Die VermögensManager
von Munich Re und ERGO

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Best Practice in Pricing from a Buy-Side Perspective

Florian Stärk
Risk Controlling
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Agenda

1. **Model Selection for OTC pricing**
2. Should you use third parties?
3. Validation of Market Data
4. Lessons learnt from Valuation Pitfalls

What do you need prices for at buy side?

- Front Office
- Trade / Limit Control
- Performance Measurement
- Risk Model
- NAV /Share Price Calculation
- Accounting /Reporting
- Collateral Management

Criteria for Pricing: Front Office Needs and Trade /Limit Control

- Front Office needs **intraday / real time pricing** capabilities
- This is especially true (tick data) if you engage into algorithmic trading
- For trade control / pre trade limit control also desirable, but not strictly necessary
- needs live data feed, as many different price sources as possible
- Real time data cleansing
- Creating huge data volume

→ Difficult and expensive to fully integrate in a buy-side STP-System , needs sell side type systems / Bloomberg etc.

Criteria for Pricing: Performance Measurement

- as far as possible, pricing sources should be synchronized with benchmark index pricing for minimal intraday noise in relative performance
- Difficult to obtain for OTCs , because normally provider benchmark ≠ provider market data
- Stale Prices / Price Jumps create artificial jumps in absolute /relative performance

→ **daily validation of market data necessary (see below)**

Criteria for Pricing: Risk Model

- Ideally, your FO system is also a Risk System, using pricing kernels for pricing and calculation of market risk (= pricing along risk factor scenarios)
- Otherwise , you need a possibly very complicated mapping from FO system => risk system models (dependent on different input data)
- Similar models in both systems strongly recommended
- Risk system tends to have less risk factors (spreads!) than pricing factors exist => you have to map to/chose risk factors anyway, but try to get maximal overlap

Criteria for Pricing: Risk Model

- Risk model has to avoid nested simulation => approximation for path dependent OTCs
- risk model has to calibrate to FO prices (for non OTCs anyway) =>

  necessary Spread/Vol difference is indicator for risk model quality
- Different pricing models create different **sensitivities**: choose the best of both worlds! (i.e. ILS sensitivites from risk model!)

Criteria for Pricing: NAV / Share price of Funds

- Fund Valuation
  - Since 2008, valuation methodology is a big topic for external and internal auditors → high standards for quality, transparency, documentation, national laws
  - Auditors are most interested in highly illiquid / difficult to price securities /OTCs
- Custodian Banks
  - Regular valuation comparison
  - wants description of pricing methodology → **"Valuation Concept"** helpful
  - Vice-versa, approval of their pricing methodology
- Collateral Management / Platform:
  you must be able to win pricing diputes!

Valuation Concept

Accounting (IFRS):

"IAS 39 contains a hierarchy for the determination of fair value in IAS 39.48A and AG69-AG82. Quoted prices in active markets provide the best evidence of fair value and must be used when available. In the absence of such quoted market prices, an entity uses a valuation technique. The objective of using a valuation technique is to establish what the transaction price would have been on the measurement date in an arm's length exchange motivated by normal business considerations. The chosen valuation technique incorporates all factors that market participants would consider in setting a price, minimising entity-specific inputs and is consistent with accepted economic methodologies for pricing financial instruments (IAS 39.48A)".

What does all that mean for selection of OTC Models?

- Try hard to use standard models included in your system / market standard models
- If you can price the derivative as combination of simpler ones, do it, because for them you have systems + high quality market data!
- Systems with free inclusion of pricing kernels favorable
- If you have to import prices: if possible, high frequency automated import including sensitivities
- For non-exotics, quality of market data is the essential thing
- Without high quality market data, you won´t be able to win pricing disputes and have an effective trade control (see below)

Accounting rules in continental Europe => OTC Derivatives often embedded into (registered) bonds

host contract =
OTC bond (fix/float)

embedded derivative

Product name	Host contract	Embedded Derivative
Callables and Multi-Callables	Registered Bond	Short Bermuda-Calls
Multitranchen	Registered Bond	Short Payer Swaptions
CMS-Floater	Registered Bond	CMS Swap, long Floor, short Cap
Vola- /Convergence Bonds	Registered Bond	Interest rate, currency swap, long Floor, short Cap

Model types for Interest Rate OTCs (embedded)

Black / Standard Swaption Model	Libor Market / Hull- White Model
▪ Callable Bond (single call) ▪ Multitranche ▪ Swaption Note ▪ CMS Floater with Cap/Floor ▪ Reverse Floater with Cap/Floor ▪ Binary payout Bonds ▪ Vola Bonds (=Interest Rate Spread over Time) ▪ CMS Spread Bonds (2s10s) with Cap/Floor	▪ Multi Callables (Bermudian Call) ▪ Callable Reverse Floater ▪ Callable Binary payout Bonds ▪ Callable CMS Spread Bonds ▪ Snowball Bonds ▪ Vola Bonds with variable multipliers ▪ Pathdependent Payouts

- Non –pathdependent Quanto Bonds

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Embedded Derivatives: Examples

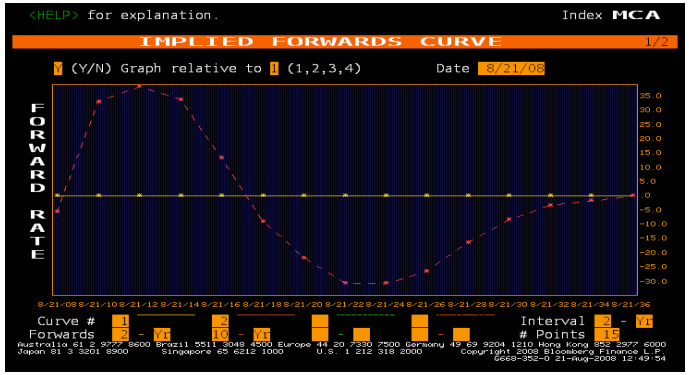
- Callable Bond = *Bond Host – Receiver Swaption*
- Putable Bond = *Bond Host – Payer Swaptions*
- Reverse Floater = *Fixed rate Bond – Floating Leg + Cap (for Zero Floor)*
- CMS Floater = *Portfolio of Payer Swaptions + Fixed Rate Bond (for fixedFloor)*

Example: CMS10-CMS2 Spread (Bond)

CMS Steepener payout depends on steepness of yield curve. For example:

- Fixed Coupon for year 1-5: 5%,
- Steepener Payout floored at 0% for year 6-20: MAX(8,5 x (CMS10 – CMS2); 0%)

Market implied forward spreads tend to go to zero or become even negative . But realized steepness always turned out much higher (so far).



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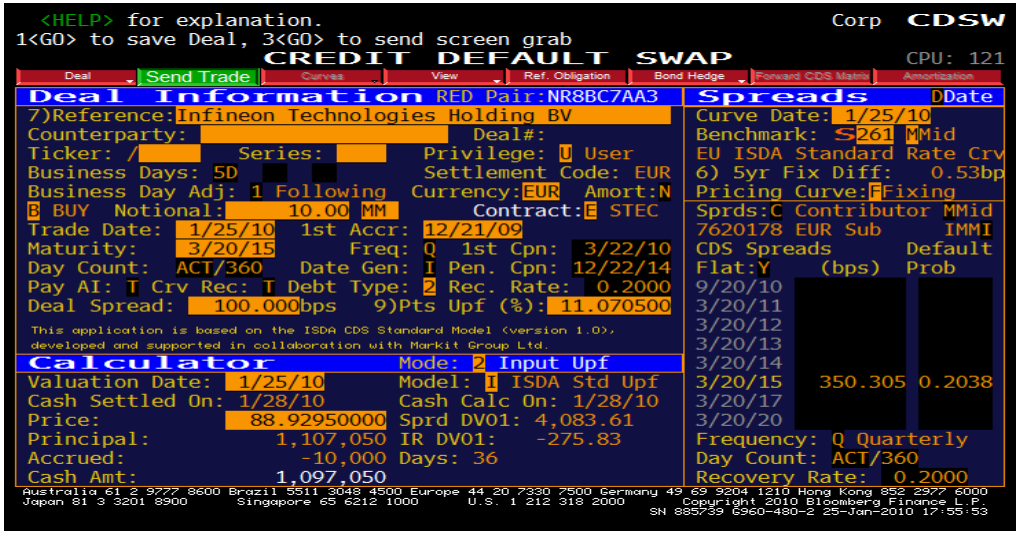
Credit Default Swaps after „Big & Small Bang“

Standard Assumptions for Pricing CDS:

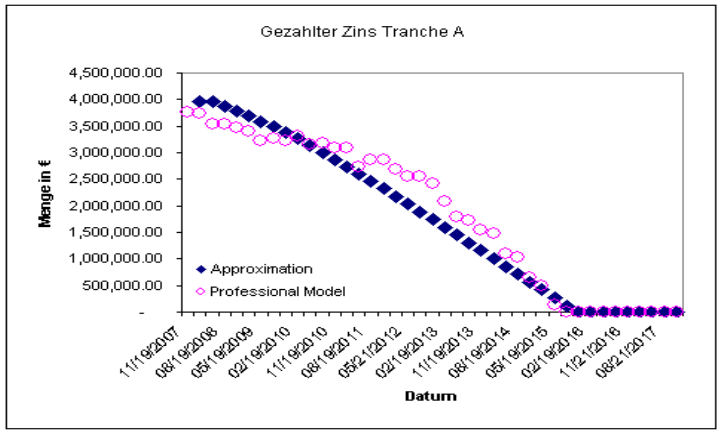
- SNAC and SEC Contract Specifications
- Fixed Rate Coupons (100 bp and 500 bp) with Upfront Payouts
- Unified „Effective Date“
- ISDA Determination Committee
- ISDA Standard Upfront Model/Fair Value Modell

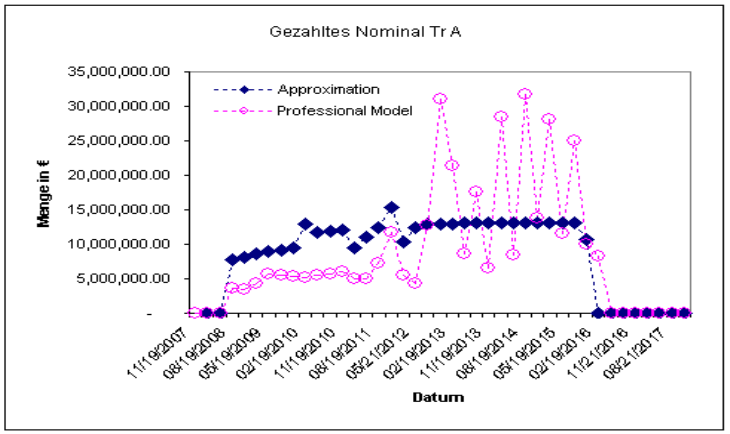


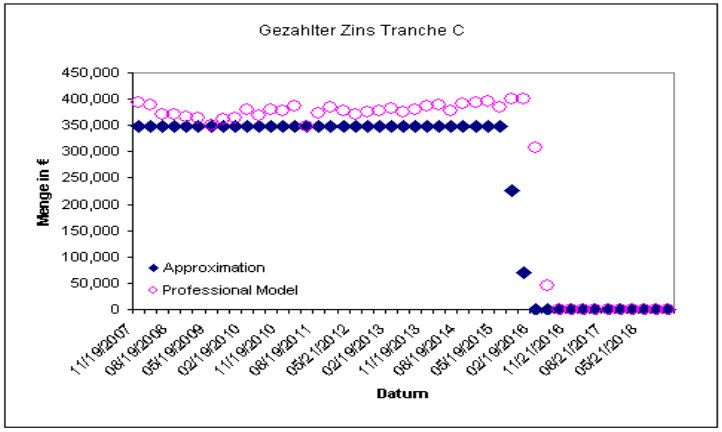
Theoretical Pricing for (illiquid) Structured Credit

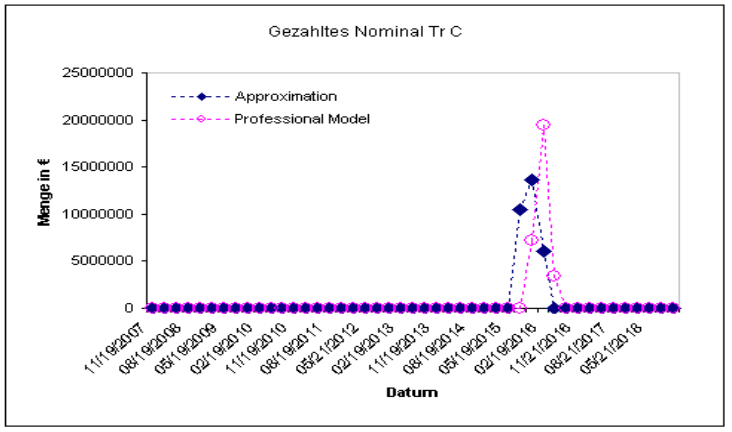
- Spread Based (Econometric) Approach
  - Mapping on Spread Curves based on maturity,, rating , sector
  - Only systematic risk/ pricing
- Fundamental Approach
  - Defaults scenarios over time based on collateral pool
  - Model for Waterfall
  - Cash flow simulation along default scenarios

Structured Credit: Cashflow Simulation









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Third party pricing is a less than ideal solution, because…

- If you can´t price it, you don´t understand it: why trade it?
- Its costly
- How to import automatically?
- In your risk model, you will have only a sensitivity instrument (stress tests!)
- Sensitivities are probably not fitting to your risk /valuation factors
- Transparency: auditors; custodians etc. are not amused, documentation available?
- How to validate?
- **When does it make sense: small volume buy-hold exotics (client´s vintage you can´t sell)**
- **Another thing: Future CCP Pricing**

How to find good third party pricing:

- You should always request test pricings from different contributors
- Main problem: How to validate these if you can´t price yourself?
- you should try to find reliable prices for a few positions at an given date (yourself or consultant)
- Use these prices as a benchmark for pricing capability in assessment of your RFP
- If you find more pricing providers, you can use clusters/outliers
- Don´t ask only for prices, but also for used models, spreads, sensitivities
- Some providers are good at modelling, but weak with spreads/market data: you would have to define data source
- Difficult decision, when different providers are best for different securities

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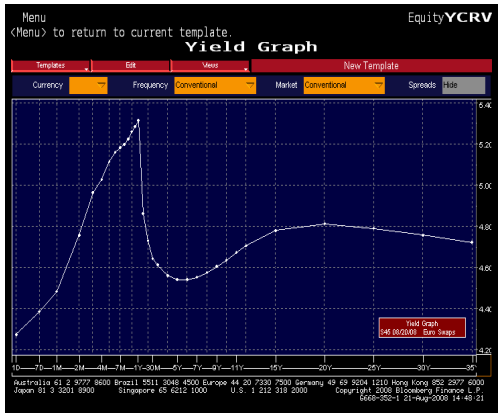
For interest rate OTCs, high quality market data is all important

- Pricing Interest rate OTCs means determination and discounting of future, probability-weighted cashflows. For that you need discount curves including spreads, volatilities including skews and sometimes correlations.

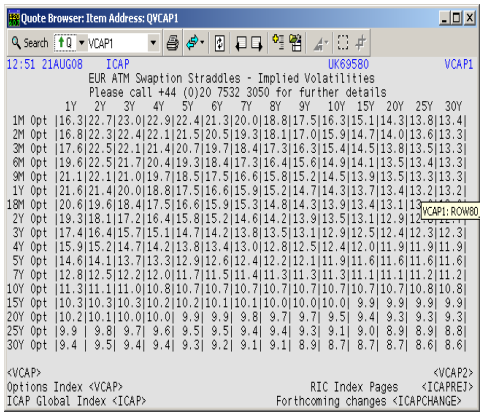
Swap Curves, Discount Factors, Spreads

- Bootstrapping gives you discount curves



Volatilities

- Skew data is important, but difficult to get => Interpolation



Correlations

- For Spread Options, you need correlations between interest rates
- Correlatios between FX and cross currency interest rates necessary for Quanto Swaps

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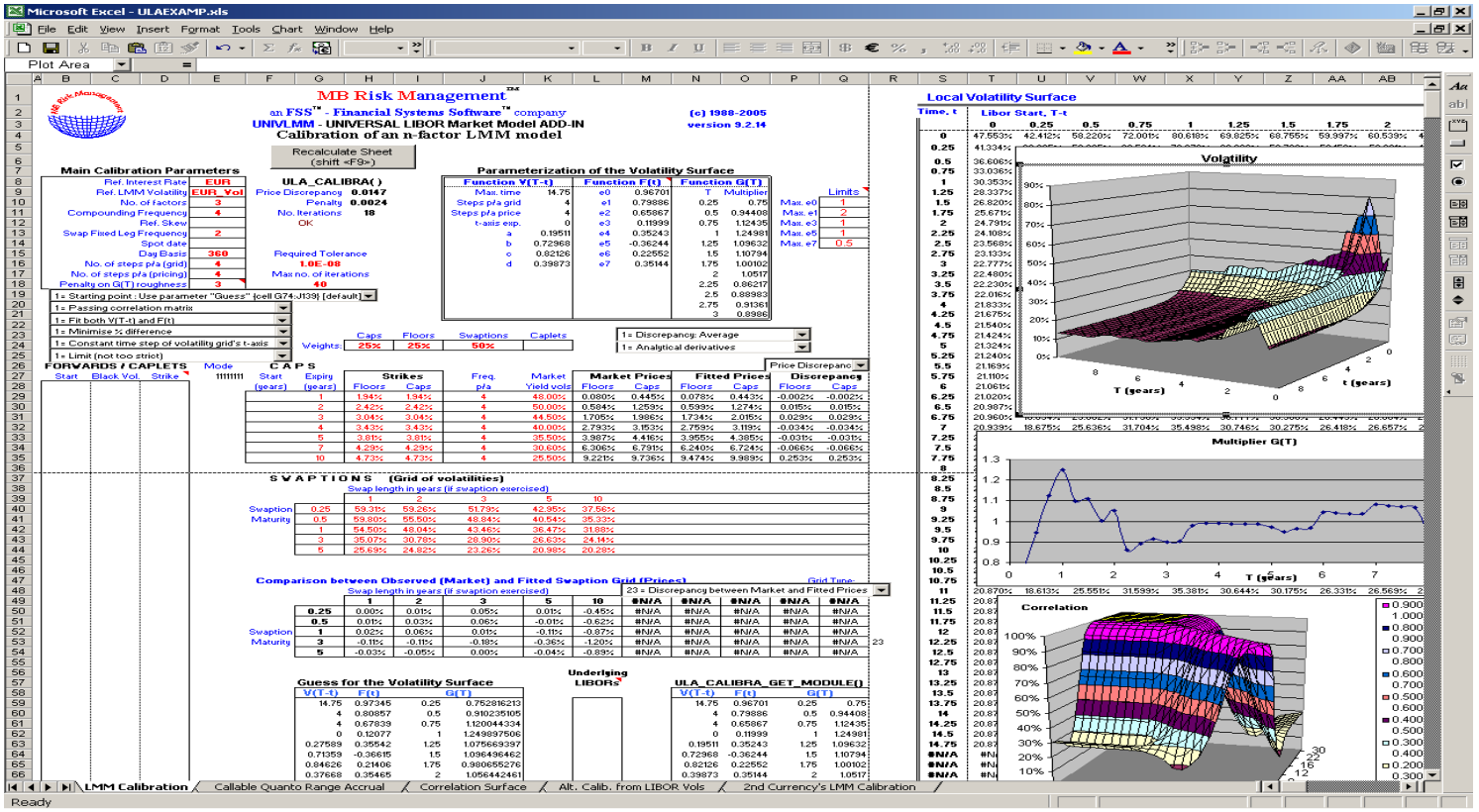
Market data is necessary also for model calibration:

- Example: To calibrate the Libor Market Model (Software: MBRM), you need Libor and swap rates, vols :



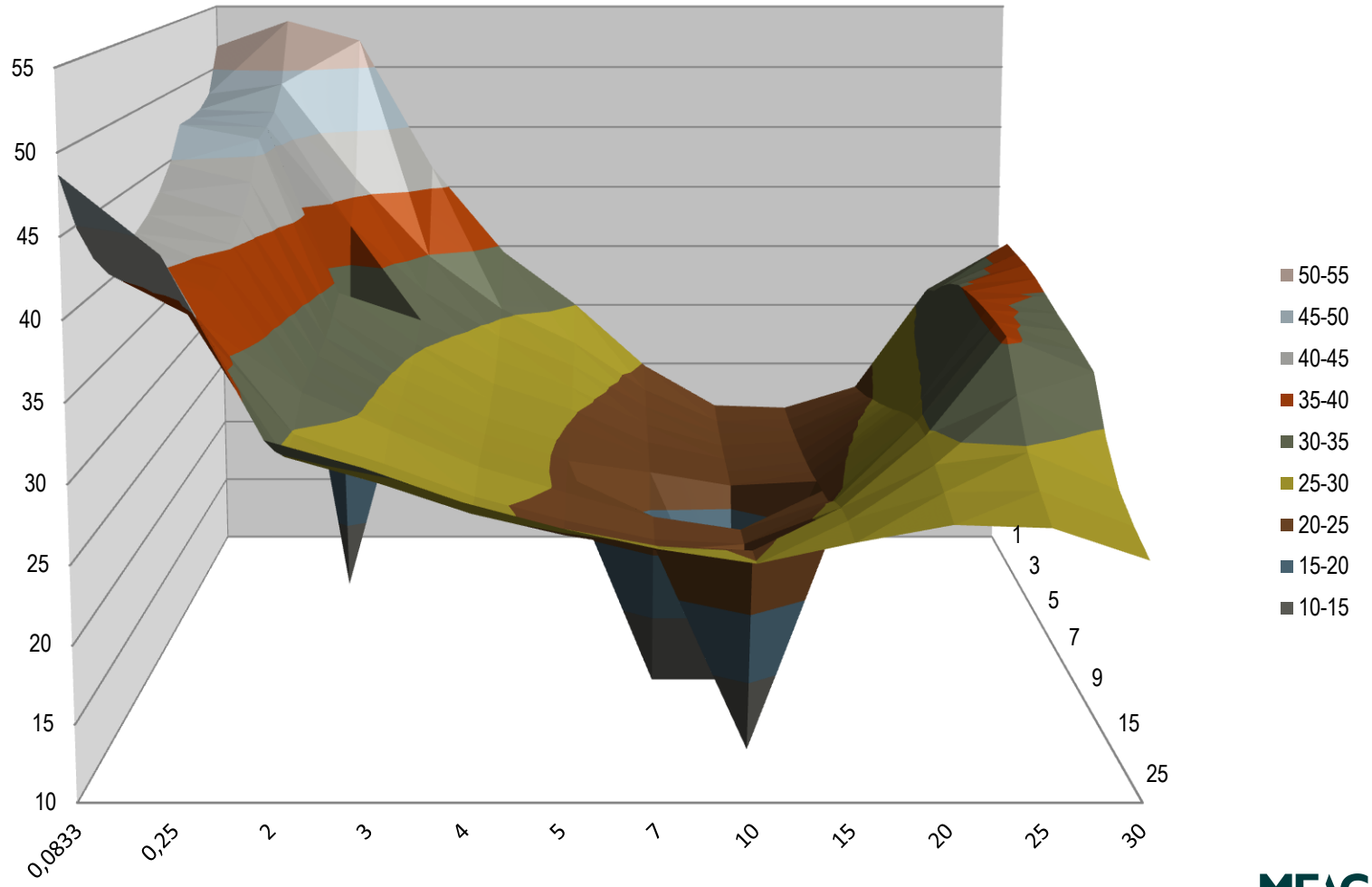
Examples of automated, regular market data checks:

- Non negative
- Zero values
- Empty values / missing data
- Up-to-datedness (value is labelled if it is older than a certain threshold)
- Flat / gap size check
- Number of standard deviations between flats / gaps
- No change

Examples of automated, regular market data checks:

- Volatility limits
- Multiple data sources when running the quality checks (e.g. comparison of values from different data providers)
- Return difference to related risk factor
- Quality check filters for curves that consider historical data and reference curves
- **Interpolation** or rolling forward of missing data points (important for vols!)

Swaption Volatility Surface: Before…



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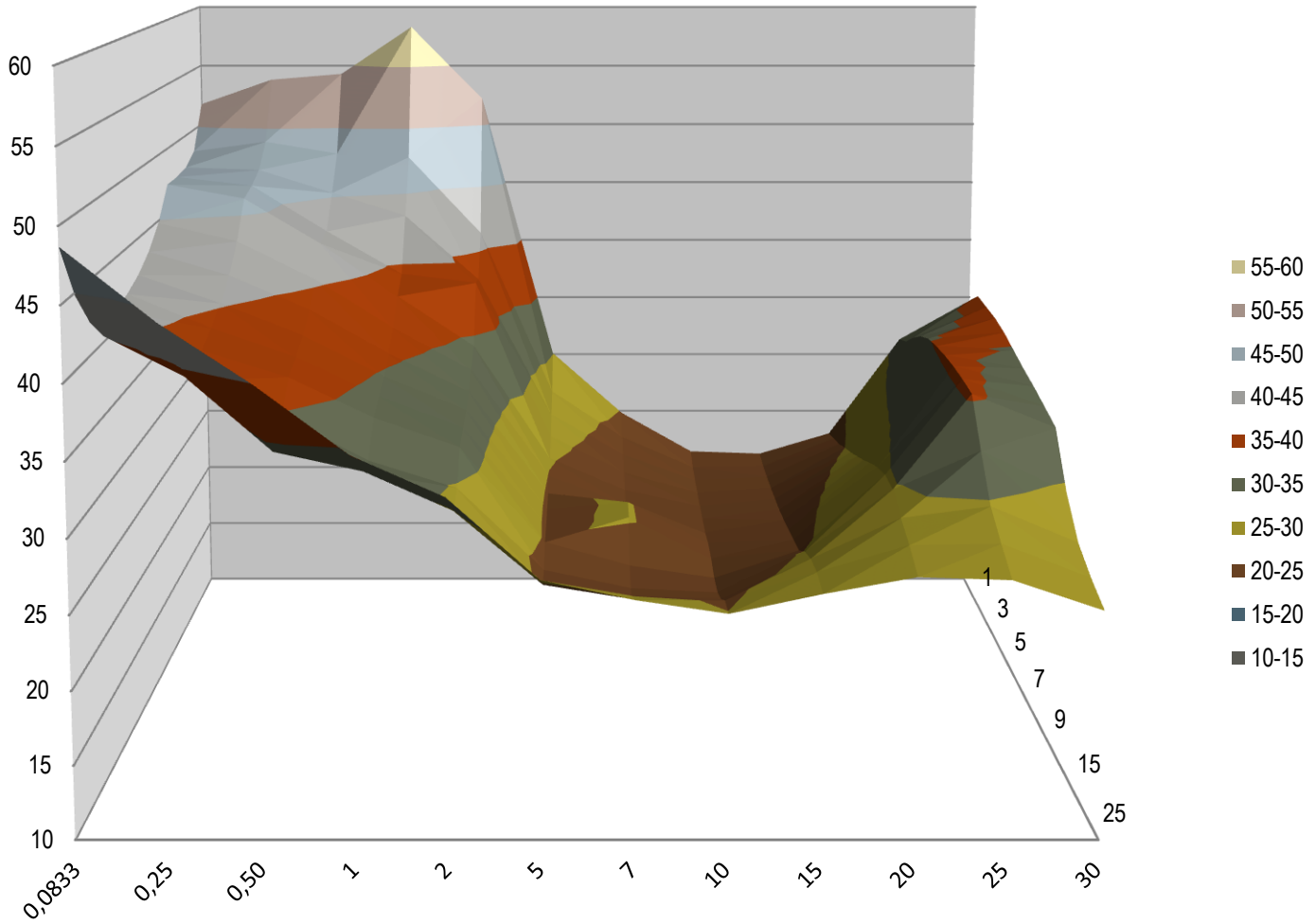
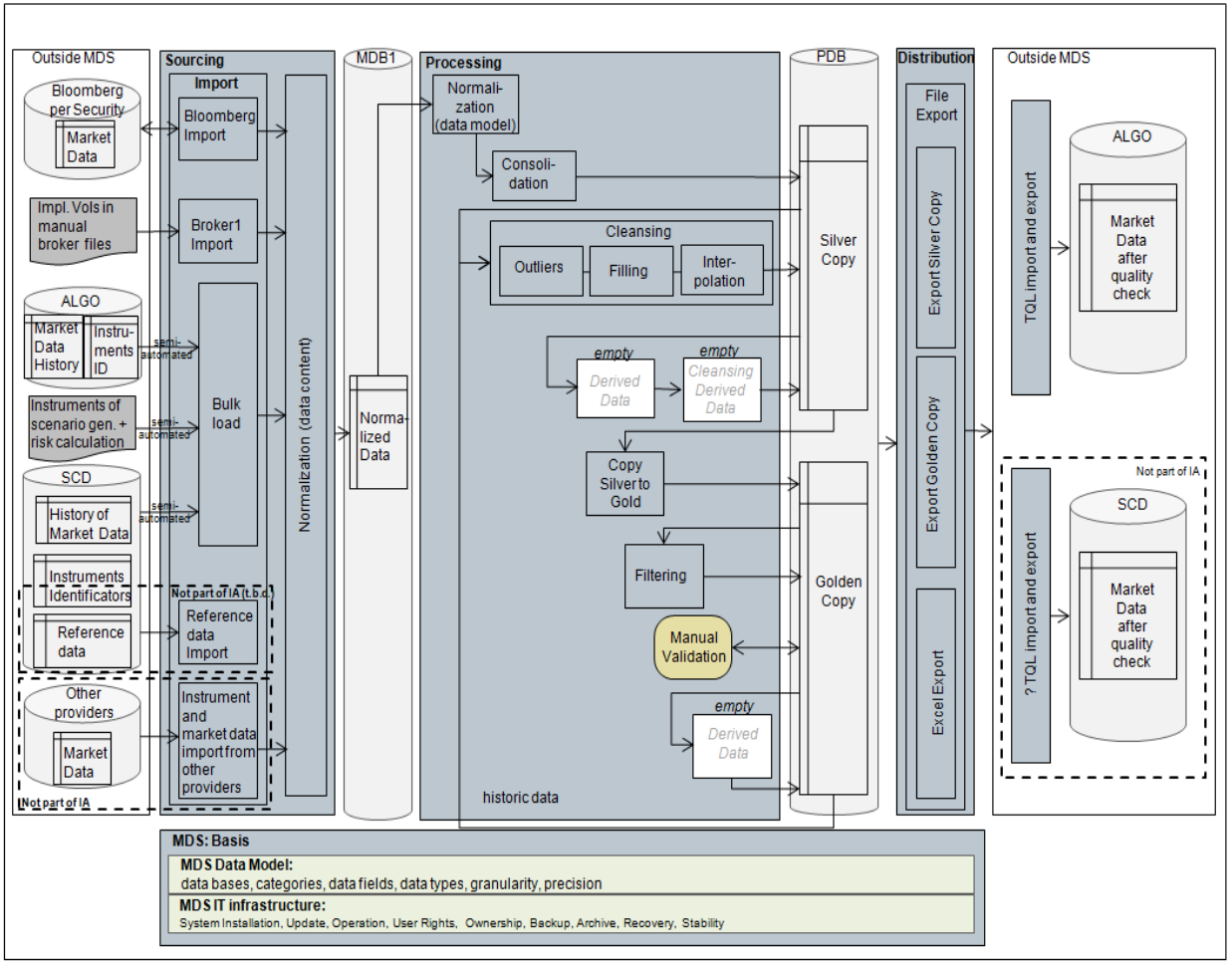
… and after employing Nadaraya-Watson estimator



Architecture of a market data system



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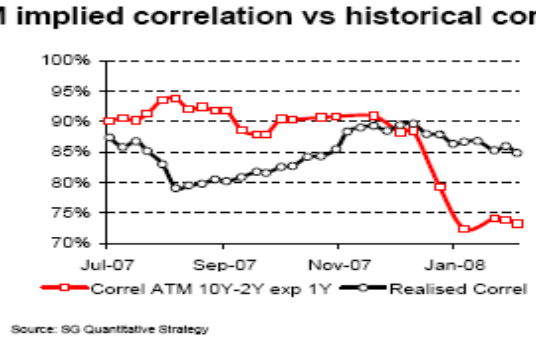
Example: CMS10-CMS2 Spread: Things to watch

(1) Convexity Adjustment:
When pricing a CMS cash flow , the swap rate has to be adjusted to compensate for the convexity mismatch between CMS and vanilla forward swap cash flows

(2) Spread Correlation:
To price the coupon floor, you have to price a series of European floors on CMS10-CMS2 spread. These options refer to two interest rates, thus the pricing depends on the correlation of those two CMS rates.



Examples of pricing parameters you need, but do not get (easily) from market data

- **Correlations between Interest Rates**
  - Important for i.e. Spread Notes, CMS Steepener
  - Important for correlation matrix within Libor Market Model
- **Correlations between FX rates and interest rates**
  - Necessary for quanto adjustment for OTCs with payout dependent on a interest rate of another currency

How to obtain parameters without available market data?

- Average historical data (correlations!)
- Calculate implicit parameters out of third party / counterparty pricing
- Look at differences of both and try to figure out, what is risk premia and what is margin

What is difficult pricing Equity Options (Cliquets, Baskets, etc.)?

- A cliquet option is a series of forward starting options, with a common participation rate:

  $$P = Nominal \times MAX(Floor; \sum MAX(R_i; 0)) \times Participation\ Rate$$

- Pricing needs the difficult to obtain Forward Volatility Smile (= variation of the volatility with strike price and contract maturity). Try average implicit vols for a guess.

- If the underlying is a basket of different equities/indices, you need their (instable!) correlations.

Relevance of CVA/DVA for Buy-Side Valuation

- For stand-alone OTCs :
  Mostly collateralized => CVA not necessary (overnight risk ignored)

- Embedded Derivatives: CVA can be necessary for Trade Control etc. because usually no collateralization in place

- CVA difficult to fully implement in buy-side systems => rule of thumb!

Rule of Thumb for single embedded OTC (no portfolio CVA!)

- Simple approximation:

$$CVA = E_A s_A - E_B s_B$$

  - E_A = PV expected exposure faced by counterparty B with respect to Bank A
  - s_A = the market loss rate of A (product of risk-neutral PD and risk neutral LGD)
  - E_B = PV expected exposure faced by A with respect to B
  - s_B = the market loss rate of B

- CVA as a spread: a trader wants a back-of-the envelope approximation of a swap's CVA (example from Gregory 2009)
  - EPE is 5%
  - CP's credit spread is 3%
  - CVA ≈ (0.03)(0.05) = 15 bps

The trader adds/subtracts 15bps from the leg of the swap as the credit charge/CVA

Pricing of Structured Credit: what went wrong?

- Impact of Cashflow Waterfall (especially squared/cubed structures).
- Main reason: **Models were not linked to underlying fundamentals** (US Houseprices due to non-recourse loans!) which was the dominant risk factor . It produced never assumed default rates and correlations.
- Thus even market participants who had the right guess on the housing market, didn t realize their effective market risk exposure to it.

Contact

Florian Stärk
Head of Risk Controlling
Tel.: +49 89 2489-2133
Fax: +49 89 2489-11 2133
Email: FStaerk@meag.com

MEAG

Oskar-von-Miller-Ring 18
80333 München
www.meag.com