Available online at www.IJournalSE.org

Italian Journal of Science & Engineering

Vol. 1, No. 1, June, 2017

Critical Analysis of the New Basel Minimum Capital Requirements for Market Risk

J. Orgeldinger [a*]

[a] *Ludwig Maximilian University of Munich, Munich, Germany.*

Abstract

In its October 2013's consultative paper for a revised market risk framework (FRTB), and subsequent versions published thereafter, the Basel Committee suggests new ways of dealing with market risk in banks' trading and banking books. The Basel Committee estimates that the new rules will result in an approximate median capital increase of 22% and a weighted average capital increase of 40% [1], compared with the current framework. Key changes can be found in the internal model approach, in the standard rules and in the scope/approval process. Among the significant changes that are being introduced by the FRTB is a stricter separation of the trading book and banking book. Regardless of whether they use standardised or internal models, banks will need to review their portfolios to determine if existing classifications of instruments and desks as trading book or banking book are still applicable or whether a revision of desk structure is needed. In this article, we analyse the theoretical foundations of the internal model approach (IMA), which are the stressed expected shortfall, liquidity adjustments, default & migration risk and non-modellable risk factors. We thoroughly investigate the criticisms for Internal Risk Model (IMA) and the introduction of a standardised floor, the sensitivity based approach (SBA) with Delta, Vega and Curvature, shock scenarios and the aggregation with asymmetric correlation and reflection of basis/default risk.

Keywords:

Fundamental Review of the Trading Book;
IMA;
Revised Standardized Model;
Factor Models;
Risk Contribution.

Article History:

Received:	02	December	2016
Accepted:	10	March	2017

1- Introduction

In January 2016 the Basel committee published the minimum capital requirements for market risk [2]. Instruments are qualified for inclusion in the trading book coupled with more rigorous guidelines governing internal risk transfers between the banking and trading book. Essential changes to older FRTB-rules are the introduction of a revised standardized model for market risk, which is based on price sensitivities, a substitution of value at risk (VAR) with an expected shortfall (ES) risk measure at a 97.5 percentile, one-tailed confidence level to an internal model desk level and the introduction of liquidity horizons in the ES calculation. Disclosure and transparency of market risk capital charges including capital ratios calculated using standardized and internal model have to be applied. Vigorous backtesting is required for institutions retaining an internal model approach (IMA) to a trading desk level. Failure to meet the validation criteria force a trading desk to revert to using the standardized approach with higher incremental capital charge. All institutions, regardless of size, complexity or whether they have allotted to retain an IMA, must report capital charge based on the standardized model. New calculation measures have to be implemented with revised data standards and sources and an increased number of simulations to be performed. In this article the standardized model and the internal model approach is analyzed with industry experience, the two approaches are compared, the consequences for the banks are described and practice examples are used to demonstrate the models.

2- Literature Review

Several reactions to the new FRTB/minimum capital requirements for market risk can be found in literature. In several opinions banks describe what might be disadvantageous for their business [2]. Also the different regulators like BAFIN, FSA, etc. posted their opinions in several publications. Many consulting firms describe their approaches how to implement the new guidelines [3] Deloitte, [4] KPMG, [5] PWC, [6] ACCENTURE etc. International academic

* **CONTACT**: orgeldi1@yahoo.de

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writers criticize many aspects of the new guidelines. In his 2015 research paper French Laurent states that the practical consistency of this comprehensive regulation package of measures is far from assured, banks have underestimated implementation costs and fundamental differences of analysis among the architectures of the financial system lead to several outstanding questions. He also questions the Basel impact studies and their quality [7]. In his presentation [8] Jorion proclaims models are usually based on historical information that may not reflect future risks, they involve simplifications, models assume current positions are frozen over the horizon and ignore liquidity issues etc. John Hull dedicates a whole chapter to the new Basel regulation in his book "Risk Management and Financial Institutions" and focusses on the replacement of VAR by the expected shortfall measure. In Germany several academics discuss the new regulation. The use of the measure VAR Value at risk is intensively elaborated in [9] Jens Fricke's book "VAR Ansätze zur Abschätzung von Marktrisiken". Also [10] Wernz "Bank management and control" describes major issues of the VAR measure. [11] Wilkens discusses selected risk factor models to derive simulation-based loss distributions and the associated risk figures. Several Phd theses have been published on central aspects of the regulation. [12] Racheva-Iotova elaborates in her 2010 thesis different approaches how to deal with market risk. Russian [13] Lobanov found critical issues for example in the new internal model approach "The internal models approach looks very appealing for banks but is not free from deficiencies, of which perhaps the most important one is a strong incentive for banks to play down their risk and capital numbers". Several other international authors like Chinese [14] Chang, Jiménez-Martín, Maasoumi, McAleer and Pérez-Amaral express their belief that for complicated cases, obtaining the ES might be more challenging. However, ES implies a greater chance of larger DCC than using VAR. Canadian [15] Wang warns of regulatory arbitrage of risk measures. In their study Hungarian [16] Bugár and Ratting discussed problems arising in relation to the application of the proposed risk measure with special regard to the testing difficulties of the new model. Danish [17] Christensen and Hansen presented an analysis of the evolution of the standardized approach and demonstrate that the regulatory effects of the new standardized approach will be higher capital requirements. The RISK magazine dedicated a complete issue to the "shortfalls of expected shortfall" (Risk December 2014) with a focus on backtesting expected shortfall, which will be discussed in this article lateron.

3- Regulatory Framework

In May 2012, the Basel Committee on Banking Supervision published its Fundamental Review of the Trading Book (FRTB), which had been promised by the Committee in its report to the G20 in October 2010. As a Consultative Document, the FRTB outlines the committee's vision for how trading risk should be capitalized in the future, providing a number of specific policy proposals, and invites the industry to submit comments. FRTB supersedes the "Market risk" section in Basel II [18] as amended in Basel 2.5 (BCBS 2010). In January 2016, the Basel Committee on Banking Supervision (BCBS) issued the new "Minimum capital requirements for market risk" [2] as the end-result of its multi-year "Fundamental review of the trading book" (FRTB).

Taking into consideration the lengthy regulator's approval process and the extraordinary extent of changes made to the market risk capital framework, banks need to move to implementation mode earlier than later. The Basel Committee of Banking Supervision (BCBS) published the Fundamental Review of Trading Book (FRTB) final rule on January 14, 2016 after five years of discussion, four quantitative impact studies (QIS) and three consultative papers [-23]. This is the first of many rules related to Basel IV that are anticipated to be finalized over the next several months, and expected to have a far-reaching impact on risk measurement, assessment, and reporting at financial institutions worldwide. Jurisdictional interpretation and adaptation by the central banks (U.S. FED, FRB, ECB, and BoE among others) are imminent, given an implementation deadline of January 1, 2019, and a "Go-Live" deadline of December 31, 2019.

The following table shows an overview of the regulatory requirements regarding market risk:

Table 1. Overview of the regulation.

Date	Basel paper	Available from:
BCBS 2005	International convergence of capital measurement and capital standards: A revised framework.	http://www.bis.org/publ/bcbs107.pdf
BCBS 2009	Revisions to the Basel II market risk framework.	http://www.bis.org/publ/bcbs158.pdf
BCBS 2012	Fundamental review of the trading book (consultative paper 1)	http://www.bis.org/publ/bcbs219.pdf
BCBS 2013	Fundamental review of the trading book: A revised market risk framework (consultative paper	http://www.bis.org/publ/bcbs265.pdf
BCBS 2013	Regulatory consistency assessment program (RCAP) - Analysis of risk-weighted assets for credit risk in the banking book.	http://www.bis.org/publ/bcbs256.htm

BCBS 2013	BCBS. 2013. Regulatory consistency assessment program (RCAP) - Analysis of risk-weighted assets for market risk.	http://www.bis.org/publ/bcbs256.htm
BCBS 2013	Regulatory consistency assessment program (RCAP) - Second report on risk-weighted assets for market risk in the trading book	http://www.bis.org/publ/bcbs240.pdf
BCBS 2014	Analysis of the trading book hypothetical portfolio exercise.	http://www.bis.org/publ/bcbs288.pdf
BCBS 2014	Reducing excessive variability in banks' regulatory capital ratios - A report to the G20.	http://www.bis.org/publ/bcbs298.pdf
BCBS 2015	Frequently asked questions: Impact study on the proposed frameworks for market risk and CVA risk	https://www.bis.org/bcbs/qis/FAQs_impact_study.pdf
BCBS 2015	Fundamental review of the trading book: Outstanding issues (consultative paper 3).	http://www.bis.org/publ/bcbs305.pdf
BCBS 2015	Instructions for Basel III monitoring - Version for banks providing data for the trading book part of the exercise.	https://www.bis.org/bcbs/qis/biiiimplmoninstr_feb15.pdf
BCBS 2015	Instructions: Impact study on the proposed frameworks for market risk and cva risk	http://www.bis.org/bcbs/qis/instr_impact_study_jul15.pdf.
BCBS 2016	Standards - Minimum capital requirements for market risk.	http://www.bis.org/bcbs/publ/d352.pdf

4- Trading Book vs. Banking Book

4-1- Differentiation Banking Book/Trading Book

The minimum capital requirements for market risk require a more complete definition of the boundary between trading book vs. banking book and there is more constraints on switching to avoid arbitrage. Instruments held in the trading book are for short-term resale, expectation of or locking in profits and hedging. They include instruments held as a trading asset or liability, those resulting from market-making activities, and instruments resulting from underwriting activities, among others. The banking book should include instruments that are not easily converted into cash such as unlisted equity, real estate, and those designated for warehousing. The minimum capital requirements states that "banks must have clearly defined policies, procedures and documented practices for determining which instruments to include in and to exclude from, the trading book for calculating their regulatory capital" [2].

An individual bank could choose to submit for approval an internal model for only a portion of its overall trading activity, or a regulator could refuse approval for an internal model applied to a single desk. The standard model must provide a credible fallback at the level of a trading desk. A more granular validation process on desk level and stricter limits along with capital disincentives are applied to the booking and transfer of instruments between the banking book and trading book is required. The new regulation lists instruments presumed to be in the trading book (art. 12 to 16), and a bank must receive explicit approval from the regulator to book any other instrument in the Trading Book. The bank has to document any deviations from the presumptive list in detail on an on-going basis (art. 17). The norm also imposes a limit on the movement of instruments between the banking book and trading book (art. 27). Any movement between books has to be approved and documented (art. 29). Policies must be updated, at least yearly (art. 30), and procedures defined and approved by senior management (art. 21). There will be no regulatory capital recognition for internal risk transfers from the trading book to the banking book (art 32), Restrictions apply for such transfers from the banking book to the trading book (art 34 to 36). Regulators can request a shift from the trading book to the banking book or vice versa if an instrument is deemed to be improperly designated or if the evidence provided is deemed incomplete (art 18 and 19). Banks also have to report on their boundary determination and assessments, as well as document compliance and conduct yearly internal audit of instrument designation (art. 20).

It might be difficult to distinguish clearly between instruments which have to be assigned to the trading books and instruments which have to be assigned to the banking book, and this will lead to higher bureaucracy. Supervisors will have to consider whether the proposed desk structures are sufficiently granular and meet all the governance conditions. The proposed changes could result in a large number of additional businesses being drawn into the trading book, resulting in smaller institutions requiring a trading book that previously have not. The committee should give clarity around derivatives attached to banking book positions. The proposal to determine the use of internal models on a desk-by-desk basis may result in inconsistent capital treatments for identical products and might impose a significant workload on both institutions and regulators.

4-2- Differentiation in Trading Desks

The classification of a trading desk allows room for maneuver. "The trading desk is an unambiguously defined group of traders or trading accounts" that implements a well-defined business strategy, operating within a clear risk management structure, defined by the bank but with the definition approved by supervisors for capital purposes" [2].

The committee's decision is to conduct model approval at the level of individual trading desks, rather than at bank level.

For IMA approval a trading desk must meet two quantitative criteria:

- P&L Attribution: A test to determine if P&L is based on risk factors used by the desks risk management model captures the material drivers of Actual P&L
- Backtesting: A test to determine how well the risks in an internal model are captured.

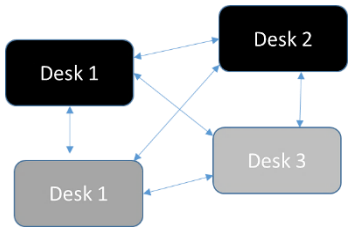

Figure 1. Trading desks relation.

If some desks use the standardized and others the internal model approach, the total charge depends on delineation of desks. Internal deals between desks influence total charge. A risk transfer within the trading book is allowed to delineate risks and is limited by documented trading strategy. The regulator can approve or remove the use of an Internal Model approach (IMA) at a trading desk level. If one desk loses the IMA approval, the resulting capital charge depends on many factors unrelated to that desk. Therefore the incentive to transfer risk to other desks arises. Desk structures would have to gain approval from the regulator to achieve IMA compatibility. Banks need to take care over citing instruments with non-modellable risk factors that require a separate capital charge.

A regulator can withdraw IMA for a trading desk, meaning that both SA and IMA results need to be calculated on a daily basis. This could lead to experimentation, where banks group existing desks together under the same risk management structure. The result could be a new trading desk with operational sub-desks that need "not be used in the market risk capital framework." A more granular validation process on the desk level should be possible. This allows a careful calibration of credit risk for non-securitization and securitization exposures in the trading book. Higher trading book capital requirements for certain activities will increase underwriting and funding costs, and can reduce liquidity in the secondary market.

5- The New Models Which Are Proposed by Basel

5-1- Model Determination–Revised Standardized Model or Internal Model?

In the past banks could choose either the standardized approach or the IMA approach. With the new requirements a revised standardized model for market risk based on price sensitivities is introduced [2]. It can be used by all banks, regulator's approval is not required. Banks are expected to maintain strict risk management systems to ensure that intraday exposures are not excessive. If a bank fails to meet the capital requirements at any time, the national regulator shall ensure that the bank takes immediate measures to correct the situation (Art. 3). The rules of the standardized approach have been revised to be closer to the IMA method. It must be calculated by all banks on a monthly basis (Art. 45). Securitization exposures also have to be calculated with the specific standardized method. The calculation approach for this method is more complex compared to the previous regulation approach. BCBS provides a decision tree showing which model has to be selected [2]. The following table also gives a good overview:

Table 2. Standardized and internal model approach.

FRTB	Approach	Addon
Interest rate	Standardized approach	Default risk charge
Foreign exchange		Residual risk addon
Equity	Internal model approach	Expected shortfall
Credit		Non modellable risk factor Default risk charge
Commodity		

5-2- The Revised Standardized Approach SA

The revised SA is based on banks' own estimates of price sensitivities to risk factors (a good analysis of the standardized approaches can be found in [28]).

Table 3. The standardized approach to market risk.

The Standardised Approach

Sensitivities-based Method: Capital charges for delta, vega and curvature risk factor sensitivities within a prescribed set of risk classes:
- General Interest Rate Risk (GIRR)
- Credit Spread Risk (CSR): non-securitisation
- CSR: securitisation
- CSR: securitisation correlation trading portfolio
- Foreign Exchange (FX) Risk
- Equity Risk
- Commodity Risk

Default Risk Charge (DRC) for prescribed risk classes:
- Default risk: non-securitisation
- Default risk: securitisation
- Default risk: securitisation correlation trading portfolio
- Banking book-based treatment of default risk, adjusted to take into account more hedging effects.

Residual risk add-on (RRAO):
- Risk weights applied to notional amounts of instruments with non-linear payoffs

In the revised standard approach linear and non-linear risks are described. General interest rate risk and foreign exchange risk weights, base vega risk weights for interest rate risk and all credit spread risk classes are increased. A cap at fair value to the capital charge of individual cash securitizations is introduced. Risk weights are lowered for certain buckets within individual risk classes, with notably large decreases for non-correlation trading portfolio securitizations. New buckets with lower risk weights are included for certain products such as covered bonds. Residual risk add-ons for instruments with exotic underlying (subject to a 1% risk weight such as volatility swaps) are differentiated from other residual risks (subject to a 0.1% risk weight) in products such as path dependent options, basket options, and instruments with prepayment risk. Liquidity Horizons are reduced under the vega risk charge for the FX, small cap equity, and all credit risk classes, in alignment with IMA.

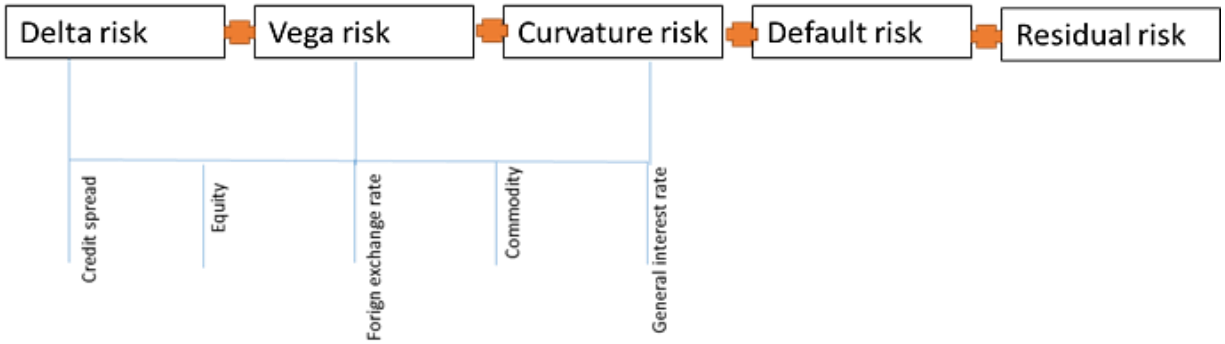

Figure 2. The different risk factors of the revised standardized approach [13].

Delta risk stands for the price change of an instrument resulting from a specified change (1 bp or 1%) in the underlying risk factor with five risk classes: interest rates, FX rates, stock prices, commodity prices, and credit spreads. It is based on sensitivities of a bank's trading book to regulatory delta risk factors. Delta sensitivities have to be used as inputs into the aggregation formula which delivers the capital requirement for the sensitivities based method.

Vega risk describes the change in the value of the option or an instrument with optionality resulting from a change in the price volatility of the underlying risk factor. *Delta risk* and *vega risk* for all risk classes are measured based on internal estimates of linear sensitivities of an instrument's price to specified small changes in its underlying risk factors.

Table 4. The dimensions of the risk factors.

Calculate net sensitivities	To risk factor	With risk classes	Assign to risk buckets	Aggregate to
Delta	Tenors on currency Risk free yield curve	General interest rate (for interest rate risk: [34] Sayah 2016)	Currency	**Risk weights** Applied to net sensitivities Reflect relative risk of buckets and risk factors
Vega	Issuer credit spread curve	Fx	Currency pair	Correlations between risk factors within a bucket Across buckets within a risk class For each risk class take the low, medium and high correlations scenarios.
Curvature	Equity option underlying of different maturities	Credit spread	Credit quality sector	
		Commodity	Category	
		Equity	market cap	

5-2-1- DeltaGIRR

Despite being labeled as sensitivity, Delta GIRR is defined via a finite 1bp shift, and then divided by the shift.

5-2-2- DeltaFx

Delta FX is defined via a finite 1% relative shift, also divided by the shift. The revised methodology is based on the already existing use of sensitivities but extending it to a broader set of risk factors. The standardised "bucket" risk weights given by the regulation within each risk class have been calibrated using an ES methodology, incorporating the article of varying liquidity horizons. The risk charge under the Sensitivities-based Method must be calculated by aggregating the following risk measures:

5-2-3- Curvature

Curvature is a risk measure which captures the incremental risk not captured by the delta risk of price changes in the value of an option. Curvature risk is based on two stress scenarios involving an upward shock and a downward shock to a given risk factor. The worst loss of the two scenarios is the risk position (defined in paragraph 48) to be used as an input into the aggregation formula which delivers the capital charge (Art. 47 (a)). Correlation effects are taken into account in the capital calculation for each risk class. Three scenarios are then applied to these effects: high correlation (125% of the defined factors), medium (100%) and low correlations (75%). The scenario with the highest impact is to be taken into account in the calculation. The two scenarios are shocked by risk weights and the worst loss is aggregated by correlations. Each of 5 risk classes is decomposed into pre-specified buckets that group together broadly similar risks within a risk class (e. g., the general interest rate risk class has buckets for 0.25 year, 0.5 year, 1 year, 2 years, 3 years, 5 years, 10 years, 15 years, 20 years, and 30 years). Fixed risk weight are assigned (approximately equal to a 97.5% expected shortfall (ES) over a specified liquidity horizon) (please refer to [14] Chang (2014) or [9] Fricke (2006). Delta, vega and curvature risks are mapped to relevant risk classes and risk factors. For delta, vega, and curvature the net sensitivity for each position in a bucket is multiplied by the specified risk weight. The risk-weighted delta, vega and curvature sensitivities for the positions in a bucket are aggregated using pre-specified correlations to account for diversification and to arrive to arrive at the total delta, vega, and curvature risk for each risk class. Curvature risk is added up to delta risk and vega risk.
As risk sensitivities are crucial to the pricing and risk management models of trading firms, a standard approach that utilizes these has to be better than one that does not. Capital requirement under standardised approach for market risk (SA-TB) is the sum of:

- The default risk charge
- The residual risk add-on.
- By aggregating delta, vega, and curvature risk measures.

5-2-4- The Standardized Default Risk Charge

This risk charge aims at taking into account the jump-to-default risk. Securitization exposures have their own set of rules for DRC calculation (please refer to [7] Laurent). The framework for default risk requires that positions are allocated to default risk bucket categories (e.g. corporates, sovereigns, local governments / municipalities for non-securitization exposures). The calculation is based on a given loss given default portion of the notional amount and

weighted according to the counterpart rating. The standardized DRC allows for some limited hedging recognition within each bucket category, but not across different buckets.

Table 5. The different risk classes according to the standardized approach.

	Risk classes					Other risks	
Instrument	**GIRR**	**FX**	**Equity**	**Commodity**	**Credit Spread**	**Default**	**Residual**
FX bond	Delta	Delta			Delta	X	
FX Forward		Delta					
Option on equity in FX		Delta	Delta Vega Curvature			X	
Spread option on natural gas				Delta Vega Curvature			X
MBS	Delta				Delta	X	X

5-2-5- Residual Risk Charge (add-on)

The Residual Risk Add-on is the simple sum of gross notional amounts of the instruments bearing residual risks, multiplied by a risk weight of 1.0% for instruments with an exotic underlying and a risk weight of 0.1% for instruments bearing other residual risks (Art. 58 c). Exotic exposures include longevity risk, weather, natural disasters and – when used for a swap – future realized volatility. Residual risk is calculated for instruments whose price changes cannot be well approximated based on price sensitivities. The residual risk is the notional amount of an instrument bearing residual risk multiplied by

- 1.0% for instruments with an exotic underlying (e.g. spread options, weather derivatives)
- 0.1% for instruments bearing other residual risks (e.g. mortgage-backed securities)

The residual risk add-on is the sum of all residual risks in the trading book.

Table 6. What measure for what kind of risk.

Sensitivity based on mothod			
Risk	**Delta**	**Curvature**	**Vega**
GIRR	☺	☺	☺
FX	☺	☺	☺
COM	☺	☺	☺
CSR-NS	☺	☺	☺
CSR-SCT	☺	☺	☺
CSR-S	☺	☺	☺
Default risk			
DEF	☺		
Residual risk adonn	☺		
RR	☺		

5-2-6- Default Risk

Default risk charge is calculated for debt and equity instruments and measured as fair value less recovery determined using LGDs. It is specified under the Foundation IRB Approach (jump to default (JTD) loss amounts). Debt and equity instruments (except securitizations) are assigned to sovereign, municipal or corporate buckets, but securitization instruments are assigned to buckets and risk weights specified in the "Revisions to the securitization Framework". Each bucket's capital charge is the difference between risk-weighted net long and short JTD amounts multiplied by a ratio < 50% to limit the recognition of hedging relationship between long and short positions.

It is a good decision to base capital on a more robust and better behaved summary statistic than VAR, especially since ES will help to ensure a more prudent capture of "tail risk" and capital adequacy during periods of significant financial market stress (Criticism of the VAR measure: [28]. Moving to a measure with greater sensitivity to low-

probability-but-high-impact events, the committee gains some flexibility to include new risks—such as an integration of short-horizon default risk that would have had little impact on VAR [29]. However, it is important to point out that neither VAR nor ES are able to forecast a maximum loss. Many banks use worst case scenarios to estimate maximum losses. Both risk measures provide instead a statistical estimation that is valid under normal market conditions – a fact that even senior management sometimes needs to be reminded of. In practice the actual benefit from switching to ES for risk management and capital requirements is limited by the available data. For calculation of the ES you need to work with hard-to-estimate extreme events that occur with very low probability but with huge impacts. The cost of building and maintaining both an internal and standard model is high, and requires a more rigorous approval process. The standard model must become more realistic and risk-sensitive in order to serve as a viable benchmark and fallback mechanism. It would be better to apply the standard model as a benchmark, and to allow regulators the flexibility to challenge internal models when they produce significantly lower capital.

The asymmetric correlation treatment should be replaced with a less complex measure to both simplify and improve risk sensitivity of the standardized approach. The disallowance factor seems to be uneconomic and the required capital for securitized products is heavily overstated. The revised standardized approach might increase the underwriting and funding costs and reduce liquidity in the secondary market due to higher capital charges. Double counting due to the overlap between historical credit spread and widening default expectations are possible. The proposed cash flow based model is fraught with implementation risk. For securitizations in the standardized approach, the impacts need to be understood and reviewed to avoid making the product uneconomic at a time when political objectives in many jurisdictions focus on reviving the market and broadening the available sources of funding.

5-3-IMA-Internal Model Approach

In the new IMA model several new regulations are proposed.

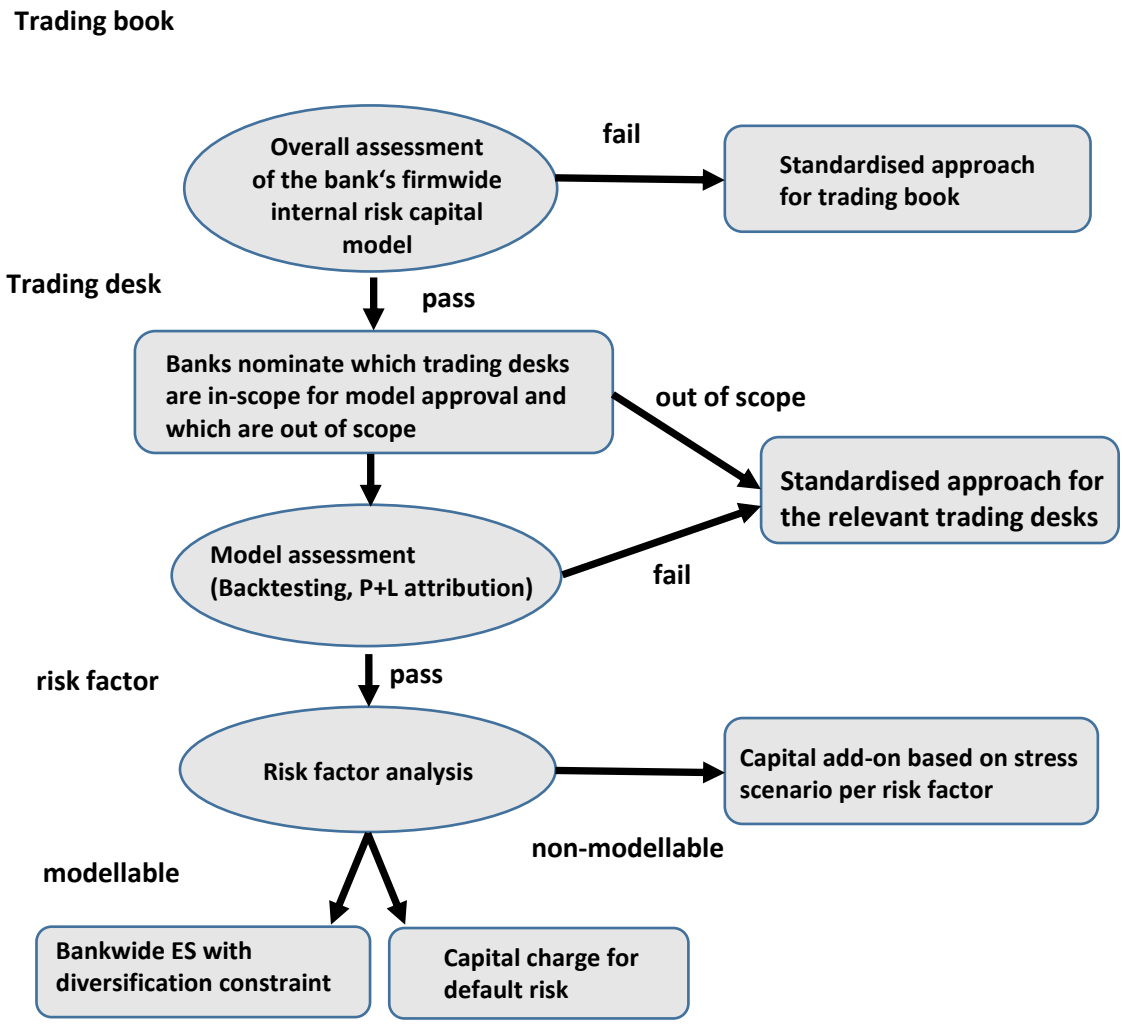

Figure 3. Determining eligibility of trading activities for the IMA approach.

An observation period with a horizon back to 2007 is recommended. Risk measures have to be changed to capture tail risks. The expected shortfall at a 97.5%, one-tailed confidence level is used instead of (VAR + Stressed VAR) and

calibrated on a stressed period to reduce procyclicality. This is due to the regulator's view that ES is better than VAR at picking up severe losses, since it covers 'the whole tail', and satisfies the sub-additivity property. Market liquidity risk is accounted for with varying liquidity horizons instead of a single 10-day liquidity horizon.

The 'stress calibration' concept has been introduced elsewhere, such as the Basel 3 Counterparty Credit and CVA regulatory capital rules. Stress calibration seems like a reasonable concept, as long as regulators show flexibility in allowing banks to use proxies for risk factors which did not exist in the stress period. Minimum capital requirements try to allow for this by permitting stress calculation on a reduced set of factors, and scaling based on a more recent window.

Internal models are assessed through tests at the desk level (if failed, the desk reverts to revised SA). Some other features are mentioned below:

- Daily VAR (!) Backtesting
- P&L attribution test (risk factors and proxies must explain correctly daily P&L)
- Capital charge for non-modellable risk factors (e. g. markets with sparse price history)
- Replacement of incremental risk charge (IRC) with a default risk charge
- Securitization instruments are no longer eligible for revised IMA

The VAR (99%) and stressed VAR market risk measurements (for the drawbacks of a stressed VAR is replaced by the expected Shortfall (ES(97.5%)) to better take in accounting for "tail risk" and market illiquidity [31].

For a bank with a bank-wide internal model approval for capital requirements for non-securitizations in the trading book, the total IMA capital requirement would be an aggregation of ES, the default risk charge (DRC) and stressed capital add-on (SES) for non-modellable risks. Banks must calculate, in parallel of IMA and at least monthly, the standardized capital charge for each trading desk as if it were a standalone regulatory portfolio (art. 184). The base multiplication factor applied to the internal model capital charge is increased to 1.5 from 1. ES liquidity horizons are now capped at 120 days, with reductions for credit and equity risks. IMA default risk charge liquidity horizon for equities is reduced to 60 days from one year. ES quantitative standards no longer reference requirements for use of full-revaluation. Look-back period for stressed period calibration has been shortened to 2007 from 2005. Vendors are recognized and accepted source for "real" price data, subject to certain conditions.

5-3-1- Default Risk

A default risk charge is calculated for debt and equity instruments. Default risk is measured as fair value less recovery determined using LGDs specified under the Foundation IRB Approach (jump to default (JTD) loss amounts). Debt and equity instruments (except securitizations) are assigned to sovereign, municipal or corporate buckets. Securitization instruments are assigned to buckets and risk weights specified in the "Revisions to the securitization Framework". Each bucket's capital charge is the difference between risk-weighted net long and short JTD amounts multiplied by a ratio < 50% to limit the recognition of hedging relationship between long and short positions.

5-3-2- Incremental Default Risk

The Incremental Risk Charge ('IRC') model [30] is replaced by the Default Risk Charge ('DRC') – there is no longer a requirement to model migration risk, but equity positions must be included. Comprehensive Risk measure ('CRM') disappears, and the correlation portfolio moves to standard rules. The incremental Risk Charge captures default and credit migration risks for credit-sensitive positions in the trading book. It applies to credit products over a one-year capital horizon at a 99.9 % confidence level, taking into account the liquidity horizons of individual positions or sets of positions. A Monte Carlo Simulation is used for calculating incremental risk charge as the 99.9 % quantile of the portfolio loss distribution and for allocating contributory incremental risk charge to individual positions. The model captures the default and migration risk in an accurate and consistent quantitative approach for all portfolios. Important parameters for the incremental risk charge calculation are exposures, recovery rates and default probabilities, ratings migrations, maturity, and liquidity horizons of individual positions.

5-3-3- Default Risk Charge

The default risk charge captures the jump-to-default risk in three independent capital charge computations for default risk of non-securitizations, securitizations and securitization correlation trading portfolio. The DRC is calculated as the 99.9% VAR of a one year default simulation with two types of systematic risk factor, to be reported weekly. The DRC replaces the former IRC for trading book positions to capture default risk exclusively (separate from all market risks, including credit spread risk) (art. 186). It must be measured using a VAR model.

5-3-4- Approved Desk Capital Charge

The approved desk capital charge has two components: a modellable risk charge, based on a modified expected

shortfall calculation, and a non-modellable risk charge, which is capitalized with a stress scenario that is at least as prudent as the equivalent ES calculation. The capital charge is floored at a multiple of the average capital charge over the last 60 days, with a conservative multiplier for the modellable risk component of between 1.5 and 2, depending on backtesting performance.

5-3-5- Non Modellable Risk Factors (NMRF)

Without a careful review of the rules, overall capital for trading books may rise substantially, either due to the NMRF factor or if a significantly larger proportion of trading is capitalized based on the SBA. Non-modellable risk factors (NMRF) charges are no longer subject to the internal model capital charge multiplier. NMRFs from idiosyncratic credit spread risk may apply the same stress scenario and a zero correlation assumption may be made when aggregating gains and losses subject to regulator's approval.

5-3-6- Stress Tests

Minimum capital requirements require that the risk unit establishes a series of scenarios that should be run at least monthly (Stress testing for trading books also in [32]**)**. The scenarios shall capture a series of historical and hypothetical events, but also requests that ad-hoc and reverse stressed test scenarios are applied. The ad-hoc scenarios shall be produced after considering the most significant risk drivers of the trading portfolio and shall specifically be designed to address illiquidity, concentration risk, event and jump-to-default risks, non-linearity of products, deep out-of-the-money positions and other risks that may not be captured appropriately in the internal models, in particular, those derived from the use of proxies. The stress testing program should not focus solely on the reasonableness of VAR results when compared with potential market losses stemming from the stressed scenarios, credit and other event losses shall also be used to assess the reasonableness of the IRC and/or correlation trading model assumptions, in particular regarding the capture of credit risk concentrations. It is implied (on page 115, part (f)) that the stress period should be different per desk, yet this is not specified in paragraph 181, nor does it appear consistent with the aggregation approach.

The introduction of ES can be seen as a minor improvement in the risk measure, but the impact and benefit have been exaggerated by some (For the critics of the Expected Shortfall please refer to [33]). Catching deep-in-the-tail events in the risk measure is beneficial, but the more important part is to model these events by using extreme value theory or the peaks-over-threshold-approach in the first place! The proposal is insensitive to bid-offer spreads. The notion of liquidity horizon—that there is always a time over which a trade can be spread in order to achieve an immaterial impact—ignores the fact that material bid-offer spreads can exist even for small trades. Some say the approach for handling liquidity horizons seems to be to complex. The VAR at 99% is replaced with expected shortfall (ES) at 97.5% confidence level (please refer to [34]. This is due the minimum capital requirements' view that ES is better than VAR at picking up severe losses, since it covers 'the whole tail', and satisfies the sub-additivity property. Of course, it allows to catch deep-in-the-tail events in the risk measure. The current double count of risk by using both VAR and Stress VAR is eliminated, now only the stress metric stress expected shortfall is used. Minimum capital requirements try to allow for this by permitting stress calculation on a reduced set of factors, and scaling based on recent window. We have to compute ES for each combination of:

- 5 liquidity horizons (10, 20, 40, 60 & 120 days)
- 6 asset classes (Equity, Commodity, Interest Rates, Credit, FX and All-in)
- 3 calibration windows (Reduced Stressed, Reduced Current, Full Current)

$\Longrightarrow$ up to 5 x 6 x 3 which leads to 90* runs of ES for every desk!

The bucketing of liquidity factors appears difficult to justify. Treating equity as having lower liquidity than major currencies' FX and IR seems inappropriate. The method for calculating liquidity factors requires the use of overlapping intervals, otherwise enough data is not available. It may lead to a significant amount of autocorrelation into the data series. Averaging idiosyncratic factors may increase the correlation between various risk factors. This breaks the 1-day correlations that are observed, but may introduce the risk of creating false correlation between risk factors. The 60-day horizon suggested for credit for example, makes a typical single name credit that may have low correlation with an index on a daily basis have high correlation on a 60-day basis. The proposal is insensitive to position sizes.

Hypothetical P&L calculations now reference to bank pricing models and not books and records. Risk-theoretical P&L calculation is now the P&L produced by banks' pricing models using risk factors captured in ES but not specifically the ES risk model. Internal models approval standards reference that regulators may continue to grant model approval under rare circumstances where a bank has breached backtesting or P&L attribution thresholds due to extraordinary circumstances such as a major regime shift or a period of significant cross-border financial market stress. The revised internal models approach introduces a more complex risk calculation and a more rigorous model approval process, which is applied at the trading desk level. Any desk that fails controls on backtesting performance and P&L attribution will fall back to the standardized approach, which may also act as a floor or surcharge to approve

desk capital charges. Securitizations are no longer eligible to be capitalized under the internal models approach and must use the standardized approach.

As continuous and real data is not always available, the treatment of many risk factors as non-modellable risk factors could lead to higher charges. Intra-day basis measurement is required. Banks may need new infrastructures and operational tools. The more aggressive ES multiplier (increased to 1.5 from 1) and a higher multiplier may diminish positive effects of LH reduction. The regulators may find it extremely difficult to evaluate the accuracy of sophisticated risk management models. Fears are growing that expected shortfall may prove to be too volatile. Since there is no standard regulatory benchmark model, an exante approach to validation is not possible. Ex post verification through the comparison of the bank's prior risk estimate and the portfolio's subsequent performance, is not promising. The reason is the low statistical power of such tests: Is the violation a rare occurrence of a low probability event that exceeds the size of an accurately estimated tail probability, or is the bank's estimate of the probability of the event biased?

The various constraints imposed on banks' internal models may create false incentives for banks. They may lead to a set of models maintained only for regulatory risk-based capital determination. The banks could 'adjust' the constrained models in order to minimize their capital requirements. By micromanaging modeling, the IMA invites gaming. The choice of model parameters may be too conservative for the bank and internally inconsistent. The arbitrary choice of a large multiplier number, which came about as a compromise Table by regulators in different countries, may impose burdensome capital requirements on most banks. The proposed design and calibration of IMA liquidity horizons may drive liquidity away from particular markets and products, fundamentally changing the economics of activities.

Risk factors which are considered non-modellable – but where the desk as a whole is in-scope – are capitalized via a not diversifiable add-on, leading to a large capital impact. Draft rules seem to be too prescriptive on data and risk aggregation. If not modified this could lead to a material capital increase for trading portfolios. Without a careful review of the rules, overall capital for trading books may rise substantially, either due to the NMRF factor or if a significantly larger proportion of trading is capitalized based on the SBA. Regulators eliminated migration risk from IRC to remove the double count, with spread risk in VAR. But they are worried about sovereign credit risk due to Eurozone issues. Elimination of the double count between spread and migration risk is a clear improvement. However, a 3bp floor on PD is quite conservative for some sovereigns.

6- Comparison of Standardized and IMA Approach

In this paragraph we compare the SA and IMA approach:

Table 7. Comparison of the standardised approach and the internal model approach.

SA	IMA
Three additive components per risk class (delta, curvature, vega)	Fully integrated modelling of liquidity adjusted ES with correlations across risk types
Calculate the charges using correlations from the regulator.	Calculate capital charge per risk class without correlation to other risk classes
Scale correlations 75% and 125 % (capped at 1)	Determine capital charge as linear combination of correlated and uncorrelated results.
Repeat calculations	
Choose correlation scenario with highest capital charge	

If an internal model fails to be accepted, then a bank must calculate their risk capital using the much more onerous standardized approach. From a model development perspective implementing the standardized approach could take a long time and if a bank fails an internal model the not only are they hit with a jump in risk capital but also a large development cost. It is not clear if the BIS committee will allow multiple. One example QIS (quantitative impact study) is presented by R. Gnutti from Banca Intesa SanPaolo [35]:

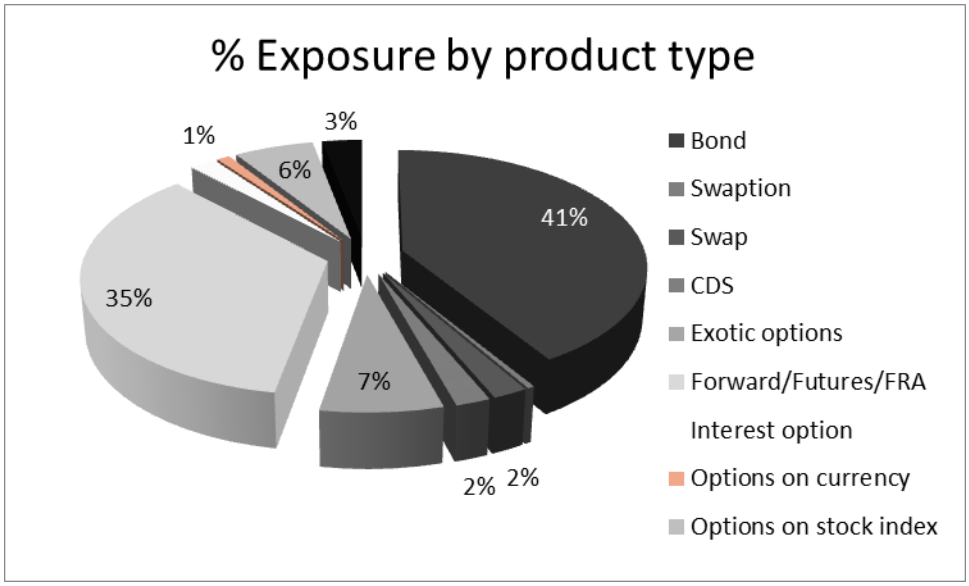

Figure 5. Composition of the trading book portfolio of Banca Intesa/SanPaolo 2015.

7- Worked Example

To illustrate the IMA approach, suppose that a firm has three trading desks in scope for model approval: exotic rates, flow credit and cash equity. We begin by computing the standalone expected shortfall by risk factor for each desk, as shown in Table 8. Then, using the risk-factor based liquidity horizons, we derive a weighted average liquidity horizon for each desk: we can see that the flow credit desk, which is mainly exposed to relatively illiquid credit instruments gets fairly long horizon of 46.7 days, whereas the Cash Equity desk, which is mainly exposed to liquid equity risk, gets a much shorter horizon of 15.0 days, with the Rates desk in between.

Table 8. Deriving desk level liquidity horizons.

		Desk Level 10 day ES			Factor level liquidity scaling		
Risk factor category	Liq horizon	Exotic rates	Flow redit	Cash EQ	Exotic rates	Flow redit	Cash EQ
IR	20	30	5		21%	3%	0%
IR ATM	60	50			34%	0%	0%
IR else	60	25			17%	0%	0%
CR sov (G)	20		30		0%	20%	0%
CR soc (HY)	60		10		0%	7%	0%
CR corp (G)	60		40		0%	27%	0%
CR corp (HY)	120		20		0%	13%	0%
EQ (large cap)	10			20	0%	0%	50%
EQ (small cap)	20			10	0%	0%	25%
FX bond	20	10	45	10	7%	30%	25%
Fx forward	60	30			21%	0%	0%
		145	150	40			
			Desk liquidity horizon		49,0	46,7	15,0

per desk % risk drivers

Weighted average of factor level horizon

Next, we derive the desk level scaling factor by desk, by taking the square root of the ratio of desklevel horizons to the 10-day baseline used to compute losses.

Table 9. Computing liquidity adjusted P+L by desk, and aggregating to total liquidity adjust P&L.

Liquidity horizon	49,0	46,7	15,0
Scaling factor	2,21	2,16	1,22

sqrt(LH)/sqrt(10)

Multiply 10 day P+L by desk scaling factors

	10 day P+L			$caled PL			
Scenario	Exotic rate	Flow credit	Cash EQ	Exotic rate	Flow credit	Cash EQ	Total
1	15	-39	-17,1	33,2	-84,2	-20,9	-72,0
2	-40	2	-32	-88,5	4,3	-39,2	-123,4
3	-3	-12	-32,5	-6,6	-25,9	-39,8	-72,4
				0,0	0,0	0,0	0,0
9999	-11	-15	28,2	-24,3	-32,4	34,5	-22,2
10000	-35	-11	59	-77,4	-23,8	72,3	-29,0

set capital as ES of total P+L post liquidity adjustment

We scale the 10-day P&L vectors for each desk. The liquidity adjusted desk P&L vectors are aggregated to find the total liquidity adjusted PL for approved desks, which flows into the capital calculation.

8- Backtesting

Vigorous backtesting requirements for institutions retaining an IMA to a trading desk level are required. Failure to meet the validation criteria would force a desk to revert to using the standardized approach, thus incurring incremental capital charge. Ongoing monitoring of IMA-eligible trading desk through backtesting and Profit and Loss Attribution (P&L) for continued eligibility for the modelbased approach is required. The backtesting test provides an assurance that trading desk risks are well captured in the model with a high confidence, while P&L attribution criteria tests how much of the trading risk is captured within the model.

Model testing performance is well established, there is a huge difference between the driver of capital – stressed and liquidity adjusted expected shortfall [36]. Backtesting the ES is highly controversial. Some authors see major challenges for the banks [16] in backtesting the EL. Expected shortfall has better properties than VAR, so if it's back-test, there is no reason to use the VAR test anymore, which was a measure choice in the first place. Expected shortfall can be back-tested [26]. Acerbi et al. define three ES back-test methods that are nonparametric, distribution-independent and do not assume any asymptotic convergence. The tests are easy to implement and generally display better power than the standard Basel VAR back-test. P&L attribution is a new concept and means comparing the ex-post P&L 'forecast' by the risk model with that actually observed. It is checked whether the model incorporates all relevant risk factors. P&L attribution can be a useful tool, but we have serious concerns about how to apply strict statistical tests on this.

9- Technological Consequences/Business Implications

The minimum capital requirements impose a new operational complexity. The expected shortfall has to be calculated for combinations of liquidity horizons, different asset classes, calibration windows, low granularity on stressed data and P+L considerations. The minimum capital requirements need high quality data and require new reporting. Market risk supervision is required on an intraday basis. Intense approval process by the regulator is required and a negative impact on market liquidity is seen. In addition we see a system consolidation. The large capital investment and highly probable lower margins will cause a mismatch. The need for a dedicated platform which is able to make computations, combine multiple models, sense of historical data, shocking curve, for each trading desk, reconciling P+L reports for every day, trading desk, risk factor. The platform must be able to combine diverse curve and pricing methodologies.

Table 10. Example technical consequences.

Minimum capital requirements for market risk	
Positions	App. 100'000 instruments from all the broad risk classes and their derivatives
Market risk exposure	Expected shortfall (daily)
Risk factor combinations	21 valid combinations of liquidity horizons and risk class
Scenarios	25×0 Expected shortfall 1 year time horizon, 3 x sets of scenarios to calibrate to a period of stress
Total scenario calculations	100'000 × 21 × 3 250 = 1'575'000'000 (daily)
Data volume	App. 700 GB

10- Conclusion

Expected shortfall has a number of advantages over VAR. This has led many financial institutions to use it as a risk measure internally. A combination of stress tests and VAR models on individual lines of business will continue to be the main focus of trading book risk measurement. The new minimum capital rules aim to make a bank's day-to-day trading activities less risky by forcing a framework that increases the risk capital charge. However, there are a number of points that need clarification. In his paper [32] Brito showed that according to Basel III capital charge rises by 232% and 182% under the standardized and internal model. From a bank's perspective it is more preferable to have an internal model approved that has to use the Standard Approach. But valid internal models could fail because of flaws in the approval process. If this happens, then one can foresee a situation where a low risk trading desk is heavily penalized with a large risk capital charge.

The regulator will have more choice to intervene in the internal guidance of a bank and will reduce the management possibilities. Under the new minimum capital rules, regulators seek to have more control and insight into internal models output, to avoid 'black boxes': This is an understandable aim, but a profusion of requirements in combination can quickly become unworkable. The calculated expected shortfall and the internal models will have a deep impact on reporting, model approval and backtesting procedures. For the standard models it is a revolution in complexity (hopefully also in the determination of risk sensitiveness), instrument and risk factors data, mapping, Greeks and IT systems.

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