Basel IV: Revised internal models approach for market risk

New challenges for banks
Contents

Preface ................................................................................................................. 5
The revisions to the existing regulatory framework are focusing on the determination of risk weighted assets ................................................................. 8
The FRTB addresses material weaknesses of the current market risk framework exposed by the financial crisis ............................................................. 9
... and aims to replace the existing regulation and harmonize the treatment of market risk across national jurisdictions ................................. 10
The FRTB introduces several enhancements to the existing framework addressing its known issues ................................................................. 12

Revised Market Risk Framework: Models based-approach ............................ 13
The new models based approach introduces a new risk measure to fully capture the risk.................................................................................................. 14
The new methodology takes into account the different liquidity horizons of various instruments .................................................................................. 16
The new calibration rules lead to capital requirements based on the markets true behaviour in stress situations ........................................................ 18
For illiquid risk factors, stress scenarios are used to determine the capital charge .............................................................................................. 20
“Default Risk Charge” replaces the present “Incremental Risk Charge” and avoids double counting ................................................................. 22
Capital requirements are calculated on the level of trading desks and are aggregated for the whole trading book ................................................................. 23
Model approval is required on desk-level and involves new requirements on back-testing .................................................................................................. 24

Regulatory Framework Revision Impacts .......................................................... 27
FRTB will have significant impacts on banks in terms of their operational capability, infrastructure, risk measurement, reporting and other areas .... 28
Banks employing internal models will face additional challenges regarding methodological questions, data availability, IT capabilities, and process management .................................................................................. 29

Our Services ...................................................................................................... 31
PwC has developed a framework to show what steps a bank needs to take to implement the new rules ................................................................. 32
In addition, the capital requirements under the new rules can be estimated and implications on the bank’s business model and strategy can be determined ............................................................................................. 33
Starting in 2012, the Basel Committee published several consultation papers on a Fundamental Review of the Trading Book (FRTB) to adapt existing rules for the capitalization of market risk to the lessons learned and shortcomings that became evident during the financial crisis. This fundamental review covers all aspects of minimum capital requirements for market risk such as the trading book – banking book boundary, the standardized approach as well as the use of internal market risk models.

Especially with regard to the latter one, the designation fundamental review is well deserved as the risk measure to be employed is changed from the Value at Risk (VaR) currently in use to a new metric, the so called Expected Shortfall (ES). This change is accompanied by a number of further revisions, covering inter alia the model approval process, taking account of market liquidity of positions, backtesting requirements and many more.
These changes, finalized in spring 2016 and, according to the BCBS’s timeline, to enter into force in 2019 will have a profound impact on all banks using internal models to capitalize market risks. The amount of risk weighted assets is expected to increase markedly, depending on the trading strategies employed. But also the implementation of the new rules will require massive efforts by the affected banks.

This brochure will help you gain an overview over the proposed rules to prepare for the tasks ahead.

Kind regards,

Martin Neisen
Global Basel IV Leader

Dirk Stemmer
Internal Market Risk Model Leader
The revisions to the existing regulatory framework are focusing on the determination of risk weighted assets

The Basel III framework mainly concentrated on banks’ own funds requirements. Currently, the Basel Committee of Banking Supervision (BCBS) is revising a diverse list of topics including the standardised and internal models approaches for calculating capital requirements of all risk types. The industry already summarises these revisions under the term “Basel IV”. The revisions will have a fundamental impact on the calculation of risk weighted assets and capital ratios of all banks independent of their size and business model. Especially the extended modifications in the “Fundamental Review of the Trading Book” will have significant effects on both RWA and calculation processes. We anticipate a significant effort in implementing and especially customizing the requirements of the new IMA at trading desk level which go far beyond the simple implementation of capital requirements!

<table>
<thead>
<tr>
<th>Capital requirements</th>
<th>Credit risk</th>
<th>Securitisation</th>
<th>Counter-party credit risk</th>
<th>Market risk</th>
<th>Operational risk</th>
<th>CVA risk</th>
<th>Step-in risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital floors</td>
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<tr>
<td>Revisions to the securitisation framework</td>
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<td>Fundamental review of the trading book</td>
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<td>Review of the CVA risk framework</td>
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The FRTB addresses material weaknesses of the current market risk framework exposed by the financial crisis ...

"The financial crisis exposed material weaknesses in the overall design of the framework for capitalising trading activities." (Basel Committee on Banking Supervision, October 2013)

Material weaknesses of current approaches ...

Trading book – banking book boundary

Treatment of credit risk in the trading book

Weaknesses of VaR approach

Hedging and diversification

Liquidity of trading book positions

Transparency and comparability of RWA

... require fundamental review

1. Banking book/trading book boundary to be more objective
   - Additional tools for supervision

2. Standardised Approach increases risk sensitivity of RWA calculation
   - Marked increase of complexity

3. Internal models approach using Expected Shortfall (ES) instead of VaR
   - Changes to model approval process
   - Floor based on standardised method
... and aims to replace the existing regulation and harmonize the treatment of market risk across national jurisdictions

During the last crisis it turned out that the regulatory capital for market risk was not adequate enough to cover the risk. Therefore the Basel Committee for Banking Supervision has developed the Fundamental Review of the Trading Book (FRTB), a new framework to replace the old market risk regulation defined under Basel II.5. The intention is “to improve trading book capital requirements and to promote consistent implementation of the rules so that they produce comparable levels of capital across jurisdictions”.

Fig. 3 Key objectives of Basel Committee

The proposals reflect BCBS's key objectives

• To develop an effective trading book/banking book boundary condition,
• to achieve a regulatory framework that captures and capitalises all market risks in the trading book,
• to improve risk measurement techniques and
• to achieve comparable levels of capital across internal risk models and the standardised approach.
The history of the trading book regime

1996 Basel I
First methodology laid out by the BCBS to set out capital requirements for market risks. The amendment to Basel Capital Accord included standardised approach and internal models approach.

2004 Basel II
The amendment was further revised in 2005. The paper changed the trading book regime.

2009 Basel 2.5
First attempt by the BCBS to address the trading book issues revealed by the global financial crisis. Revisions to the Basel II market risk framework.

2012 FRTB
The BCBS issued the Fundamental Review of the Trading Book (FRTB) consultation paper.

2012–2015
Two more consultative papers and four quantitative impact studies.

2016 Revised standards
In 2016 the Basel Committee on Banking Supervision (BCBS) published revised standards for minimum capital requirements for market risk.

2019
BCBS’s deadline for local regulation in January 2019

End of 2019
Deadline for final implementation.
The FRTB introduces several enhancements to the existing framework addressing its known issues

<table>
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<tr>
<th>Fig. 4 Key changes induced by FRTB</th>
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<tr>
<td><strong>Regulatory boundary between trading and banking book</strong></td>
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<tr>
<td>• New defined list of instruments presumed to be included either in the trading book or the banking book. Deviation requires explicit approval from supervisor.</td>
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<td>• Strict limits on the movement of instruments between the books after initial designation. Should a re-designation be approved a capital benefit will not be allowed.</td>
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<tr>
<td><strong>Revised Standardised Approach</strong></td>
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<td>• Significant changes by introducing a sensitivities-based method.</td>
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<td>• The revised standardised approach will act as a fall back solution and floor to the internal models approach.</td>
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<td><strong>From VaR to Expected shortfall</strong></td>
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<tr>
<td>• Banks must calibrate the internal model to an expected shortfall measure and periods of significant market stress.</td>
</tr>
<tr>
<td>• This metric will help to capture the tail risk and to maintain adequate capital during periods of significant market stress.</td>
</tr>
<tr>
<td><strong>Inclusion of market illiquidity</strong></td>
</tr>
<tr>
<td>• Varying liquidity horizons included in the standardised and internal models approach.</td>
</tr>
<tr>
<td>• Replaces the static 10 day liquidity horizon currently assumed in the VaR framework.</td>
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<td><strong>Revised approach to approval for internal models</strong></td>
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<tr>
<td>• Supervisors will review the use of internal models at desk level.</td>
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<tr>
<td>• More rigorous model approval process, using both qualitative and quantitative criteria.</td>
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Revised Market Risk Framework
Internal Models Approach – New methodology
The new models based approach introduces a new risk measure to fully capture the risk

The present internal models approach for the calculation of capital requirements for market risk is based on the value-at-risk (VaR) measure, where a 99% quantile is used.

However, the VaR suffers from the drawback of not being a coherent risk measure as it lacks sub-additivity. Furthermore, VaR does not capture tail risk, i.e. high impact events with low probability do not affect the VaR. Thus, basing the capital requirements on VaR can lead to unwanted risk taking.

The new models based approach uses expected shortfall at a 97.5% quantile, addressing the issues described above. For a normal distribution, $\text{ES}_{97.5\%} \approx \text{VaR}_{99\%}$. 
• Definition:
  \( \text{VaR}_\alpha(X) = \inf\{x \mid F_X(x) \geq \alpha \} \)

• The probability that the loss (modelled by random variable \(X\)) exceeds \(\text{VaR}_\alpha(X)\) is not larger than \(1 - \alpha\)

• Definition:
  \( \text{ES}_\alpha(X) = \frac{1}{1-\alpha} \int_\alpha^1 \text{VaR}_\gamma(X) d\gamma \)

• The expected loss given that \(X\) exceeds \(\text{VaR}_\alpha(X)\) (therefore also called conditional Value-at-risk)
The new methodology takes into account the different liquidity horizons of various instruments

The present internal models approach uses the same 10-day liquidity horizon for all risk factors. This does not account for the fact that while e.g. plain vanilla interest swaps are traded daily on well organised markets, other instruments such as structured credit derivatives are much less liquid. Therefore, the new internal models approach introduces differentiated liquidity horizons as exemplarily shown in the table below.

Doubling the liquidity horizon amounts to an increase of the regulatory expected shortfall ES (c.f. formula below) by approx. 40%. Therefore, holding instruments with sensitivities to risk factors which have been assigned to a category with a large liquidity horizon, becomes disproportionally expensive from a capital requirement point of view.

**Tab. 1 Liquidity horizons**

<table>
<thead>
<tr>
<th>Most important risk factor categories</th>
<th>Liquidity horizons (in days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate (major currencies)</td>
<td>10</td>
</tr>
<tr>
<td>Equity volatility</td>
<td>20</td>
</tr>
<tr>
<td>Interest rate volatility</td>
<td>40</td>
</tr>
<tr>
<td>Credit spread – high yield</td>
<td>60</td>
</tr>
<tr>
<td>Credit spread – structured</td>
<td>120</td>
</tr>
</tbody>
</table>
Fig. 6 Calculation of regulatory ES

<table>
<thead>
<tr>
<th>Calculation</th>
</tr>
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<tbody>
<tr>
<td><strong>1</strong> Calculate 10-day ES with all risk factors.</td>
</tr>
<tr>
<td><strong>2</strong> Calculate 10-day ES with risk factors with ( n \geq 20 ).</td>
</tr>
<tr>
<td><strong>3</strong> Scale the result with the ( \sqrt{T} )-rule.</td>
</tr>
<tr>
<td><strong>4</strong> Add the scaled ES (see formula).</td>
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<tr>
<td><strong>5</strong> Repeat from 2. with ( n \geq 40, 60, 120 ).</td>
</tr>
</tbody>
</table>

\[
ES_B = \sqrt{ES(Q)^2 + \sum_{j \geq 2} \left( \frac{ES(Q_j)}{\sqrt{(n_j - n_{j-1})/10}} \right)^2} \quad \text{10-days ES with all risk factors}
\]

\[
ES(Q_j) = \text{10-days ES with risk factors with liquidity horizons larger than } n_j
\]

\[
\text{j-th largest liquidity horizon}
\]
The new calibration rules lead to capital requirements based on the markets true behaviour in stress situations

In the present regime, the VaR is calibrated to the market movement of the last year. In calm, non-volatile periods, this methodology leads to capital requirements which have been proven to be insufficient in more turbulent times as the one following the default of Lehmann Brothers. For this reason, the present capital requirements contain another term, the stressed value at risk (SVaR) which is calibrated to stress periods.

The new internal models approach to be introduced with FRTB replaces both VaR and SVaR with a single risk measure based on expected loss which is calibrated to the one-year period of most severe stress from 2005 up to now. As good quality data going back so long is often not available for all relevant risk factors, a simplified treatment is allowed by the methodology (see below). Thus, long data history is only required for a subset of risk factors explaining at least 75% of the full P&L variance. For all other modelled risk factors, only data for the last year is needed and considered.
Fig. 7 Scaling approach for regulatory ES

- Reduced set of risk factors must explain at least 75% of P&L variance
- Full historical data (10Y) must be available

- Find the 12 month period for which the ES calculated with the reduced set of risk factors is largest \( ES_{R,S} \)
- Use the same set of risk factors with the current 12 month period \( ES_{R,C} \)

- Calculate ES with all risk factors for the current 12 month period. \( ES_{F,C} \)
- Combine these numbers to the regulatory expected shortfall

\[
ES = ES_{R,S} \times \frac{ES_{F,C}}{ES_{R,C}}
\]
For illiquid risk factors, stress scenarios are used to determine the capital charge

The calculation of a meaningful expected shortfall requires a good data quality for the risk factors. Therefore, the new rules proposed by the BCBS make a distinction between modellable risk factors, for which such data exists, and non-modellable risk factors for which appropriate data does not exist.

For the latter (mostly stocks of minor companies), capital requirements have to be calculated by using stress scenarios (which are subject to the supervisor's approval). For idiosyncratic credit risk, correlations between the risk factors may be neglected given that the institute can prove to the supervisors that this is indeed the case. For other risk factors, e.g. equities, worst case correlations must be assumed.

If there are \( L \) non-modellable idiosyncratic credit risk factors with stress losses \( ISES_i \) and \( K \) other non-modellable risk factors with losses \( SES_j \), the aggregated risk measures is

\[
SES = \sqrt{\sum_{i=1}^{L} ISES_i^2} + \sum_{j=1}^{K} SES_j
\]
Fig. 8 Modellable and non-modellable risk factors

Classification of Risk Factors

Modellable

- Need to have representative transactions in relevant products with a history of “real” prices
- At least 24 observations/year and gaps between quotes not larger than 1 month
- Capital for a single trading desk calculated with the same ES model as the trading book wide capital

Non-modellable

- Relevant products very illiquid
- Prudent stress scenario must be used
- No diversification may be assumed
- Liquidity horizon must not be smaller than gaps between observed prices
“Default Risk Charge” replaces the present “Incremental Risk Charge” and avoids double counting

### Present regulatory framework

In the present CRR framework, the capital requirements for market risk under the internal models approach are calculated as a sum of three components:

\[
\text{CapitalRequirement}_{\text{CRR}} = \text{VaR}_{\text{CCR}} + \text{SVaR}_{\text{CCR}} + \text{IRC}_{\text{CCR}}
\]

The last term, the *incremental risk charge* (\(\text{IRC}_{\text{CCR}}\)) accounts for losses occurring when an issuer defaults or its rating deteriorates.

### New internal models approach

In the new internal models approach, the IRC is replaced by the *Default Risk Charge* (DRC). This measure only captures default risk as the risk of migration has to be included in the ES calculation.

For the calculation of the DRC, banks have to use a *two-factor model* default simulation model, with the following requirements:

- VaR Model at 99.9% quantile
- One year time horizon
- Weekly calculation
- Correlations based on credit spreads or equity prices.
- 10y history
- No market implied PDs to be used.
- PDs floored at 0.03%
- When possible PDs/LGDs consistent with IRB-approach are to be used.
- 5y calibration period minimum for PDs
Capital requirements are calculated on the level of trading desks and are aggregated for the whole trading book

The new capital requirements are calculated on the level of trading desks which increases the calculation effort compared to the present regime. Results are then aggregated.

**Fig. 10 Aggregation of capital requirements**

$$\text{IMMC} = \rho \cdot ES_B + (1 - \rho) \cdot \sum_i ES_{i,B}$$

$$\text{ACC} = C_A + DRC + C_U$$

<table>
<thead>
<tr>
<th>IMA – Desk 1</th>
<th>…</th>
<th>IMA – Desk N</th>
<th>IMA – Desk 1</th>
<th>…</th>
<th>IMA – Desk N</th>
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<tr>
<td>Modellable risk factors</td>
<td>…</td>
<td>Non-modellable risk factors</td>
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<tr>
<td>Capital requirements for IMA approved desks</td>
<td>…</td>
<td>Capital charge for not IMA approved desks (calculated with standardised approach)</td>
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<tr>
<th>IMMC</th>
<th>Capital measure for modellable risk factors</th>
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<td>ES_{i,B}</td>
<td>Expected shortfall on a single desk level</td>
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<tr>
<td>ES_B</td>
<td>Total expected shortfall for the trading book</td>
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<tr>
<td>\rho</td>
<td>Correlations set to 0.5 by the BCBS.</td>
</tr>
<tr>
<td>C_A</td>
<td>Capital requirements</td>
</tr>
<tr>
<td>SES</td>
<td>Capital charge for non-modellable risk factors</td>
</tr>
<tr>
<td>m_c</td>
<td>Multiplication factor (between 1.5 and 2 depending on</td>
</tr>
<tr>
<td>IMCC_{avg}</td>
<td>Average of IMMC over the last 60 days</td>
</tr>
<tr>
<td>SES_{avg}</td>
<td>Average of SES over the last 60 days</td>
</tr>
<tr>
<td>ACC</td>
<td>Total capital requirements for market risk</td>
</tr>
<tr>
<td>DRC</td>
<td>Default risk Charge</td>
</tr>
<tr>
<td>C_U</td>
<td>Capital requirements for non IMA approved desks</td>
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Model approval is required on desk-level and involves new requirements on back-testing

In the **new** internal models approach, trading desks will require approval by the component authority. The respective process is outlined below.

As back-testing *ES* suffers from theoretical limitations (c.f. Carver, L.: “Back-testing expected shortfall: mission possible?” Risk.net. 2014), back-testing will be still based on *VaR*. This exercise needs to be performed both for the “actual trading outcome” and for the “hypothetical trading outcome” where effects of intraday trades have been removed.
### Definition of Trading Desks

<table>
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<tr>
<th>Three criteria</th>
<th>Definition</th>
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<tr>
<td><strong>1</strong></td>
<td>Is an unambiguously defined group of traders or trading accounts reporting to a <strong>head trader</strong>.</td>
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<tr>
<td><strong>2</strong></td>
<td>Has a <strong>well defined business strategy</strong> including a list of allowed activities.</td>
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<tr>
<td><strong>3</strong></td>
<td>Has a clear risk management structure. Provides P&amp;L-reports at least weekly.</td>
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### Evaluation of model on trading desk level

1. **Back testing** performed for 1-day VaR at 97.5% and 99% quantile
   - More than 30 (97.5%) and 12 (99%) violations

2. **P&L attribution**: Comparison of the risk P&L with the actual and hypothetical P&L
   - Unexplained P&L > 10% or ratio of variance > 20%

- The new model approval rules lead to significant amount of new work to be done.
- Model approval process requires a wide range of skills:
  - Regulatory
  - Quantitative
  - IT
  - Processes
- Impact studies are requirement to assess for which desks to seek model approval and for which to use the standardised approach.

In case the desk is not approved the SBA must be used for capital calculation.
Regulatory Framework Revision Impacts
**FRTB will have significant impacts on banks in terms of their operational capability, infrastructure, risk measurement, reporting and other areas**

**Fig. 12 Impact on banks**

<table>
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<tr>
<th>Capital charge</th>
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<tr>
<td>• Capital requirements are expected to increase notably. Risk factor classes credit (median: +48%) and equity (median: +29%) affected most strongly (c.f. BCBS 346 (2015): Fundamental review of the trading book – interim impact analysis)</td>
</tr>
<tr>
<td>• Consistent with liquidity horizons. No or only moderate increase for interest rates and FX</td>
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<tr>
<td>• Huge variance across the reporting banks</td>
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<table>
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<tr>
<th>Desk level review</th>
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<tbody>
<tr>
<td>• Defining the trading desks requires a clear strategy to realise the optimisation potential</td>
</tr>
<tr>
<td>• The required supervisory approval might require the revision and extension of existing process documentation and policies</td>
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<tr>
<th>Calculation and reporting requirements</th>
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<tr>
<td>• Every bank must, in addition to the internal models approach also calculate the standardised approach</td>
</tr>
<tr>
<td>• Standardised approach used as fall-back when a desk looses its approval</td>
</tr>
<tr>
<td>• Calculation must be performed both on a desk level and for the full trading book</td>
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<tr>
<td>• All results must be reported to competent authority</td>
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<tr>
<td>• Supervisors will monitor the difference between internal models approach and standardised approach values</td>
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<table>
<thead>
<tr>
<th>Methodology</th>
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<tr>
<td>• New methodology (expected shortfall, liquidity-horizons, aggregations rules) must be implemented in the bank’s IT systems</td>
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<tr>
<td>• Processes need to be set up to ensure the required ongoing validation</td>
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<table>
<thead>
<tr>
<th>Methodology</th>
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<tr>
<td>• Banks need good quality data which goes back to 2005</td>
</tr>
<tr>
<td>• Requirements on the quality of P&amp;L-explain may require banks to extend their risk management systems by new risk factors for which data sources must be defined</td>
</tr>
<tr>
<td>• Non-modellable risk factors need to be identified and the required stress scenarios must be derived</td>
</tr>
<tr>
<td>• As deeming a risk factor to be non-modellable leads to substantially higher capital charges, all effort should be taken to fulfil the requirements for being modellable</td>
</tr>
</tbody>
</table>
Banks employing internal models will face additional challenges regarding methodological questions, data availability, IT capabilities, and process management

**Fig. 13 Aspects requiring particular attention**

<table>
<thead>
<tr>
<th>Special attention must be paid to several aspects of the operations and support framework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy frameworks</strong>: As part of implementation of the revised standards banks have to review and revise their internal policies and related procedures (including the trading book policy, the market risk policy, the model management policy, and the model validation and backtesting policy)</td>
</tr>
<tr>
<td><strong>Infrastructure</strong>: As calculation of the standardised approach capital charge will become mandatory for benchmarking and fallback purposes, the need to build, maintain and develop risk systems – as well as data availability and quality within the banks – increases</td>
</tr>
<tr>
<td><strong>Processes, models and controls</strong>: We expect that banks need to reassess and organize their business processes and controls as a result of the new standard. The representation of risk may diverge further between business and regulatory needs. This is likely to be reflected in the processes and models needed to fulfil these needs</td>
</tr>
<tr>
<td><strong>Resources</strong>: We expect that the changes will lead to a (temporary) demand for additional skilled risk personnel within the banks</td>
</tr>
</tbody>
</table>
Our Services
PwC has developed a framework to show what steps a bank needs to take to implement the new rules

Fig. 14  Steps needed to implement the new rules

1. Analysis of functional requirements
   - Review of banking and trading book positions to analyze impact of the new methodology to capital consumption
   - SBA and ES are significant new additions
   - As SBA capital charge calculation will become mandatory, banks have to analyze the bank specific degree of complexity that will be required
   - Adapting the asset allocation can potentially minimize the capital charge
   - Desk level review will likely increase the complexity of internal models

2. Test calculations and analysis of processual implementation aspects
   - Consider need to restructure desks to reduce complexity related to models and the capital calculation
   - Develop and maintain architecture and infrastructure capability to incorporate the granular desk level data into risk and finance systems
   - Identify and analyze portfolios for those asset classes, risk factors and trading desks contributing mainly to the capital charge
   - Potential identification of data issues increasing regulatory capital

3. Planning of the implementation project
   - Business specifications must be identified for the aggregation & final reporting process
   - Deduction and finalisation of implementation requirements for IT-infrastructure adjustments
   - Development of a business case and preparation of strategic decisions
   - Deviation of project scope, sub-projects and timelines incl. milestones
   - Analysis of costs and impacts to the project and capital needs
   - Broadened supervisory scope will require more communication between banks and the supervisors

Alignment of the different workstreams wherever possible
In addition, the capital requirements under the new rules can be estimated and implications on the bank’s business model and strategy can be determined.

Fig. 15 Further steps

PwC provides an approved SBA-Tool and Internal Models Risk Comparison Approach

The SBA-Tool offers:
- **Pragmatic test calculations** of capital requirements for delta-, vega-, curvature and default risk as well as additional risk add-on
- Calculations for all asset classes and for all desks are possible
- Tested performance also for big data volumes
- High adaption flexibility for e.g. scenario analysis with different correlation parameters

The IM Risk Comparison Approach offers the reassessment and optimization of business models taking into account:
- SBA vs. IMA calculations
- Fine-tuning of the ES model, data quality and desk organisation
- Analyzing capital impact driven by different factors for each trading strategy
- Identification of adjustments in the FO pricing policy, repositioning on the market
- Comparing limited business potential with expected costs

The conclusions taken from the technical analysis build the basis for planning and structuring an implementation project.
Our Expertise
Whether regarding the Basel Committee, EU-regulation or national legislation – we use our established know-how of the analysis and implementation of new supervisory regulation to provide our clients with high-quality services. Embedded into the international PwC network, we have access to the extensive knowledge of our experts around the world.

PwC’s Global Basel IV Initiative was established to support you in all aspects of getting compliant with the new regulatory requirements to the trading book – accomplishing a presstudy as a first step, supporting you at quantitative impact studies (QIS) up to the implementation at all business units and areas of the bank.

PwC can draw on long lasting experience of implementing new regulatory requirements by supporting a number of banks in completing quantitative impact studies prior to the implementation of Basel II and Basel III and by the functional and technical implementation of the final regulations. The PwC-tools used during the QIS are flexible and will be updated automatically in case of new consultations by the Basel Committee.
About us
PwC helps organisations and individuals create the value they’re looking for. We’re a network of firms in 157 countries with more than 195,000 people who are committed to delivering quality in assurance, tax and advisory services. Tell us what matters to you and find out more by visiting us at www.pwc.com. Learn more about PwC by following us online: @PwC_LLP, YouTube, LinkedIn, Facebook and Google +.
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