Prudent Valuation

Bridging the gap between pricing and risk management

Cass Business School
London, 4 November 2015

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Summary

1. Introduction
2. Regulation
3. AVA calculation
4. Conclusions
5. References
1: Introduction
Overview

Traditionally, quantitative finance practitioners are divided into two populations: those who seek fair values, i.e. means of price distributions, and those who seek risk measures, i.e. quantiles of price distributions. Fair value people and risk people typically live in separate lands, and worship different gods: the profit and loss balance sheet, and regulatory capital, respectively.

Prudent Valuation is a rather unexplored midland which has recently emerged somewhere in between the well known mainlands of Pricing and Risk Management. In fact, the Capital Requirements Regulation (CRR), requires financial institutions to apply prudent valuation to all fair value positions. The difference between the prudent value and the fair value, called Additional Valuation Adjustment (AVA), is directly deducted from the Core Equity Tier 1 (CET1) capital. On March 31st 2014, the European Banking Authority (EBA) published a draft Regulatory Technical Standards (RTS) for prudent valuation, to be approved by the EU Commission.

The 90% confidence level required by regulators for prudent valuation links quantiles of price distributions (exit prices) to capital, thus bridging the gap between the Pricing and Risk Management mainlands, and forcing the crossbreeding of the fair value and risk populations above.

In this seminar, we will explore the Prudent Valuation land.
1: Introduction
Overview

Q-Land
Q-measure
Pricing: extrapolate the present
Fair value
Profit and loss

P-Land
P-measure
Risk: model the future
Risk measures
Capital

Prudent Land
Prudent measure
Price distribution
90% exit price
Capital

1: Introduction
Prudent valuation history [1]

- **August 2008**: FSA “Dear CEO letter”
- **April 2012**: FSA “Regulatory Prudent Valuation Return”, Policy Statement
- **November 2010**: FSA “Product Control Findings and Prudent Valuation Presentation”
1: Introduction

Prudent valuation history [2]

2012

13 November 2012
EBA Discussion Paper (EBA/DP/2012/03)

2013

10 July 2013
EBA Consultation Paper (EBA/CP/2013/28)

2014

31 March 2014
EBA Final Draft RTS and first application of prudent valuation

1 January 2014
CRR 575/2013

Q3 or Q4 2015
Expected final approval of EBA RTS by the European Commission

2015

8 November 2013
EBA Quantitative Impact Study

23 June 2015
EBA Final Draft RTS amended

Prudent valuation in place

Dashed = unofficial
Article 34

Additional value adjustments

Institutions shall apply the requirements of Article 105 to all their assets measured at fair value when calculating the amount of their own funds and shall deduct from Common Equity Tier 1 capital the amount of any additional value adjustments necessary.
2: Regulation
CRR 575/2013 [2]

CRR Prudent Valuation Tree

- **Art. 34**
  - Prudent valuation scope
  - Prudent valuation principles
    - Systems and controls
    - Valuation
      - Valuation adjustments
       - Illiquid positions, art. 105.11
       - Other valuation adj., art. 105.12
       - Complex products, art. 105.13
  - Degree of certainty, art. 105.1
    - S&C requirements, art. 105.2
    - Revaluation frequency art. 105.3
      - Mark to market, art. 105.4-5
      - Mark to model, art. 105.6-7
      - IPV, art. 105.8
    - Valuation adjustments, art. 105.9-10

CRR 575/2013

Art. 105
2: Regulation
EBA RTS: overview

EBA RTS Prudent Valuation Tree

General provisions Sec. 1
- Methodology for AVA, art. 1
- Definitions, art. 2
- Sources of market data, art. 3

Simplified approach Sec. 2
- Conditions of application, art. 4
- AVA calculation, art. 5
- AVA aggregation, art. 6

Core approach Sec. 3
- Overview, fall back, art. 7
- General provisions, art. 8
- AVA calculation, art. 9-17

Documentation systems & controls Sec. 4
- Documentation, art. 18
- Systems & controls, art. 19
- Entry into force, art. 20

AVA MPU, art. 9
AVA CoCo, art. 10
AVA MoRi, art. 11
AVA CVA, art. 12
AVA FVA, art. 13
AVA CoPo, art. 14
AVA FAC, art. 15
AVA EaT, art. 16
AVA OpR, art. 17
2: Regulation

EBA RTS: prudent valuation scope

General criteria for exclusion

Positions subject to prudential filters (AFS)

Positions for which a change in their accounting fair value has only a partial or zero impact on CET 1 (art. 4.2 and 8.1)

EBA RTS Prudent Valuation scope: exclusions

Positions excluded

% of exclusion

EU Gov. bonds
100%

Other bonds
Partial

Equity
Partial

Simplified appr.
100%

Core appr.

Positions excluded:

Partial, residual exposure to CVA, FVA, CoPo, FAC, EaT, OpR AVAs

Partial, residual exposure of hedged + hedging items

M. Bianchetti - Prudent Valuation – Cass Business School– London, 4 Nov. 2015
2: Regulation
Global view of key regulatory concepts

- Fair value
  - Mark to market
  - Mark to model
  - IPV

- Prudent value
  - Scope and exclusions
  - 90% confidence level
  - Simplified approach
  - Core approach
    - 0.1% Formula
    - 9 AVAs
      - Expert based
      - Diversification
      - Fall back

- Systems and controls

CRR art. 34, 105
EBA RTS
What about real price distributions...?

Price distribution, fair value, fair value adjustment, prudent value, AVA
2: Regulation
Fair Value Vs Prudent Value [2]

**Fair Value**
- Regulation: IFRS13
- Application: balance sheet
- Percentile: 50% (expected value)
- The price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date
- Must include all the factors that a market participants would use, acting in their economic best interest.
- Atoms: single trades.
- Fair value adjustments
- Non-entity specific

**Prudent value**
- Regulation: CRR/EBA
- Application: CET1
- Percentile: 90%
- Must reflect the exit price at which the institution can trade within the capital calculation time horizon.
- Atoms: valuation positions subject to a specific source of price uncertainty
- Entity specific
- Subject to diversification benefit (50% weight for MPU, CoCo, MoRi AVAs)
The EBA conducted a QIS to estimate the total impact of the requirements of the RTS including 59 banks across 15 jurisdictions, with the following results.

<table>
<thead>
<tr>
<th>Number of Institutions</th>
<th>All amounts in €m</th>
<th>AVA €m</th>
<th>% of CET1</th>
<th>% of Fair Value Balance Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>16</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>France</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>Sweden</td>
<td>5</td>
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<td>Austria</td>
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<td>Belgium</td>
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<td>Germany</td>
<td>2</td>
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<tr>
<td>Spain</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Greece</td>
<td>4</td>
<td></td>
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<td>Croatia</td>
<td>3</td>
<td></td>
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<tr>
<td>Italy</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Norway</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lithuania</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>59</strong></td>
<td><strong>13,431</strong></td>
<td><strong>1.46%</strong></td>
<td><strong>0.07%</strong></td>
</tr>
</tbody>
</table>

- Small banks: < 15 €/bln
- Medium banks: 15 - 100 €/bln
- Large banks: > 100 €/bln

Average 227 €/mln per bank
Summary

1. Introduction
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3: AVA calculation
AVA overview

The AVA hierarchy

Core approach
Additional Valuation Adjustments

Main AVAs
- Market Price Uncertainty (MPU) Art. 9
- Close Out Costs (CoCo) Art. 10
- Model Risk (MoRi) Art. 11

CVA/FVA AVAs
- Unearned Credit Spread (CVA) Art. 12
- Investing & Funding Cost (FVA) Art. 13

Other AVAs
- Concentrated Positions (CoPo) Art. 14
- Future Admin Costs (FAC) Art. 15
- Early Termination (EaT) Art. 16
- Operational Risk (OpR) Art. 17

Market risk factors
- 50% weights for diversification
- Split onto main AVAs

Non-market risk factors
- 100% weights, no diversification
# 3: AVA calculation

## Definitions and basic assumptions

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fair value</strong></td>
<td>$FV(t) = \sum_{i=1}^{N_p} FV_i(t)$</td>
<td>$i = \text{index for valuation positions}$</td>
</tr>
</tbody>
</table>
| **Prudent Value** | $PV_{ijk}(t) \leq FV_i(t)$ \quad \forall \ i = 1, ..., N_p, j = 1, ..., N_u, k = 1, ..., N_{AVA}$ | $\circ \ j = \text{index for risk factors}$  
$\circ \ k = \text{index for AVAs}$ |
| **Additional Valuation Adjustment (simplified)** | $AVA(t) = 0.1\% \left[ \sum_{i=1}^{N_{Assets}} FV_i(t) + \sum_{i=1}^{N_{Liabilities}} FV_i(t) \right]$ | $AVA(t)$ is the total valuation adjustment at time $t$ |
| **Additional Valuation Adjustment (core)** | $APVA_{ijk}(t) := w_k \left[ FV_i(t) - PV_{ijk}(t) \right]$  
$AVA_k(t) := \sum_{i=1}^{N_p} \sum_{j=1}^{N_u} APVA_{ijk}(t)$ | $\circ \ APVA_{ijk}(t)$ is the $k$-th AVA associated to source of valuation uncertainty $j$ and valuation position $i$ at time $t$,  
$\circ \ AVA_k(t)$ is the total $k$-th AVA at $t$ |
| **Prudent Valuation Adjustment** | $PVA(t) := \begin{cases} AVA(t) & \text{Simplified} \\ \sum_{k=1}^{N_{AVA}} AVA_k(t) & \text{Core} \end{cases}$ | $PVA(t)$ is the total valuation adjustment at time $t$ |
3: AVA calculation
AVA Market Price Uncertainty (MPU)

Case study of AVA MPU calculation for a security.

- Top left: market bid and ask prices. FV is computed as average mid price = 162.25.
- Bottom left: ranking and percentiles of mid prices, AVA MPU for long and short positions, equal to 0.14 and 0.12, respectively.
- Top right: distribution chart.

### Bond price distribution

<table>
<thead>
<tr>
<th>Point</th>
<th>Source</th>
<th>Bid</th>
<th>Ask</th>
<th>Mid</th>
<th>Bid-Ask</th>
<th>Mid-Bid</th>
<th>Ask-Mid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contr.</td>
<td>161.61</td>
<td>162.34</td>
<td>161.97</td>
<td>0.73</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>2</td>
<td>Contr.</td>
<td>162.16</td>
<td>163.08</td>
<td>162.62</td>
<td>0.92</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td>3</td>
<td>Contr.</td>
<td>161.84</td>
<td>162.60</td>
<td>162.22</td>
<td>0.75</td>
<td>0.38</td>
<td>0.38</td>
</tr>
<tr>
<td>4</td>
<td>Contr.</td>
<td>161.56</td>
<td>163.05</td>
<td>162.36</td>
<td>1.39</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>5</td>
<td>Contr.</td>
<td>161.74</td>
<td>162.98</td>
<td>162.36</td>
<td>1.24</td>
<td>0.62</td>
<td>0.62</td>
</tr>
<tr>
<td>6</td>
<td>Contr.</td>
<td>162.02</td>
<td>162.48</td>
<td>162.25</td>
<td>0.46</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>7</td>
<td>Contr.</td>
<td>160.31</td>
<td>162.48</td>
<td>161.69</td>
<td>1.57</td>
<td>0.79</td>
<td>0.79</td>
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<tr>
<td>8</td>
<td>Contr.</td>
<td>160.86</td>
<td>163.85</td>
<td>162.35</td>
<td>2.98</td>
<td>1.49</td>
<td>1.49</td>
</tr>
<tr>
<td>9</td>
<td>Contr.</td>
<td>162.18</td>
<td>162.79</td>
<td>162.49</td>
<td>0.60</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>10</td>
<td>Contr.</td>
<td>161.68</td>
<td>163.00</td>
<td>162.34</td>
<td>1.32</td>
<td>0.66</td>
<td>0.66</td>
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<tr>
<td>11</td>
<td>Contr.</td>
<td>160.73</td>
<td>163.59</td>
<td>162.16</td>
<td>2.85</td>
<td>1.43</td>
<td>1.43</td>
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<tr>
<td>12</td>
<td>Contr.</td>
<td>161.85</td>
<td>162.60</td>
<td>162.23</td>
<td>0.75</td>
<td>0.38</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Average: 161.60 162.90 162.25 1.30 0.65 0.65

Valuation date: 30 Jun. 2014, ISIN: xxx

### Market price uncertainty

<table>
<thead>
<tr>
<th>Point</th>
<th>Mid</th>
<th>Rank</th>
<th>Percent</th>
<th>Bin</th>
<th>Freq.</th>
<th>Cumul. %</th>
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<tbody>
<tr>
<td>2</td>
<td>162.52</td>
<td>1</td>
<td>100.00%</td>
<td>161.69</td>
<td>1</td>
<td>8.33%</td>
</tr>
<tr>
<td>9</td>
<td>162.49</td>
<td>2</td>
<td>90.90%</td>
<td>161.85</td>
<td>0</td>
<td>8.33%</td>
</tr>
<tr>
<td>5</td>
<td>162.36</td>
<td>3</td>
<td>81.80%</td>
<td>162.00</td>
<td>1</td>
<td>16.67%</td>
</tr>
<tr>
<td>4</td>
<td>162.36</td>
<td>4</td>
<td>72.70%</td>
<td>162.16</td>
<td>0</td>
<td>16.67%</td>
</tr>
<tr>
<td>8</td>
<td>162.35</td>
<td>5</td>
<td>63.60%</td>
<td>162.31</td>
<td>4</td>
<td>50.00%</td>
</tr>
<tr>
<td>10</td>
<td>162.34</td>
<td>6</td>
<td>54.50%</td>
<td>162.47</td>
<td>4</td>
<td>83.33%</td>
</tr>
<tr>
<td>6</td>
<td>162.25</td>
<td>7</td>
<td>45.40%</td>
<td>162.62</td>
<td>2</td>
<td>100.00%</td>
</tr>
<tr>
<td>12</td>
<td>162.23</td>
<td>8</td>
<td>36.30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>162.22</td>
<td>9</td>
<td>27.20%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11</td>
<td>162.16</td>
<td>10</td>
<td>18.10%</td>
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</tr>
<tr>
<td>1</td>
<td>161.97</td>
<td>11</td>
<td>9.00%</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>161.69</td>
<td>12</td>
<td>0.00%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Long: PV 161.97  AVA 0.14
Short: PV -162.49  AVA 0.12
AVA definition
AVA Model Risk (MoRi) refers to the valuation uncertainty of a valuation exposure arising from uncertainty in models and model calibrations used by market participants. In particular, AVA MoRi does not refer to the uncertainty in market risk capital arising from model risk (see FAQ 23.1).

AVA main references
- EBA RTS, article 11.
- EBA FAQs 10, 23.1, 28.

AVA scope of application
Within the general prudent valuation scope (see before), AVA MoRi refers in particular to those valuation positions for which the Institution estimates that there is a lack of firm exit price due to model and/or model calibration choices. Of course, instruments which can be replicated by exact static combination of mark-to-market instruments should not contribute to AVA MoRi.
Alternative models and calibrations
AVA MoRi is not based on any possible alternative model or model calibration, but on those specific alternative models or model calibrations that may reasonably used by market participants to price the same or similar valuation exposures.

Examples
- alternative but reasonable models,
  - calibrated to the same calibration basket
  - Referred to the same group of financial instruments
- Same model, alternative calibration approaches, e.g.
  - different calibration baskets
  - different calibration weights (e.g. flat, or vega weighted)
  - different objective functions
  - different optimization algorithm (e.g. global vs local)
  - Etc.
- Same model, same calibration, alternative numerical approaches, e.g.
  - analitical approximations
  - semi-analitical approximations
  - numerical PDE solution
  - Monte Carlo simulation
  - etc.

Inspiration: «There’s plenty of room at the bottom»
Richard Feynman, 1959
www.its.caltech.edu/~feynman/plenty.html
## Historical sources of model risk

<table>
<thead>
<tr>
<th>Period</th>
<th>Main driver</th>
<th>Main risk factor</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>Black Monday</td>
<td>Volatility</td>
<td>Volatility smile</td>
</tr>
<tr>
<td>2004</td>
<td>CMS market</td>
<td>Volatility</td>
<td>Swaption volatility smile and CMS convexity adjustment</td>
</tr>
<tr>
<td>2004</td>
<td>IAS39</td>
<td>Credit</td>
<td>Credit Risk Adjustment (CRA)</td>
</tr>
<tr>
<td>2007</td>
<td>Credit crunch</td>
<td>Credit, liquidity</td>
<td>Subprime writedown</td>
</tr>
<tr>
<td>2007</td>
<td>Credit crunch</td>
<td>Interest rate basis</td>
<td>Multiple yield curves</td>
</tr>
<tr>
<td>2009-2010</td>
<td>Credit crunch</td>
<td>Interest rate basis</td>
<td>CSA discounting</td>
</tr>
<tr>
<td>2009-2010</td>
<td>Credit crunch</td>
<td>Bilateral credit</td>
<td>CVA &amp; DVA (IFRS13, 2013)</td>
</tr>
<tr>
<td>2013-2015</td>
<td>Credit crunch</td>
<td>Funding</td>
<td>Funding Valuation Adjustment (FVA)</td>
</tr>
<tr>
<td>2013-2014</td>
<td>Credit crunch</td>
<td>Interest rate</td>
<td>Negative interest rates and inflation, negative Floor strikes, Bond floater coupons floored, end of Black’s model.</td>
</tr>
<tr>
<td>2014-</td>
<td>Credit crunch</td>
<td>Capital charges</td>
<td>Capital Valuation Adjustment (KVA)</td>
</tr>
<tr>
<td>2017</td>
<td>Credit crunch</td>
<td>Funding</td>
<td>Bilateral initial margins</td>
</tr>
</tbody>
</table>
3: AVA calculation
AVA MoRi: model risk scenarios vs traditional scenarios

- Market Risk Scenarios vs Model Risk Scenarios
  - Risk measures are typically linked to scenarios
  - Scenarios are related to the risk factors relevant for a particular risk typology

<table>
<thead>
<tr>
<th>Risk class</th>
<th>Scenarios</th>
<th>Risk measures</th>
</tr>
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<tbody>
<tr>
<td>Market risk</td>
<td>Present market data</td>
<td>VaR, Expected shortfall, etc.</td>
</tr>
<tr>
<td>Counterparty risk</td>
<td>Future market data</td>
<td>EPE, Effective EPE, etc.</td>
</tr>
<tr>
<td>Operational risk</td>
<td>Operational loss event frequency and severity</td>
<td>VaR 99.9%</td>
</tr>
<tr>
<td>Model risk</td>
<td>Model scenarios</td>
<td>K-th percentile of distribution of model prices (10(^\circ) percentile for Prudent Valuation)</td>
</tr>
</tbody>
</table>
3: AVA calculation

AVA MoRi: model risk scenarios for interest rate derivatives

<table>
<thead>
<tr>
<th>Product class</th>
<th>OIS/Libor curve construction</th>
<th>CCS basis curve construction</th>
<th>Libor volatility construction</th>
<th>Libor correlation construction</th>
<th>Libor path dependency</th>
<th>Swap rate volatility construction</th>
<th>Swap rate convexity adjustment</th>
<th>Swap rate correlation construction</th>
<th>Callability</th>
<th>Joint distributions</th>
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<tbody>
<tr>
<td>Futures</td>
<td>X</td>
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<tr>
<td>Forward Rate Agreement (FRA)</td>
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<td>Interest Rate Swap (IRS)</td>
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<td>Basis Swap (BIRS)</td>
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<td>European Cap/Floor</td>
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<td>Path dependent (e.g. Sticky/ratchet)</td>
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<td>European CMS Cap/Floor</td>
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<td>European CMS Spread Option</td>
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<td>Callable (e.g. Bermudan Swaption)</td>
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</table>

Model scenarios: base scenarios (Fair Value Policy)
- Market Futures/FRA/BIRS, bootstrapping, linear interp. on zero rates
- Market Cap/Floor tenor, Libor SABR, Kienitz, Levenberg-Marquardt
- Rebonato functional form, 2 parameters, swap rate calibration via LMM
- LMM
- Market Swaption tenor x, swap rate SABR, Kienitz, Levenberg-Marquardt
- Hagan replication, SABR, adaptive numerical integration
- Market Spread Options, implied bi-lognormal correlations, comparable approach
- Hull-White Two Factor, autocalibrated
- Bi-lognormal model, adaptive num. integration

Model scenarios: alternative calibrations
- Alternative market data
- Alternative market data
- Alternative correlation calibration
- Alternative interpolation
- Alternative correlation calibration
- Alternative interpolation

Model scenarios: alternative numerical methods
- Alternative solver
- Alternative solver
- Alternative numerical integration

Model scenarios: alternative models
- Alternative SABR model
- Alternative SABR model
- Bi-normal model
- Alternative short rate model
- Bi-normal model

M. Bianchetti - Prudent Valuation – Cass Business School– London, 4 Nov. 2015
3: AVA calculation
AVA Model Risk (MoRi): case study 1 [1]

Case study 1: model risk in interest rate yield curve construction

- Interest rate yield curves are used everywhere for discounting and for interest rate derivatives and securities with floating rate coupons. So, this is an important case study.

- Yield curve construction is based on recursive application of pricing formulas applied to interest rate market instruments. So, there is a lot of modelling inside.

- In particular, the interpolation algorithm is very important, both pre and post bootstrapping:
  - Simple but non-smooth linear interpolation algorithms are very simple and robust, but produces irregular forward curves
  - Standard spline interpolation is less simple but produces oscillating yield curves
  - Monotonic cubic spline interpolation is regular.
3: AVA calculation
AVA Model Risk (MoRi): case study 1 [2]

Linear interpolation on zero interest rates

Monotonic cubic spline interpolation on zero interest rates
3: AVA calculation

AVA Model Risk (MoRi): case study 1 [3]

- Differences in bps between three different interpolation algorithms (linear, natural cubic spline and monotonic cubic spline) for a portfolio of 3 standard IRS on Euribor 1M, 6M, 12M + 3 standard Basis Swaps.
3: AVA calculation
AVA Model Risk (MoRi): case study 2 [1]

Case study 2: model risk experiment with Numerix

- **Sensitivity of prices to models**
  - Various dimensions of modelling decisions
  - Example of Bermudan swaption pricing with HW1F, HW2F, CIR, and BK models
  - Impact of calibration choices
  - AVA MoRi for a Bermudan swaption
  - Model implied European swaption smile

- **Impact of changing market environment on model performance**
  - Handling of negative rates
  - Example of floor pricing with very low strikes by using various models

### 3: AVA calculation

**AVA Model Risk (MoRi): case study 2 [2]**

Case study 2: model risk experiment with Numerix (cont’d)

- Global modelling approach

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>FX spot</th>
<th>Yield Curve</th>
<th>Basis spread</th>
<th>Correlation</th>
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<tbody>
<tr>
<td>Model underlying</td>
<td>Short-rate</td>
<td>Swap rate</td>
<td>Forward curve</td>
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<td>Distribution type</td>
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<td>HW1F</td>
<td>HW2F</td>
<td>BK</td>
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<tr>
<td>Calibration instruments</td>
<td>Caplets</td>
<td>Swaptions</td>
<td>CMS</td>
<td>...</td>
<td>...</td>
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<tr>
<td>Instruments configuration</td>
<td>10Y diagonal</td>
<td>20Y diagonal</td>
<td>10Y column</td>
<td>10Y diag + 10Y column</td>
<td>...</td>
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</table>
### 3: AVA calculation

### AVA Model Risk (MoRi): case study 2 [3]

#### Case study 2: model risk experiment with Numerix (cont’d)

<table>
<thead>
<tr>
<th>Experiment #</th>
<th>Instruments</th>
<th>Models</th>
<th>Calibrations</th>
</tr>
</thead>
</table>
| Bermuda swaption | • Coterminial bermudan payer swaption  
• Euribor 6M  
• 10Y maturity  
• Annual callability  
• Sstrike ATM 10Y swap  
• OIS discounting | • Hull-White 1 Factor (HW1F)  
• Black-Karasinski (BK)  
• Cox-Ingersoll-Ross 1 Factor (CIR1F)  
• Hull-White 2 Factors (HW2F)  
• Cox-Ingersoll-Ross 2 Factors (CIR2F) | • Set 1: 10 Y diagonal swaption ATM  
• Set 2: 10Y diagonal and 1Y column swaption ATM  
• Set 3: 20Y diagonal and 1Y column swaption ATM |
| Caps/Floors with negative rates | • 5Y Floor  
• Euribor 6M  
• Negative and positive strikes  
• Yield curves with negative rates  
• Linear interpolation and flat extrapolation  
• SABR interpolation and flat extrapolation | • Black (analytic)  
• Hull-White 1 Factor (HW1F)  
• Shifted Black-Karasinski (SBK) | • Set 1: Cap volatility columns for strikes ATM and 1%  
• Set 2: full Cap volatility surface, with strikes from 1% to 10% |

three: AVA calculation
AVA Model Risk (MoRi): case study 2 [4]

Overview of results

- Prices range from 1.45% to 3.91%
- Normal models produce consistently higher PVs for all calibration sets compared to non-normal models
3: AVA calculation
AVA Model Risk (MoRi): case study 2 [5]

Results by calibration set

- Calibration set 1 (10Y diagonal) produces highest distribution of prices
- Average price is fairly stable across different calibration sets
- Same model stays consistently below or above the average price for all calibration sets
AVA calculation
AVA Model Risk (MoRi): case study 2 [6]

Results by model

HW1F and BK models exhibit lowest variations in prices with changing calibration set
Prices of 1F and 2F models of the same model type can differ significantly
3: AVA calculation
AVA Model Risk (MoRi): case study 2 [7]

Results

- Notional is 10m EUR
- Assuming Fair Value is the average of all price

- **Long swaption:**
  - Fair Value: $FV = 258k$ EUR
  - Prudent value is the 10% percentile of all prices: $PV = 177k$ EUR
  - $AVA\ MoRi = 0.5 \times (FV - PV) = 40.5k$ EUR

- **Short swaption:**
  - Fair Value: $FV = -258k$ EUR
  - Prudent value is the 90% percentile of all prices: $PV = -317k$ EUR
  - $AVA\ MoRi = 0.5 \times (FV - PV) = 29.5k$ EUR
### 3: AVA calculation

**AVA Model Risk (MoRi): case study 2 [8]**

#### Excluding models

<table>
<thead>
<tr>
<th></th>
<th>Long swaption</th>
<th>Short swaption</th>
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<tbody>
<tr>
<td></td>
<td>All models</td>
<td>All except HW2F</td>
</tr>
<tr>
<td><strong>Fair Value (1)</strong></td>
<td>258</td>
<td>258</td>
</tr>
<tr>
<td><strong>Prudent Value</strong></td>
<td>177</td>
<td>158</td>
</tr>
<tr>
<td><strong>Model Risk AVA</strong></td>
<td>40.5</td>
<td>50</td>
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</tbody>
</table>

Fair Value (1) is computed as the average of all model prices

<table>
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<tr>
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<th>Long swaption</th>
<th>Short swaption</th>
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<tbody>
<tr>
<td></td>
<td>All models</td>
<td>All except HW2F</td>
</tr>
<tr>
<td><strong>Fair Value (2)</strong></td>
<td>258</td>
<td>240</td>
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<td><strong>Prudent Value</strong></td>
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</tr>
<tr>
<td><strong>Model Risk AVA</strong></td>
<td>40.5</td>
<td>41</td>
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</tbody>
</table>

Fair Value (2) for “All except HW2F” is computed excluding the price of the HW2F model
3: AVA calculation
AVA Model Risk (MoRi): case study 2 [9]

Exercise probabilities

Exercise probability per coupon
- CIR-type models imply a higher probability of early exercise than HW models
- The term structure of exercise probabilities is regular for all models for calibration set 1, humped for calibration sets 2 and 3.
3: AVA calculation
AVA Investing and Funding Costs [1]

- **AVA definition**
  AVA Investing and Funding Costs (FVA) refers to the valuation uncertainty in the funding costs used when assessing the exit price of a valuation position, according to the applicable accounting framework. Such valuation uncertainty refers, in particular, to MPU, CoCo and MoRi uncertainties in the calculation of the funding cost. Hence, AVA FVA shall be split into such components, to be aggregated to their corresponding AVAs.

- **AVA scope of application**
  Within the general prudent valuation scope (see before), AVA FVA refers in particular to those valuation positions subject to a funding valuation adjustment and specifically, to OTC derivatives. Securities are excluded, since funding risk is already included in the security credit spread.
3: AVA calculation
AVA Investing and Funding Costs [2]

FVA losses as of end of 2014.

FVA for general instruments

Computing the funding valuation adjustment (FVA) is hard, as it requires the numerical solution of generally non-linear partial differential equations. In this paper, Alexander Antonov, Marco Bianchetti and Ion Mihai develop a universal and efficient approach to numerical FVA calculation for portfolios of general instruments with multiple stochastic assets and funding sources.

4: Conclusions

Let’s go prudent!
5: References

Regulations [1]


5: References

Regulations [2]


5: References

Regulations [3]

5: References

Papers


5: References

Others

1) Ernst & Young, “Prudent Valuation”, 24 May 2013.

2) Ernst & Young, “BIS III – Prudent Valuation – AVAs Overview and relations to IFRS13”, July 2013.


5: References

Events

- 16 May 2014: ABI conference, Roma, talk “Funding Valuation and Prudent Valuation Adjustments (PVA & FVA)”, M. Bianchetti, U. Cherubini
Disclaimer and acknowledgments

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- Members of the AIFIRM committee on market risk for the stimulating discussions on prudent valuation methodology and applications.
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