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Securitization – Theory & Practice

XXXIII Heidelberg Physics Graduate Days

Heidelberg, October 10th, 2014

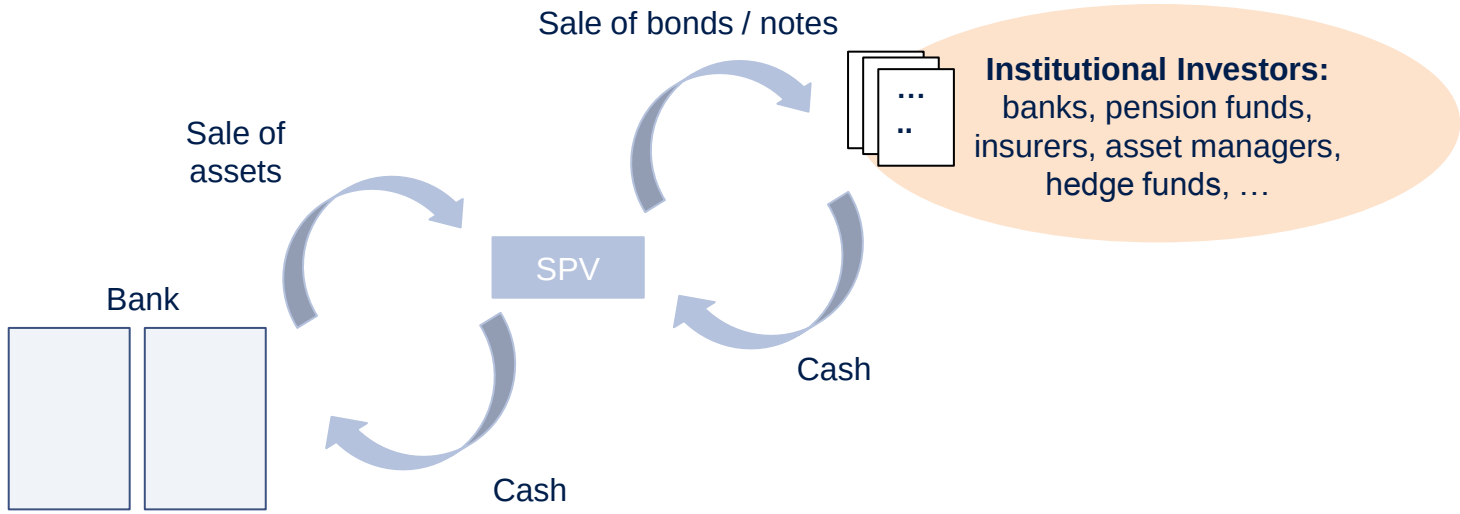
Agenda

Securitization – „Theory“

What is Securitization?

Securitization – What is it? (1/2)

- Securitization (German: “Verbriefung”)
  - Process of pooling debt assets (e.g. loans, mortgages) into a separate legal entity that then issues a new financial instrument or security for sale to investors
  - Result is called ABS, CDO, MBS…
  - Typically, banks use securitization to manage their balance sheet and risk (more details later..)



In a nutshell: Securitization means converting debt into tradable securities.

Securitization – What is it? (2/2)

- ABS (Asset Backed Security) / CDO (Collateralized Debt Obligation)
  - In General: Debt instrument secured by assets with fixed cash flows
  - Diverse collateral: (retail) consumer loans, student loans, credit car debt, …
- MBS (Mortgage Backed Security)
  - Securities are backed by mortgages; Market larger in volume than ABS
  - CMBS (Commercial Mortgage Backed Security)
  - RMBS (Residential Mortgage Backed Security)

- Legal structures of securitizations
  - Assets are pooled in a separate legal entity, a so called “SPV” (Special Purpose Vehicle); this structure is used because of legal aspects
  - True-Sale Transaction: portfolio is sold to SPV
  - Synthetic Transaction: bank retains portfolio but enters into a swap contract with SPV

Securitization is a technique that can take many different shapes.

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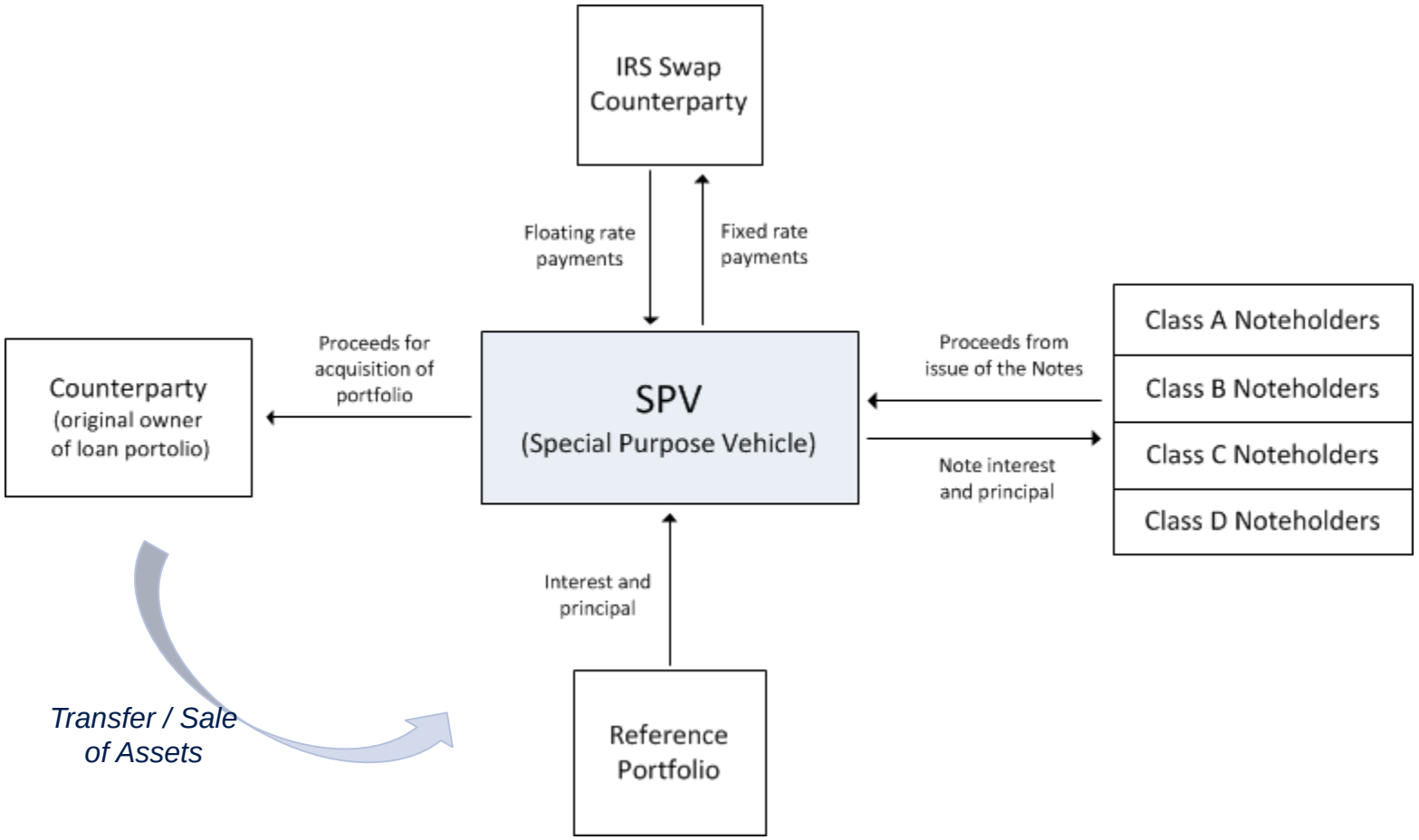
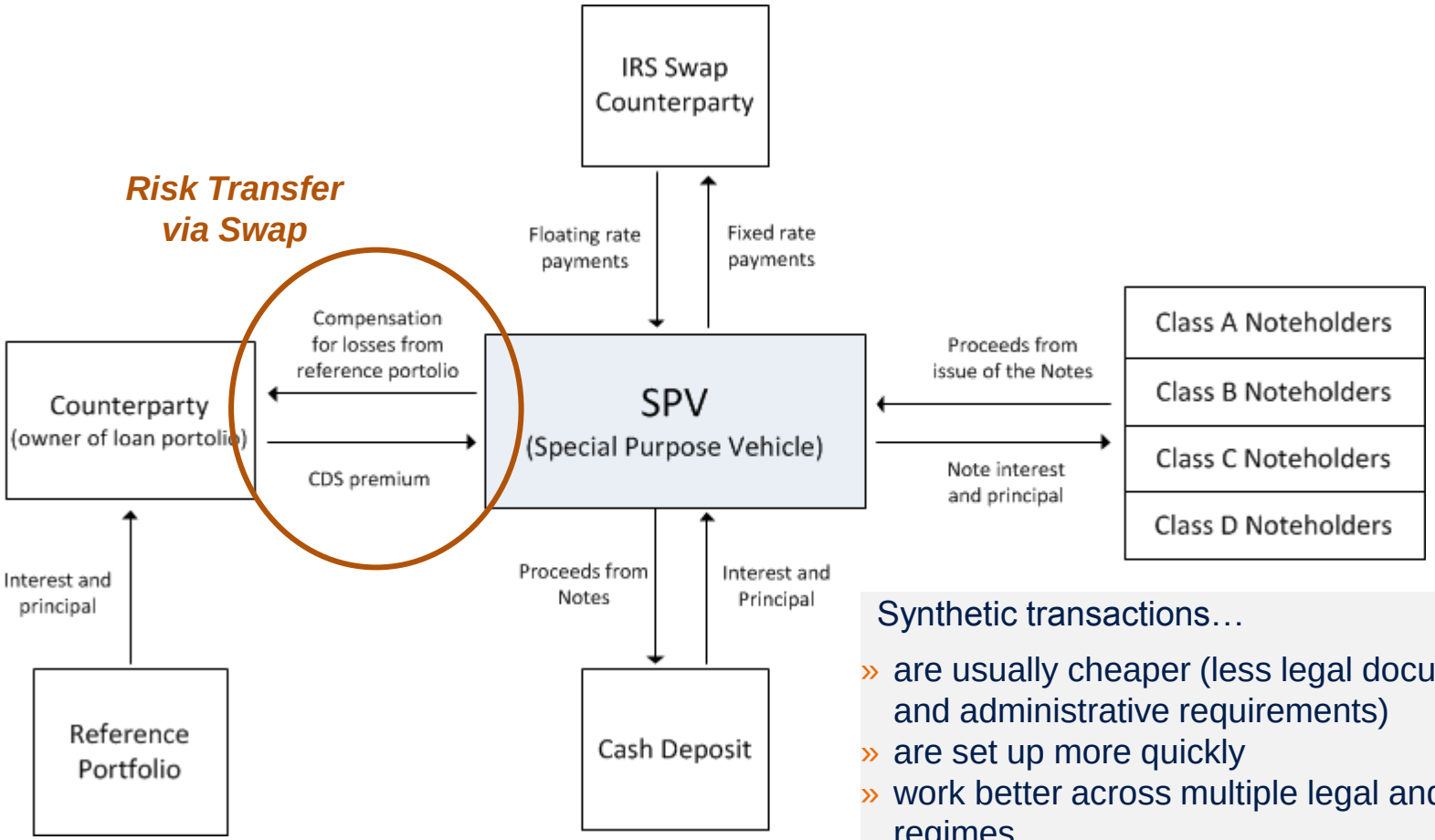
Securitization via True Sale



In a true-sale transaction, a bank “physically” sells a portfolio of loans to the SPV.

Securitization via Swap (“Synthetic Transaction”)



Synthetic transactions…

- are usually cheaper (less legal documentation and administrative requirements)
- are set up more quickly
- work better across multiple legal and regulatory regimes

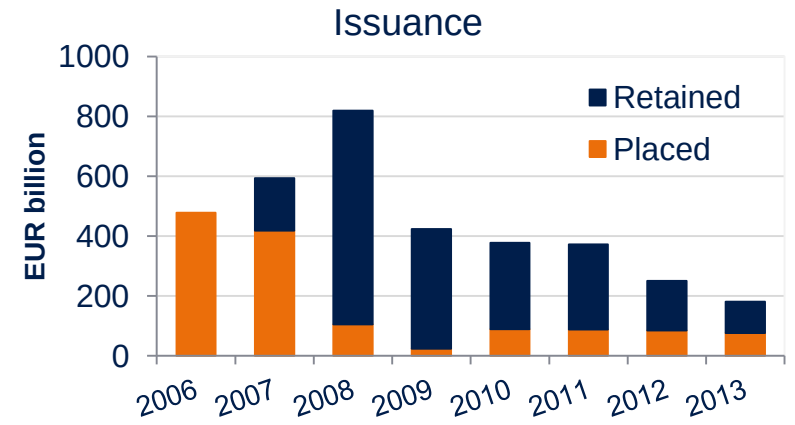
In a swap transaction, the bank retains the loan portfolio but transfers the default risk.

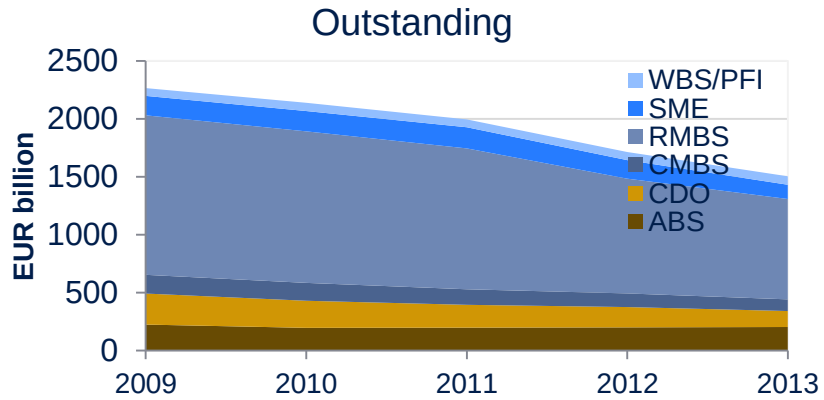
CDS: Credit Default Swap

Securitization and the Financial Industry

Securitization in Europe – Trends

- ABS total outstanding amount in Europe is about EUR 1500 bn (≈1/4 of US market)
- Securitization market continues to be impaired as a result of the financial crisis
- This is despite the fact that European structured finance products performed well during the crisis (i.e. low default rates)
- Placements with non-bank investors are low but are slightly increasing
- Regulators want to promote "*ABS with simple structures and well-identified and transparent underlying asset pools with predictable performance*"[1]





Securitization market remains difficult but regulators want to strengthen its role in the financial system.

Source: Association for Financial Markets in Europe (AFME). Securitization Data Report Q2 2014.

1) ECB/BoE (2014): The impaired EU Securitization Market: Causes, Roadblocks and how to deal with them.

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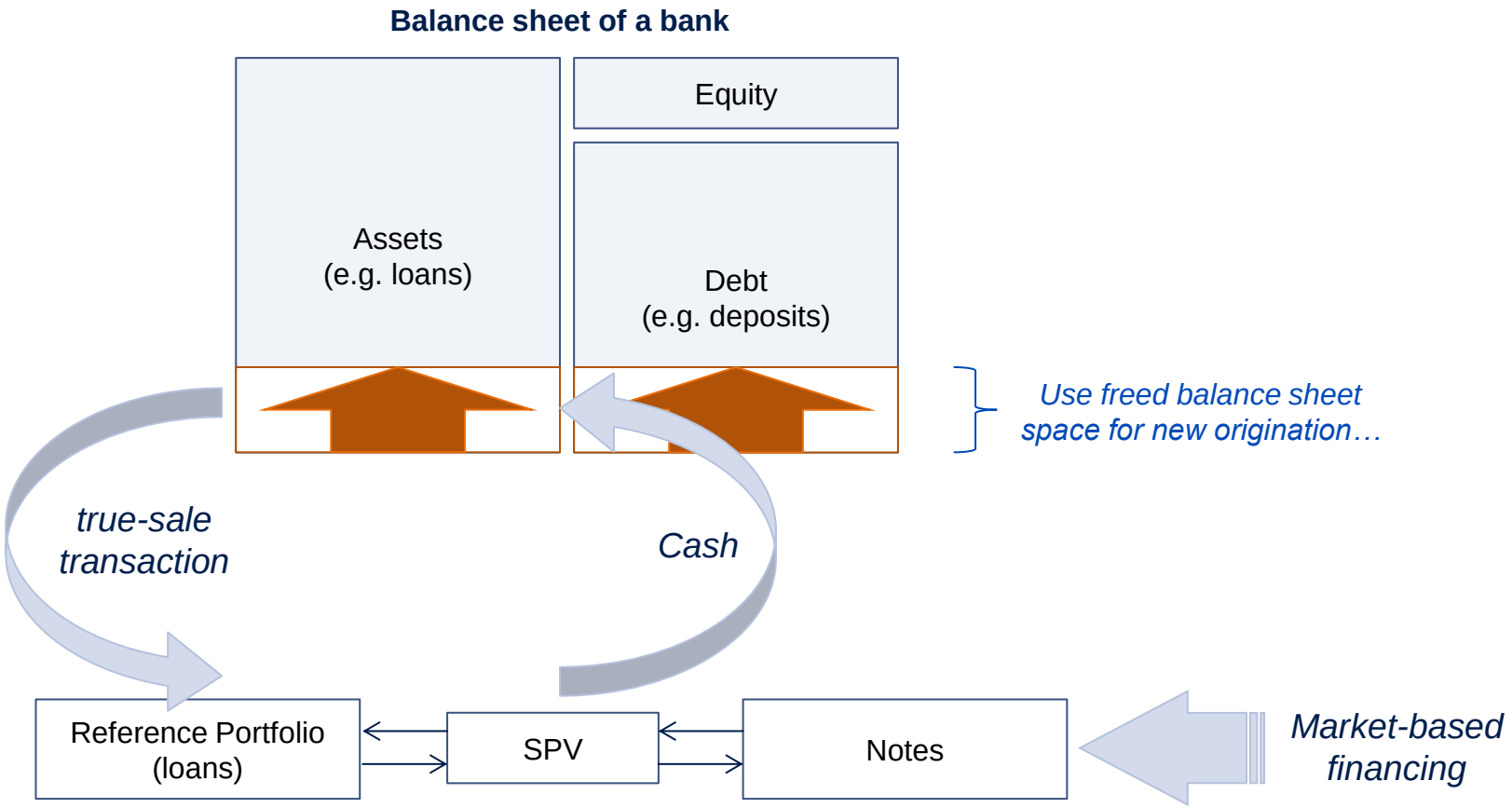
Illustration of Balance Sheet Management via Securitization



Banks use securitization to actively manage their balance sheet (risk, exposure, …).

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Benefits of Securitization for Banks and the Economy

- Manage risk profile: diversification of risk / limitation of exposure to certain
  - Borrowers
  - Geographies
  - Loan types
  - Risk levels
- “Regulatory arbitrage” – move loans off the book to reduce regulatory capital
- Realize economies of scale
  - leverage origination platforms, branches, servicing operations
  - Increase return on equity (ROE)
- Risk sharing in the economy
  - Participation of non-bank investors allows for risk sharing in the financial system
  - More diversified bank liability structures reduce the dependency of banks’ lending decisions on business cycle conditions
  - “High quality” ABS can serve as complement to government debt
- Market participation in bank supervision: third party discipline, market pricing of assets

Securitization can lower cost and improve availability of credit while reducing volatility of the financial system. Securitization is a feature of any advanced financial system.

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Risk and Side Effects of Securitization

Two business models?

originate-to-hold (without securitization)	**originate-to-distribute** (with securitization)
› lenders make loans with the intention of holding them through maturity	› lenders make loans with the intention of selling them to other financial institutions or investors

» Securitization comes with *"agency problem"*
  › Banks care less about credit quality, tendency for credit bubble
  › Important factor for financial crisis 2007/08

» Financial flows are moved outside the regulated financial system ("shadow banking")
  › Non-bank-financial firms that typically invest in securitizations are not protected by public-sector liquidity backstops like central bank financing
  › No deposit insurance for investors
  › Potential increase of systemic risk

» ABS structures are complex and harder to understand and price than individual loans
  › Transparency decreases

Securitization needs to be properly regulated.

Credit Enhancement & Risk Tailoring in Securitization

Credit Enhancements in Securitization

- Securitization often redistributes the credit risk of an underlying portfolio to create securities with different risk characteristics
- Credit enhancement is a way of creating some high quality securities from average (or low) quality debt and to create customized risk profiles for investors

Types of credit enhancements

- Structural
  - Profit and Loss prioritization (also called “waterfall”)
- Originator-provided
  - Cash collateral account
  - Overcollateralization
  - Excess spread
- Third-party-provided
  - Insurances, guarantees

ABS can be structured so that their risk-return profile exactly meets specific targets of investors.

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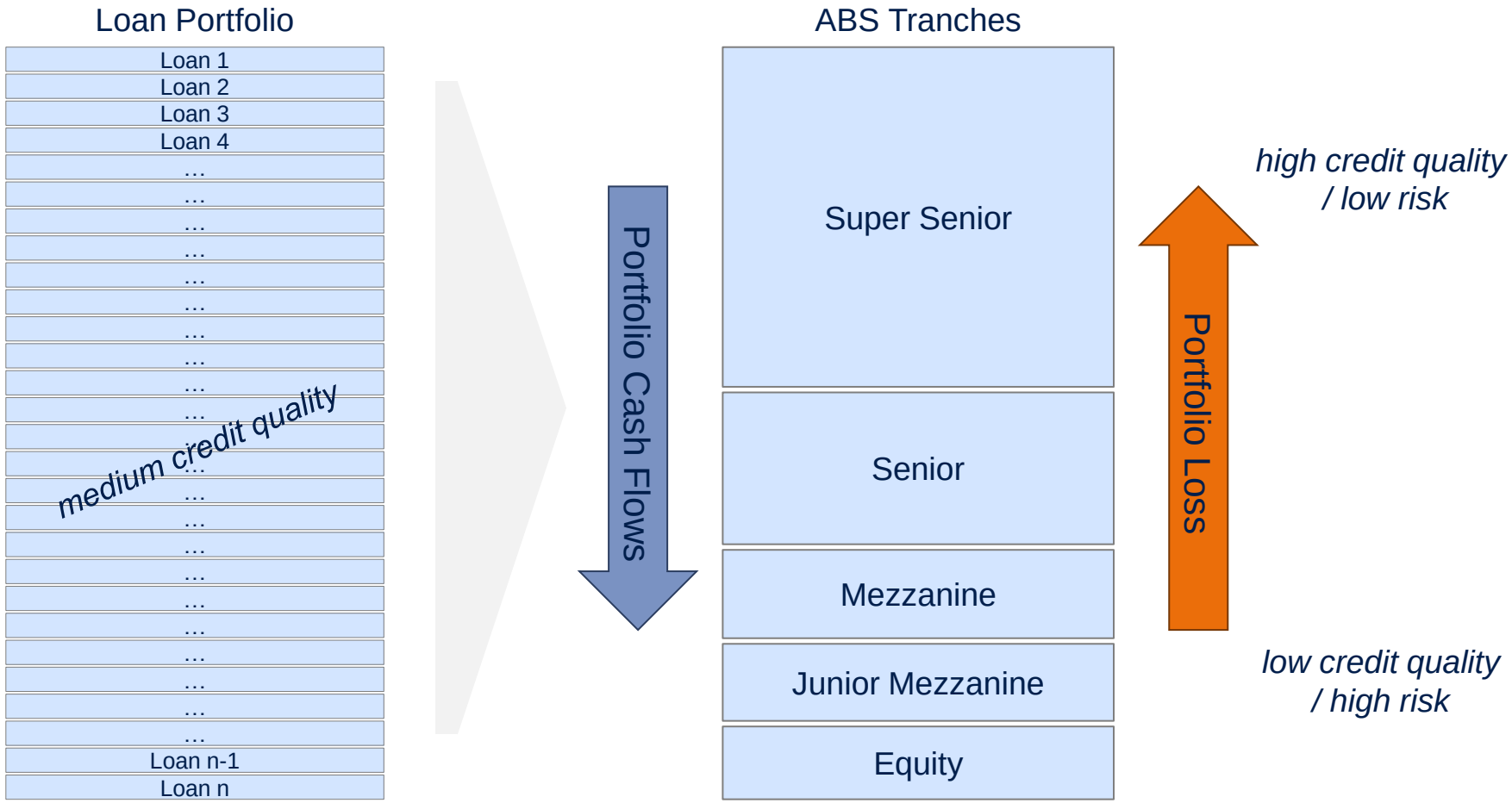
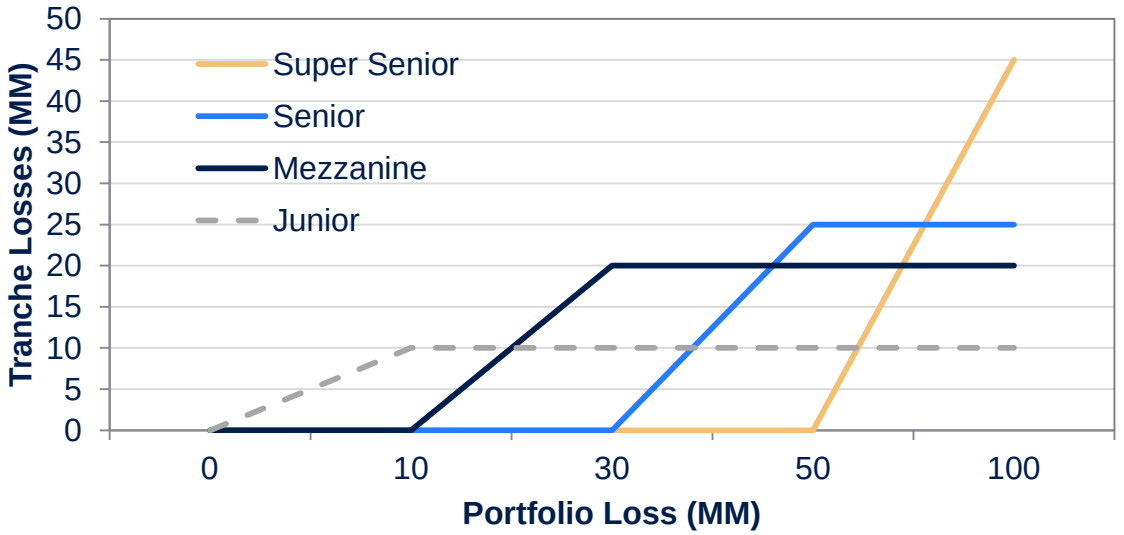
Profit and Loss Prioritization in a Securitization



Securitization can create securities with widely different risk characteristics from a portfolio of debt instruments.

Tranche Profit & Loss in a Securitization depending on Portfolio Performance

» Example structure:



Tranche Nominals (in MM)	
Super Senior	45
Senior	25
Mezzanine	20
Junior	10
Total	100

» Super Senior tranche: “short put option”-like position with strike 50mm

» Mezzanine tranche: “long put option (strike 30mm) + short put option (strike 10mm)”

Tranches in an ABS structure can be viewed as options or option combinations on the portfolio loss.

Securitization – „Practice“

How to value a Securitization

Vocabulary & Concepts: Mark to Market (1/2)

- Primary market
  - When securities are first issued
  - Fixed income securities are usually structured so that their issue price is equal to par, e.g. nominal EUR 1000, coupon 3,25%, issue price $P(t_0) = EUR\ 1000$
- Secondary market
  - Market for securities that have already been issued and are now being traded
  - Prices can deviate significantly from the issue price

Perceived Risk	Price	Yield*
↑ vs. t_0	↓ < $P(t_0)$	↑
↓ vs. t_0	↑ > $P(t_0)$	↓

When talking about the price of a security, one usually refers to its price in the secondary market.

*Yield ≠ Coupon

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Vocabulary & Concepts: Mark to Market (2/2)

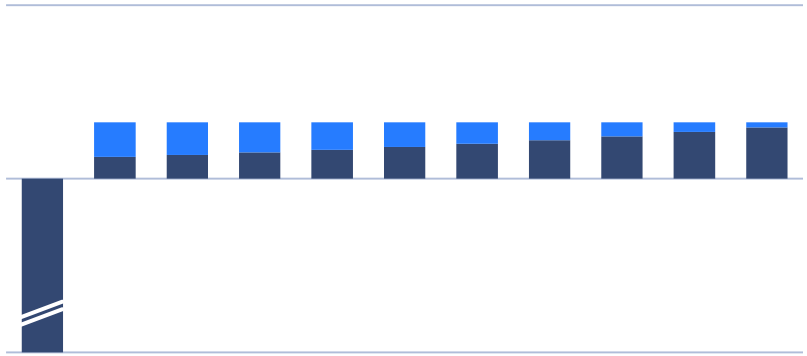
- Prices of liquid securities like common shares and “plain vanilla” bonds of large corporations can be observed directly in the market
- Securities can be illiquid for a variety of reasons
  - Supply and demand: few suitable investors, lack of market makers
  - High risk; “distressed” securities
  - Difficulty to assign a value
- **Mark to market (MtM)** – determine the current ‘hypothetical’ market value for illiquid instruments; needs to be done for:
  - accounting purposes
  - Monitoring / risk management
  - when up for sale
- Securitizations usually do not have a liquid secondary market

Price, i.e. MtM of securitizations needs to be calculated independently.

Vocabulary & Concepts: Typical Cash Flow Series for Debt

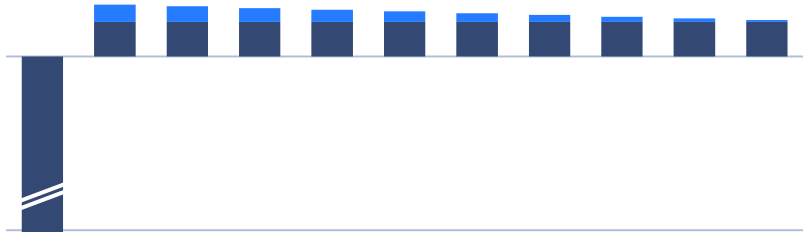
Bullet repayment (e.g. fixed rate bond)

Annuity repayment (e.g. mortgage)



Zero repayment (e.g. zero bond)

Linear repayment



Vocabulary & Concepts: Time Value of Money & Present Value

» What is better: Receive EUR 100 today OR receive EUR 100 in one year?

	T=0	*Invest at the risk free rate, e.g. 3%*	T=1
Scenario 1	EUR 100		EUR 103
Scenario 2			EUR 100

» **Time value of money** – The value of a cash flow depends on the time at which it occurs

» **Present value**:

› Current value of future series of cash flows

	T=1	T=2	T=3	Present Value
CF Series 1	EUR 100	EUR 100	EUR 100	$PV = \frac{100}{(1{,}03)^1} + \frac{100}{(1{,}03)^2} + \frac{100}{(1{,}03)^3} = 282{,}86$
CF Series 2	EUR 0	EUR 0	EUR 305	$PV = \frac{305}{(1{,}03)^3} = 279{,}12$

The present value is a method to make different cash flow series comparable.

Vocabulary & Concepts: Present Value

» More formally, the present value of a series of cash flows is calculated by summing up the discounted cash flows:

$$PV = \sum_{i}^{n} CF^{i} \cdot D(t_i)$$

» $D(t)$ is the so called *discount factor* and is defined as today's value of a riskless payment of one monetary unit at a future time $t \geq 0$.

» $D(t)$ is calculated depending on how many times per year interest is paid (assuming reinvestment of interest payments)

› Annual compounding: $D(t) = (1 + r)^{-t}$

› m times compounding: $D(t) = \left(1 + \frac{r}{m}\right)^{-mt}$

› Continuous compounding: $D(t) = \lim_{m \to \infty} \left(1 + \frac{r}{m}\right)^{-mt} = e^{-rt}$ (most common assumption)

The present value is an essential tool for valuing financial instruments.

Vocabulary & Concepts: Modeling Cash Flows and Credit Risk (1/2)

» Consider the following (hypothetical) example:

› Riskless bond: coupon $c = 3\%$ (paid annually), maturity 3 years, nominal EUR 100

› Risk free rate: $r = 3\%$

$$P(t_0) = PV = \sum_i^n CF^i \cdot D(t_i) = \frac{3}{(1+r)^1} + \frac{3}{(1+r)^2} + \frac{103}{(1+r)^3} = EUR\ 100\ (= N\ or\ "par")$$

› Risky (corporate) bond: coupon $c = 5\%$, maturity 3 years, nominal EUR 100

› Issue price $P(t_0) = \text{EUR } 100$, however $PV = EUR\ 105{,}66$

→This implies an expected loss of EUR 5,66 over the life of the bond!

Valuation of fixed income securities in general is built on quantifying risk and return of these securities.

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Vocabulary & Concepts: Modeling Cash Flows and Credit Risk (2/2)

» Normally, cash flows are risky, so ‘present value’ is understood to be the present value of a series of *expected* cash flows:

$$PV = \sum_{i}^{n} CF_{exp}^{i} \cdot D(t_i)$$

» For fixed income:

› modeling cash flows ←→ modeling credit risk (or default risk) over time

› Cash flows = scheduled payments – expected losses

» Basic Equation for Expected Loss: $E(L) = E(EAD) \cdot E(LGD) \cdot PD$

» Usually, most effort is spent modeling PD, i.e. default distribution

EAD: *Exposure at default*
LGD: *Loss given default*
PD: *Probability of default*

Credit risk models can be calibrated using different kind of data:	
› CDS (Credit Default Swap) spread curves › CDS-sector curves as proxies	+ reflects view of investors + forward looking
› historical default rates based on e.g. ratings/sectors	+ Alternative if no market data available

Vocabulary & Concepts: A simple Model for Credit Risk (1/2)

$PD(t)$: Cumulative probability of default	Probability of there having been any default up to a particular point in time
$PS(t)$: Cumulative probability of survival	Probability of there having been no default up to a particular point in time
$PD(t_1, t_2)$: Unconditional probability of default	Probability of there being a default between t_1 and t_2 ($t_1 < t_2$) *as seen from today*
$PD_{cond}(t_1, t_2)$: Conditional probability of default (or *hazard rate λ for small time intervals*)	Probability of there being a default in a given period, conditional on there not having been a default up to that period.

$$PD_{cond}(t_1, t_2) = PD(t_1, t_2)/PS(t_1)$$

$$\lambda(t)\Delta t = PD(t, t+\Delta t)/PS(t) = [PS(t) - PS(t+\Delta t)]/PS(t)$$

$$PS(t+\Delta t) - PS(t) = -\lambda(t)PS(t)\Delta t$$

Taking Limits:

$$\frac{dPS(t)}{dt} = -\lambda(t)PS(t)$$

Solution:

$$PS(t) = e^{-\int_0^t \lambda(\tau)d\tau} \quad (\Leftrightarrow PD(t) = 1 - e^{-\int_0^t \lambda(\tau)d\tau})$$

Vocabulary & Concepts: A simple Model for Credit Risk (2/2)

Example: Moody's Rating class B has historical cumulative default rates:

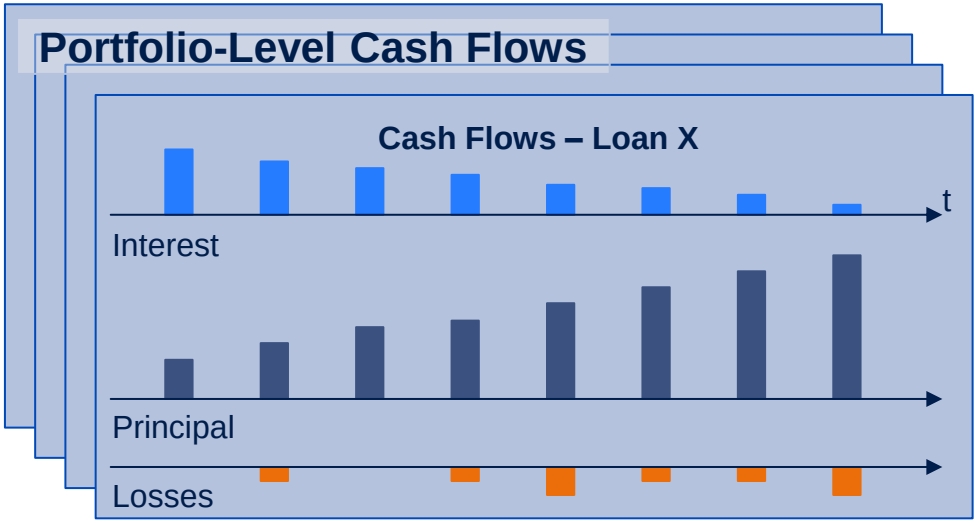
Term (years)	1	2	3	4	5
PD cum. (%)	5,21	12,19	17,24	21,95	26,29

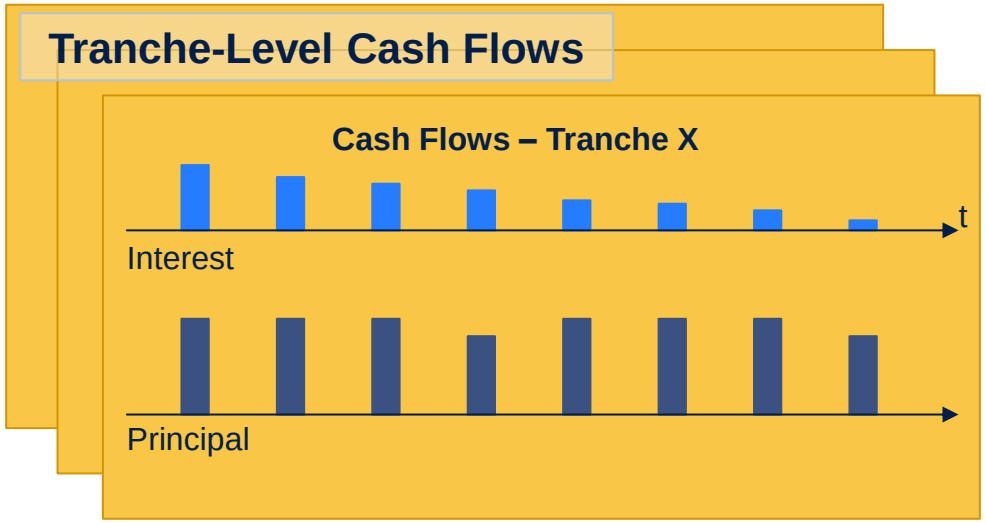
Find hazard rates using *bootstrapping method*:

- $PD_{cond}(0,1) = 1 - e^{-\lambda_1} = 0{,}0521 \quad \Leftrightarrow \quad \boldsymbol{\lambda_1 = 0{,}053506}$
- $PD(1,2) = PS(1) - PS(2) = PD(2) - PD(1) = 12{,}19 - 5{,}21 = 6{,}98\%$
- $PD_{cond}(1,2) = PD(1,2)/PS(1) = 0{,}0698/(1 - 0{,}0521) = 7{,}36\%$
- $PD_{cond}(1,2) = 1 - e^{-\lambda_2} = 0{,}0736 \quad \Leftrightarrow \quad \boldsymbol{\lambda_2 = 0{,}07648}$
- $PD_{cond}(2,3) = \ldots$
- *Check*: $PD(2) = 1 - e^{-\int_0^2 \lambda(\tau)d\tau} = 1 - e^{-(0{,}0535+0{,}0765)} = 12{,}19\%$

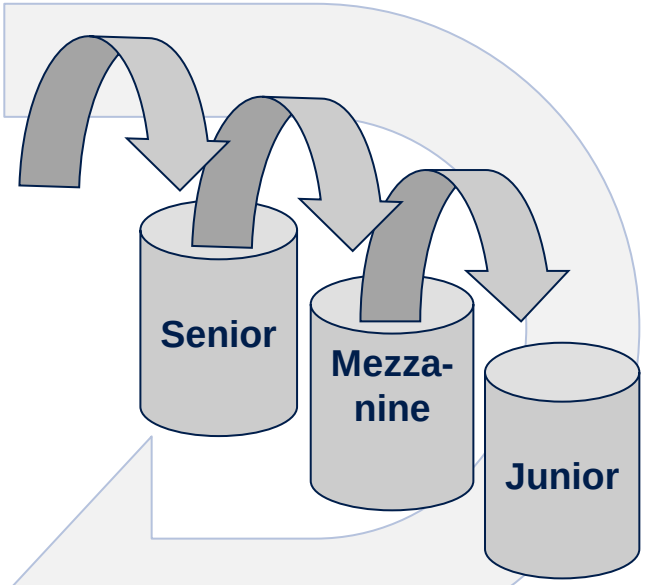
Model default rates of illiquid securities with a credit risk model that is calibrated to available market or historical data.

Securitization Pricing Framework: Cash Flow Simulation





- Simulation of cash flows on individual loan level
- Aggregation of all cash flows



- Distribution of interest, principal, losses to tranches, based on waterfall & triggers
- PV of expected cash flows

Securitization Cash Flow Model Input (1/2)

Reference Portfolio / Underlying Loans

Cash flow profile:
- Nominal
- Maturity
- Repayment style (annuity, bullet, …)
- Prepayment assumptions
- Interest (fixed or floating + spread; frequency)

Credit risk:
- Default rate
- Recovery rate
- Recovery lag

- If no information on individual loans available, use stratification tables to derive synthetic loans

General information

- Day count convention (act/365, act/360, 30/360, …)
- Business day convention (following, modified following, preceding, …)
- Holiday calendars
- Offsets

Modeling of the reference portfolio's cash flows will be more precise the more information is available.

Securitization Cash Flow Model Input (2/2)

Tranches

Tranche details:
- (Outstanding) Nominal
- Maturity
- Coupon (frequency)

Tranche functionalities:
- Treatment of lost interest
- Deferred interest
- Cumulative losses
- Reinstatements

Waterfall and Triggers

Waterfall
- Order of priority
- Distribution of principal
- Distribution of interest
- Application of losses (if applicable)
- Pay reinstatements (if applicable)

Triggers based on PF performance
- Overcollateralization Tests
- Interest Coverage Tests
- Clean Up Trigger
- Default Trigger

- IRS: maturity, reference floating rate, fixed rate, payment frequency

Elaborate cash flow engines can incorporate a broad range of contractual features to model expected cash flows as realistic as possible.

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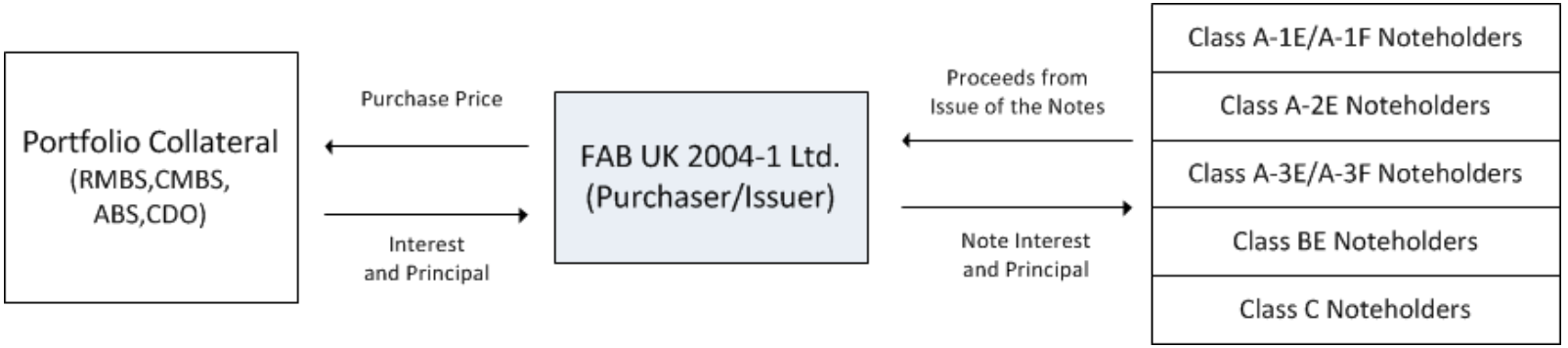
Case Study – FAB UK 2004-1 Ltd.

ABS CDO^2

FAB UK 2004-1 Ltd. – Deal Summary

Key Figures	
Format	fixed & floating rate notes
Portfolio	59 mezzanine ABS CDO tranches (UK assets)
Total Notional	GBP 204,5MM
Notional 31.12.2013	GBP 141,5MM
Issue Date	6.4.2004
Maturity	6.12.2045*



Complex Structure: Securitization of Securitizations → “ABS CDO^2” or “Structured Finance CDO”

* Unless redeemed before.

FAB UK 2004-1 Ltd. – Offering Circular

OFFERING CIRCULAR

FAB UK 2004-1 Limited

(incorporated in Jersey with limited liability under registered number 87004)

£157,500,000 Class A-1E Floating Rate Notes due 2045
£7,500,000 Class A-1F Zero Coupon Notes due 2045*
£10,000,000 Class A-2E Floating Rate Notes due 2045
£8,800,000 Class A-3E Floating Rate Notes due 2045
£4,700,000 Class A-3F Fixed Rate Notes due 2045
£9,000,000 Class BE Floating Rate Notes due 2045
£7,000,000 Class C Subordinated Notes due 2045
£10,000,000 Class S1 Combination Notes due 2045**
£7,000,000 Class S2 Combination Notes due 2045***

Issue Price - ClassA-1E Floating Rate Notes: 100 per cent., Issue Price - Class A-1F Zero Coupon Notes: 65.6608 per cent.*
Issue Price - Class A-2E Floating Rate Notes: 100 per cent.,
Issue Price - Class A-3E Floating Rate Notes: 100 per cent., Issue Price - Class A-3F Fixed Rate Notes: 100 per cent.
Issue Price - Class BE Floating Rate Notes: 100 per cent.
Issue Price - Class C Subordinated Notes: 100 per cent.
Issue Price - Class S1 Combination Notes: 74.2456 per cent.**
Issue Price - Class S2 Combination Notes: 100 per cent.***

*The Class A-1F Notes shall bear interest from the Class A-1F Target Date (as defined below) if not fully redeemed on or prior to such date.
**Each Class S1 Combination Note consists of two "Components", a Class S1/C Component and a Class A-1F Component.
***Each Class S2 Combination Note consists of two "Components", a Class S2/C Component and a Class A-3F Component.
The initial principal amount of the Class S1 Combination Notes and the Class S2 Combination Notes above is included in the initial principal amount of the respective Components of the Class S1 Combination Notes and the Class S2 Combination Notes shown above.

Secured by a Portfolio of Asset Backed Securities managed by Gulf International Bank (UK) Limited

FAB UK 2004-1 Limited, (incorporated in Jersey with limited liability under registered number 87004) (the "**Issuer**") will issue £157,500,000 Class A-1E Floating Rate Notes due 2045 (the "**Class A-1E Notes**"), £7,500,000 Class A-1F Zero Coupon Notes due 2045 (the "**Class A-1F Notes**" and together with the Class A-1E Notes, the "**Class A1 Notes**"), £10,000,000 Class A-2E Floating Rate Notes due 2045 (the "**Class A-2E Notes**"), £8,800,000 Class A-3E Floating Rate Notes due

FAB UK 2004-1 Ltd. – Issued Notes in descending Order of Priority

Class of Notes	**Notional** (GBP)	**Issue Price** (% of Notional)	**Interest**
A-1E	157.500.00	100%	6m Libor + 0,5%
A-1F Zero	7.500.000	65,66%	6m Libor + 0,5%*
A-2E	10.000.000	100%	6m Libor + 0,8%
A-3E	8.800.000	100%	6m Libor + 1,1%
A-3F	4.700.000	100%	6,155%
BE	9.000.000	100%	6m Libor + 3,0%
C	7.000.000	100%	10% + Class C Residual Interest
Total Notional	**204.500.000**		
Total Net Proceeds		**201.924.560**	

Transaction has many “tranches” with different risk-return-profile.

* Interest paid only after a certain date.

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FAB UK 2004-1 Ltd. – Collateral Portfolio

» Data from investor report Dec. 2013:

Security Name	ISIN	Type	Principal Balance	Curr	Fitch	S&P	Payment	Index	Spread	Maturity
ALBA 2005-1 - C Libor + 0.6% 11/2042	XS0235713822	RMBS	1.453.035,92	GBP	BBB-	BBB-	Quarterly	GBPLIBOR3	0,60%	25.11.2042
ALBA 2005-1 - Class D + 1.00% - 11/2042	XS0235715363	RMBS	799.095,56	GBP	B-	BB	Quarterly	GBPLIBOR3	1,00%	25.11.2042
ALBA 2007-1 - E Libor+1.2% - 01/2039	XS0301708573	RMBS	4.500.000,00	GBP	B	B	Quarterly	GBPLIBOR3	1,20%	17.01.2039
ALBA20062 - E Libor+0.95% 06/2038	XS0271531435	RMBS	3.119.130,00	GBP	B	B	Quarterly	GBPLIBOR3	0,95%	15.06.2038
AUBN3 - M Gbplibor+1.25% - 11/2039	XS0157588723	ABS	2.500.000,00	GBP	AA	AA-	Monthly	GBPLIBOR1	1,25%	01.11.2039
AUBN4 - D Gbplibor+1.05% - 10/2041	XS0202812276	ABS	4.000.000,00	GBP	A-	BBB	Monthly	GBPLIBOR1	1,05%	01.10.2041
AUBN4 - E Gbplibor+3.20% - 10/2041	XS0202812516	ABS	3.500.000,00	GBP	BB+	BB-	Monthly	GBPLIBOR1	3,20%	01.10.2041
BLSuperFin - Floating - 10/2015	XS0244893375	CMBS	66.720,04	GBP	BBB	BBB	Quarterly	GBPLIBOR3	0,85%	04.10.2015
BRNL 2007-1X - A4B +0.11 Floating - 01/2039	XS0289303215	RMBS	7.500.000,00	GBP	AAA	A+	Quarterly	GBPLIBOR3	0,11%	13.01.2039
BUMF1 - B Libor+4.75% 07/2036	XS0186221577	CMBS	1.412.322,28	GBP	AA	A-	Quarterly	GBPLIBOR3	4,75%	20.07.2036
BUMF2 - B Gbplibor+2.80% - 02/2037	XS0203851463	CMBS	2.500.000,00	GBP	A	BBB	Quarterly	GBPLIBOR3	2,80%	15.02.2037
BUMF5 - B1 Libor+2.25% 02/2039	XS0271325291	CMBS								039
DECO 2007-C4X - Class E + 1.00% - 01/2020	XS0289644808	CMBS								020
ECLIP 2006-4 - D GBPLibor + 0.62 - 10/2018	XS0276413183	CMBS								018
EPICP MLDN - Floating - 07/2017 Class D	XS0251156781	CMBS								017
ERF 4 - Class C Libor +1.65% 07/2049	XS0197424236	ABS								049
ERF 5 - C Libor+0.9% 07/2050	XS0225884278	RMBS								050
ERF3 - B Gbplibor+1.40% - 04/2038	XS0169951000	CMBS								038
FLEX 4 - A Gbplibor+0.27% - 07/2036	XS0132692384	RMBS								036
FLEX5 - B Cl...	XS0149246711	RMBS								034

Asset Class	No. of securities	% of Outst. Notional
RMBS	30	46,5%
CMBS	18	30,6%
ABS	9	17,0%
CDO	2	5,9%
Total	**59**	**100,00%**

The collateral portfolio is very diverse (risk, maturity, payment frequencies, spreads).

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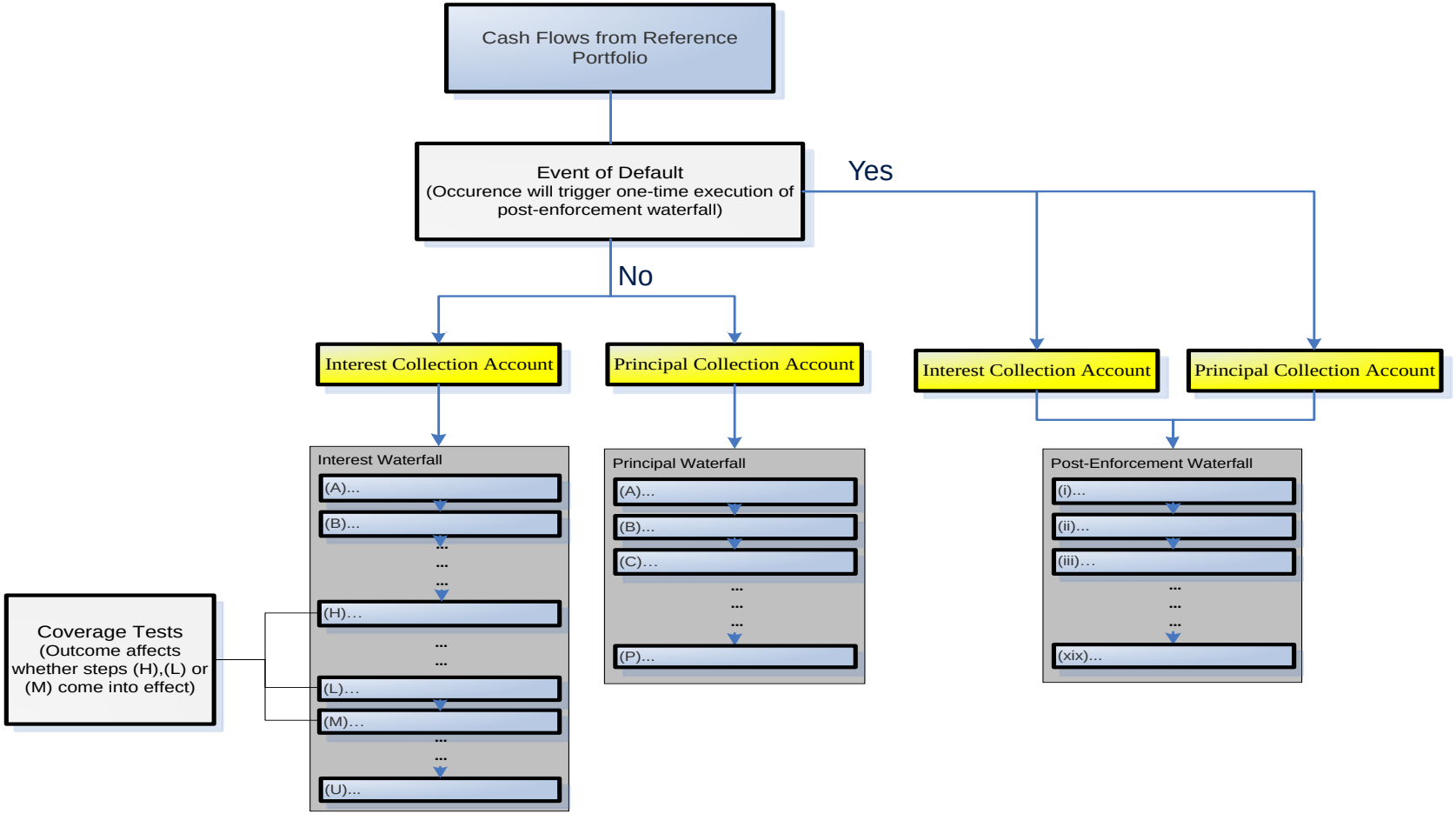
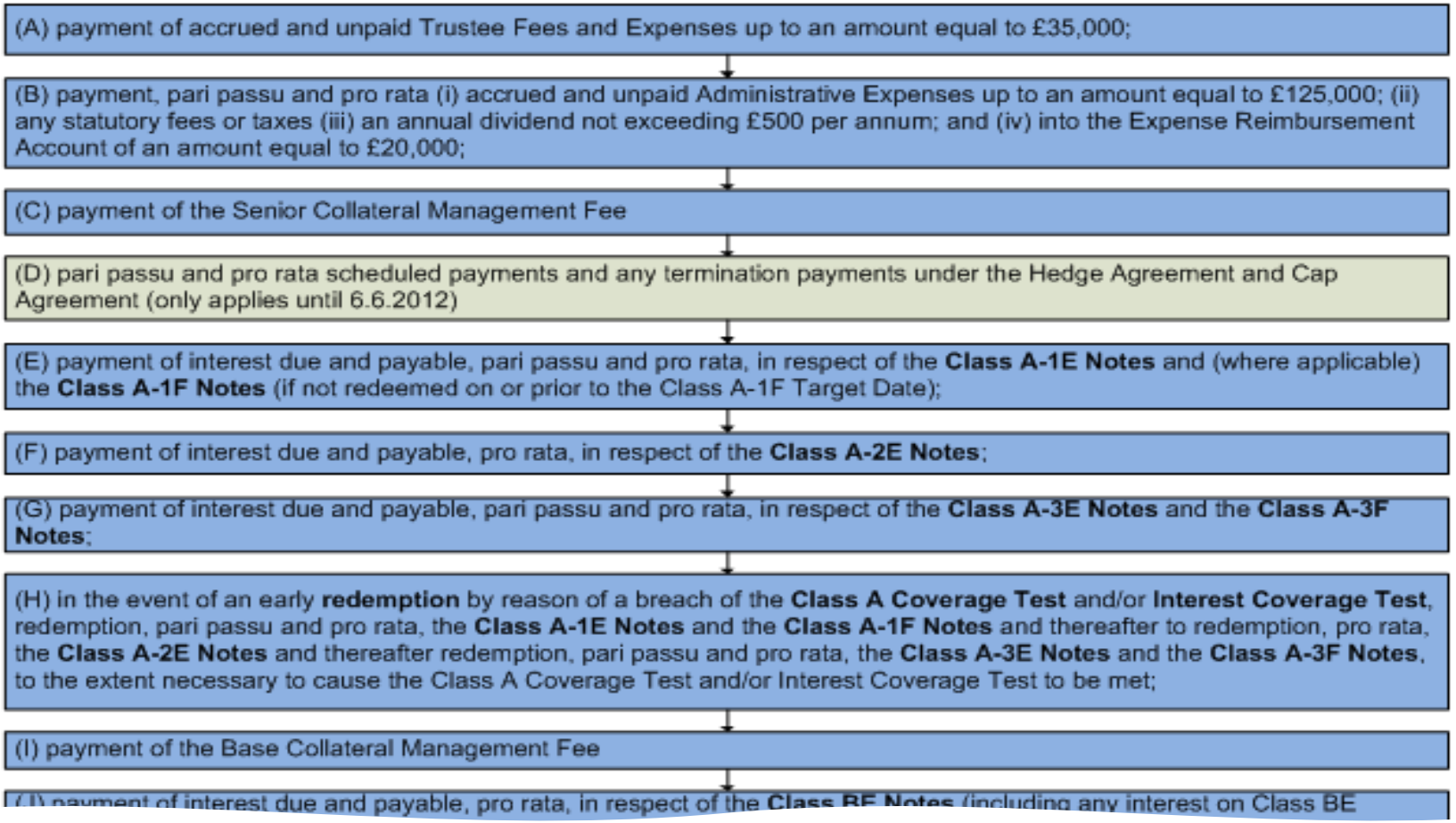
FAB UK 2004-1 Ltd. – Schematic View of Transaction Triggers



Trigger mechanisms are designed to protect senior notes of the transaction.

FAB UK 2004-1 Ltd. – Pre-Enforcement Priority of Payments – Interest



FAB UK 2004-1 Ltd. – Coverage Tests and Event of Default

Test	Calculation method*	Condition
Class A Overcollateralization Test	(Outstanding Principal Portfolio + Repayments in excess of Class A Interest Coverage) / Outstanding Principal Class A	≥ 103,5%
Class B Overcollateralization Test	(Outstanding Principal Portfolio + Repayments in excess of Class A+B Interest Coverage) / (Outstanding Principal Class A + B)	≥ 101,0%
Interest Coverage Tests	2 * (Annualized Interest Proceeds - Annualized Interest due for Class A) / Outstanding Principal Class A	≥ 1,0%
Additional Coverage Test	See Class B OC Test	≥ 101,5%

- Outcome of Coverage Tests determines certain steps of “Pre-enforcement” waterfall
- Event of Default
  - Occurs IF Interest on the most senior note with nominal outstanding is not paid at a payment date (with the exception of Class C Note) OR if there is outstanding principal at maturity
  - Default triggers sale of collateral portfolio and switch to “Post-enforcement” waterfall

Waterfall is determined by portfolio performance (indicated by Coverage Tests and Event of Default).

* Some simplifications were made.

Case Study – FAB UK 2004-1 Ltd. – Revaluation Results

d-fine's Approach to value Structured Credit Securitizations

Background and Methodology

- "MoCo" (Model Consolidation) Library is d-fine's internal valuation library
- It can price a wide range of products (also structured credit securitizations)
- Used at many customers for both validating and production environment
- Validated by third parties and used in a production environment

Valuation of Structured Credit Securitizations

- MoCo Modeling Language (MoML): Build into MoCo to allow the modeling of structured credit securitizations (waterfalls, triggers, tranches, portfolio)
- Modeling is based on estimate of future cash flows
- Excel Interface
- System provides full transparency (all figures are exposed and can be validated manually)

d-fine's valuation capabilities cover nearly any level of complexity.

d-fine's Approach to value Structured Credit Securitizations

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 **reference portfolio**	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 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

d-fine can model and value securitizations from scratch offering full transparency throughout the whole process.

FAB UK 2004-1 Ltd. – Modeling Approach for ABS Reference Portfolio

Main Challenge: Modeling cash flows of ABS CDO tranches in the reference portfolio

- Important information that was not available:
  - Default rates/ expected losses
  - Redemption schedules
  - Prepayment assumptions

Portfolio Modeling Approach:

- Modeling ABS CDOs like individual loans using the following assumptions:
  - Annuity repayment profile as mortgages typically repay in annuities
  - Probability of default based on historical default rates for the S&P rating given in latest investor report
  - Recovery rate based on recovery assumptions from Offering Circular (Junior tranches)
  - Zero prepayments, as they were not mentioned in the investor reports
- Alternative approach:
  - Modeling all 59 underlyings explicitly using deal information and investor reports →unreasonable effort

Chosen approach is reasonable trade-off between model simplification and valuation accuracy.

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FAB UK 2004-1 Ltd. – Assumptions for Credit Quality of Reference Portfolio

S&P Rating	Historical Default Rate	Notional by Rating	Portion of Total Notional
AAA	0,04%	446.414,88	0,3%
AA	0,09%	7.029.532,75	5,0%
A	0,17%	35.080.286,04	24,8%
BBB	0,50%	29.784.686,30	21,1%
BB	3,52%	12.643.039,16	9,0%
B	3,32%	36.263.230,04	25,7%
CCC	16,14%	3.800.494,25	2,7%
CC	35,34%	-	0,0%
C	35,34%	2.000.000,00	1,4%
D	100,00%	8.158.127,42	5,8%
NR	50,00%*	6.000.000,00	4,2%
		141.205.810,84	**100%**

S&P Rating	Assumed Recovery Rate
AAA	65,0%
AA	55,0%
A	40,0%
BBB	30,0%
BB	10,0%
B	2,5%
CCC	0,0%
CC	0,0%
C	0,0%
D	0,0%
NR	0,0%

» Example: first-year **expected loss** for a AA-rated security with notional of GBP 1000:
$EAD \cdot LGD \cdot PD = 1000 \cdot (1 - 0{,}55) \cdot 0{,}0009 = 0{,}405$

Default rates taken from RatingsDirect Report by S&P; Recovery rates taken from the transaction's offering circular. (* Own assumption)

FAB UK 2004-1 Ltd. – Transaction Specific Valuation Approach

Summary of the valuation approach:

- Reference Portfolio
  - Remodeling ABS tranches as synthetic loans
  - Use historic rating performances as information about credit quality
- Modeling specific features of transaction
  - Identify and model relevant steps of waterfall
  - Modeling of coverage tests
  - Make reasonable simplifications: substitution of collateral, optional redemption, IRS
- Simulate different scenarios of portfolio performance
- Calculate Present Values for tranches

FAB UK 2004-1 Ltd. – Cash Flow Tables Reference Portfolio

Cashflows for ReferencePortfolio

Reference	RefPortList
ValDate	31.12.2013

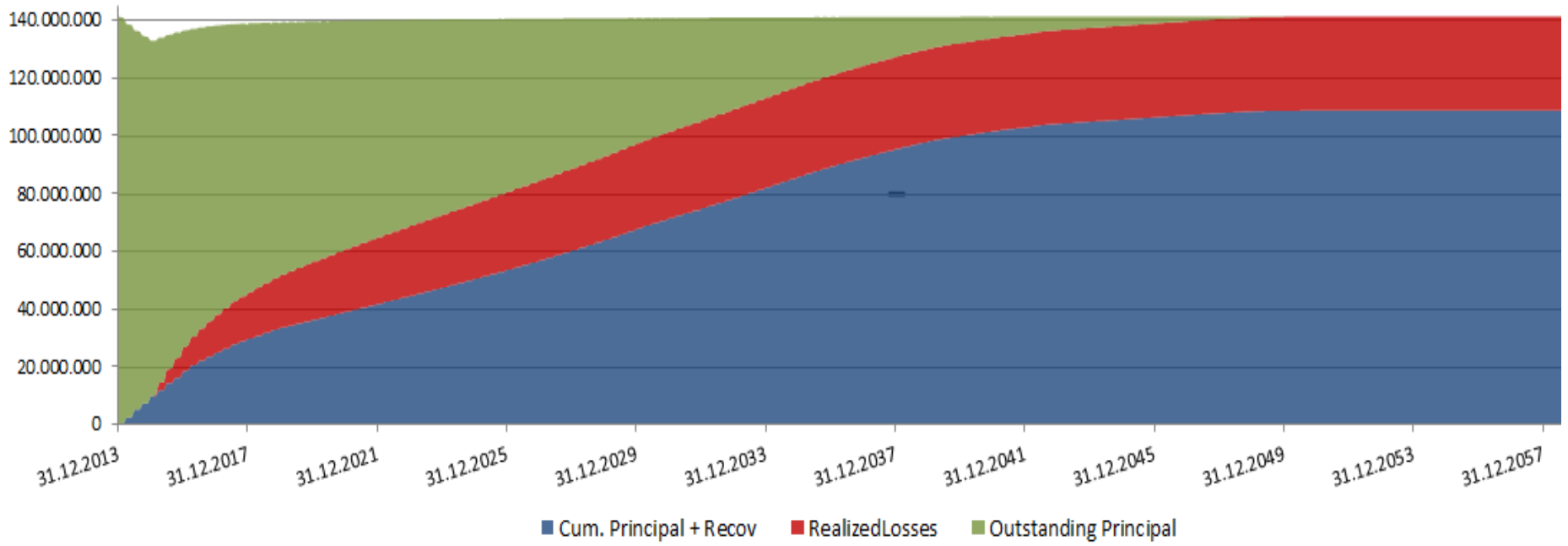
Check OK

Totals	70.830.871,00	106.870.903,64	-	34.334.907,20	1.741.465,12	32.593.442,08

PayDate	Interest	Principal	Prepayment	Default	Recovery	RealizedLosses
20.10.2010	1,00	0,00	0,00	0,00	0,00	0,00
22.10.2012	0,00	0,00	0,00	0,00	0,00	0,00
31.01.2014	44.487,80	72.171,30	0,00	216.759,02	0,00	0,00
28.02.2014	39.680,64	75.770,81	0,00	189.206,10	0,00	0,00
31.03.2014	591.417,82	2.191.672,39	0,00	2.174.198,74	0,00	0,00
30.04.2014	41.759,20	71.193,74	0,00	189.106,50	0,00	0,00
02.06.2014	45.166,30	66.506,46	0,00	200.627,30	0,00	0,00
30.06.2014	592.579,83	2.577.703,75	0,00	1.855.161,19	0,00	0,00
31.07.2014	42.234,50	67.267,14	0,00	175.898,24	0,00	0,00
01.09.2014	42.886,78	65.497,44	0,00	175.173,73	0,00	0,00
30.09.2014	606.136,09	2.013.407,76	0,00	1.600.290,59	0,00	0,00
20.10.2014	0,00	0,00	0,00	0,00	0,00	0,00
31.10.2014	40.964,77	65.431,50	0,00	158.360,80	0,00	0,00
01.12.2014	40.326,83	65.094,54	0,00	152.885,91	0,00	0,00
31.12.2014	627.909,11	2.409.139,68	0,00	1.384.371,71	0,00	0,00
02.02.2015	49.868,51	53.674,50	0,00	151.702,20	2.096,04	214.662,98
02.03.2015	41.696,72	61.053,09	0,00	124.435,74	1.883,48	187.322,63
31.03.2015	667.928,31	1.846.441,23	0,00	1.166.744,44	30.870,46	2.143.328,28
30.04.2015	43.506,28	57.652,52	0,00	124.867,30	1.996,72	187.109,78
01.06.2015	45.790,08	54.548,85	0,00	128.671,35	0,00	0,00
02.06.2015	0,00	0,00	0,00	0,00	2.184,69	198.442,61
30.06.2015	658.206,40	2.294.447,72	0,00	1.030.103,78	32.153,42	1.823.007,77
31.07.2015	43.201,87	55.676,46	0,00	116.540,34	2.030,81	173.867,43
01.09.2015	44.016,04	54.122,26	0,00	116.192,34	2.085,31	173.088,42
30.09.2015	747.772,85	1.699.128,81	0,00	907.009,41	30.150,02	1.570.140,57

MoCo MoML allows a view on all portfolio cash flows (on an aggregated level).

FAB UK 2004-1 Ltd. – Cash Flows Reference Portfolio (Base Case)



» Total expected realized losses are around 23% (of total nominal)

FAB UK 2004-1 Ltd. – Cash Flow Tables Tranches

Cashflows for Tranche

XS0187962104_Amount

ClassA-1E

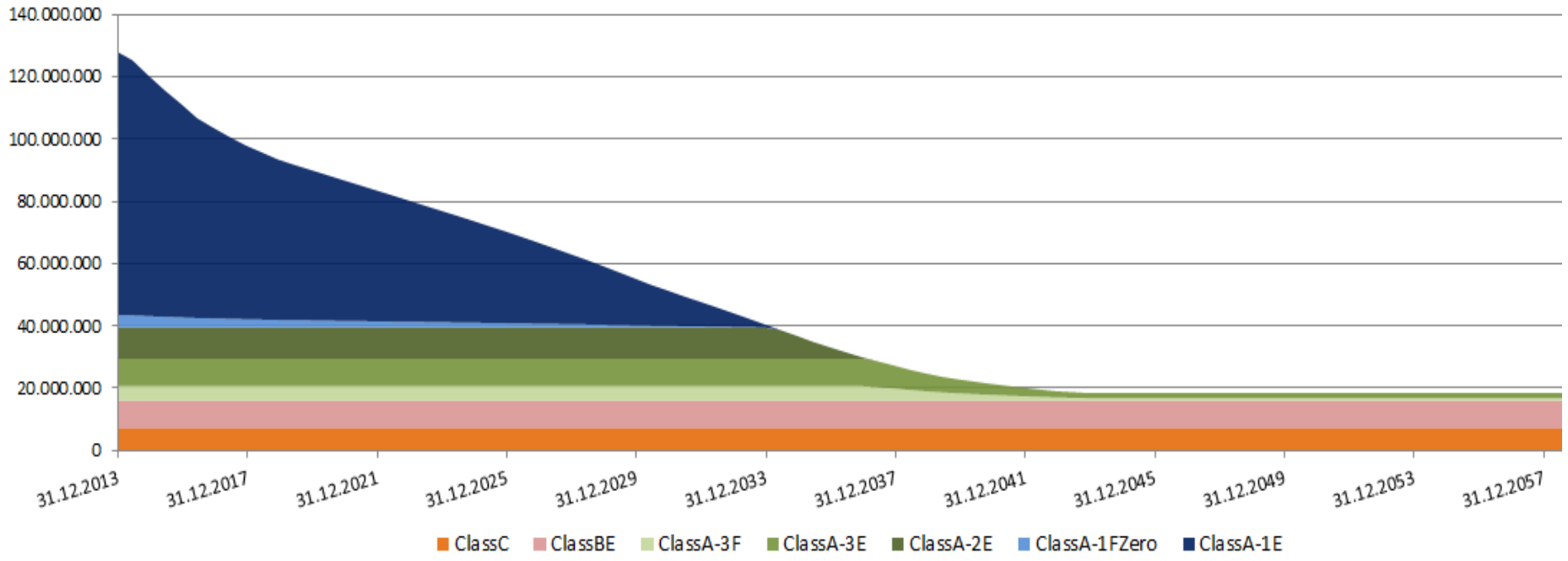
Calculate

WAL	8,93
Non-disc. CFs	112.613.759,37
Non-disc. CFs / Nom.	134%

Per_beg	Per_end	Pay_dat	Fix_dat	Year.frac	'non-disc' PV	Nom.	Outst.Nom	Coupon	rate	I-Paymt	CID	P-Paymt
00.01.1900	31.12.2013	31.12.2013	31.12.2013	0,0000	0,00	84.295.503,36	84.295.503,36	0,00	0,00	0,00	0,00	0,00
31.12.2013	06.06.2014	06.06.2014	04.06.2014	0,4301	2.826.111,38	84.295.503,36	81.930.793,87	461.401,89	0,0127	461.401,89	0,00	2.364.709,49
06.06.2014	08.12.2014	08.12.2014	04.12.2014	0,5068	5.461.524,77	81.930.793,87	77.127.249,61	657.980,51	0,0158	657.980,51	0,00	4.803.544,26
08.12.2014	08.06.2015	08.06.2015	04.06.2015	0,4986	5.224.626,68	77.127.249,61	72.666.914,85	764.291,92	0,0199	764.291,92	0,00	4.460.334,75
08.06.2015	07.12.2015	07.12.2015	03.12.2015	0,4986	5.090.300,17	72.666.914,85	68.545.501,79	968.887,11	0,0267	968.887,11	0,00	4.121.413,07
07.12.2015	06.06.2016	06.06.2016	02.06.2016	0,4986	5.346.320,87	68.545.501,79	64.152.528,36	953.347,44	0,0279	953.347,44	0,00	4.392.973,42
06.06.2016	06.12.2016	06.12.2016	02.12.2016	0,5014	4.037.647,53	64.152.528,36	61.207.195,90	1.092.315,07	0,0340	1.092.315,07	0,00	2.945.332,46
06.12.2016	06.06.2017	06.06.2017	02.06.2017	0,4986	3.855.890,10	61.207.195,90	58.421.622,71	1.070.316,92	0,0351	1.070.316,92	0,00	2.785.573,19
06.06.2017	06.12.2017	06.12.2017	04.12.2017	0,5014	3.763.269,79	58.421.622,71	55.802.171,66	1.143.818,74	0,0391	1.143.818,74	0,00	2.619.451,05
06.12.2017	06.06.2018	06.06.2018	04.06.2018	0,4986	3.248.497,89	55.802.171,66	53.657.956,34	1.104.282,57	0,0397	1.104.282,57	0,00	2.144.215,32
06.06.2018	06.12.2018	06.12.2018	04.12.2018	0,5014	3.300.667,76	53.657.956,34	51.482.546,85	1.125.258,27	0,0418	1.125.258,27	0,00	2.175.409,49
06.12.2018	06.06.2019	06.06.2019	04.06.2019	0,4986	2.698.945,80	51.482.546,85	49.866.970,66	1.083.369,61	0,0422	1.083.369,61	0,00	1.615.576,19
06.06.2019	06.12.2019	06.12.2019	04.12.2019	0,5014	2.656.227,58	49.866.970,66	48.297.464,83	1.086.721,75	0,0435	1.086.721,75	0,00	1.569.505,83
06.12.2019	08.06.2020	08.06.2020	04.06.2020	0,5068	2.622.018,11	48.297.464,83	46.744.822,24	1.069.375,52	0,0437	1.069.375,52	0,00	1.552.642,59
08.06.2020	07.12.2020	07.12.2020	03.12.2020	0,4986	2.595.549,73	46.744.822,24	45.199.610,44	1.050.337,94	0,0451	1.050.337,94	0,00	1.545.211,80
07.12.2020	07.06.2021	07.06.2021	03.06.2021	0,4986	2.570.873,37	45.199.610,44	43.650.062,79	1.021.325,72	0,0453	1.021.325,72	0,00	1.549.547,65
07.06.2021	06.12.2021	06.12.2021	02.12.2021	0,4986	2.542.594,78	43.650.062,79	42.111.517,38	1.004.049,37	0,0461	1.004.049,37	0,00	1.538.545,41
06.12.2021	06.06.2022	06.06.2022	02.06.2022	0,4986	2.521.213,22	42.111.517,38	40.562.265,23	971.961,07	0,0463	971.961,07	0,00	1.549.252,14
06.06.2022	06.12.2022	06.12.2022	02.12.2022	0,5014	2.497.061,38	40.562.265,23	39.011.925,47	946.721,61	0,0466	946.721,61	0,00	1.550.339,77
06.12.2022	06.06.2023	06.06.2023	02.06.2023	0,4986	2.482.010,83	39.011.925,47	37.436.556,13	906.641,49	0,0466	906.641,49	0,00	1.575.369,34
06.06.2023	06.12.2023	06.12.2023	04.12.2023	0,5014	2.434.221,73	37.436.556,13	35.887.459,63	885.125,23	0,0472	885.125,23	0,00	1.549.096,50
06.12.2023	06.06.2024	06.06.2024	04.06.2024	0,5014	2.414.617,31	35.887.459,63	34.322.920,00	850.077,67	0,0472	850.077,67	0,00	1.564.539,64
06.06.2024	06.12.2024	06.12.2024	04.12.2024	0,5014	2.400.195,21	34.322.920,00	32.735.700,93	812.976,15	0,0472	812.976,15	0,00	1.587.219,06
06.12.2024	06.06.2025	06.06.2025	04.06.2025	0,4986	2.388.868,13	32.735.700,93	31.118.016,49	771.183,69	0,0472	771.183,69	0,00	1.617.684,44
06.06.2025	08.12.2025	08.12.2025	04.12.2025	0,5068	2.364.609,50	31.118.016,49	29.482.389,72	728.982,74	0,0462	728.982,74	0,00	1.635.626,77
08.12.2025	08.06.2026	08.06.2026	04.06.2026	0,4986	2.362.580,43	29.482.389,72	27.796.689,63	676.880,34	0,0460	676.880,34	0,00	1.685.700,09
08.06.2026	07.12.2026	07.12.2026	03.12.2026	0,4986	2.350.346,48	27.796.689,63	26.084.490,07	638.146,92	0,0460	638.146,92	0,00	1.712.199,56
07.12.2026	07.06.2027	07.06.2027	03.06.2027	0,4986	2.338.338,29	26.084.490,07	24.345.020,43	598.868,64	0,0460	598.868,64	0,00	1.739.469,65
07.06.2027	06.12.2027	06.12.2027	02.12.2027	0,4986	2.327.289,97	24.345.020,43	22.576.662,96	558.932,50	0,0460	558.932,50	0,00	1.768.357,47
06.12.2027	06.06.2028	06.06.2028	02.06.2028	0,5014	2.313.185,10	22.576.662,96	20.784.710,87	521.233,01	0,0460	521.233,01	0,00	1.791.952,09
06.06.2028	06.12.2028	06.12.2028	04.12.2028	0,5014	2.323.724,83	20.784.710,87	18.917.120,51	456.134,48	0,0438	456.134,48	0,00	1.867.590,36
06.12.2028	06.06.2029	06.06.2029	04.06.2029	0,4986	2.320.672,90	18.917.120,51	17.005.939,50	409.491,89	0,0434	409.491,89	0,00	1.911.181,01
06.06.2029	06.12.2029	06.12.2029	04.12.2029	0,5014	2.309.028,85	17.005.939,50	15.067.037,44	370.126,79	0,0434	370.126,79	0,00	1.938.902,06
06.12.2029	06.06.2030	06.06.2030	04.06.2030	0,4986	2.278.739,87	15.067.037,44	13.114.448,15	326.150,57	0,0434	326.150,57	0,00	1.952.589,30
06.06.2030	06.12.2030	06.12.2030	04.12.2030	0,5014	1.988.196,07	13.114.448,15	11.411.682,27	285.430,19	0,0434	285.430,19	0,00	1.702.765,88
				0,4986	2.014.251,20	11.411.682,27				247.024,45	0,00	1.767.226,74

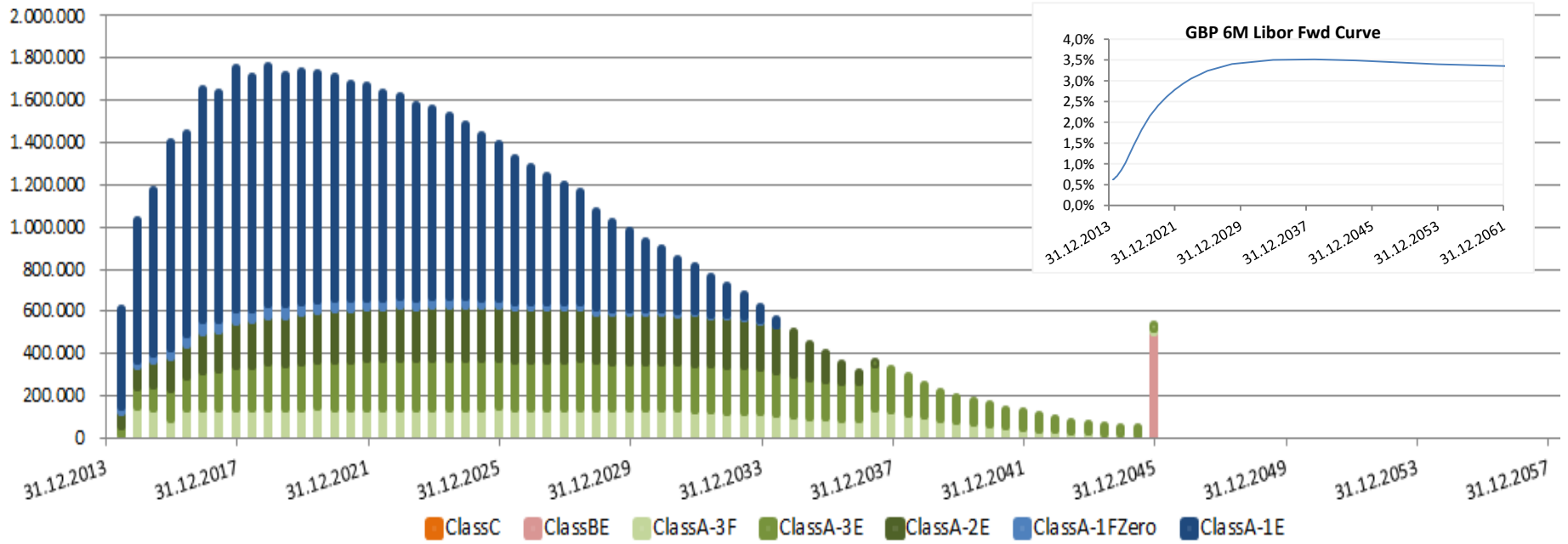
MoCo MoML allows a view on all tranche cash flows.

FAB UK 2004-1 Ltd. – Principal Cash Flows to Notes (Base Case)



- Senior tranches are expected to be redeemed long before their legal maturity (2045)
- The two lowest tranches are not expected to receive any principal payments

FAB UK 2004-1 Ltd. – Interest Cash Flows to Notes (Base Case)



» Exp. interest payments are driven by shape of the forward curve and outstanding nominal

» Class BE receives large interest cash flow from expected asset sale at maturity

FAB UK 2004-1 Ltd. – Reference Portfolio Assumptions under Stress Scenario

S&P Rating	Historical Default Rate
AAA	0,10%
AA	0,23%
A	0,43%
BBB	1,25%
BB	8,80%
B	8,30%
CCC	40,35%
CC	88,35%
C	88,35%
D	100,00%
NR	100,00%*

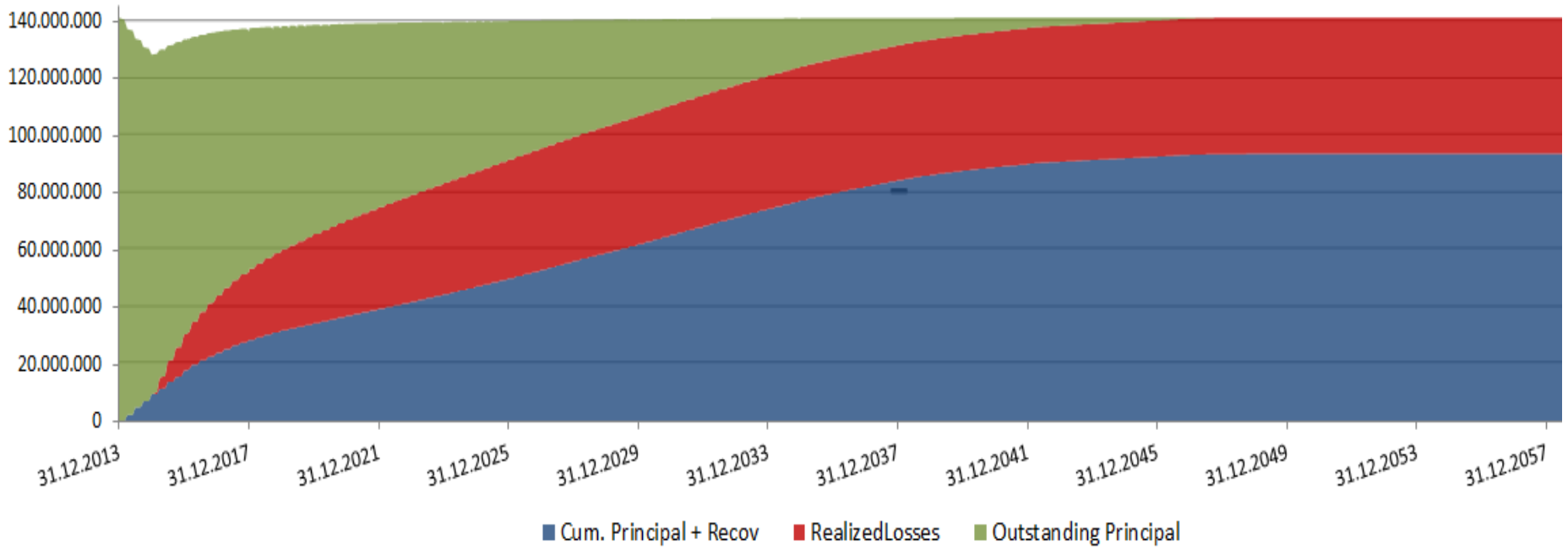
S&P Rating	Assumed Recovery Rate
AAA	32,5%
AA	27,5%
A	20,0%
BBB	15,0%
BB	5,0%
B	1,3%
CCC	0,0%
CC	0,0%
C	0,0%
D	0,0%
NR	0,0%

- Stress Scenario
  - Default rates increase by factor 2,5
  - Recovery rates decrease by factor 0,5

Scenario is to test protection of senior tranches.

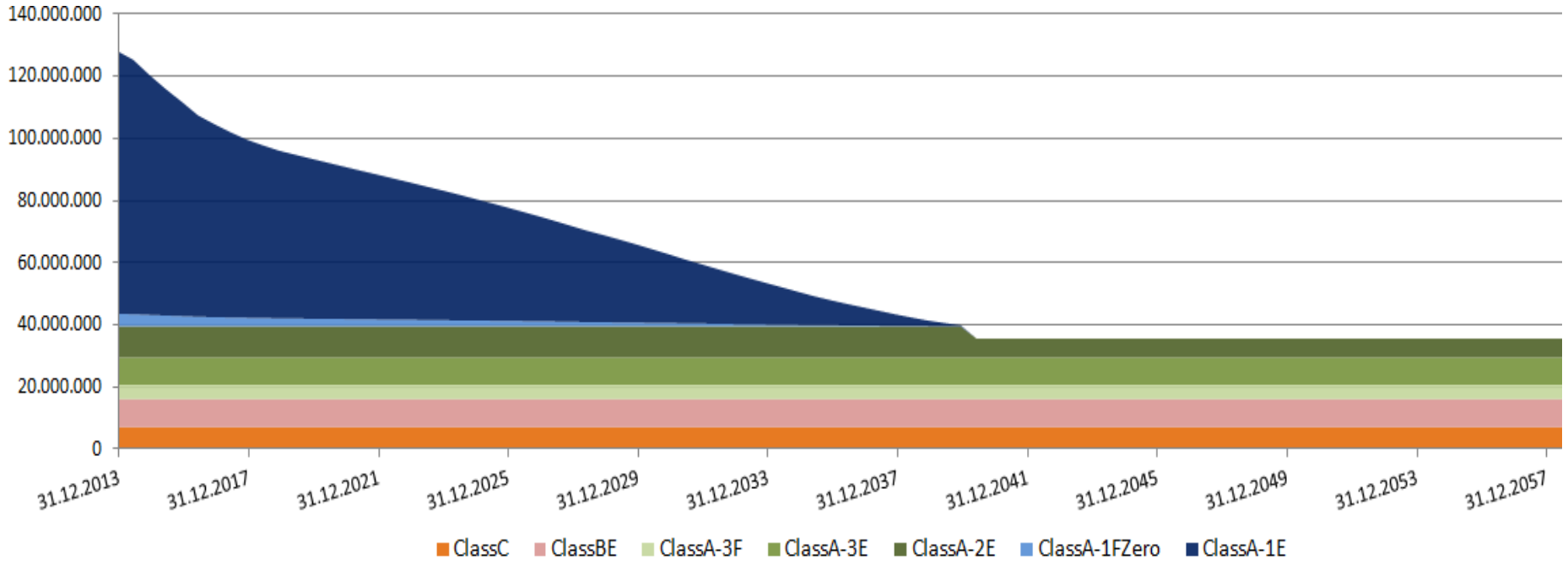
Default rates taken from RatingsDirect Report by S&P; Recovery rates taken from the transaction's offering circular. (* Own assumption)

FAB UK 2004-1 Ltd. – Cash Flows Reference Portfolio (*Stress Case*)



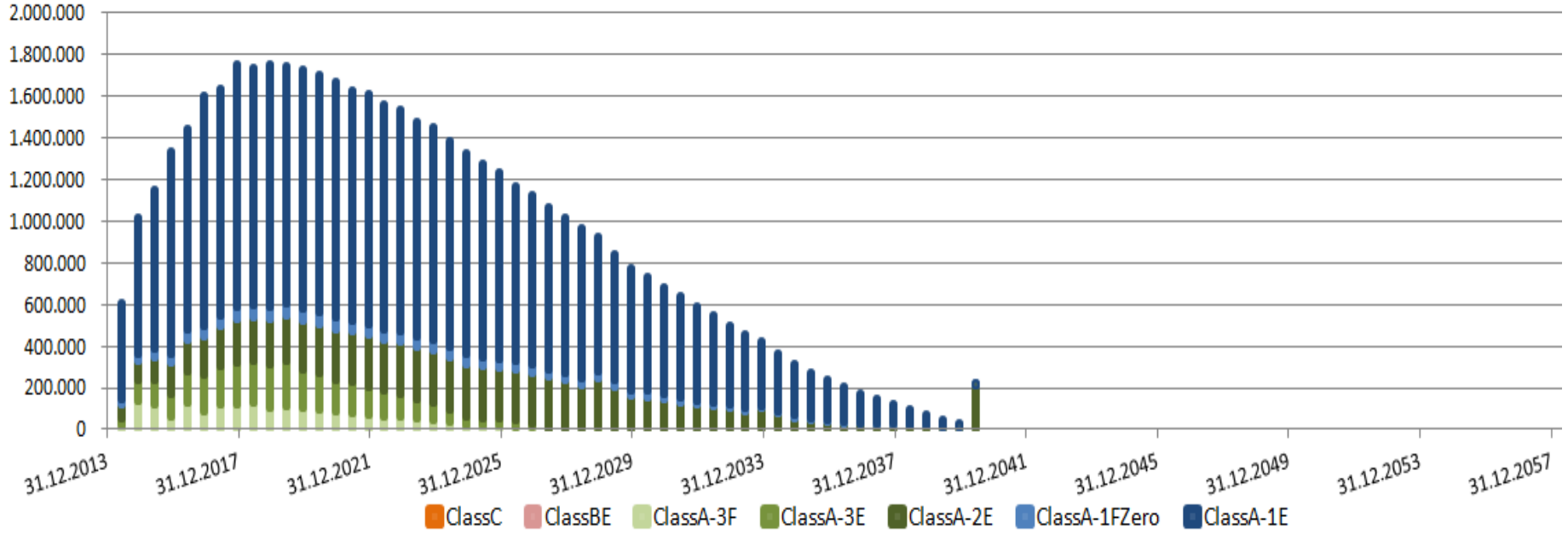
» Total expected realized losses amount to around 34% (of total nominal)

FAB UK 2004-1 Ltd. – Principal Cash Flows to Notes (*Stress Case*)



- Senior tranches still redeem in full but later than in base case
- The *four* lowest tranches are not expected to receive any principal payments

FAB UK 2004-1 Ltd. – Interest Cash Flows to Notes (*Stress Case*)



- Class A1 interest payments stretch further as expected redemption is later
- Classes BE and C do not receive any interest (or principal) payments

FAB UK 2004-1 Ltd. – Revaluation Results as of 31.12.2013

Class of Notes	PV (Base Case, in %)	PV (Stress Case, in %)
A-1E	104,89	105,41
A-1F Zero	104,89	105,41
A-2E	113,82	76,93
A-3E	119,78	30,99
A-3F	141,57	36,51
BE	1,84	0,00
C	0,00	0,00

- Present values reflect theoretical “fair value” based on expected cash flows
  - Senior notes’ PV is very little affected by change in portfolio performance (to a certain point)
  - Mezzanine notes offer high return if portfolio performs normal
- However, illiquidity can have major effect on actual realized price

True MtM would require knowledge of the actual demand-supply situation (“market color”).

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Further Reading

- Fabozzi, Frank J. and Kothari, Vinod (2008): Introduction to Securitization. Hoboken, New Jersey: John Wiley & Sons, Inc.
- Federal Reserve Bank of New York (2012): Staff Report No. 458 – Shadow Banking. http://www.newyorkfed.org/research/staff_reports/sr458.pdf
- Financial Crisis Inquiry Commission (2011): Financial Crisis Inquiry Report. http://fcic.law.stanford.edu/report
- European Central Bank & Bank of England (2014): The impaired EU Securitization Market: Causes, Roadblocks and how to deal with them. https://www.ecb.europa.eu/pub/pdf/other/ecb-boe_impaired_eu_securitisation_marketen.pdf
- Association for Financial Markets in Europe (AFME): Securitization Data Report Q2:2014 www.afme.eu/WorkArea/DownloadAsset.aspx?id=10815

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