



# Using Replicating Portfolios for Economic Capital and Market Risk Modelling

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Corporate Insurance Risk Management  
ERM Symposium: April 2008

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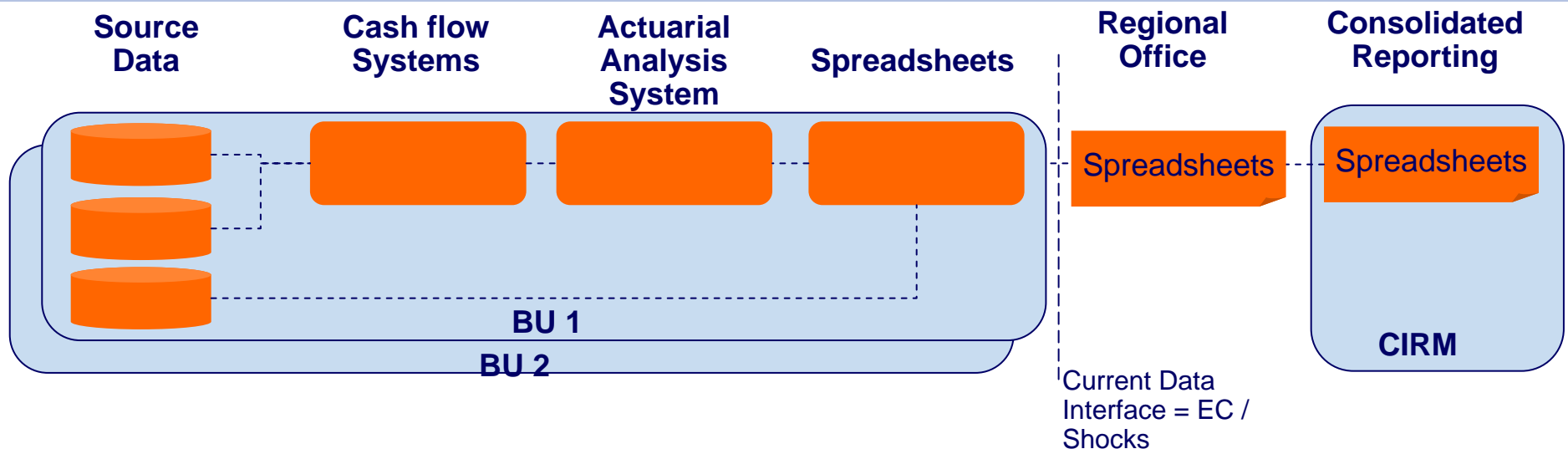
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- ING's Internal Risk Model Challenge and Response
- ING's Internal Risk Model Summary

# ING ERM covers all roles of risk management – all supported by ING’s EC/internal risk model

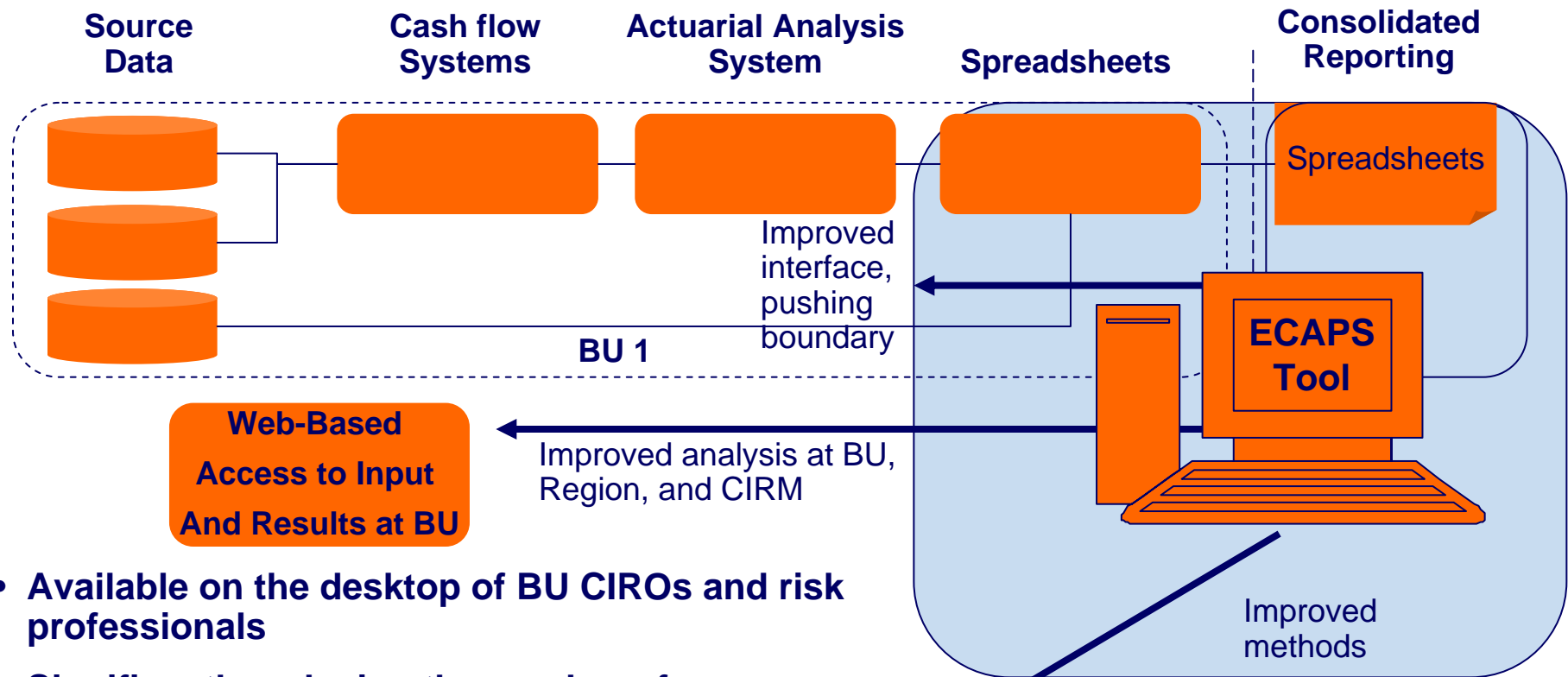
|                                   | <b>Purpose</b>   | <b>Examples</b>   |
|-----------------------------------|--|---|
| <b>Risk Disclosure</b>            | Our risks and strategy are transparent to internal and external stakeholders to support an appropriate evaluation        | <ul style="list-style-type: none"> <li>• Investor disclosures – substantially improved in 07/08</li> <li>• IFRS 7 Risk Paragraph</li> <li>• Basis for Solvency II/QIS 4</li> </ul>                                    |
| <b>Risk Strategy</b>              | Delegated authorities are consistent with the overall Group strategy for profitable growth and the Group’s risk appetite | <ul style="list-style-type: none"> <li>• Establish Risk Appetite</li> <li>• Strategic Planning: EC/limits/value metrics</li> <li>• Capital Management &amp; Planning</li> </ul>                                       |
| <b>Risk Reporting/Controlling</b> | Our risk profile is transparent, e.g. “no surprises”, and consistent with authorities and limits delegated by the Group  | <ul style="list-style-type: none"> <li>• Risk Dashboard at EB level</li> <li>• MVaR limit structure</li> <li>• EC and MVS quarterly</li> <li>• Innovative EC system ties to market risk analysis</li> </ul>           |
| <b>Risk Underwriting</b>          | Our products and portfolios are structured, underwritten, priced, approved and managed appropriately                     | <ul style="list-style-type: none"> <li>• Clear product approval standards for insurance/investment products</li> <li>• SoPs/Guidelines</li> <li>• Value metrics for new business-IRR and market consistent</li> </ul> |

# Significant Systems Challenges of ING's Prior EC process – fairly common



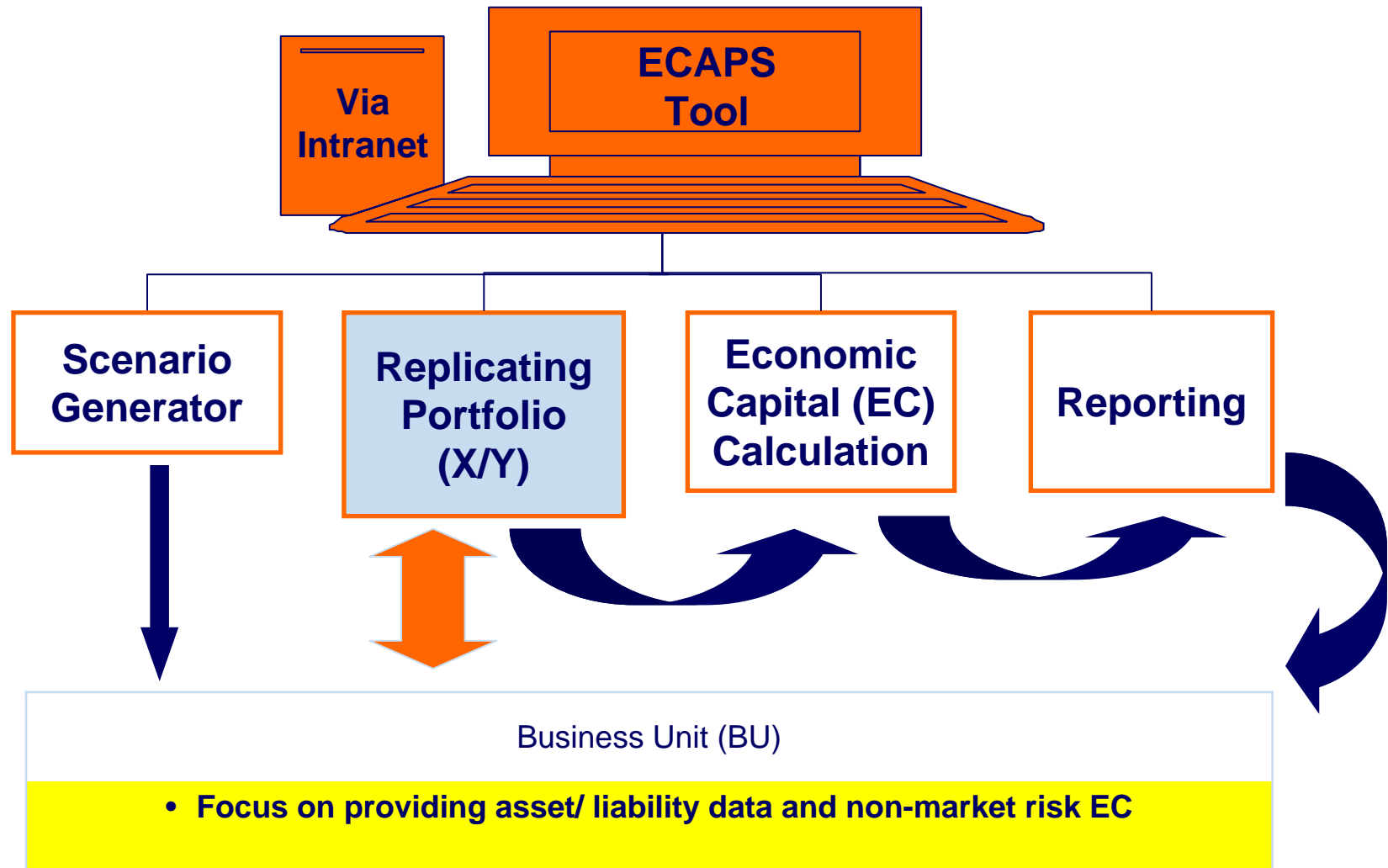
- **Efficiency:** Complex processes & system environment implying need to automate interfaces, optimize hardware / software, balance precision & effort, leverage development
- **Control & Audit:** Confidence in numbers & consistency, implying need for clear standards, improved systems, documentation, controls & procedures
- **Functionality:** Improved methods and greater analysis needs, implying need for changing data interface and new techniques
- **In 40+ different units + 8 Regional Offices + CIRM globally!**

# Overview of ECAPS Project Approach

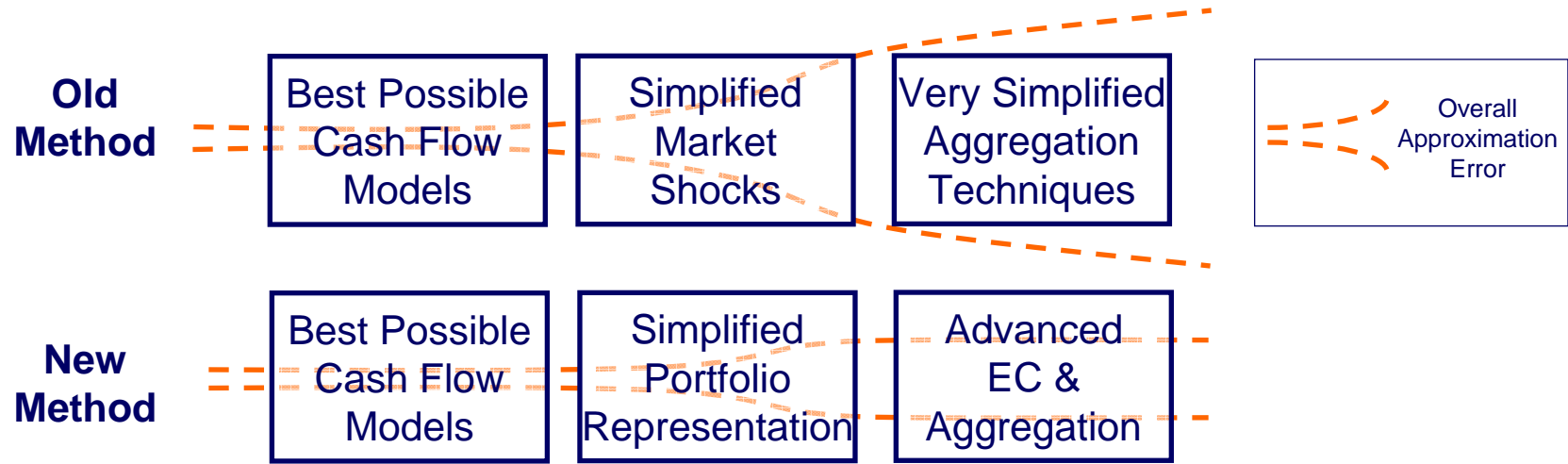


- Available on the desktop of BU CIROs and risk professionals
- Significantly reducing the number of downstream spreadsheets
- Improved Analytics: based on industry market risk platform well known within ING (e.g. Algorithmics)
- Facilitating timely reporting

# ECAPS Overview



# Approach narrows the overall approximation



- ING's prior approach tried to measure individual liabilities very accurately, but made big approximations for
  - Market shocks (e.g. single factor for term structure, etc.)
  - Diversification / aggregation (e.g. simplified covariance matrix)
- New methodology uses replicating portfolio approximations to capture asset and liability risk profiles
- Much more accurate EC market shocks & diversification possible due to Monte-Carlo method

# Key Benefits of ECAPS

|                                |   |
|--------------------------------|---|
| <b>Auditability</b>            | <ul style="list-style-type: none"> <li>• Clear control procedures and documentation leading to <b>auditable</b> and SOXable EC and CaR reporting</li> <li>• Substantial increase in <b>automated</b> processes and IT controls</li> <li>• Supports auditable <b>Risk Dashboard</b> reporting</li> </ul>   |
| <b>Timeliness</b>              | <ul style="list-style-type: none"> <li>• <b>Timely</b> quarterly reporting - from current 10 weeks to within financial calendar</li> </ul>  |
| <b>Consistency</b>             | <ul style="list-style-type: none"> <li>• <b>Standardised</b> methodology and reporting format</li> <li>• Enhanced <b>comparability</b> of results across entities</li> </ul>  |
| <b>Functional Improvements</b> | <ul style="list-style-type: none"> <li>• <b>Improved methodologies, particularly on market risk calculations and diversification</b></li> <li>• Addition of <b>implied volatility</b> and <b>Fx translation</b> risks / improvement to <b>credit spread</b> risk</li> <li>• <b>Expandable</b> to support MV balance sheet attribution analysis</li> </ul> |
| <b>Market Risk Analysis</b>    | <ul style="list-style-type: none"> <li>• Much faster and improved <b>Group-wide market risk analysis</b> of specific risks</li> <li>• Improved ability to analyse <b>insurance and banking diversification</b></li> <li>• <b>Increased analysis &amp; communication</b> – move from getting the numbers to using the numbers</li> </ul>                   |

# ECAPS sets the stage for market value reporting

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- ING's Capital Management
  - Economic view requires MV balance sheet and EC on timely and reliable basis
  - ECAPS allows improved analysis and projection capabilities to manage risks, required capital, and available capital on more real time basis
- Solvency II
  - European solvency regulations will be market value based
  - ECAPS provides the basis in an auditable format
- IFRS
  - IFRS 7 requires us to disclose risk the way we manage the business
  - Future IFRS requirements are expected to include fair value for insurance liabilities- a timely, auditable approach will be necessary
- Rating Agencies
  - Internal models will become increasingly important to risk management assessments by rating agencies
- MCEV reporting to be required by CFO Forum

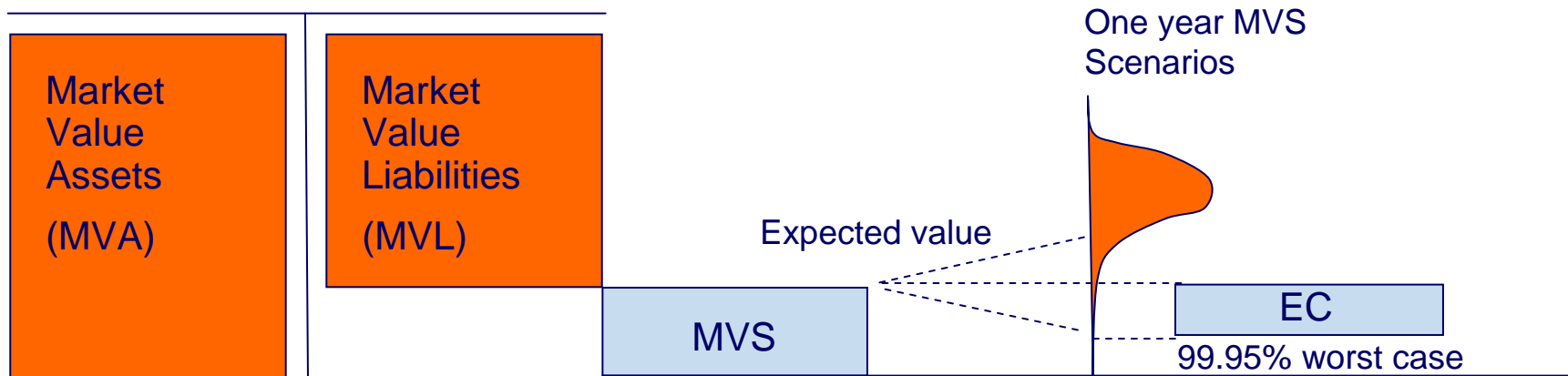
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# ING Economic Capital Framework is aligned with Solvency II

**Definition:** ING Insurance economic capital is defined as the maximum loss to ING Insurance's Market Value Surplus (MVS) within a 99.95% confidence interval based on shocks which could occur over a one-year horizon



## Based on total Market Value Surplus

- Current balance sheet value only – no future business or future return expectations
- MVL (including financial options), rather than best-estimate liabilities
- Includes free surplus; no assumption about “duration of equity” or surplus

## Economic Capital definition

- Maximum loss within a confidence interval over one year (“VaR”), consistent with Solvency II
- 99.95% confidence interval consistent with AA rating, more conservative than Solvency II minimum of 99.5%

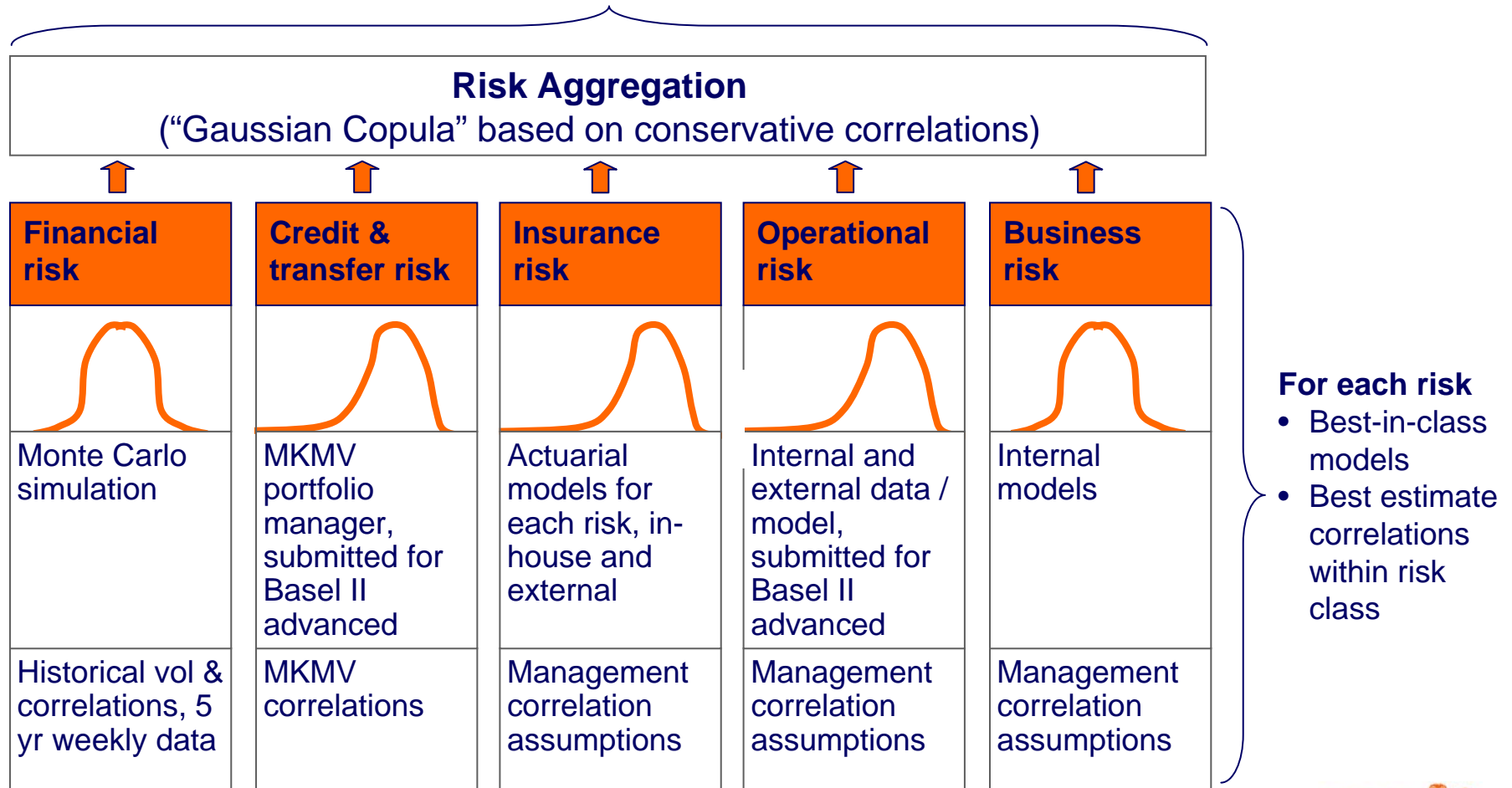
# Five risk categories which impact Market Value Surplus

| Financial risk   | Credit & transfer risk   | Insurance risk  | Operational risk   | Business risk   |
|--|--|---|--|---|
| <p>Changes in financial markets which would impact the market value of assets and liabilities (including options in assets and liabilities) from:</p> <ul style="list-style-type: none"> <li>• Interest rates</li> <li>• Equity prices</li> <li>• Real estate</li> <li>• Credit spreads</li> <li>• Implied vols</li> <li>• Currency rates</li> </ul> | <p>Changes in the credit quality of assets, reinsurance receivables and counterparties, including default.</p> <p>The recovery risk in case of default or loss of value due to migration.</p> <p>Transfer risk is related to the inability to repatriate or transfer shareholder value due to restrictions</p> | <p>Deviations from best estimate claims development, including size, frequency and timing of both level and long term trend, covering:</p> <ul style="list-style-type: none"> <li>• Mortality</li> <li>• Morbidity</li> <li>• Longevity risk</li> <li>• Property</li> <li>• Casualty</li> <li>• NATCAT</li> </ul> | <p>Unexpected events such as processing errors, fraud, systems failures, litigation, regulatory or compliance breaches, etc.</p> | <p>Deviations from best estimates on business expenses, lapses / persistency and future premium re-rating</p> |

# ING uses best practice models within and across risk categories

## Across risk classes

- Best-in-class aggregation model
- Conservative correlation assumptions



# Why Replicating Portfolios?

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- Capture the risk profile of assets and insurance liabilities by mapping onto a small set of standard financial instruments
- Significant simplification of EC calculations
  - EC calculation reduces to determining the risk profile of the constellation of replicating portfolios
  - Ability to utilise Monte Carlo simulation for determining risk metrics
- Allows work to be spread more evenly across the year
  - Replicating portfolios can be calculated prior to the reporting period
  - These portfolios will automatically adjust for changes to market variables
- Allows for much more standardised and enhance risk reporting across ING Group
  - Standardised market risk dashboards across Group
  - Sophisticated market risk analysis available to all business units – especially a benefit for emerging markets businesses
  - Ability to quickly analyse ING's risk to stress scenarios by revaluing replicating portfolios only

# Replicating Portfolios - Underlying Idea

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- **Insurance contracts consist of building blocks**
  - Fixed cash flows → Discount bond
  - Profit-sharing → Client Option on “upside”
  - Lapsation → Client Option on “upside”
  - Minimum Guarantees → Client Option on “downside”
- **Use these (simple) building blocks to replicate any insurance contract from the following instruments:**
  - Zero Coupon Bonds, Equity Forwards
  - Swaptions
  - Equity Options
  - Foreign Currency Options
- **In 2008, new instruments will be added:**
  - Callable bonds
  - CMS Caps/Floors
  - Composite market indices for use as basket equity options/forwards

# Understanding the Calculation of Repl Portfolio

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- **To find the replicating portfolio, we use a Linear Programming algorithm**
- **Input: 500 sets of “cash flow paths” from business unit asset or liability projection systems**
- **Objective: find a replicating portfolio that matches the cash flows as closely as possible for the 500 paths**
  - Make the best use of the set of standard instruments
  - Allow some trade-off between neighbouring cash flows
- **Output: optimal weight for each standard instrument**

# ING's replicating portfolio approach – Comparing target with replicating portfolio

Belgium  
Replicating Portfolio Summary

Product Family Member:

Liab Universal Life 3,00%

Valuation Date :

Jun 30, 2007

Input File:

MF\_Universal\_Life\_300\_200706\_no\_links.xls

Currency:

EUR

Unit of Measure:

1.00

Allocation Factor:

1.0000

Instrument Types:

Swaption, Zero Coupon Bond

Bucketing Approach:

Low

Value Constraints:

No

Trade Penalty:

Yes

Max Time to Maturity (days):

Replication Request ID:

32228

Start Replication:

Jul 30, 2007 7:31:41PM

End Replication:

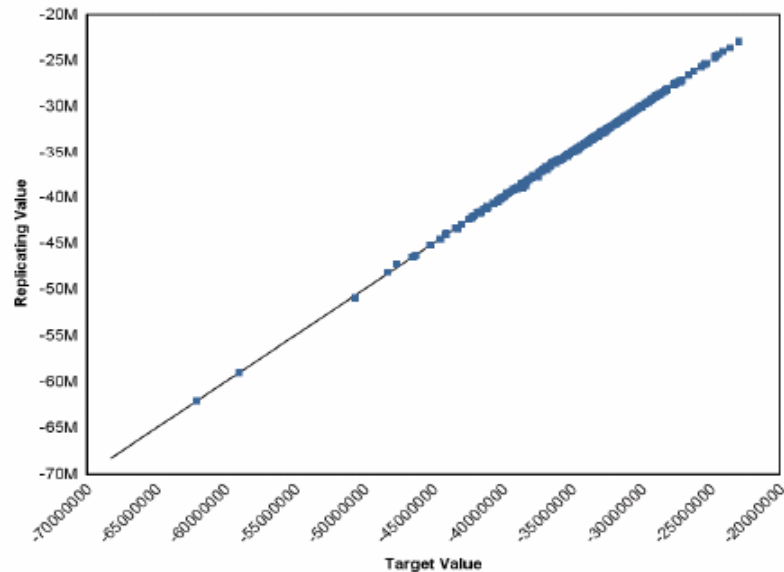
Jul 30, 2007 7:35:04PM

Scenario Used:

RN\_Set\_1\_EUR\_200706.xls

**- Illustrative -**

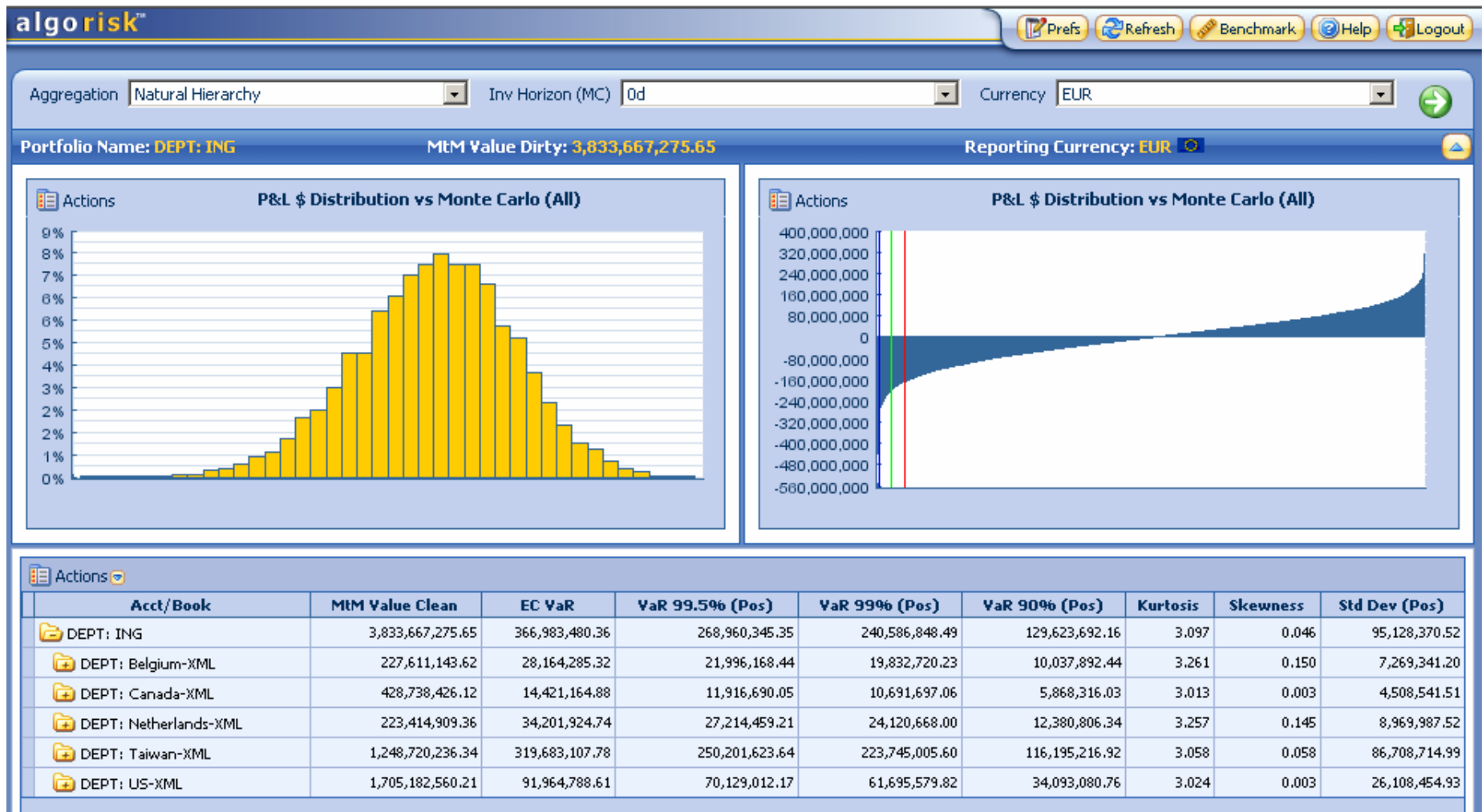
Graph of PV liabilities/PV Replicating Portfolio for all scenarios



# ING's replicating portfolio approach – Understanding portfolio characteristics

| Belgium<br>Replicating Portfolio Summary<br>Product Family Member:<br>Valuation Date :<br>Input File:<br>Currency:<br>Unit of Measure:<br>Allocation Factor:<br>Instrument Types:   |                             | <b>Assessment criteria</b><br>Liab<br>Ju<br>MF_Universal_Life_300_200706_no_links.xls<br>EUR<br>1.00<br>1.0000<br>Swaption, Zero Coupon Bond |          | Bucketing Approach:<br>Value Constraints:<br>Trade Penalty:<br>Max Time to Maturity (days):<br>Replication Request ID:<br>Start Replication:<br>End Replication:<br>Scenario Used: |  | Low<br>No<br>Yes<br>- <b>Illustrative</b> -<br>32228<br>Jul 30, 2007 7:31:41PM<br>Jul 30, 2007 7:35:04PM<br>RN_Set_1_EUR_200706.xls  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
|---|-----------------------------|--|----------|--|--|--|--|--|-----------------------------|---|-------|---------------|----------------|------|--------|-------------|----------------|------|--------|---------------|----------------|------|--------|-------------|----------------|------|--------|---------------|----------------|---------------|--------|-------------|----------------|--------------|---------|---------------|----------------|----------------|---------|-------------|----------------|--------------|----------|
| <b>Goodness of Fit Statistics</b><br>R^2<br>Average Regret<br>Maximum Regret  |                             | 99.97 %<br>48,526.79<br>474,993.29   |          | <b>Interest Rate Deltas</b><br>1 yr<br>2 yr<br>3 yr<br>4 yr<br>5 yr<br>7 yr<br>10 yr<br>15 yr<br>20 yr<br>30 yr<br>30 yr+  |  | -187.50<br>14.48<br>-530.79<br>-1,887.24<br>-1,500.83<br>433.98<br>-16,491.26<br>-3,038.31<br>-2,294.00<br>-1,118.61<br>-435.28  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| <b>Market Value Sensitivities</b><br>Duration<br>Convexity<br>Interest Rate Delta (1bp)<br>Interest Rate Gamma (1bp)<br>Interest Rate Vega (1%)<br>Equity Delta (1 unit currency)<br>Equity Gamma (1 unit currency)<br>Equity Vega (1%)<br>Fx Delta<br>Fx Gamma<br>Fx Vega<br>Fx Domestic Rho<br>Fx Foreign Rho |                             | 7.83<br>104.63<br>-27,034.78<br>-36.13<br>0.00<br>0.00<br>0.00<br>0.00<br>0.00<br>0.00<br>0.00<br>0.00<br>0.00<br>0.00                       |          | <b>Allocation</b><br><b>Main Fund</b><br>Liab Universal Life 3,00<br>Total   |  | 1.0000<br>1.0000   |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
|   |                             |  |          | <b>Market Value Summary</b><br>Value target portfolio<br>Value replicating portfolio   |  | -34,251,311.06<br>-34,531,232.96<br>System calculated  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
|   |                             |  |          | shift scenarios<br>value replicating portfolio<br>difference to<br>value replicating portfolio<br>ratio  |  | <table border="1"> <thead> <tr> <th></th> <th>value replicating portfolio</th> <th>difference to value replicating portfolio</th> <th>ratio</th> </tr> </thead> <tbody> <tr> <td>EQ-10pct-down</td> <td>-34,531,232.96</td> <td>0.00</td> <td>0.00 %</td> </tr> <tr> <td>EQ-10pct-up</td> <td>-34,531,232.96</td> <td>0.00</td> <td>0.00 %</td> </tr> <tr> <td>EQ-30pct-down</td> <td>-34,531,232.96</td> <td>0.00</td> <td>0.00 %</td> </tr> <tr> <td>EQ-30pct-up</td> <td>-34,531,232.96</td> <td>0.00</td> <td>0.00 %</td> </tr> <tr> <td>IR-100bp-down</td> <td>-37,440,033.15</td> <td>-2,908,800.19</td> <td>8.42 %</td> </tr> <tr> <td>IR-100bp-up</td> <td>-32,001,024.18</td> <td>2,530,208.78</td> <td>-7.33 %</td> </tr> <tr> <td>IR-300bp-down</td> <td>-44,918,702.81</td> <td>-10,387,468.85</td> <td>30.08 %</td> </tr> <tr> <td>IR-300bp-up</td> <td>-27,782,404.31</td> <td>6,748,828.64</td> <td>-19.54 %</td> </tr> </tbody> </table> |  |  | value replicating portfolio | difference to value replicating portfolio | ratio | EQ-10pct-down | -34,531,232.96 | 0.00 | 0.00 % | EQ-10pct-up | -34,531,232.96 | 0.00 | 0.00 % | EQ-30pct-down | -34,531,232.96 | 0.00 | 0.00 % | EQ-30pct-up | -34,531,232.96 | 0.00 | 0.00 % | IR-100bp-down | -37,440,033.15 | -2,908,800.19 | 8.42 % | IR-100bp-up | -32,001,024.18 | 2,530,208.78 | -7.33 % | IR-300bp-down | -44,918,702.81 | -10,387,468.85 | 30.08 % | IR-300bp-up | -27,782,404.31 | 6,748,828.64 | -19.54 % |
|   | value replicating portfolio | difference to value replicating portfolio  | ratio    |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| EQ-10pct-down   | -34,531,232.96              | 0.00   | 0.00 %   |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| EQ-10pct-up   | -34,531,232.96              | 0.00   | 0.00 %   |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| EQ-30pct-down   | -34,531,232.96              | 0.00   | 0.00 %   |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| EQ-30pct-up   | -34,531,232.96              | 0.00   | 0.00 %   |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| IR-100bp-down   | -37,440,033.15              | -2,908,800.19  | 8.42 %   |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| IR-100bp-up   | -32,001,024.18              | 2,530,208.78   | -7.33 %  |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| IR-300bp-down   | -44,918,702.81              | -10,387,468.85   | 30.08 %  |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
| IR-300bp-up   | -27,782,404.31              | 6,748,828.64   | -19.54 % |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |
|   |                             | <b>Additional risk information</b>   |          |  |  |  |  |  |                             |   |       |               |                |      |        |             |                |      |        |               |                |      |        |             |                |      |        |               |                |               |        |             |                |              |         |               |                |                |         |             |                |              |          |

# Illustrative EC/VaR Report



# Enhanced Risk Reporting : Illustrative

## Economic Capital\*

| EC (99.95%)  | 2007 Q3       |                |                |                   |                       | 2007 Q2       |                |                |                   |                       |
|--------------|---------------|----------------|----------------|-------------------|-----------------------|---------------|----------------|----------------|-------------------|-----------------------|
|              | EC Total      | Market Risk EC | Credit Risk EC | Insurance Risk EC | Non-financial Risk EC | EC Total      | Market Risk EC | Credit Risk EC | Insurance Risk EC | Non-financial Risk EC |
| Bu1          | 4,262         | 2,554          | 103            | 1,110             | 496                   | 4,389         | 2,685          | 119            | 1,136             | 449                   |
| Bu2          | 4,158         | 2,259          | 409            | 404               | 1,085                 | 3,794         | 2,047          | 388            | 359               | 999                   |
| Bu3          | 3,958         | 2,588          | 249            | 510               | 610                   | 3,788         | 2,447          | 338            | 445               | 559                   |
| Bu4          | 2,312         | 2,312          | 0              | 0                 | 0                     | 1,834         | 1,834          | 0              | 0                 | 0                     |
| <b>Total</b> | <b>14,690</b> | <b>9,714</b>   | <b>761</b>     | <b>2,024</b>      | <b>2,191</b>          | <b>13,805</b> | <b>9,013</b>   | <b>845</b>     | <b>1,940</b>      | <b>2,008</b>          |

## Equity + Real Estate Positions\*

| EQ Position  | Down 10% Q3   | Down 10% Q2   | Up 10% Q3    | Up 10% Q2    |
|--------------|---------------|---------------|--------------|--------------|
| Bu1          | -348          | -304          | 335          | 296          |
| Bu2          | -819          | -826          | 706          | 626          |
| Bu3          | -1,331        | -1,392        | 1,331        | 1,373        |
| Bu4          | -7            | -8            | 7            | 8            |
| <b>Total</b> | <b>-2,505</b> | <b>-2,530</b> | <b>2,379</b> | <b>2,302</b> |

## Credit Spread Positions\*, \*\*

| 10 bps increase | AAA         | AA         | A           | BBB        | BB        | B        | Others     | Total       |
|-----------------|-------------|------------|-------------|------------|-----------|----------|------------|-------------|
| Bu1             | -10         | -22        | -13         | -3         | -1        | 0        | -6         | -54         |
| Bu2             | -42         | -6         | -88         | -52        | -8        | 0        | 0          | -196        |
| Bu3             | -114        | -12        | -45         | -11        | 0         | 0        | -1         | -182        |
| Bu4             | -1          | 0          | -1          | 0          | 0         | 0        | 0          | -3          |
| <b>Total</b>    | <b>-148</b> | <b>-39</b> | <b>-147</b> | <b>-64</b> | <b>-8</b> | <b>0</b> | <b>-27</b> | <b>-435</b> |

(In EUR million)

## Interest Rate Positions\*

| IR Position  | PrI -100bps Q3 | PrI -100bps Q2 | PrI +100 bps Q3 | PrI +100 bps Q2 |
|--------------|----------------|----------------|-----------------|-----------------|
| Bu1          | -2,207         | -2,410         | 909             | 1,039           |
| Bu2          | -384           | -122           | 76              | -309            |
| Bu3          | -799           | -704           | 278             | -18             |
| Bu4          | -1,162         | -1,065         | 995             | 898             |
| <b>Total</b> | <b>-4,553</b>  | <b>-4,301</b>  | <b>2,258</b>    | <b>1,611</b>    |

## Foreign Exchange Positions : Down 5% Scenario\*,\*\*\*

| FX Position  | USD         | TWD        | CAD        | PLN        | Others      | Total       |
|--------------|-------------|------------|------------|------------|-------------|-------------|
| Bu1          | -44         | -165       | 0          | 0          | -165        | -375        |
| Bu2          | -249        | 0          | -73        | 0          | -68         | -388        |
| Bu3          | -10         | 0          | 0          | -59        | -71         | -140        |
| Bu4          | 105         | 273        | 0          | 0          | 41          | 419         |
| <b>Total</b> | <b>-198</b> | <b>108</b> | <b>-73</b> | <b>-59</b> | <b>-263</b> | <b>-484</b> |

\*\*\* These Results Are from shocks to all currencies against EUR

