Deloitte.

Structured Derivatives Valuation

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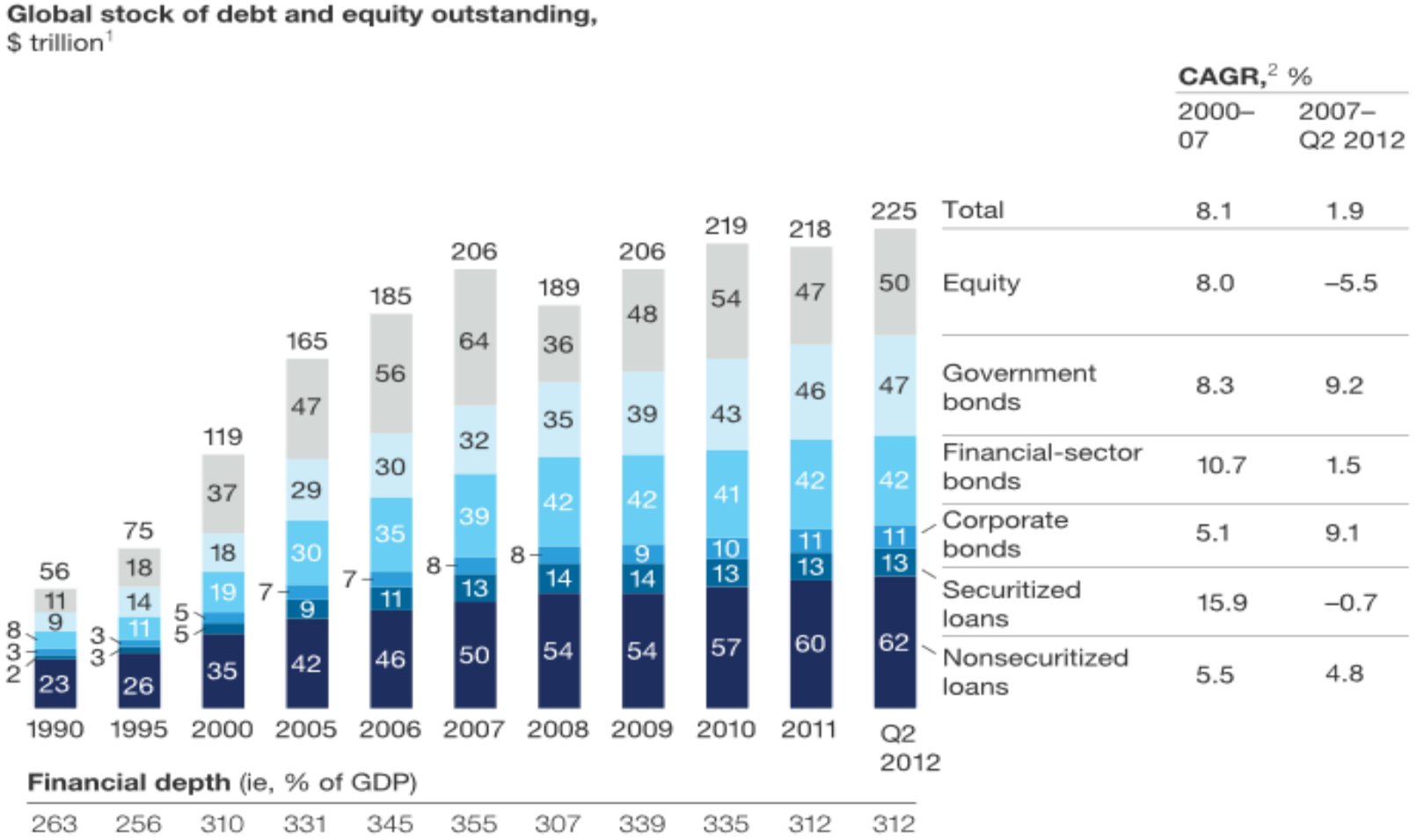
Praha, 7 June 2016

Global financial assets = 225 trillion USD



[1]End-of-year figures for a sample of 183 countries, based on constant 2011 exchange rates. Figures may not sum to totals, because of rounding.

[2]Compound annual growth rate.

Source: McKinsey Global Institute analysis

Size of derivatives market = 710 trillion USD

Table 19: Amounts outstanding of over-the-counter (OTC) derivatives

By risk category and instrument

In billions of US dollars

	Notional amounts outstanding					Gross market values				
Risk Category / Instrument	**Dec 2011**	**Jun 2012**	**Dec 2012**	**Jun 2013**	**Dec 2013**	**Dec 2011**	**Jun 2012**	**Dec 2012**	**Jun 2013**	**Dec 2013**
Total contracts	**647,811**	**639,395**	**632,582**	**692,924**	**710,182**	**27,297**	**25,408**	**24,733**	**20,082**	**18,658**
Foreign exchange contracts	**63,381**	**66,672**	**67,358**	**73,121**	**70,553**	**2,592**	**2,249**	**2,313**	**2,427**	**2,284**
Forwards and forex swaps	30,526	31,395	31,718	34,421	33,218	923	773	806	957	824
Currency swaps	22,791	24,156	25,420	24,654	25,448	1,324	1,190	1,259	1,131	1,186
Options	10,065	11,122	10,220	14,046	11,886	345	286	249	339	273
Interest rate contracts	**504,117**	**494,427**	**489,706**	**561,314**	**584,364**	**20,001**	**19,113**	**18,833**	**15,081**	**14,039**
Forward rate agreements	50,596	64,711	71,353	86,334	73,819	67	51	47	168	108
Interest rate swaps	402,611	379,401	370,002	425,584	461,281	18,046	17,214	17,080	13,588	12,758
Options	50,911	50,314	48,351	49,396	49,264	1,888	1,848	1,706	1,325	1,174
Equity-linked contracts	**5,982**	**6,313**	**6,251**	**6,821**	**6,560**	**673**	**639**	**600**	**692**	**700**
Forwards and swaps	1,738	1,880	2,045	2,321	2,277	156	147	157	206	202
Options	4,244	4,434	4,207	4,501	4,283	518	492	443	486	498
Commodity contracts	**3,091**	**2,994**	**2,587**	**2,458**	**2,206**	**466**	**379**	**347**	**384**	**264**
Gold	521	523	486	461	341	63	51	42	80	47
Other commodities	2,570	2,471	2,101	1,997	1,865	403	328	304	304	217
Forwards and swaps	1,745	1,659	1,363	1,327	1,261					
Options	824	812	739	670	603					
Credit default swaps	**28,626**	**26,930**	**25,068**	**24,349**	**21,020**	**1,586**	**1,187**	**848**	**725**	**653**
Single-name instruments	16,865	15,566	14,309	13,135	11,324	958	715	527	430	369
Multi-name instruments	11,761	11,364	10,760	11,214	9,696	628	472	321	295	284
of which index products	10,506	9,723	9,656	10,163	8,746					
Unallocated	**42,612**	**42,059**	**41,611**	**24,861**	**25,480**	**1,978**	**1,841**	**1,792**	**772**	**718**
Memorandum Item:										
Gross Credit Exposure						3,938	3,691	3,609	3,784	3,033

BIS Quarterly Review, September 2014

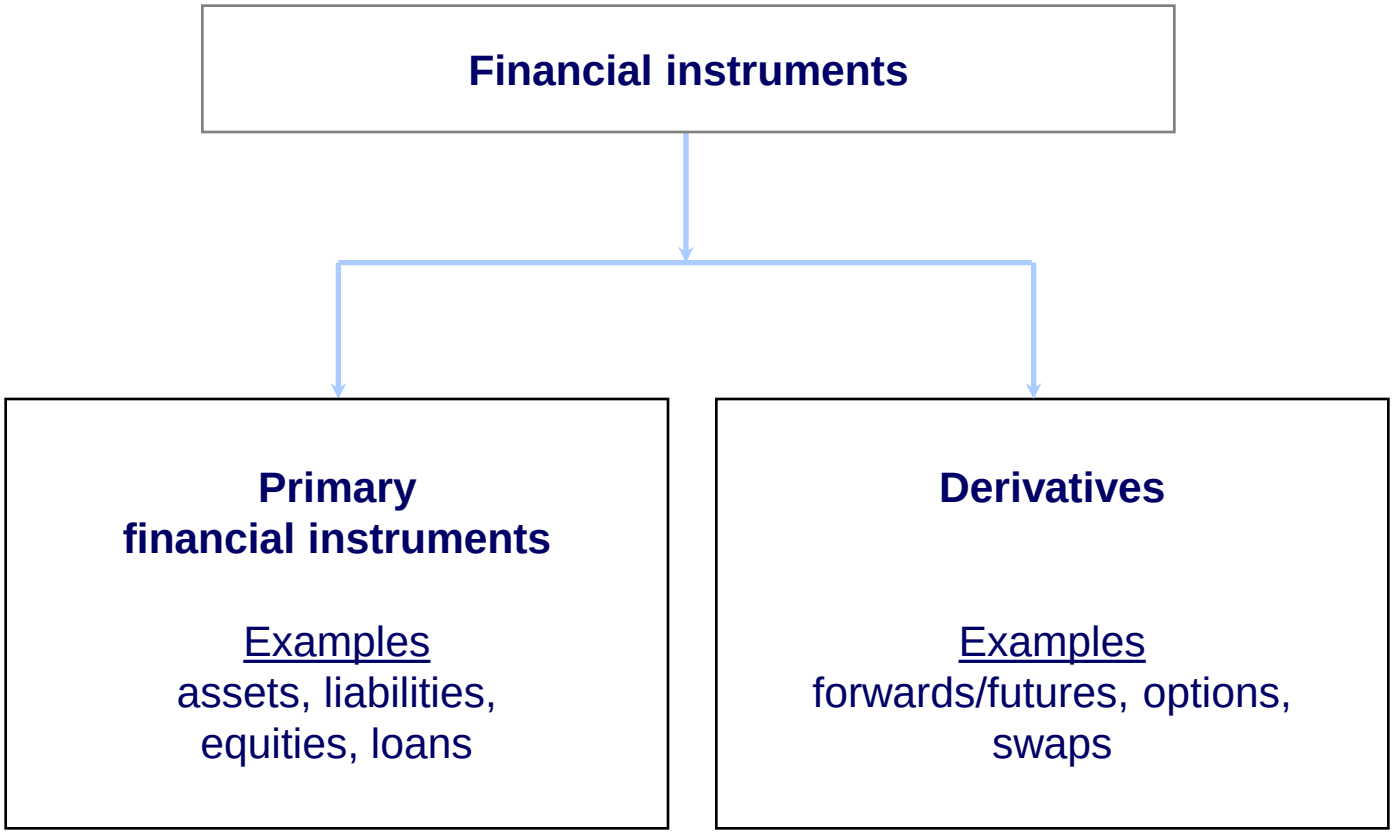
Size of derivatives market

- The value of the world's financial assets—including all stock, bonds, and bank deposits — is about 225 trillion USD
- Over the counter derivatives market has an estimated size of about 710 trillion USD

How can the derivatives market be worth more than 3 times the world's total financial assets?

Financial Instruments - definition

A **financial instrument** is any contract that gives rise to a financial asset of one entity and a financial liability or equity instrument of another entity



Derivatives

A **derivative** is a financial instrument with all 3 of the following characteristics:

- its **value changes in response to a change in a specified underlying** (e.g. interest rate, financial instrument price, commodity price, foreign exchange rate, index of prices or rates, credit rating or credit index)

- it requires **no or very small initial net investment** (when a derivative contract originates, the entity does not pay or collect the notional amount)

- it is **settled at a future date** (the period from the trade date of the derivative transaction to the settlement date is longer than for spot transactions, i.e. longer that the ordinary settlement period for standard transactions)

Why derivatives

There is not a single investment bank which does not have a derivatives desk. Moreover, now even some non-financial institutions have their own derivatives analysts. For example oil companies spend quite a lot of money on derivatives research which may seem as an odd activity unrelated to the industry's main business. Why then derivatives are so popular among so many? It turns out that different businesses love derivatives for different reasons.

Why derivatives are used?

- To hedge risks
- To reflect a view on the future direction of the market
- To lock in an arbitrage profit
- To change the nature of a liability
- To change the nature of an investment without incurring the costs of selling one portfolio and buying another

Most commonly used derivatives

The most used instruments

- FX forward, FX option (call, put), Forward rate agreement (FRA), …
- Interest rate swap (IRS), Cross currency swap (CCS), Forward-start interest rate swap, Amortizing swap, Accreting swap, Roller Coaster swap, …
- Interest rate option - Cap, Floor, Collar, Swaption, Range Accrual, …
- Zero cost option strategies - Butterfly, Straddle, Strangle, Bull, Bear, …
- Structure option - FX barrier, Digital, Asian, …
- Constant maturity swap (CMS), Credit default swap (CDS), …

Example 1 – Cross currency swap

CROSS CURRENCY SWAP

First Fixed Amounts

First fixed Rate Payer: Bank

First fixed Rate Payer Currency Amount: USD 100,000,000.00

First fixed Rate Payer Payment dates: 2 Business days before First fixed Rate Payer Period End Dates

First fixed Rate Payer Period End Dates: Each April 15 and October 15, commencing October 15,2010

First Fixed Rate: 4,5% p.a.

COUPON is paid EACH 6 MONTHS (i.e. 2.250%, i.e. 4.5% p.a.)

First Fixed Rate Count Function: 30/360

Second Fixed Amounts

Second fixed Rate Payer: Counterparty

Second fixed Rate Payer Currency Amount: EUR 73,670,251.95

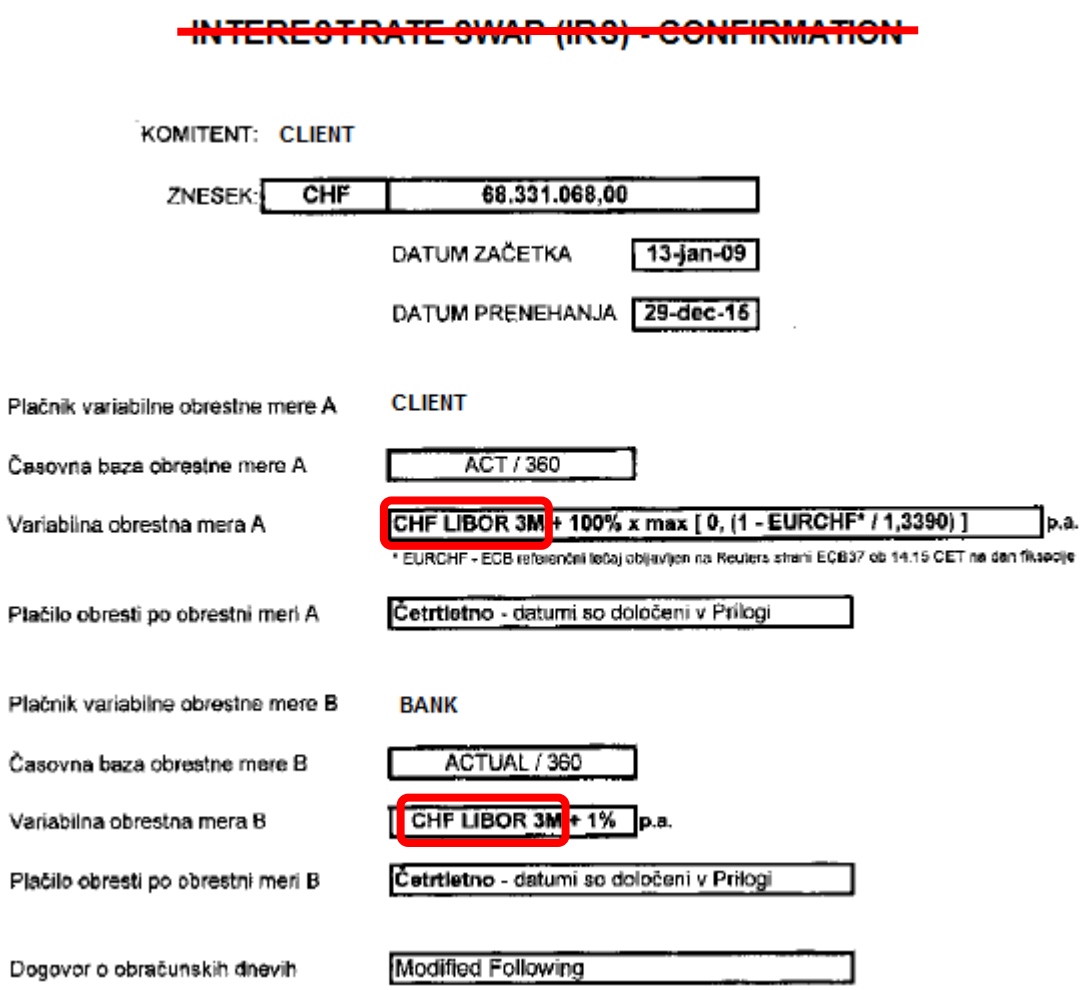
Second fixed Rate Payer Payment dates: 2 Business days before Second fixed Rate Payer Period End Dates

Second fixed Rate Payer Period End Dates: Each April 15 and October 15, commencing October 15,2010

Second Fixed Rate: 3,95 % p.a.

Second Fixed Rate Count Function: 30/360

Example 2 – Interest rate swap



~~INTEREST RATE SWAP (IRS) - CONFIRMATION~~

KOMITENT: CLIENT

ZNESEK: CHF 68.331.068,00

DATUM ZAČETKA 13-jan-09

DATUM PRENEHANJA 29-dec-15

Plačnik variabilne obrestne mere A	CLIENT
Časovna baza obrestne mere A	ACT / 360
Variabilna obrestna mera A	CHF LIBOR 3M + 100% x max [0, (1 - EURCHF* / 1,3390)] p.a.
	* EURCHF - ECB referenčni tečaj objavljen na Reuters strani ECB37 ob 14.15 CET na dan fiksacije
Plačilo obresti po obrestni meri A	Četrtletno - datumi so določeni v Prilogi
Plačnik variabilne obrestne mere B	BANK
Časovna baza obrestne mere B	ACTUAL / 360
Variabilna obrestna mera B	CHF LIBOR 3M + 1% p.a.
Plačilo obresti po obrestni meri B	Četrtletno - datumi so določeni v Prilogi
Dogovor o obračunskih dnevih	Modified Following

What kind of derivative is this instrument?

FX option

Motivation


Guaranteed Bond
Guaranteed Bond
Guaranteed Bond
Guaranteed Bond

Example 1 – Cross currency swap (cont.)

CROSS CURRENCY SWAP

First Fixed Amounts

First fixed Rate Payer: Bank

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First fixed Rate Payer Payment dates: 2 Business days before First fixed Rate Payer Period End Dates

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First Fixed Rate Count Function: 30/360

COUPON is paid EACH 6 MONTHS (i.e. 2.250%, i.e. 4.5% p.a.)

what if

COUPON is paid EACH 3 MONTHS (i.e. 1.125%, i.e. 4.5% p.a.)

Second Fixed Amounts

Second fixed Rate Payer: Counterparty

Second fixed Rate Payer Currency Amount: EUR 73,670,251.95

Second fixed Rate Payer Payment dates: 2 Business days before Second fixed Rate Payer Period End Dates

Second fixed Rate Payer Period End Dates: Each April 15 and October 15, commencing October 15,2010

Second Fixed Rate: 3,95 % p.a.

Second Fixed Rate Count Function: 30/360

DIFFERENCE IN FAIR VALUE 120 million CZK

Quantitative methods involved

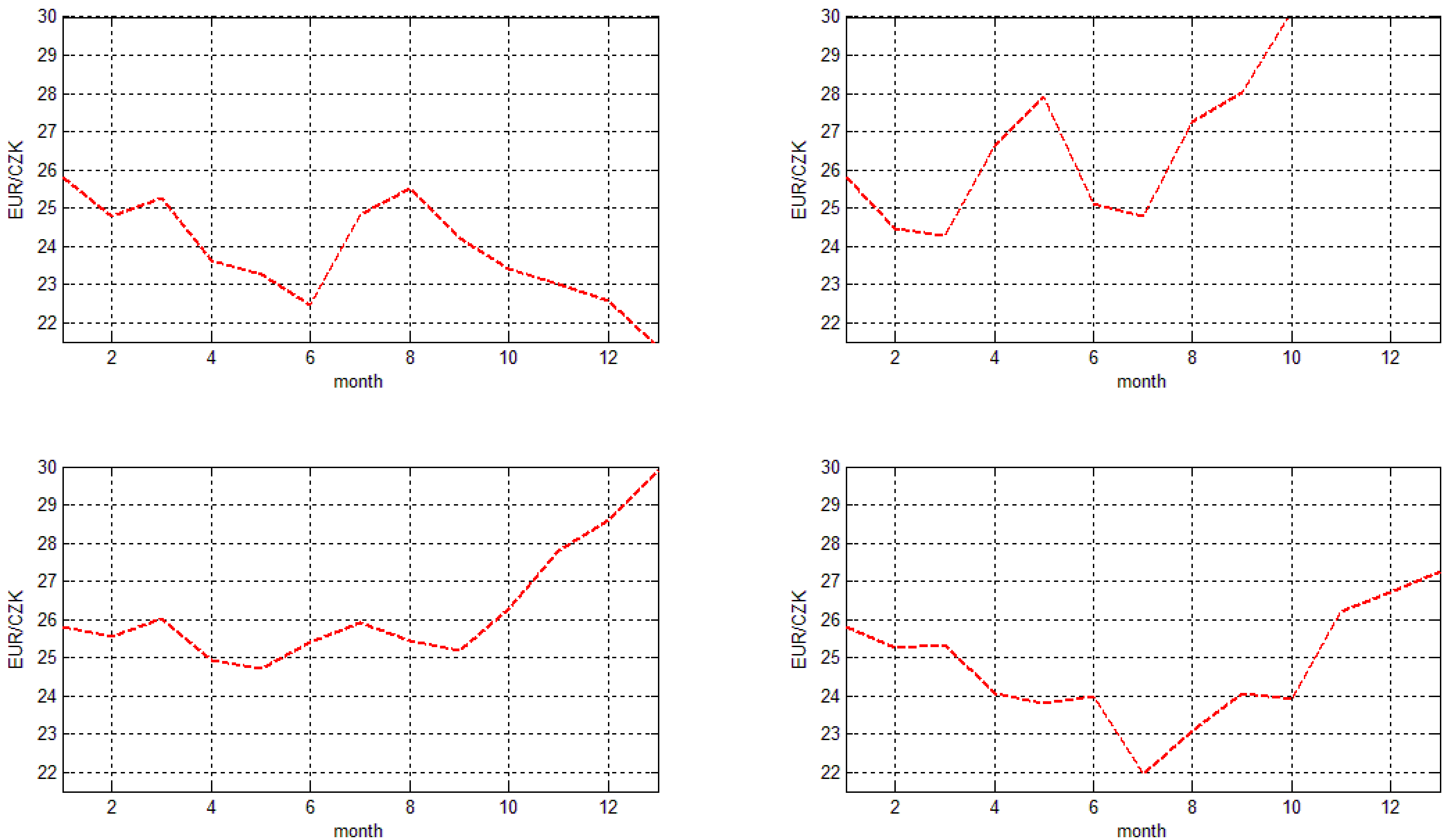
Topics often discussed in derivatives valuation:

- expected value, expected return, mean, median
- standard deviation, historical volatility, exponentially weighted volatility, correlation matrix, Cholesky decomposition, Copula function
- probability concept, joint and conditional probability
- discrete probability distribution, binomial and Poisson distribution
- random variable, standard normal distribution
- time value of money, future value, present value, discount factors
- sampling method and sampling distribution
- Markov chain, Markov process, Jump-diffusion process

Many quantitative methods should be combined to compute fair value of complex financial instruments, e.g. using Monte Carlo simulation.

Monte Carlo simulation

- **Monte Carlo simulation** are usually more efficient than other methods when there are many stochastic variable, provides a standard error for the estimates, can handle more complex stochastic processes.



Structured derivatives

Structured derivatives is an investment strategy, which is based on derivatives, such as a single security, a basket of securities, options, indices, commodities, debt issuances, foreign currencies, and/or swaps.

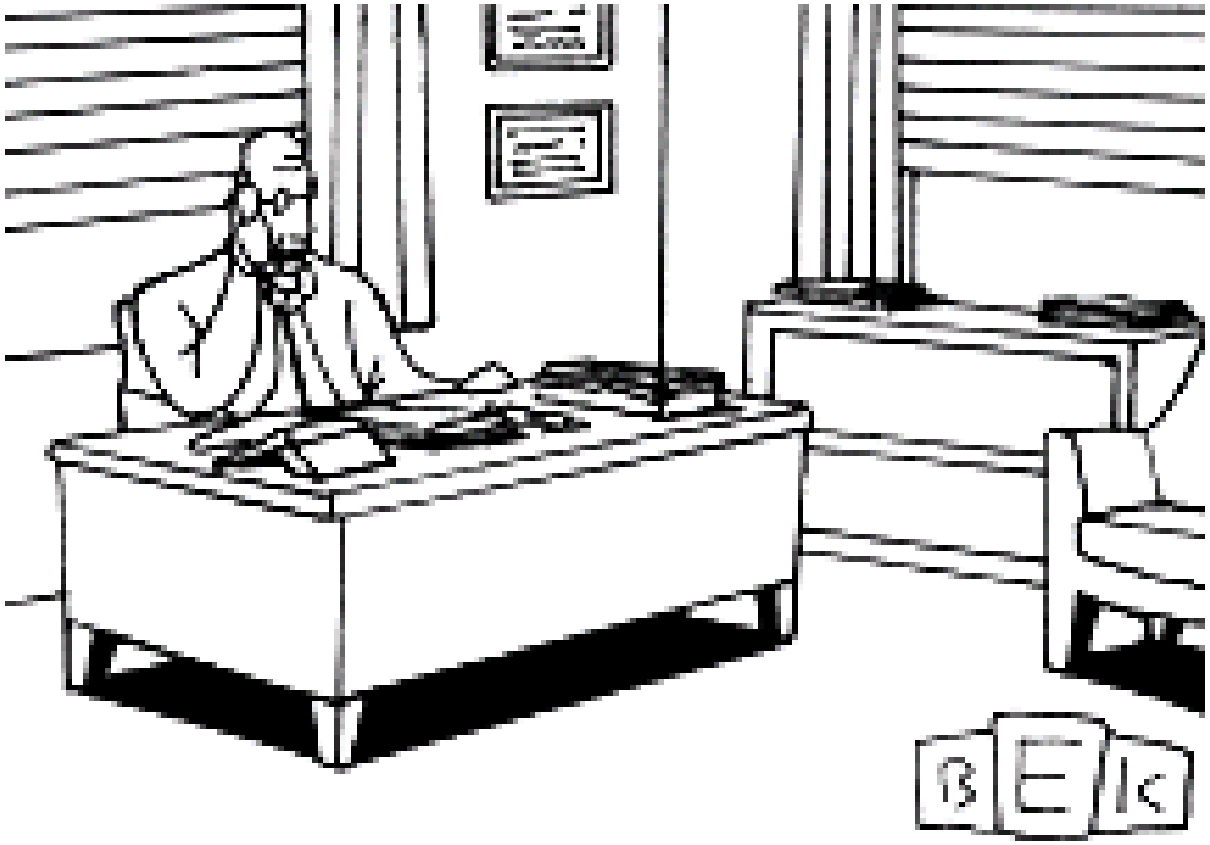
Structured derivatives refers to a group of financial instruments with varying terms, payout and risk profiles on a range of underlying assets.

Structured derivative is an instrument that derives its price in a non-linear way from multiple derivatives and/or multiple cash instruments.

Two implications:

1. Banks like structuring such deals because of the fees it provides.
2. Clients (usually) don't understand the risk related to this type of investment.

Motivation



"We structure the deal so it won't make any sense to you."

Example 3 – Structured product (Inflation)

°Podmienky nároku klienta na vyplatenie bonusového úroku z vkladu na Protiinflačnom vklade[TB]

(tranža PV002)

Klient Tatra banky, a.s., so sídlom na Hodžovom námestí 3, 811 06 Bratislava, IČO: 00 686 930, DIČ:2020408522, IČ DPH: SK2020408522, zapísanej v Obchodnom registri Okresného súdu Bratislava I, oddiel Sa, vložka číslo 71/B (ďalej len „Tatra banka, a.s.“), ktorý v období platnosti týchto Podmienok nároku klienta na vyplatenie bonusového úroku z vkladu na Protiinflačnom vklade[TB] uzatvoril s bankou Zmluvu o zriadení Protiinflačného vkladu[TB], má podľa tejto Zmluvy o zriadení Protiinflačného vkladu[TB] a podmienok produktu Protiinflačný vklad[TB] obsiahnutých v Obchodných podmienkach Tatra banky, a.s. pre vkladové účty nárok na vyplatenie bonusového úroku z vkladu na Protiinflačnom vklade[TB], ktorý bude stanovený nasledovným spôsobom:

Celková výška úrokovej sadzby bonusového úroku za celé obdobie od 7.12.2011 do 6.12.2016 (ďalej len „BÚS“) je odvodená od zmeny podkladového indexu, a to nasledovne:

BÚS = 5% + 100% x Zmena podkladového indexu v %

pričom minimálna výška BÚS bude 5% a maximálna výška BÚS nebude limitovaná.

Výška ročnej úrokovej sadzby bonusového úroku za jednotlivé roky v rámci obdobia od 7.12.2011 do 6.12.2016 (ďalej len „BÚSPA“) sa vypočíta nasledovne:

$$BÚSPA = (BÚS + 1)^{1/5} - 1$$

pričom minimálna výška BÚSPA bude 0,98 % a maximálna výška BÚSPA nebude limitovaná.

Podkladový index je definovaný nasledovne:
Index harmonizovanej spotrebiteľskej inflácie Eurozóny s vyňatím tabaku publikovaný štatistickým úradom Eurostat (Eurostat Eurozone HICP Ex Tobacco Unrevised Series NSA; Bloomberg® Code: <CPTFEMU><Index>).

Zmena podkladového indexu sa rovná percentuálne vyjadrenému podielu sledovaných hodnôt podkladového indexu a bude stanovená nasledovne:

$$\text{Zmena podkladového indexu v \%} = \max\left[0, \left(\frac{HICP_t}{HICP_{t-1}} - 1\right)\right] \times 100$$

$HICP_t$ Hodnota indexu Eurostat Eurozone HICP Ex Tobacco Unrevised Series NSA za september 2016

$HICP_{t-1}$ Hodnota indexu Eurostat Eurozone HICP Ex Tobacco Unrevised Series NSA za september 2012

Rozhodujúce hodnoty podkladového indexu, výslednú zmenu podkladového indexu a BÚS určuje Tatra banka, a.s. ako kalkulačný agent.

Tieto Podmienky nároku klienta na vyplatenie bonusového úroku z vkladu na Protiinflačnom vklade[TB] sú platné v období 14.11.2011. do 6.12.2011 a platia pre každú Zmluvu o zriadení Protiinflačného vkladu[TB] uzatvorenú medzi Tatra bankou, a.s. a klientom v období platnosti týchto Podmienok nároku klienta na vyplatenie bonusového úroku z vkladu na Protiinflačnom vklade[TB].

Example 4 – Structured product (Equity)

KB AMETYST 5

ISIN : FR0010616706 – Investiční fond („IF“)
Spravovaný společností LYXOR INTERNATIONAL ASSET MANAGEMENT („LIAM“)

Cíle a investiční politika

Klasifikace: Zajištěnýfond
Záruka: Úplná záruka kapitálu mimo vstupní poplatky.
Vzorec IF je sestaven na dobu trvání přibližně 5 let. Potenciál zisku závisí na vývoji indexu Euro Stoxx 50.

MECHANISMUS VZORCE PO DOBU ŽIVOTA FONDU

Každý čtvrtletní výkon indexu pohybující se mezi -15 % a +15 % včetně se považuje za rovnající se +15 %.
Každý záporný výkon striktně nižší než -15 % se považuje za nulový.
Každý výkon striktně překračující +15 % je přímo zohledněn při výpočtu aritmetického průměru čtvrtletních výkonů.

MECHANISMUS VZORCE PO UPLYNUTÍ SPLATNOSTI 5 LET

Cílem správy investičního fondu KB AMETYST 5 je poskytnout ke dni splatnosti dne 30.prosince 2013, nebo jestliže tento den není burzovním dnem, tak následujícího burzovního dne, držiteli vypořádací hodnotu rovnající se:

100 % Referenční vypořádací hodnoty
+
60 % aritmetického průměru čtvrtletních výkonů indexu Euro Stoxx 50 (mimo dividendy) vypočítaných od počátku

Complex structured derivatives

Stochastic instruments:

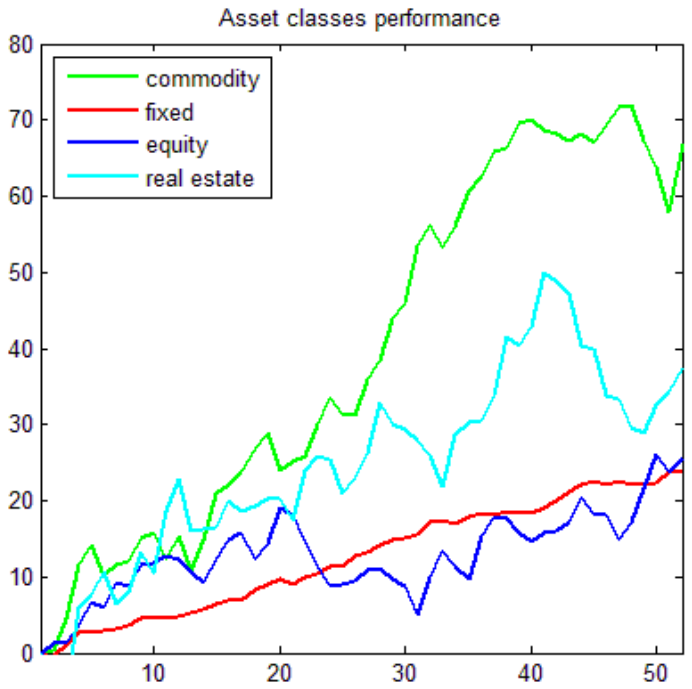
- **Himalaya** - at a given frequency, the level of the best performing underlying is locked-in until the end; at maturity, the investor receives his capital invested plus the average of the locked-in performances
- **Annapurna** - payout equals to the greater of a capital guarantee plus a fixed coupon and a participation in the performance of the underlying basket, the fixed coupon level and the performance participation rate depend on whether and when the worst-performing stock breaches a downside barrier, the later the breach, the higher the fixed coupon and performance participation rate
- **Kilimanjaro** - an enhanced reverse convertible including a capital protection. The investor receives a fixed annual coupon if no stock has breached the limit on any predetermined observation date
- **Amarante** - the yearly rolling average performance (since launch) is calculated for thee investment profiles: secure, balanced and dynamic, at maturity the investor receives the capital invested plus the best of this yearly rolling average performance

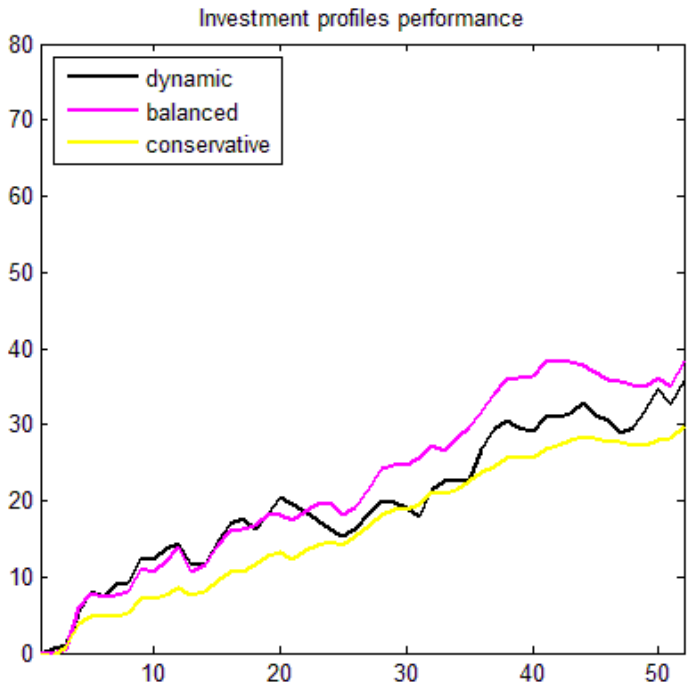
Complex structured derivatives

Example 5 – Amarante option

Amarante option - the annual performance is calculated for three investment profiles: at maturity the investor receives the best of this annual rolling average performance

- **Investment profiles**: dynamic (mainly equities), balanced (mix between the four asset classes) and conservative (mainly fixed-income).
- **Asset classes**: equity markets (Europe, US, Japan, UK, China), fixed income, real estate, commodities, etc.





Example 6 – Himalaya option

Expectation

Reality

Member of
Deloitte Touche Tohmatsu