Deloitte.

Link'n Learn
12 May 2016

Introduction to Derivative Instruments

Part 1

Contacts

Guillaume Ledure – Manager
Capital Markets
Luxembourg
Email: gledure@deloitte.lu
Tel: 00 352 45145 4701

Jean-Benoît Demelenne – Senior Consultant
Capital Markets
Luxembourg
Email: jdemelenne@deloitte.lu
Tel: 00 352 45145 2883

Preface

This presentation (along with Webinar Link 'n Learn: Introduction to Derivatives Instruments Part 2) is designed to give an introductory overview of the characteristics of some of the more prevalent derivatives along with addressing some topical issues currently faced when valuing these instruments

Further learning references regarding valuation and analysis of these instruments will be provided at the end of this webinar

Part 1 depicts essentially the classical characteristics of the derivatives world while Part 2 focuses on its more recent evolutions and trends observed since the financial crisis of the late 2000s

Agenda

1. Definition and use of derivatives
2. Case studies: derivatives failures
3. Classification of derivatives
   - 3.1. Linear instruments
   - 3.2. Swaps
   - 3.3. Non-linear instruments
   - 3.4. Structured products
   - 3.5. Hybrid products
4. Conclusions and key messages

1. Definition and Use of Derivatives

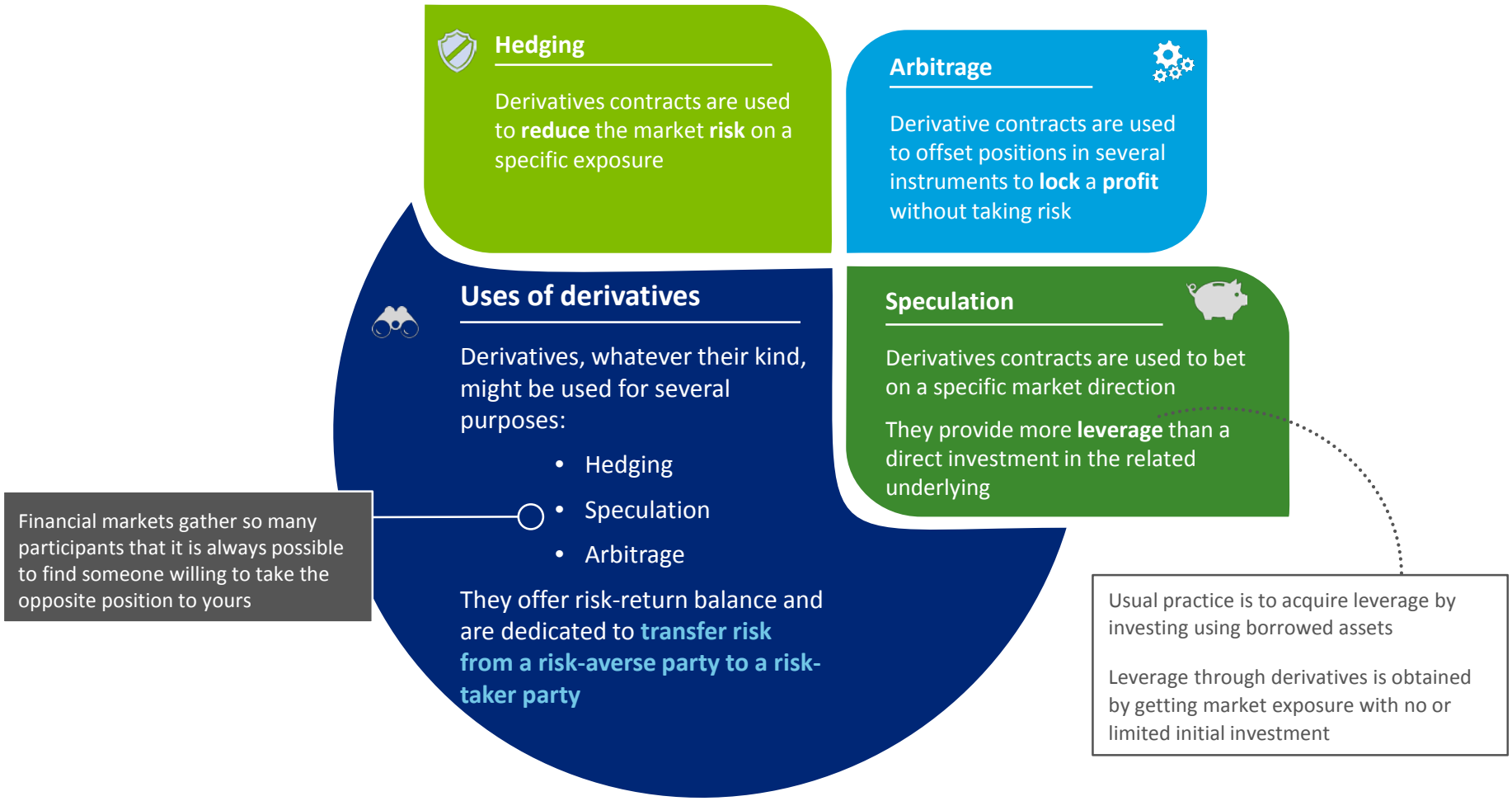
Definition of Derivatives

- A derivative can be defined as a financial instrument whose value depends on (or derives from) the value of other basic underlying variables

- Usually, the underlying variables are the prices of traded assets, e.g.
  - Stocks (Microsoft, ArcelorMittal, BNP Paribas,…)
  - Equity indices (S&P500, Nikkei225, CAC40,…)
  - Bonds (government, corporate, senior/subordinate,…)
  - Commodities (gold, platinum, corn, CO_2,…)
  - Interest rates indices (Libor, Eonia, CMS,…)
  - …
  - But derivatives can be dependent on almost any variable, from the price of hogs to the amount of snow falling on a ski resort

- Derivatives themselves can be traded on organized markets, or alternatively agreed-upon between two counterparties (“over-the-counter” or “OTC” transactions)
  - Organized market: a derivative has a market observable price
  - OTC: a derivative has no observable price, but a value that can be computed using a model

Use of Derivatives



Some Terminology

Distinguish terms that are close to each other but still different:

The **Price** is the amount you observe on a market (organized or OTC) and would pay or receive to trade a certain instrument

The **Value** or **Mark-to-Market** is the amount you estimate you would be willing to pay/receive for trading the instrument

The **Premium** is the amount you actually pay/receive "up-front" when trading the instrument (e.g. an option or a CDS)

The **Profit & Loss** is the total value gained or lost in a trading strategy, including both initial premium and, either current unrealized value or realized payoff

2. Case Studies: Derivatives Failures

Case Studies: Derivatives Failures

Effective Tools to Manipulate Carefully

Derivatives can be highly profitable because of the direct profit they generate or by the potential losses they contribute to erase

Despite this, their public image nowadays is like…

The reality is probably more like…

Case Studies: Derivatives Failures

- Several factors affect a derivative contract, such as:
  - Operating model
  - Modelling factors
  - System issues

- A bad handling of these factors may lead to catastrophic consequences

BARINGS

- In 1995, Nick Leeson, both head of trading and settlement operations, took unauthorized positions, made large losses and led the bank to bankruptcy
- No Chinese wall between front and back-offices, no management oversight

Operating model failure

LTCM The financial technology company

- LTCM was a hedge fund run by star quants, playing highly leveraged statistical arbitrage strategies
- Market crises in Asia and Russia led it to massive losses and bailout in 1998
- Model assumptions of the strategies stopped holding under huge market stress

Modelling factors failure

SOCIETE GENERALE

- In 2008, Jérôme Kerviel took unauthorized positions and fooled risk control systems to cover them up
- Unwind of the positions after discovery led to a EUR 4.9 billion loss
- Deficiency in the internal risk control systems and in applying clean risk limits

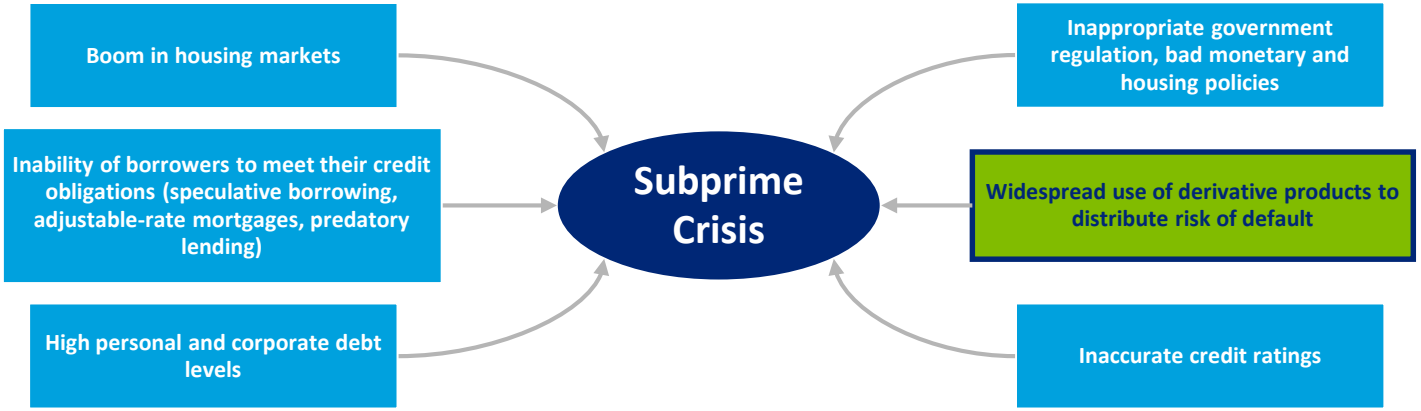
Internal systems failure

- Handling derivatives requires not only financial and mathematical know-how, but appropriate processes and safeguards to prevent from disaster

Case Studies: Derivatives Failures

Is the Subprime Crisis a Derivative Failure?

- In 2007-2009, recession in the US economy led to a spectacular decline in home prices, an explosion of defaults on personal mortgages, and eventually a global financial and economic crisis



- Derivatives are not the main cause but an accelerating factor of the crisis
  - Credit derivatives (e.g. Credit Default Swaps, Mortgage-Backed Securities, Collateralized Debt Obligations) and securitization are dedicated to transfer risk of default from a hedger to a speculator
  - They increase liquidity in the market but contribute to hiding default risk and disincentivize market participants of properly assessing such risk when they do not support it
  - Global default risk was under-estimated by usual models (correlation risk)

3. Classification of Derivatives

3.1. Linear Instruments

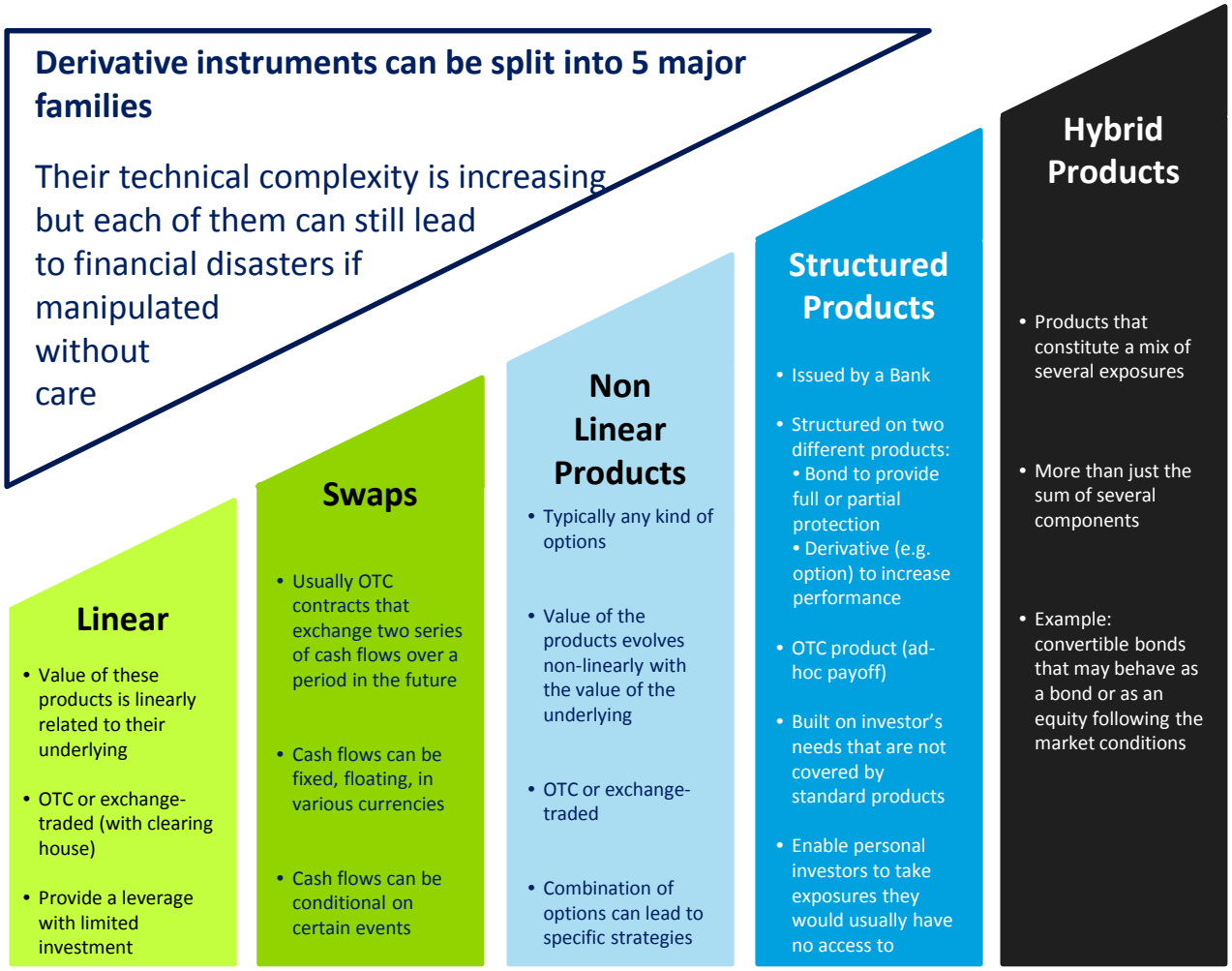
3.2. Swaps

3.3. Non-Linear Instruments

3.4. Structured Products

3.5. Hybrid Products

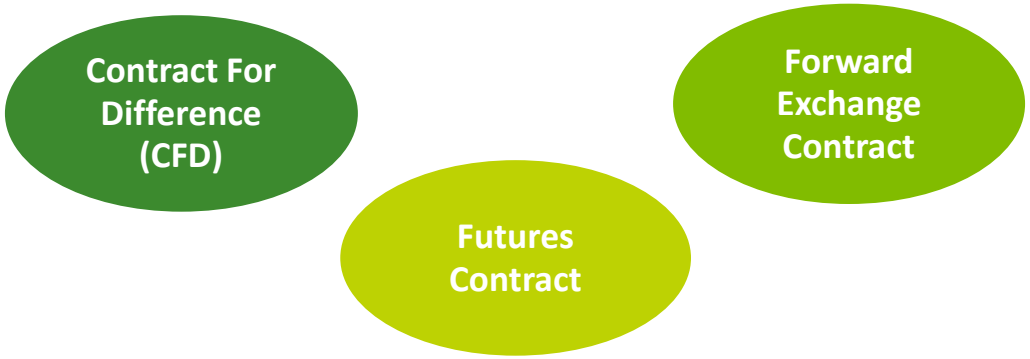
Classification of Derivatives



Linear Instruments

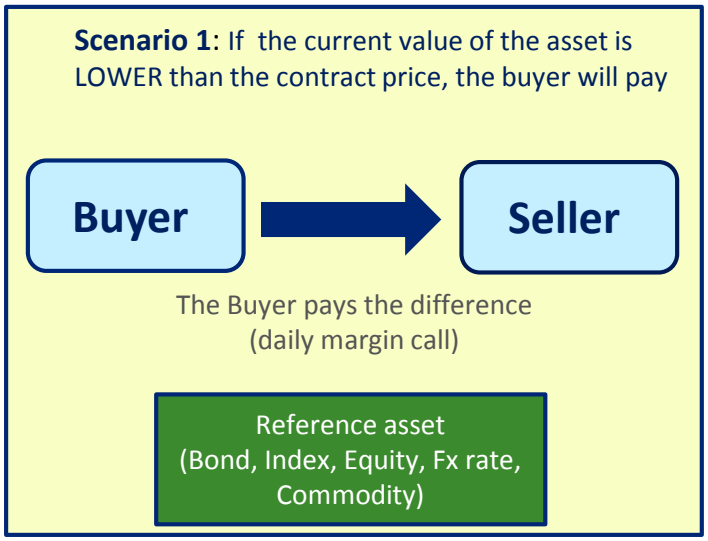
- Linear products are instruments that see their value directly related to the market price of the underlying variable
  - In case of a move in the underlying asset, the value of the derivative will move with a nearly identical quantity
  - Often called "Delta-One" products because there is a 1:1 relationship between the values of the underlying and derivative in case of market move

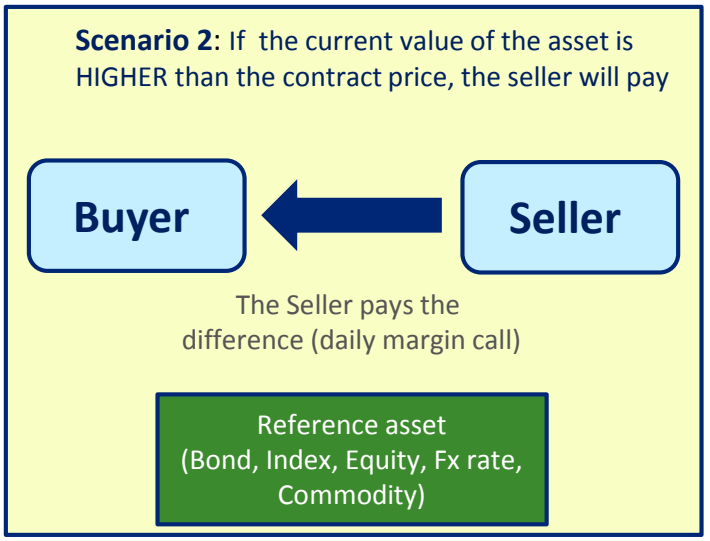
- Such products are not particularly complex mathematically but they may still provide high leverage and give exposure to high risks



Linear Instruments
Contract For Difference

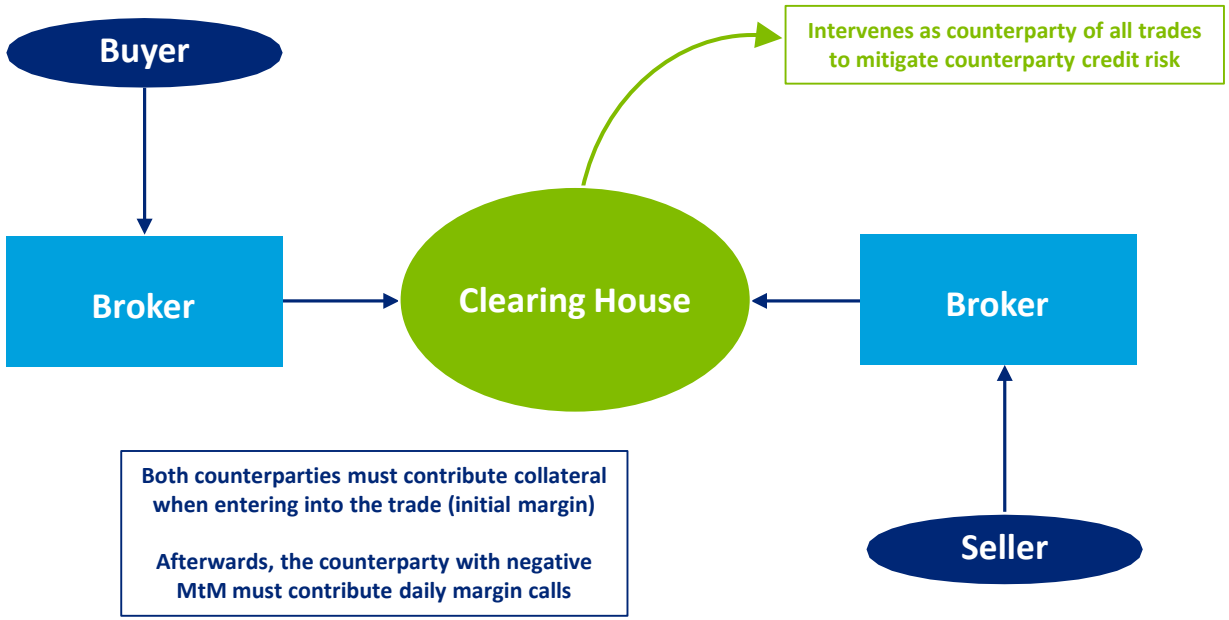
- Bilateral contract in which one counterparty (the "seller" or the "provider") agrees to pay out to the other party (the “buyer”) the difference between the spot price and the contract price of a specified asset





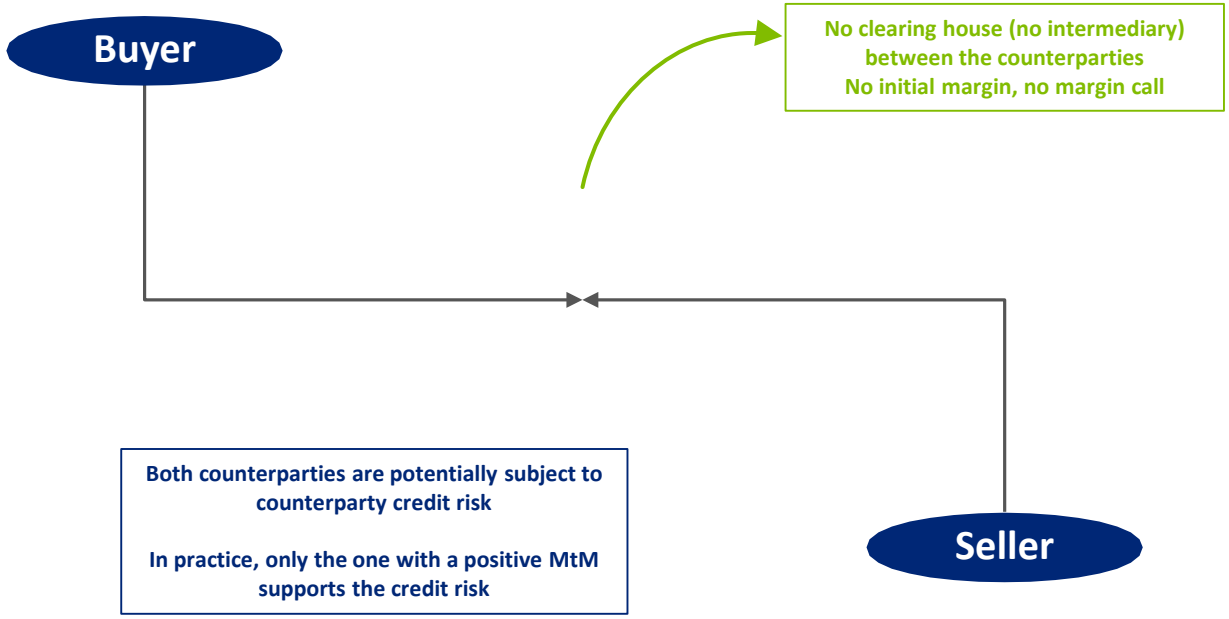
Linear Instruments
Futures Contract

- Bilateral contract in which two counterparties agree to buy/sell an underlying at a predetermined price at a specified date in the future
- Futures are traded on organized markets (exchanges), so they are standardized contracts



Linear Instruments
Forward Exchange Contract

- Bilateral contract in which two counterparties agree to buy/sell an underlying at a predetermined price at a specified date in the future
- Contrarily to Futures, Forwards contracts are Over-The-Counter ("OTC") instruments traded directly between two counterparties



Linear Instruments

Futures vs. Forward

Futures	Forward
• Traded on organized markets	• Traded over-the-counter
• Position easily liquidated at any time	• Position usually held until maturity
• Highly standardized	• Highly customizable (maturity, quantity, underlying…)
• Daily margin calls occur, i.e., P&L is accumulated day after day (liquidity may be a concern)	• Settlement occurs at maturity of the trade (no liquidity risk during the product's lifetime)
• No counterparty credit risk (except bankruptcy of the exchange, highly unlikely)	• Subject to counterparty credit risk

3. Classification of Derivatives

3.1. Linear Instruments

3.2. Swaps

3.3. Non-Linear Instruments

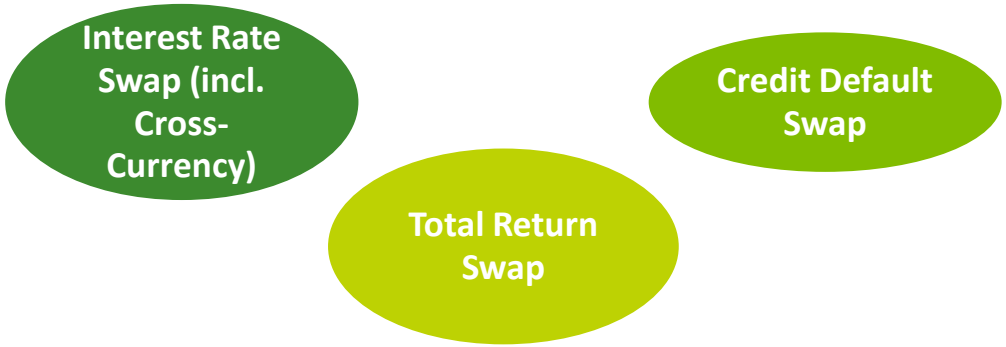
3.4. Structured Products

3.5. Hybrid Products

Linear Instruments

- Swap contracts consist in the exchange by two counterparties of two streams of cash flows (legs) at future dates
  - Nowadays, swaps represent the highest part of global derivatives volumes
  - Swaps are usually traded OTC, so share the following characteristics with forwards
    - Can be highly customizable
    - Subject to counterparty credit risk

- Main categories of swaps



Swaps
Interest Rate Swap and Cross-Currency Swap

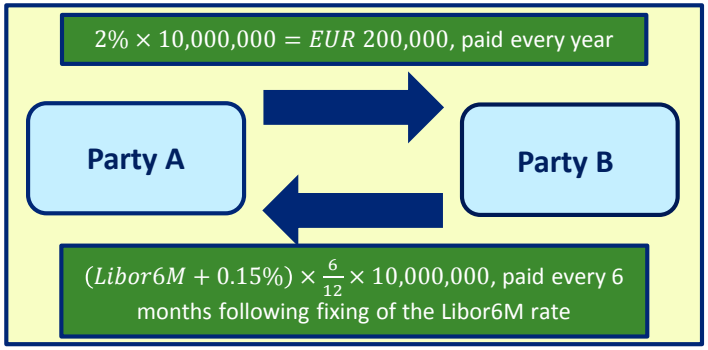
- An Interest Rate Swap (IRS) exchanges two streams of cash flows ("legs")
  - A fixed leg that pays cash flows indexed on a fix rate
  - A floating leg that pays cash flows indexed on a floating rate index, such as a (Libor rate + margin)
  - No notional exchange at maturity of the swap
  - Objective: transform a fixed-rate exposure into a floating-rate exposure, or vice-versa

- A Cross-Currency Swap (CCIRS) exchanges two legs in different currencies
  - A CCIRS is exposed to both interest rate and fx rate risks

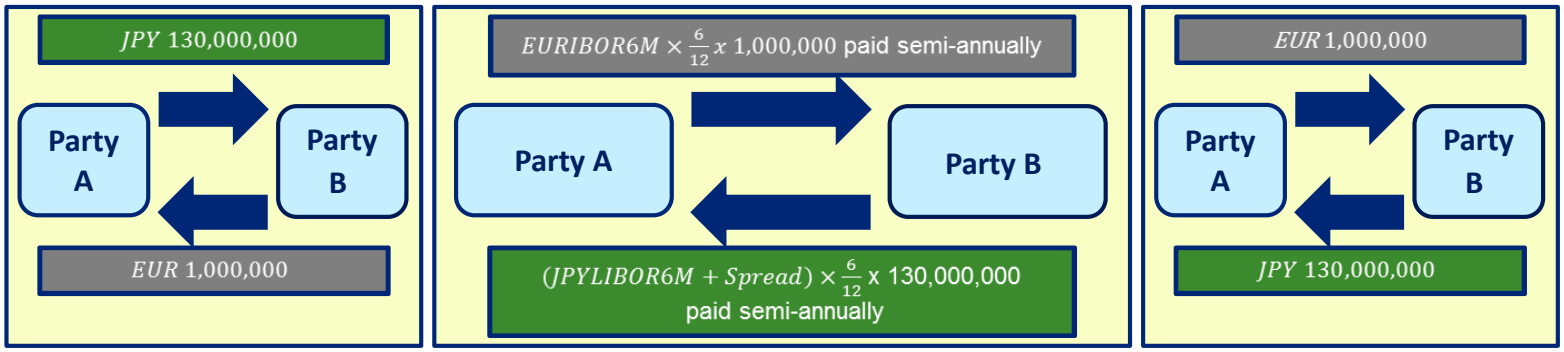
Interest Rate Swaps	Cross-Currency Swaps
• Traded over-the-counter • Upfront fee is usually equal to zero • Notional amounts on both legs are in the same currency • No exchange of notional • Plain vanilla IRS: exchange of fixed against floating rate (typically LIBOR + spread) • Exchange of 2 cash-flows is netted • Subject to counterparty credit risk	• Traded over-the-counter • Upfront fee is usually equal to zero • Notional on both legs are in different currencies • Exchange of notional at effective and maturity dates • Exchange of a fixed vs. floating rate or fixed vs. fixed or floating vs. floating • Payment in original currency, no netting • Subject to counterparty credit risk

Swaps
Interest Rate Swap and Cross-Currency Swap

- IRS example



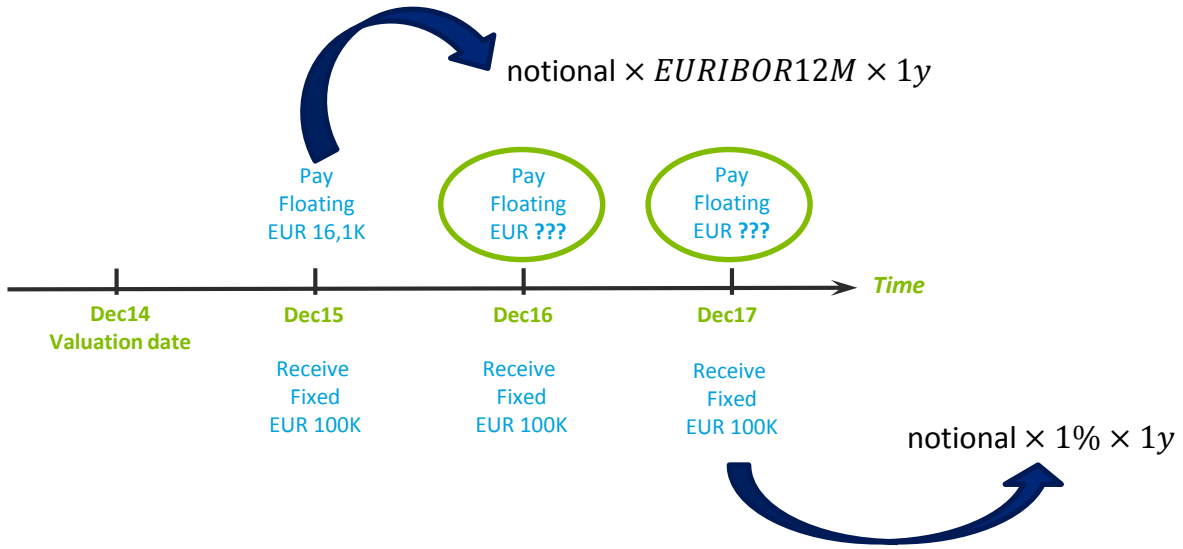
- CCIRS example



Swaps
Valuation: Discounted Cash Flows Method

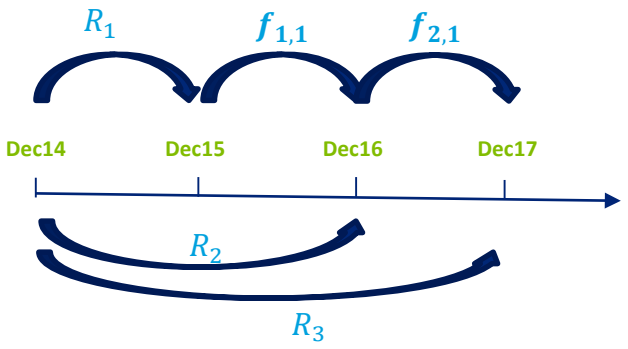
- IRS: notional of 10,000,000 EUR, 3-year maturity, fixed rate 1% versus EURIBOR12M

- An IRS can be viewed as a strategy involving a pair of securities:
  - **Fixed Rate leg:** Purchase of a fixed rate note ("Bond") for EUR 10,000,000 paying annual fixed interest and receiving principal at maturity
  - **Floating Rate leg:** Sale of a floating rate note paying floating annual interest (EURIBOR12M) and repaying principal at maturity



Swaps
Valuation: Discounted Cash Flows Method

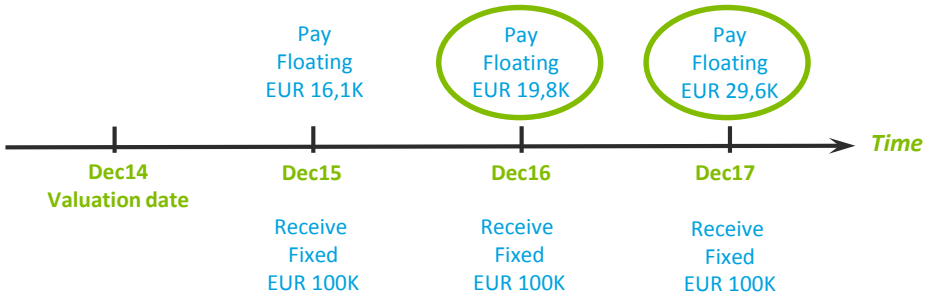
- Step 1: Estimation of the forward rate from zero coupon yield curve



$$f_{1,1} = 0,20\%$$
$$f_{2,1} = 0,30\%$$

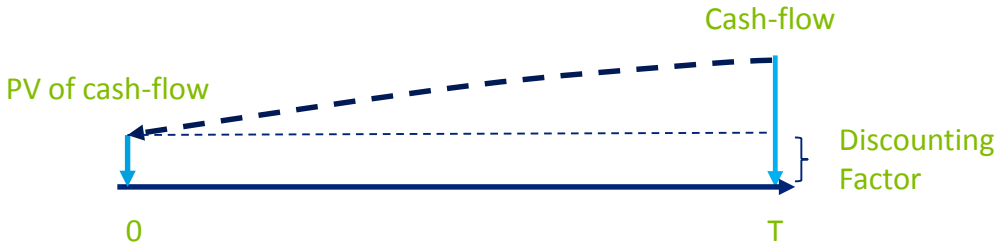
Date	Market Rate	Zero Rate	Discount
07/06/2015	0.17100	0.17100	0.999136
08/05/2015	0.16900	0.17240	0.998986
09/07/2015	0.16400	0.16970	0.998846
10/05/2015	0.16000	0.16627	0.998741
11/05/2015	0.15700	0.16396	0.998617
12/07/2015	0.15400	0.16258	0.998485
01/05/2016	0.15200	0.16154	0.998365
02/05/2016	0.14700	0.16067	0.998236
03/07/2016	0.14800	0.16053	0.998100
04/05/2016	0.15100	0.16022	0.997975
05/05/2016	0.15500	0.16069	0.997835
06/06/2016	0.15900	0.16141	0.997683
07/05/2016	0.16300	0.16211	0.997543
01/05/2017	0.18200	0.18202	0.996370
01/05/2018	0.22040	0.22050	0.993414
01/07/2019	0.28350	0.28386	0.988710
01/06/2020	0.35810	0.35901	0.982232

Bloomberg Interest Rates Curve



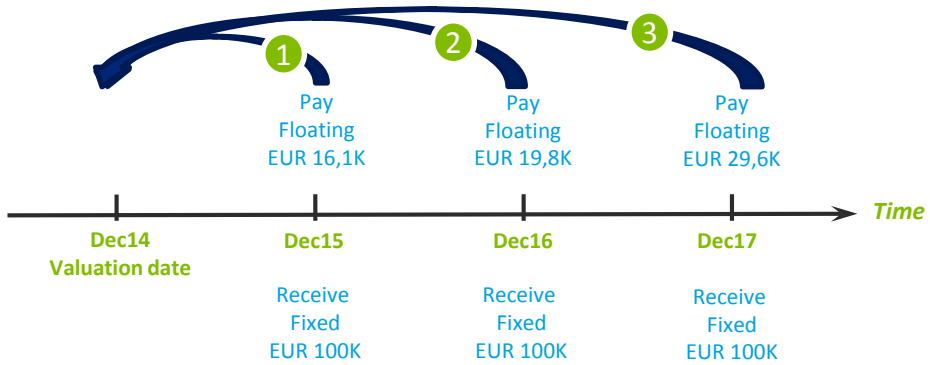
Swaps
Valuation: Discounted Cash Flows Method

- Step 2: Discounting the future cash flows (cf. time value of money)



Date	Market Rate	Zero Rate	Discount
07/06/2015	0.17100	0.17100	0.999136
08/05/2015	0.16900	0.17240	0.998986
09/07/2015	0.16400	0.16970	0.998846
10/05/2015	0.16000	0.16627	0.998741
11/05/2015	0.15700	0.16396	0.998617
12/07/2015	0.15400	0.16258	0.998485
01/05/2016	0.15200	0.16154	0.998365
02/05/2016	0.14700	0.16067	0.998236
03/07/2016	0.14800	0.16053	0.998100
04/05/2016	0.15100	0.16022	0.997975
05/05/2016	0.15500	0.16069	0.997835
06/06/2016	0.15900	0.16141	0.997683
07/05/2016	0.16300	0.16211	0.997543
01/05/2017	0.18200	0.18202	0.996370
01/05/2018	0.22040	0.22050	0.993414
01/07/2019	0.28350	0.28386	0.988710
01/06/2020	0.35810	0.35901	0.982232

Bloomberg Interest Rates Curve

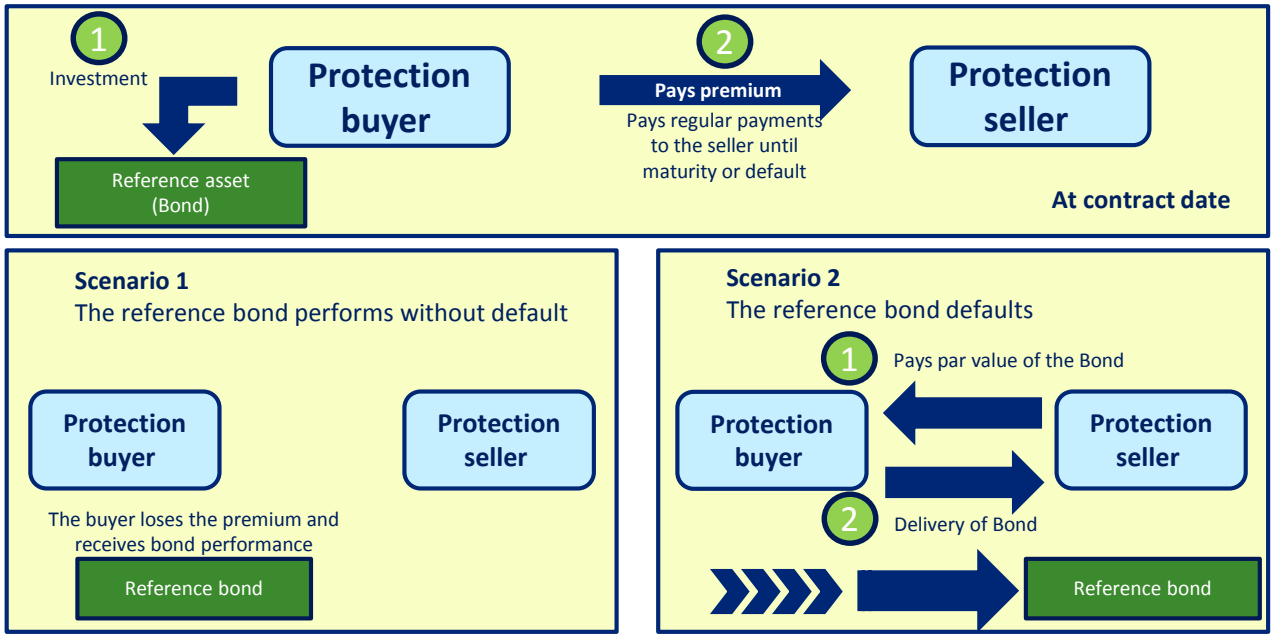


$$\text{Swap value} = \underbrace{(-16{,}1\text{K} + 100\text{K}) \times DF_1}_{1} + \underbrace{(-19{,}8K + 100K) \times DF_2}_{2} + \underbrace{(-29{,}6K + 100K) \times DF_3}_{3}$$

Swaps
Credit Default Swap

A Credit Default Swap (CDS) is some kind of insurance contract

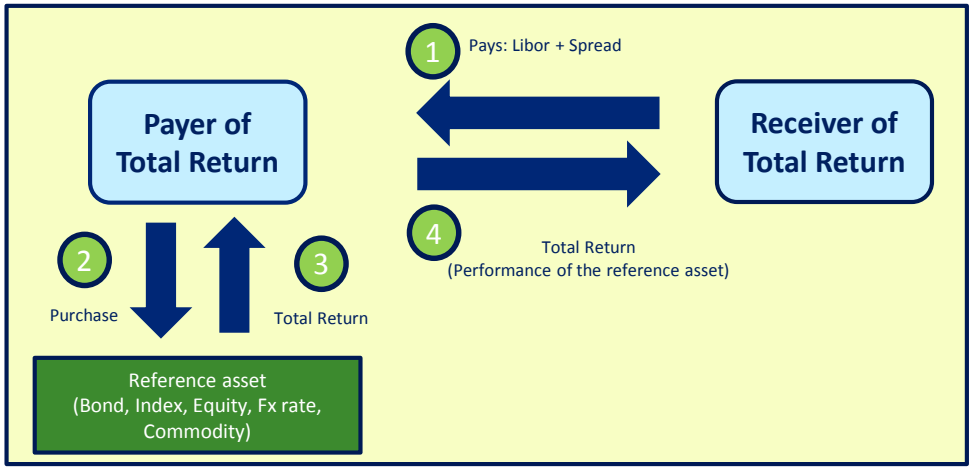
- One party pays a premium leg (fixed or floating) to obtain protection against the default of a reference asset
- **Objective**: transfer the credit risk exposure of the reference asset from the risk-averse party to the protection seller



Swaps
Total Return Swap

A Total Return Swap (TRS) exchanges two streams of cash flows

- A total return leg that pays cash flows corresponding to the total return on the period of a specified asset (including any capital appreciation/depreciation and interest/coupon payments)
- A premium leg that pays cash flows indexed on a fixed rate or floating rate index
- No notional exchange at maturity of the swap
- **Objective**: transfer the total economic exposure (market and credit risk) of the reference asset without having to purchase or sell it



3. Classification of Derivatives

3.1. Linear Instruments

3.2. Swaps

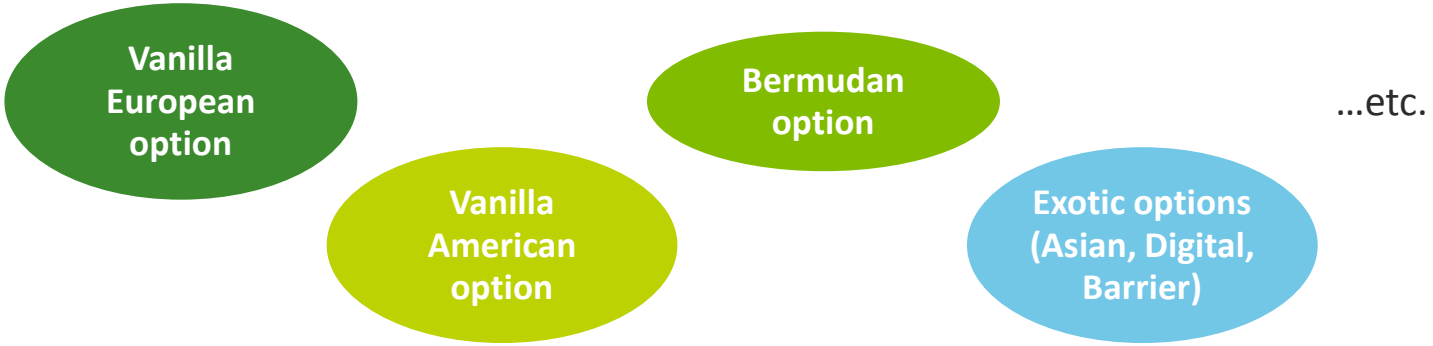
3.3. Non-Linear Instruments

3.4. Structured Products

3.5. Hybrid Products

Non-Linear Instruments

- Non-linear products are instruments that see their value related to the market price of the underlying variable, but under a non-linear relationship
  - The payoff of such products varies with the value of the underlying, but also with other elements (interest rates, volatility, dividends, etc.)
  - Non-linear products are often referred to as “options” but this is a global name for a wide range of different payoffs



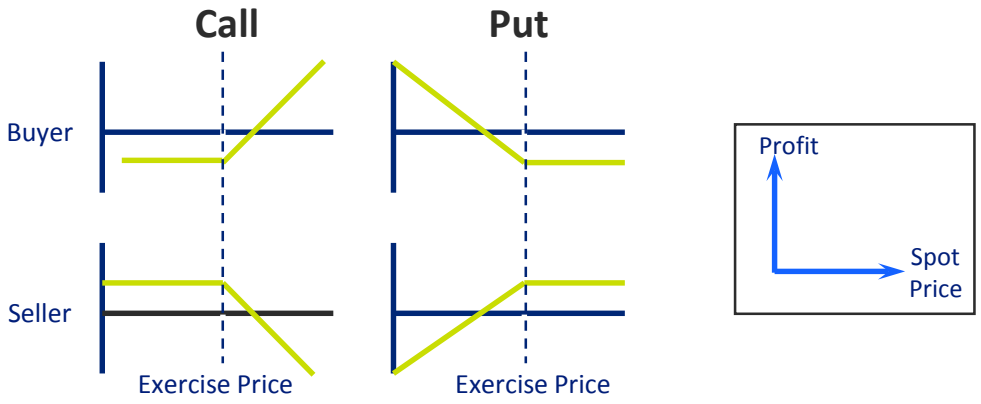
- Various underlying assets: stocks, indices, funds, fx rate, interest rates, bonds, etc.
- These products can be exchange-traded or OTC

Non-Linear Instruments
Vanilla Options

- European vanilla options: positive payoff if the underlying value at maturity is higher/lower than a specified value (strike) and 0 otherwise
  - Call option: payoff $= \max(0, S_T - K)$
  - Put option: payoff $= \max(0, K - S_T)$

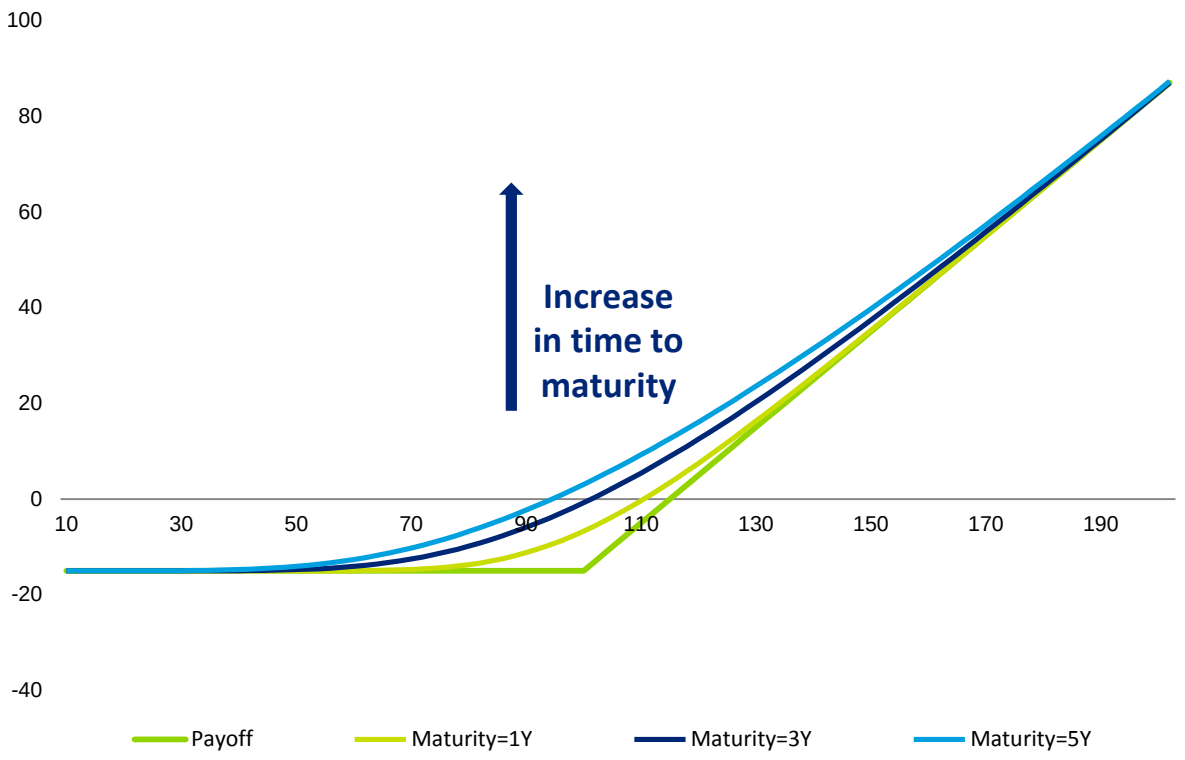
- To enter into an option, a certain premium must be paid by the option purchaser

- P&L profile of vanilla options



Vanilla Options

Profile of the option's P&L (MtM – premium) and impact of time to maturity



Non-Linear Instruments
Time Value

- Let's assume that a call option has these characteristics:
  - Strike is 100 USD
  - Underlying spot price is 90 USD
  - Maturity is 1 year

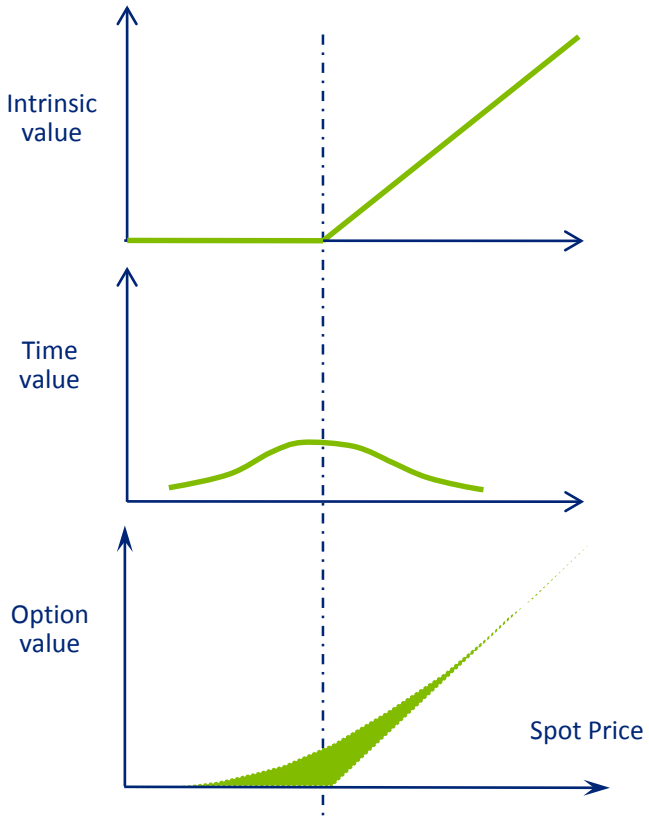
  (assume no rates, no dividends for simplicity)

- What is the option price ?

- Premium = Intrinsic Value + Time Value

The payout if the option were maturing immediately

The additional premium due to the remaining time-to-maturity of the option



Vanilla Options
Volatility

Volatility is a measure of dispersion of the price of the underlying asset around the trend

Two assets may exhibit different levels of volatility

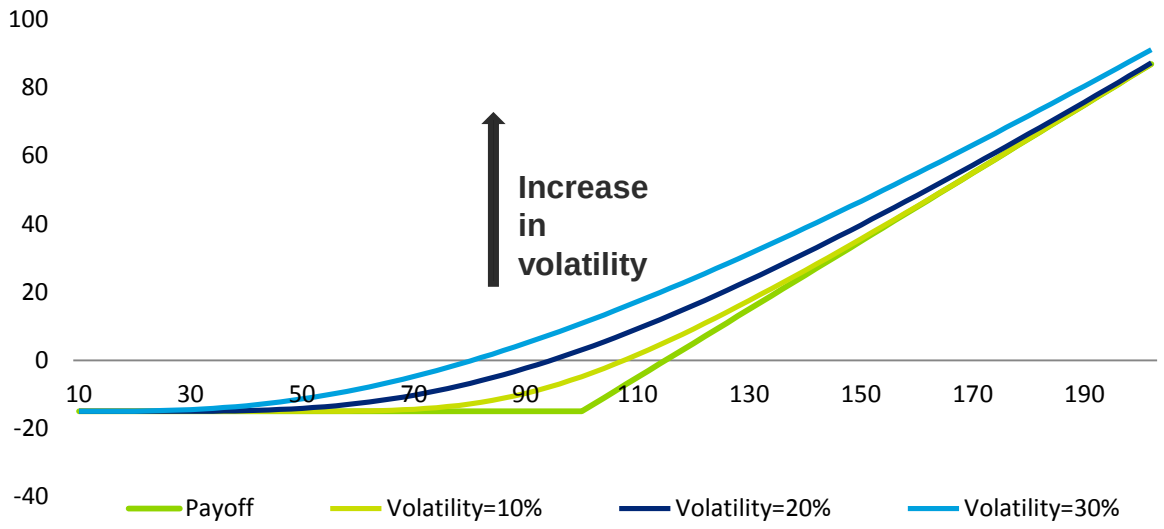
Microsoft / SP500 Index (source: Bloomberg)

Vanilla Options
Impact of Volatility

An increase in volatility leads to an increase of the option value due to the higher probability to get a high payoff for a given date

- In case of decrease of the underlying: a higher volatility leads to a stronger fall, but no loss for the call holder
- In case of increase of the underlying: a higher volatility leads to a stronger rise, so a higher profit for the call holder

➢ **The call value increases with volatility!**



Vanilla Options
Impact of the Market Parameters

Impact of an increase of a given parameter on the option premium

Parameters / Variables	Call Option	Put Option
Underlying price	+	-
Time to maturity	+	+
Volatility	+	+
Strike	-	+
Risk free rate	+	-
Dividend yield	-	+

Vanilla Options
Valuation

- Assume we want to value a call option on a stock that will pay a certain cash flow only if the stock price matures above a certain level K
  - The payoff at maturity can be written as follows:

$$\max(S_T - K, 0)$$

  - The price of the option will equal:

$$\text{Price}(\text{Option}) = E[\max(S_T - K, 0) \times DF_T]$$

- The critical aspect is to determine what is the probability distribution of S_T, i.e. the different possible values of S_T and their respective probabilities
  - For that purpose, make use of a model!
  - For instance, the famous Black-Scholes formula enables to value vanilla calls and puts:

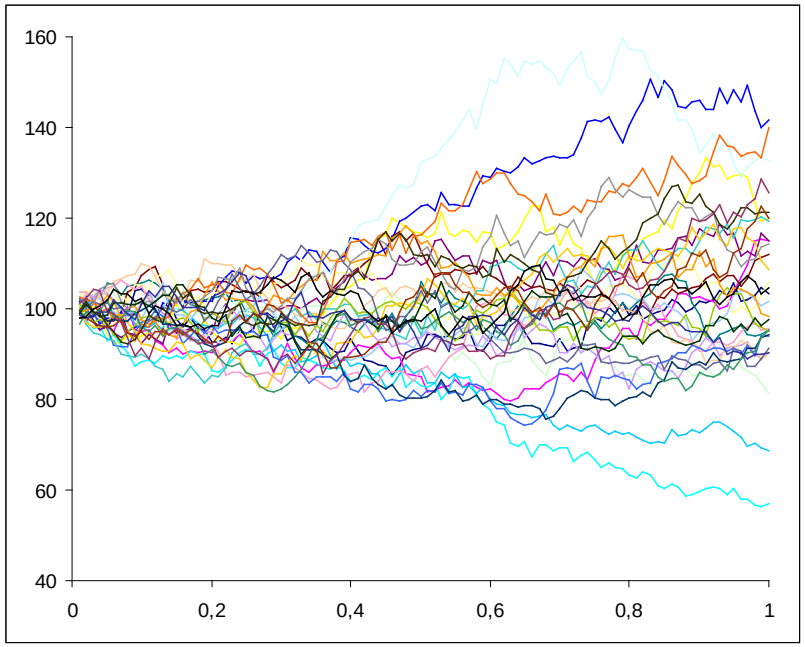
European Call price $=$ $\mathbf{function}$**(spot price, strike, volatility, time–to–maturity, dividend yield, risk–free rate)**

Vanilla Options
Valuation with Monte Carlo Simulations

Given a model, you can compute the expectation E using a numerical method like the Monte Carlo simulation

Steps to follow

1. Simulate the random walk from the valuation date to maturity date
2. Calculate the option payoff for this simulation
3. Repeat the steps 1 and 2 (a lot of times)
4. Calculate the average payoff of all simulations
5. Take the present value of this average



3. Classification of Derivatives

3.1. Linear Instruments

3.2. Swaps

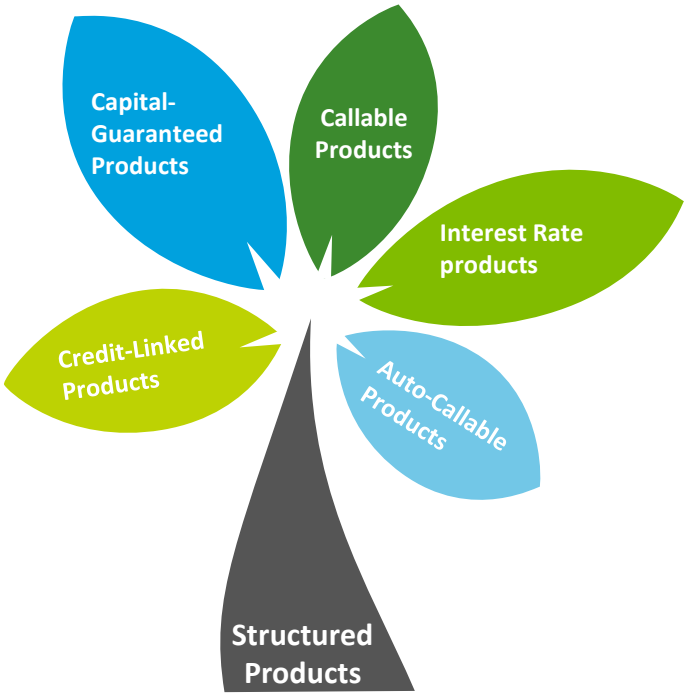
3.3. Non-Linear Instruments

3.4. Structured Products

3.5. Hybrid Products

Structured Products

Structured products are financial instruments that are the result of the combination of several basic instruments, all wrapped together to provide specific payoffs and exposures



Credit Linked Products

This family covers products such as ABSs, MBSs, CDOs, CLOs, CLNs

Capital-Guaranteed Products

This family covers products that provide full reimbursement or at least some **protection on the invested capital** (airbag)

Callable Products

This family covers structured products that, at certain points in time, can be early terminated following the choice of one of the parties (issuer or noteholder)

Interest Rates products

This family covers products providing **exposure on interest rates markets** such as CMS products, snowball, range accruals,...

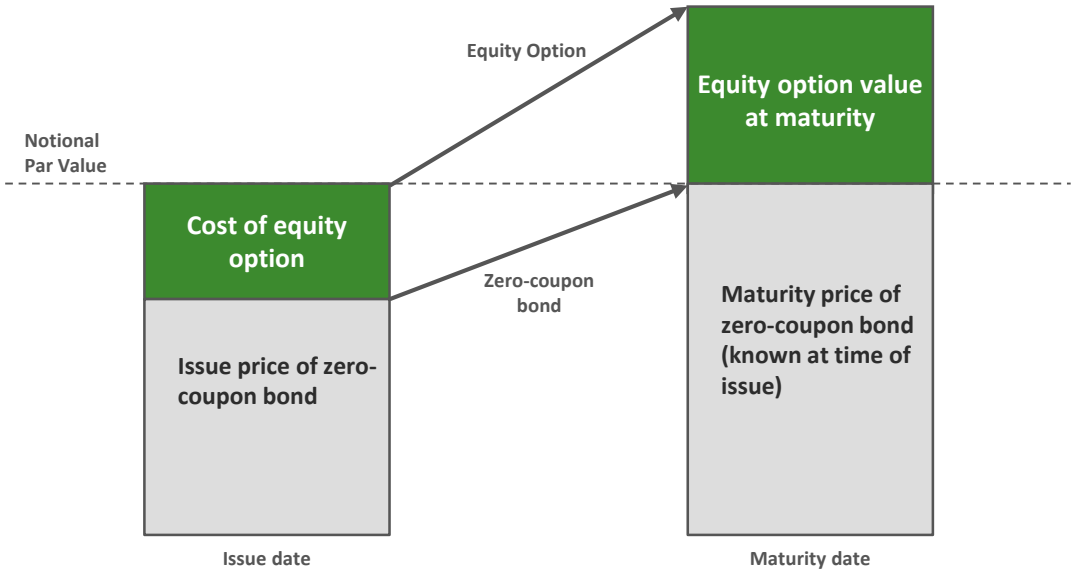
Auto-Callable Products

This family covers products than might be **early terminated automatically** as soon as specific conditions are fulfilled. Examples cover Phoenix notes and all related

Structured Products

Example 1: a capital-guaranteed structured product will be obtained by combining

- A zero-coupon bond to provide the guarantee of capital
- One or several options to provide the upside exposure to equity markets



Structured Products

Example 2: "credit-linked note"

- Note or bond, so subject to interest rate and credit risk of the issuer
- Dependent on the credit risk of an underlying entity: the investor is paid coupons and par value at maturity, unless the underlying entity goes into default
- Structured as a security with an embedded CDS allowing the issuer to transfer the credit risk of the underlying entity to investors

- In case of default of the underlying entity:

- Double credit risk: issuer + underlying entity
- Valuation is lower than a regular bond with same features, due to the additional risk

3. Classification of Derivatives

3.1. Linear Instruments

3.2. Swaps

3.3. Non-Linear Instruments

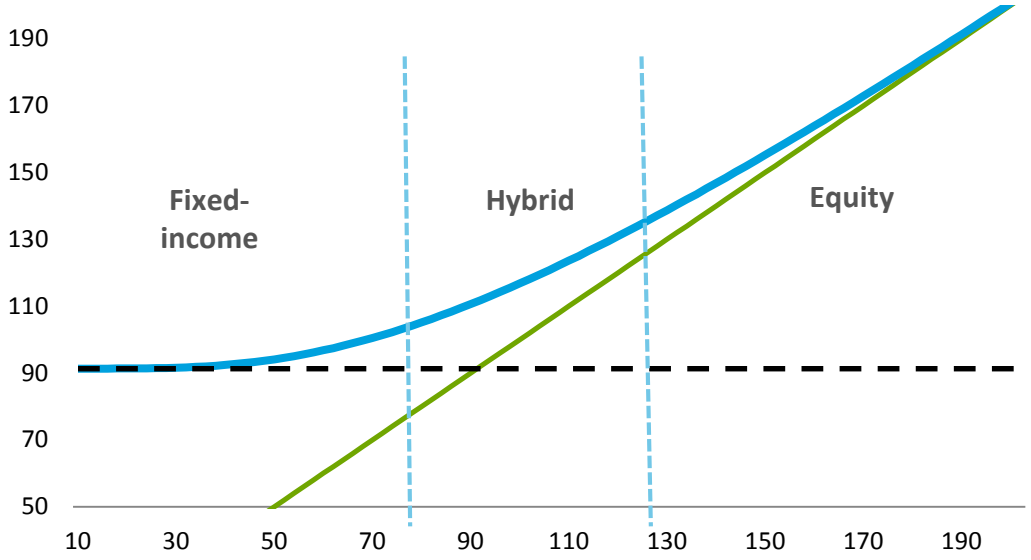
3.4. Structured Products

3.5. Hybrid Products

Hybrid Products

- A hybrid product combines several characteristics and may exhibit different behaviors according to the market conditions

- Typical example: “convertible bond”
  - Behaves roughly like a bond (subject to interest and credit risk) if the underlying stock price is low
  - Behaves roughly like an equity if the underlying stock price is high



4. Conclusions and Key Messages

Key Messages

- Definition and use of derivatives
  - A financial instrument whose value depends on (or derives from) the value of other basic underlying variables
  - Derivatives may be used for hedging, speculation or arbitrage, but always as a mean to transfer risk exposure
- Derivatives are powerful tools that may create disasters if not handled with great care
- Derivatives can be classified in 5 categories: linear, swaps, non-linear, structured and hybrid products
- Swaps valuation relies on the discounted cash flows method
- Valuation of non-linear products (e.g. options) is performed under the discounted cash flows method, where future values of the underlying are modelled statistically

Contents of Part 2

Part 2 (scheduled on October 13th, 2016) will deal with more recent trends in the derivatives industry, and more specifically the following topics:

- Nowadays regulatory environment
- Complex credit derivatives, such as Collateralized Debt Obligations
- OIS discounting and the multi-curve swap valuation environment
- Credit Valuation Adjustment

Q&A