CoCo Bonds and their extension risk

Jan De Spiegeleer (Jabre Capital Partners – KU Leuven)
Wim Schoutens (KU Leuven)
Extension Risk
### Deutsche Bank

<table>
<thead>
<tr>
<th>Bond Type</th>
<th>Tier 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue Date</td>
<td>January 16, 2004</td>
</tr>
<tr>
<td>S&amp;P Rating</td>
<td>BBB+</td>
</tr>
<tr>
<td>Maturity</td>
<td>January 16, 2014</td>
</tr>
<tr>
<td>Initial Coupon (%)</td>
<td>3.875</td>
</tr>
<tr>
<td>Coupon Frequency</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Possible Coupon Deferral</td>
<td>No</td>
</tr>
<tr>
<td>Par Amount</td>
<td>1,000</td>
</tr>
<tr>
<td>ISIN</td>
<td>DE0003933511</td>
</tr>
<tr>
<td>First Call Date</td>
<td>January 16, 2009</td>
</tr>
<tr>
<td>Call Price</td>
<td>100%</td>
</tr>
<tr>
<td>Call Notice</td>
<td>30 Days</td>
</tr>
<tr>
<td>Step Up Coupon</td>
<td>3M EURIBOR + 88bps</td>
</tr>
</tbody>
</table>
The industry too often prices the bond up till the first call date.
<table>
<thead>
<tr>
<th>$t$</th>
<th>$t_i$ (year)</th>
<th>$C_i$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>7</td>
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<tr>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
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<td>8</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

100 bps Coupon Step-Up
Extension Risk : 10 Yr NC5

Aarhus Quant Factory   January 2014
Extension Risk: Credit Spread Volatility

HISTORICAL PRICE VOLATILITY
CBAB1E5 EUR CDS/BACR SEN. 5 Y
From 5/8/13 to 11/5/13 N= 10 day 30 50 100 Overlay Values ?N

Period 3

Overlay Values

260 Annualization factor

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2013 Bloomberg Finance L.P.
SN 532556 CET GMT+1:00 6904-4777-0 05-Nov-2013 22:57:09

Aarhus Quant Factory January 2014
Extension Risk : 10 Yr NC5

Rho

Price to Maturity
- Price to Call

Yield (%) 
- 750
- 700
- 650
- 600
- 550
- 500
- 450
- 400

Aarhus Quant Factory   January 2014
### Extension Risk: 10 Yr NC5

<table>
<thead>
<tr>
<th>Yield (%)</th>
<th>Price to Maturity (Step Up = 100bps)</th>
<th>Price to Maturity (Step Up = 200bps)</th>
<th>Price to Maturity (No Step Up)</th>
<th>Price to Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The graph illustrates the relationship between yield (%) and price at maturity for different scenarios, including Step Up adjustments.
Contingent Convertibles
A CoCo bond is a **loss-absorbing** bond issued by a financial institution (bank or insurance company) that suffers either a conversion into equity or a write-down of its face value on the appearance of a trigger event. The loss absorbing mechanism is specified in the terms and conditions of the bond.

- Lack of standardization
- $50 bn issued in Europe
- European banks mainly
- Outspoken difference with bail-in capital
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
- Host Instrument
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
- Host Instrument
- Conversion in Shares
- Write Down
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
- Host Instrument

**Conversion in Shares**

\[
\text{Loss}_{\text{CoCo}} = N - C_r \times S^* \\
= N(1 - \frac{S^*}{C_p}) \\
= N(1 - \Pi_{\text{CoCo}})
\]
CoCos : Anatomy

- Loss Absorption Mechanism
- Trigger Event
- Host Instrument

Conversion Price Mechanisms

- **Fixed Conversion Price** \( C_p = \alpha S_0 \)
  Example: Lloyds 2009 (\( \alpha = 1 \)), Barclays 2013 (\( \alpha = 2/3 \))

- **Floating Conversion Price** \( C_p = S^* \)
  Example: /
  Regulators oppose this idea

- **Floored Conversion Price** \( C_p = \max(S^*, SF) \)
  SF=Floored Conversion Price
  Example: Credit Suisse 2011 CoCos

**Conversion in Shares**

\[
\text{Loss}_{CoCo} = N - C_r \times S^*
\]

\[
= N \left(1 - \frac{S^*}{C_p}\right)
\]

\[
= N \left(1 - \Pi_{CoCo}\right)
\]
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
- Host Instrument

**Write Down Example**

- **Full Write Down**
  Example: KBC, Barclays

- **Partial Write Down**
  Example: Rabobank (75% haircut)

- **Staggered Write Down**
  Example: ZKB

**Conversion in Shares**

\[
\text{Loss}_{CoCo} = N - C_r \times S^*
\]

\[
= N \left(1 - \frac{S^*}{C_P}\right)
\]

\[
= N \left(1 - \Pi_{CoCo}\right)
\]

**Write Down**

- Full Write Down: \( \Pi_{CoCo} = 0 \)
- Partial Write Down: \( \Pi_{CoCo} > 0 \)
- Staggered Write Down:
  \( \Pi_{CoCo} = f(\text{circumstances}) \)
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
  - Accounting
  - Non-Viability / Regulatory
- Host Instrument
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
  - Accounting
  - Non-Viability / Regulatory
- Host Instrument

<table>
<thead>
<tr>
<th></th>
<th>CET1 Trigger Level (%)</th>
<th>Fully Loaded CET1 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barclays</td>
<td>7.0</td>
<td>8.2</td>
</tr>
<tr>
<td>Credit Suisse</td>
<td>7.0</td>
<td>8.1</td>
</tr>
<tr>
<td>KBC</td>
<td>7.0</td>
<td>10.8</td>
</tr>
<tr>
<td>Lloyds</td>
<td>5.0</td>
<td>7.7</td>
</tr>
<tr>
<td>UBS</td>
<td>5.0</td>
<td>9.8</td>
</tr>
</tbody>
</table>

March 2013
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
  - Accounting
  - Non-Viability / Regulatory
- Host Instrument

The accounting trigger can be hit if

- Bank makes a loss which “eats” into the equity
- Regulator reviews the risk weighting of the assets

Example:

- In June 2013, Denmark’s FSA requested a review of Danske’s IRB models, which results in a net increase of DKK100 billion (US$18 billion) or ~12.5% of group RWAs.
- In October 2013, the Ministry of Finance in Norway increased the LGD (loss given default) floors for residential mortgages. This has increased the riskweights.
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
  - Accounting
  - Non-Viability / Regulatory
- Host Instrument

- The decision by the relevant authority to use public funds and inject these in the bank without which this bank would become non-viable.
- The decision by the same relevant authority that the bank is no longer viable without a write-off on its debt.
CoCos: Anatomy

- Loss Absorption Mechanism
- Trigger Event
- Host Instrument
  - Corporate Bond
    - Callable
    - Perpetual with Call
    - Fixed Maturity
    - Coupon Deferral
  - Convertible Bond
## Barclays: One Bank, Three Different CoCos

<table>
<thead>
<tr>
<th>ISIN</th>
<th>US06740L8C27</th>
<th>US06739FHK03</th>
<th>US06738EAA38</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coupon</strong></td>
<td>7.625</td>
<td>7.75</td>
<td>8.25</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>Semi-Annual</td>
<td>Semi-Annual</td>
<td>Quarterly</td>
</tr>
<tr>
<td><strong>Coupon</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Cancellation</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td>11/21/2022</td>
<td>4/10/2023</td>
<td>Perpetual</td>
</tr>
<tr>
<td><strong>Face Value</strong></td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Currency</strong></td>
<td>USD</td>
<td>USD</td>
<td>USD</td>
</tr>
<tr>
<td><strong>Issue Date</strong></td>
<td>11/21/2012</td>
<td>4/10/2013</td>
<td>11/20/2013</td>
</tr>
<tr>
<td><strong>Issue Size (bn)</strong></td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Regulatory</strong></td>
<td>TIER 2</td>
<td>TIER 2</td>
<td>TIER 1</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Callable</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Step Up</strong></td>
<td>683</td>
<td>671</td>
<td></td>
</tr>
<tr>
<td><strong>Next Call Date</strong></td>
<td>4/10/2018</td>
<td>12/15/2018</td>
<td></td>
</tr>
<tr>
<td><strong>Call Frequency</strong></td>
<td>Onetime</td>
<td>Every 5 Years</td>
<td></td>
</tr>
<tr>
<td><strong>CET Trigger</strong></td>
<td>7.00%</td>
<td>7.00%</td>
<td>5.00%</td>
</tr>
<tr>
<td><strong>Loss Absorption</strong></td>
<td>Full Write Down</td>
<td>Full Write Down</td>
<td>Equity Conversion</td>
</tr>
<tr>
<td><strong>Conversion Price</strong></td>
<td></td>
<td>2.64 USD</td>
<td></td>
</tr>
</tbody>
</table>

*Extension Risk*
Example: Barclays AT1 CoCo (issue date: December 2013)

- UK/Ireland: 53%
- US: 14%
- Asia: 12%
- France/Benelux: 9%
- Switzerland: 6%
- Southern Europe: 6%
Example: Barclays AT1 CoCo (issue date: December 2013)

CoCos: Investment Base (Investor Type)

- Fund Managers: 61%
- Hedge Funds: 21%
- Private Banks: 9%
- Insurance/Pension Funds: 5%
- Other: 2%
- Banks: 2%
Regulatory Framework

CoCos

- Tier 2: 8%
- Additional Tier 1: 4.5%
- Common Equity Tier 1: 6%
Regulatory Framework

**ADDITIONAL TIER 1**
- No maturity date
- No incentives to redeem earlier
- Can be callable after a minimum of 5 years
- Full discretion over coupon cancellability
- Dividend stoppers are allowed
- At least a non-viability trigger

**TIER 2**
- Subordinated to senior debt
- Senior to common equity and additional Tier 1 (AT1)
Regulatory Framework

Issuance of Contingent Capital in Europe

- Additional Tier 1
- Tier 2

Issue Size ($ bn)

Extension Risk
CoCos: Several Layers of Risk

- Loss Absorption
- Extension
- Coupon Cancellation
- Interest Rate Risk
Valuation of CoCo bonds
Market Implied Valuation: Two Approaches

Market Implied Models

Credit Derivatives Method

Equity Derivatives Method
Market Implied Valuation: Two Approaches

Market Implied Models

Credit Derivatives Method

Equity Derivatives Method
Models can be downloaded: www.allonhybrids.com

### Credit Model (Rule of Thumb)

<table>
<thead>
<tr>
<th></th>
<th>Share Price</th>
<th>Volatility</th>
<th>Interest Rate</th>
<th>Dividend Yield</th>
<th>Conversion Price</th>
<th>Trigger Price</th>
<th>Delta (Shares)</th>
<th>Delta Cash (M EUR)</th>
<th>Maturity Yrs</th>
<th>Gamma ½ (Shares)</th>
<th>Face Value</th>
<th>Issue Size (M EUR)</th>
<th>Coupon</th>
</tr>
</thead>
<tbody>
<tr>
<td>JP MORGAN</td>
<td>100</td>
<td>50.00%</td>
<td>2.72%</td>
<td>5.00%</td>
<td>100</td>
<td>20.00</td>
<td>100</td>
<td>10,678,510</td>
<td>127,113</td>
<td>-0.00501</td>
<td>100</td>
<td>-2538</td>
<td>11.13%</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>45.00%</td>
<td>3.36%</td>
<td>3.74%</td>
<td>100</td>
<td>20.00</td>
<td>100</td>
<td>4,368,730</td>
<td>437</td>
<td>-0.00178</td>
<td>100</td>
<td>100</td>
<td>9.00%</td>
</tr>
</tbody>
</table>

Legend:
- **Delta**: change in the CoCo Price for a 1 USD change in the price of the share
- **Gamma**: change in the Delta CoCo for a one unit (1 USD) change in the price of the share
- **Delta (Shares)**: delta of the total issue, expressed in number of shares
- **Delta Cash**: delta of the total issue expressed in USD
- **Gamma ½ (Shares)**: change in the delta (shares) when the underlying share price moves with 1 %

### Equity Derivatives Model

<table>
<thead>
<tr>
<th></th>
<th>Share Price</th>
<th>Volatility</th>
<th>Interest Rate</th>
<th>Dividend Yield</th>
<th>Conversion Price</th>
<th>Trigger Price</th>
<th>Delta (Shares)</th>
<th>Delta Cash (M EUR)</th>
<th>Maturity Yrs</th>
<th>Gamma ½ (Shares)</th>
<th>Face Value</th>
<th>Issue Size (M EUR)</th>
<th>Coupon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity Derivatives Model - Flexible CashFlows</td>
<td>Share Price</td>
<td>Volatility</td>
<td>Interest Rate</td>
<td>Dividend Yield</td>
<td>Conversion Price</td>
<td>Trigger Price</td>
<td>Delta (Shares)</td>
<td>Delta Cash (M EUR)</td>
<td>Maturity Yrs</td>
<td>Gamma ½ (Shares)</td>
<td>Face Value</td>
<td>Issue Size (M EUR)</td>
<td>Coupon</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>45.00%</td>
<td>3.36%</td>
<td>3.74%</td>
<td>100</td>
<td>20.00</td>
<td>100</td>
<td>4,368,730</td>
<td>437</td>
<td>-0.00178</td>
<td>100</td>
<td>100</td>
<td>9.00%</td>
</tr>
</tbody>
</table>

Date (Years) | Cash Flow (% Face Value)
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>0.5</td>
<td>5%</td>
</tr>
<tr>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td>5</td>
<td>5%</td>
</tr>
</tbody>
</table>
Valuation : Credit Derivatives Approach

- Credit Triangle: \( cs = \lambda \times (1 - \Pi_{bond}) \)

- Link between a credit spread \((cs)\), recovery rate \((\pi)\) and instantaneous default probability \((\lambda)\)

- The parameter \((\lambda)\) is also called default intensity.

- The probability to go default during a particular time \(T\) is: \(1 - \exp(-\lambda T)\)
Valuation: Credit Derivatives Approach

CoCo Spread $\rightarrow S^*$ (Implied Trigger Level)

Graph showing stock price movements over time with key points labeled $C_P$ and $S^*_T$.
Valuation: Credit Derivatives Approach

- Hitting $S^*$ can be modeled.
- In a Black-Scholes world, the probability $p^*$ of hitting $S^*$ is:

$$p^* = N\left(\frac{\log\left(\frac{S^*}{S}\right) - \mu T}{\sigma \sqrt{T}}\right) + \left(\frac{S^*}{S}\right) \frac{2\mu}{\sigma^2} N\left(\frac{\log\left(\frac{S^*}{S}\right) + \mu T}{\sigma \sqrt{T}}\right)$$

$$\mu = r - q - \frac{\sigma^2}{2}$$

- $q$: Continuous dividend yield
- $r$: Continuous interest rate
- $\sigma$: Volatility
- $T$: Maturity of the contingent convertible
- $S$: Current share price
Valuation : Credit Derivatives Approach

Rule of Thumb Pricing for a Credit Default Swap:
Credit Spread = Expected Loss * Default Intensity
\[ cs = (1 - \pi_{Bond}) \times \lambda_{default} \]

The expected loss is determined by the value of the shares (S*) when conversion takes place. The CoCo investor loses the face value of the bond (N), but receives \( C_r \) shares instead. (The conversion ratio \( C_r = N / C_p \).)
Expected Loss = \( N - C_r \times S^* \)

Rule of Thumb Pricing for a CoCo Spread:

\[ \text{CoCo spread} = (1 - \frac{S^*}{C_p}) \times \lambda_{trigger} \]

\[ \lambda_{trigger} = -\frac{\log(1 - p^*)}{T} \]
Valuation: Credit Derivatives Approach

Choose $S^*$

Calculate Recovery Bond
$\Pi = S^*/C_p$

Calculate $p^*$
(probability of hitting this barrier)

Calculate $\lambda$

Coco spread
Valuation of CoCos: Credit Derivatives Approach

Implied Trigger level for Lloyds

![Graph showing implied trigger level for Lloyds](image-url)
<table>
<thead>
<tr>
<th>ISIN</th>
<th>US06740L8C27</th>
<th>US06739FHK03</th>
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<td>7.75</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>Semi-Annual</td>
<td>Semi-Annual</td>
</tr>
<tr>
<td><strong>Coupon Cancellation</strong></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td>11/21/2022</td>
<td>4/10/2023</td>
</tr>
<tr>
<td><strong>Face Value</strong></td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Currency</strong></td>
<td>USD</td>
<td>USD</td>
</tr>
<tr>
<td><strong>Issue Date</strong></td>
<td>11/21/2012</td>
<td>4/10/2013</td>
</tr>
<tr>
<td><strong>Issue Size (bn)</strong></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Regulatory Treatment</strong></td>
<td>TIER 2</td>
<td>TIER 2</td>
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<tr>
<td><strong>Callable</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Step Up</strong></td>
<td>683</td>
<td></td>
</tr>
<tr>
<td><strong>Next Call Date</strong></td>
<td>4/10/2018</td>
<td></td>
</tr>
<tr>
<td><strong>Call Frequency</strong></td>
<td>Onetime</td>
<td></td>
</tr>
<tr>
<td><strong>CET Trigger</strong></td>
<td>7.00%</td>
<td>7.00%</td>
</tr>
<tr>
<td><strong>Loss Absorption</strong></td>
<td>Full Write Down</td>
<td>Full Write Down</td>
</tr>
<tr>
<td><strong>Conversion Price</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Valuation of CoCos: Credit Derivatives Approach

Implied Trigger level for Barclays

Barclays CoCo Bond – US06740L8C27

$S^*/S$(%) vs T

Non-Callable CoCo
Callable 10Yr NC5 (priced till call date)

Implied Trigger Levels are different?
Including Extension Risk
Including Extension Risk

(1) \( T \rightarrow cs_{coCo} \)
Including Extension Risk

- Assume that CoCo Spread follows geometric Brownian Motion
- Introduce
  - CoCo Spread Volatility: $\sigma_{\text{CoCo}}$
  - Coupon Step-Up at the call date $t_i = c_{x,i}$
- Calculate the probability that bond is called at the different call dates

\[
\begin{align*}
  & c \quad c \quad r + c_{x,1} \quad r + c_{x,i-1} \quad r + c_{x,k-1} \quad r + c_{x,k} \\
& t_0 \quad \ldots \quad t_1 \quad t_2 \quad \ldots \quad t_i \quad \ldots \quad t_k \quad T
\end{align*}
\]

- Fixed Coupons $\rightarrow \leftarrow$ Floating Coupons

- Calculate the expected Maturity Date $T_E$

\[
T_E = \sum_{i=1}^{k} \text{Prob}(\text{call on } t_i) \times t_i + \left(1 - \sum_{i=1}^{k} \text{Prob}(\text{call on } t_i)\right) \times T
\]
Including Extension Risk
Including Extension Risk

\[ (1) \ T \rightarrow \ cS_{coC_o} \]

\[ (2) \ cS_{coC_o} \rightarrow T_E \]
Including Extension Risk (CallDate = April 2018)
Including Extension Risk

Barclays CoCo Bond – US06740L8C27

T

S^\prime / S (%)

Non–Callable CoCo
Callable 10Yr NC5
Callable 10Yr NC5 (with Extension Risk)

Thank you

www.allonhybrids.com