rightarrow$ 180.000 €
  - Exchange rate in 3 months (3): 1,00 € $\Rightarrow$ 200.000 €

Analyse the hedging possibilities of the company!

4.6.3. Hedging of Exchange Rate Risk (2)

Immediate coverage:

- Buy Dollars at current exchange rate
- Invest Dollars
- Interest Rate on investment depends on national situation (yield curve)

Advantages

- Exchange rate is known
- No additional costs

Disadvantages

- Capital binding
- Company can't profit from exchange rate chances

Forward Contract on Exchange Rates:

- Company receives fixed exchange rate from bank.
- Company is required to purchase Dollars on expiration date (in 3 months).
- Suppose: Exchange rate (in 3 months): 1 US$ = 1 €

Advantages

- Exchange rate is known
- No additional costs
- No capital binding

Disadvantages

- Company can't profit from exchange rate chances

Option Contract on Exchange Rate:

- Computereinkauf GmbH purchases a call on Dollars.
- Right to purchase Dollars **at a fixed price** at a specified time (in 3 months).
  - Exercise price: 1US$ = 1 €
  - Call price: 0,025 € pro US$
    → Total: 5.000 €

Advantages

- No capital binding
- Company is hedged against negative exchange rate developments
- Company can profit from exchange rate chances

Disadvantages

- Additional costs due to call price

Possible Scenarios:

- Exchange rate in 3 months (1): 1,05 € ⇒
  - with call option:
    200.000 € + 5.000 € = 205.000 €
  - without call option:
    210.000 € + 0 € = 210.000 €
- Exchange rate in 3 months (2): 0,90 € ⇒
  - with call option:
    ⇒ Computereinkauf GmbH doesn’t exercise the option
    180.000 € + 5.000 € = 185.000 €
  - without call option:
    180.000 € + 0 € = 180.000 €

Hedging with Option Contracts