Current issues of financial product valuation

XXXV Heidelberg Physics Graduate Days

Heidelberg, October 6th, 2015

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Agenda

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Financial instruments’ examples

Underlyings vs. derivatives

Underlyings

» Stocks, interest rates, FX rates, deposit, plain bond, …

More complex financial products are „derived“ from simpler products

» Derivatives are payoff claims somehow based on prices of simpler products or other derivatives

» Derivatives may be traded via an exchange or directly between two counterparties (OTC: over-the-counter)

» OTC-Derivatives are based on freely defined agreements between counterparties and may be arbitrarily complex

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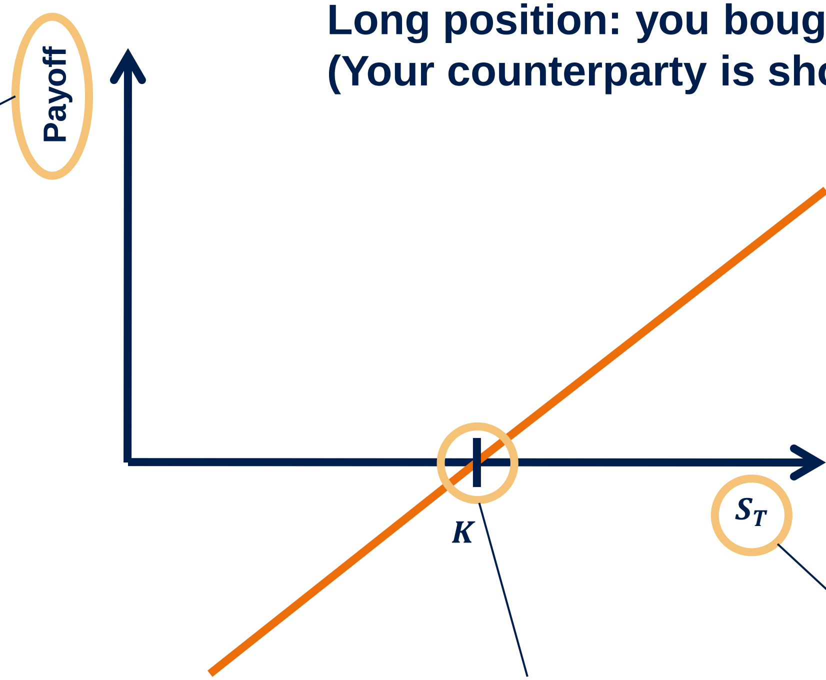
Example I: Forward (or Futures) contract

Buying (or selling) assets at some future date

Long position: you bought the stock
(Your counterparty is short)

Payoff $S_T - K$ at maturity (expiry) T



Physical Settlement: get Asset, pay K

Cash Settlement: get $S_T - K$

Forward Price K or Strike Price

Asset Price S_T at maturity (expiry) T

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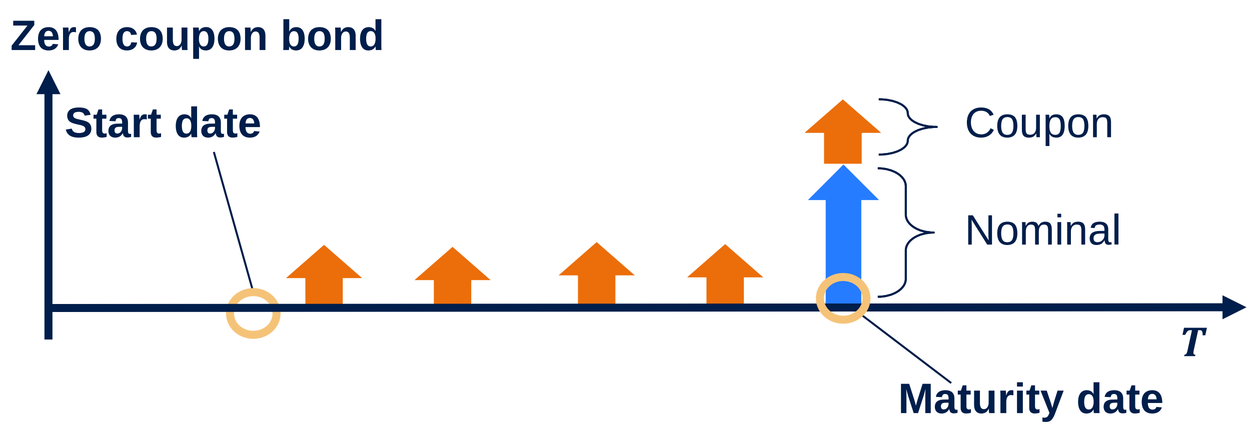
Example II: (Plain Vanilla) Bond



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Example of Bond term sheet

Filed pursuant to Rule 433
Registration Statements Nos. 333-183618 and 333-183618-01
Relating to Preliminary Prospectus Supplement dated
March 10, 2014

U.S.$2,500,000,000 6.250% Global Notes due 2024
Pricing Term Sheet

A preliminary prospectus supplement of Petrobras Global Finance B.V. accompanies this free writing prospectus and is available from the SEC's website at www.sec.gov.

Issuer:	Petrobras Global Finance B.V. ("PGF")
Guarantor:	Unconditionally and irrevocably guaranteed by Petróleo Brasileiro S.A. - Petrobras
Form:	Senior Unsecured Notes
Offering:	SEC-Registered
Currency:	U.S. Dollars
Principal Amount:	U.S.$2,500,000,000
Maturity:	March 17, 2024
Coupon Rate:	6.250%
Interest Basis:	Payable semi-annually in arrears
Day Count:	30/360
Interest Payment Dates:	March 17 and September 17
First Interest Payment Date:	September 17, 2014
Gross Proceeds:	U.S.$2,494,300,000
Issue Price:	99.772%
U.S. Treasury Benchmark:	2.750% due February 15, 2024
Benchmark Treasury Spot and Yield:	99-23+ / 2.781%
Spread to Benchmark Treasury:	+ 350 bps
Yield to Investors:	6.281%
Make-Whole Call Spread:	+ 50 bps
Pricing Date:	March 10, 2014
Settlement Date:	March 17, 2014 (T+5)

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Denominations:	U.S.$2,000 and integral multiples of U.S.$1,000 in excess thereof
CUSIP:	71647N AM1
ISIN:	US71647NAM11
Joint Bookrunners:	Bank of China (Hong Kong) Limited BB Securities Ltd. Banco Bradesco BBI S.A. Citigroup Global Markets Inc. HSBC Securities (USA) Inc. J.P. Morgan Securities LLC
Co-Managers:	Banca IMI S.p.A. Scotia Capital (USA) Inc.

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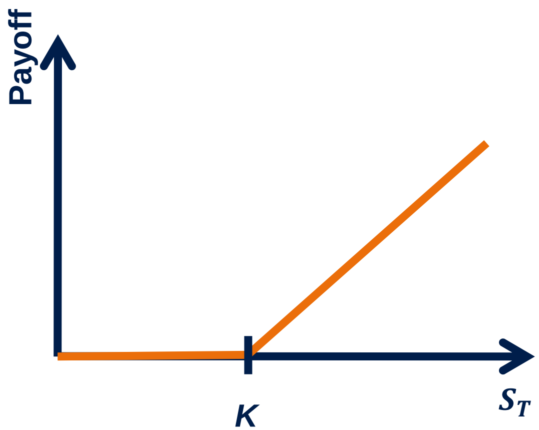
Example III: Plain Vanilla Option

Simplest and most liquidly traded options

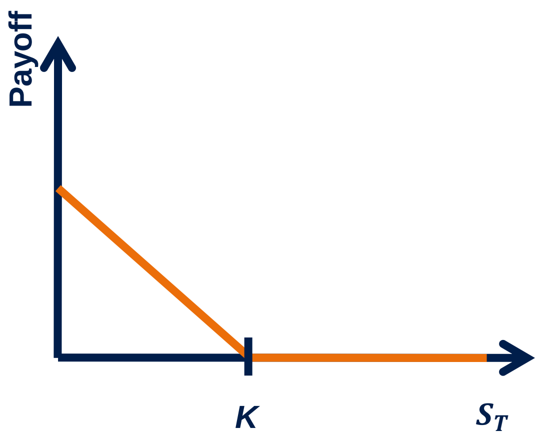
(Plain Vanilla) Call Option



Payoff:

$$\max(S_T - K, 0) \equiv (\boldsymbol{S_T - K})^+$$

(Plain Vanilla) Put Option



Payoff:

$$\max(K - S_T, 0) \equiv (\boldsymbol{K - S_T})^+$$

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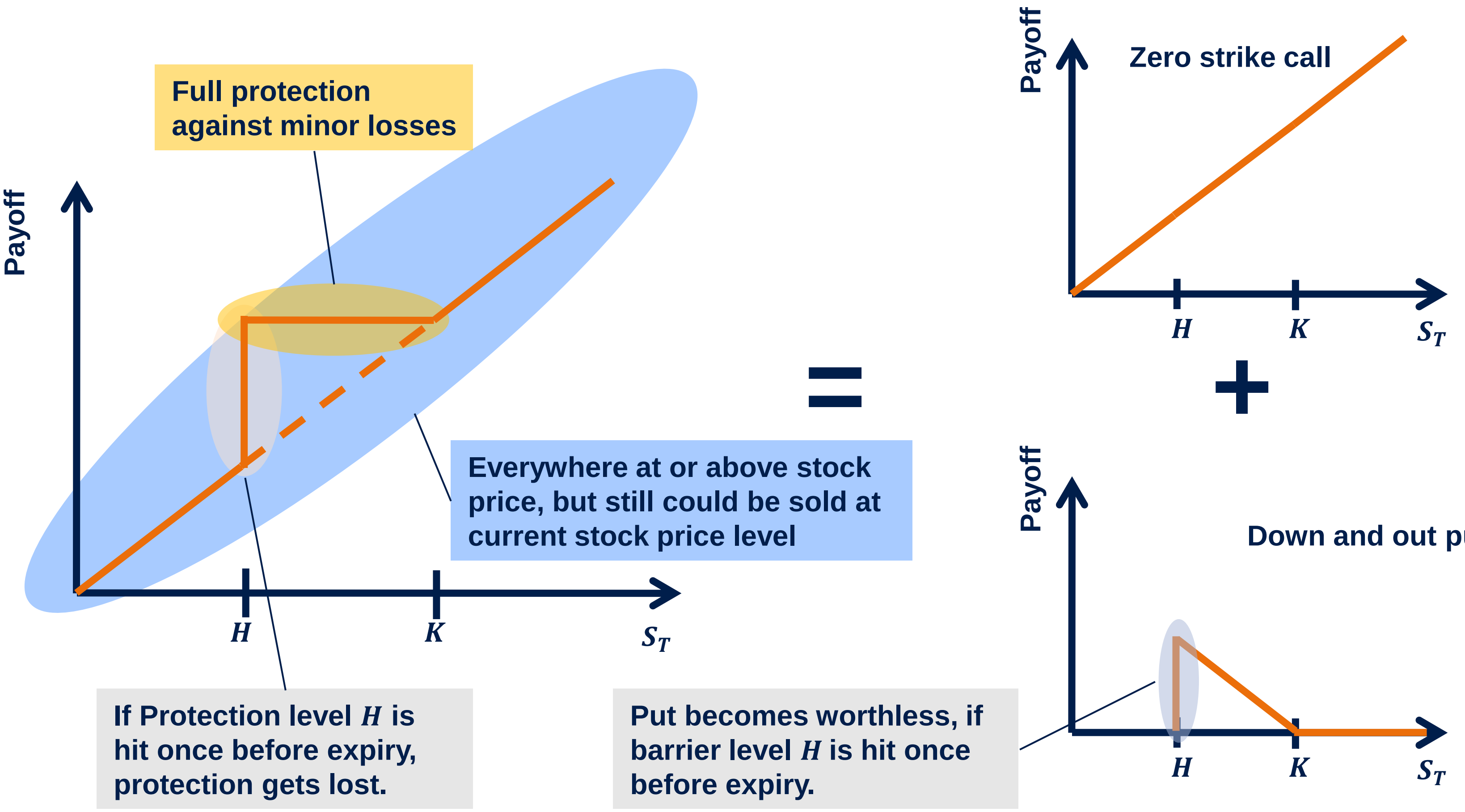
Example IV: Bonus Certificate

Getting more than you might expect



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Arbitrage free pricing

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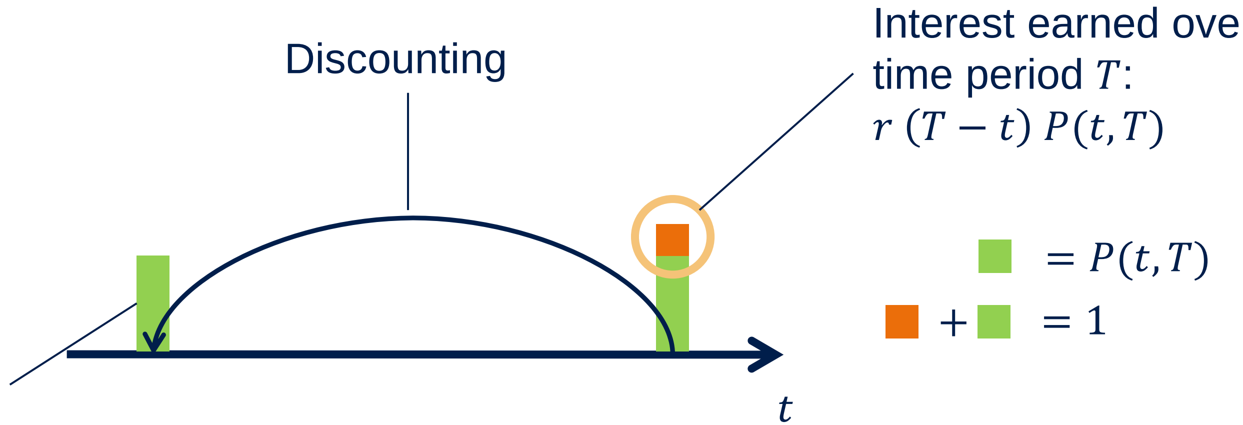
Time is money. But how much money is it?

- Money today is worth more than the same amount in some distant future
  - Risk of default
  - Missing earned (risk free) interest
- Zero discount bond $P(t,T)$: discounted value as of time t of payment of 1 unit at future time T
- Discount factor: Factor to be multiplied to a future cash flow to get its present value
  - Equal to price of zero bond

Cash flow 1 at future time T is worth now

$P(t,T) = \frac{1}{1+r(T-t)}$



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Compounding of interest rates

- Usually, interest is paid on a regular basis, e.g. monthly, quarterly or annually
- If re-invested, the compounding effect is significant
  - Annual, semi-annual, quarterly, monthly or daily compounding is used
  - Anyway, the rate r is quoted as annualised rate, i.e. interest per year
- Without re-investing, the rate is called “simple compounding”

$$\underbrace{\left(1+\frac{r}{m}\right)\left(1+\frac{r}{m}\right)\cdots\left(1+\frac{r}{m}\right)}_{nm\text{ times}} = \left(1+\frac{r}{m}\right)^{nm}$$

Compoundings per year

Number of years

- Continuous compounding is the limit of compounding in infinitesimal short time periods

$$\lim_{\substack{m\to\infty \\ n=\text{const.}}} \left(1+\frac{r}{m}\right)^{nm} = e^{rT}, \quad T = n, \qquad\qquad P(t,T) = e^{-rT}$$

If not stated otherwise, this convenient notation is used throughout the rest of the talk. It is also most often assumed in papers on finance.

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Arbitrage: making money out of nothing

- Arbitrage is the art of earning money (immediately) without taking risk
- If the markets are inefficient, there may be opportunities for arbitrage
- Since money earned by arbitrage is easy money, market participants will take immediate advantage of arbitrage opportunities
- Fair values should be arbitrage free

- Example:
  - Party A offers to sell stock for 10 (ask price)
  - Party B is willing to buy stock for 15 (bid price)
  - Arbitrage! Buy from A and sell to B without risk, making riskless profit of 5
  - Because of this, A will have a lot of potential buyers (and will rise the price) while B has many offers and lowers the price, reducing the arbitrage opportunity until ask price > bid price

There is no free lunch!

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Example: valuation of Forward contract

- Forward contract buy some asset (e.g. a stock) for a fixed price K at a later time T
  - Question: What is the fair strike price K?
- The bank replicates the Forward contract:

At time $t = 0$:

1. Step: Enter into short forward contract (0 cost)
2. Step: Borrow amount S_0 at risk free rate
3. Step: Buy stock at price S_0

At time $t = T$:

1. Step: Settle Forward contract and receive K in return for stock
2. Step: Pay back loan

Time	Forward contract on stock	Stock	Loan	Sum
$t = 0$	0	S_0	$-S_0$	0
$t = T$	$K - S_T$	S_T	$-e^{rT}S_0$	$K - e^{rT}S_0$

Assume $K > e^{rT}S_0$. In this case, our strategy has provided us with a riskless profit (> 0) at no cost, which contradicts the no-arbitrage assumption.

Assume $K < e^{rT}S_0$. In that case, use the opposite strategy: long forward contract, short sell stock and lend cash. You make $K - e^{rT}S_0$ out of zero investment, no risk.

To avoid arbitrage, the forward price (no dividends) must be $K = e^{rT}S_0$

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The fundamental theorem of asset pricing

Theorem: Suppose we have an arbitrage free market and a numeraire, i.a. an asset N with strictly positive price for all $t \in [0, T]$.

Then there exists a measure Q_N (the martingale measure) such that for any derivative V with payoff $V(T)$ the present value is given by

$$\frac{V(0)}{N(0)} = E_{Q_N}\left(\frac{V(T)}{N(T)}\right)$$

Example: With the zero bond $P(t, T)$ as numeraire, we get

$$V_{\text{Forward}}(0) = P(0, T)(E_T(S_T) - K)$$

and therefore

$$V_{\text{Forward}}(0) = S_0 - e^{-rT} K$$

since $S(t)$ follows $dS_t = rS_t dt + \sigma dW_t$ under the martingale measure associated to $P(t, T)$

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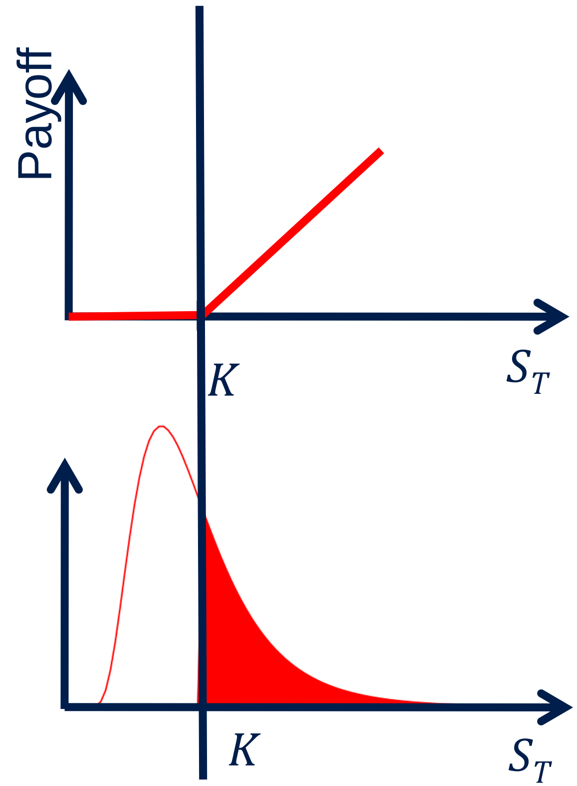
Adding optionality

- For options, the distribution function matters
- Plain Vanilla option: cut off distribution function at strike K
- European Call option payoff: $\max(S_T - K, 0) \equiv (S_T - K)^+$

- Question: Is there any arbitrage free replication strategy to finance these payoffs?



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Stock process

The Geometric Brownian motion of some stock price $S(t)$

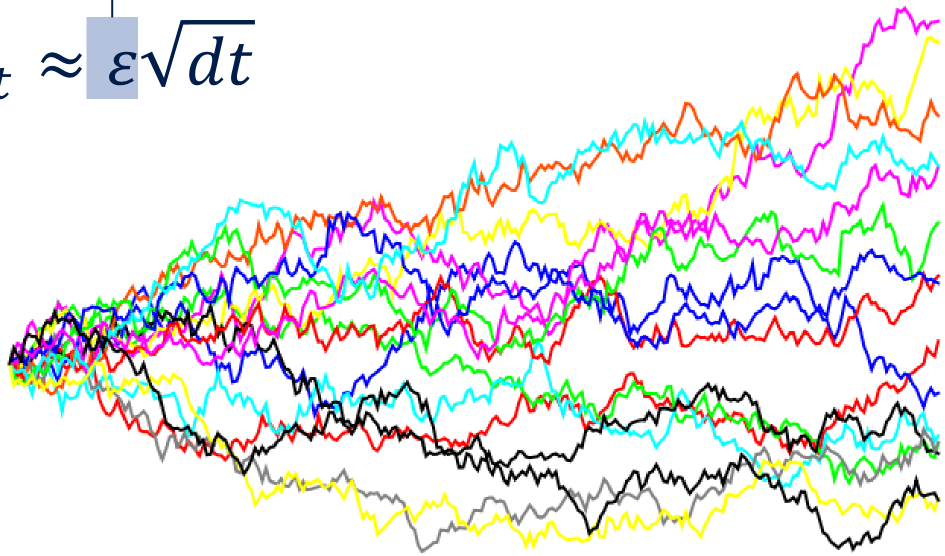
Drift

Volatility

Standard normal distributed random number

$$dS_t = \mu S_t dt + \sigma S_t dW_t \qquad dW_t \approx \varepsilon\sqrt{dt}$$

$$d \ln S_t = \left(\mu - \frac{\sigma^2}{2}\right) dt + \sigma dW_t$$



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Ito‘s lemma

- What’s the stochastic process of a function of a stochastic process?
  - Apply Ito’s lemma

- Process of underlying: $dS = \mu S dt + \sigma S dW$
- Fair value V of option is function of S: $V = V(S)$
- Ito‘s lemma:

$$dV = \left(\frac{\partial V}{\partial S}\mu S + \frac{\partial V}{\partial t} + \frac{1}{2}\frac{\partial^2 V}{\partial S^2}\sigma^2 S^2\right)dt + \frac{\partial V}{\partial S}\sigma S dW$$

Caused by stochastic term $\sim\sqrt{dt}$.

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Replication portfolio for general claims

» Replicate option payoff by holding portfolio of cash account and stock

» Ansatz: $V = B + xS$ with $dB = rBdt$.

» Changes in option fair value V

$$dV = \left(\frac{\partial V}{\partial S}\mu S + \frac{\partial V}{\partial t} + \frac{1}{2}\frac{\partial^2 V}{\partial S^2}\sigma^2 S^2\right)dt + \frac{\partial V}{\partial S}\sigma S dW$$

$$dV = rBdt + x\mu Sdt + x\sigma SdW$$

» Choose $x = \frac{\partial V}{\partial S}$ and insert for $B = V - xS$:

$$\frac{\partial V}{\partial t} + \frac{1}{2}\frac{\partial^2 V}{\partial S^2}\sigma^2 S^2 = rB = rV - rS\frac{\partial V}{\partial S}$$

$$\Leftrightarrow \quad \frac{\partial V}{\partial t} + rS\frac{\partial V}{\partial S} + \frac{1}{2}\frac{\partial^2 V}{\partial S^2}\sigma^2 S^2 = rV$$

Black-Scholes PDE

With this choice of x, the stochastic term vanishes

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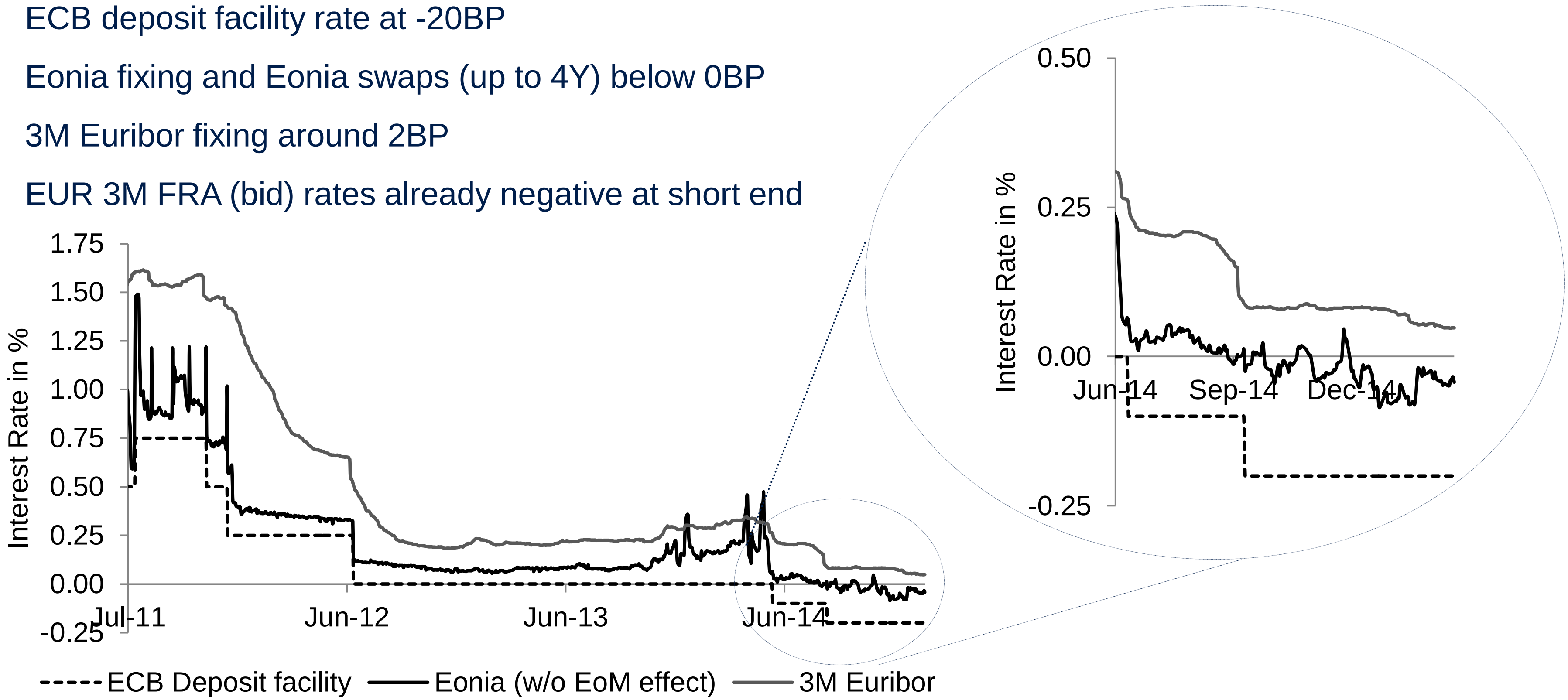
Below zero – challenges from negative interest rates

ECB policy drags down reference market interest rates

Status Quo:

- ECB deposit facility rate at -20BP
- Eonia fixing and Eonia swaps (up to 4Y) below 0BP
- 3M Euribor fixing around 2BP
- EUR 3M FRA (bid) rates already negative at short end



Given the ongoing quantitative easing it is uncertain if current interbank rates levels already mark a floor. Interest rates in other currencies, such as CHF and DKK, already show a strong negative tendency.

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There are various types of risk in low interest rate markets

Negative Eonia - Zero/Negative Euribor - Low Forward Rates - Zero/Negative Forward Rates

Operational Risk	Model Risk	Market Risk
Can systems process negative values for fixings, forward rates and strikes?	Are models still in line with peers and market standard given the new market environment?	Can models calibrate to market environment and yield reasonable pricing and risk numbers?

What if the answer is 'No'?

Operational Risk	Model Risk	Market Risk
» Interruption in EoD valuation runs » Limitations of new business	» Collateral disputes » Disadvantages when competing for deals	» Wrong prices/hedges/risks » Bleeding P&L due to potential arbitrage

Current low interest rate markets require active operational, market and model risk management

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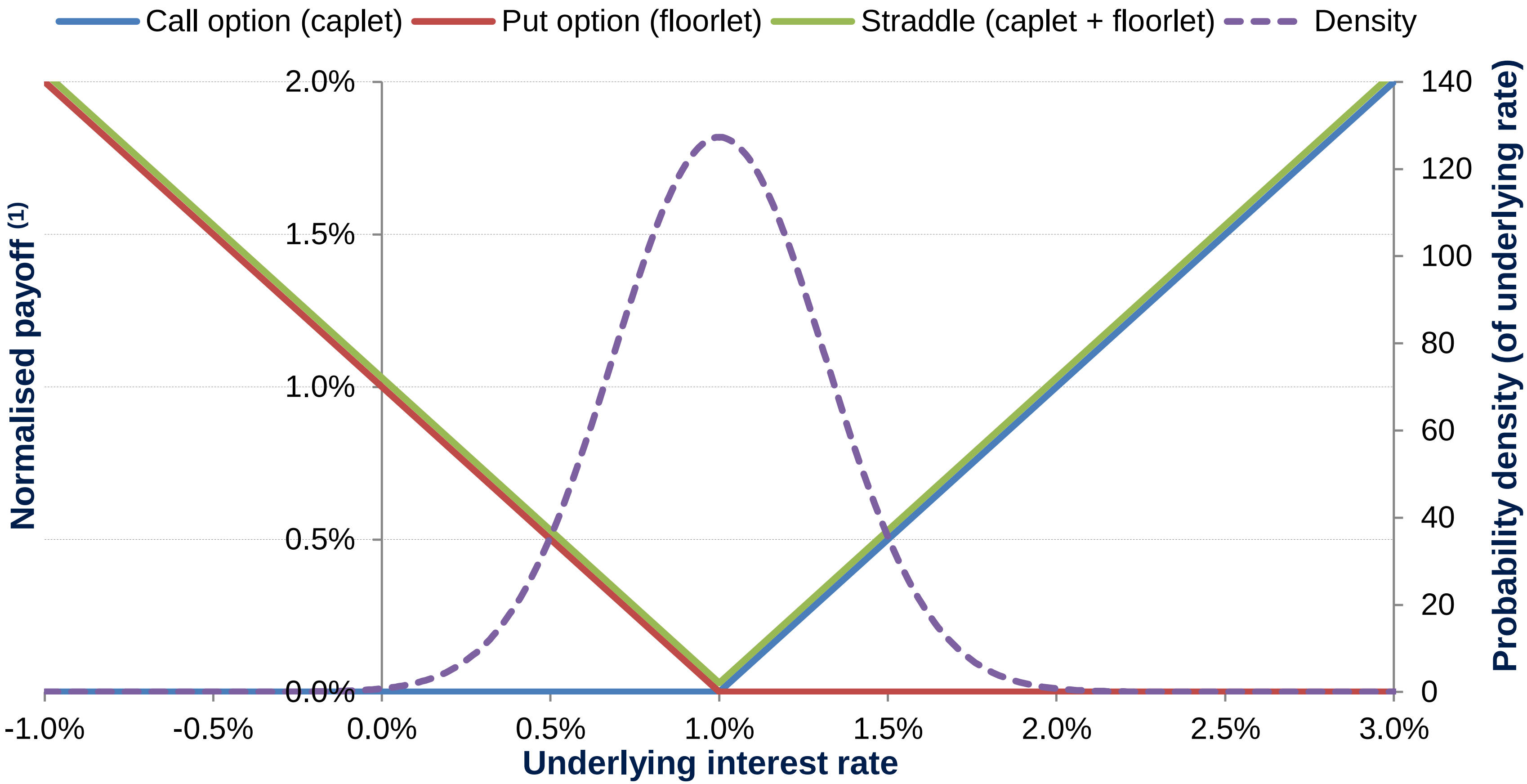
Vanilla option pricing is affected most by low and negative interest rates

A (very) brief introduction to Vanilla interest rate options



Vanilla option price becomes the option payoff integrated against the probability density of underlying rate

(1) Actual payoff is normalised payoff times annuity (notional, year fractions and discount factors)

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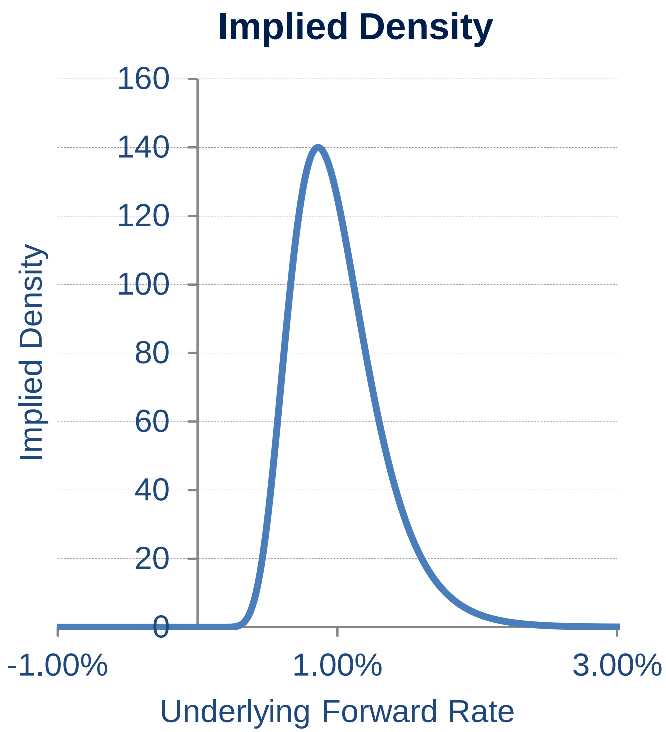
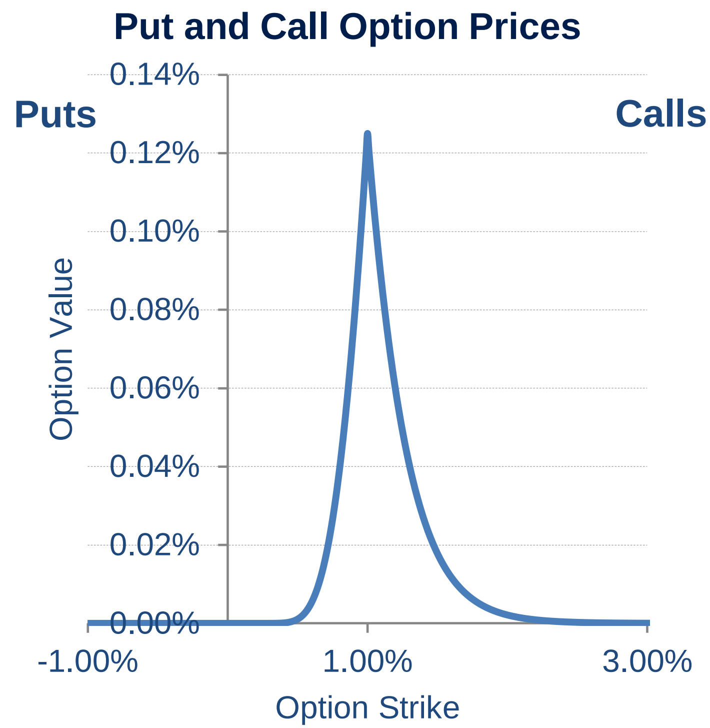
In the past log-normal-style models used to be market standard

- Example: log-normal model calibrated to price of interest rate option (1y x 1y straddle, forward at 1%)





- No probability density below zero forward rates; Hence zero-strike options are always priced at zero
- More advanced models (e.g. like SABR model) may show similar behaviour

> Limitation of Log-normal-style models force the industry to develop new models and methodologies

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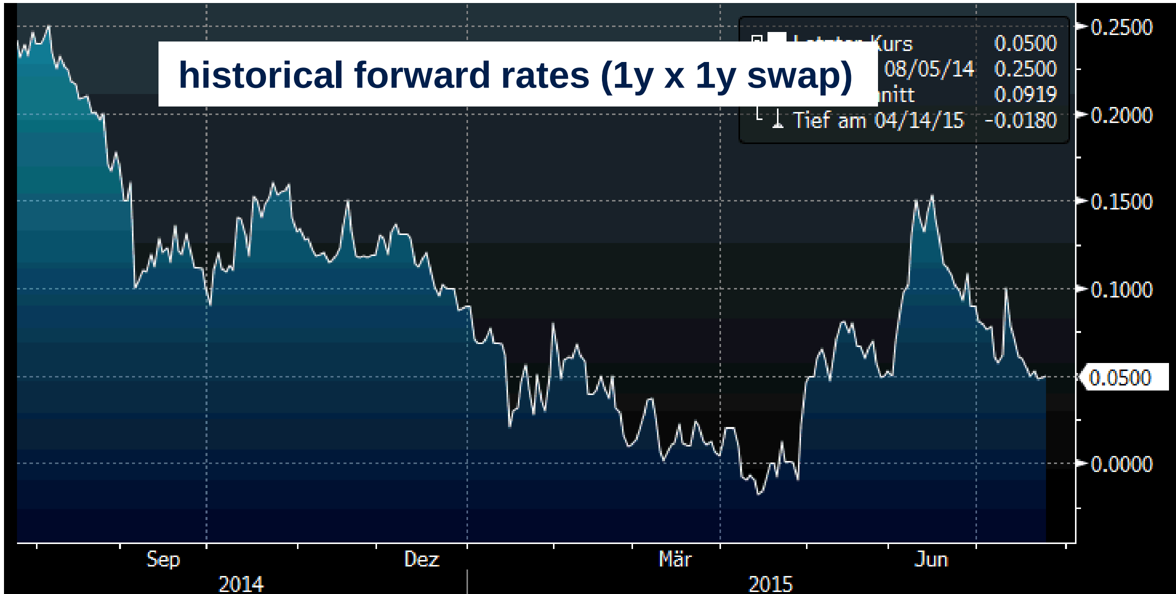
The market does assign non-trivial values to low-strike interest rate options



Interest rates go down

But straddle prices go up

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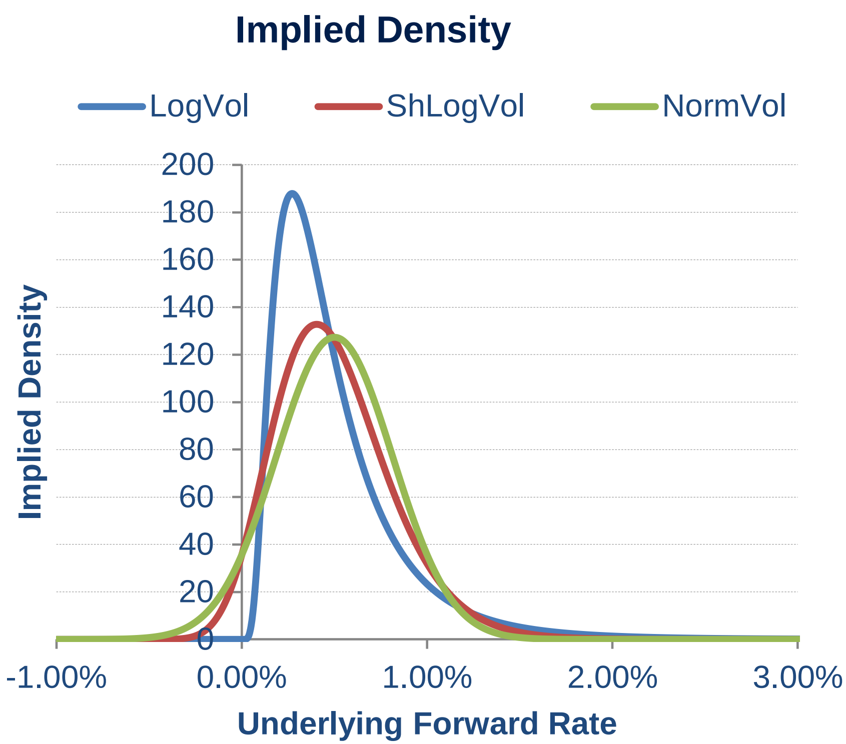
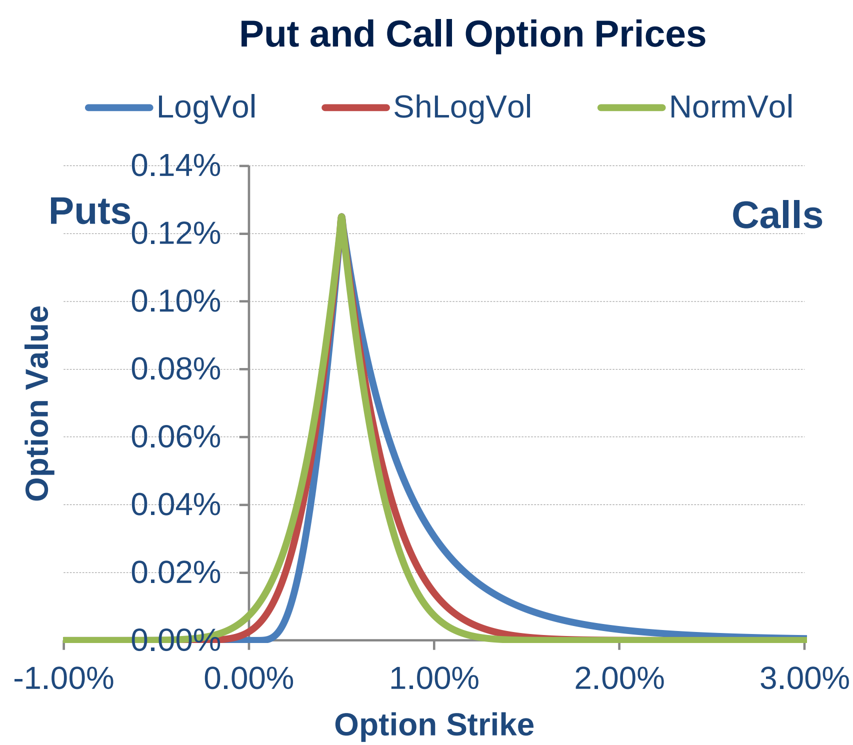
Shifted log-normal and normal distributions are alternatives for Vanilla option modelling





» Shifted log-normal and normal distribution yield probability mass also for negative forward rates

» Zero- and negative strike options get a non-trivial model price

There is still no clear picture whether shifted log-normal or normal distributions become new modelling standard

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Summary

Pricing in Low Rates Environment

- » New challenges for operational, model and market risk management
- » Vanilla models require most attention
- » Market standard log-normal Black formula (+ SABR interpolation) requires improvements

Shifted Log-normal and Normal Volatilities

- » Quotation of log-normal volatilities switched to shifted log-normal and normal volatilities
- » New modelling approaches for interest rate options are evolving

Further Reading (background, models and references)

http://www.d-fine.com/unternehmen/aktuelle-themen/negative-zinsen/

If you want to take up these and many other challenges with us then get involved! Contact us in person or have a look at www.d-fine.com

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Implications of counterparty credit risk

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CVA = Credit Value Adjustment

The value of counterparty default risk (credit risk)

Positive part of derivative value at time t

$$CVA = \mathrm{E}\left[\int_0^T \left(1 - R(t)\right) 1_{\{\tau = t\}}(t)\, B(0,t)\, V^+(t)\, dt\right]$$

Recover y Rate

Time of default

The derivative value with default risk $V^D(0)$ equals $V(0) - CVA$.

Counterparty risk can be traded by means of Credit Default Swaps – paying periodically a premium for insurance against default of specific counterparty

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CVA simplified

Special assumption reduce complexity

1. Assumption: default probability can be expressed in terms of hazard rate *h*(*t*) default probability in infinitesimal short time *dt*.

$$V^D = V - \mathrm{E}\left[\int_0^T (1-R)h(t)e^{-h(t)t}\, e^{-rt}\, V^+(t)\, dt\right]$$

2. Assumption: deterministic and constant recovery

$$V^D = V - (1-R)\mathrm{E}\left[\int_0^T h(t)e^{-h(t)t}\, e^{-rt}\, V^+(t)\, dt\right]$$

3. Assumption: no wrong/right way risk (exposure and default probability are independent)

$$V^D = V - (1-R)\int_0^T h(t)e^{-h(t)t}\, \mathrm{E}\left[e^{-rt}\, V^+(t)\right] dt$$

4. Assumption: exposure is always positive and (piece-wise) constant hazard rate

$$V^D = V - (1-R)\int_0^T h e^{-ht}\, V\, dt = V - (1-R)\left(1-e^{-hT}\right)V$$

5. Assumption: zero recovery rate

$$V^D = e^{-hT}V$$

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Forward fair value with CVA

Counterparty risk adds option feature

Call option with CVA:

$$V_{\mathrm{Call}}^{D} = V_{\mathrm{Call}} - (1-R)\left(1-e^{-hT}\right)V_{\mathrm{Call}}$$

Special case *R*=0:

$$V_{\mathrm{Call}}^{D} = e^{-hT}\left(SN(d_1) - Ke^{-rT}N(d_2)\right)$$

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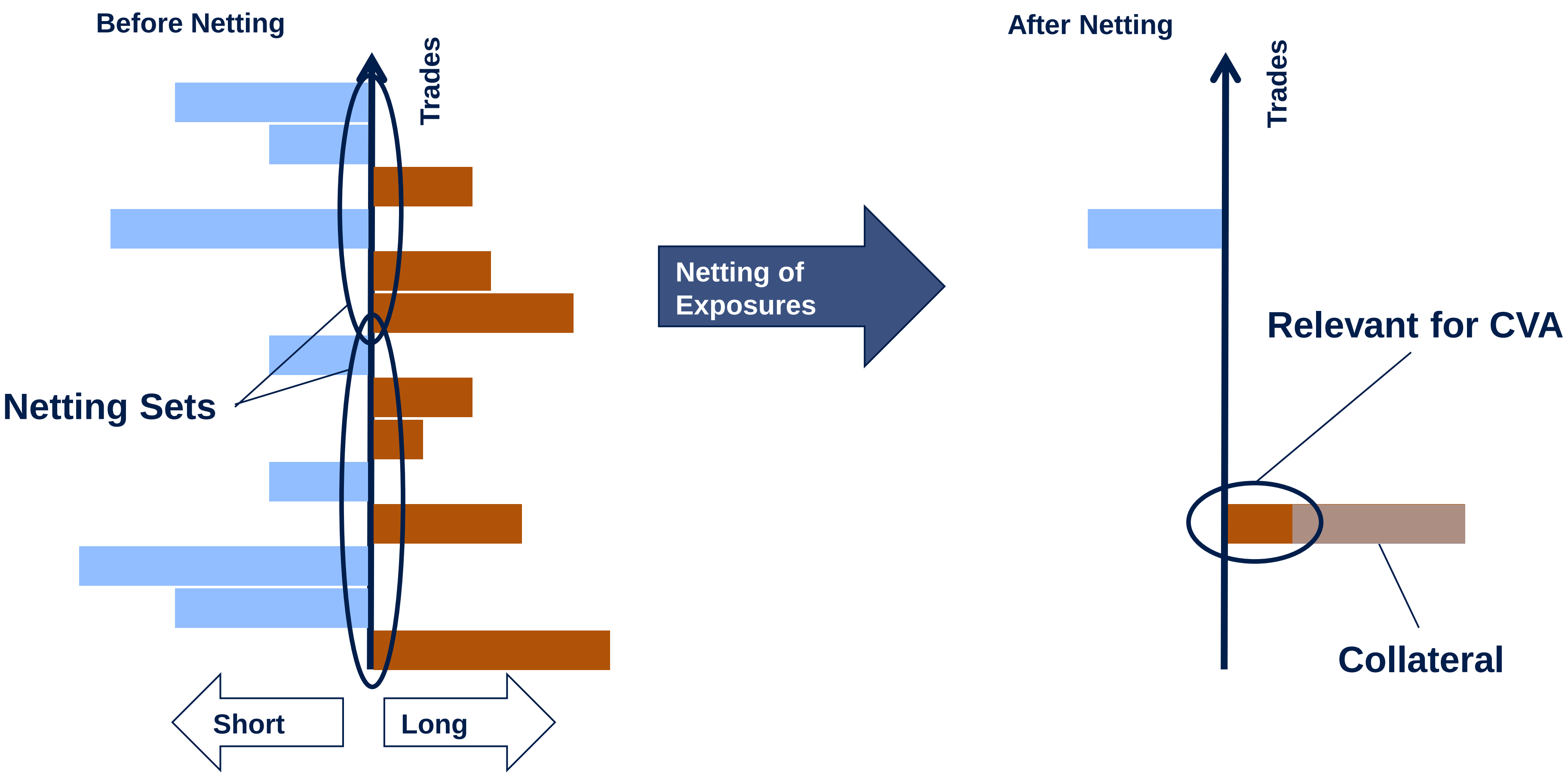
CVA for the bank's derivatives portfolio

Effect of netting agreements and collateral management



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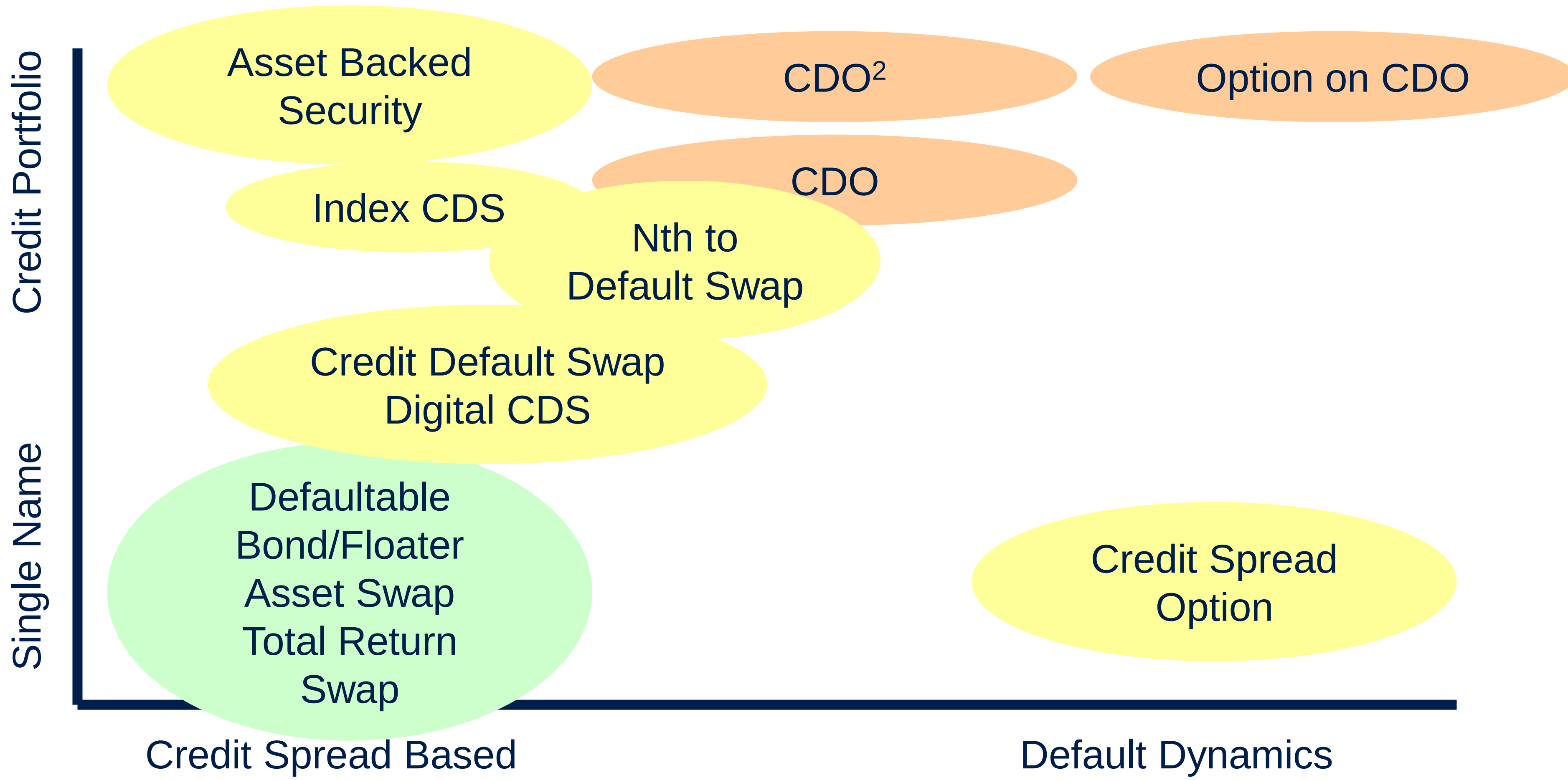
Products with credit risk

Typical credit linked products



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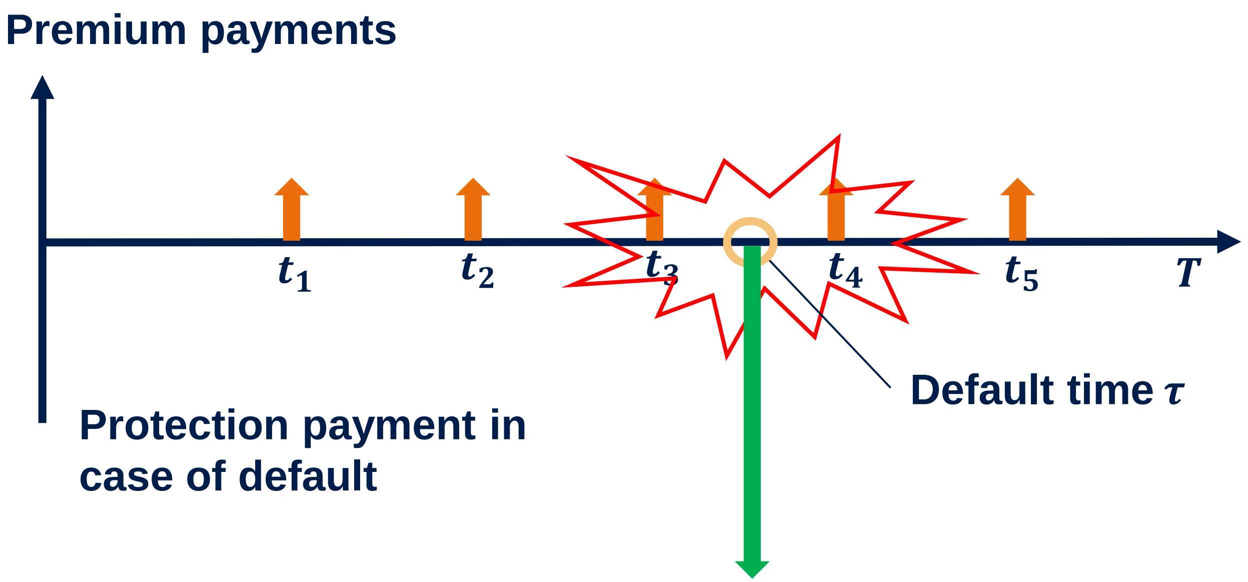
Single name Credit Default Swap



- Market practice is to use a simplified approach for pricing CDS
- Value of protection leg

$$V_{\text{Prot}} = (1 - R) \sum_{i}^{n} D(t_i)\big(Q(t_{i-1}) - Q(t_i)\big)$$

- Value of premium leg

$$V_{Prem} = s \sum_{i}^{n} D(t_i)\delta(t_{i-1}, t_i)Q(t_i) + s \sum_{i}^{n} \frac{1}{2} D(t_i)\delta(t_{i-1}, t_i)\big(Q(t_{i-1}) - Q(t_i)\big)$$

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CDO/ABS: securitization of credit risk portfolios

» Securitization of credit risk portfolios allow transfer of credit risk without transferring the assets itself
  » Portfolio is cut in several tranches (see next slide)

ABS: Asset backed security	CDO: Credit debt obligation
• Large portfolio of (~thousand) of credit risky assets, e.g. consumer loans, mortgages, credit cards, etc.	• Portfolio of (~hundred) credit default swaps (sometimes bonds)
• Underlying assets are not tradeable	• Usually tradeable credit names as CDS underlying
• No look-through on portfolio (i.e. buyer does not have direct access to underlying portfolio	• Often look-through possible (i.e. credit names of underlying are known by CDO buyer)
• Valuation is highly depending on information provided by issuer	• Models can be calibrated to available market data (i.e. credit indices like iTraxx, CBX, etc.)
• Pay off structure (waterfall) often rather complex	• Pay off structure is usually fairly simple
• Valuation is often limited to correct distribution of cash flows assuming a deterministic default schedule	• Valuation by dynamic simulation of defaults of single underlying (with many simplifications)

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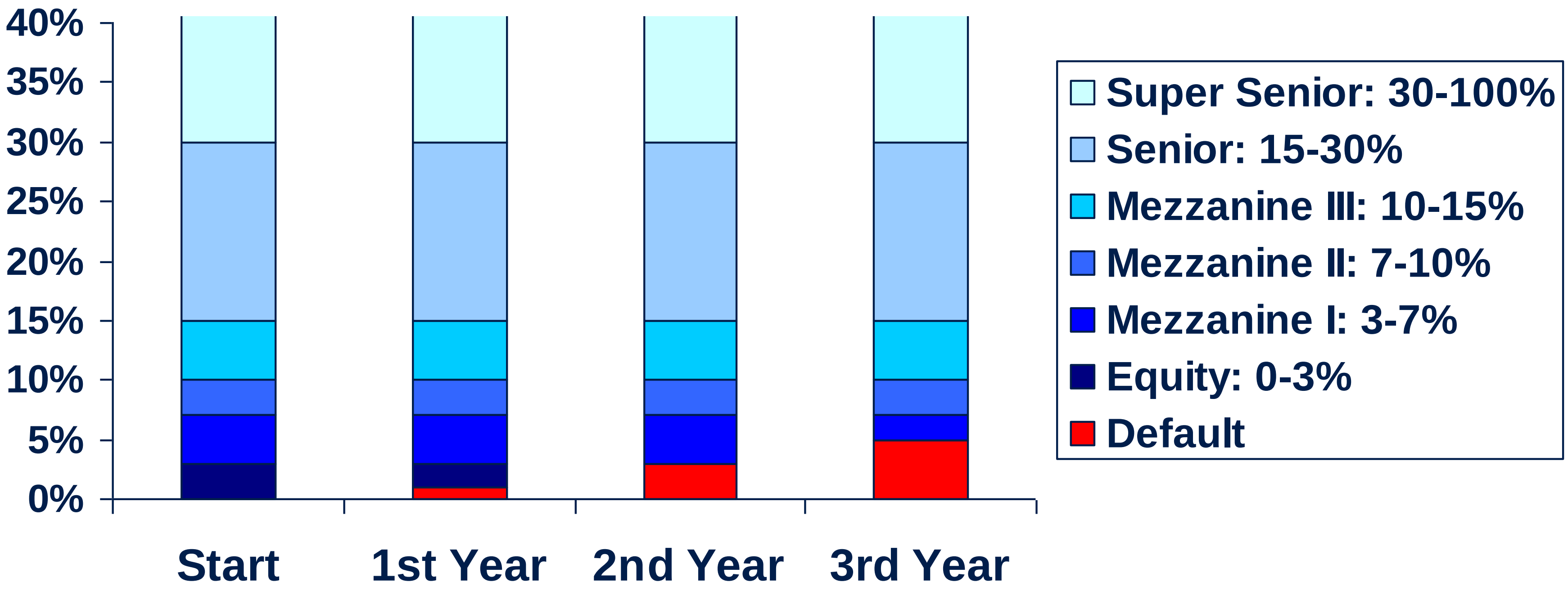
ABS/CDO performance over time



After 1st year, 1% of total nominal has defaulted, i.e. 33% of equity tranche
After 2nd year, 100% of equity tranche has defaulted
After 3rd year, 5% of total nominal has defaulted, i.e. 50% of mezzanine I tranche

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Valuation of structured credit securitizations

d-fine's approach to value structured credit securitizations (1/2)

» **We offer:** Independent and transparent valuation of structured credit securitization on a per-deal basis

» **Data basis:**

- Offering Circular (OC) of the transaction including all appendices and amendments
- Investor reports and/or supporting documents for the composition of the reference pool.

» **Output:** Present values for all tranches within transaction including their cash flows

» **Steps performed by d-fine:**

1	In-depth analysis of the deal based on the transaction documents	Critical analysis of components of the contract and identification of gaps and loopholes which have the potential to change the value significantly.
2	Modeling of the underlying pool	Appropriate cash flow structure resembling interest, redemption structure (regular redemption and prepayments), defaults and recoveries from the reference pool.
3	Modeling of the waterfall structure, relevant triggers and other relevant contractual components	Modeling of all waterfalls for the distribution of principal, interest, defaults, recoveries, reinstatements. Modeling of specific ledgers, excess spreads, overcollateralization, triggers, swaps etc.
4	Validation of our deal modeling	Validating waterfalls, triggers, ledgers to make sure that the modeling corresponds to the understanding of the contract.
5	Documentation of all steps above	Transparent and traceable valuation

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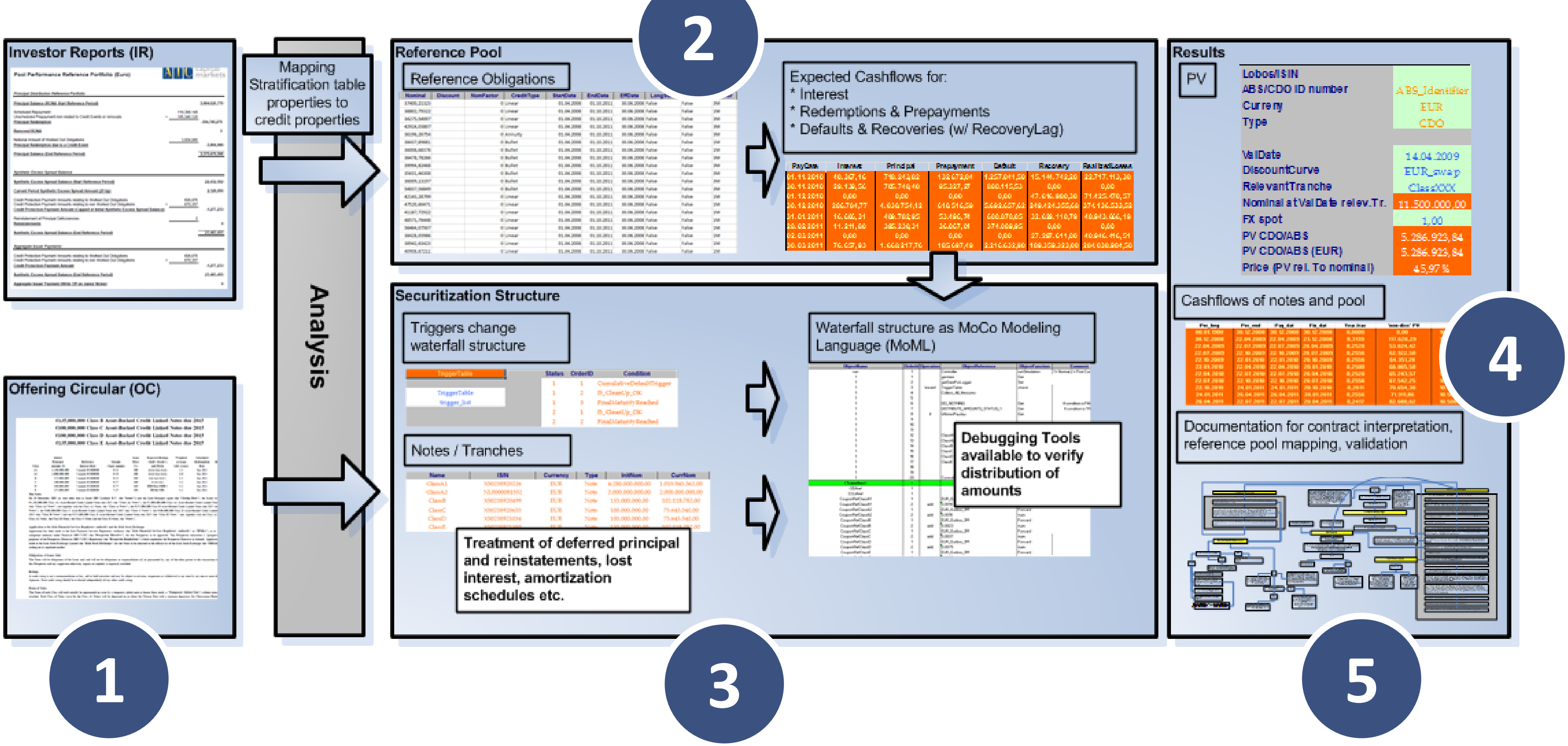
d-fine's approach to value structured credit securitizations (2/2)

» Process of securitization valuation



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Reference pool modeling

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Modeling the reference pool

- **Reference pool:** Usually consists of a pool of credits.

- **Credits** are characterized by properties from which cash flows can be derived. Those properties are:
  - Current notional
  - Paydays for interest and amortizations
  - Specific interest rates
  - Credit type (Amortization structure of the credit)
  - Estimated prepayment rate

- For the valuation of the securitization one also needs the **default probability**.

- The distributions of the properties for the pool are given in the Offering Circular (OC) and later in the Investor Reports (IR).

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Interpreting raw data and converting to pre-processed data

» **Goal:** Construction a reference pool consisting of synthetic credits that has the same marginal distributions given in the reports.

» **Available Information:** Stratification tables contain marginal distributions of the properties for the pool. Tables may contain one or several properties.

» **Interpretation and pre-processing** of the data from the OC or IR is **necessary**.

» **Example**: Maturities as Tenors

Raw Data

Maturity	Weight
Up to 1 Year	3,42%
2 Years	4,80%
3 Years	4,83%
4 Years	2,77%
5 Years	2,90%
7 Years	10,45%
10 Years	13,37%
15 Years	16,55%
20 Years	23,85%
25 Years	12,22%
More than 25 Years	4,84%

Pre-Processed Data

Enddate	Weight
01.10.2008	3,42%
01.10.2009	4,80%
01.10.2010	4,83%
01.10.2011	2,77%
01.10.2012	2,90%
01.04.2014	10,45%
01.10.2016	13,37%
01.10.2020	16,55%
01.10.2025	23,85%
01.10.2030	12,22%
01.04.2033	4,84%

» **Example**: Survival probabilities from Rating

Raw Data

Rating	Weight
1	0,04%
2+	0,46%
2	1,61%
2-	0,63%
3+	13,58%
3	5,10%
3-	8,92%
4+	12,04%
4	14,91%
4-	16,42%
5+	11,76%
5	4,50%
5-	1,76%
6+	0,88%
6	1,99%
7	0,47%
8	0,17%

Mapping to Markit

Moodys	Markit	Weight
Aaa	AAA	0,04%
Aa1	AA	2,70%
Aa2		
Aa3		
A1	A	27,60%
A2		
A3		
Baa1	BBB	48,14%
Baa2		
Baa3		
Ba1	BB	18,02%
Ba2		
Ba3		
B1	B	3,34%
B2		
B3		
Caa1	CCC	0,17%
Caa2		
Caa3		

Pre-Processed Data

SurvProbRef	Weight
MarkitSurvival_AAA	0,04%
MarkitSurvival_AA	2,70%
MarkitSurvival_A	27,60%
MarkitSurvival_BBB	48,14%
MarkitSurvival_BB	18,02%
MarkitSurvival_B	3,34%
MarkitSurvival_CCC	0,17%

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Creating synthetic credits

» By combining the distributions of the properties, a reference pool of synthetic credits is build.

» Our pricing library determines the cash flows of the reference pool by considering, e.g.
  › credit type
  › interest rate periods
  › reference rates.

» The pool will generate expected cash flows for:
  › Interest payments
  › Principal payments, prepayments
  › Defaults and recoveries

Nominal	Discount	NomFactor	CreditType	StartDate	EndDate	EffDate
2.299.282,80		0	Annuity	30.01.2009	31.12.2010	30.04.2009
44.586.092,54		0	Annuity	30.01.2009	01.07.2013	30.04.2009
117.363.391,60		0	Annuity	30.01.2009	02.07.2018	30.04.2009
190.840.472,30		0	Annuity	30.01.2009	02.07.2023	30.04.2009
248.922.355,20		0	Annuity	30.01.2009	31.12.2032	30.04.2009
395.776.547,90		0	Annuity	30.01.2009	01.01.2028	30.04.2009

PayDate	Interest	Principal	Prepayment	Default	Recovery	RealizedLosses
01.04.2010	3.063.434,87	8.650.567,29	175.099,21	3.521.780,17	0,00	3.521.780,17
06.04.2010	2.198.878,36	16.274.412,65	126.008,17	2.533.521,09	0,00	2.533.521,09
01.07.2010	3.034.280,45	8.680.735,84	173.419,96	3.525.771,90	0,00	3.525.771,90
02.07.2010	1.566.632,27	8.831.497,21	89.584,77	1.822.774,86	0,00	1.822.774,86
05.07.2010	301.212,01	7.493.634,81	14.750,66	354.368,53	0,00	354.368,53
01.10.2010	2.899.128,47	8.811.556,87	165.682,50	3.405.240,32	0,00	3.405.240,32
04.10.2010	1.774.080,99	12.000.902,30	101.598,28	2.087.090,97	0,00	2.087.090,97
03.01.2011	4.395.874,27	21.083.383,56	251.380,41	5.165.120,72	0,00	5.165.120,72

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Modeling expected cash flows of the reference pool

- We model **expected cash flows**, e.g. each payment is weighted by its survival probability during the interest period.

- The modeling of the pool has the following particularities:
  - No Monte Carlo simulation for the default of obligations
  - Expected cash flow modeling ⇨ No correlations modeled

- In general possible to upgrade to a fully stochastic model, but would be based on very unsafe assumptions

- Address model risk by providing a price range for the securitization by varying input parameters, especially for the reference pool.

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MoCo Modeling Language

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Basics of the MoCo Modeling Language (MoML)

» **MoCo Modeling Language (MoML):**

› Table-based **calculator**

› Connects different objects and functions by basic arithmetic in order to **define new functionalities**.

› Includes **specialized objects** for securitizations (e.g. triggers, tranches, reference pool)

› Allows modeling and valuating of the securitization transaction.

» **Waterfalls** are modeled within a so called "tasklist" based on MoML.

» **Example**:

› 0.3 * Nom(A) + 0.2 * Nom(B) - 0.5 * Nom(C)

› "*Weighted_NotesNominal*" is a function and can be called from other functions.

ObjectName	Order-ID	Operat-ion	Object-Reference	Object Function
Weighted_NotesNominal	1		ClassA	GetNominal
Weighted_NotesNominal	2	mult	0.3	num
Weighted_NotesNominal	3		ClassB	GetNominal
Weighted_NotesNominal	4	mult	0.2	num
Weighted_NotesNominal	5	add		
Weighted_NotesNominal	6		ClassC	GetNominal
Weighted_NotesNominal	7	mult	0.5	num
Weighted_NotesNominal	8	sub		

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Integrating specialized securitization objects into MoML

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Specialized securitization objects within MoML

» Goal: Simulating distribution of amounts (⇔simulating waterfalls) to determine expected cash flows of tranches

» Specialized objects for securitizations:

1	**Controller**	Controller unit of the complete system. Contains • references to the sub-objects • all global variables • Steps through the task list and calls individual objects • Main tasks are the aggregation of the regular income and its distribution to the tranches within the different waterfalls
2	**Tasklist**	Contains a **list ordered by the current system state** (⇔different modi of the transaction ⇔ different waterfall structures)
3	**Trigger Table**	Contains **conditions ordered by the current system state**. If a condition is true, the system state will change and the transaction changes into a **different distribution mode**. The conditions are defined within the Tasklist.
4	**Tranche**	Describes a tranche. Different Types possible („Notes“ and „CDS“). The tranche object has information about the paydays, calculation of interest and many functions and references to keep track of defaults and reinstatement mechanisms.
5	**Reference Portfolio**	This object contains the cash flows from the reference pool (Interest, Principal, Prepayments, Defaults, Recovery).

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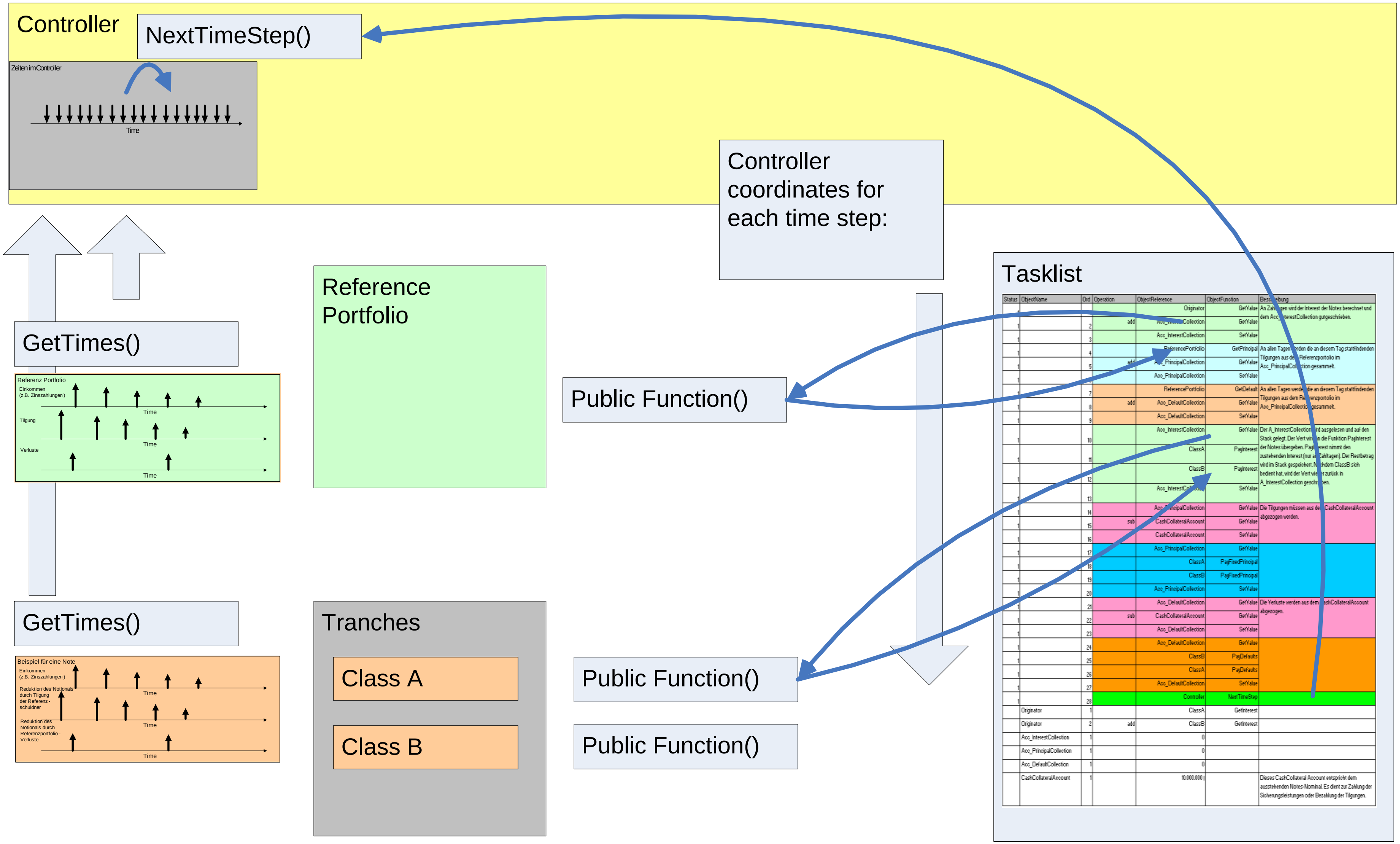
Interaction of the components in the overall system



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Example securitization Berica 6

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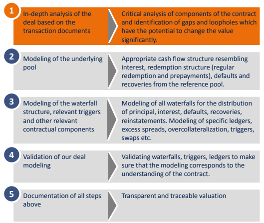
Basic data for transaction Berica 6

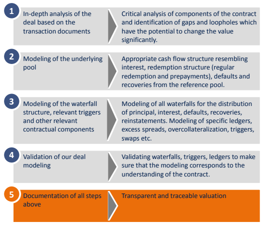
» Offering Circular (OC)



» Investor reports for transaction performance and pool performance

» The documentation belongs to the client. It contains around 15 pages and is structured in the following sections:

1	Summary of the transaction
2	Representation of the deal constituents
2.1	Status of the SPV
2.2	Notes
2.3	Simplifications made in the PDL representation
2.4	Not modeled events / triggers
3	Reference Pool
3.1	Credit Types and Maturities of the credits
3.2	Interest rates and interest rate periods of the credits
3.3	Prepayment rates of the credits
3.4	Default probabilities of the credits
3.5	Recovery rates
4	Protocol of the validation
5	Information on data updates



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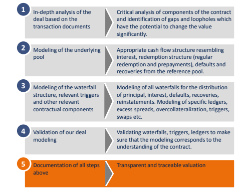
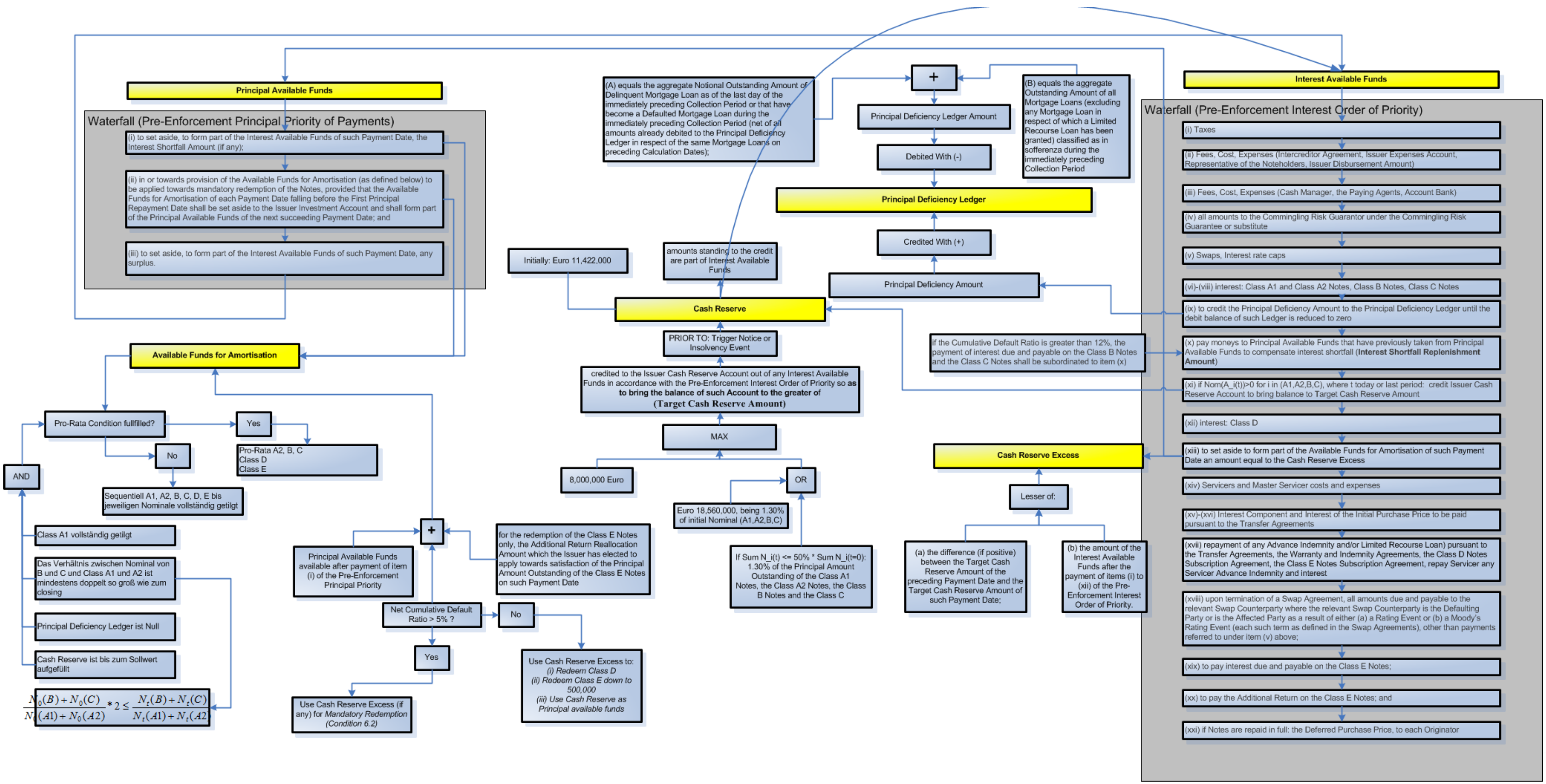
Schematic modeling for transaction Berica 6



» The documentation usually contains a summary of the distributions of all amounts and the modeling of the risk mitigation mechanisms:



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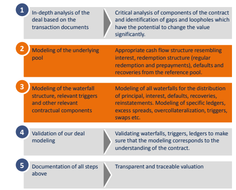
MoCo screenshots for transaction Berica 6



» MoCo representation of the reference pool:

Reference Portfolio $F$6:$F$10004 $F$6:$DC$6

Reload

ReferencePortfolio	
Name	ReferencePortfolio
ReferenceCredit	Ref_CreditList
ValDate	01.02.2009

$F$6:$AE$12

Nominal	Discount	NomFactor	CreditType	StartDate	EndDate	EffDate	LongStart	LongEnd	Tenor	StubTenor	CouponCal	CouponAdjust	PayOffset	PayAdjust
2.299.282,80		0	Annuity	30.01.2009	31.12.2010	30.04.2009	FALSE	FALSE	1M		EU	following	0b	following
44.586.092,54		0	Annuity	30.01.2009	01.07.2013	30.04.2009	FALSE	FALSE	1M		EU	following	0b	following
117.363.391,60		0	Annuity	30.01.2009	02.07.2018	30.04.2009	FALSE	FALSE	1M		EU	following	0b	following
190.840.472,30		0	Annuity	30.01.2009	02.07.2023	30.04.2009	FALSE	FALSE	1M		EU	following	0b	following
248.922.355,20		0	Annuity	30.01.2009	31.12.2032	30.04.2009	FALSE	FALSE	1M		EU	following	0b	following
395.776.547,90		0	Annuity	30.01.2009	01.01.2028	30.04.2009	FALSE	FALSE	1M		EU	following	0b	following

» MoCo representation of the tranches:

TranchesList
TranchesList
Listtr

Orderid	Name	ISIN	Currency	Type	InitNom	CurrNom	Startdate	Enddate	Effdate	Tenor	Stubtenor	LongStart
1	ClassA1		EUR	Note	171.250.000,00	0,00	30.01.2009	30.04.2043	30.04.2043	3M	3M	FALSE
2	ClassA2		EUR	Note	1.185.000.000,00	923.311.510,72	30.01.2009	30.04.2043	30.04.2043	3M	3M	FALSE
3	ClassB		EUR	Note	42.800.000,00	42.800.000,00	30.01.2009	30.04.2043	30.04.2043	3M	3M	FALSE
4	ClassC		EUR	Note	28.600.000,00	28.600.000,00	30.01.2009	30.04.2043	30.04.2043	3M	3M	FALSE
5	ClassD		EUR	Note	8.565.000,00	8.565.000,00	30.01.2009	30.04.2043	30.04.2043	3M	3M	FALSE
6	ClassE		EUR	Note	4.600.000,00	4.600.000,00	30.01.2009	30.04.2043	30.04.2043	3M	3M	FALSE

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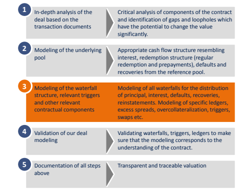

» MoCo representation of the tasklist:

ObjectName	OrderId	Operation	ObjectReference	ObjectFunction	Comment
1	1	breakif	TriggerTable	Check	1 = Normal , 2 = Clean up, Termination Optio
1	2				
1	3		Touch_Tranches		Technical: Tranches need to be touched ir
1	4				
1	5		Collect_Amounts_Accrue_Interest		Collects Amounts in Acc_TMP_Interest, Ac
1	6		Interest_Waterfall_ON_Paydays_DO		Follow pre-enforcement interest order of pı
1	7		Principal_Waterfall_ON_Paydays_DO		Follow pre-enforcement principal order of p
1	8				
1	9		Store_Simulation_Date_As_Last_NotePayday_Date		
1	10		Controller	NextTimeStep	
2	1		Collect_Amounts_Accrue_Interest		
2	2				
2	3		Touch_Tranches		Technical: Tranches need to be touched ir
2	4				
2	5		Accrued_Interest_On_Receivables	Get	
2	6	add	Acc_TMP_Principal	Get	
2	7	add	Acc_TMP_Prepayment	Get	
2	8	add	Acc_Cash_Account	Get	
2	9	add	Swap_Class_A_to_C	Get	
2	10	add	Swap_Class_D	Get	
2	11	add	Cap_Euribor	Get	
2	12	add	ReferencePortfolio	GetOutstandingPrincipal	
2	13	sub	ReferencePortfolio	GetPrincipal	
2	14	sub	ReferencePortfolio	GetPrepayment	
2	15				
2	16				
2	17		ClassA1	PayDeferredInterest	
2	18		ClassA1	PayInterest	
2	19		ClassA1	PayFixedPrincipal	
2	20				
2	21		ClassA2	PayDeferredInterest	
2	22		ClassA2	PayInterest	

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Valuation output provided by MoCo for transaction Berica 6

» Sample Output:

Lobos/ISIN		Link	
ABS/CDO ID number	Berica_6	PVPrice	100,2143
Curreny	EUR	Rate	0,0000
Geschäftsart	CDO	Accrual	0,0000
		PayRec	receiver
ValDate	01.02.2009	OptPvPrice	0,0000
DiscountCurve	EUR_swap		
RelevantTranche	ClassA2		
Nominal at ValDate relev.Tr	923.311.510,72		
FX spot	1,00		
PV CDO/ABS	925.290.098,60		
PV CDO/ABS (EUR)	925.290.098,60		
Price (PV rel. To nominal)	100,21%		

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Summary: d-fine's approach to value structured credit securitizations

- Independent and transparent valuation of structured credit securitizations on a per-deal basis:
  - Valuation **based on publicly available data**: Offering Circular, investor reports
  - **Critical and independent analysis** of components of the contract and identification of gaps and loopholes which have the potential to change the value significantly.
  - **Reference Pool**: Cash flow structure resembling interest, redemption structure (regular redemption and prepayments), defaults and recoveries based on **expected cash flows**.
  - **Transparent consideration of waterfalls, triggers, loss buffers**
  - Thorough and transparent **validation of the structure**
  - **Deal specific documentation** containing deal interpretation, summary of the distribution of amounts, validation protocols which can be **used for an independent review**.
- **Time Estimate** per deal is typically between 9-20 person days depending on:
  - The quality of the Offering Circular / Contract
  - The complexity of the deal structure
  - The considered complexity used in the valuation
- **The time average** for a deal structure is estimated to be 12 person days.

1	In-depth analysis of the deal based on the transaction documents	Critical analysis of components of the contract and identification of gaps and loopholes which have the potential to change the value significantly.
2	Modeling of the underlying pool	Appropriate cash flow structure resembling interest, redemption structure (regular redemption and prepayments), defaults and recoveries from the reference pool.
3	Modeling of the waterfall structure, relevant triggers and other relevant contractual components	Modeling of all waterfalls for the distribution of principal, interest, defaults, recoveries, reinstatements. Modeling of specific ledgers, excess spreads, overcollateralization, triggers, swaps etc.
4	Validation of our deal modeling	Validating waterfalls, triggers, ledgers to make sure that the modeling corresponds to the understanding of the contract.
5	Documentation of all steps above	Transparent and traceable valuation

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