

# Bonds

Ugo Pomante

Professor of «Finance & Banking»

Tor Vergata University

# Why are they issued?

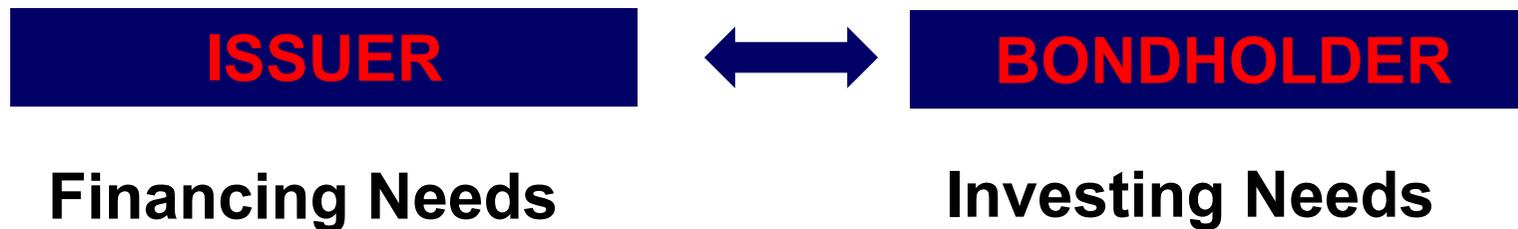
They are issued in order to *borrow money*

Funding Sources/Channels:

- Banks (via *loans*)
- **Market (via bonds)** 

# A. Definition

The bond is a contract between the **issuer** (lender) and the **bondholder** (borrower), where the issuer is obliged to pay an interest and to return the borrowed capital.



## B. Bonds: Classification

Bonds can be classified in many ways. These are the most common and widely applied:

- **Issuer:** Government-Corporate
- **Maturity:** Short term – Long Term
- **Presence of the Coupon:** Zero coupon bond – Coupon bond
- **Type of interest:** Fixed rate bond – Floating rate bond
- **Quality of the issuer:** Investment grade – Speculative grade
- **Embedded Derivatives:** plain vanilla bond – structured bond

# Bonds: Valuation

\* *The analysis is focused only on fixed rate bonds*

# **An Introduction to the Pricing of Financial Assets**

# Pricing of Financial Assets

- Pricing of Financial asset is based on a BASIC RULE:

**Asset Price = Present Value of future cash flows**

$$P = \sum_{t=1}^n \frac{E(CF_t)}{(1+r)^t}$$

**Where:**

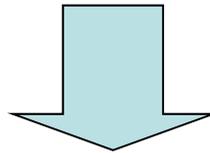
**$P$  = Asset Price**

**$E(CF_t)$  = Cash Flow that the asset is expected to pay at time  $t$**

**$r$  = Fair return required by the investor (the discount rate)**

# Pricing Problems

- **Maturity may be uncertain**
- **Cash flow unknown**
- **Timing of cash flows unknown**



**Anyway, these problems don't affect the valuation of fixed rate bonds held to maturity**

## **C. Bond Pricing on Yield curve**

# Bond Pricing on Yield curve *(follows)*

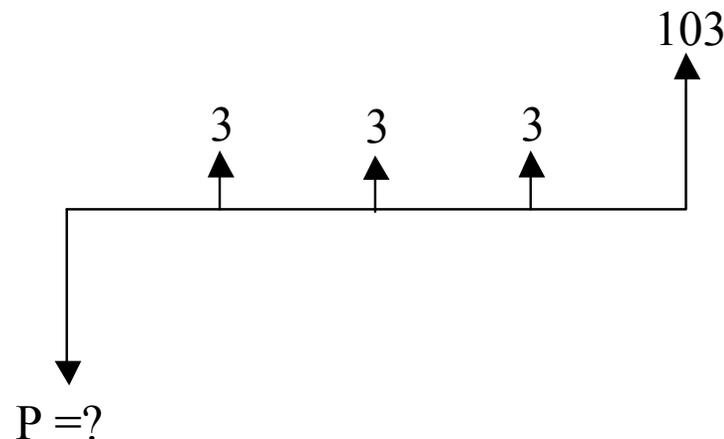
Suppose we need to price the following Government Bond issued by country which credit quality is average:

T = Maturity = 4 yrs

Coupon frequency = yearly

Coupon Value = 3

So, the financial structure of the bond is the following:

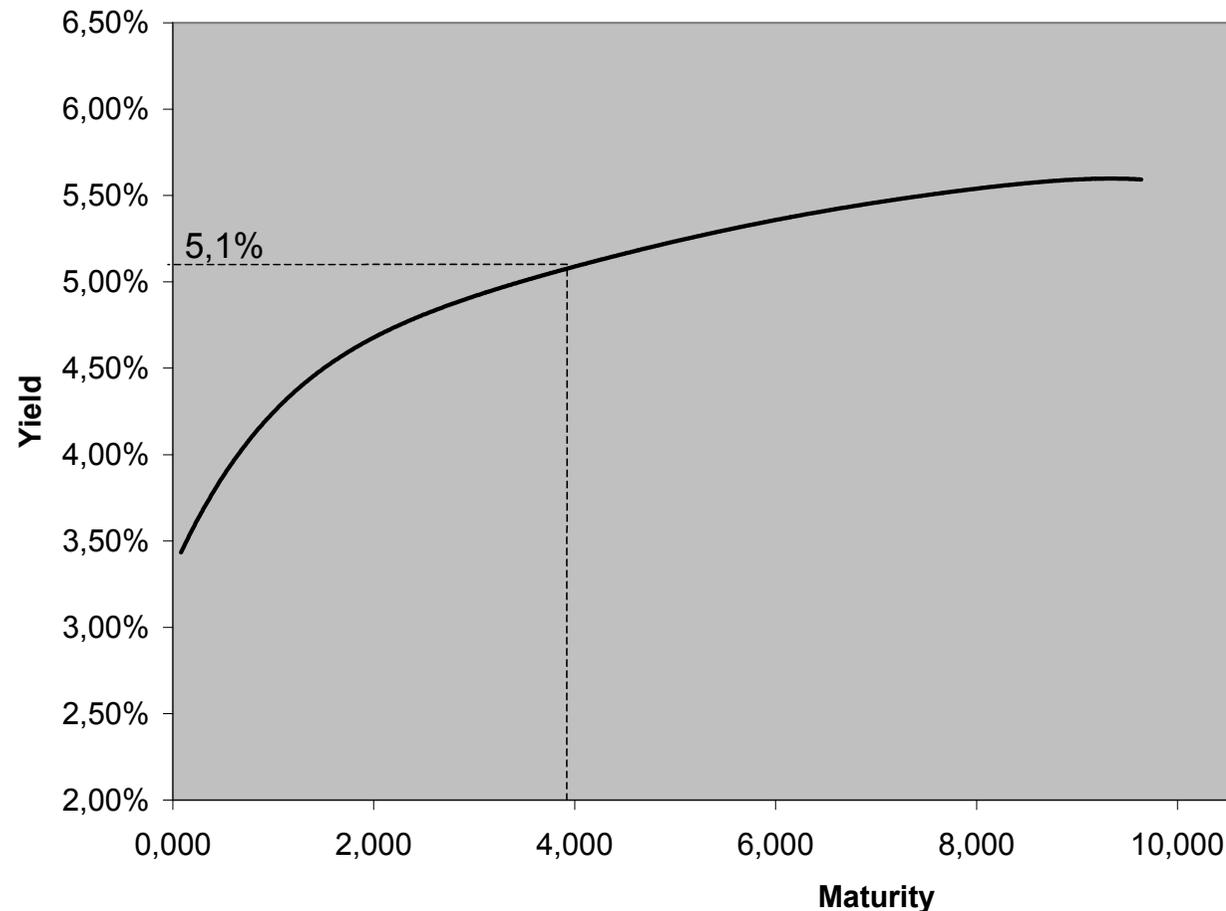


- In order to price the Bond, we need to discount all the future cash flows (in other words, we need to find the present value of the future cash flows). To do that, we need to choose **the discount rate**.

# Bond Pricing on Yield curve

*(follows)*

- **At the valuation date, the Bond Market “shows” the following Yield Curve of Bonds issued by this country:**



**Yield Curve shows the yields that market “quotes” for different maturities of bonds.**

# Bond Pricing on Yield curve

*(follows)*

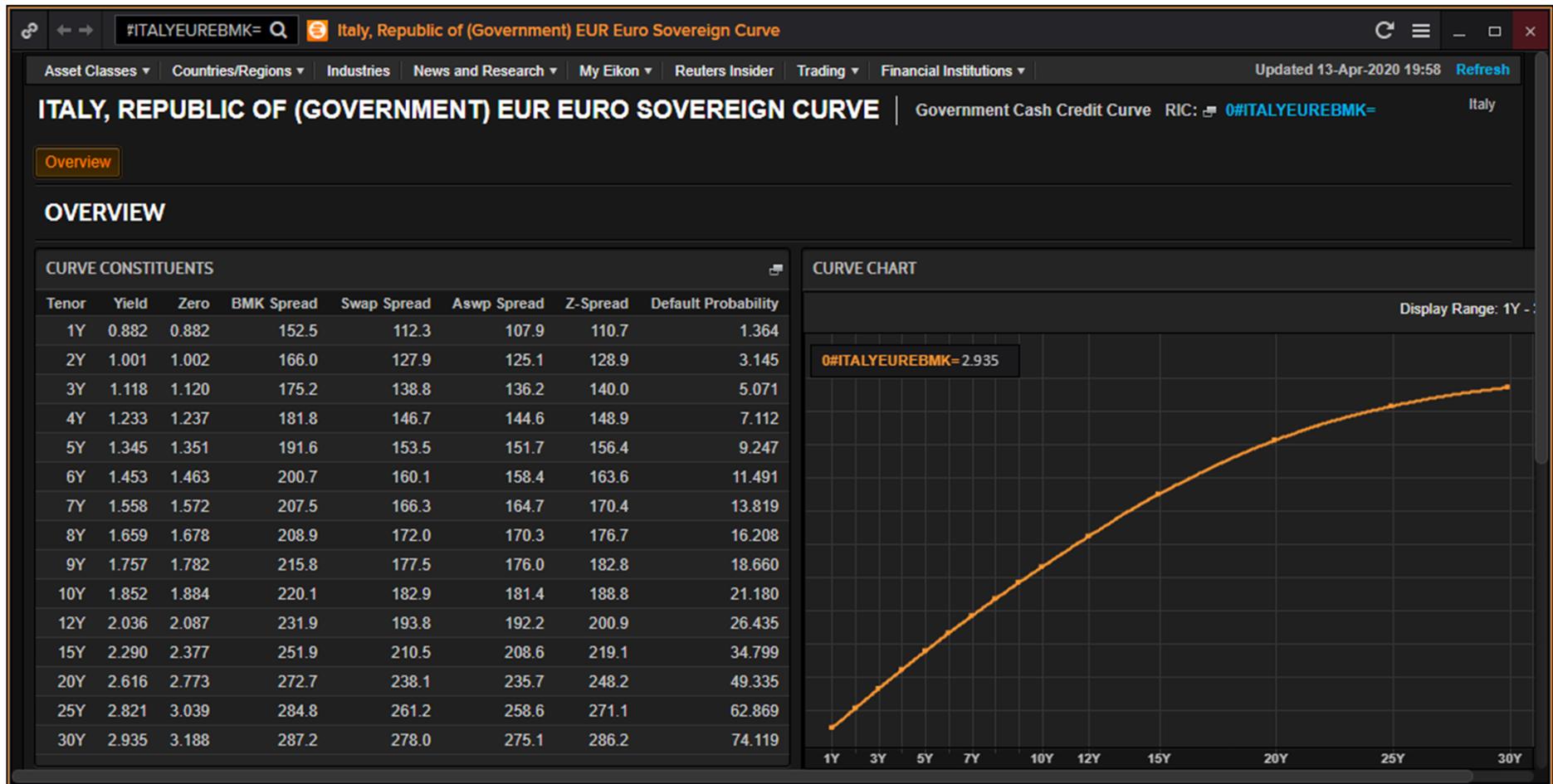
- Previous Chart shows that for the 4 yrs maturity bonds issued by this country market requires a yield-to-maturity of 5.1%.
- So In order to price the Bond, we need to discount all the future cash flows using the discount rate of 5.1%:

$$P_{Fair} = \frac{3}{(1+5.1\%)^1} + \frac{3}{(1+5.1\%)^2} + \frac{3}{(1+5.1\%)^3} + \frac{103}{(1+5.1\%)^4} =$$
$$= 2.85 + 2.72 + 2.58 + 84.42 = 92.57$$

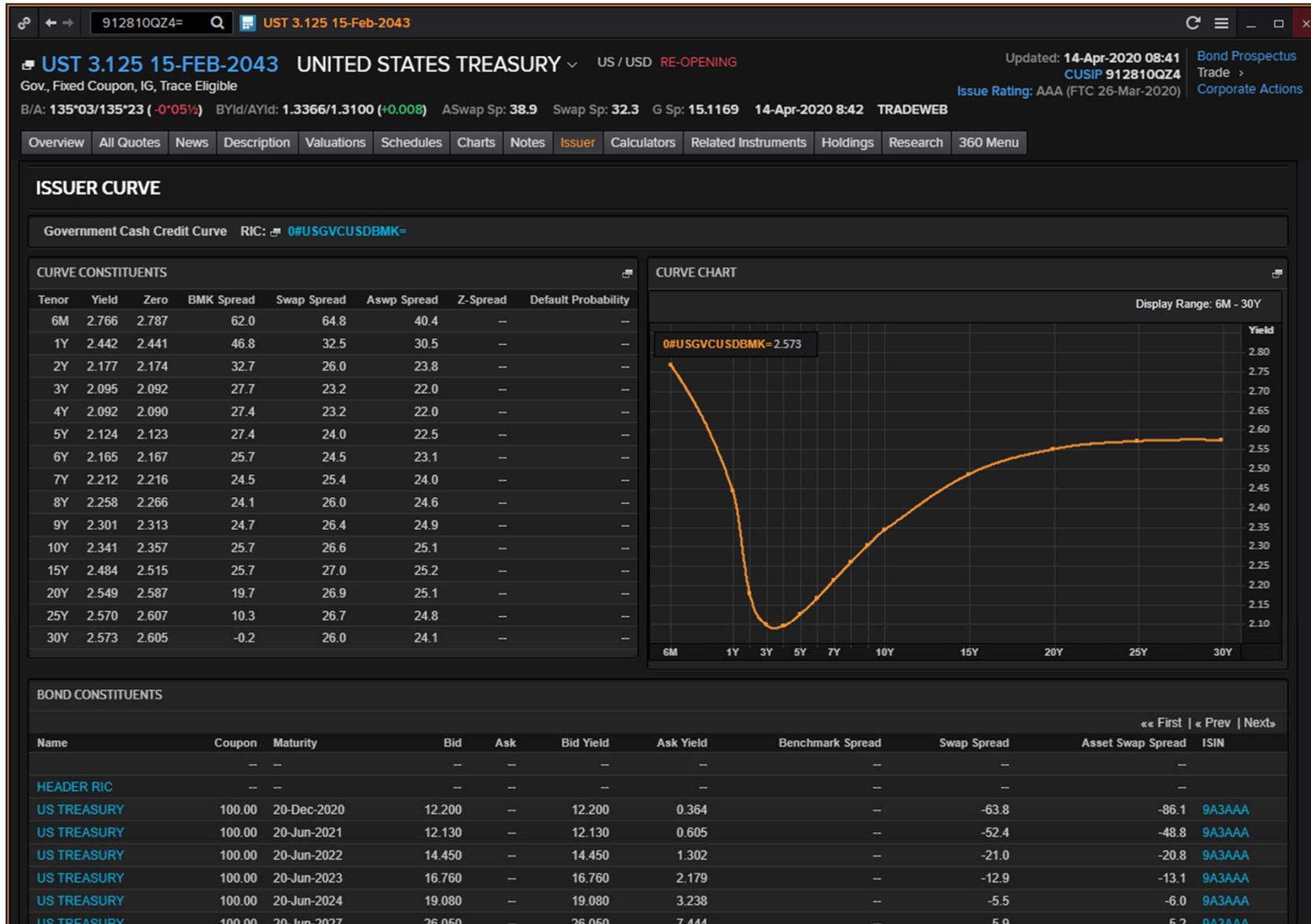
- If the price were differed from 92.57, the bond wouldn't have the yield-to-maturity (5.1%) that market requires on a 4yrs government bond.

# Bond Pricing on Yield curve: conclusion

- In order to price a Bond on the Yield curve, you have to discount its cash flows using the yield-to-maturity that the bond market “quotes” for bonds having same issuer and same maturity.



# US Treasury Yield Curve



## D. Risk

The purpose of this section is to analyse the risk measures useful to quantify the overall risk of bonds.

## **D. Risk**

**Investors in bonds face three types of risk:**

- Interest Rate Risk**
- Credit Risk**
- Liquidity Risk**

***(\*if the bonds are issued in foreign currency, Exchange Rate Risk)***

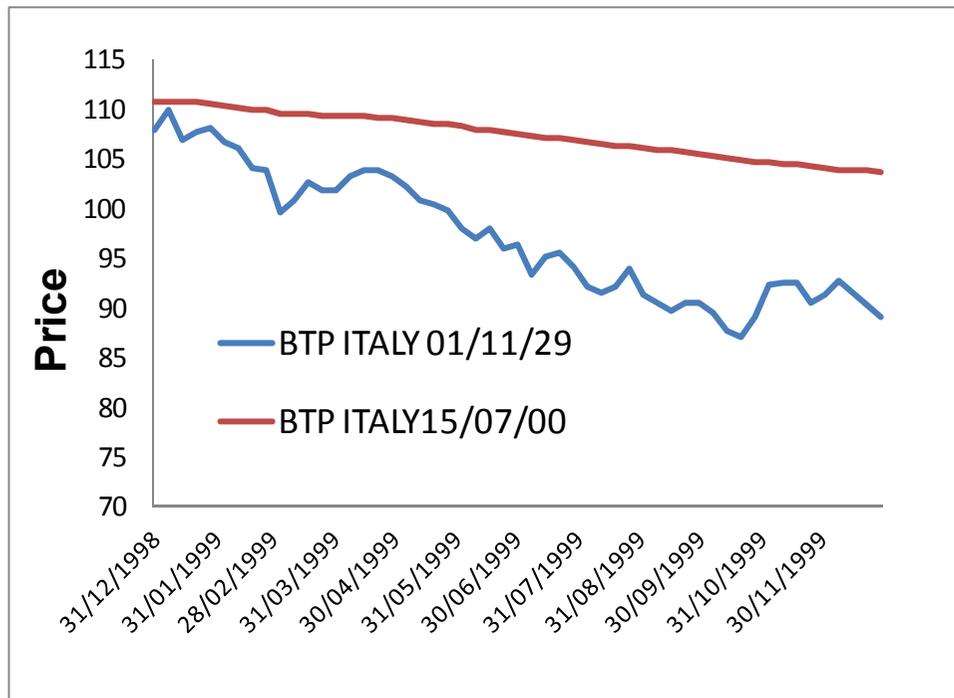
 Interest Rate Risk

## Info:

a. We are at the date: December 31, 1998

b. Let's analyze the following Bonds:

- **BTP ITALY 5,25 01/11/29**
- **BTP ITALY 10,5 15/07/00**

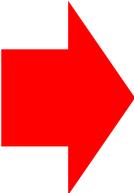


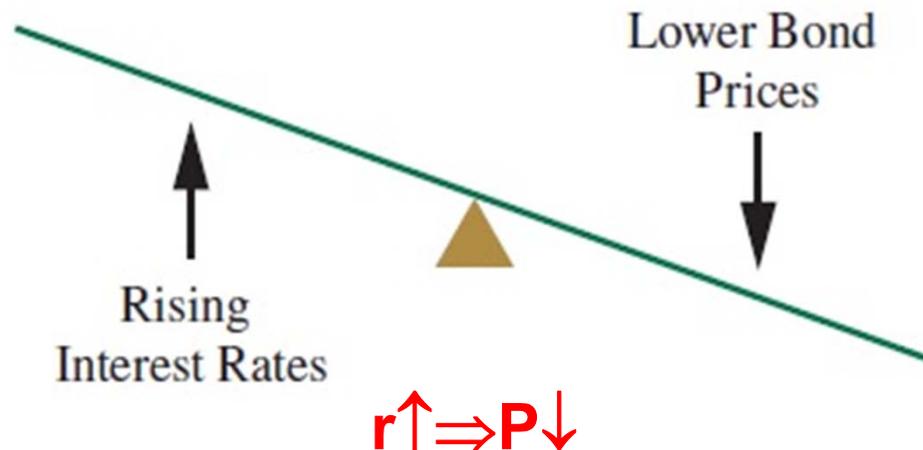
BTP ITALY 01/11/29	BTP ITALY 15/07/00
-17,4%	-6,4%

# Interest Rate Risk

Among the risk measures mentioned, this is undoubtedly the one which, before the 2008 crisis, assumed greater importance.

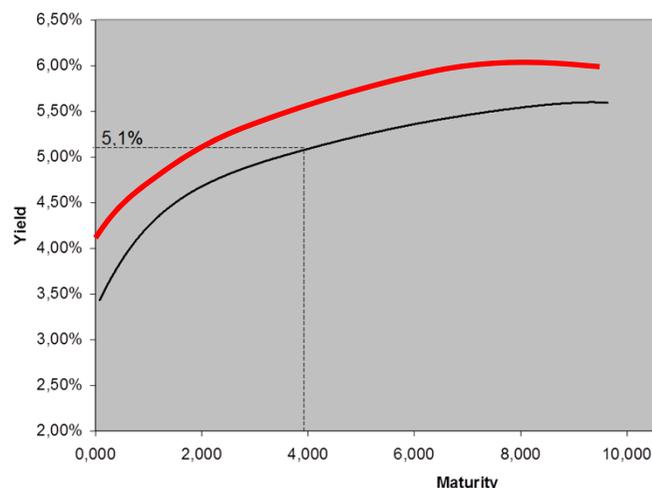
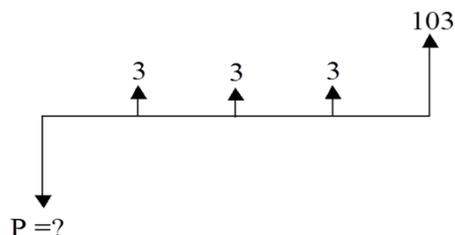
Definition: "*Interest rate risk is the risk of a reduction in the price of a bond, due to an unexpected rise of market interest rates*".

**Increase of market interest rate**  **Price reduction**



# Example

T = Maturity = 4 yrs  
 Coupon frequency = yearly  
 Coupon Value = 3



$$P_{Fair} = \frac{3}{(1+5.1\%)^1} + \frac{3}{(1+5.1\%)^2} + \frac{3}{(1+5.1\%)^3} + \frac{103}{(1+5.1\%)^4} =$$

$$= 2.85 + 2.72 + 2.58 + 84.42 = 92.57$$



Due to an unexpected **increase** in inflation rates, interest rates increase by 1% ( $\Delta r = +1\%$ )

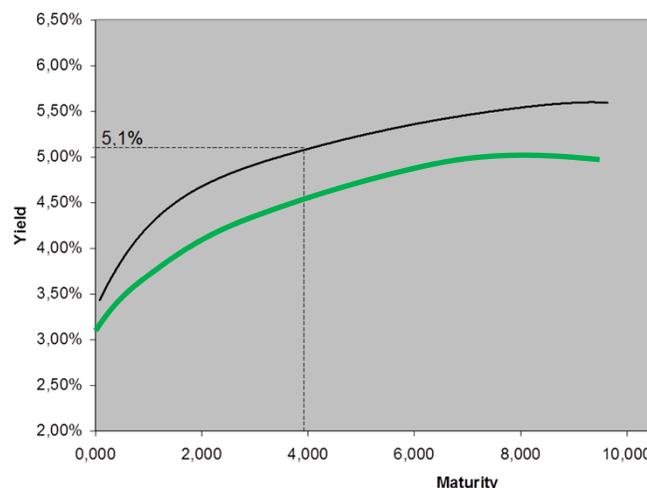
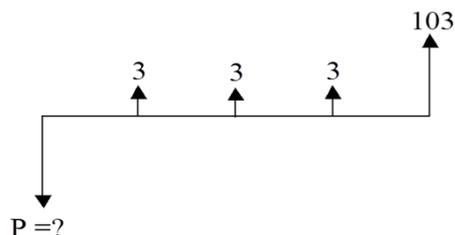
$$P_{Fair} = \frac{3}{(1+6.1\%)^1} + \frac{3}{(1+6.1\%)^2} + \frac{3}{(1+6.1\%)^3} + \frac{103}{(1+6.1\%)^4} =$$

$$= 2.83 + 2.66 + 2.51 + 81.28 \approx 89.28$$

$$\Delta\%P = \frac{(89.28 - 92.57)}{92.57} = -3.55\%$$

# Example

T = Maturity = 4 yrs  
 Coupon frequency = yearly  
 Coupon Value = 3



$$P_{Fair} = \frac{3}{(1 + 5.1\%)^1} + \frac{3}{(1 + 5.1\%)^2} + \frac{3}{(1 + 5.1\%)^3} + \frac{103}{(1 + 5.1\%)^4} =$$

$$= 2.85 + 2.72 + 2.58 + 84.42 = 92.57$$



Due to an unexpected **reduction** in inflation rates, interest rates decrease by 1% ( $\Delta r = -1\%$ )

$$P_{Fair} = \frac{3}{(1 + 4.1\%)^1} + \frac{3}{(1 + 4.1\%)^2} + \frac{3}{(1 + 4.1\%)^3} + \frac{103}{(1 + 4.1\%)^4} =$$

$$= 2.88 + 2.77 + 2.66 + 87.71 \approx 96.02$$

$$\Delta\%P = \frac{(96.02 - 92.57)}{92.57} = +3.73\%$$

# How to easily calculate the interest rate risk

3 well known bond pricing relationships:

1. Bond prices and yields are so inversely related:  $r \uparrow \Rightarrow P \downarrow$      $r \downarrow \Rightarrow P \uparrow$
2. Long-maturity bond prices tend to be *more sensitive* to interest rate changes than short- maturity bond prices (given  $\Delta r$ ,  $\Delta P$  is higher for long maturity bonds).
3. Interest rate risk is inversely related to the bond's coupon rate (given two bond with the same maturity,  $\Delta P$  is higher for bonds having little coupons).

# Modified Duration

Modified Duration: a measure of the sensitivity of a bond price to interest rate changes.

The Modified Duration (MD) is directly proportional to the maturity and inversely proportional to the coupon.

*[\* The analytics of this risk indicator will be analyzed in Financial Mathematics courses]*

Let's consider a government bond issued by Italy  
(BTP)

**ITGV 3.000 01-AUG-2029**

**Price: 112.5**

**Annual Coupon 3**

**Maturity: August 1, 2029**

**Yield to Maturity = 1.52%**

BOND INFORMATION		Summary View	
<b>PRINCIPAL / COUPON INFORMATION</b>		<b>ISSUANCE DETAILS</b>	
Maturity Date	01-Aug-2029 @ 100%	Issue Date / Price / Yield	01-Mar-2019 / 101.85% / 2.81
Principal / Coupon Currency	EUR / EUR	Issue Spread	--
Coupon Type	Fixed:Plain Vanilla Fixed Coupon	Announcement Date	22-Feb-2019
Coupon Frequency	Semiannually	Country of Issue	Italy
Current Coupon / Next Pay D...	3.00000 / 01-Aug-2020	Market of Issue	Domestic
Dated / First / Final Coupon	01-Feb-2019 / 01-Aug-2019 / ...	Underwriters	--
Amount Outstanding	20,262,500,000 EUR	▶ Show More	
Par Value / Min. Denominatio...	1,000.00 / 1,000.00 / 1,000.00...	<b>MORE BOND INFORMATION</b>	
Floating Rate Note	No	Rank (Seniority)	New Sovereign
▶ Show More		Series #	10Y
<b>MARKET CONVENTIONS</b>		▶ Listed On	
Day Count Basis	Actual/Actual ICMA, Act/Act IC...	▶ Show More	
Settlement	Trade + 2 Business Days	<b>TAX DETAILS</b>	
▶ Show More		EU Savings Tax Directive	Yes
<b>BOND TYPE</b>		01-Mar-2002 or later tap	Yes
Instrument Type	Bond	Issued on or before 01-Mar-2...	No (01-Mar-2019)
MTN	No	▶ Show More	
▶ Show More		<b>REGULATIONS</b>	
<b>COVENANTS</b>		MIFIR Identifier / MiFID Bond ...	Bond / Sovereign bond
Prospectus Available	Yes (27-Feb-2019)	MIFID Liquidity Indicator (COF...	No
Latest Prospectus	31-Jul-2019	MiFID liquidity indicator (ESMA)	Yes
Collective Action Clause	Yes	▶ Show More	
<b>TRADING RESTRICTIONS</b>			
Name	Country	Status	

➤ **What is the loss if rates go up 100 basis points (+ 1.0%)?**

IT536516= ITGV 3.000 01-Aug-2029

**ITGV 3.000 01-AUG-2029** ITALY, REPUBLIC OF (GOVERNMENT) IT / EUR RE-OPENING

Gov., Fixed Coupon, IG, RegS

Updated: 13-Apr-2020 19:57 ISIN IT0005365165 Bond Prospectus Trade > Corporate Actions

Issue Rating: BBB (high) (DOM 15-Nov-2019)

B/A: 112.200/112.800 (-0.197) BYld/AYld: 1.590/1.524 (+0.022) ASwap Sp: 168.91 Swap Sp: 161.10 G Sp: 196.274 13-Apr-2020 8:06 TR COMPOSITE

Overview All Quotes News Description Valuations Schedules Charts Notes Issuer Calculators Related Instruments Holdings Research 360 Menu

### VALUATIONS

PRICE INFORMATION		HISTORICAL VALUATION																																																					
Bid / Ask Price	*112.8260400 / 113.0098700	Change Information	Previous Day End of Month																																																				
Bid / Ask Spread	18.4	Price	112.9291300 113.4168000																																																				
Priced Using	190.0 bp yield spread off 9.29 YR / -0.38% (interpolated European Monetary Union/EUR Native Treasury Curve) (MAT Aug-2029)	Price Change	-0.1030900 -0.5907600																																																				
Pricing Source	Thomson Reuters End of Day Pricing (EJV)	OAS	191.0 197.8																																																				
Valuation Date	10-Apr-2020	OAS Change	0.14 -6.62																																																				
Valuation Settle Date	15-Apr-2020	YTW	1.5047450 1.4573000																																																				
Accrued Interest (Days)	0.610 (74 Days)	YTW Change	0.0111400 0.0585850																																																				
* Bid Price affects P/Y Values and Options Adjusted Values calculations		Return Information	Previous Day End of Month																																																				
<table border="1"> <thead> <tr> <th>PRICE YIELD VALUES</th> <th>Maturity</th> <th>Worst</th> <th>OPTION ADJUSTED VALUES</th> </tr> </thead> <tbody> <tr> <td>Yield</td> <td>1.5212090</td> <td></td> <td>Yield 1.5212090</td> </tr> <tr> <td>DV01/PVBP</td> <td>0.0925</td> <td></td> <td>Spread 191.1</td> </tr> <tr> <td>Interpolated Spread</td> <td>189.5</td> <td></td> <td>Effective Duration 8.095</td> </tr> <tr> <td>OTR Spread</td> <td>191.2 (EPT9Y)</td> <td></td> <td>Effective Convexity 0.7595</td> </tr> <tr> <td>Modified Duration</td> <td>8.154</td> <td></td> <td>Price (+25bp) 110.5416610</td> </tr> <tr> <td>Mac. Duration</td> <td>8.216</td> <td></td> <td>Price (-25bp) 115.1642650</td> </tr> <tr> <td>Convexity</td> <td>0.7601</td> <td></td> <td>Option Cost 0.0000</td> </tr> <tr> <td>Disc Margin</td> <td>-</td> <td></td> <td>Option Value 0.0000</td> </tr> <tr> <td>Average Life</td> <td>9.30</td> <td></td> <td>DV01 0.0918</td> </tr> <tr> <td></td> <td></td> <td></td> <td>Zero Volatility 191.1</td> </tr> <tr> <td></td> <td></td> <td></td> <td>Spread Duration 8.095</td> </tr> <tr> <td></td> <td></td> <td></td> <td>Spread Convexity 0.7595</td> </tr> </tbody> </table>		PRICE YIELD VALUES	Maturity	Worst	OPTION ADJUSTED VALUES	Yield	1.5212090		Yield 1.5212090	DV01/PVBP	0.0925		Spread 191.1	Interpolated Spread	189.5		Effective Duration 8.095	OTR Spread	191.2 (EPT9Y)		Effective Convexity 0.7595	Modified Duration	8.154		Price (+25bp) 110.5416610	Mac. Duration	8.216		Price (-25bp) 115.1642650	Convexity	0.7601		Option Cost 0.0000	Disc Margin	-		Option Value 0.0000	Average Life	9.30		DV01 0.0918				Zero Volatility 191.1				Spread Duration 8.095				Spread Convexity 0.7595	Price Return	-0.091 -0.518
PRICE YIELD VALUES	Maturity	Worst	OPTION ADJUSTED VALUES																																																				
Yield	1.5212090		Yield 1.5212090																																																				
DV01/PVBP	0.0925		Spread 191.1																																																				
Interpolated Spread	189.5		Effective Duration 8.095																																																				
OTR Spread	191.2 (EPT9Y)		Effective Convexity 0.7595																																																				
Modified Duration	8.154		Price (+25bp) 110.5416610																																																				
Mac. Duration	8.216		Price (-25bp) 115.1642650																																																				
Convexity	0.7601		Option Cost 0.0000																																																				
Disc Margin	-		Option Value 0.0000																																																				
Average Life	9.30		DV01 0.0918																																																				
			Zero Volatility 191.1																																																				
			Spread Duration 8.095																																																				
			Spread Convexity 0.7595																																																				
		Coupon Return	0.000 0.094																																																				
		Reinvestment Return	0.000 0.000																																																				
		Principal Return	0.000 0.000																																																				
		Total Return	-0.091 -0.424																																																				

- What is the loss if rates go up 100 basis points (+1.0%)?

$$\begin{aligned}\frac{\Delta P}{P} &= -DM \cdot \Delta i = \\ &= -8.154 \cdot (+1.0\%) = \\ &= -8.154\%\end{aligned}$$

if interest rates rise by 100 basis points, the market value falls by 8.154%.

- What is the profit if rates go down 50 basis points (- 0.5%)?

$$\begin{aligned}\frac{\Delta P}{P} &= -DM \cdot \Delta i = \\ &= -8.154 \cdot (-0.5\%) = \\ &= +4.077\%\end{aligned}$$

**if interest rates fall by 50 basis points, the market value goes up by 4.077%.**

Let's have a look to a different bond

**ITGV 4.750 01-AUG-2023**

**Price: 112.6**

**Annual Coupon 4.75**

**Maturity: August 1, 2023**

**Yield to Maturity = 0.78%**

IT435684= ITGV 4.750 01-Aug-2023

**ITGV 4.750 01-AUG-2023 ITALY, REPUBLIC OF (GOVERNMENT)** IT / EUR RE-OPENING Updated: 14-Apr-2020 08:33  
 Gov., Fixed Coupon, IG, 144a ISIN IT0004356843 Bond Prospectus  
 Issue Rating: BBB (FTC 07-Feb-2020) Trade > Corporate Actions

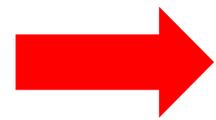
B/A: 112.558/112.616 (-0.1910) BYId/AYId: 0.8756/0.8588 (+0.052) ASwap Sp: 119.94 Swap Sp: 112.84 G Sp: 146.5500 14-Apr-2020 8:35 TR COMPOSITE

Overview All Quotes News Description Valuations Schedules Charts Notes Issuer Calculators Related Instruments Holdings Research 360 Menu

**BOND INFORMATION** Summary View

PRINCIPAL / COUPON INFORMATION		ISSUANCE DETAILS		ISSUER	
Maturity Date	01-Aug-2023 @ 100%	Issue Date / Price / Yield	16-Apr-2008 / 99.135% / 4.888	Name	ITALY, REPUBLIC OF (GOVERNMENT)
Principal / Coupon Currency	EUR / EUR	Issue Spread	-	Domicile	Italy (IT)
Coupon Type	Fixed:Plain Vanilla Fixed Coupon	Announcement Date	07-Apr-2008	Country of Incorporation	Italy (IT)
Coupon Frequency	Semiannually	Country of Issue	Italy	Industry	Finance - Finance
Current Coupon / Next Pay D...	4.75000 / 01-Aug-2020	Market of Issue	Domestic	▶ Show More	
Dated / First / Final Coupon	01-Feb-2008 / 01-Aug-2008 / ...	▶ Underwriters		<b>IDENTIFIERS</b>	
Amount Outstanding	24,799,152,000 EUR	▶ Show More		Type	Value
Par Value / Min. Denominatio...	1,000.00 / 1,000.00 / 1,000.00...	<b>MORE BOND INFORMATION</b>		ISIN	IT0004356843
Floating Rate Note	No	Rank (Seniority) <b>New</b>	Sovereign	Italian Securities	435684
▶ Show More		Series #	15Y	Common Code	035868062
<b>MARKET CONVENTIONS</b>		▶ Listed On		▶ Show More	
Day Count Basis	Actual/Actual ICMA, Act/Act IC...	▶ Show More		<b>BOND RATINGS</b>	
Settlement	Trade + 2 Business Days	<b>TAX DETAILS</b>		Rating Agency &...	Rating ... Outlook ... Affirm...
▶ Show More		EU Savings Tax Directive	Yes	Fitch Long-term I...	BBB ... -- -- ... 07-Feb...
<b>BOND TYPE</b>		01-Mar-2002 or later tap	Yes	Dominion Bond ...	BBB ... -- Stb (15-... --
Instrument Type	Bond	Issued on or before 01-Mar-2...	No (16-Apr-2008)	Moody's Long-te...	Baa3... -- -- ... --
MTN	No	▶ Show More		S&P Long-term Is...	NR (... -- -- -- --
▶ Show More		<b>REGULATIONS</b>		<b>** Unsolicited ratings</b>	
<b>COVENANTS</b>		MiFIR Identifier / MiFID Bond ...	Bond / Sovereign bond		
Prospectus Available	Yes (27-Mar-2012)	MiFID Liquidity Indicator (COF...	No		
Latest Prospectus	20-Jan-2020	MiFID liquidity indicator (ESMA)	No		
Change of Control	No	▶ Show More			
<b>TRADING RESTRICTIONS</b>					
Name	Country	Status			
US Rule 144A	United States	Active			





Credit Risk

OMGV 6.750 17-Jan-2048 MTN

**OMGV 6.750 17-JAN-2048 MTN** OMAN, SULTANATE OF (GOVERNMENT) OM / USD

Gov., Fixed Coupon, HY, RegS, Eurobonds

Updated: 14-Apr-2020 20:07  
 ISIN XS1750114396  
 Issue Rating: BB (FTC 12-Mar-2020)

Close Bid: 68.127 Close Ask: 68.794 Close Bid Yield: 10.225127 Close Ask Yield: 10.125127 13-Apr-2020 TR Pricing Service

Overview All Quotes News Description Valuations Schedules Charts Notes Issuer Calculators Related Instruments Holdings Research 360 Menu

**BOND INFORMATION**

Summary View

PRINCIPAL / COUPON INFORMATION		ISSUANCE DETAILS		ISSUER	
Maturity Date	17-Jan-2048 @ 100%	Issue Date / Price / Yield	17-Jan-2018 / 98.796% / 6.845	Name	OMAN, SULTANATE OF (GOVERNMENT)
Principal / Coupon Currency	USD / USD	Issue Spread	395	Domicile	Oman (OM)
Coupon Type	Fixed: Plain Vanilla Fixed Coupon	Announcement Date	10-Jan-2018	Country of Incorporation	Oman (OM)
Coupon Frequency	Semiannually	Country of Issue	Eurobond	Industry	Finance - Finance
Current Coupon / Next Pay D...	6.75000 / 17-Jul-2020	Market of Issue	Eurobond	▶ Show More	
Dated / First / Final Coupon	17-Jan-2018 / 17-Jul-2018 / 1...	▶ Underwriters		▶ Show More	
Amount Outstanding	2,750,000,000 USD	▶ Show More		IDENTIFIERS	
Par Value / Min. Denominatio...	1,000.00 / 200,000.00 / 1,000...	MORE BOND INFORMATION		Type	Value
Floating Rate Note	No	Rank (Seniority)	New Sovereign	ISIN	XS1750114396
▶ Show More		Series #	3	▼ SAME OFFERING	
MARKET CONVENTIONS		▶ Listed On		Corresponding 144A ISIN	US682051AJ69
Day Count Basis	30/360 US, 30U/360, 30US/3...	▶ Show More		Common Code	175011439
Settlement	Trade + 2 Business Days	TAX DETAILS		▶ Show More	
▶ Show More		EU Savings Tax Directive	Yes	BOND RATINGS	
BOND TYPE		01-Mar-2002 or later tap	No	Rating Agency & Type	Rating
Instrument Type	Note	Issued on or before 01-Mar-2...	No (17-Jan-2018)	Fitch Long-term Issue ...	BB (12...
MTN	Yes	▶ Show More		Moody's Long-term Is...	Ba2 (0...
▶ Show More		REGULATIONS			DNG (30-Mar...
COVENANTS		MIFIR Identifier / MIFID Bond ...	Bond / Sovereign bond		
Prospectus Available	Yes (18-Jan-2018)	MIFID Seniority	Senior Debt		
Latest Prospectus	18-Jan-2018	MIFID Liquidity Indicator (COF...	No		
Events of Default	Yes	▶ Show More			
TRADING RESTRICTIONS					
Name	Country	Status			
FFA PRIIP Non-Ret	European Economi	Active			

OM175011439= Q **OMGV 6.750 17-Jan-2048 MTN** Updated: 14-Apr-2020 20:09 [Bond Prospectus](#)  
**OMGV 6.750 17-JAN-2048 MTN** OMAN, SULTANATE OF (GOVERNMENT) OM / USD [Trade >](#)  
 Gov., Fixed Coupon, HY, RegS, Eurobonds [ISIN XS1750114396](#)  
 Issue Rating: **BB (FT)** C 12-Mar-2020

B/A: 71.502/72.227 (+3.500) BYId/AYId: 9.736/9.636 (-0.508) ASwap Sp: 678.88 Swap Sp: 872.44 G Sp: 841.343 14-Apr-2020 17:54 TR PRICING

Overview All Quotes News Description **Valuations** Schedules Charts Notes Issuer Calculators Related Instruments Holdings Research 360 Menu

### VALUATIONS

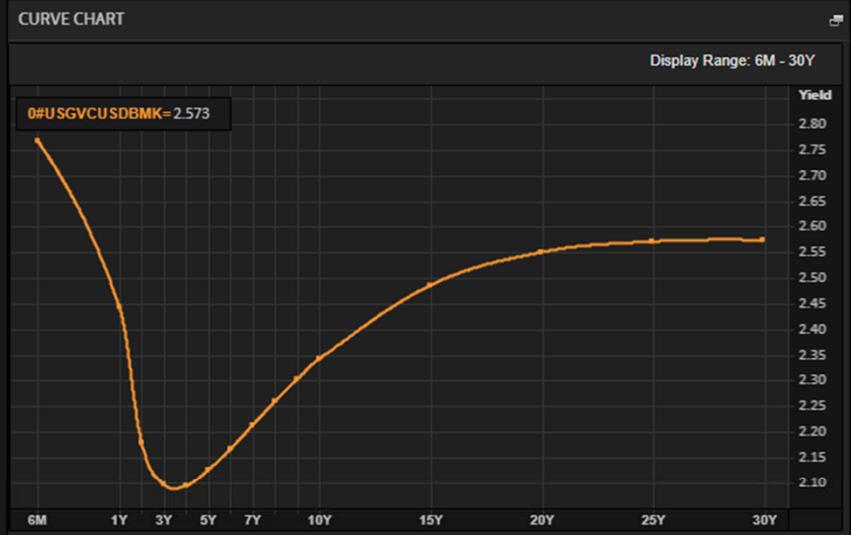
PRICE INFORMATION		HISTORICAL VALUATION		
Bid / Ask Price	*68.1270000 / 68.7940000	Change Information	Previous Day	End of Month
Bid / Ask Spread	66.7	Price	68.0020000	65.4990000
Priced Using	yield priced at 10.225% (MAT Jan-2048)	Price Change	0.1250000	2.6280000
Pricing Source	Thomson Reuters End of Day Pricing (EJV)	OAS	929.3	971.4
Valuation Date	13-Apr-2020	OAS Change	-3.30	-45.36
Valuation Settle Date	15-Apr-2020	YTW	10.2440510	10.6350990
Accrued Interest (Days)	1.650 (88 Days)	YTW Change	-0.0189240	-0.4099720
* Bid Price affects P/Y Values and Options Adjusted Values calculations		Return Information	Previous Day	End of Month
<b>PRICE YIELD VALUES</b>	<b>Maturity Worst</b>	Price Return	0.179	3.928
Yield	10.2251270	Coupon Return	0.000	0.364
DV01/PVBP	0.0662	Reinvestment Return	0.000	0.000
Interpolated Spread	892.8	Principal Return	0.000	0.000
OTR Spread	886.2 (TSY30Y)	Total Return	0.179	4.292
Modified Duration	9.482	Yield	10.2251270	
Mac. Duration	9.967	Spread	926.0	
Convexity	1.6064	Effective Duration	9.482	
Disc Margin	-	Effective Convexity	1.5275	
Average Life	27.76	Price (+25bp)	66.5482640	
		Price (-25bp)	69.7723520	
		Option Cost	0.0000	
		Option Value	0.0000	
		DV01	0.0662	
		Zero Volatility	926.0	
		Spread Duration	9.482	
		Spread Convexity	1.5275	

**ISSUER CURVE**

Government Cash Credit Curve RIC: 0#USGVCUSDBMK=

CURVE CONSTITUENTS

Tenor	Yield	Zero	BMK Spread	Swap Spread	Aswp Spread	Z-Spread	Default Probability
6M	2.766	2.787	62.0	64.8	40.4	--	--
1Y	2.442	2.441	46.8	32.5	30.5	--	--
2Y	2.177	2.174	32.7	26.0	23.8	--	--
3Y	2.095	2.092	27.7	23.2	22.0	--	--
4Y	2.092	2.090	27.4	23.2	22.0	--	--
5Y	2.124	2.123	27.4	24.0	22.5	--	--
6Y	2.165	2.167	25.7	24.5	23.1	--	--
7Y	2.212	2.216	24.5	25.4	24.0	--	--
8Y	2.258	2.266	24.1	26.0	24.6	--	--
9Y	2.301	2.313	24.7	26.4	24.9	--	--
10Y	2.341	2.357	25.7	26.6	25.1	--	--
15Y	2.484	2.515	25.7	27.0	25.2	--	--
20Y	2.549	2.587	19.7	26.9	25.1	--	--
25Y	2.570	2.607	10.3	26.7	24.8	--	--
30Y	2.573	2.605	-0.2	26.0	24.1	--	--

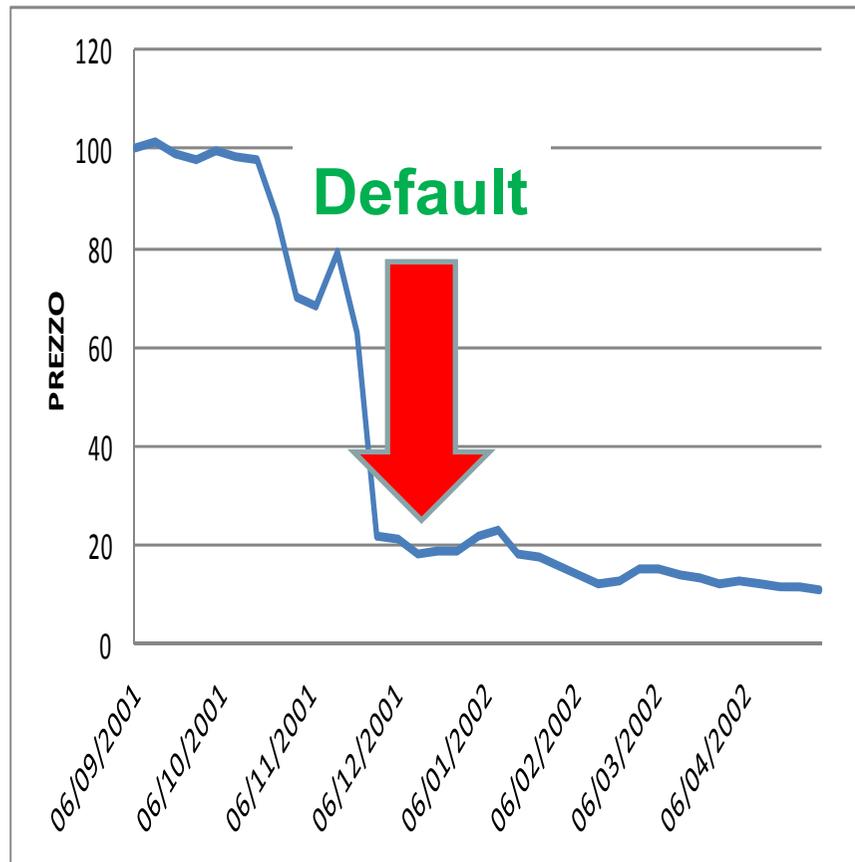


**BOND CONSTITUENTS**

Name	Coupon	Maturity	Bid	Ask	Bid Yield	Ask Yield	Benchmark Spread	Swap Spread	Asset Swap Spread	ISIN
HEADER RIC	--	--	--	--	--	--	--	--	--	--
US TREASURY	100.00	20-Dec-2020	12.200	--	12.200	0.364	--	-63.8	-86.1	9A3AAA
US TREASURY	100.00	20-Jun-2021	12.130	--	12.130	0.605	--	-52.4	-48.8	9A3AAA
US TREASURY	100.00	20-Jun-2022	14.450	--	14.450	1.302	--	-21.0	-20.8	9A3AAA
US TREASURY	100.00	20-Jun-2023	16.760	--	16.760	2.179	--	-12.9	-13.1	9A3AAA
US TREASURY	100.00	20-Jun-2024	19.080	--	19.080	3.238	--	-5.5	-6.0	9A3AAA
US TREASURY	100.00	20-Jun-2027	26.050	--	26.050	7.444	--	5.9	5.2	9A3AAA

Info:

a. **ENRON CORP. 6,75 01/08/09**



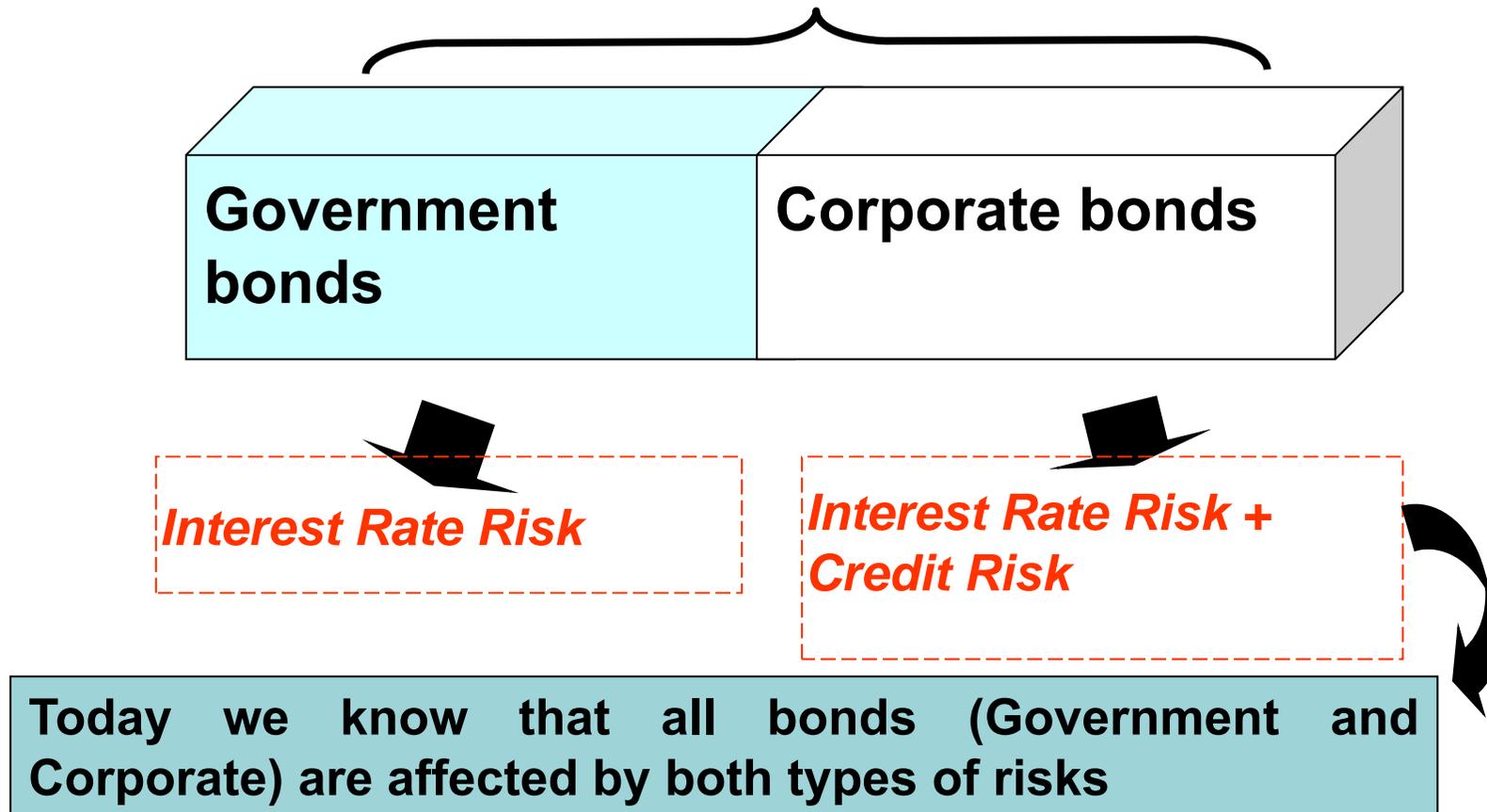
Enron Corporation, an US energy company based in Houston, Texas

# Definition

Among the risk measures previously mentioned, this is undoubtedly the one which, after the 2008 crisis, is perceived as the most relevant.

Definition: "*Credit risk is the risk of negative price **fall/decrease** due to a **negative credit event***".

## A classification (today) out of date



## Rating by Agencies

- In order to “capture” the credit risk of a bond, we need a measure of the creditworthiness of the issuer.
- Rating Agencies express judgements with the purpose to measure (*in a synthetic way*) the credit quality of the issuers.
- The better the rating the lower the probability that the issuer may have problems on repaying the debt and paying interest (for ex, paying *coupons*).
- For the rating attribution, rating agencies use a symbolic and a synthetic language.
- The best-known rating companies are Moody's, Standard & Poor's and Fitch.

# Rating by Agencies

<b>MOODY'S</b>	<b>S&amp;P</b>	<i>Short description</i>
<b><i>Investment Grade Bonds</i></b>		
Aaa	AAA	<i>Superior quality / maximum safety</i>
Aa1 Aa2 Aa3	AA+ AA AA-	<i>High Quality</i>
A1 A2 A3	A+ A A-	<i>Strong payment capacity</i>
Baa1 Baa2 Baa3	BBB+ BBB BBB-	<i>Adequate payment capacity</i>
<b><i>Speculative Grade Bonds / High Yield Bonds / Junk Bonds</i></b>		
Ba1 Ba2 Ba3	BB+ BB BB- <i>NOTCHES</i>	<i>Low quality, speculative bonds</i>
B1 B2 B3	B+ B B-	<i>Highly speculative securities</i>
Caa Ca C	CCC CC C	<i>Extremely speculative bonds, Maximum risk of insolvency</i>
D	D	<i>Default</i>

# Bond ratings

- Bond issuer pays rating agency
- Bond ratings may change over time
- A Rating improve is named *upgrading*
- Rating decrease is named *downgrading*)

# Enron: rating

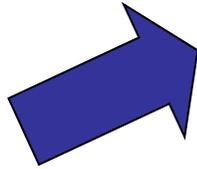
ENRON	
Data	S&P
19/04/01	BBB+
27/06/01	BBB+
15/08/01	BBB+
16/10/01	BBB+
23/10/01	BBB+
24/10/01	BBB+
26/10/01	BBB+
29/10/01	BBB+
31/10/01	BBB+
01/11/01	BBB (neg.)
06/11/01	BBB (neg.)
07/11/01	BBB (neg.)
09/11/01	BBB- (neg.)
21/11/01	BBB- (neg.)
26/11/01	BBB- (neg.)
28/11/01	BBB- (neg.)
28/11/01	B-
29/11/01	B-
30/11/01	CC (neg.)
03/12/01	D

# A peculiar type of speculative grade bond

➤ **Fallen angels**

## From credit risk to default risk

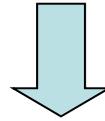
**The most  
known and  
most serious  
type of credit  
risk:**



***Default Risk***

## Default Risk

**It represents the risk that the bond issuer will declare bankruptcy before the title expires**



**Thanks to the rating agencies it is possible to estimate the default probability.**

# The default rate matrix

**Global corporate average cumulative default rates by rating modifier (1981 - 2017)**

Credit rating	Time horizon									
	1	2	3	4	5	6	7	8	9	10
AAA	0.00	0.03	0.13	0.24	0.35	0.46	0.51	0.60	0.65	0.71
AA+	0.00	0.05	0.05	0.10	0.16	0.21	0.27	0.33	0.39	0.45
AA	0.02	0.03	0.08	0.22	0.36	0.48	0.61	0.72	0.81	0.91
AA-	0.03	0.09	0.18	0.25	0.33	0.45	0.52	0.57	0.63	0.69
A+	0.05	0.09	0.20	0.34	0.45	0.55	0.66	0.79	0.93	1.08
A	0.06	0.15	0.24	0.36	0.49	0.68	0.86	1.03	1.23	1.47
A-	0.07	0.17	0.28	0.40	0.57	0.74	0.98	1.16	1.30	1.42
BBB+	0.11	0.31	0.53	0.77	1.03	1.32	1.54	1.78	2.04	2.30
BBB	0.17	0.43	0.68	1.05	1.42	1.80	2.15	2.49	2.85	3.23
BBB-	0.25	0.77	1.39	2.11	2.84	3.50	4.09	4.65	5.11	5.53
BB+	0.34	1.11	2.02	2.94	3.86	4.74	5.50	6.05	6.70	7.33
BB	0.56	1.71	3.38	4.94	6.52	7.77	8.89	9.85	10.75	11.53
BB-	1.00	3.13	5.37	7.66	9.66	11.62	13.24	14.80	16.04	17.12
B+	2.08	5.71	9.23	12.21	14.53	16.33	17.98	19.43	20.77	21.97
B	3.60	8.29	12.29	15.46	17.89	20.15	21.66	22.76	23.77	24.81
B-	7.15	14.28	19.62	23.37	26.18	28.31	29.99	31.13	31.84	32.40
CCC/C	26.82	36.03	41.03	43.97	46.22	47.13	48.33	49.23	50.08	50.71
Investment grade	0.10	0.26	0.45	0.68	0.92	1.17	1.40	1.61	1.82	2.03
Speculative grade	3.75	7.31	10.39	12.90	14.95	16.64	18.05	19.23	20.27	21.21
All rated	1.50	2.95	4.22	5.29	6.18	6.94	7.57	8.12	8.60	9.05

*Source: Standard and Poor's Global Research*

# Default probability is not stable over time!

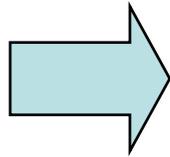
Varies over the business cycle:

- higher in economic recession
- lower in economic expansion

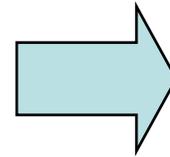
So, during economic crisis, spread between Treasury bonds and Bond with low rating increases

## default risk & yield

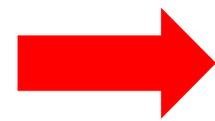
**Lower  
credit  
rating**



**Higher  
default  
risk**



**Higher  
yield**



Liquidity Risk

# Liquidity Risk

The previous risk measures are considered much more relevant than liquidity risk that however can not be ignored.

Definition: "Liquidity risk identifies the risk of failing to **sell quickly** a bond or to sell the bond at a **fair price**".

# Liquidity depends on:

Size of issuer (Positive correlation between size and liquidity)

Efficiency/Liquidity of markets where bonds are traded