CRO Forum
QIS3 Benchmarking Study

20 November 2007

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Background and objectives

Background

- The CRO Forum companies have developed internal capital models, which they expect to be approved by the regulators as a basis for setting the level of target capital ("SCR"). The CRO Forum companies have also participated in QIS3.
- The CRO Forum asked the Tillinghast business of Towers, Perrin, Forster and Crosby Inc., in association with Prof. Dr. Damir Filipovic and Dr. Daniel Rost, to undertake a benchmarking study of the QIS3 calibration. The benchmarking was undertaken through a comparison of the results of internal models and those resulting from the QIS3 submissions from CRO Forum members, both for solo entities and for groups.

Objectives

The objectives of the study are as follows:

- Compare the capital requirements produced by CRO Forum members' internal models with those calculated according to the standard approach defined for QIS3.
- Obtain insight into the causes for differences between the standard approach under QIS 3 and internal models.
- Identify any inherent conservatism/optimism in the QIS3 calibration, or potential problems in methodologies proposed by CEIOPS.

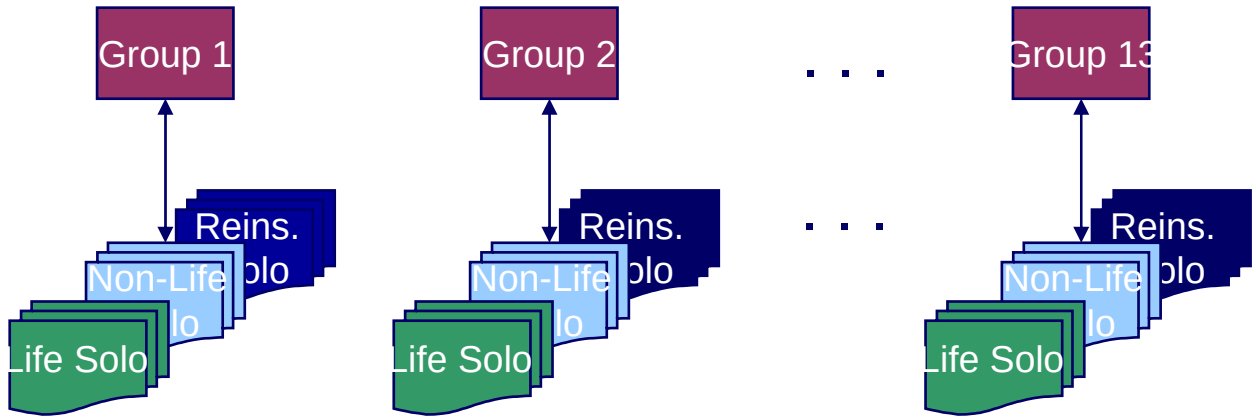
Process

- A standard template was developed to compile results for analysis. CRO Forum members recalibrated their internal model results to 1 year Value-at-Risk based on a 99.5% confidence interval i.e. a consistent basis was used for comparison with QIS3.
- The results templates were submitted to Prof. Dr. Damir Filipovic for aggregation and analysis before being transmitted to Tillinghast for analysis. The intention of this process was to ensure to protect the confidentiality of the data.
- In order to protect confidentiality, no data is shown for individual companies. In general we have shown averages across companies, risks and countries, weighted by the corresponding measures.
- Furthermore, results are only shown for a particular segment of business (e.g. a specific country) if at least 3 companies submitted data.
    - Where there were insufficient submissions, no results are shown for a particular segment but the results are used for later aggregation of results (e.g. across all countries).

Data flow

1 CRO-Forum

- Template completed by CRO Forum companies
- Submissions include data on
  - QIS3
  - Internal Models



2 Academic Advisor

(Prof. Dr. Damir Filipovic And Dr. Daniel Rost)

- Data Check and Anonymization
- Data Aggregation and Analysis

At least 3 companies had to submit reliable data for it to be grouped in a particular segment

3 Tillinghast

- Data Analysis and Interpretation
- Reasonableness checks

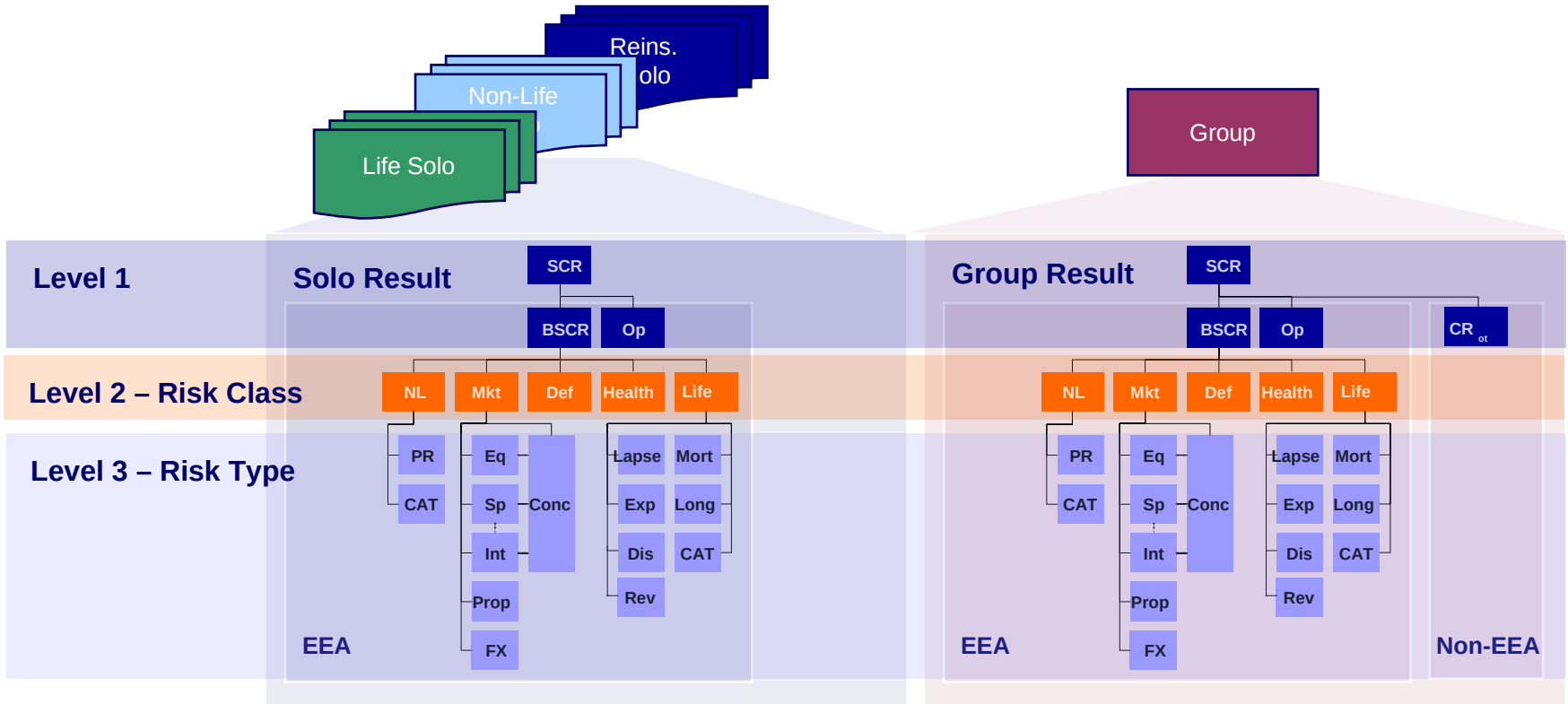
	A	B	CEE	F	D	I	NL	SP	UK	EEA	Non-EEA	Total
Group										Group	Group	Group
Life	N/A	Life Solo	N/A	Life Solo	Life Solo	Life Solo	Life Solo	Life Solo	Life Solo	Life Solo		
Non-Life	Non-Life Solo	Non-Life Solo	N/A	Non-Life Solo	Non-Life Solo	Non-Life Solo	Non-Life Solo	Non-Life Solo	Non-Life Solo	Non-Life Reinsur.		

Classification for analysis

- Solo-entity and group results are analysed at three different levels – we follow the QIS3 terminology and approach for ease of comparison.
- The three different levels are set up as follows:
  - Level 1 consists of the top level results such as
    - Required Capital
    - Basis Required Capital (“BSCR”)
    - Operational Risk
    - Non-EEA insurance Required Capital, Other Financial Sectors and Participations at Equity Value

      (“CR_{ot}“, group only)
  - Level 2 consists of the Risk Classes which are aggregated in QIS3 to the BSCR
    - Underwriting Risks (Life, Non-Life, Health)
    - Market
    - Counterparty Default
  - The most granular level are the Risk Types on level 3 which are aggregated to the Risk Classes

Solo-entity and group results are analysed at three different levels



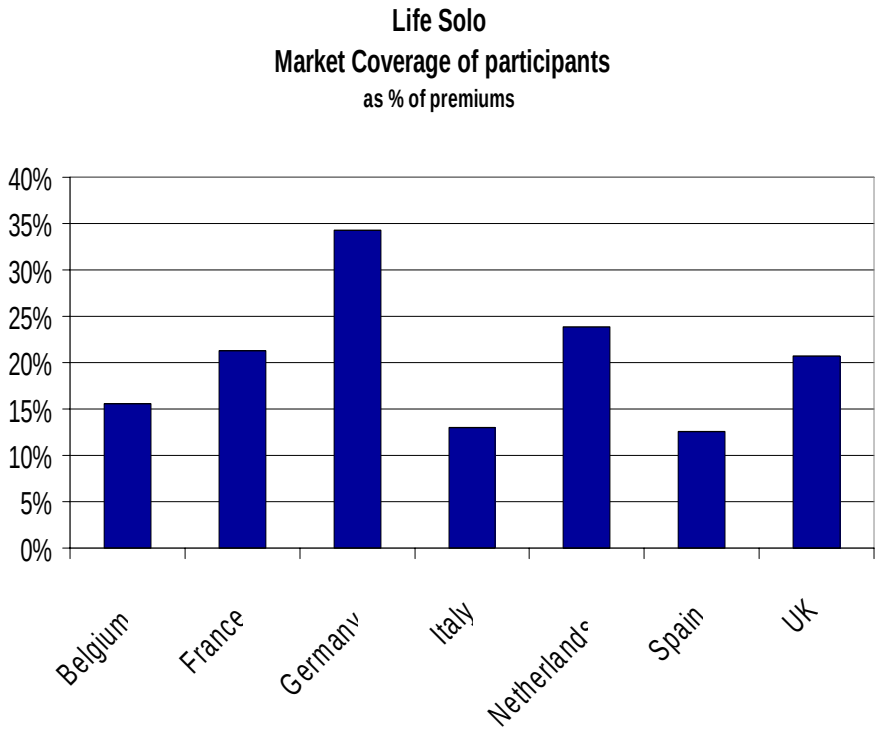
Participation/coverage

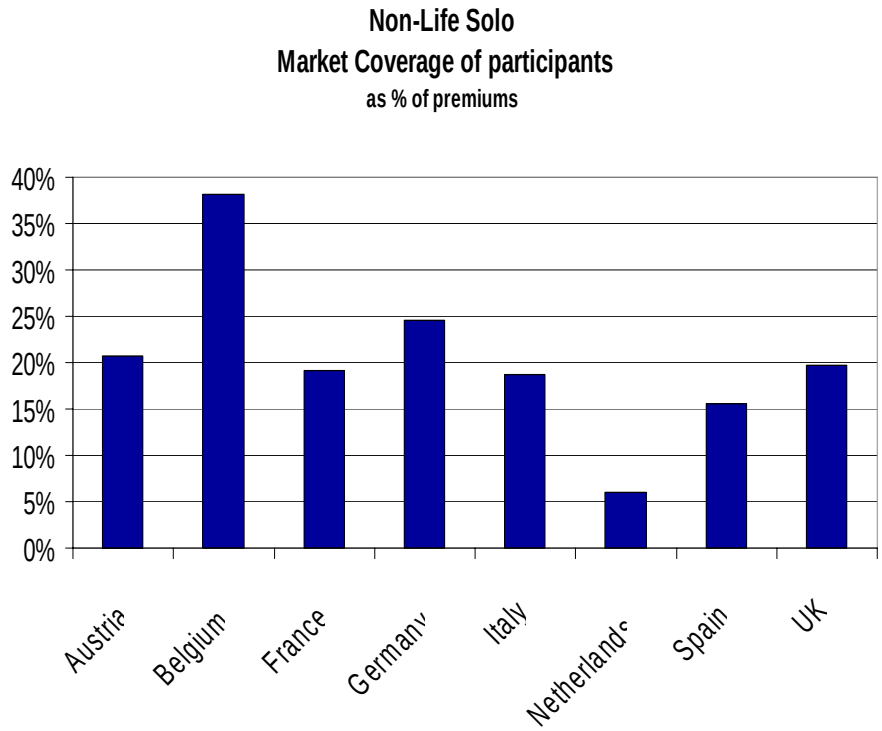
- All 13 members of the CRO Forum (as at June 2007) submitted QIS3 results, but internal models results and group data were not provided by all companies in the format required for comparison
  - In total data from 11 CRO Forum groups was used to compare QIS3 and internal model results for solo entities
  - A total of 84 solo entities were included in the study across 8 EU countries
  - These submissions covers approximately one-fifth of the insurance premiums in the 8 markets for which data could be obtained.

- Group submissions on internal model results were received from 7 groups:
  - Swiss groups did not submit data as they are subject to Swiss Solvency Test at group level
  - 4 others did not submit group data for internal models and QIS3 for comparison

- Health companies were excluded due to an insufficient volume of credible results to make the comparisons meaningful.

In aggregate, the study covers about one-fifth of solo business across 8 EU countries





2006 premiums

Source: Submissions from participating companies and CEA market statistics

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Key conclusions

- At EEA group level, internal model capital requirements amount to 71% of QIS3 requirements i.e. the calibration of the standard approach produces a capital requirement which is 40% higher than in internal models of CRO Forum companies.
- The additional capital requirements arise primarily from higher non-life and life underwriting risks with significant differences for certain lines of business.
  - The absence of an adjustment for size on non-life reserve risks makes the standard approach particularly inappropriate for CRO Forum solo companies.
  - For reinsurers, the differences are significantly higher than for direct writers, which suggests that the standard approach for underwriting risks works less well for reinsurance companies.
- The other key source of difference arises from the lower credit for diversification in QIS3 between risks within solo entities, and across solo entities (i.e. geographic diversification).
- Total capital requirements seem to be similar under QIS3 and internal models for market risks.
- The requirements for non-EEA countries are significantly lower than those determined in internal models, which is a consequence of the use of local statutory requirements for most of these countries. The assessment of available capital is also different to that used for EEA.
- Other key concerns raised by our members are the following:
  - There are substantial doubts as to the appropriateness of the use of KC factors (i.e. risk mitigation through future profit sharing) which do not always produce results consistent with those produced in internal models.
  - Several CRO Forum companies have expressed concerns that the Catastrophe models in non-life produce inappropriate results as actual risk exposures are not properly captured.
  - The comparison has been complicated by the fact that certain countries have developed guidance for calculations, which results in differences in application between countries. These differences create distortions in QIS3 results which are not present in internal models.

Key recommendations

- Whilst the CRO Forum agrees that there should be some incentive to use internal models, the level of conservatism in QIS3 is too high and is not uniformly distributed across all risks.
- The CRO Forum believes that it is imperative to incorporate a consistent calibration for each type/class of risk, and that it is not appropriate to rely on any offsetting between risks, or different levels of conservatism across different risks. This will ensure that there are the right incentives to use internal models and that pricing by companies appropriately reflects the underlying risks.
- There is also as a concern that the conservatism in non-market risks generates an additional cost of capital charge in the technical provisions, which effectively adds further unnecessary conservatism to the evaluation process.
- The CRO Forum therefore recommends that the calibration be reviewed for QIS4 to ensure a consistent calibration across all risks, and therefore a more appropriate level of incentive to use internal models. In addition, it is recommended to reflect the size of portfolios in the calibration for non-life reserve risks.
- The CRO Forum also recommends that the approach at group level be improved in QIS4:
  - It would be more appropriate to apply a consistent economic assessment of available and required capital to all businesses, both EEA and non-EEA.
  - The credit for geographic diversification should be reviewed to give more appropriate credit for well diversified groups.
- Finally, the CRO recommends for QIS4 that:
  - The working of the KC factors be reviewed to ensure that risk mitigation on participating life business is appropriately reflected.
  - Alternative approaches be used for Catastrophe risks to ensure that capital requirements reflect actual exposures.
  - CEIOPS should provide more guidance and precision in the QIS4 Specification to reduce the need for country-specific guidance.
- The CRO Forum would be happy to work with CEIOPS to provide support in implementing these recommendations, and on any related issues for QIS4.

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- Results
  - **Parameters/calibrations**
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  - Solo entity results
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    - Non-Life / Reinsurance
  - Operational risks

Calibration of stress tests and parameters

Market risks

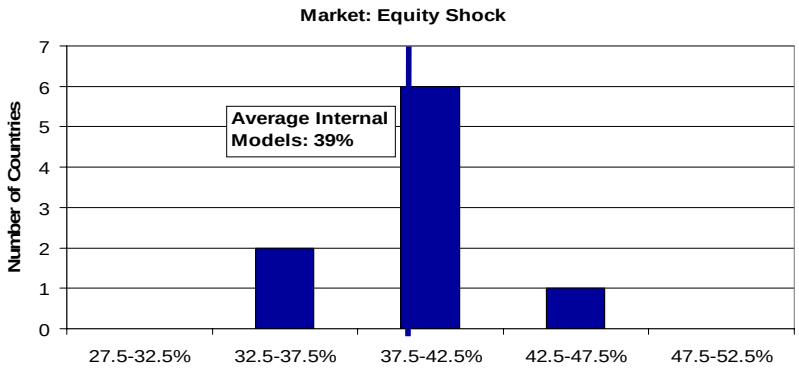
- The data provided made it relatively straight forward to compare stress tests for key market risks.
- Equity and property stresses are higher in internal models than in QIS3
  - Average equity stress is 39% in the internal models vs. 32% in QIS3
  - Average property stress is 26% vs. 20% in QIS3
- Interest rates
  - Although the stresses applied are not identical, they are close under QIS3 and internal models

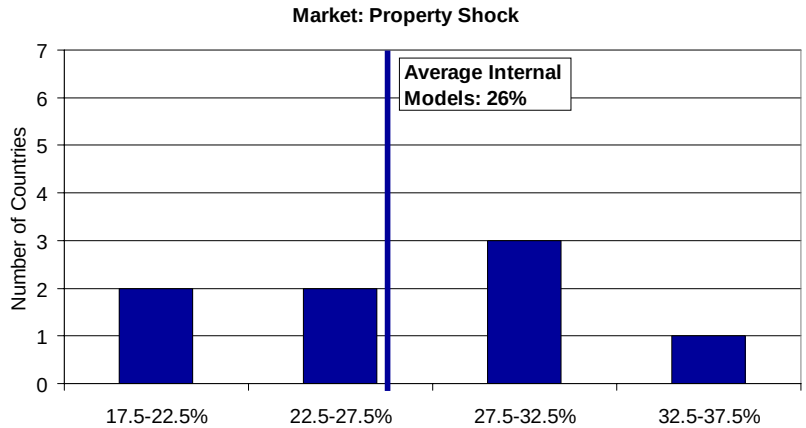
Other risks

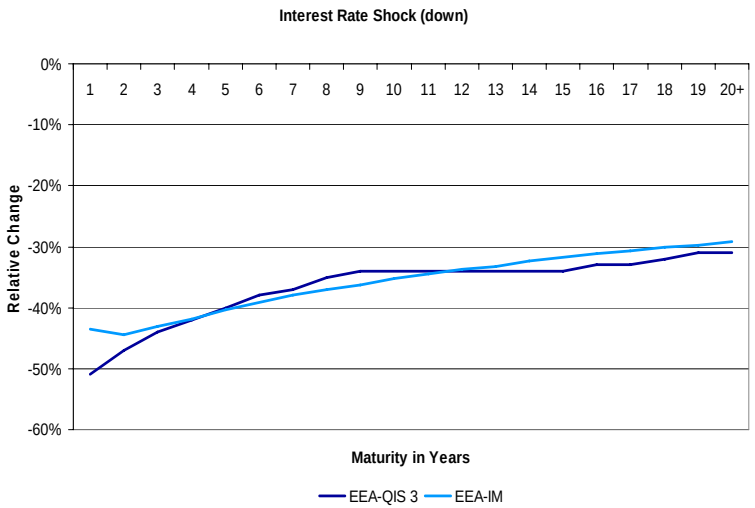
- We encountered difficulties in comparing stress tests for other risks, primarily because of differences in methodology and risk classification for internal models, compared to the approaches and classification specified for QIS3.
- For life underwriting, CRO Forum companies classify these risks in a variety of ways in their internal models. For example, stress tests for mortality parameter risk cannot always be separated from mortality calamity risks. However, we note later in this report that the overall capital requirement for life underwriting risks (as sum of risk types) is higher under QIS3 than that included in the internal models of CRO Forum companies.
- At an aggregate level, the required capital for non-life underwriting risks (as sum of risk types) is also higher under QIS3 than in internal models (see later sections). A comparison of the volatility parameters for premium and reserve risk in QIS3 with the averages of those used by CRO Forum companies in internal models shows significant differences, both positive and negative, but this comparison may be distorted by differences in risk classification and lines of business used for analysis in internal models.

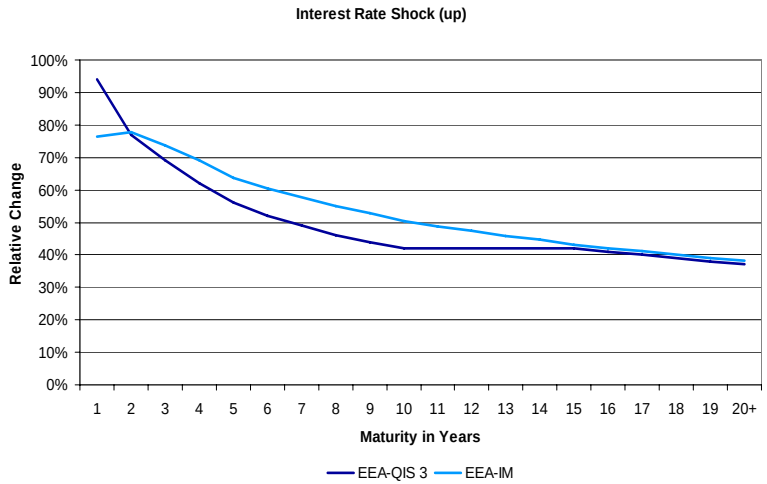
Parameters – Market risk

For each participating country, an average stress parameter was derived by the number of submissions. The overall average internal model parameters is the simple average of stress tests submitted. Interest Rate curves have been smoothed









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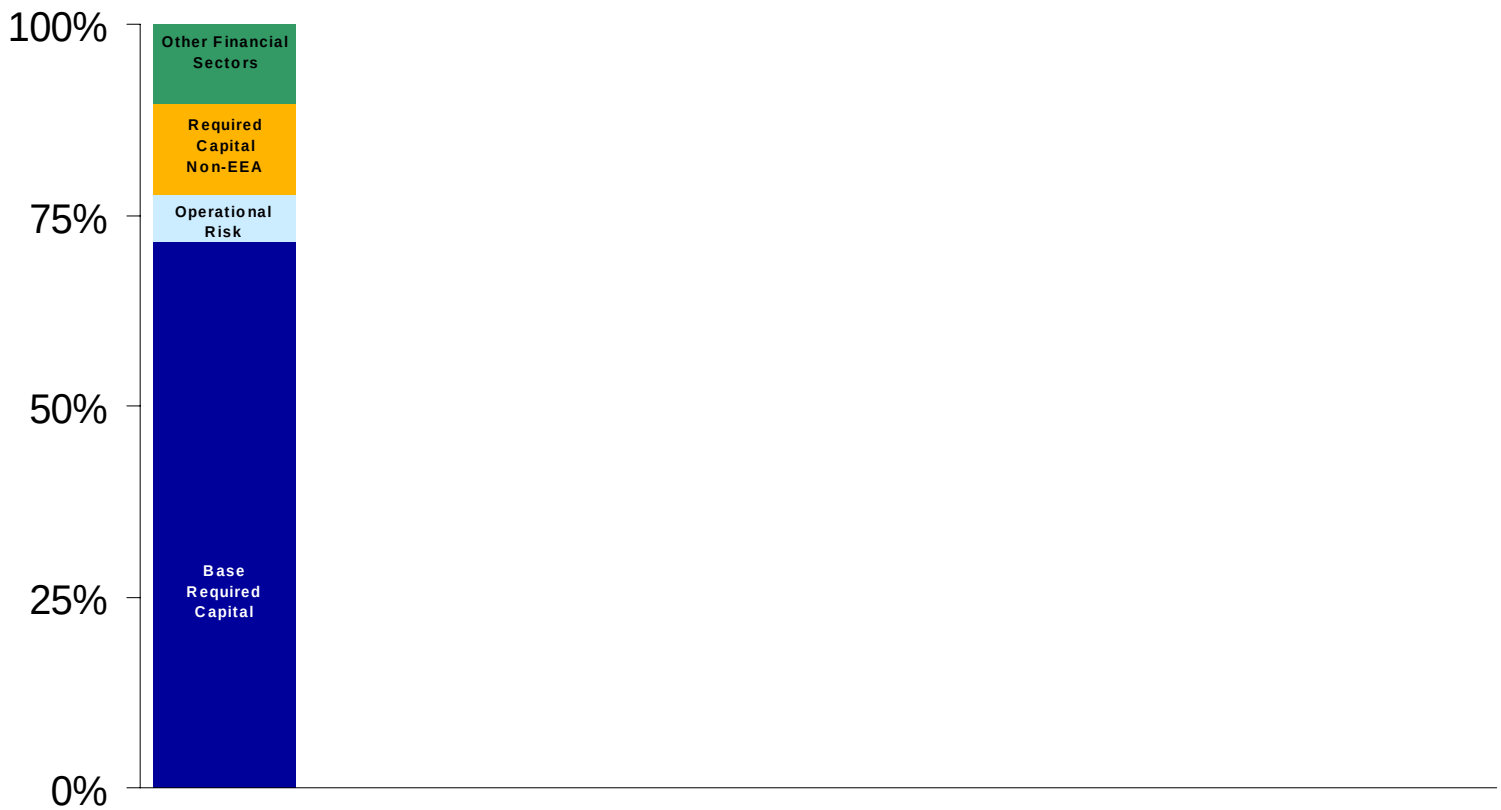
Summary of findings – Group analysis

- **At EEA level, internal model capital requirements are 29% lower than QIS3 requirements** which suggests that the QIS3 standard approach includes significant elements of conservatism compared to group economic assessments undertaken by CRO Forum companies.
- Our analysis indicates that this is driven primarily by:
  - More severe stress tests in QIS3 for life and non-life underwriting risks, than those used in internal models.
  - Less recognition of the impact of diversification between risk classes and between solo entities.
- **For solo entities, internal model requirements are substantially lower (see later sections)**
  - 13% lower for life and 20% lower for non-life
- **Therefore, there is a further layer of conservatism in the QIS3 group model compared to solo-entity basis**
  - Internal model results diverge by a further 10 – 15% from the QIS3 results.
- **At overall group level, including non-EEA, and non-insurance operations, internal model requirements are 21% lower than QIS3 requirements**
  - This indicates that the QIS3 requirements for non-EEA countries and for non-insurance businesses are lower under QIS3 than in the internal models.
  - The main source of difference is on non-EEA insurance businesses. Although the capital requirements are lower, they may be held in addition to statutory reserves (not economic) in non-EEA countries, which creates confusing results.
- **The CRO Forum considers that non-EEA businesses and other financial sectors should be assessed using economic principles consistent** with those used in internal models and under the Solvency II standard approach, and not using the local statutory requirements, which are very different in all respects and therefore create distortions. This applies to available and required capital.
- Operational risk capital requirements are higher under internal models, but these risks diversify across groups and are expected to be closer to QIS3 requirements on a fully diversified basis.

Breakdown of QIS3-Group Required Capital

Left Column: Split of QIS3 Group Required Capital into the components Base Required Capital („BSCR"), Operational Risk, Required Capital Non-EEA and Other Financial Sectors („CR ot").

Note: Geographical diversification and the diversification from aggregating the risk types are implicitly contained in the Base Required Capital and are therefore not shown here.

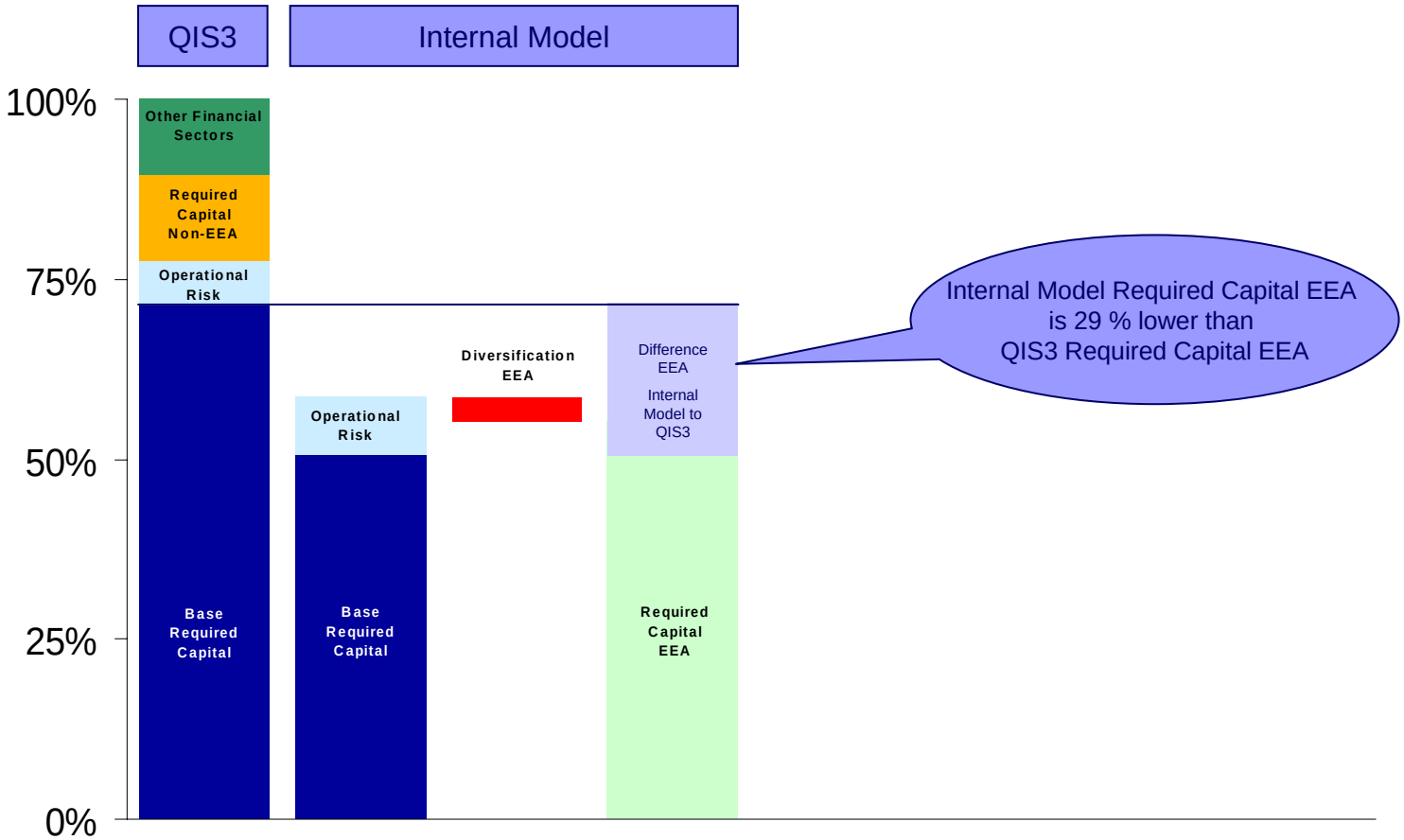


Comparison QIS3 group capital requirements with EEA requirements in internal models

Left Column: QIS3 group results

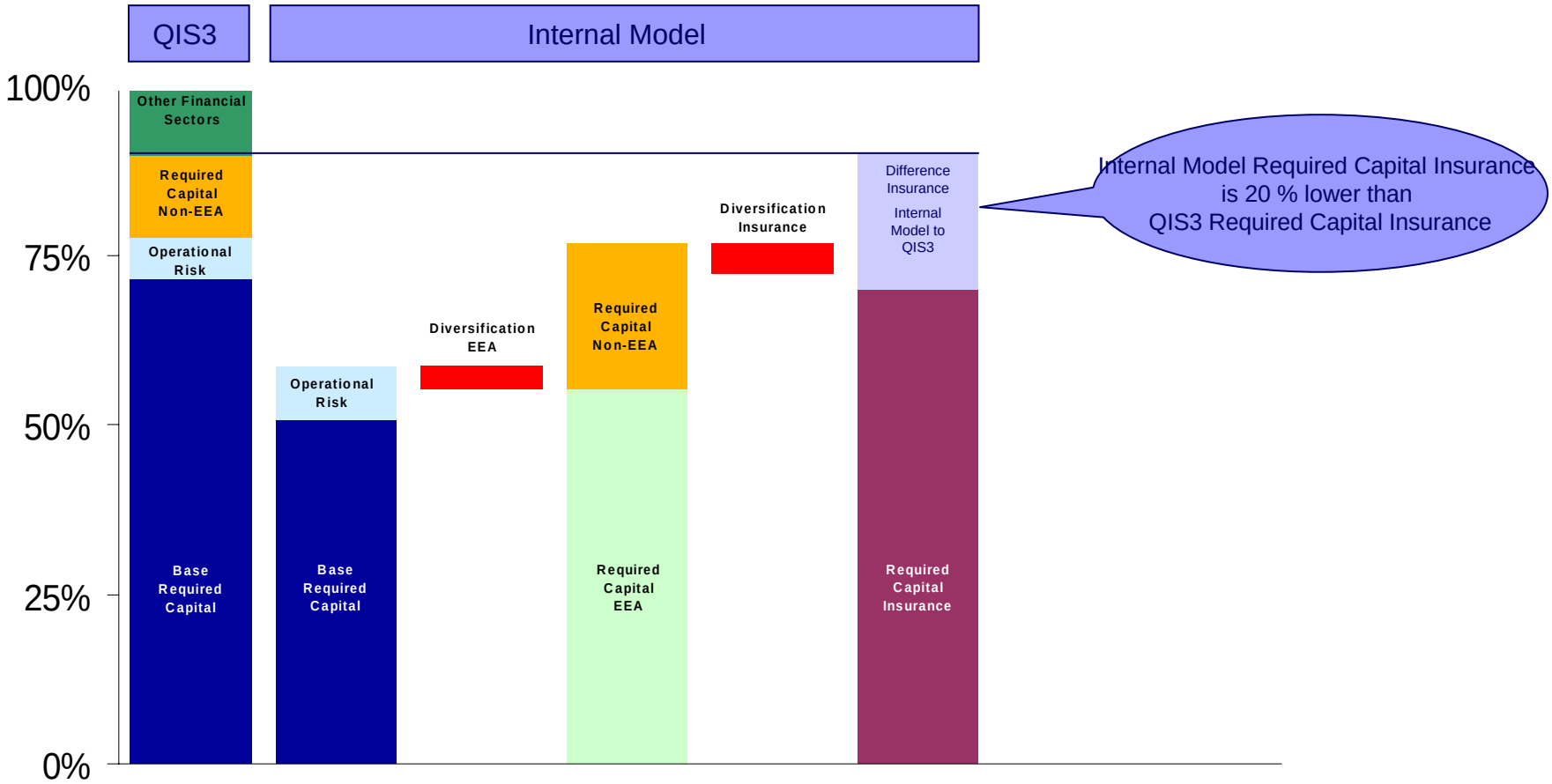
Columns to the right: Internal model results expressed as % of QIS3 Group Required Capital. Diversification EEA represents diversification between

Operational risks and Base Required Capital



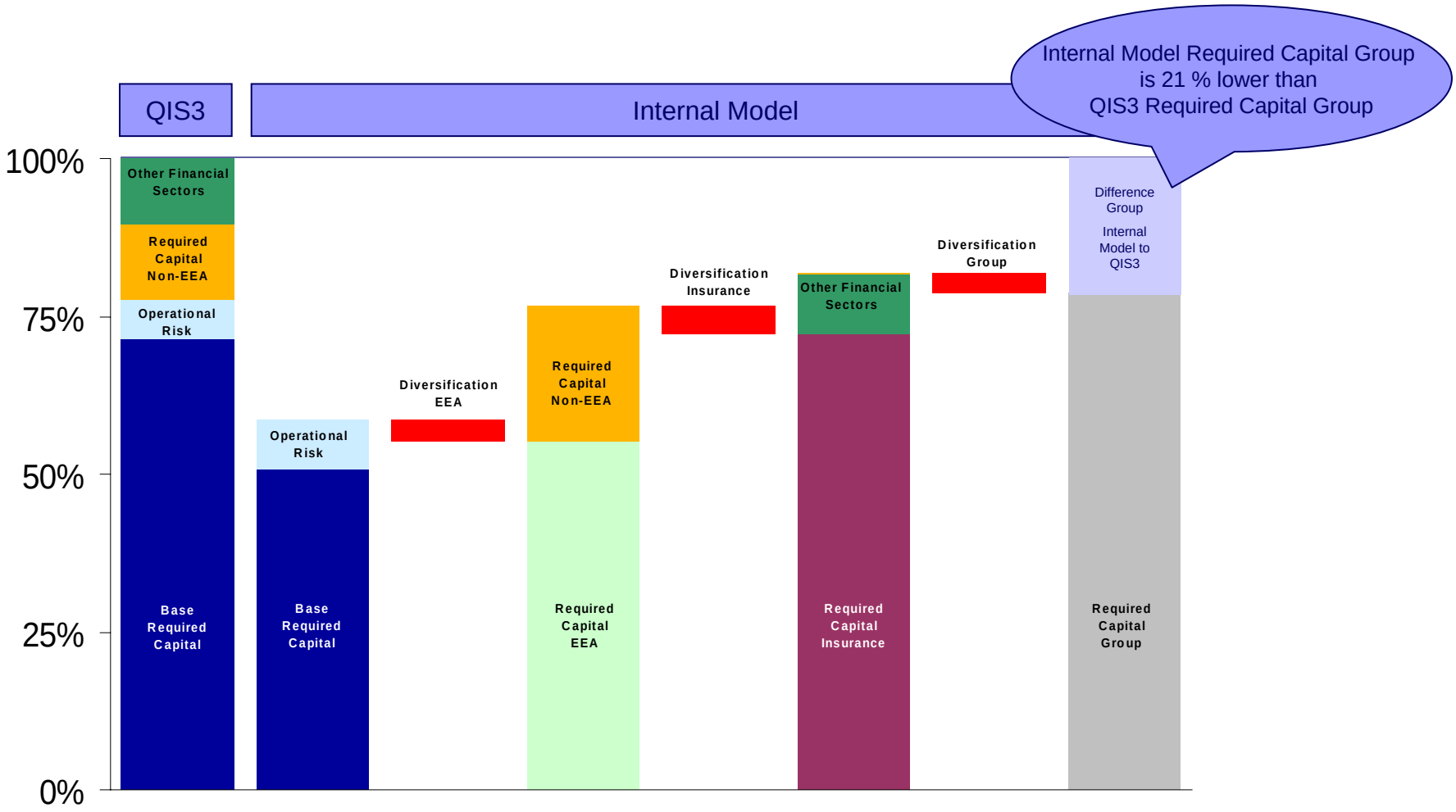
Group view: with impact of non-EEA businesses

Results shown with addition of internal model results for non-EEA



Group view: with impact of other financial services businesses

Results shown with other financial sectors and all group diversification



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    - Non-Life / Reinsurance
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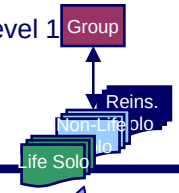
How to read the data

[Type of business]
[Type of comparison]



Type of business:
- Solo Life
- Solo Non-Life
- Solo Reinsurance
- Group

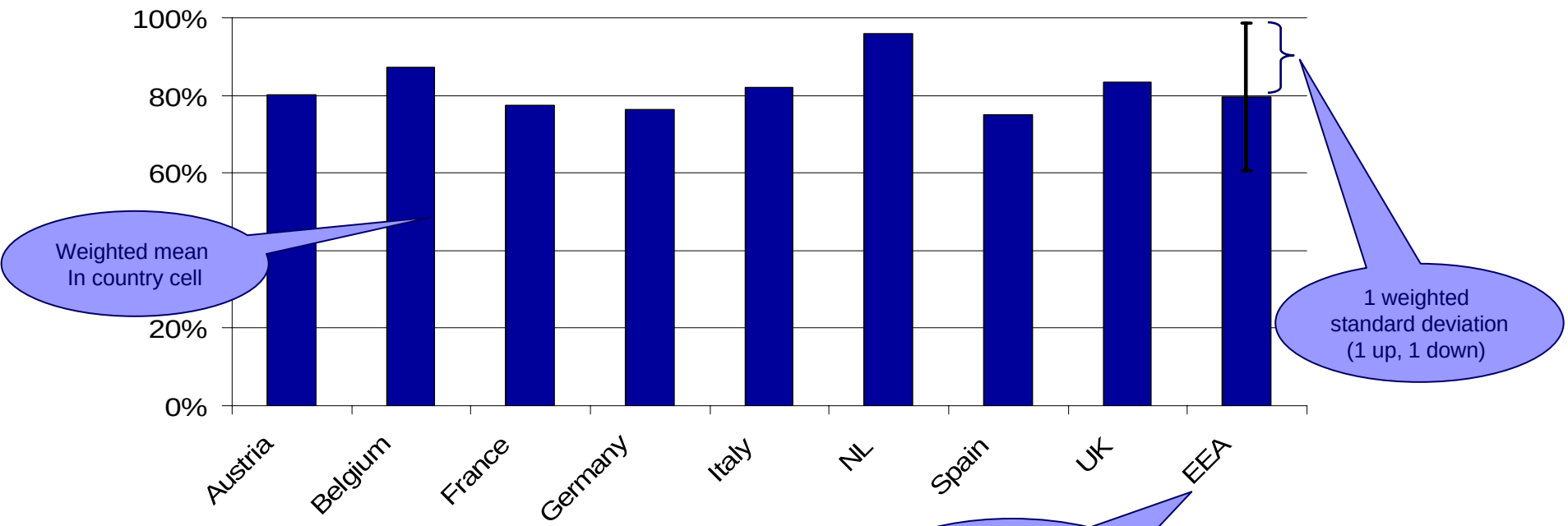
Short description of ratio considered

[measure considered]

More detailed description of measure considered

Level of Analysis:
1 – Top Level
2 – Risk Classes
3 – Risk Types

Quick reference to what type of business is analysed:
- Solo Life
- Solo Non-Life
- Solo Reinsurance
- Group



Weighted mean In country cell

1 weighted standard deviation (1 up, 1 down)

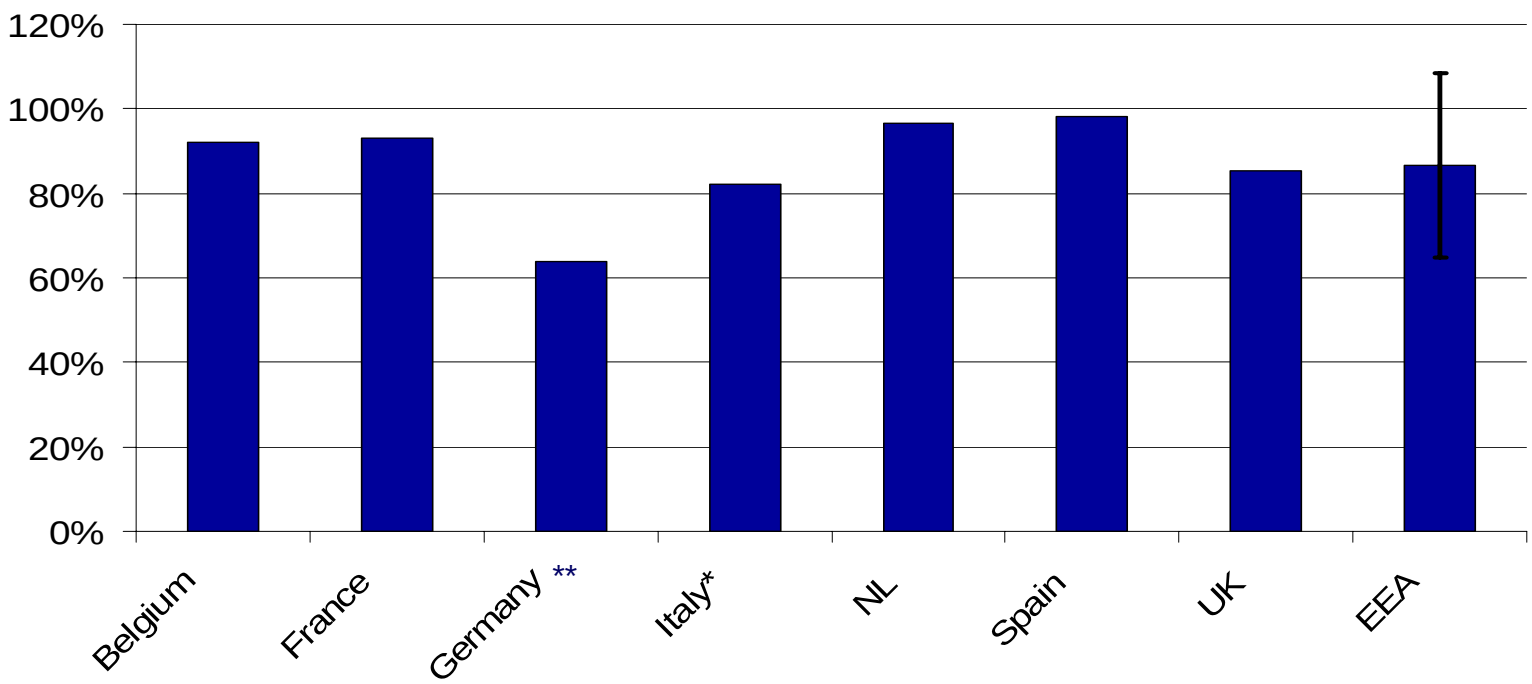
EEA includes weighted mean of all solo data, including those not passed the rule of 3

Summary of findings – Solo-entity life analysis

- Whilst the aggregate results are reasonably close between QIS3 and internal models, **it is incorrect to conclude that the calibration is appropriate**. The aggregate results hide variations by risk type and by country**.**
- **A comparison between undiversified requirements of internal models with the standard approach under QIS3 shows differences by risk**
  - The market risk component similar in internal models and QIS3; the equity/property component higher whilst the interest rate risk component is lower.
  - The life u/w risk component in QIS3 is substantially higher than in the internal model.
- **Total required capital for the internal model amounts to 87% of QIS3 SCR,** with variations by country.
  - The ratio for Germany is out of line with other countries (64%).
  - Much of the difference between QIS3 and internal models can be explained by lower allowance for diversification in QIS3. This impact of diversification is driven partly by results from Germany. This is thought to be due to the significant differences in methodology for Germany where CEIOPS has prescribed definitions of available and required capital which includes treatment of profit-sharing reserves on a basis which is not consistent with that applied in other countries.
  - Some members have expressed concern that the KC factors do not provide an appropriate recognition of the impact of risk mitigation through changes to bonus rates, which may cause distortion of the results. We have not been able to quantify this impact.

Life Solo
Internal model Required Capital to QIS3 Required Capital

Required Capital („SCR") including Operational Risk



*Combined results of life and non-life solo entities are shown because several companies are composites.

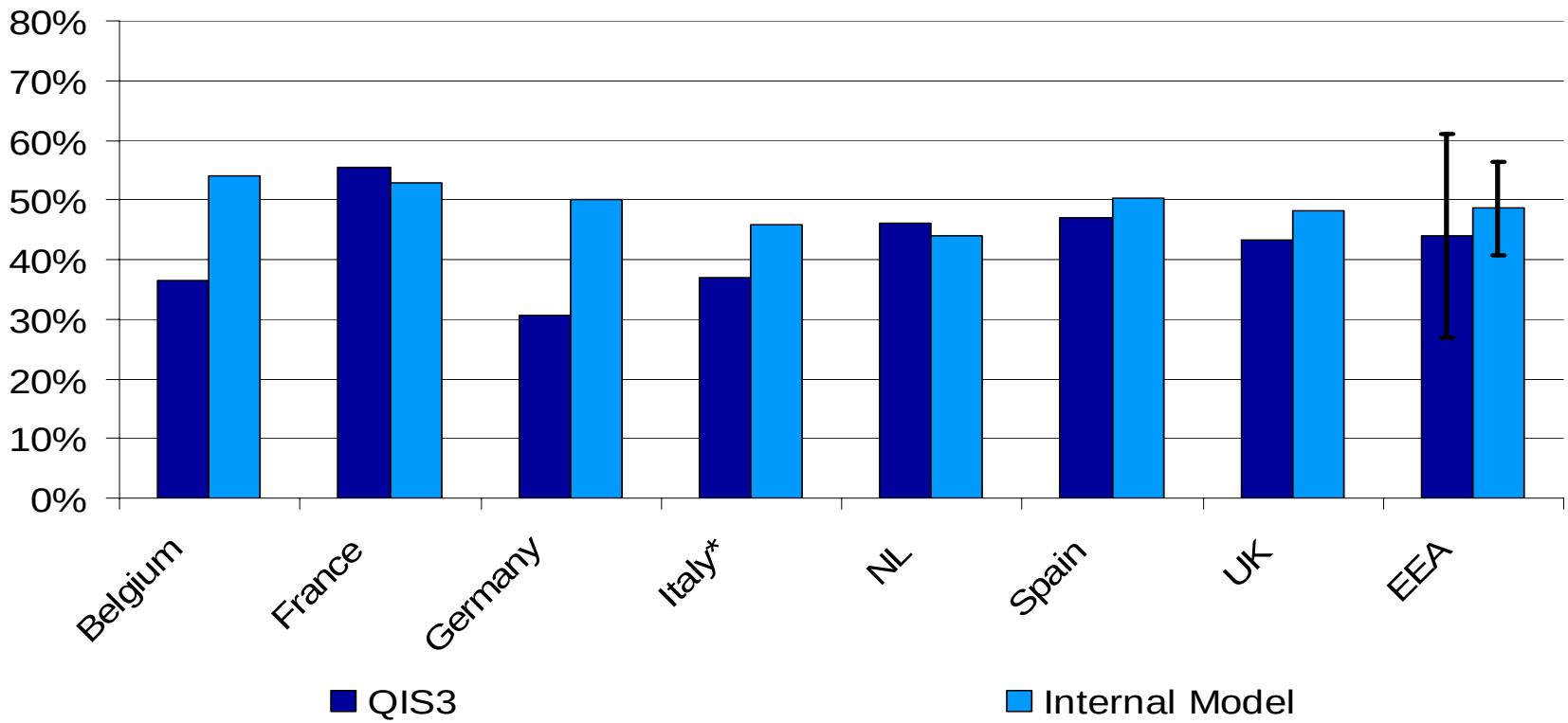
** Different methodologies were prescribed for Germany

Impact of diversification

- The reduction in capital requirements due to diversification is lower under QIS3 than that included in internal models. In aggregate for the EEA, the diversification credit across risk types is 49% of undiversified capital in internal models, compared to 44% under QIS3 i.e. the allowance is some 10% lower.

Life Solo
Impact of Diversification

Diversification is between sum of risk types (net of KC) and Basis Required Capital („BSCR"), i.e. without considering aggregation at risk class level.
For QIS3, after limitation by future distribution benefits (FDB).
Internal Model figures contain diversification effects from operational risk.



* Combined results of life and non-life solo entities are shown because several companies are composites.

Required capital by risk class

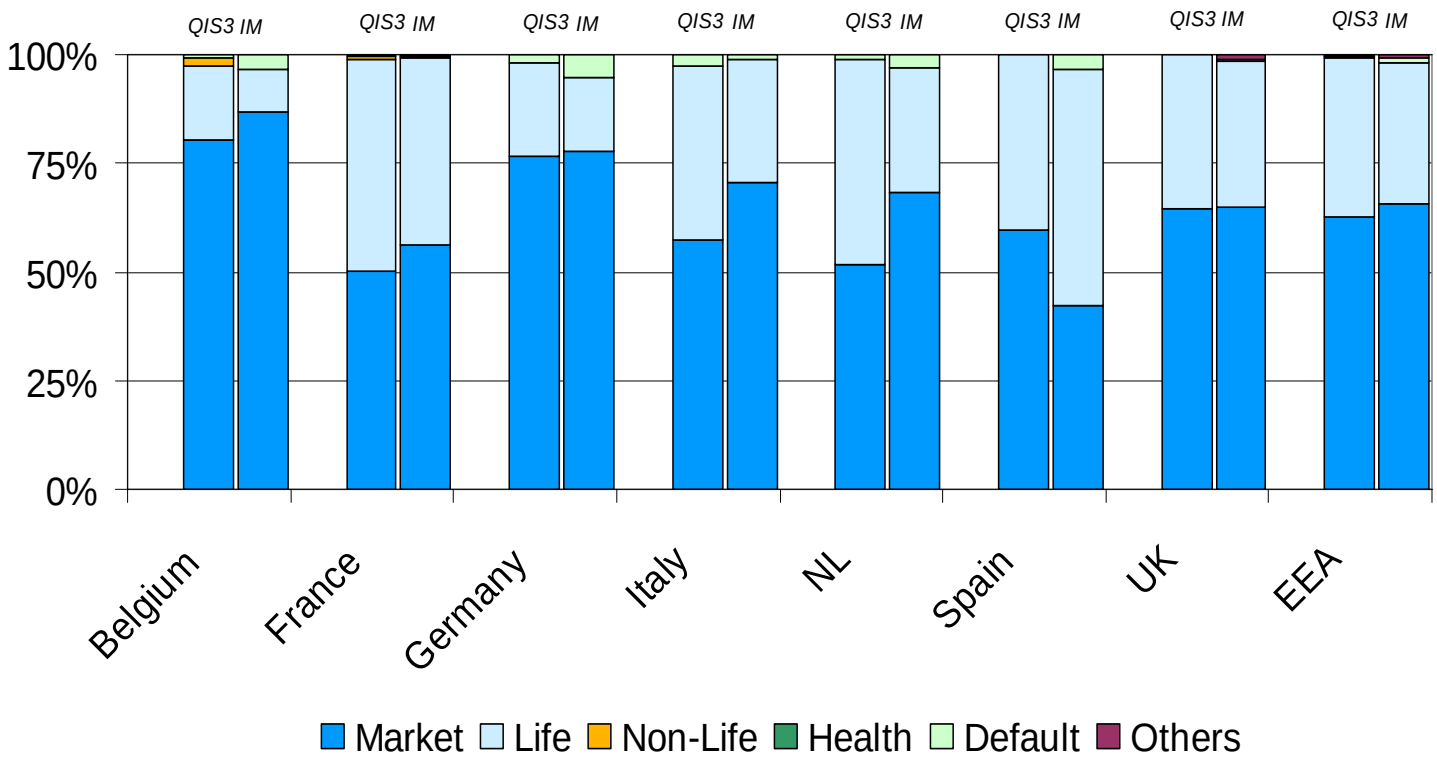
- The breakdown of required capital by undiversified risk classes is broadly similar under QIS3 and internal models
- Note that
  - The aggregate undiversified market risk component is similar in internal models and in QIS3, although the higher requirements for equities/property offset lower requirements for interest rate risk and spread.
  - The total undiversified life underwriting risk component is higher in QIS3 than in the internal model
- Non-life risks are not shown here for Italy (composites).

Life Solo
Required Capital by undiversified Risk Classes as % of Sum of Risk Types before Diversification

Each Risk Class is undiversified, i.e. equals the sum of Risk Types (net of KC – after risk mitigation through future profit sharing).

All the Risk Classes have been summed.

The graph shows the split of the undiversified Risk Classes.

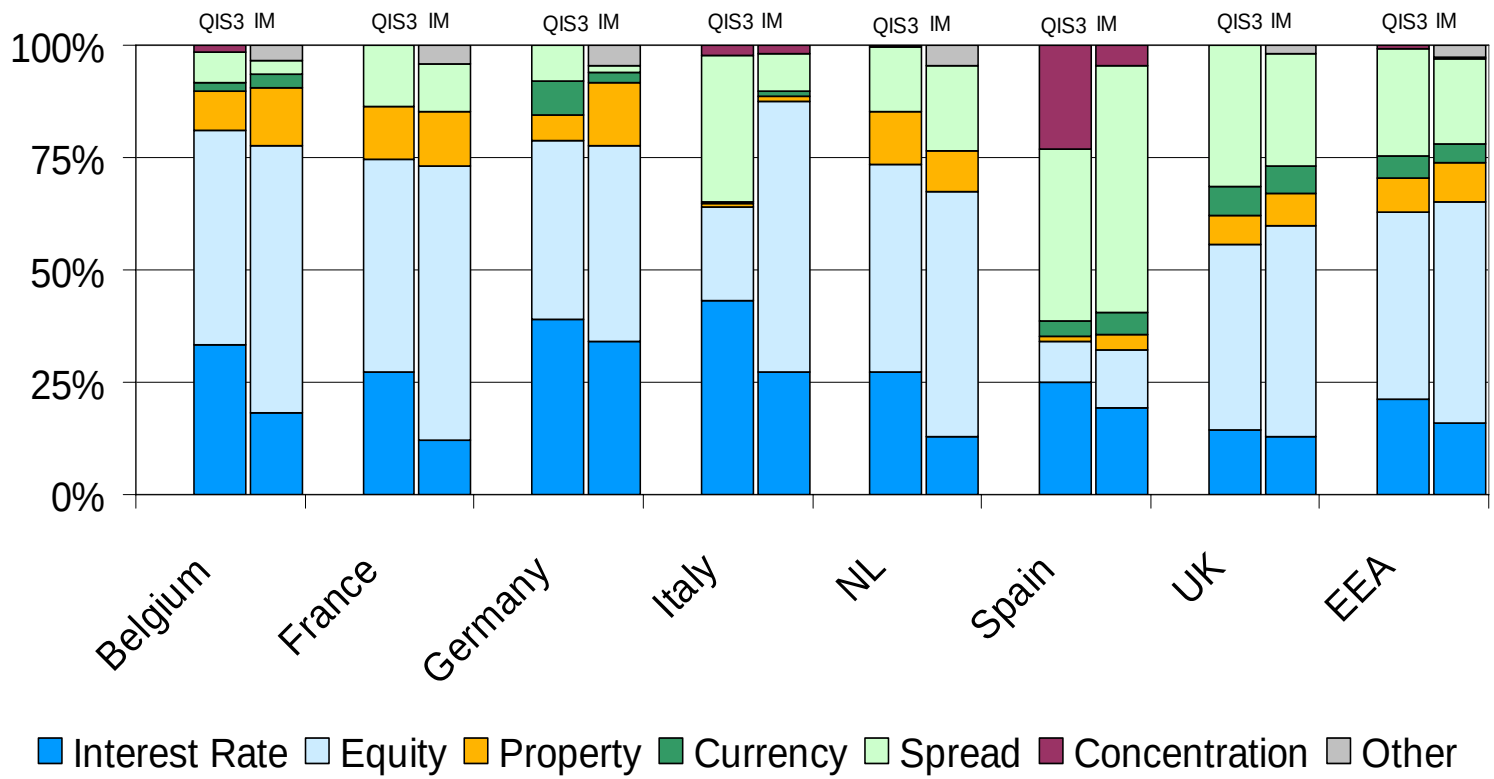


Market risk – breakdown by risk type

- In aggregate for the EEA, the breakdown of capital requirements by risk type is similar under QIS3 and internal models

Life Solo
Market Risk by Risk Types
as % of Total Requirements for all Risk Types before Diversification

Total Requirements for all Risk Types before Diversification refers to the sum of Risk Types (net of KC – after risk mitigation through future profit sharing)



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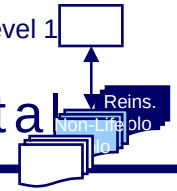
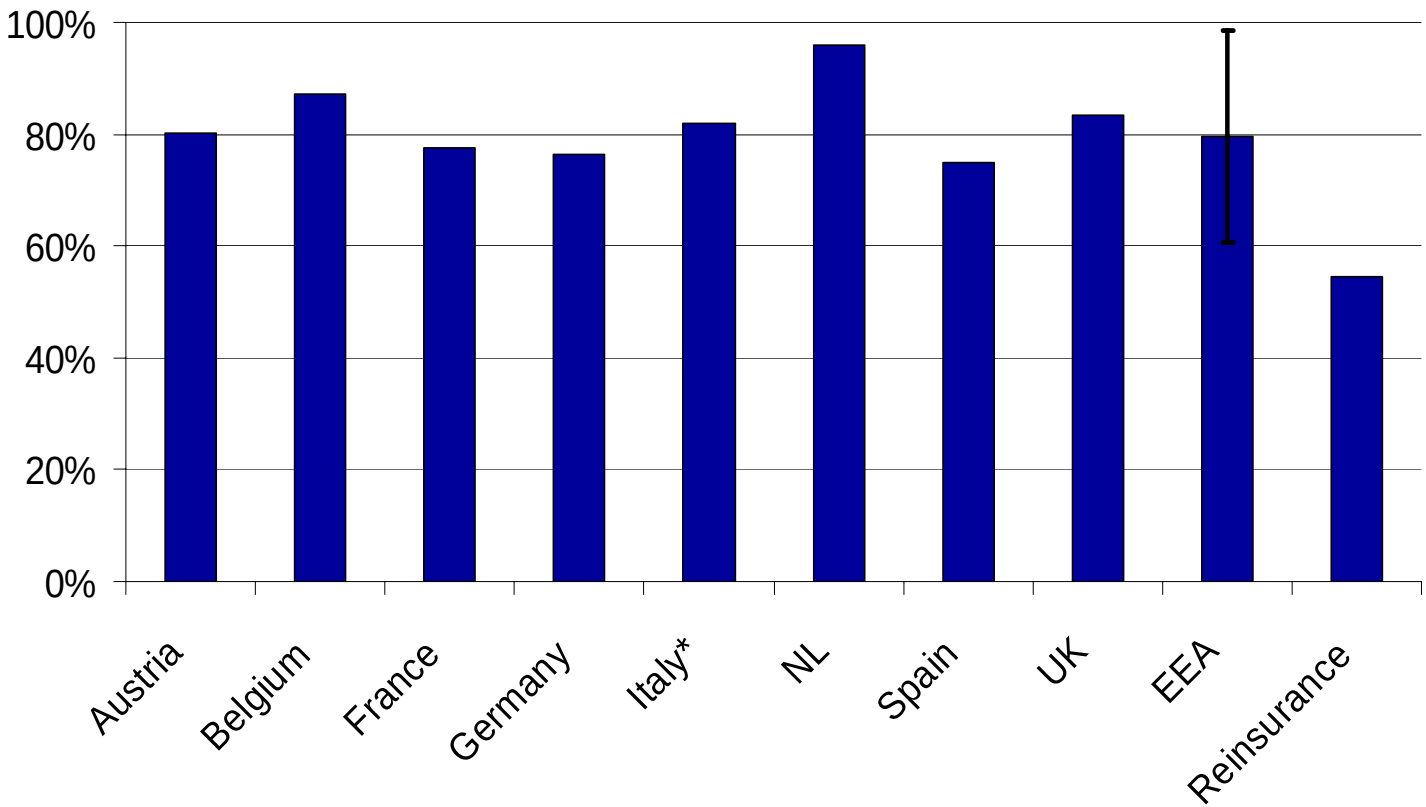
Summary of findings – Solo entity non-life analysis

- **Required capital for internal models amounts to 80% of QIS3 SCR**
  - The results are surprisingly similar/stable by country, but this hides variation between companies. Requirements for reinsurance are much lower in internal models (54%) which suggests that the calibration of the standard approach for QIS3 was particularly unsuitable for reinsurers.
  - Capital requirements are significantly higher than under the current solvency regime.
- **The two key reasons for the difference are:**
  - Higher capital requirements for non-life underwriting risks under QIS3
  - Less credit for diversification between risk types and lines of business.
- **For reinsurers, possible reasons for the additional differences are:**
  - non-life reinsurance portfolios exhibit a larger degree of geographic diversification than primary insurance portfolios
  - due to the coverage of many markets and products in reinsurance portfolios, run-off behaviours are different and diversify better
- Overall, the calibration of non-life risk is too high for the business written by CRO Forum companies.
  - This impacts not only the required capital, but also leads to overstatement of the technical provisions through the cost of capital in the market value margin and hence reduces the available resources.
  - This will also have adverse consequences on product pricing.

Non-Life / Reinsurance Solo
Internal model Required Capital to QIS3 Required Capital



Required Capital („SCR") includes Operational Risk



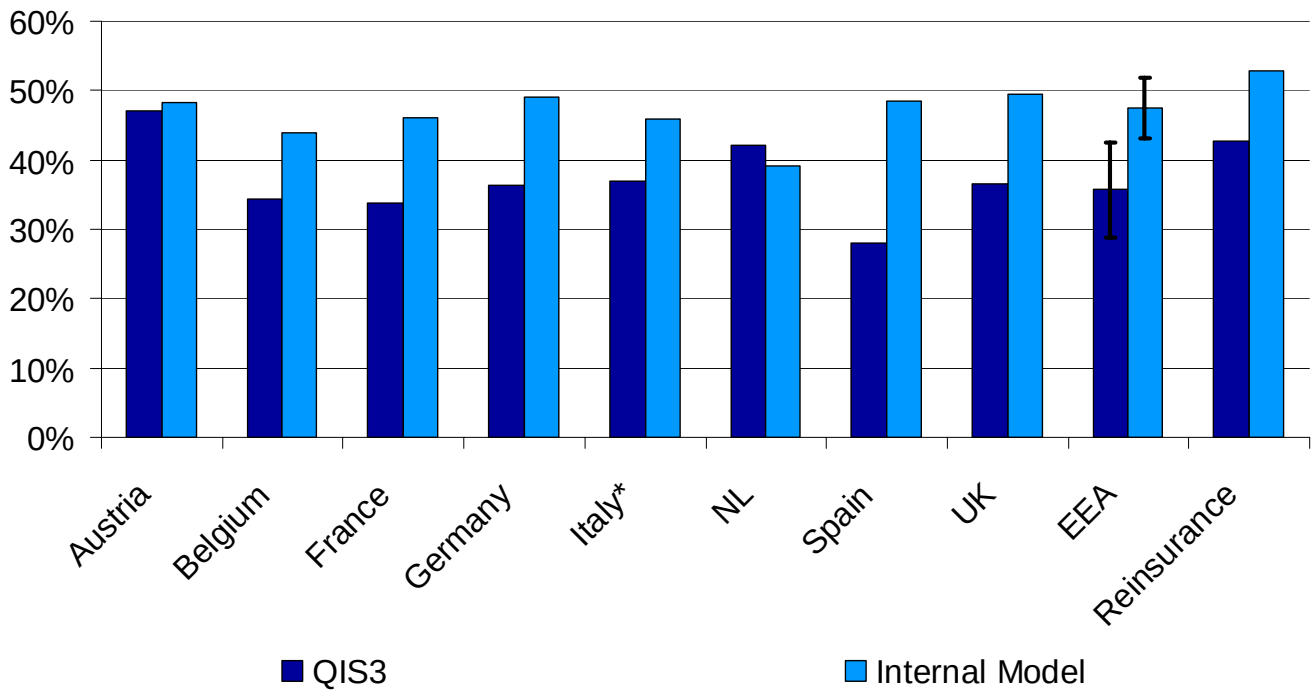
* Combined results of life and non-life solo entities are shown because several companies are composites.

Allowance for diversification

- The reduction in capital requirements due to diversification is significantly lower under QIS3 than that included in internal models. In aggregate for the EEA, the diversification credit across risk types is 48% of undiversified capital in internal models, compared to 36% under QIS3 i.e. the allowance is some 25% lower.
- For all countries except for the Netherlands, the allowance under QIS3 is lower, in some cases very significantly which suggests that the calibration has been set in a conservative manner.

Non-Life / Reinsurance Solo
Impact of Diversification

Diversification is between sum of risk types (net of KC) and Basis Required Capital ("BSCR"), i.e. without considering aggregation at risk class level.
For QIS 3, after limitation by future distribution benefits (FDB).
Internal Model figures contain diversification effects from operational risk.
In QIS3, Premium and Reserve Risk (NL_{pr}) are considered one risk type, i.e. QIS3 figures are after diversification effects arising from aggregating Premium Risk and Reserve Risk.



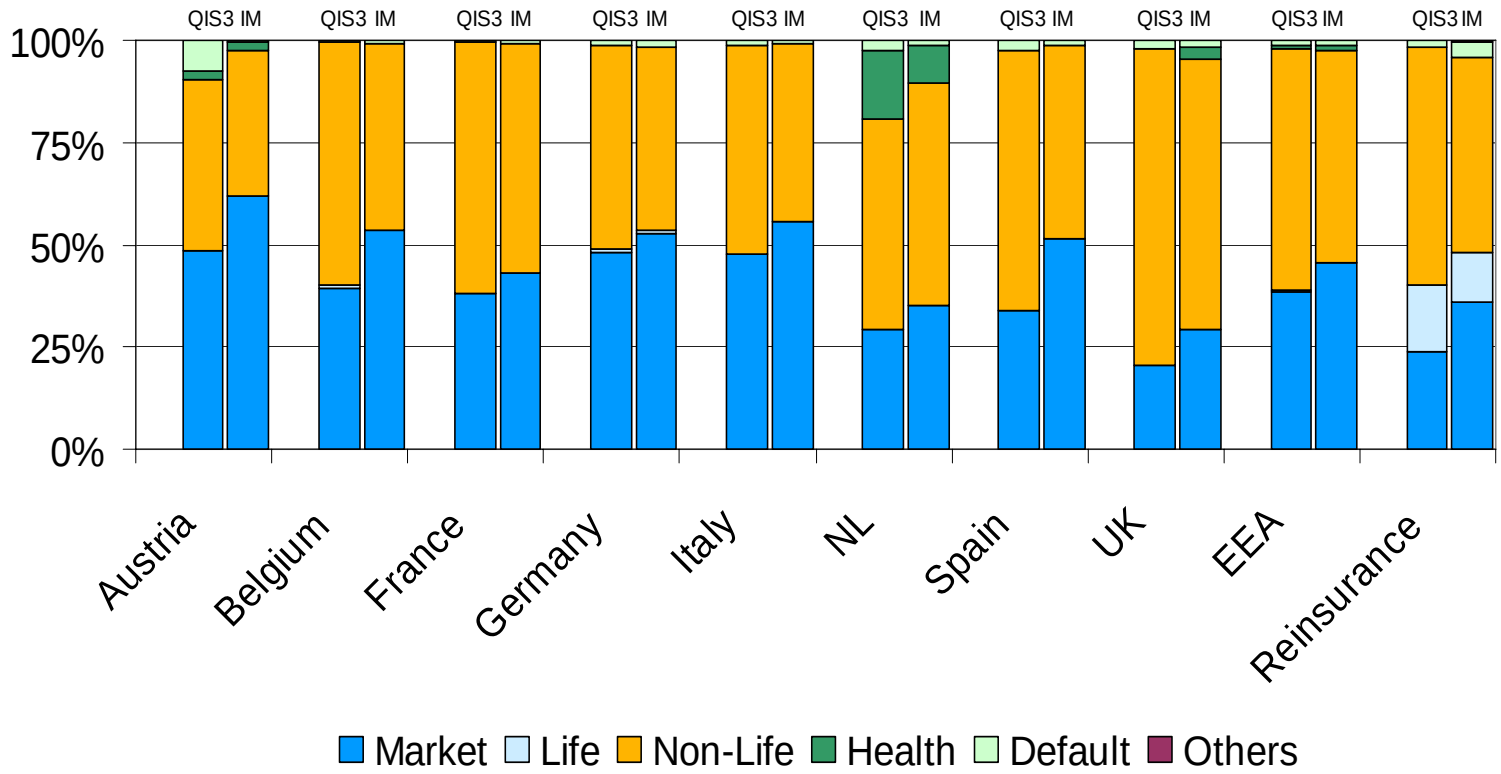
* Combined results of life and non-life solo entities are shown because several companies are composites.

Required capital by risk class

- The breakdown of required capital by undiversified risk classes shows lower market risk and higher non-life u/w risk components in QIS3 compared to internal models (expressed as a percentage of the total)
- The capital requirement for non-life underwriting risk for reinsurance is significantly higher under QIS3.

Non-Life / Reinsurance Solo
Required Capital by undiversified Risk Classes as % of sum of Risk Types before Diversification

Each Risk Class is undiversified, i.e. equals the sum of Risk Types (net of KC – after risk mitigation through future profit sharing).
All the Risk Classes have been summed.
The graph shows the split of the undiversified Risk Classes.

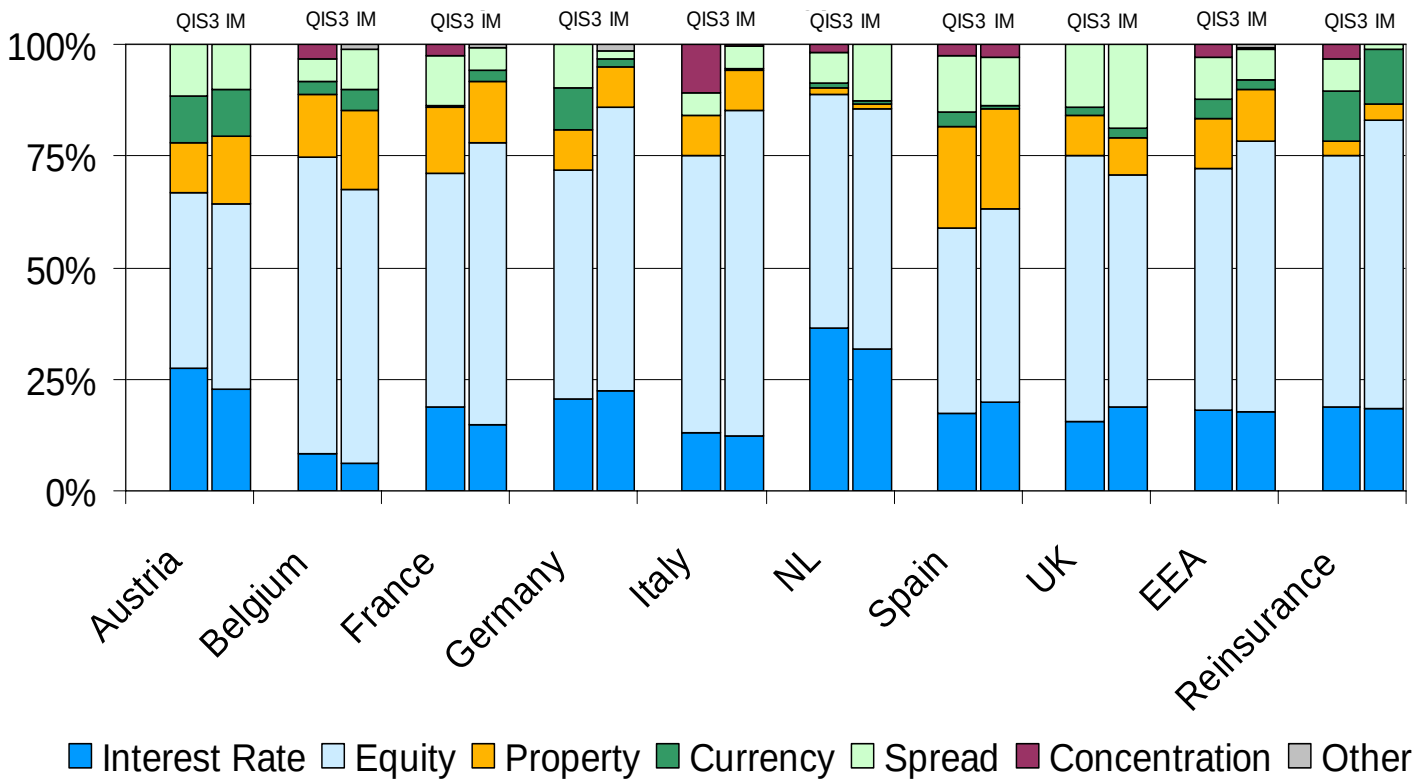


Market risk – breakdown by risk type

- The breakdown of capital requirements by risk type are overall broadly similar under QIS3 and internal models

Non-Life / Reinsurance Solo
Market Risk by Risk Types
as % of Total Requirements for all Risk Types before Diversification

Total Requirements for all Risk Types before Diversification refers to the sum of Risk Types (net of KC –after risk mitigation through future profit sharing)

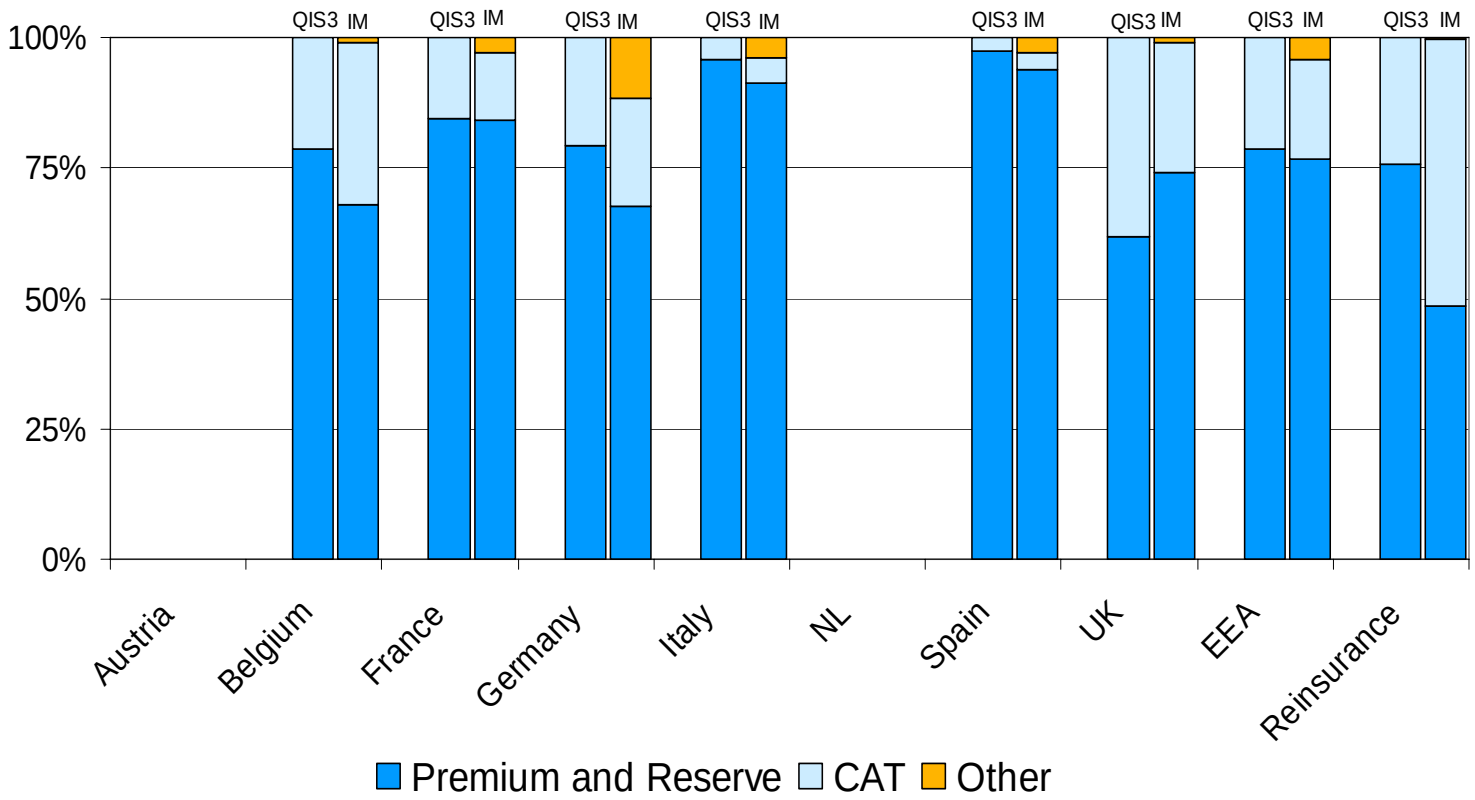


Non-life underwriting risks by risk type

- CRO Forum members have expressed concerns that the results for Catastrophe capital requirements are not appropriate.
  - There is a concern that the aggregate results hide inappropriate results for individual companies that are over- and understated, in some cases significantly.
  - Some members have expressed concerns in the group context: the current aggregation method underestimates diversification effects for Catastrophe risks.
  - There should be more encouragement for company-defined scenarios or partial internal models (e.g. internal assessment of capital required for Catastrophes, combined with standard approach) to better reflect actual risk exposures.

Non-Life / Reinsurance Solo
Non-Life u/w Risk by Risk Types
as % of Total Requirements for all Risk Types before Diversification

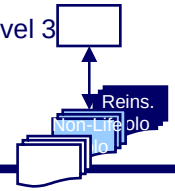
Total Requirements for all Risk Types before Diversification refers to the sum of Risk Types (net of KC – after risk mitigation through future profit sharing)

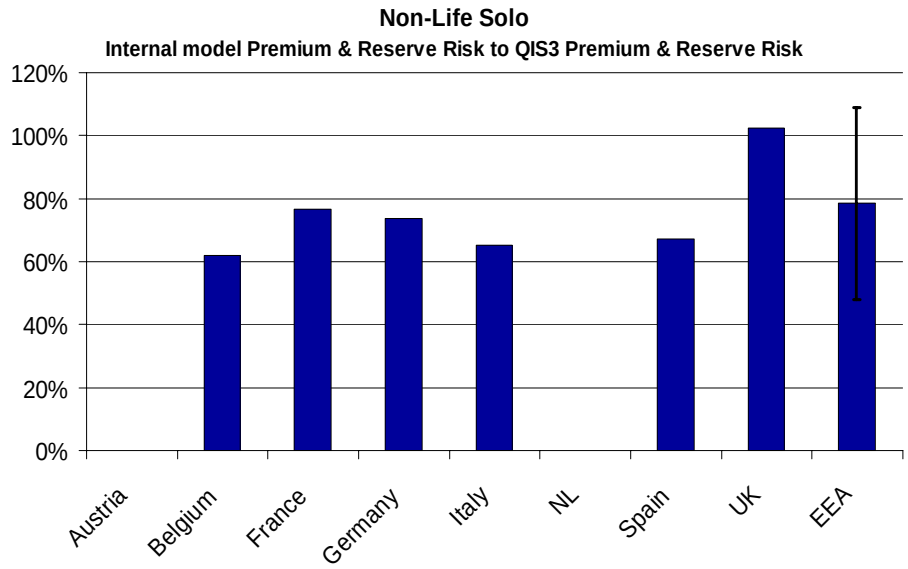


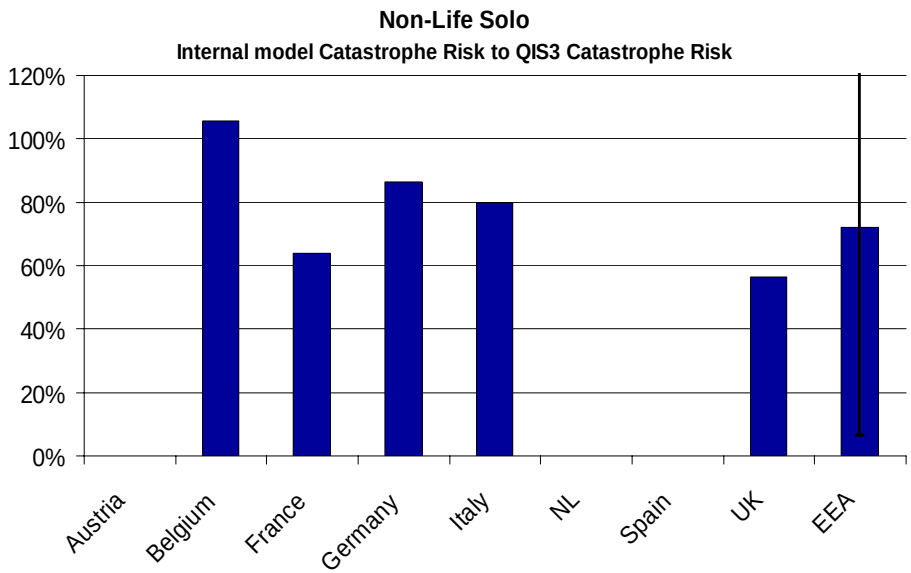
Non-life u/w risk types

- Premium and Reserve Risk as well as CAT risk in QIS3 is substantially higher for most countries than in the internal models, but there are massive variations by solo company for CAT risk.

Non-life u/w risk types
Internal model to QIS3







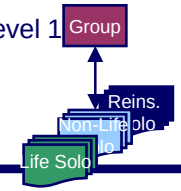
CONTENTS

- Background and Objectives
- Key Conclusions and Recommendations
- Results
  - Group
  - Parameters/calibrations
  - Solo Entity
    - Life
    - Non-Life / Reinsurance
  - **Operational risks**

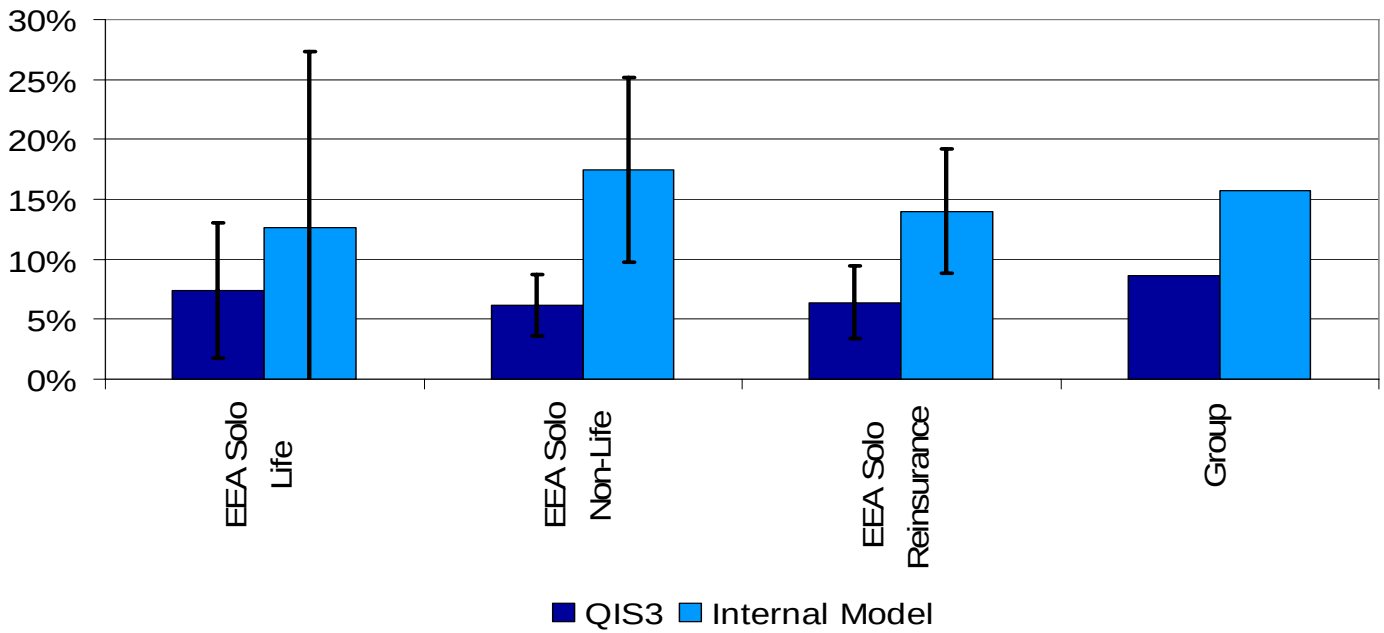
Operational risks

- Required capital for operational risks is higher under the internal models, but much of this difference diversifies between solo entities and with other risks in internal models
  - Under QIS3, the requirement is lower, but no credit is given for diversification.
- Therefore, these results should be interpreted with caution, as the general approaches in QIS3 and internal models are very different.

Solo and Group
Operational Risk as % of Basis Required Capital



Basis Required Capital („BSCR“) does not include Operational Risk
Caution 1: Data Bases between Solo and Group results may be different
Caution 2: Figures are undiversified both for QIS3 and Internal Model. In QIS3, there is no allowance for diversification whereas internal models allow for diversification on operational risk.

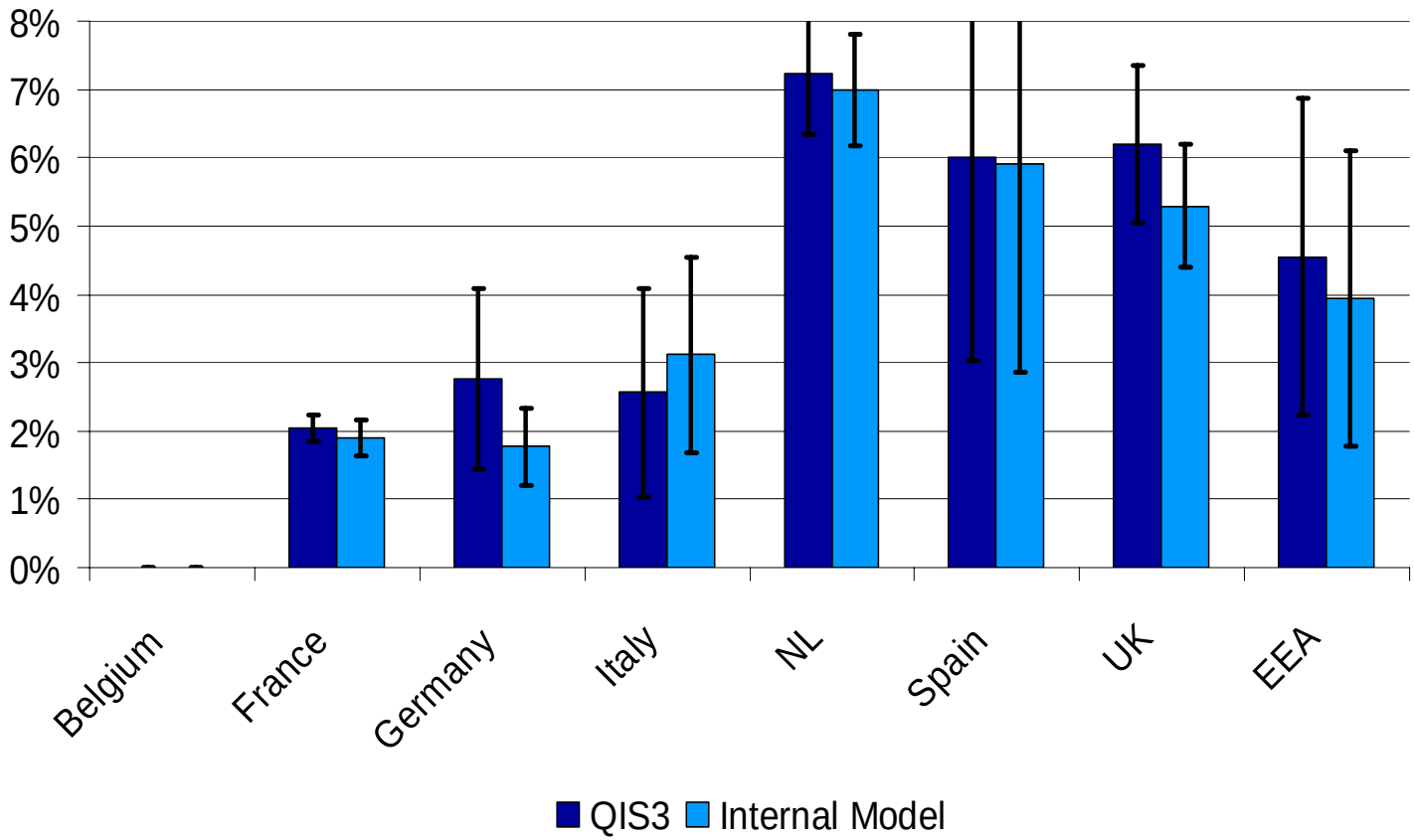


APPENDIX

Life Solo
Required Capital as % of Total Assets

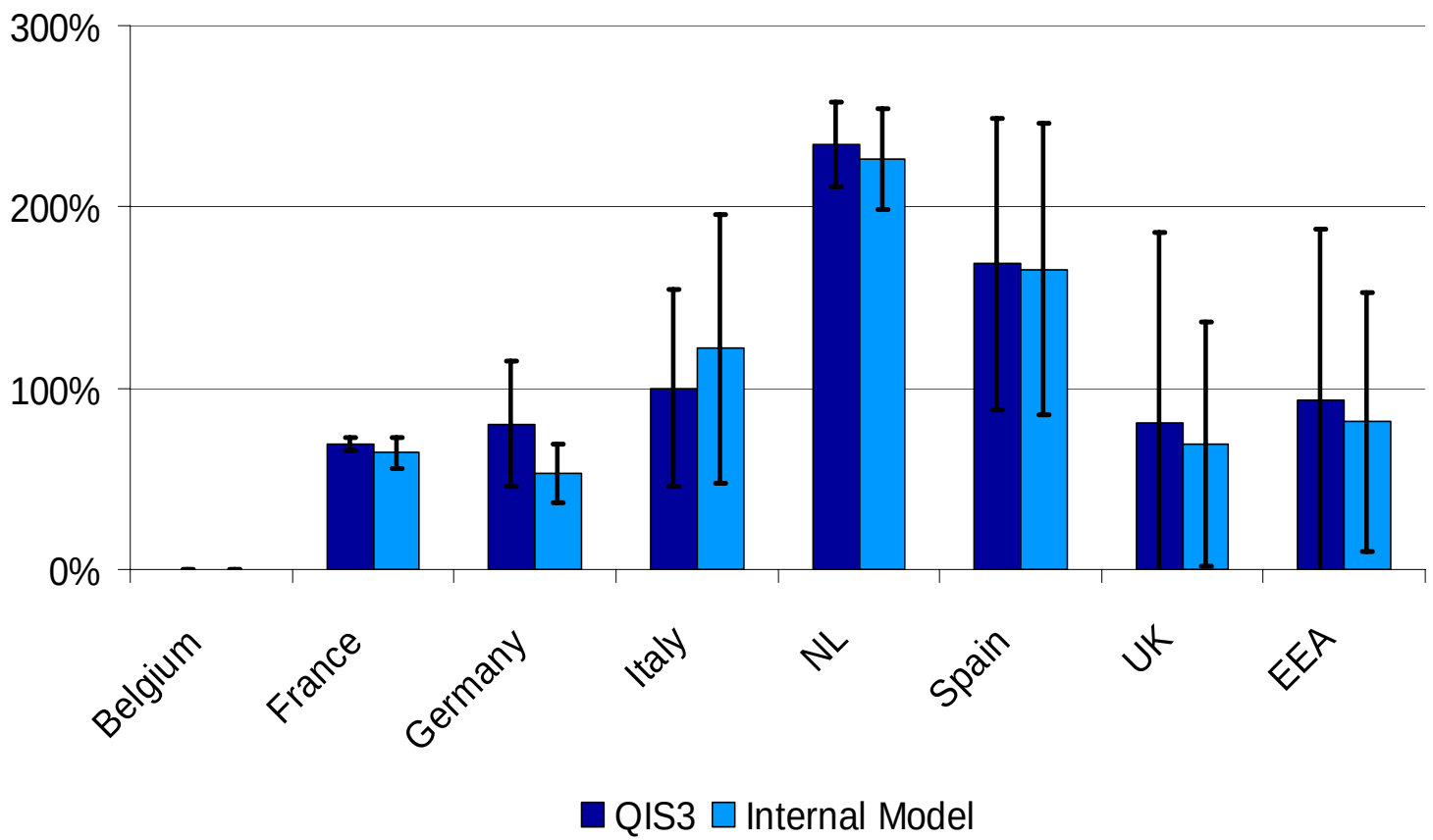
Required Capital („SCR“) includes Operational Risk

Total Assets refers to balance sheet total

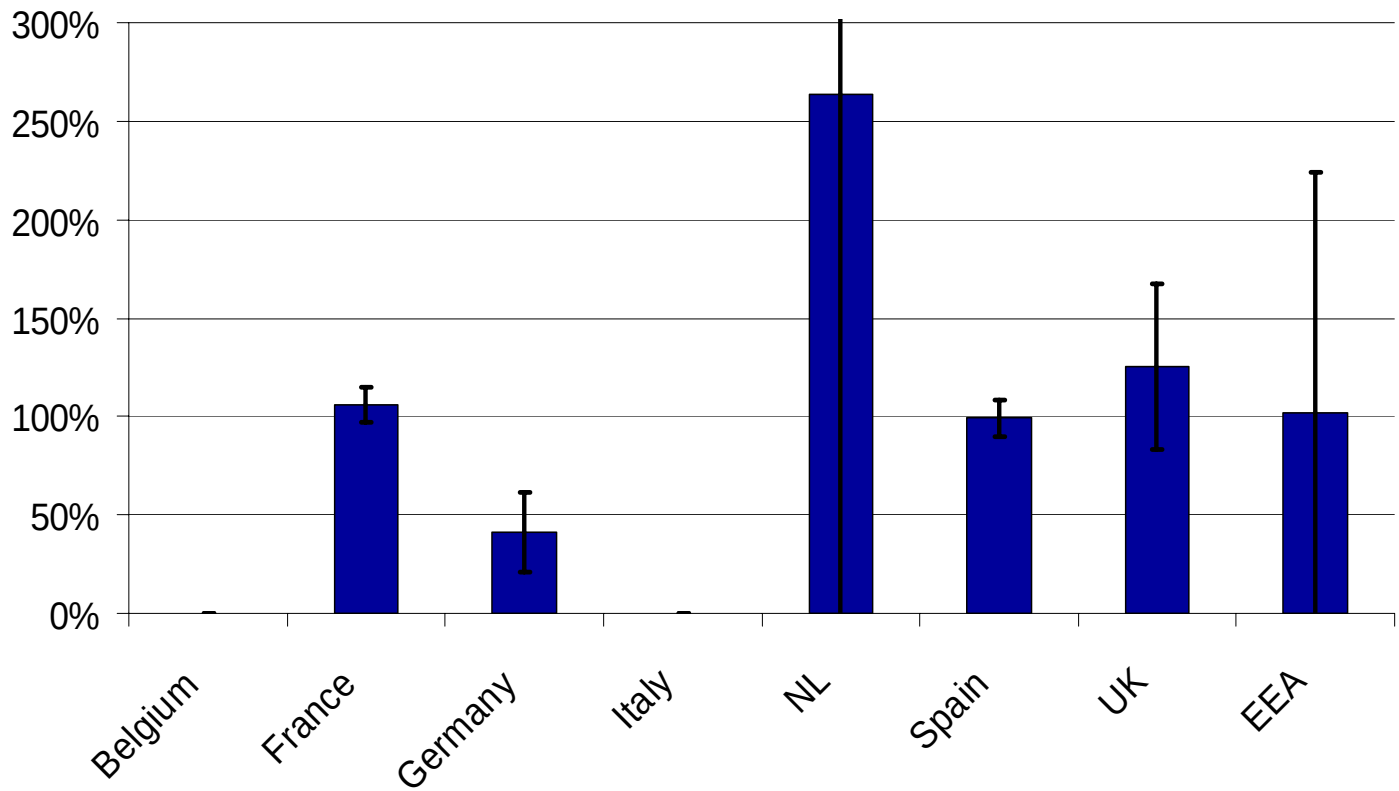


Life Solo
Required Capital as % of Solvency I Required Capital

Required Capital („SCR“) includes Operational Risk

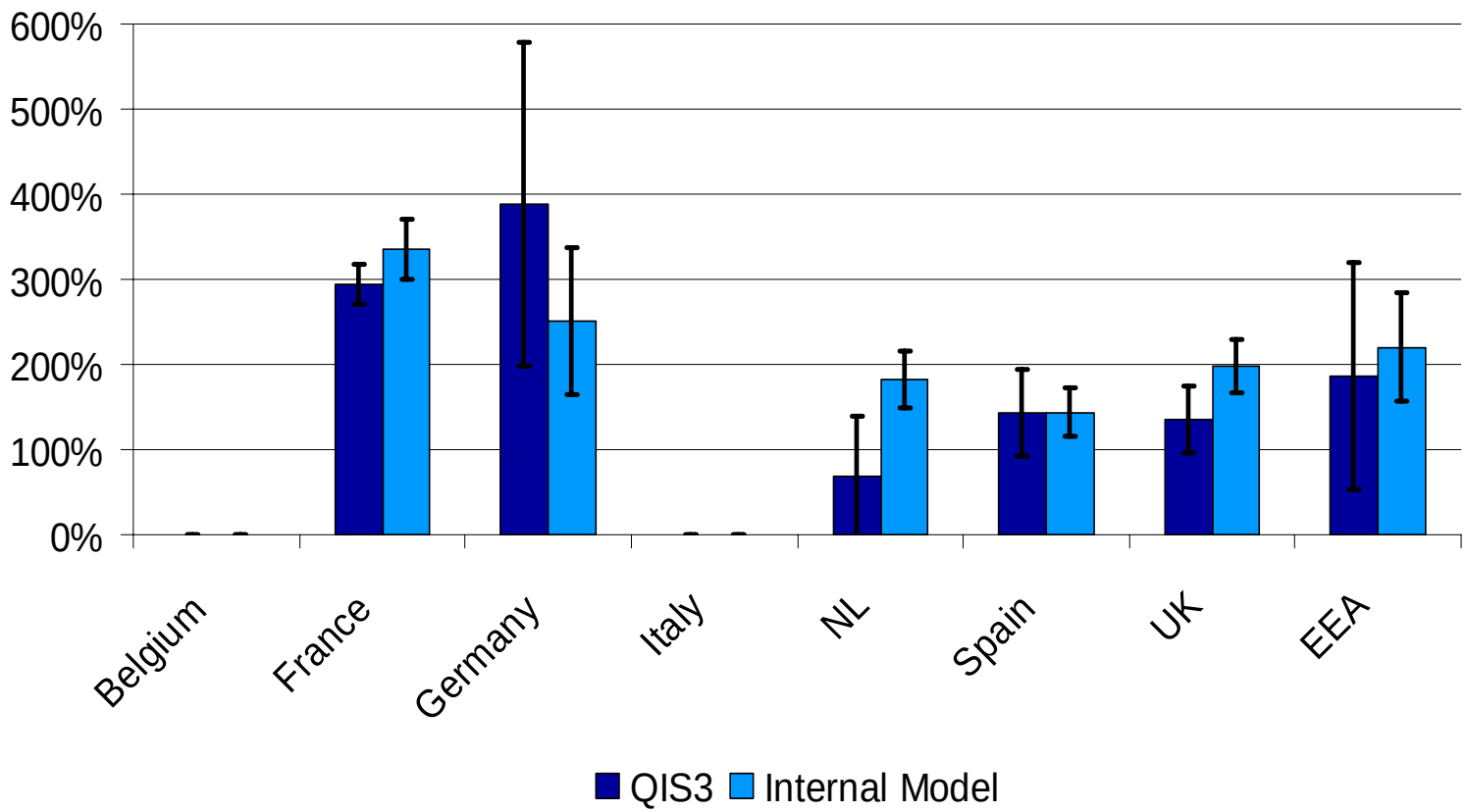


Life Solo
Internal Model Eligible Capital as % of QIS3 Eligible Capital



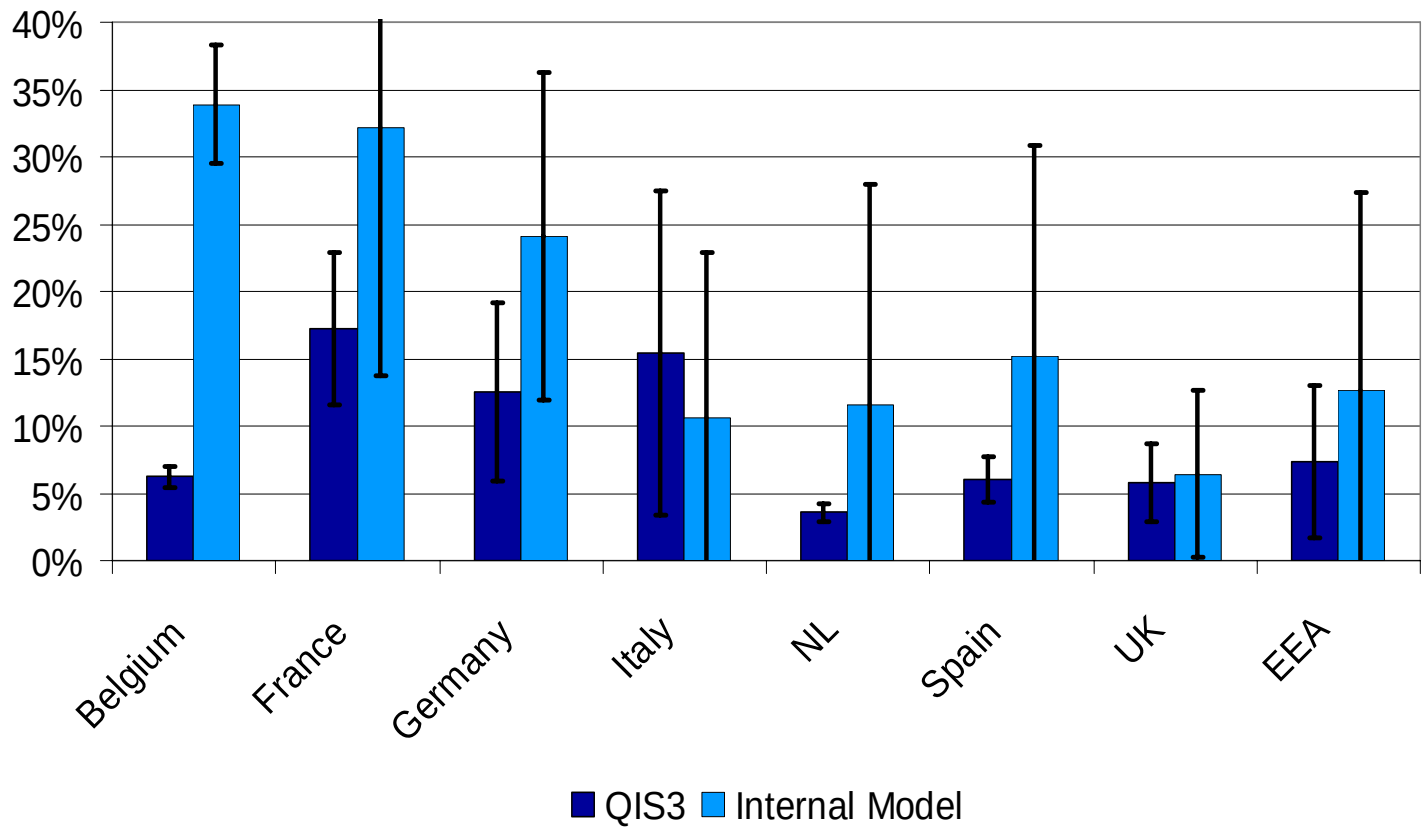
Life Solo
Coverage Ratio
Eligible Capital as % of Required Capital

Required Capital („SCR“) includes Operational Risk



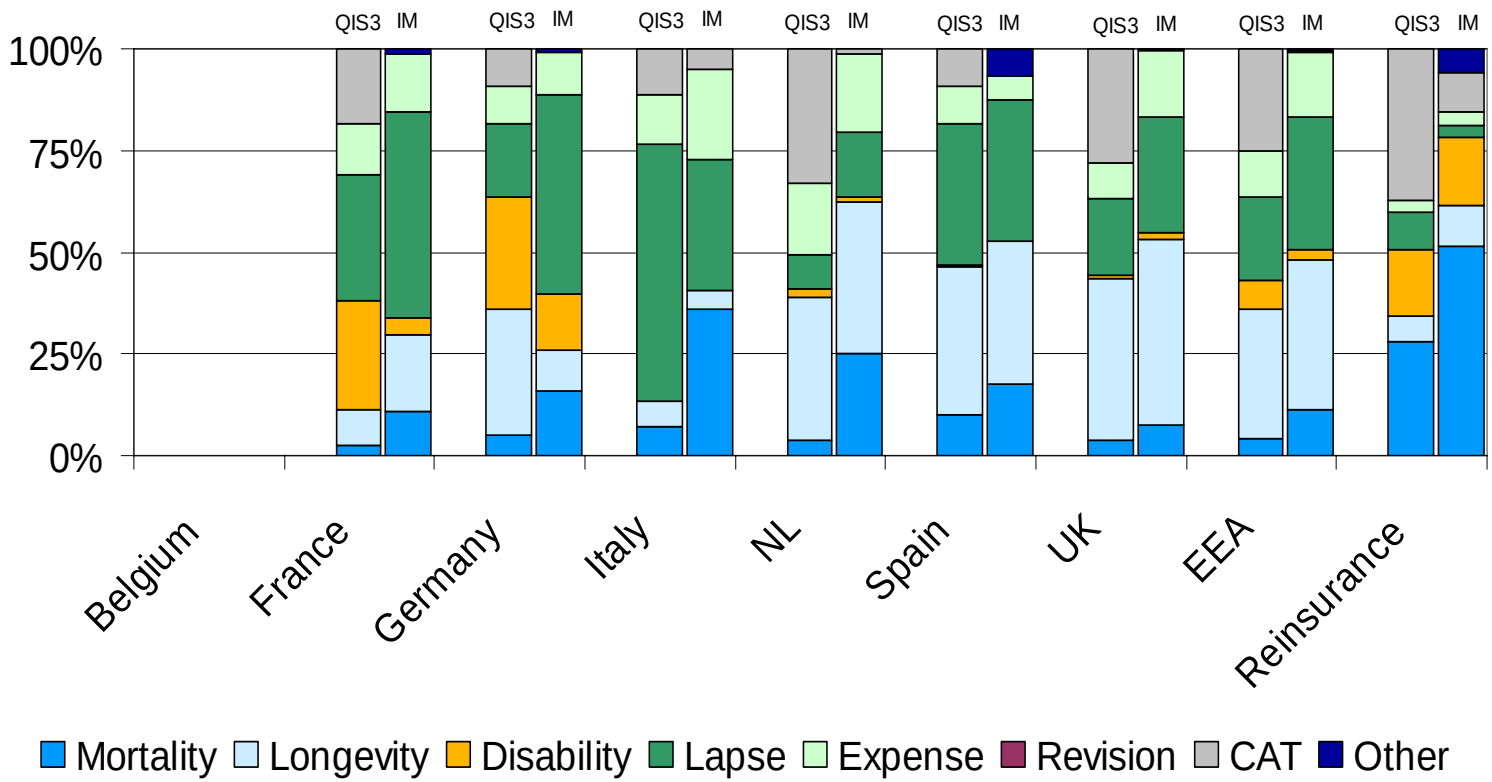
Life Solo
Operational Risk as % of Basis Required Capital

Basis Required Capital („BSCR“) does not include Operational Risk



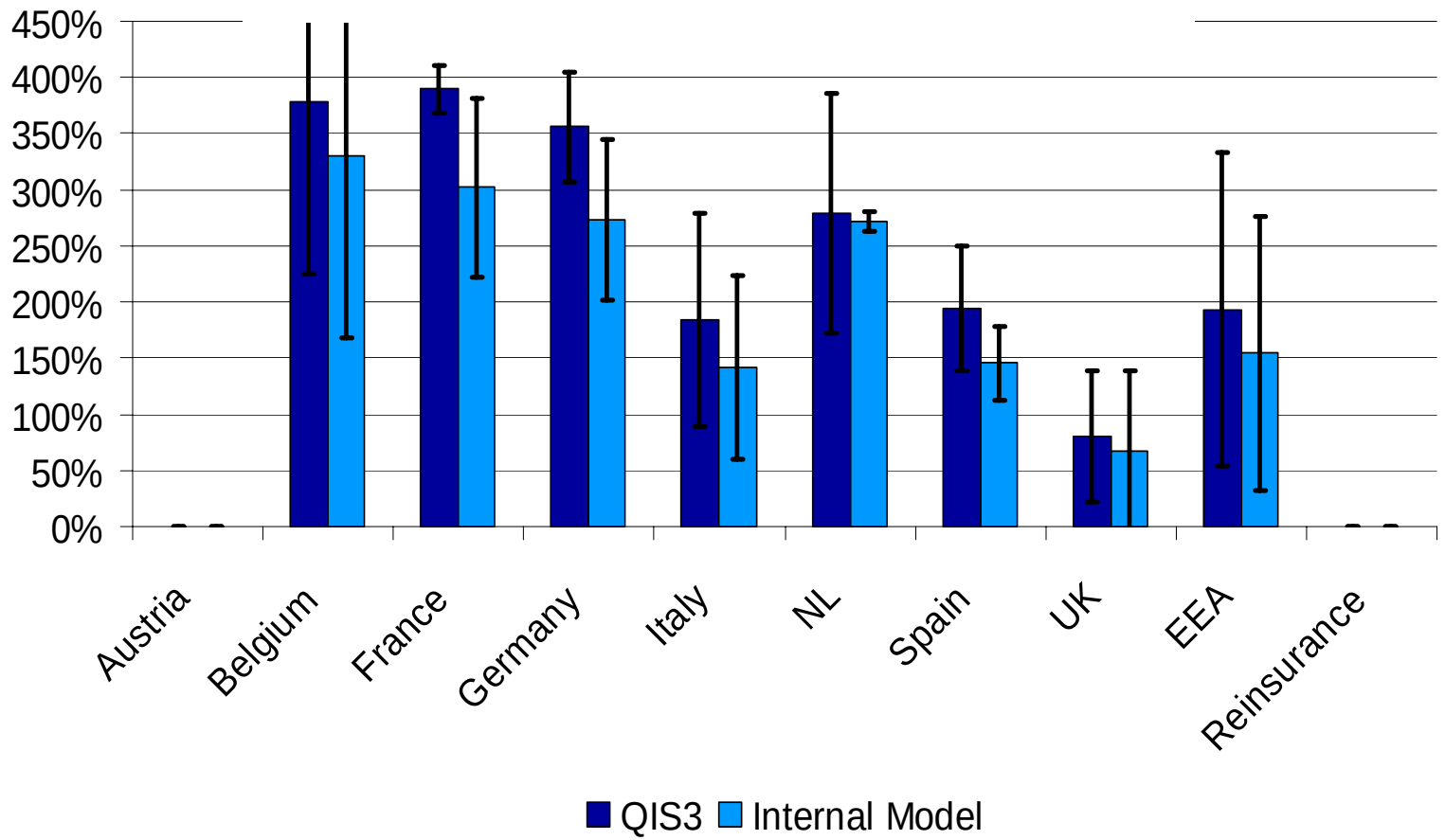
Life Solo
Life u/w Risk by Risk Types
as % of Total Requirements for all Risk Types before Diversification

Total Requirements for all Risk Types before Diversification refers to the sum of Risk Types (net of KC – after risk mitigation through future profit sharing).

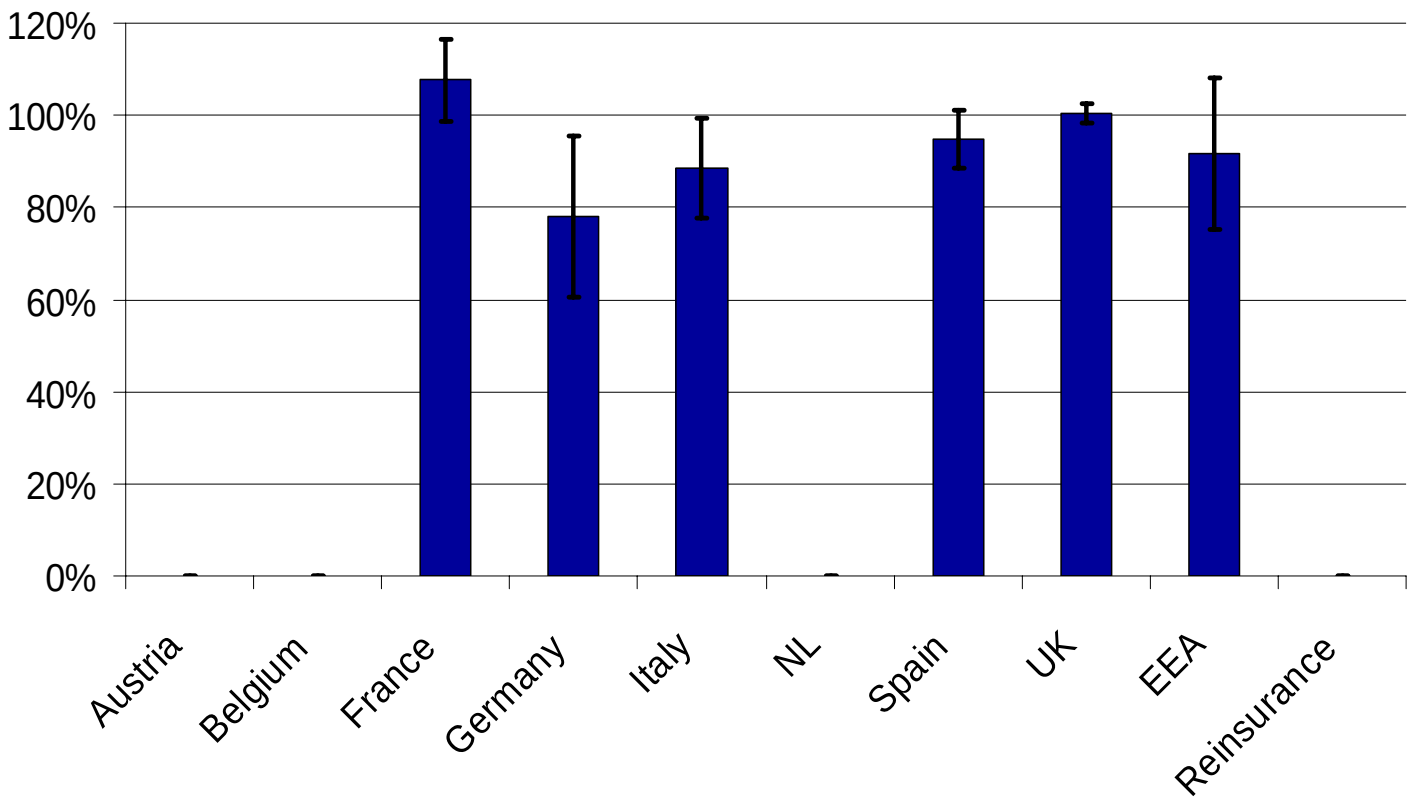


Non-Life / Reinsurance Solo
Required Capital as % of Solvency I Required Capital

Required Capital („SCR“) includes Operational Risk

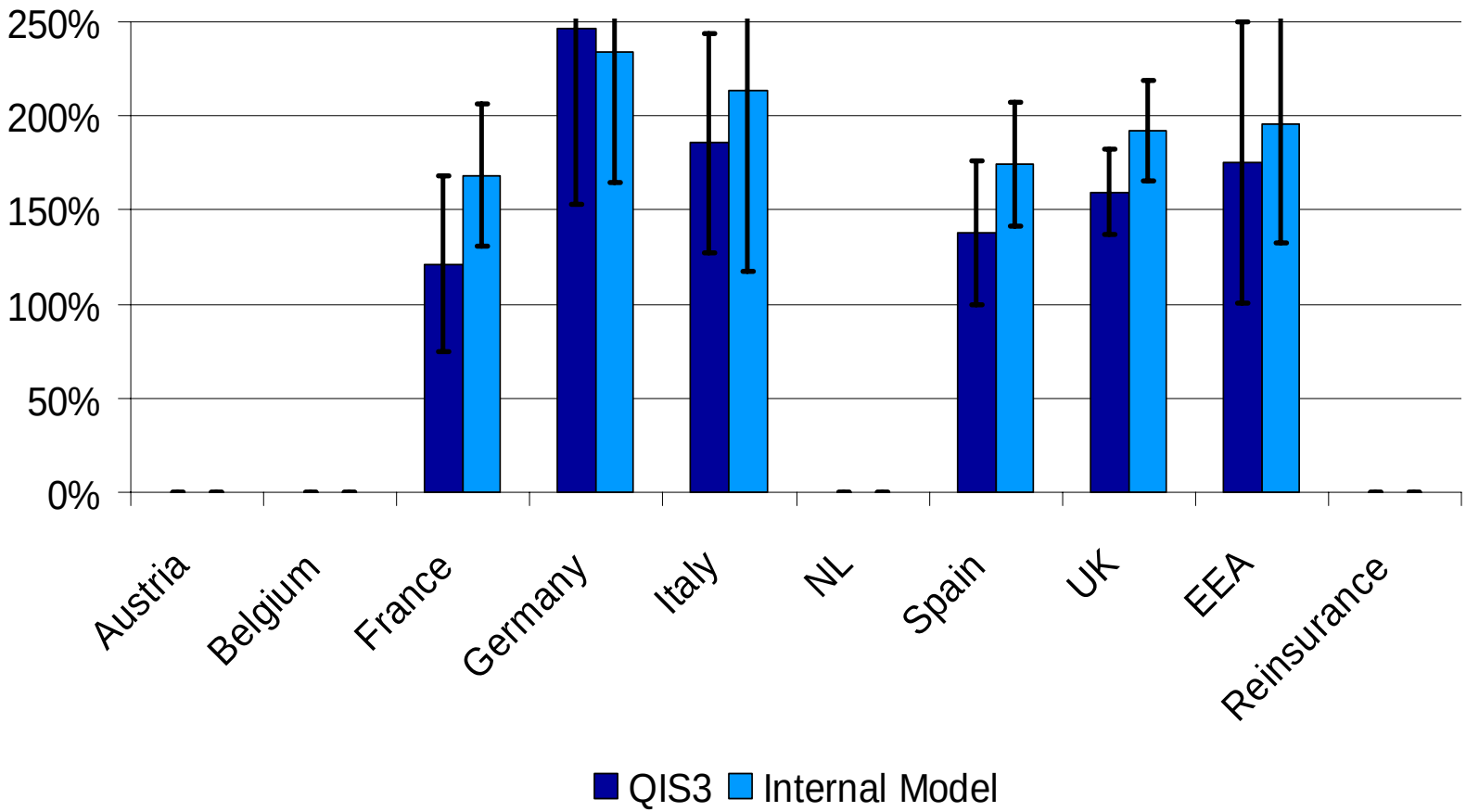


Non-Life / Reinsurance Solo
Internal Model Eligible Capital as % of QIS3 Eligible Capital



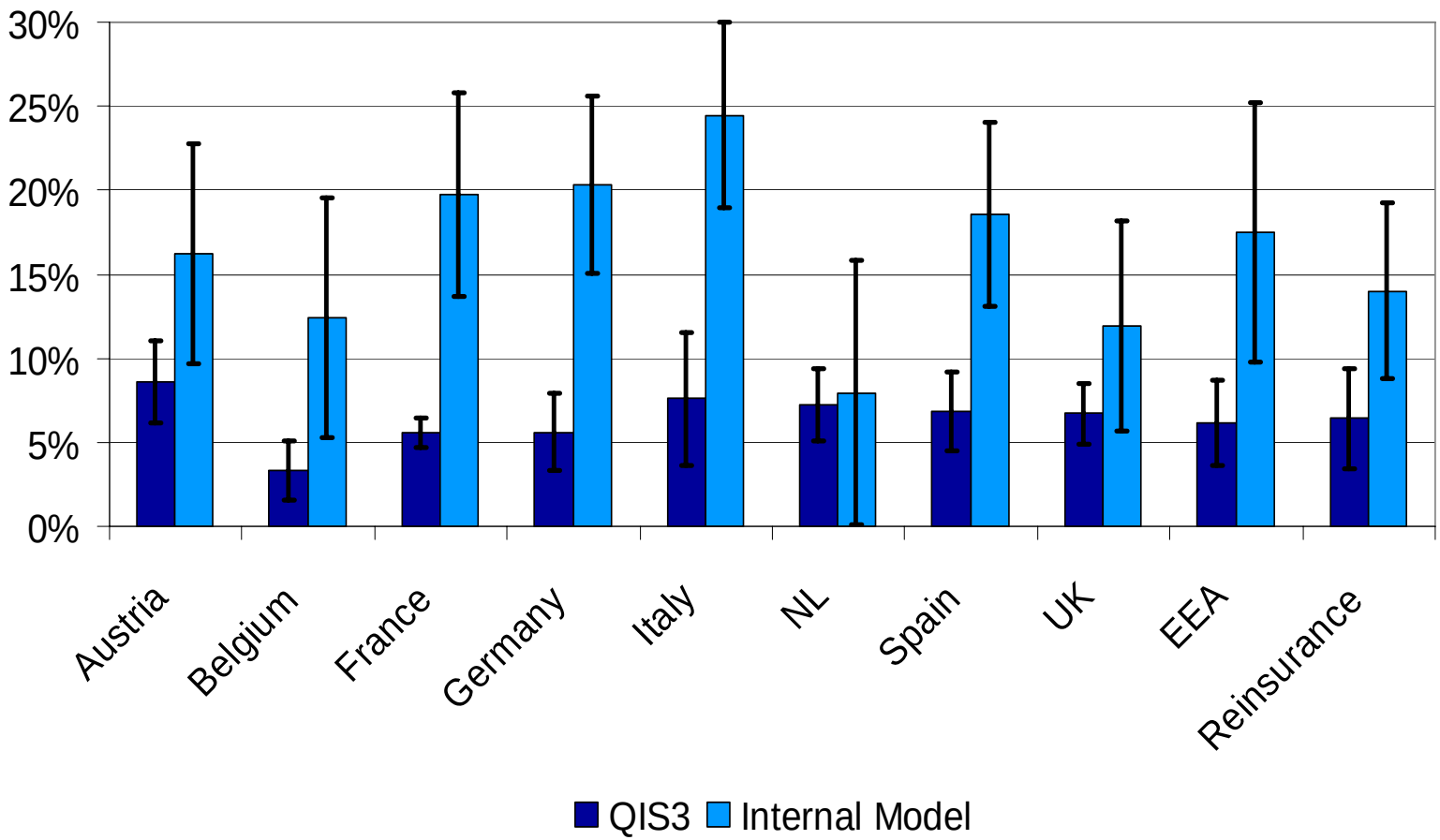
Non-Life / Reinsurance Solo
Coverage Ratio
Eligible Capital as % of Required Capital

Required Capital („SCR“) includes Operational Risk

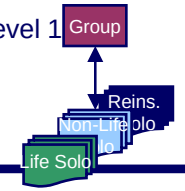


Non-Life / Reinsurance Solo
Operational Risk as % of Basis Required Capital

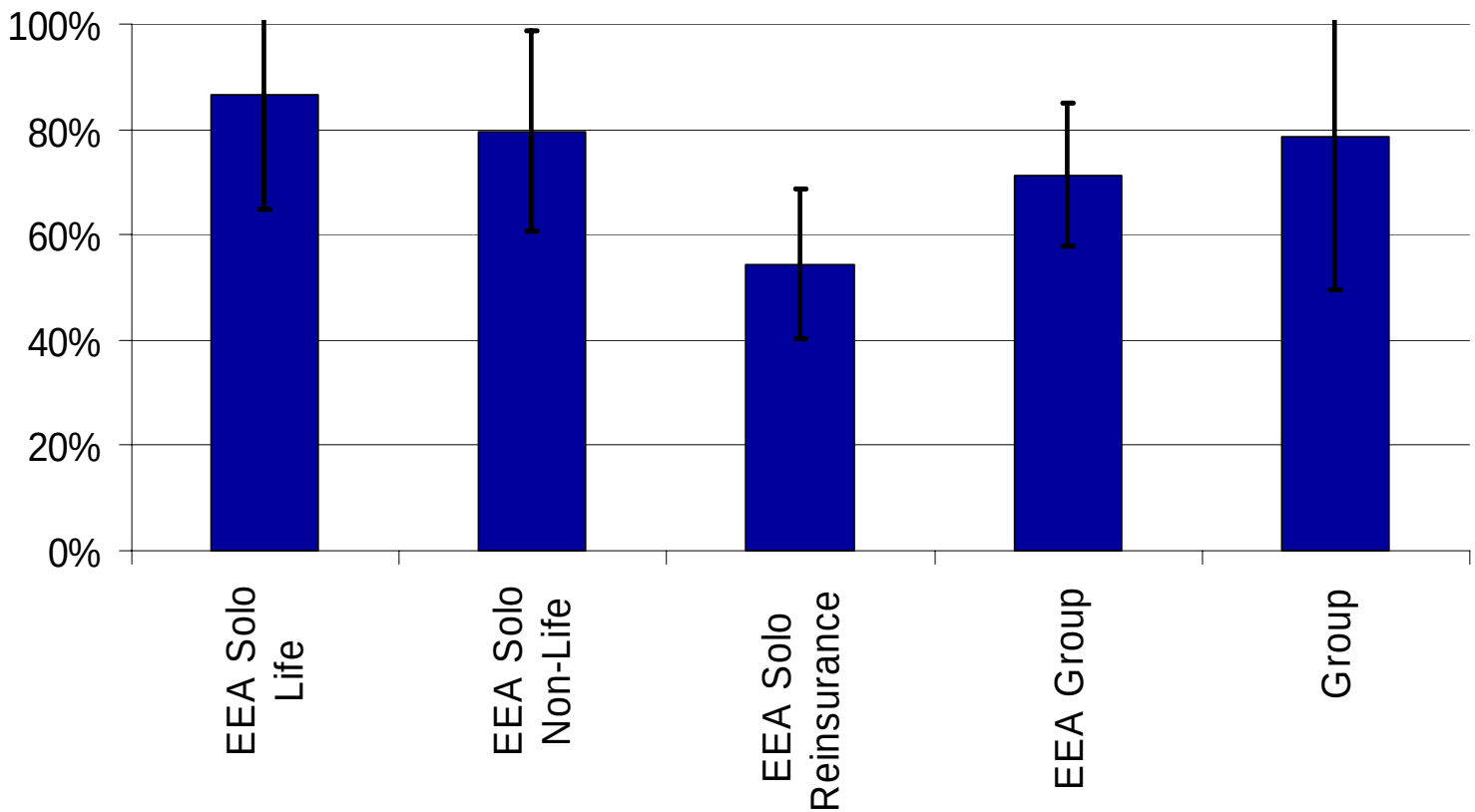
Basis Required Capital („BSCR“) does not include Operational Risk



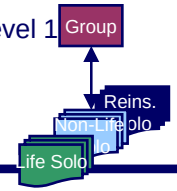
Solo and Group
Internal model Required Capital to QIS3 Required Capital



Required Capital („SCR“) includes Operational Risk
Caution: Data Bases between Solo and Group results may be different



Solo and Group
Required Capital as % of Solvency I Required Capital



Required Capital („SCR“) includes Operational Risk
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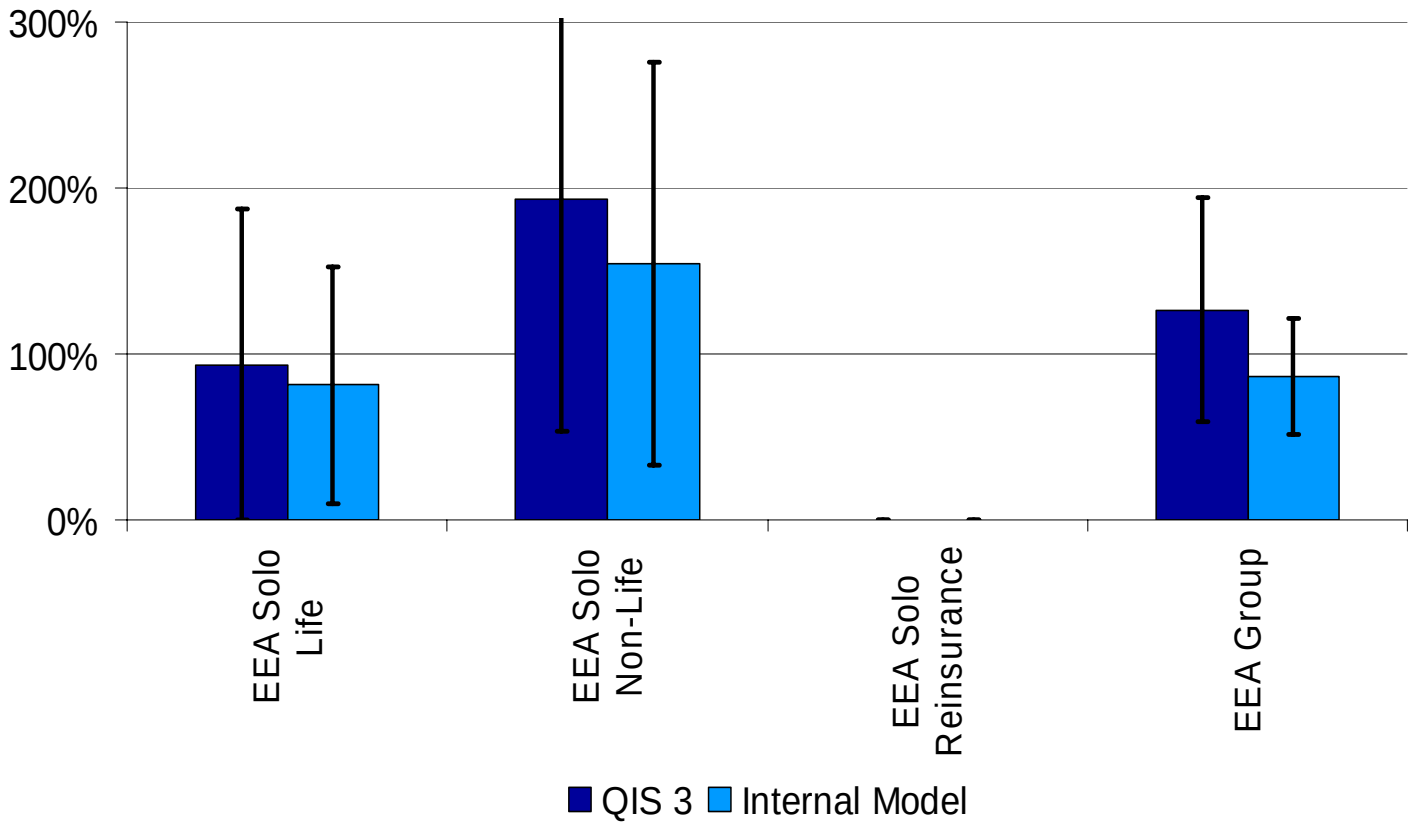
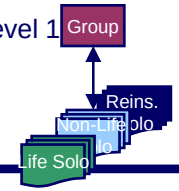


Solo and Group
Coverage Ratio
Eligible Capital as % of Required Capital



Required Capital („SCR“) includes Operational Risk
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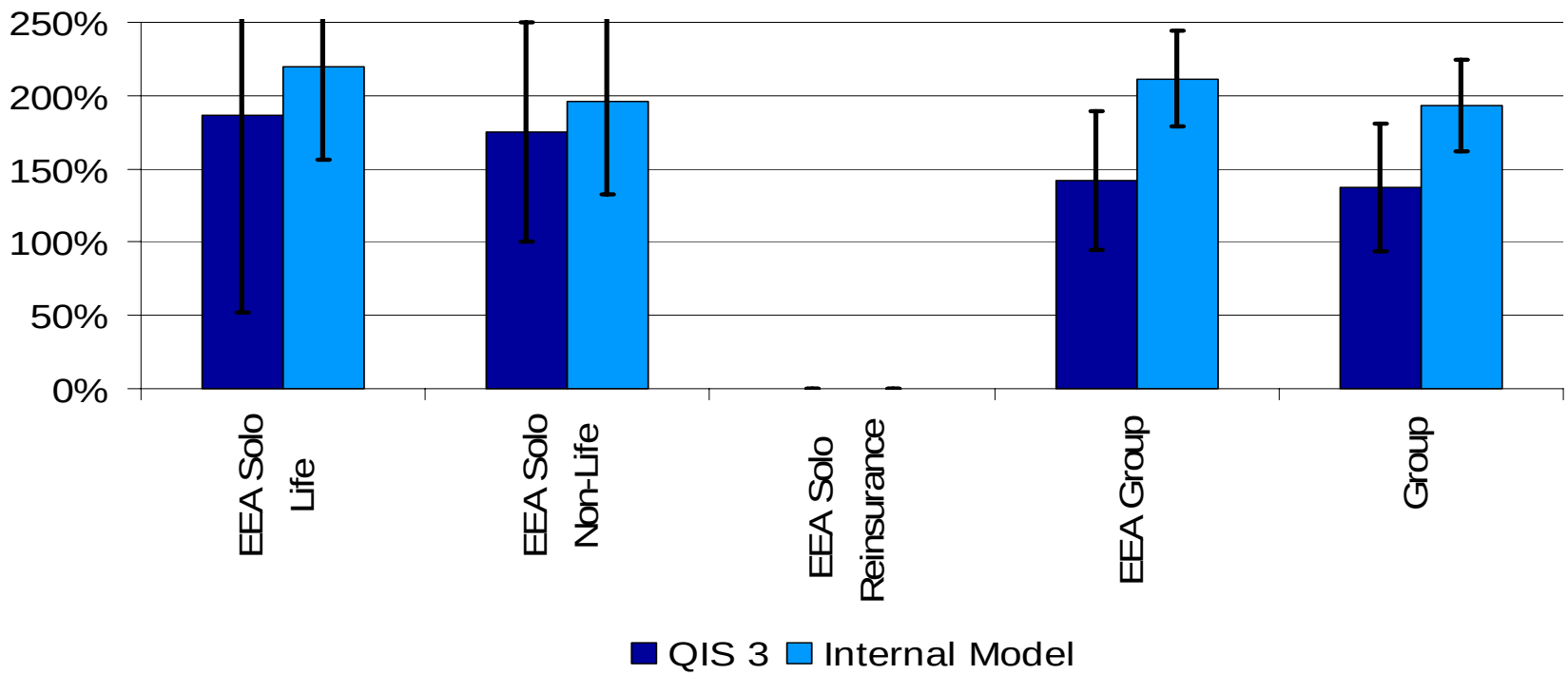


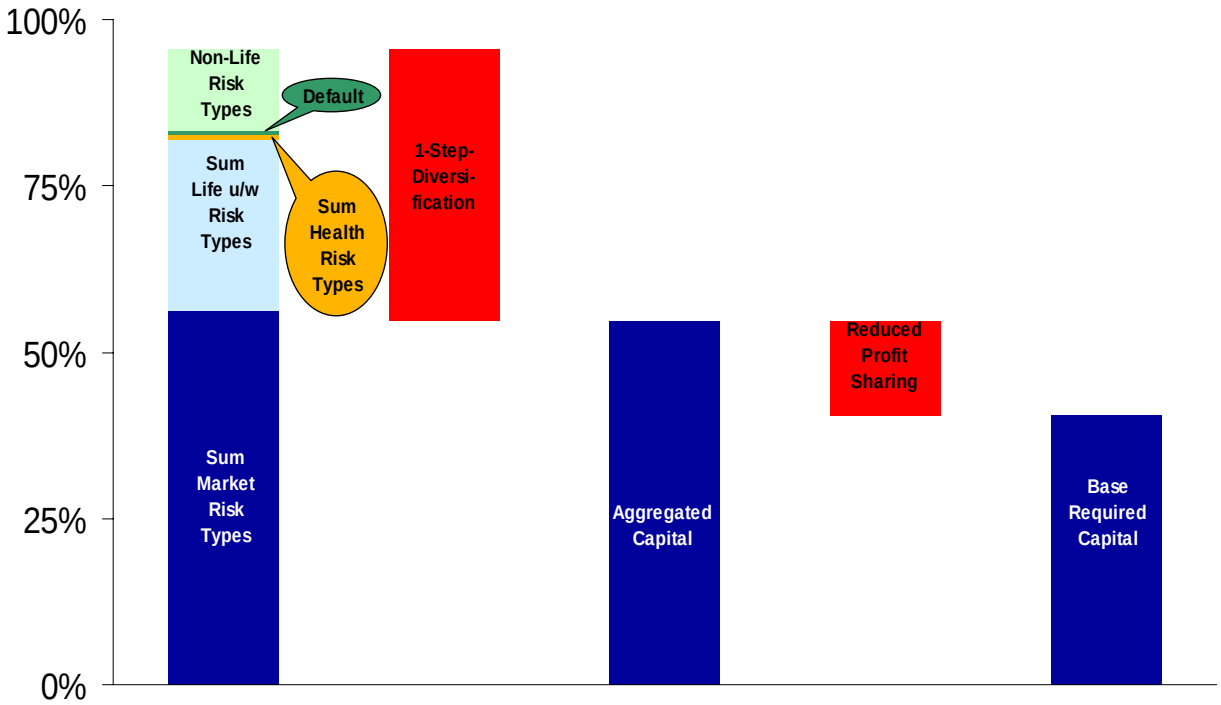
QIS3 Group - Movement of sum of undiversified Risk Classes to Base Required Capital as % of sum of QIS3 undiversified Risk Classes

Left Column: Split of sum of QIS3 group risk types (gross of KC – excluding Operational Risk) after geographical diversification (except for Non-Life u/w Risk Types) but before diversification between and across risk classes.

1 Step Diversification refers to the effect from aggregation between and across risk classes.

Reduced Profit Sharing means the effect arising from risk mitigation through future profit sharing („KC“)

Basis for all columns: Sum of QIS3 group risk types (gross of KC – excluding Operational Risk)



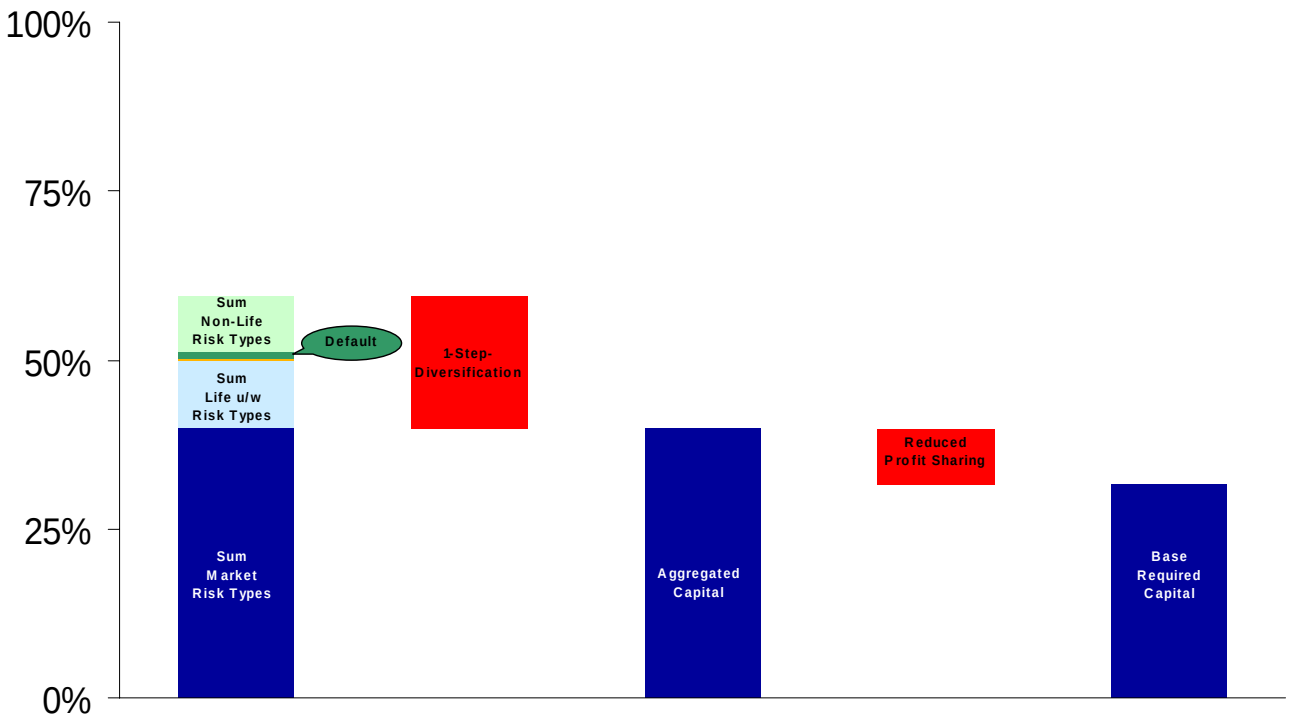
Internal Model Group - Movement of sum of undiversified Risk Classes to Base Required Capital as % of sum of QIS3 undiversified Risk Classes

Left Column: Split of sum of Internal Model group risk types (gross of KC – excluding Operational Risk) after geographical diversification (except for Non-Life u/w Risk Types) but before diversification between and across risk classes.

1 Step Diversification refers to the effect from aggregation between and across risk classes.

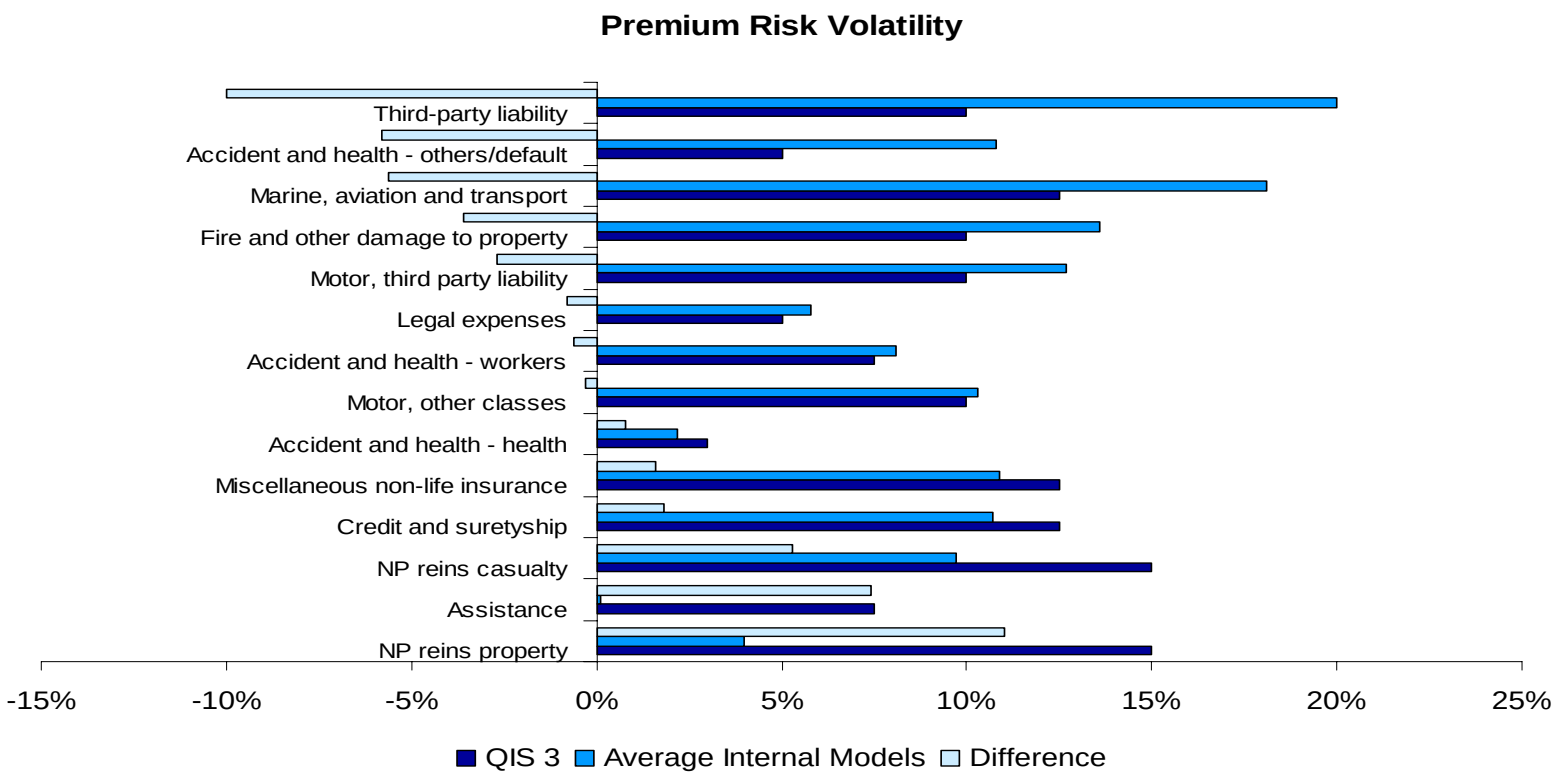
Reduced Profit Sharing means the effect arising from risk mitigation through future profit sharing („KC“)

Basis for all columns: Sum of QIS3 group risk types (gross of KC – excluding Operational Risk)



Parameters – non-life underwriting risks: variations by line of business

In QIS3, parameters are without considering credibility factors



Parameters – non-life underwriting risks: variations by line of business

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