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Minimum capital requirements for market risk: An overview and critical analysis of the standardized approaches under Basel III

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Kurzzusammenfassung: Im Januar 2019 veröffentlichte der Baseler Ausschuss für Bankenaufsicht eine revidierte Fassung der Mindestanforderungen an Eigenkapital für Marktrisiken, die am 01.01.2023 in Kraft treten wird. Diese Arbeit beschäftigt sich mit dem auf Sensitivitäten basierenden Standardansatz und dem Vereinfachten Standardansatz. Neben der Darstellung und kritischen Analyse beider Ansätze wird untersucht, wie sich die Ansätze in ihren Auswirkungen auf die Eigenkapitalanforderungen unterscheiden. Zudem werden die Ergebnisse für Instrumente mit Ausfallrisiko mit denen des Standardansatzes des Bankbuchs verglichen. Insbesondere wird gezeigt, dass der auf Sensitivitäten basierende Standardansatz konzeptionelle und technische Schwachstellen aufweist. Er ist zudem unnötig kompliziert und läuft so der vom Baseler Ausschuss selbst formulierten Forderung nach mehr Transparenz und Vereinfachung zuwider.

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Abstract: In January 2019, the Basel Committee on Banking Supervision published a revised version of the minimum capital requirements for market risk, which will take effect on January 1, 2023. This paper focuses on the sensitivity-based standardized approach and the simplified standardized approach. In addition to presenting and critically analyzing both approaches, the paper examines how the approaches differ in their impact on capital requirements. Moreover, the results for instruments with default risk are compared with those of the standardized approach for the banking book. In particular, it is shown that the sensitivity-based standardized approach has conceptual and technical weaknesses. It is also unnecessarily complicated and thus runs counter to the Basel Committee's own call for greater transparency and simplification.

Keywords: Basel III, Standardized Approach, Market Risk, Minimum capital requirements

JEL classification: G21, G28

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List of Abbreviations

ABS	=	Asset-backed securities
AFME	=	Association for Financial Markets in Europe
AM	=	Advanced Markets
bps	=	Basis Points
CC	=	Correlation coefficient
CLO	=	Collateralized loan obligations
CMBS	=	Commercial mortgage-backed securities
CR	=	Capital adequacy requirements
CSR	=	Credit Spread Risk
CTP	=	Correlation Trading Portfolio
DRC	=	Default Risk Capital Requirement
EM	=	Emerging Markets
ERBA	=	External-ratings-based approach
HBR	=	Hedge Benefit Ratio
IG	=	Investment Grade
LGD	=	Loss Given Default
NIG	=	Non-Investment Grade
RRAO	=	Residual Risk Add-On
RMBS	=	Residential mortgage-backed securities
SA BB	=	Standardized approach for the banking book
SA TB	=	Standardized sensitivity-based approach for the trading book
SREP	=	Supervisory review and evaluation process
SSA	=	Standardized simplified approach for the trading book
SSA M	=	Maturity ladder approach (commodity price risk)
SSA S	=	Standard method (commodity price risk)
STC	=	Simple, transparent, comparable securitizations

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Part 1: Overview of the standardized approaches

I. Introduction

On January 1, 2023, several new regulations under Basel III are scheduled to come into force.[1] One of these is the revised framework for calculating minimum capital requirements for market risk.[2] Following the revisions, the disputable separation between banking book and trading book positions with regard to interest rate, credit and equity price risk is to be maintained, without disclosing the rationale of this decision.

Market risk includes those in the trading book as well as foreign exchange rate and commodity price risks in the banking book. The latter are therefore still treated in the same way, regardless of which of the two books they are assigned to.[3] To determine capital adequacy requirements (CRs), banks may use the standardized sensitivity-based approach for the trading book (SA TB) or an internal model approach subject to approval. Banks with small or non-complex trading books may be permitted by the supervisor to use a standardized simplified approach (SSA). Banks that are allowed to use an internal models approach must compute CRs in parallel using the SSA. In addition, all banks must use the standardized approach for the banking book (SA BB) for investments in loan securitizations and investments in funds that do not permit a look-through approach. Despite the very legitimate concerns expressed in these rules about the use of internal models, this option remains available for market risks, while it is not to be available for operational risks as of 2023.

Sections II and III present an overview of the two standardized approaches for the trading book SA TB and SSA. Simplified calculations illustrating how the approaches work can be found in the appendix. The corresponding calculations for positions with default risk, including investments in loan securitizations in the banking book, are also shown there to illustrate the different treatment of positions depending on their allocation to one of the two books. In the central section IV, CRs for portfolios under the different approaches are calculated, compared and analyzed separately for six of the seven SA TB risk classes.

In contrast to the SA BB, both approaches for the trading book do not compute risk-weighted assets directly. Rather quasi-provisional CRs for market risk are computed and must then be converted into risk-weighted assets by multiplying by 12.5. A certain percentage is then applied

[1] BCBS (2020a); BCBS (2020b).
[2] BCBS (2019a).
[3] BCBS (2019a), p.15, para.11.1

to these risk assets, which, including the capital conservation buffer, amounts to at least 10.5%.[4] Only then is the actual CR for market risk obtained. In the following, CR always refers to the preliminary CR, unless explicit reference is made to the actual CR.

II. The sensitivities-based standardized approach for market risk

CR under the SA TB is the sum of three components.

The first component is the calculation of sensitivity-based risk for the

- Delta risk for all instruments that are not considered exotic[5]
- Vega risk for non-linear instruments with optionalities and
- Curvature risk based on the losses of two stress scenarios for non-linear instruments with optionalities.

In the separate calculations of the three risks of the first component, diversification effects are taken into account using predetermined correlation coefficients (CCs). This requires numerous calculation steps. Since correlations are unstable, especially in times of crisis, the CR must be calculated three times on the basis of different scenarios for the CCs in addition to the stress scenarios for the curvature risk. However, the consideration of correlations largely contributes to the unnecessarily high complexity of the SA TB.

The second component, the default risk capital requirement (DRC), is the calculation of a CR for the risk that may arise from a sudden default with respect to an instrument with default risk. The surcharge in the form of the DRC is a complement to the treatment of credit risk in the banking book and is intended to reduce possible discrepancies in terms of CRs between banks due to different allocations of instruments to the two books. This can also be seen as an indication of the disputable distinction between the banking and trading book.

The third component, the residual risk add-on (RRAO), is a surcharge on the CR for market risks of certain complex or exotic products that cannot be adequately captured in a standardized approach. The reference to the RRAO is unnecessary, however, as supervisors are already required to assess whether risks are adequately captured in the course of the supervisory review and evaluation process (SREP).

[4] BCBS (2019b), p.9. The preliminary CR must therefore be multiplied by at least 12.5*10.5% = 1.3125.

[5] Exotic instruments are particularly complex option instruments or instruments that involve weather risks or life insurance-related longevity risks.

The general procedure for calculating capital adequacy is the same for all risk classes. The SA TB defines seven risk classes: General interest rate risk, three classes for credit spread risk (CSR), equity price risk, commodity price risk, and foreign currency risk. For each risk class, the CR is calculated separately, first within so-called buckets (a group or combination of risk factors) and then also across these buckets of a given risk class using CCs. This leads to a massive capital relief compared to the prescribed risk weights.

Paragraph 2.1 provides an overview of the rules for determining delta and vega risk, since they have more similarities than the curvature risk rules presented subsequently. Paragraph 2.2 presents the rules for computing the DRC. By its very nature, there are no fixed rules for the third component RRAO.

2.1 Computation of risks based on sensitivities

2.1.1 and 2.1.2: Computation of delta and vega risk

These risks are calculated in six steps:

Step 1: Allocation of risk positions to one or more of the seven risk classes.

If individual positions contain different types of risk, they are assigned to different risk classes. For example, since a foreign currency bond is exposed to various market risks, it is assigned to the risk classes interest rate risk, CSR and foreign currency risk.

Step 2: Assignment of positions to buckets within the risk class.

This step requires for example to assign risk positions bearing interest rate risk to buckets of yield curves of different currencies. Exposures bearing CSR are assigned to buckets of various industries and credit qualities. Equities are assigned to buckets of different market capitalizations, regions, and industries. For commodities, the rulebook provides buckets by different commodity types. Finally, each foreign currency represents a distinct bucket.

Step 3: Separate calculation of net sensitivities s_k per risk factor k for delta and vega risk per instrument and risk class.

The sensitivities are intended to show how position values change for given changes in predefined risk factors for delta or vega risk.

Step 4: Calculation of weighted sensitivities WS_k by multiplying s_k by prescribed risk weights RW_k.

Step 5: Aggregation within buckets.

The WS_k are not added but aggregated within the buckets b by taking CCs ρ_{kl} into account. The coefficient ρ_{kl} either needs to be calculated for each pair of position values k and l according to prescribed parameters or is already preset. The aggregated weighted sensitivity within a bucket K_b and thus the CR of a bucket is obtained by a formula known from portfolio theory:

$$K_b = \sqrt{MAX\ (0; \sum_k WS_k^2 + \sum_k \sum_{k \neq l} \rho_{kl} * WS_k * WS_l)}$$

Step 6: Aggregation across buckets.

The aggregation of Kb across buckets of a risk class also requires CCs Υ_{bc}. Again, the coefficient Υ_{bc} either needs to be computed according to prescribed parameters or is preset for each pair of buckets b,c respectively. With $S_b = \sum_k WS_k$ and $S_c = \sum_k WS_k$ for the sum of all weighted sensitivities of all risk factors in bucket b or c, the formula for the delta or vega risk, i.e. the CR of a risk class, is as follows:

$$CR_b = \sqrt{\sum_b K_b^2 + \sum_b \sum_{b \neq c} \gamma_{bc} * S_b * S_c}$$

If the term $\sum_b K_b^2 + \sum_b \sum_{b \neq c} \gamma_{bc} * S_b * S_c$ is negative, the following applies for all risk factors in bucket b and c, respectively: $S_{b,c} = \text{MAX}\ (\text{MIN}\ \left(\sum_k WS_{k,} K_b\right), -K_b)$.

However, it can be shown that one is not free in the choice of CCs. Since for the aggregation across buckets the sums of all weighted sensitivities S are used instead of the CRs of the buckets K, it may happen that the total of all K_b after step 5 is lower than the CR after step 6 taking into account diversification effects. This may happen if the CCs are lower for the aggregation within buckets than for the aggregation across buckets. Therefore, in the rule book, the CCs had to be manipulated accordingly to avoid possible inconsistencies.

2.1.3 Computation of curvature risk

The computation of curvature risk for each risk class is based on the results of two stress scenarios. The additional loss exceeding the delta risk is then determined from these calculations. The calculation follows five steps:

Step 1: For each instrument subject to curvature risk (in particular options), the respective risk factors k are raised or lowered once to determine the value of the instrument after a stress test. The extent of the stress scenarios is predetermined and corresponds:

- for currency and equity risk, as a rule, to the risk weight used to calculate the delta risk

- for the other risk classes, to a parallel shift of the interest rate or spread curves that is equal to the highest delta risk weight of the respective risk class.

Step 2: Calculation of the CR CVR_k for the curvature risk per risk factor k

$$CVR_k^+ = - \sum_i \{V_i (x_k^{RW(Curvature)+}) - V(x_k) - RW_k^{Curvature} * s_{ik}\}$$

$$CVR_k^- = - \sum_i \{V_i (x_k^{RW(Curvature)-}) - V(x_k) + RW_k^{Curvature} * s_{ik}\}$$

With the two equations for the upward and downward shift of the risk factor k, the two CRs are obtained from the following three items:

- Price of instrument i after the stress test $V_i\ (x_k^{RW(Curvature)+/-})$
- Price of instrument i before the stress test $V_i\ (x_k)$, i.e. at the current level of risk factor k which is x_k
- Product of the risk weight for curvature risk k, i.e., the magnitude of the shift in risk factor k, $RW_k^{Curvature}$, and the delta sensitivity s_{ik} of instrument i with respect to k.

Step 3: Separate aggregation of the two CVRs within buckets using prescribed CCs ρ_{kl} with the following equations for both scenarios:

$$K_b^+ = \sqrt{MAX\ (0, \sum_k MAX(CVR_k^+, 0)^2 + \sum_{l \neq k} \sum_k \rho_{kl} * CVR_k^+ * CVR_l^+ * \psi(CVR_k^+, CVR_l^+))}$$

$$K_b^- = \sqrt{MAX\ (0, \sum_k MAX(CVR_k^-, 0)^2 + \sum_{l \neq k} \sum_k \rho_{kl} * CVR_k^- * CVR_l^- * \psi(CVR_k^-, CVR_l^-))}$$

The CR per bucket K_b is the larger of the two requirements under the upward and downward scenarios K_b+ and K_b-. The parameter $\psi(CVR_k, CVR_l)$ equals 0 in both cases when CVR_k and CVR_l are both negative, and 1 otherwise.

Step 4: Aggregate K_b per bucket across buckets within the risk class using prescribed CCs Υ_{bc} with the following equation:

Curvature risk = = $\sqrt{MAX(0, \sum_b K_b^2 + \sum_{c \neq b} \sum_b \gamma_{bc} * S_b * S_c * \psi(S_b, S_c))}$

with $S_b = \sum_k CVR_k^+$ for all risk factors in bucket b if the upward scenario is chosen, or $S_b = \sum_k CVR_k^-$ otherwise. The parameter $\psi(S_b, S_c)$ is 0 if S_b and S_c are both negative, and 1 otherwise.

After calculating the delta, vega, and curvature risk with the prescribed CCs ρ_{kl} and Υ_{bc} for aggregation within buckets and across buckets of a risk class (scenario 1), all aggregations need to be repeated two more times. In the second scenario, all CCs ρ_{kl} and Υ_{bc}, respectively, are multiplied by 1.25, but the values are capped at 1. In the third scenario, all CCs ρ_{kl} or Υ_{bc} are replaced by MAX(2 * ρ_{kl} -1; 0.75 * ρ_{kl}) or MAX(2 * Υ_{bc} -1; 0.75 * Υ_{bc}). This is because correlations have proven to be unstable over time and may change significantly, especially in times of crisis.

For each of the three correlation scenarios, the separately calculated results for delta, vega and curvature risk are then summed across all risk classes, i.e. reasonably, correlations between risk classes are not considered. Finally, the highest result of the three scenarios determines the CR. Scenarios with reduced correlations may be relevant for portfolios consisting of long and short positions, as they reduce the hedging effect and thus increase the CR. However, the CR of such a portfolio is typically lower than that of a portfolio consisting only of long or of short positions. For the latter, the scenario of increased correlations is relevant as it leads to the highest CR.

Taking into account CCs and the two scenario calculations due to concerns about the instability of the chosen CCs, hugely complicates the SA TB. The number of CCs to be considered for the corresponding pairs of positions for aggregation within and across buckets and for three scenarios may be several thousand, and may even significantly exceed 10,000 for larger banks. The following is an example using interest rate risk. With 12 different maturities between 0.25 and 10 years, (12 * 12 - 12) / 2 = 66 different correlations per currency have to be computed, so that for positions in the seven defined main currencies already 7 * 66 = 462 CCs are needed. Since three scenarios are required, one obtains already 3 * 462 = 1,386 CCs for the delta risk only. For vega risk of an equally large portfolio of instruments with optionalities, the number of CCs to be calculated when aggregating within buckets is twice as high (2,772) and for curvature risk it is just as high (1,386) as for delta risk.[6] In the example, more than 5,500 CCs would need to be determined for this risk class alone. Add to this the modest number of 3 * 3 = 9 CCs for aggregation across buckets in the case of interest rate risk. Admittedly, the numbers of CCs for the other risk classes are significantly lower than for interest rate risk, with credit spread risks requiring significantly more computational effort than the remaining risk classes.

The complexity of the SA TB due to the consideration of correlations can also be illustrated by the number of calculations. If CCs were not considered, the weighted sensitivities could simply be added across all buckets and risk classes. By considering CCs, on the other hand, several hundred intermediate calculations may be required across all risk classes. An example using credit spread risk for non-securitized instruments follows. For 17 of the 18 buckets in this risk

[6] To calculate the vega risk, two coefficients must be determined, which are then multiplied with each other to obtain the applicable CC.

class, three scenarios must be computed for the aggregation within the buckets, resulting in 17 * 3 + 1 = 52 calculations. Add to this three scenarios for the aggregation across buckets, for a total of 55 computational steps. Thus, a total of 3 * 55 = 115 calculations are potentially required for delta, vega, and curvature risk. Admittedly, the number of calculations for the three classes of CSR is higher than for the other risk classes due to the higher number of buckets.

2.2 Calculation of the default risk capital requirement

The DRC is the second component and is intended to capture the risk of a sudden default of an issuer that is not adequately captured otherwise. Therefore, the DRC is to be computed only for positions with default risk (bonds, securitization tranches, equities, derivatives). National authorities are allowed to exclude exposures to governments, public institutions and multinational banks from the calculation of the DRC. As in the banking book, this represents an unjustified privileging of government financing and reinforces the so-called nexus between governments and banks, which has undesirable consequences for members with high credit ratings, especially in a monetary union. The calculation is performed separately for the three risk classes:

- Non-securitized positions
- Securitized positions ex correlation trading portfolio (CTP) and
- Securitized positions of the CTP.

Although the calculations provide for differences in detail, they follow a common scheme for all three classes. First, the gross and net positions are determined by issuer and the net positions are assigned to predefined buckets (e.g. type of issuer or asset class and region). Within a bucket, a so-called hedge benefit ratio (HBR) is then computed, which determines the extent to which netting of long and short positions within a bucket is permitted. The higher the HBR, the more long and short positions can be offset and the lower the DRC. The resulting net positions are then multiplied by specified risk weights and added. Finally, the DRC of the buckets are simply added, i.e. correlations between the buckets and between the three risk classes are neglected when computing the DRC.

2.2.1 Non-securitized positions

Initially, the gross position is computed. It is the product of its nominal value and its loss given default (LGD) plus the accumulated gain or loss (difference between market value and nominal value). A gain increases and a loss reduces the nominal value of a long position. The LGDs are set at 100% for equities and subordinated debt, 75% for non-subordinated debt and 25% for covered bonds. Long and short positions vis-à-vis the same issuer may be netted, provided that the short position is equally ranked or subordinated to the long position.

The time horizon for the default risk is one year. Therefore, gross positions with a residual maturity of less than one year are considered on a pro-rata basis, i.e. a position with a residual maturity of six months is multiplied by 0.5.[7] Equity positions may be considered as having a remaining maturity of three or 12 months.[8] For derivatives, the remaining term of the contract applies. However, a floor of three months applies to all positions. The remaining net long and short positions are then aggregated separately.

In the next step, a HBR is determined for each bucket. Risk positions multiplied by their respective LGDs are assigned to one of three predefined buckets for corporates, central or regional governments, depending on the issuer. The HBR is the sum of net non-risk-weighted long positions divided by the sum of net non-risk-weighted long positions and the absolute value of net short positions HBR = $\sum netJTD_{long} \,/\, (\sum netJTD_{long} + \sum |netJTD_{short}|)$.

Finally, the buckets' net positions are multiplied by risk weights ranging from 0.5% to 50% for non-defaulted and at 100% for already defaulted positions, depending on the credit quality. The capital requirement per bucket DRC_b is the sum of the net risk-weighted long positions minus the product of HBR and the sum of the absolute values of the net risk-weighted short positions

$$DRC_b = \mathrm{MAX}[(\textstyle\sum_{i \in Long} RW_i * netJTD_i) - HBR * (\sum_{i \in Short} RW_i * |netJTD_i|); 0].$$

If there are no short positions, i.e. if HBR equals 0, the DRC for net non-defaulted long positions is between 0.5% and 50% multiplied by the corresponding LGD of 25%, 75%, or 100%, depending on their rating.

It is disputable that long and short positions of different issuers and irrespective of credit quality are allowed to be offset against each other across the board as it is not plausible to assume that, for example, a short position of a AA-rated European pharmaceutical company offers meaningful protection against the default of a BB-rated U.S. car manufacturer. Although offsetting is restricted by the equation for DRC, it is doubtful that the HBR takes sufficient account of basis risk.[9]

[7] The longer-term positions are considered as positions with remaining maturity of 1 year.

[8] Presumably, this is to allow short positions in equities to be used as a hedge for longer-term long positions in debt instruments, while long positions in equities, for example, can benefit from a lower DRC.

[9] At WestLB, long and short positions in the common and preferred shares of even the same listed companies led to massive losses in 2007.

2.2.2 Securitized Positions ex CTP

For securitization positions, the approach is basically the same as described for non-securitized positions in 2.2.1, i.e. the equations for calculating HBR and DRC are identical. However, the gross position equals the market value. Moreover, the LGD is not required, as loss severity is supposed to be taken into account in the risk weights for securitizations. The risk weights ranging from 10% or 15% up to 1,250% equal those for tranches held in the banking book with a residual maturity of one year. In general, netting is only allowed between the same tranches of a common pool of securitized assets.

In addition to only one bucket for large corporates, there are another 44 buckets defined by 11 asset classes and four regions, and one bucket for unclassifiable tranches. The capital requirement of a non-derivative securitization position is capped at its market value.

2.2.3 Securitized Positions CTP

CTPs include credit derivatives relating to individual borrowers, credit index products (e.g. the CDS indices CDX and iTraxx), and securitization tranches that are not based on real estate loans and loans to retail customers. In principle, the same approach as described in 2.2.2 applies here. The gross position corresponds to the market value. Netting is generally only allowed between identical risk positions. Each index is considered a separate bucket. If the risk positions are securitization tranches, the risk weights are calculated according to the banking book rules as described in 2.2.2. For non-securitized instruments, the risk weights from 0.5% to 100% as described in 2.2.1 apply. In contrast to 2.2.1 and 2.2.2, the capital requirement per bucket DRC_b is computed according to the following equation.

$$DRC_b = (\sum_{i \in Long} RW_i * netJTD_i) - HBR_{ctp} * (\sum_{i \in Short} RW_i * |netJTD_i|)$$

Contrary to 2.2.1, the DRC of a bucket may also be negative. HBR_{ctp} is the ratio of long and short positions of all indices across all buckets and not only from the positions of the bucket by itself as in 2.2.1. Moreover, the DRCs of the buckets are not simply added, but aggregated using the following formula despite the basis risk.

$$DRC_{CTP} = MAX\ [\sum_b (MAX[DRC_b; 0] + 0{,}5 * MIN[DRC_b; 0]), 0]$$

Long positions of bucket b may be offset with short positions of bucket c, but the short positions are only counted at 50%. For example: a long position of +100 in b and a short position of -100 in c results in a CR of +100 - 0.5 * 100 = 50. Even though the equations limit the offsetting of long and short positions when aggregating within and across buckets, the computations provide a capital relief that seems inadequate given the uncertainty about the diversification effect and add additional complexity to the rules.

III. The simplified standardized approach for market risk

The SSA is intended as an alternative for banks with smaller or less complex portfolios. It is the current standardized approach under Basel 2.5.However, the separately determined results for the four risk classes under consideration - interest rate, equity price, foreign currency and commodity price risk – will be subject to newly introduced scaling factors ranging from 1.2 to 3.5 and then still added.[10] The calculation of CRs for the four risk classes does not follow a uniform scheme, but varies depending on the risk class. Derivative positions other than options are generally converted into positions of the underlying. Neither DRC nor RRAO are needed for the SSA. Moreover, there are three different approaches for options regardless of risk class, which are discussed in the appendix, as are sample calculations for the four risk classes of the SSA. These conceptual differences hamper comparability between SA TB and SSA.

3.1 Interest rate risk

Regarding interest rate risk, the SSA distinguishes between general and specific interest rate risk.[11]

General interest rate risk is calculated for each currency separately using either the maturity method or the duration method.[12] The results are then multiplied by a scaling factor of 1.3 regardless of the method applied.

In simplified terms, the maturity method determines the net interest rate positions for each maturity band and multiplies them by risk weights. Risk weights typically increase from 0% to 6% as the remaining term of the fixed-interest period rises, and may amount to 8% or 12.5% for very long maturities and very low coupons. Net long or net short positions are then determined for each maturity band. Balanced positions within a band are weighted at 10%. The maturity bands are assigned to a short-, medium- or long-term zone. In a next step, net positions across maturity bands can be netted first within a zone and then also across zones, with matched positions weighted at 30% or 40% and unmatched positions at 100%.

[10] BCBS (2011); BCBS (2019e), p.11.
[11] Specific interest rate risk is the counterpart to CSR.
[12] Hartmann-Wendels/Pfingsten/Weber (2019), p.627ff.

According to the duration method, price sensitivities to specified interest rate changes between 60 basis points (bps) and 100 bps are calculated within the maturity bands. These are sized to produce almost identical results to the duration method. Balanced positions within the band are weighted at 5% instead of 10%. Further calculations are made in the same way as for the maturity method.

To compute the specific interest rate risk, the gross exposure value of non-securitized positions is multiplied by a risk weight, which depends on credit quality and, in the investment grade (IG), also on maturity. However, sovereign exposures rated AA- or above are exempt from CRs. Taking into account the scaling factor of 1.3, the risk weights for other debtors amount up to 2.08% in the IG categories and to 10.4% (BB+ to B- or unrated) or 15.6% (below B-) in the non-investment grade (NIG) categories.

Similar to the SA TB, the specific interest rate risk for securitized positions follows the banking book approach. CRs for investments in loan securitizations and for credit derivatives is capped at the maximum possible loss.

3.2 Equity price risk

Similar to interest rate risk, a distinction is made between general and specific equity risk, which are computed separately. The CR for specific risk is calculated on the gross position (sum of all long and short positions) and for general risk on the net position (difference of all long and short positions separately for each national market). The CR for general and specific risk is 8% each multiplied by the scaling factor of 3.5. Thus, for an equity position (long or short) of €100, the total CR of a single position is 2 * 8% * 3.5 = 56% or €56.

3.3 Foreign currency risk

Initially, the net open positions per currency and for gold are determined.[13] Banks that are not permitted to use an internal model must determine the risk position using the so-called shorthand method and convert it into their reporting currency. Then, across all currencies, one calculates the sum of all net long positions and the sum of all net short positions. The CR is 8% of the larger of the two sums and additionally 8% of the net gold position both multiplied by the scaling factor of 1.2.

[13] Contrary to the SA TB, gold is assigned to foreign currency risk and not to commodity price risk.

3.4 Commodity price risk

Banks with limited commodity business may compute its CRs according to the maturity ladder approach or the simplified approach.

For the maturity ladder approach, the net positions of each commodity are converted into the reporting currency and assigned to seven time bands depending on the maturity of the contracts.[14] Matched long and short positions within a time band are each multiplied by 1.5%, i.e. by 3% in total. Thus, if the matched long and short positions each amount to €100, the CR is 100 * 1.5% * 2 = €3 or 3% of the matched position of €100. An unmatched residual position within a shorter-term time band may then be carried forward to the subsequent longer-term time band for further offsetting. However, an unmatched position is subject to a capital surcharge of 0.6% each time it is carried forward to another maturity band. An open residual long or short position remaining at the end is multiplied by 15%. The total across all currencies is multiplied by a scaling factor of 1.9. Thus, the maximum requirement for an open commodity position is 15% * 1.9 = 28.5%. The minimum requirement for a closed position within a band is 3% * 1.9 = 5.7%.

According to the simplified method, the absolute amount of the net long or net short position for each commodity type must be computed and multiplied by 15%. In addition, the gross position for each commodity type as the sum of the absolute amounts of all long and short positions are multiplied by 3%. The total across all currencies is multiplied by a scaling factor of 1.9. Thus, the maximum requirement for an open commodity position is also 28.5%. However, the minimum requirement for a closed position is 2 * 3% * 1.9 = 11.4%.

[14] This also applies to options for which the delta-plus method is used.

Part 2: Analysis of the standardized approaches

IV. A comparison of the two standardized approaches to market risk.

In section IV follows a comparison of CRs according to the SA TB and the SSA for the trading book and, as appropriate, the SA BB. CRs were computed for randomized and partially specified portfolios consisting of either long positions or of long and short positions and for all risk classes.

4.1 General interest rate risk

Regarding general interest rate risk, the risk factor for delta risk is a yield curve of the relevant currency. The sensitivity is measured by a shift of the interest rate by 1 bp. Depending on the maturity, the prescribed risk weights range from 1.7% for 1 year to 1.1% for 5 years or more. This corresponds to an immediate change in interest rates of 170 bps and 110 bps, respectively, which appears to be very conservative.[15] For positions in the reporting currency and in the seven most important currencies globally, the CR is reduced by a flat reduction of 29.29% as all risk weights are divided by $\sqrt{2}$.[16]

Instead of adding the risk-weighted sensitivities WS_k, they are first aggregated separately within the buckets (currencies). CCs are taken into account, each of which is to be calculated for two position values of the same currency according to predefined parameters. The calculation of the CCs differs depending on the risk class. When calculating interest rate risk, the values of the CCs are floored at 0.4 and capped at 1.0. The greater the gap in the residual maturities of two position values are, the lower the CCs will be.[17] If the yield curves relevant for calculating the market values of the positions are different, the CC is multiplied by 99.9%. This step is practically irrelevant for the calculation of the capital requirement and unnecessarily increases complexity. In a portfolio diversified by maturity, the CCs are predominantly very close to 1.

For the aggregation within currency buckets, 500 portfolios were examined for each of seven buckets. For one thing, the SA TB defines seven main currencies that are given privileged treatment. Second, few banks are likely to hold interest rate positions of significant importance

[15] The Basle committe uses the term risk weight although its meaning is different when computing market risk compared to computing credit risk.

[16] This means that the expected liquidation period for main currencies is supposed to be half as long as for ordinary currencies.

[17] According to the formula for computing CC, a value of 0.4 follows if the gap in the remaining maturity of two risk positions expressed in years divided by the lower of the two maturities yields at least 30.5. For example, for two positions with remaining maturities of 8 years and 0.25 years or 16 and 0.5 years the value is 31, which translates into a CC of 0.4.

in more than seven currencies. Each of the 500 portfolios consists of 13 positions in different maturity bands and randomized market values. The maturity bands correspond to the first 13 maturity bands of the SSA's duration method from 0 - 12 years, which was used for comparison with the SA TB.[18]

As a result, for portfolios consisting only of long (or short) positions, CRs reduced only marginally. For portfolios consisting of both long and short positions, on the other hand, CRs for ordinary currencies decreased by 1% - 100% and on average already by 65% compared to the total of all CRs.[19] For major currencies, the reductions were 30% - 100% and on average 75%.

For the subsequent aggregation across all currencies the CC between buckets is uniformly set at 0.5. Taking into account the results of the first aggregation, another 500 simulations were performed. Here, for portfolios consisting of long or short positions only, CRs were reduced by 17% on average for ordinary currencies and by 41% for major currencies compared to the sum of the CRs over the seven buckets. For portfolios consisting of long and short positions, CRs fell on average by 56% for ordinary currencies and by 69% for major currencies. The difference between ordinary and major currencies resulted from the flat reduction of 29.29% for major currencies. Thus, the risk weights, which originally appear conservative, are greatly reduced for a reasonably diversified portfolio.

[18] The number of 13 risk positions is sufficient to illustrate the impact of aggregations as the marginal diversification benefit from additional positions declines rapidly. Duration was limited to 12 years for two reasons. Firstly, the proportion of positions above 12 years is presumably low and secondly, in order to limit the overall proportion of longer-term positions.

[19] The extreme values of 0% and 100% reduction are due to the potentially high CCs.

Results for general interest rate risk:

	CR in % of market value		
	SA TB ordinary currencies	**SA TB major currencies**	**SSA**
Single position up to 12 years			
Min. - Max.	0,0% - 13,2%	0,0% - 9,3%	0,0% - 9,4%
Diversified portfolio, long only, CC scenario "high"			
Sum: Min. - Max.	3,9% - 5,2%	2,8% - 3,7%	3,0% - 4,0%
Post aggregations: Min. - Max.	3,3% - 4,4%	2,3% - 3,1%	
Post aggregations: Average	3,9%	2,7%	3,5%
Diversified portfolio, long and short			
Sum: Min. - Max.	0,4% - 3,0%	0,3% - 2,1%	0,8% - 2,5%
Post aggregations: Min. - Max.	0,2% - 2,1%	0,1% - 1,5%	
Post aggregations: Average	0,7%	0,5%	1,6%

Table 1: Comparison of CRs for general interest rate risk according to SA TB und SSA

The simulations yielded the following results (table 1):

- Under the SA TB, the CR of a single position with maturities up to 12 years may rise up to 13.2% of the market value for ordinary and up to 9.3% for major currencies.
- For portfolios randomized by market value and consisting only of long positions, the simulations in the high correlation scenario yielded CRs from 3.3% to 4.4% of market value for ordinary currencies and from 2.3% to 3.1% for major currencies.
- Simulation results for portfolios randomized by long and short positions and market values resulted in CRs from only 0.2% to 2.1% for ordinary currencies and from 0.1% to 1.5% for major currencies, respectively, with average values of 0.7% and 0.5% of the market value of the sum of all long and short positions (gross position).
- Under the SSA, CRs for portfolios consisting only of long positions were intermediate between those for ordinary and major currencies under the SA TB.
- For portfolios mixed by long and short positions, the simulations under the SSA resulted in CRs from 0.8% to 2.5% with an average of 1.6% in terms of the market value of the gross position, above those for major and ordinary currencies under the SA TB.

Across all simulations, the differences between CRs under SA TB and SSA were small. For example, for portfolios consisting of long positions, CRs under the SA TB were 0.2 to 0.4 percentage points higher than CRs under the SSA for ordinary currencies and 0.7 to 0.9 percentage points lower for major currencies. For portfolios consisting of long and short positions, CRs under the SA TB were 0.1 to 1.6 percentage points below CRs under the SSA for ordinary currencies and 0.6 to 1.8 percentage points below CRs for major currencies based on the market value of the gross position.

Assessment of the approach:

Given the small differences in CRs, the purpose and usefulness of the much more burdensome SA TB relative to the simpler SSA are questionable. Whereas the SA TB requires an almost pedantic computational effort for the aggregation within buckets, it allows at the same time for a flat relief for major currencies of 29.29% (1/√2) and uses a uniform CC for aggregation across buckets.[20] Moreover, it is not clear that prudential objectives can be achieved only by using both methods side by side. Therefore, there is an argument for using only the scaled SSA for simplicity and better comparability, without adding a new, unnecessarily complicated and yet only seemingly accurate SA TB to the rulebook.[21] In doing so, one could further simplify the SSA by limiting oneself to the duration method only. Furthermore, it remains inappropriate that general interest rate risks are only considered in the trading book, but not in the banking book.

4.2 Credit spread risk (CSR)

Credit spread risk (CSR) includes the three categories:

- CSR of non-securitized positions
- CSR of securitized positions ex CTP
- CSR of securitized positions as CTP

4.2.1 CSR of non-securitized positions

CSR takes into account the risk of a change in market value due to a deterioration in credit quality. The risk of a sudden default, on the other hand, is captured by the DRC. The sensitivities are calculated in the same way as the sensitivities of the interest rate risk, assuming a shift of the spread curve instead of the yield curve by 1 bp as well. Thus, both sensitivities are equal. The specified risk weights are not based on maturity, but on the debtors' sector affiliation (e.g.

[20] It should also be borne in mind that flat-rate capital buffers and SREP surcharges will shape CR later on anyway.
[21] The new SSA is the current SA, with the results multiplied by a factor of 1.3.

central government, regional government, corporate sectors) and their credit quality (investment grade IG or non-investment grade NIG and unrated NR). However, there is no differentiation of risk weights within the IG and NIG categories, although it has been demonstrated that the credit quality of higher rated borrowers is more stable than that of lower rated borrowers. In total, there are 18 buckets with risk weights ranging from 0.5% to 12%.

Again, the calculation of the CR starts with the aggregation within the buckets. Within the most significant buckets 1 - 15, the CCs are calculated by multiplying three factors. Buckets 16 - 18 for positions in other sectors or indices are not considered here for the comparison. In the case of two different issuers with different maturities and based on different yield curves, the result is a very low CC of 0.35 * 0.65 * 0.999 = 0.2273.

For the analysis, 500 portfolios per bucket were examined for the 15 buckets with 15 positions each. For portfolios consisting only of long or short positions, the CRs were on average 39% lower than the total due to the aggregation within the buckets using CCs. For portfolios consisting of long and short positions, the reduction was significantly higher at 66%.

For the subsequent aggregation across buckets, the values of the specified CCs for buckets 1 - 15 are mostly between 0.05 and 0.25. Only between buckets 1 and 2 for central and regional governments is the CC set at 0.75. The CCs are additionally weighted by 0.5 if one of the two buckets belongs to the IG category and the other bucket to the NIG/NR category. However, in the case of long positions, this results in two positions belonging to IG buckets being considered more highly correlated, and thus riskier overall, than two buckets, one of which belongs to the lower or unknown credit quality class. On the other hand, if positions are long and short, the rulebook does not consider whether the short position is held in the lower-risk IG buckets or the higher-risk NIG buckets.

What follows is a comparison of the CRs for CSRs of non-securitized positions according to the rules of SA TB including DRC, SSA, and SA BB, since debt securities, unlike listed equities, are often part of both books.[22] It should be noted that different criteria are used to calculate CRs depending on the approach, although this does not appear to be justified (table 2).

[22] BCBS (2019a), p.5, para. 25.9: There is a strong presumption that listed shares are generally part of the trading book.

	Trading book			Banking book
	SA TB			
Criteria:	**Sensitivity**	**DRC**	**SSA**	**SA BB**
Type of issuer	Relevant: Public sector, banks and industries	Relevant only for aggregation of long and short positions	Irrelevant	Relevant: Public sector, banks, other industries
Creditworthiness	Relevant: Investment or Non-Investment grade	Relevant: Rating category	Relevant: Rating category	Relevant: Rating category
Maturity	Relevant	Irrelevant: Maturities up to 1 Jahr pro rata	Relevant for Investment Grade	Irrelevant
Seniority	Irrelevant	Relevant: Senior/Non-senior, Equity, Covered Bonds	Irrelevant	Irrelevant
Correlations	Relevant	Irrelevant	Irrelevant	Irrelevant

Table 2: Criteria for the computation of CRs for CSR of non-securitized positions

For the aggregation within the buckets, 500 portfolios were examined for each of the 15 buckets, each consisting of 15 individual positions of highest seniority. Based on these results, a further 500 simulations were performed for the aggregation across the 15 buckets.

In a first analysis, the portfolios were purely randomized by market values and ratings. Upper limits were defined only for the residual maturities of the individual positions, since the CR of a debt instrument under the SA TB increases proportionally to its residual maturity and is not capped by its market value. Accordingly, due to the size of the risk weights, CRs may even exceed 100% for high durations, which is counterintuitive. Therefore, it seems plausible to cap the remaining maturities of government bonds at 10 years and those of other bonds at five years. Thus, for a single position one obtains CRs relative to market values of up to 5% (IG) and 20% (NIG) for government bonds and bonds of regional governments, up to 15% (IG) and 42.5% (NIG) for bonds of non-financial companies and up to 25% (IG) and 60% (NIG) for bonds of financial companies.[23]

[23] With a flat yield curve at 0% duration equals modified duration. The high risk-weights for bank bonds are presumably intended to restrict mutual purchases of bank bonds among banks for obvious reasons.

In a second analysis, more realistic ranges for the composition of the portfolio were additionally defined, as different debt instruments held require hugely different amounts of capital. Moreover, the holdings fulfill different functions (liquidity reserve, market making, profitability targets, portfolio diversification) and are not equally available in the market. Therefore, the following assumptions were made regarding the credit quality of debt instruments for “managed” portfolios in order to obtain results that are as plausible as possible (table 3).[24] The proportions within the specified ranges were determined randomly.

Debtor	**Portfolio composition**	**Ratings of other debtors (40%-60% of portfolio values)**	**Portfolio composition**
Government bonds	40% - 50%	AA	0% - 10%
Other debtors	40% - 60%	A	40% - 50%
- Investment Grade	40% - 50%	BBB	40% - 50%
- Non-Investment Grade	0% - 10%	BB	0% - 8%
		B	0% - 2%

Table 3: Preset ranges for the composition of managed portfolios for CSR of non-securitized positions

Since the category “other debtors” also includes bonds issued by regional governments and covered bonds, the overall share of bonds considered low-risk is above 50%. The shares of the IG buckets 2 - 8 and the NIG buckets 9 - 15 were randomly determined in compliance with the specifications. The option to risk weight public bonds at 0% was assumed to be used. The CCC, D, and "unrated" categories were neglected. In addition, subordinated bonds with LGDs of 100% that carry higher CRs were excluded.

Aggregation across the 15 buckets resulted in an average capital relief compared to the total, for portfolios consisting of long or short positions only by a further 27% for randomly composed portfolios and by 22% for managed portfolios composed in compliance with the specifications. For randomly assembled portfolios with long and short positions CRs were reduced by 68% through the aggregation and by 61% for managed portfolios.[25]

[24] Neither the ECB nor the EBA publish detailed data on the composition of banks' trading book debt instruments.
[25] The specifications for the composition of the portfolios lead to a strong decrease in the importance of buckets 9-15, which reduces the diversification effect.

Whether a position is long or short and its credit quality are crucial for the level of DRC. Netting of long and short positions with the HBR resulted in an average capital relief of 72% for the randomly assembled portfolios compared to the total under the SSA.

The CR under the SSA and SA BB, on the other hand, is vastly determined by the selection of positions by credit quality. In the SSA, residual maturities also play a role for IG positions. Offsetting of long and short positions, on the other hand, is prohibited.

Results for the CSR of non-securitized positions:

	CR in % market value				
	SA TB	**DRC**	**SA TB + DRC**	**SSA**	**SA BB**
Single position up to 5 years, rating above CCC					
Min. - Max.	0,0% - 60,0%	2,0% - 30,0%	0,0% - 90,0%	0,0% - 15,6%	1,6% - 12,0%
Diversified portfolio, long only, randomized, CC scenario "high"					
Sum: Min. - Max.	5,1% - 7,2%	10,1% - 13,8%	15,7% - 20,3%	5,8% - 7,7%	5,7% - 7,2%
Post aggregations: Min. - Max.	3,7% - 5,4%		14,4% - 19,0%		
Post aggregations: Average	4,6%	12,2%	16,8%	6,8%	6,6%
Diversified portfolio, long only, randomized within specified ranges, CC scenario "high"					
Sum: Min. - Max.	2,1% - 4,1%	1,3% - 2,7%	3,5% - 6,7%	0,8% - 2,0%	2,4% - 3,8%
Post aggregations: Min. - Max.	1,7% - 3,1%		3,2% - 5,6%		
Post aggregations: Average	2,3%	2,0%	4,4%	1,4%	3,1%
Diversified portfolio, long and short, randomized					
Sum: Min. - Max.	2,7% - 4,7%	1,3% - 5,6%	4,7% - 9,6%	5,8% - 7,7%	5,7% - 7,2%
Post aggregations: Min. - Max.	0,6% - 2,2%		2,7% - 7,4%		
Post aggregations: Average	1,1%	3,4%	4,5%	6,8%	6,6%
Diversified portfolio, long and short, randomized within specified ranges					
Sum: Min. - Max.	1,0% - 2,4%	0,2% - 1,0%	1,4% - 3,4%	0,8% - 2,0%	2,4% - 3,8%
Post aggregations: Min. - Max.	0,3% - 1,3%		0,7% - 2,0%		
Post aggregations: Average	0,6%	0,6%	1,2%	1,4%	3,1%

Table 4: Comparison of CRs for CSR of non-securitized positions according to SA TB und SSA

The simulations yielded the following results (table 4):

- For the residual maturities of up to 5 years and ratings of B and above considered here, according to the SA TB, the CR of a single position amounts to up to 60% of the market value, depending on the maturity and rating. For longer maturities, the CR may exceed the market value, as it isn´t capped by the rulebook.[26] On top, there is the DRC, which depends on the rating and increases from 2% to 30% of the market value for ratings between AA and B.

- For portfolios randomized by market values and ratings and consisting only of long positions, the simulations yielded CR under the SA TB in the high correlation scenario, including the DRC, from 14.4% to 19.9% of market values. For managed portfolios, the CR including the DRC reduced to 3.2% to 5.6%. In both cases, CRs under SA TB as a result of DRC significantly exceeded CRs under SSA and SA BB. Thus, for long positions, banks that are allowed to use the SSA are unjustifiably privileged. Banks using the SA TB have an incentive to hold long positions in the banking book.
- The simulation results for portfolios randomized by long and short positions, market values and ratings led to CRs under the SA TB including the DRC from only 2.7% to 7.4% with an average value of 4.5% based on the market value of the gross position. This is significantly less than under the SSA or under the SA BB and unjustifiably privileges banks that are allowed to use the SA TB.[27]
- For the managed portfolios of long and short positions, which were randomly determined within predefined ranges in terms of obligors and credit ratings, CRs under the SA TB including DRC were only from 0.7% to 2.2% and on average only 1.2% in terms of the market value of the gross position. The results under the SSA were nearly identical with a range from 0.8% to 2.0% and an average of 1.4%. Across all simulations, CRs under the SA TB including the DRC were only up to 77 bps higher and up to 100 bps lower than CRs under the SSA. Under the SA BB rules, on the other hand, CRs were significantly higher with a range from 2.4% to 3.8% and an average of 3.1%.

Assessment of the approach:

Under the much more computationally demanding SA TB including the DRC, compared to the SSA and SA BB, CRs are driven less by the selection of obligors and credit ratings and more by correlations and the HBR, which allows long and short positions to be largely netted.

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[26] An example of this is a bank bond rated in the NIG category with a duration of over 8.33 years. If the DRC is also taken into account, the CR is over 100%.

[27] In this and the following calculation, all positions were valued according to banking book rules for comparison, although positions resulting in a net short position in the banking book are generally to be allocated to the trading book according to BCBS (2019a), p.4, para. RBC 25.6.

As a result, the differences between the approaches are large for randomly assembled portfolios and, by contrast, small for managed portfolios of higher credit quality. This is not very plausible. Moreover, the CRs under the SA TB including DRC appear very low for portfolios composed of long and short positions. This is particularly evident for the randomly constructed portfolios, whose CR under the SA TB including DRC averaged only 4.5%. This appears too low in absolute terms and in comparison with the portfolios of higher credit quality, whose CR averaged even lower at 1.2%.

Positive features of the SSA and SA BB are, in addition to the better traceability and predictability, their independence from assumptions on correlations and netting of opposing positions of different debtors and credit ratings. However, the SSA may also lead to very low CRs for managed portfolios.

The unequal treatment of trading book and banking book is detrimental to comparability. Methodologically, too, it is not convincing that different criteria are used to compute CRs for credit risk under the various approaches with seemingly arbitrary weightings, leading to implausible differences in results depending on the portfolio composition (see table 5). Uniform application of SA BB in the banking and trading books would therefore lead to greater consistency and simplification of calculations.[28]

Credit Rating	SA TB	DRC TB	SA TB + DRC	SSA	SA BB	SA BB
AAA	2,44%	0,38%	4,90%	1,67%	1,60%	4,33%
AA		1,50%		1,67%	1,60%	
A		2,25%		1,67%	4,00%	
BBB		4,50%		1,67%	8,00%	
BB	7,36%	11,25%	22,59%	10,40%	8,00%	9,71%
B		22,50%		15,60%	12,00%	

Table 5: Comparison of the approaches used to determine CRs by rating category for the CSR of senior non-securitized positions excluding government bonds

4.2.2 CSR of securitized positions ex CTP

The calculation of SA TB sensitivities is basically the same for securitized and non-securitized instruments. However, the specified risk weights are linked to eight types of securitizations (e.g. RMBS, CMBS, ABS, CLO) and the credit quality (senior investment grade, non-senior

[28] It is also incomprehensible that according to the SA BB for financial companies in the BBB category (4.00%) and in the B category (8.00%) the CR are still lower than for non-financial companies (8.00% and 12.00%, respectively), whereas in the SA TB for financial companies CR are basically higher than for non-financial companies.

investment grade or non-investment grade or unrated) of securitization tranches.[29] In total, there are 25 buckets (three credit qualities for each of eight types and one bucket "other") with risk weights ranging from 0.80% to 3.50%.

The risk weights for securitizations are very low compared to non-securitized positions. However, CRs are enhanced by a DRC, which is calculated according to the SA for securitizations in the banking book, with two key differences when applying the External-ratings-based approach (ERBA).[30] Firstly, only the lower risk weights for 1-year residual maturity are applied when calculating the DRC. Secondly, long and short positions are allowed to be netted out, taking into account the HBR, which may significantly lower the DRC.

The SSA, on the other hand, is equivalent to the SA BB, i.e. in contrast to the calculation of the DRC, the higher risk weights associated with longer residual maturities of tranches up to a maximum of five years are applied, but the sensitivity-based requirement is omitted. The CR may be limited to the position value.[31] Moreover, there is no netting of long and short positions, as net short positions are to be allocated to the trading book.

For aggregation within buckets excluding the bucket "other", the CCs are again determined by the multiplication of three factors. If two positions of different securitization transactions with different maturities and based on different yield curves are involved, the result is a low CC of $0.4 * 0.8 * 0.999 = 0.3197$. Although limited by the HBR, the offsetting of long and short positions across regions provided for in this calculation largely underestimates basis risk.[32]

For the analysis, 500 portfolios per bucket were first examined for the 15 buckets, each with 15 positions. For portfolios consisting of only long or short positions, CRs were found to be 31% lower on average than the total due to aggregation within buckets. For portfolios consisting of long and short positions, the capital relief was significantly higher at 67%.

For the subsequent aggregation across buckets, the CC is a flat 0%.

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[29] Senior refers to the tranche of a securitization transaction with the highest seniority. The risk weights of the non-senior tranches are determined by simply multiplying the risk weights of the senior tranches by the factors 1.25 and 1.75, respectively.

[30] The non-ratings-based standardized approach, which is also permitted, is not examined in detail here.

[31] BCBS (2019a), p.122, para. 40.15 and p.74, para. 22.34.

[32] Accordingly, a long position in a securitization from a country with a weak credit rating and a short position from a country with a strong credit rating are generally regarded as less risky than two long positions from two countries with strong credit ratings.

As shown in table 6, the comparison of the two approaches for trading and banking books, is complicated because CRs are computed using different criteria without any plausible justification.

	Trading book			**Banking book**
	SA TB			
Criteria:	**Sensitivity**	**DRC**	**SSA**	**ERBA**
Type of securitization (underlying)	Relevant	See banking book positions	See banking book positions	Irrelevant
Creditworthiness	Relevant: Investment or Non-Investment grade	See banking book positions	See banking book positions	Rating category
Maturity	Relevant	Maturity set at 1 year	See banking book positions	Relevant: Maturities up to 5 years
Seniority	Relevant	See banking book positions	See banking book positions	Relevant
Thickness of tranches	Irrelevant	See banking book positions	See banking book positions	Relevant
Correlations	Relevant	See banking book positions	See banking book positions	Irrelevant

Table 6: Criteria for the calculation of CRs for the CSR of securitized positions ex CTP

For the aggregation within the buckets, 500 portfolios were examined for each of the 15 buckets, consisting of five of the eight securitization types over all three credit qualities and with each bucket consisting of 15 risk positions.[33] Based on these results, an additional 500 simulations were subsequently performed for the aggregation across the 15 buckets.

In an initial analysis, the portfolios were purely randomized by market values and ratings. The selection between traditional securitizations and securitizations, that are considered simple, transparent, and comparable (STC) and are therefore privileged, was also randomized. The remaining maturities of the tranches were also randomly assembled and capped at 10 years for low-weighted RMBS and 5 years for other, higher risk-weighted securitizations.[34]

In a second analysis, the composition of the portfolios by securitization type and rating, was additionally based on more plausible ranges, which were derived from data provided by the Association for Financial Markets in Europe (AFME) on the composition of outstanding

[33] The five types are RMBS, CMBS, ABS Credit Cards, ABS Auto and CLO. The three credit grades are senior investment grade (AAA, senior AA), non-senior investment grade (non-senior AA, A, BBB) and non-senior non-investment grade (BB, B, CCC).

[34] This assumption is made, as already explained in 4.2.1, because the CRs increase proportionally to the instrument maturity.

European securitization tranches.[35] The proportions within the specified ranges were determined randomly (table 7).

<table>
<tr><th>By type</th><th>Total share</th><th>Of which: Senior</th><th>Of which: Non-senior IG</th><th>Of which: Non-senior NIG</th><th></th><th></th></tr>
<tr><td>RMBS Prime</td><td>60%-65%</td><td>68%-78%</td><td>22%-29%</td><td>0%-3%</td><td></td><td></td></tr>
<tr><td>CMBS</td><td>0%-8%</td><td rowspan="4">56%-67%</td><td rowspan="4">32%-41%</td><td rowspan="4">0%-5%</td><td></td><td></td></tr>
<tr><td>ABS Consumer</td><td>2%-19%</td><td></td><td></td></tr>
<tr><td>ABS Auto</td><td>2%-19%</td><td></td><td></td></tr>
<tr><td>CLO</td><td>15%-25%</td><td></td><td></td></tr>
<tr><th>By rating</th><th>AAA</th><th>AA Senior</th><th>AA Non-senior</th><th>A</th><th>BBB</th><th>BB/B/ CCC each</th></tr>
<tr><td>RMBS Prime</td><td>44%-59%</td><td>20%-24%</td><td>12%-21%</td><td>6%-11%</td><td>0%-3%</td><td>0%-1%</td></tr>
<tr><td>CMBS</td><td rowspan="4">36%-50%</td><td rowspan="4">20%-28%</td><td rowspan="4">18%-30%</td><td rowspan="4">8%-16%</td><td rowspan="4">0%-4%</td><td rowspan="4">0%-2%</td></tr>
<tr><td>ABS Consumer</td></tr>
<tr><td>ABS Auto</td></tr>
<tr><td>CLO</td></tr>
</table>

Table 7: Specified ranges for the composition of portfolios for CSR of securitized positions ex CTPs

The aggregation across the 15 buckets resulted in an average capital relief of another 72% compared to the total for purely randomized portfolios and 48% for portfolios randomly assembled in line with the specifications.[36]

When computing DRC or CRs under the SSA and SA BB, respectively, consideration was given to residual maturities, ratings, and thickness of tranches according to the ERBA. Again, for the randomly composed portfolios, the netting of long and short positions taking into account the HBR resulted in an average capital relief of 72% in the calculation of the DRC compared to the total. Contrary to this, results according to the SSA and SA BB are simply added without netting.

[35] AFME (2020). The breakdown of U.S. securitizations is even less detailed. For European securitizations, additional consideration was given to the fact that the proportion of senior tranches of RMBS is in practice about 20% higher than that of other securitization types. With regard to AA-rated tranches, it was assumed that half belong to the lower risk-weighted senior tranches and half to the higher risk-weighted non-senior tranches.

[36] Since the CC for aggregation across buckets is 0.0, the results are identical for portfolios with long and short positions and portfolios with long or short positions.

Results for the CSR of securitized positions without CTP:

	CR in % of market value			
	SA TB	**DRC**	**SA TB + DRC**	**SSA = SA BB**
Single position up to 5 years, rating AAA to CCC				
Min. - Max.	0,0% - 17,5%	0,8% - 100,0%	0,0% - 117,5%	0,8% - 100,0%
Diversified portfolio, long only, randomized, CC scenario "high"				
Sum: Min. - Max.	2,8% - 3,9%	23,0% - 33,9%	28,2% - 37,3%	24,2% - 35,0%
Post aggregations: Min. - Max.	0,8% - 1,1%		23,4% - 34,9%	
Post aggregations: Average	1,0%	27,7%	28,7%	29,2%
Diversified portfolio, long only, randomized within specified ranges, CC scenario "high"				
Sum: Min. - Max.	2,2% - 3,8%	2,4% - 4,6%	5,7% - 7,9%	3,2% - 6,1%
Post aggregations: Min. - Max.	1,0% - 2,3%		3,8% - 6,6%	
Post aggregations: Average	1,6%	3,6%	5,2%	4,7%
Diversified portfolio, long and short, randomized				
Sum: Min. - Max.	1,3% - 2,1%	3,3% - 14,4%	6,5% - 16,2%	24,2% - 35,0%
Post aggregations: Min. - Max.	0,4% - 0,7%		3,9% - 15,0%	
Post aggregations: Average	0,5%	7,7%	8,2%	29,2%
Diversified portfolio, long and short, randomized within specified ranges				
Sum: Min. - Max.	1,0% - 2,4%	0,3% - 2,0%	2,0% - 3,9%	3,2% - 6,1%
Post aggregations: Min. - Max.	0,4% - 1,6%		1,1% - 2,9%	
Post aggregations: Average	0,80%	1,00%	1,80%	4,70%

Table 8: Comparison of CRs for CSR of securitized positions ex CTP according to SA TB, SSA and SA BB

The simulations yielded the following results (table 8):

- For a single position, the CR under the SA TB including DRC isn´t capped and may exceed an instrument´s market value, depending on its maturity and rating.[37] The driver of the CR is the DRC. Only the SSA or SA BB allows to cap the CR at its market value.
- For portfolios randomly assembled by market values and ratings, consisting only of long positions, the simulations under the SA TB resulted in CRs including DRC from 23.4%

[37] This is the rule for tranches with ratings B or CCC, as the DRC already provides for risk weights of 1050% to 1250%.

to 34.9% of market values in the scenario with high CCs. Considering the specified ranges for portfolio composition, these values were reduced from 3.8% to 6.6%. These results were comparable to those of the SSA and the SA BB, respectively. For portfolios assembled in line with the specified ranges, the CRs of the trading book under the SA TB moderately exceeded the CRs under the SSA or the SA BB in 98% of the cases as a result of the DRC. Thus, if a portfolio consists of long positions, banks that are allowed to use the SSA and the banking book positions are slightly privileged.

- For portfolios consisting only of long positions of either AAA- to AA-rated senior tranches or NIG rated tranches, the CR under the SA TB including DRC was always higher than under the SSA or the SA BB. For long positions consisting only of IG-rated non-senior tranches, the reverse result was observed. This unequal treatment may hardly be justified.
- Simulation results for portfolios randomized by long and short positions, market values, and ratings resulted in CRs under the SA TB including DRC from 3.9% to 15.0% with an average of 8.2% in terms of the gross market value of the sum of all long and short position. This is significantly lower than under the SSA or SA BB, which does not provide for netting of long and short positions.[38]
- For managed portfolios of long and short positions randomly determined within predefined ranges in terms of debtors and credit ratings, the CRs under the SA TB including DRC ranged from only 1.1% to 2.9% and averaged only 1.8% in terms of the gross market value of positions. These results were also significantly lower than those of the SSA and the SA BB, respectively, for which a range from 3.2% to 6.1% and an average of 4.7% was observed. Across all simulations of the three scenarios, CRs under SA TB including DRC was 139 bps to 440 bps lower than CRs under the SSA or SA BB. This privileges banks that hold long and short positions and are allowed to use the SA TB.

Assessment of the approach:

In principle, the comments already made regarding 4.2.1 CSR of non-securitized positions apply here. It is additionally noteworthy that in the calculation of CRs according to the SA TB

[38] In this and the following calculation, all positions were valued according to banking book rules for comparison purposes, although positions resulting in a net short position in the banking book are generally to be allocated to the trading book according to BCBS (2019a), p.4, para. RBC 25.6.

for securitizations, the DRC, which is crude and less complex to compute, is even more important, while the components based on sensitivities, which are very complex to compute, accounted for less or even significantly less than half of the total CRs due to the low risk weights and low CCs. Again, a uniform application of the SA BB in the banking and trading books would lead to more consistency and would largely simplify the calculations.

4.2.3 CSR of securitized positions CTP

CTP primarily includes credit derivatives that relate to individual obligors and securitization tranches that do not relate to real estate loans and loans to retail customers (e.g. collateralized bond or collateralized debt obligations).[39]

The calculation of CRs is similar to that shown in 4.2.1 for non-securitized positions. Buckets 1 - 16 (industries, credit quality) are equally defined, whereas buckets 17 and 18 are omitted. The calculation of sensitivities is also basically the same, although the risk weights of the buckets are higher (between 2.0% and 16.0%).

The CCs within the buckets are identical except for the insignificant factor for yield curves (here 99% instead of 99.9%). When dealing with two positions of different issuers with different maturities and based on different yield curves (the latter is again insignificant for the overall analysis), this results in a very low coefficient of 0.35 * 0.65 * 0.99 = 0.2253. The CCs across buckets are identical.

The calculation of the DRC of non-securitized positions of the CTP also follows the same rules as described in 4.2.1. The calculation of DRC of securitized positions of the CTP essentially follows the banking book rules as described in 4.2.2.

Furthermore, according to the SSA, as described under 4.2.2, securitized positions in the trading book are treated like positions in the banking book. For non-securitized positions, the risk weighting described under 4.2.1 applies.

The approach for securitized positions as CTP is therefore a mixture of the approaches for non-securitized and securitized positions with the main difference that the risk weighting is higher under the sensitivity-based approach. Consequently, the CR for securitized positions as CTP is always higher than for the other two non-CTP positions. Therefore, a separate analysis appears to be unnecessary.

[39] BCBS (2019a), p.22, para.20.5

4.3 Equity price risk

The equity delta risk factors are the equity spot prices and equity repo rates. The repo rates are not considered here. The sensitivity according to the SA TB equals 1% of the market value of the equity position. The sensitivity is multiplied by predefined risk weights, which vary by region, market capitalization (large/small cap) and industry sector. In advanced markets (1st region AM), the weights and thus the CRs are between 30% and 50%, in emerging markets (2nd region EM) between 45% and 70% of the market value.

There are 13 buckets in total, with five industry buckets for each of the two regions. The remaining three buckets for individual stocks that cannot be allocated by industry and indices are not considered in this analysis. The CCs for the aggregations within and between buckets are linked to the buckets. In addition, the DRC, which depends on the rating, must be added.

For aggregation within buckets, the CCs are 0.15 for large caps in EM (buckets 1 - 4) and 0.25 for large caps in AM (buckets 5 - 8). For small caps in EM (bucket 9) and AM (bucket 10), they are lower at 0.075 and 0.125, respectively. Overall, 500 portfolios for each the 10 buckets, each containing 15 positions were examined. For portfolios consisting only of long or short positions, CRs were found to be on average 46% lower than the total due to the use of CCs. For portfolios consisting of long and short positions, the capital relief was as high as 70%. Since buckets in the AM region with higher risk weights use lower CCs than those in the EM region, aggregation leads to a substantial but presumably unjustified equalization of CRs per bucket.[40]

For the aggregation across buckets the CC is always set at 0.15. Based on the results of the aggregation within buckets, an additional 500 simulations were performed for the aggregation across the 10 buckets.

In a first simulation, portfolios were purely randomized by market values and ratings. In a second simulation, the following ranges were defined for the composition of portfolios by region, market capitalization, and ratings. The more frequent rating categories were weighted higher (table 9).

[40] The CRs after aggregation are roughly equivalent to the CR of a position in a AM Large Cap Index amounting to 25%.

Buckets	Portfolio composition by buckets	Ratings	Portfolio composition by ratings
1 - 4 EM Large Caps	0% - 25%	**AA**	0% - 18%
5 - 8 AM Large Caps	75% - 100%	**A**	13% - 30%
9 EM Small Caps	25% of buckets 1 - 4	**BBB**	27% - 50%
10 AM Small Caps	25% of buckets 5 - 8	**BB**	20% - 40%
		B	0% - 18%

Table 9: Specified ranges for the composition of equity portfolios

To calculate the DRC, equity positions were assigned to a maturity of 1 year. It is also possible to assign a maturity of three months, which would reduce the DRC by 75%.[41]

Aggregation across the 10 buckets resulted in an average reductions in the CRs of a further 16% - 20% for portfolios consisting of long or short positions compared to the total, and of a further 55% - 67% on average for portfolios consisting of long and short positions for randomized and managed portfolios in line with the specified ranges.

Netting long and short positions with the HBR to determine the DRC resulted in an average capital relief of 71% for the randomly composed portfolios compared to the total.

Under the SSA, specific market risk amounts to 8% of the sum of all long and short positions and general market risk amounts to 8% of the difference between all long and all short positions in a given market.

[41] BCBS (2019a), p.69, para. 22.16 The option to allocate positions to a maturity of either 3 months or 1 year is relevant for netting long and short positions.

Results for equity price risk:

	CR in % of market value			
	SA TB	**DRC**	**SA TB + DRC**	**SSA**
Single position, rating above CCC				
Min. - Max.	30% - 70%	0,5% - 30%	30,5% - 100%	56,0%
Diversified portfolio, long only, randomized, CC scenario "high"				
Sum: Min. - Max.	25,1% - 26,4%	8,2% - 14,5%	34,2% - 39,7%	56,0%
Post aggregations: Min. - Max.	21,1% - 22,3%		30,0% - 36,1%	
Post aggregations: Average	21,7%	11,1%	32,7%	
Diversified portfolio, long only, randomized within specified ranges, CC scenario "high"				
Sum: Min. - Max.	21,1% - 27,6%	7,7% - 10,9%	29,1% - 37,4%	56,0%
Post aggregations: Min. - Max.	16,7% - 23,5%		25,5% - 34,0%	
Post aggregations: Average	19,3%	9,5%	28,8%	
Diversified portfolio, long and short, randomized				
Sum: Min. - Max.	12,9% - 16,8%	0,9% - 6,2%	14,7% - 22,2%	56,0%
Post aggregations: Min. - Max.	3,7% - 8,7%		5,7% - 14,1%	30,5% - 40,1%
Post aggregations: Average	4,7%	3,2%	7,9%	34,7%
Diversified portfolio, long and short, randomized within specified ranges				
Sum: Min. - Max.	9,3% - 17,6%	0,5% - 5,3%	11,2% - 24,3%	56,0%
Post aggregations: Min. - Max.	4,0% - 11,9%		6,3% - 15,4%	29,4% - 44,4%
Post aggregations: Average	5,6%	2,6%	8,2%	34,8%

Table 10: Comparison of CRs for equity price risk according to SA TB and SSA

The simulations yielded the following results (table 10):

- For a single B-rated item, the CR under the SA TB including DRC may be 100%. For lower ratings, the CR may even exceed 100%.
- For portfolios randomly constructed by market values and ratings, consisting only of long positions, the simulations under the SA TB resulted in CRs including DRC from 30.0% to 36.1% of the market value in the high CC scenario. Considering the specified ranges, these values reduced only moderately to between 25.5% and 34.0%.

- The simulation results for portfolios randomly assembled by long and short positions, market values and ratings led to CRs including DRC from only 5.7% to 14.1% with an average value of 7.9% based on the gross market value of the sum of all long and short positions. For portfolios randomly constructed within specified ranges, the results were comparable.
- According to the SSA, there is no diversification benefit for a portfolio consisting only of long positions. Therefore, the CR amounts to 56% (=2*8%*3.5). For portfolios consisting of long and short positions, the CR decreased by 38% to an average of 35% of the market value of the gross position.

Assessment of the approach:

According to the SA TB including DRC for equity price risk, the application of CCs and the HBR resulted in a massive reduction in CRs to an average of only 8% of the market value of gross positions for mixed portfolios of long and short positions. Across all simulations, the differences between CRs under the SA TB and SSA were exceptionally large compared to the other risk classes. This is mainly due to the introduction of the scaling factor of 3.5 for equity price risk under the SSA, which puts banks using the SSA unjustifiably at a severe disadvantage.

At the same time, the level of CRs for equity price risks highlights the low CRs for other risk classes, especially for interest rate and credit risks.

It remains unclear what advantage the crude but cumbersome aggregations and nettings provide compared to the SSA, since a desired recalibration may also be achieved by changing the scaling factor of the SSA accordingly. Therefore, there would also be some arguments in favor of the general use of the SSA with possibly a reduced scaling factor.

As equities are regularly assigned to the trading book, the comparison with equity positions in the banking book is not applicable here.

4.4 Foreign currency risk

The currency delta risk factors are the exchange rates of the reporting currency. According to the SA TB, the sensitivity amounts to 1% of the market value of the currency position. This is generally multiplied by a uniform risk weight of 15%. However, for exchange rates between the 20 most significant currencies (= 190 currency pairs), a bank is allowed to multiply the 15% weight by $1/\sqrt{2}$, reducing the risk weight by 29.29% to 10.61%. Since each currency represents a bucket, the aggregated value within the buckets equals the total. The calculation of a DRC is not applicable. Furthermore, the calculation of the CR is the same for positions in the trading and banking book.

Across buckets, the CC is uniformly set at 0.60. Overall, 500 portfolios per bucket were examined for up to seven currency buckets containing 15 positions each. Long or short positions and market values were randomly determined. Firstly, seven major currencies are designated in the calculation of general interest rate risk. Secondly, it is rather rare for banks to hold equally and appreciably large positions in more than seven currencies. Thirdly, the diversification benefit already declines sharply from the fourth currency onward.

Aggregating across the buckets resulted in an average capital relief of 23% for two to 56% for seven currencies compared to the total. Again, it is noteworthy that elaborate calculations are required for the aggregation, whereas the rulebook also allows for an additional flat reduction of 29,29% of the CR for major currencies.

According to the SSA, the CR is 8% * 1.2 = 9.6% of the market value of a single item. On average, the simulations for the SSA resulted in reductions ranging from 14% for two currencies to 30% for seven currencies.

Results for foreign currency risk:

	CR in % of market value		
	SA TB ordinary currencies	**SA TB major currencies**	**SSA**
Single position			
Min. - Max.	15,0%	10,6%	9,6%
Diversified portfolio, long only, randomized, CC scenario "high"			
Sum: Min. - Max.	15,0%	10,6%	9,6%
Min. - Max.: 2 currencies	14,0% - 15,0%	9,9% - 10,6%	
Min. - Max.: 7 currencies	13,3% - 13,7%	9,4% - 9,7%	
Average: 2 currencies	14,3%	10,1%	
Average: 7 currencies	13,4%	9,5%	
Diversified portfolio, long and short, randomized			
Sum: Min. - Max.	15,0%	10,6%	4,8% - 9,6%
Min. - Max.: 2 currencies	5,3% - 15,0%	3,8 % - 10,6%	
Min. - Max.: 7 currencies	3,1% - 13,7%	2,2 % - 9,7%	
Average: 2 currencies	11,5%	8,1%	8,2%
Average: 7 currencies	6,6%	4,7%	6,7%

Table 11: Comparison of CRs for foreign currency risk according to SA TB and SSA

The simulations yielded the following results (table 11):

- Under the SA TB, the CR of a single position is 15.0% for ordinary currencies and 10.6% for major currencies relative to the market value of the position.
- For portfolios randomized by market values with two to seven foreign currencies consisting of long positions only, the simulations yielded CRs in the high correlation scenario from 13.3% to 15.0% for ordinary currencies and from 9.4% to 10.6% for major currencies.
- The simulation results for portfolios randomly composed of long and short positions and market values with two to seven foreign currencies resulted in CRs from 3.1% to 15.0% for ordinary and from 2.2% to 10.6% for major currencies based on the gross market value of the sum of all net long and net short positions without netting across currencies. The averages were 11.5% and 6.6% for two to seven ordinary currencies and 8.1% and 4.7% for two to seven major currencies, respectively.
- According to the SSA, the CR for long positions is 9.6%. For portfolios of long and short positions CRs were up to 50% lowere ranging from 4.8% to 9.6% of the gross market value using the shorthand method.

Assessment of the approach:

Across all simulations, the differences between CRs for major currencies under SA TB and SSA were comparatively moderate. For example, CRs under the SA TB were up to 1 percentage point above or up to 3 percentage points below the CRs under the SSA relative to the gross market value of the currency positions. For long-only portfolios, the CRs under the SA TB were up to 1 percentage point above or up to 0.2 percentage points below the SSA.

Moreover, using the flat 29.29% haircut for major currencies calls into question the need for detailed calculations. Therefore, one could dispense with the more elaborate SA TB and instead use only the SSA, differentiated by major and ordinary currencies if desired.

4.5 Commodity price risk

The commodity delta risk factors are the commodity spot prices. According to the SA TB, the sensitivity amounts to 1% of the market value of the commodity position which is multiplied by predetermined risk weights. The weightings of the 11 predefined buckets range from 20% to 80% depending on the type of commodity. Bucket 11 is for unspecified types of commodities and not considered in this analysis. The calculation of a DRC is not applicable. Furthermore, the calculation is the same for positions in the trading and banking book.

For the aggregation within the buckets, the CCs are set between 0.15 and 0.95, depending on the bucket. Although irrelevant for the outcome, the CCs are multiplied by 0.99 and by 0.999 if the commodity contracts provide for different maturities and delivery locations. Overall, 500 simulations were performed for each of the 10 buckets consisting of 15 positions each. For portfolios consisting only of long or short positions with randomly determined market values, this resulted in a reduction in CRs of 0% - 51% and on average by 18% compared to the total. For portfolios with randomly selected long and short positions, the CRs were 6% - 100% and on average already about 70% lower than the risk weights.[42]

For the aggregation across the ten buckets, a uniform CC of 0.20 is specified. As a result of 500 additional simulations, the average capital relief compared to the total was another 39% for portfolios with long or short positions and another 64% for portfolios with long and short positions.

The simulations according to the two simplified methods provided for commodity price risk (maturity ladder approach, SSA M and standard method, SSA S) resulted in a capital relief between 37% and 80% for portfolios with long and short positions and on average by 65% under the SSA M and by 56% under the SSA S, respectively.

Results for commodity price risk:

	CR in % of market value		
	SA TB	**SSA M**	**SSA A**
Single position			
Min. - Max.	20% - 80%	28,5%	28,5%
Diversified portfolio, long only, randomized, CC scenario "high"			
Sum: Min. - Max.	31,9% - 36,7%	28,5%	28,5%
Post aggregations: Min. - Max.	19,0% - 24,1%		
Post aggregations: Average	20,8%		
Diversified portfolio, long and short, randomized			
Sum: Min. - Max.	6,2% - 17,6%	5,8% - 15,3%	8,3% - 18,0%
Post aggregations: Min. - Max.	2,3% - 7,7%		
Post aggregations: Average	4,1%	10,1%	12,5%

Table 12: Comparison of CRs for commodity price risk according to SA TB and SSA

[42] The extreme values of 6% and 100% capital relief are due to the high CCs of 95% and 80% in buckets 2 and 4, respectively.

The simulations yielded the following results (table 12):

- Under SA TB, the CR of a single position ranges from 20% to 80% of the market value.
- For portfolios randomized by market values and ratings and consisting only of long positions, the simulations yielded CRs from 19.0% to 24.1% of the market value.
- The simulation results for portfolios randomized by long and short positions and market values resulted in CRs from only 2.3% to 7.7% with an average value of 4.1% in terms of the gross market value of the sum of all long and short positions.
- According to the SSA, there is no diversification effect for a portfolio consisting only of long positions. For portfolios mixed by long and short positions, the simulations for the two SSAs yielded CRs from 5.8% to 18.0% with average values of 10.1% (SSA M) and 12.5% (SSA S), respectively.

Assessment of the approach:

Similar to equity price risk, the scaling factor for the two SSAs leads to differences in CRs compared to the SA TB that are significantly higher than for other risk classes. For portfolios consisting of long or short positions, CRs were 7 to13 percentage points lower under SA TB than under SSA M, or 10 to 15 percentage points lower than under SSA A. For portfolios consisting of long and short positions, CRs under SA TB were 2 to 11 percentage points lower than under SSA M and 5 to 14 percentage points lower than under SSA A relative to the gross market value of commodity positions. Thus, again, banks using one of the two SSAs are unjustifiably severely disadvantaged.

The use of two simplified approaches leading to broadly similar results seems unnecessary. It is also questionable whether it is actually justified that commodity price risks can be regarded as less risky on average than equity price risks. A comparison of the MSCI World Index for equities and the JPMCCI AGGREGATE TRI, which tracks 36 individual commodity indices, over the past 10 years shows that the standard deviation of the daily returns of equities at 0.94% was actually slightly lower than that of commodities at 1.00%. Therefore, it seems unjustified that the SSAs for diversified portfolios allow for a significant reduction in CR for commodity price risk to an average of 10% - 12%, while the CR for equity price risk is on average 35% of gross market value.

The CRs for commodity price risk according to the SA TB averaging only 4% of gross market values appear unreasonably low. Furthermore, it is doubtful that the supposed accuracy of the

SA TB´s calculations actually leads to better results than either of the SSAs. Finally, full or at least greater harmonization of CRs for equity and commodity risks should be considered.

V. Conclusion

The sensitivity-based standardized approach SA TB for market risk displays several shortcomings.

1. The different approaches to determine CRs for banking book and trading book positions is retained as far as interest rate, credit and equity price risk are concerned. In addition, interest rate risk in the banking book continues to be disregarded. This increases the complexity of the Basel rules. Moreover, positions bearing the same risk continue to be treated differently, which appears to be unjustified considering the experience of the financial market crisis. The treatment of positions with exchange rate and commodity price risk as well as for loan securitizations does not depend on their allocation to one of the two books, which demonstrates that harmonization is feasible.
2. The results of the computationally intensive SA TB, including the DRC, are largely reliant on the mechanistic effectiveness of correlations and the HBR, which allows extensive netting of long and short positions. However, these factors have proven to be less reliable in times of crisis.
3. CRs under the SA TB including DRC may be very low for portfolios with long and short positions. In the simulations, they averaged 0.5% for interest rate risk and less than 2% for credit risk in terms of the market value of the sum of all long and short positions. For commodity price, foreign currency and equity price risks, they averaged between 4% and 8%. The SA TB therefore appears to be a concession to banks that have been granted permission to use internal models, and in the future will additionally have to perform and presumably disclose their calculation under the SA TB.
4. The SA TB is unnecessarily burdensome and complicated. Systematically, detailed rules for the calculation of CRs are overlaid by lump-sum deductions or the crudely determined DRC. Risk weights that appear conservative are heavily diluted by taking correlations into account, leading to a high dependence on the reliability of the CCs. However, since regulators understandably doubt the stability of the correlations, the calculation needs to be performed three times overall with flatly increased or reduced CCs. When aggregating across risk classes, correlations are not taken into account. Moreover, it does not seem logical that at the beginning seemingly accurate CRs have

to be determined using thousands of CCs and hundreds of intermediate computation steps and scenario calculations, whereas ultimately the flat deductions for major currencies in the calculation of interest rate and currency risk, the comparatively easy-to-calculate DRC and, last but not least, the lump-sum capital buffers as well as the SREP surcharges and requirements imposed by regulators regarding MREL are the main drivers of CRs.

5. The calculations of CRs according to the SA TB and SSA of the trading book and the SA of the banking book use different criteria for undisclosed reasons. Moreover, multiple methods are sometimes allowed for one risk class. This makes comparisons between the approaches difficult and leads to inconsistent requirements. Mostly, but not in all cases, banks using the SSA are disadvantaged compared to those using the SA TB. In addition, the differences in results vary widely by risk class.
6. The SA TB is based on numerous assumptions, mainly regarding the definition of or allocation of positions to buckets, the assessment of risk weights and CCs, and the scope of netting of long and short positions based on the HBR. Each of these assumptions is subject to a great deal of uncertainty as to the level and stability over time. They are also difficult to verify because the Basel Committee does not disclose the basis for determining the key parameters. Moreover, the Committee has published only sparse explanations and does not respond to inquiries. This lack of transparency is not conducive to creating the trust in regulation that is so important for financial markets.

In addition to the conceptual shortcomings, a number of individual technical regulations of the SA TB raise questions.

- For bonds, securitizations, equities and options, the regulatory CR is not capped at the position value and may thus exceed the maximum loss for individual positions.
- The calculation of the CSR of non-securitized positions under the SA TB lacks sufficient differentiation by credit quality. In addition, diversification into lower credit quality positions may lead to greater capital relief than diversification into higher credit quality positions.
- The disputable separation of the banking and trading book is evident in CSR.
    - While portfolios consisting of non-securitized long positions in the banking book are privileged over those in the trading book, the opposite is true for portfolios mixed of long and short positions.

    - While financial institutions are partially privileged in the SA BB, it is the other way around in SA TB. Moreover, the treatment of positions by rating category shows differences. Due to such inconsistencies between the banking book and the trading book, different CRs may result unjustifiably, depending on the allocation of the portfolio to one of the two books.
    - For holdings of securitized positions, differences in results between the two books are essentially due to the fact that one has to apply both the sensitivity-based SA TB and a modified SA BB for the trading book at the same time. Given the mostly lesser significance of sensitivities, this is not only unnecessary, but also leads to unequal treatment of tranches depending on their seniority, rating and allocation to one of the two books.
- When computing equity price risk, high risk weights are associated with low CCs and, conversely, low risk weights are associated with high CCs. However, the assumption that equities considered riskier are less correlated than those considered less risky is disputable. Moreover, this approach leads to a convergence of results and calls into question the need for the elaborate SA TB.
- In calculating the DRC, which would not be necessary without the separation of trading and banking books, the HBR allows for generous netting of long and short positions of different issuers, industries, regions and credit ratings despite the inevitable basis risk. Moreover, no account is taken of whether the short position relates to low or high credit ratings.
- The unjustified privileging of sovereign issuers is also perpetuated.

The deficiencies highlighted are clearly at odds with the Basel Committee's intention to strike a better balance between risk sensitivity, simplicity and comparability.[43]

The root cause of the persisting imbalance is probably a fundamental misconception regarding the tasks and capabilities of supervisors. The regulations, some of which are detailed but largely irrelevant to supervision, such as the use of an additional multiplier of 99.9% in the calculation of CCs, indicate that supervisors believe they can determine CRs with mathematical precision. However, complicated but only seemingly accurate internal models or regulatory standardized approaches are neither superior nor necessary with regard to ensuring sufficient resilience of

[43] BCBS (2013).

banks to crises, which are unpredictable in terms of their course or severity. Moreover, their results would then be overlaid by less differentiated deductions or surcharges anyway.

It would therefore be better to confine oneself to comparatively simple, conservative standardized approaches and abandon the separation between banking and trading books. This would give supervisors more time to better understand the risks to which a bank is exposed. It would also create more transparency and trust vis-à-vis market participants if the calculation of capital requirements were comprehensible. Should simple calculations lead to higher minimum requirements it would not be a disadvantage. No bank has ever failed because of too much capital. Claims that higher capital requirements would make loans more expensive and would thus inhibit economic growth are not very plausible on closer examination.

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Appendix to Part 1: Sample calculations

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Tables

1. The sensitivities-based standardized approach for market risk

The following examples illustrate the calculation of CRs for six of the seven risk types.

1.1 General interest rate risk

The following example shows the computation of the CR for the delta risk of a bond portfolio consisting of four positions in two currency buckets (table A1). The bonds are based on different yield curves for governments and corporates.

EUR-Portfolio							
Debtor	Market value €	MD years	Change in value €	Sensitivity per bp = s_k	Risk weight RW_k	WS_k	WS_k^2
Government	100,00	1,00	0,01	100,00	1,60%	1,60	2,56
Corporate	100,00	10,00	0,1	1.000,00	1,10%	11,00	121,00
USD-Portfolio							
Government	100,00	2,00	0,02	200,00	1,30%	2,60	6,76
Corporate	100,00	6,00	0,06	600,00	1,10%	6,60	43,56

Table A1: Sample portfolio: General interest rate risk

The change in value of the Euro-denominated government bond of €100 with a modified duration (MD) of 1 year upon an interest rate change by 1 bp amounts to (100 * 1 * 1bp =) €0.01. This divided by 1 bp yields a sensitivity of €100. The residual maturity of 1 year corresponds to a prescribed risk weight of 1.60%, which multiplied by sensitivity results in the weighted sensitivity WS_k of €1.60. This is the CR of a single bond. Accordingly, the WS_k of the other three bonds are computed using risk weights depending on their residual maturities.

The equation for the CC ρ_{kl} for the aggregation within the buckets is: $\mathrm{MAX}(99{,}9\% * e^{-3\% * |Tk-Tl| / \mathrm{MIN}(Tk;Tl)}; 0{,}4)$. T_k and T_l denote the remaining maturities of the positions (equal to MD in this example). The multiplier 99.9% is used because the bonds are based on different yield curves. For the two bonds in the Euro-denominated portfolio, the maturity-dependent CC is 99.9% * $e^{-3\%*9/1}$ = 0.7626 and for those in the USD portfolio, 0.9408. The CR for the Euro portfolio amounts to:

$$K_b = \sqrt{MAX\ (0; \sum_k WS_k^2 + \sum_k \sum_{k \neq l} \rho_{kl} * WS_k * WS_l)}$$

$$K_b = \sqrt{2{,}56 + 121{,}00 + 2 * 0{,}7626 * 1{,}60 * 11{,}00} = 12{,}26\ €.$$

Since the Euro is considered a major currency, the CR for the Euro portfolio may be reduced to €12.26 / √2 = €8.67 after the aggregation within the bucket. For the USD portfolio, K_c amounts to €9.09 / √2 = €6.43.

The calculations are to be performed for three correlation scenarios, of which the one with the highest CR is to be used. In the high correlation scenario, the CC for the aggregation within buckets for the Euro portfolio increases to 0.7626 * 1.25 = 0.9533. By definition, the CC must not exceed 1. K_b increases accordingly from €12.26 to €12.53 and because the Euro is considered a major currency it may be reduced from €8.67 to €12.53 /√2= €8.86. In the low correlation scenario, the CC would decrease to MAX (2*0.7626 -1; 0.75 *0.7626) = 0.5720 and thus K_b would also decrease to 11.99 /√2 = 8.48 €. It is therefore not relevant here. For the USD portfolio, the CC increases to the maximum value of 1 in the high correlation scenario since 0.9408 * 1.25 exceeds 1. Thus, one obtains for K_c: €9.20 / √2 = €6.51.

For the following aggregation across buckets, the CC Υ_{bc} in the relevant high correlation scenario is 0.5 * 1.25 = 0.625. The calculation under the other two scenarios is omitted here. The CR amounts to $\sqrt{\sum_b K_b^2 + \sum_b \sum_{b \neq c} \gamma_{bc} * S_b * S_c}$ or

CR = $\sqrt{12{,}53^2 + 9{,}20^2 + 2 * 0{,}625 * (1{,}60 + 11{,}00) * (2{,}60 + 6{,}60)}$ / $\sqrt{2}$ = 13,90 €.

with S_b and S_c as the sum of WS_k in bucket b and c, respectively.

Compared to the sum of the WS_k of the four buckets amounting to €21.80, this is a capital relief of 36%, which is largely based on the preferential treatment for major currencies which crudely reduces the CR by 1 - 1/√2 = 29.29%. Aggregation within buckets reduces the CR by only 1 - (12.53 + 9.20) / (12.60 + 9.20) = 0.30%. Aggregation across buckets lowers CR by another 1 - (19.66 / (12.53 + 9.20) = 9.54%. If two ordinary currencies were involved, the capital relief would only be 1 - 19.66 / 21.80 = 9.80%.

Excursus: Treatment of derivatives in the calculation of general interest rate risk

Depending on their type, derivatives must be converted into positions of the underlying spot positions and treated equivalently. For example, a receiver swap can be decomposed into a long position of a fixed-rate government bond according to the maturity of the swap and a short position of a floating-rate government bond with maturity until the next interest rate fixing. A forward purchase maturing in one year with respect to a corporate bond with a remaining maturity of five years can be treated as a long position of five years and a short position of one year each with respect to the corporate bond. For a bond option, one computes the difference between the option price before and after a change in interest rates by 1 bp and divides this by 1 bp to obtain the sensitivity s_k. This is multiplied by the risk weight RW_k corresponding to the maturity of the underlying bond to obtain the weighted sensitivity WS_k. Again, RW_k can be divided by √2 for all seven major currencies. If the sensitivities of a bond and a bond option and the maturities of the respective bonds are equal, then, given the same risk weight, the WS_k are also equal.

Here is an example: The CR of an option on a fixed-rate bond with an annual coupon of 3%, a remaining maturity of four years and a current bond price of €100 is to be calculated. The yield curve is supposed to be flat at 3%. The option term is one year, the strike price is €100 and the volatility is 20%. The option price is €0.6058.[44] If interest rates rise by 1 bp, the option price will fall by €0.0112 and the delta sensitivity s_k amounts to €0.0112 / 1 bp = €111.6273. With a maturity-dependent risk weight RW_k of 1.15% (mean of the risk weights for residual maturities of 3 and 5 years), WS_k yields €1.2837 or for major currencies €1.2837 / √2 = €0.9077.

For instruments with optionalities, the vega and curvature risks still need to be calculated. The risk factor for the vega risk is also a yield curve of the corresponding currency. The vega sensitivity s_k of 0.6645 is the product of the vega of 0.0332 and the implied volatility of 20%. With RW_k of 1.15%, WS_k amounts to €0.0076 and for major currencies to €0.0054.

To compute the curvature risk CVR, the yield curve must be shifted by 170 bps. The option price falls to €0.0275 upon an upward shift and rises to €4.8807 upon a downward shift. According to the equations:

$$CVR_k^+ = -\sum_i \{V_i\,(x_k^{RW(Curvature)+}) - V(x_k) - RW_k^{Curvature} * s_{ik}\}$$

$$CVR_k^- = -\sum_i \{V_i\,(x_k^{RW(Curvature)-}) - V(x_k) + RW_k^{Curvature} * s_{ik}\}$$

one obtains:

CVR_k^+ = - (0.0275 € - option price 0.6058 € - WSk 1.2837 €) = +1.8620 € resp.

CVR_k^- = - (4.8807 € - option price 0.6058 € + WSk 1.2837 €) = - 2.9912 €

or for major currencies:

CVR_k^+ = - (0.0275 € - option price 0.6058 € - WSk 0.9077 €) = +1.4861 € resp.

[44] For this and the following calculations an option price calculator provided by John C. Hull for readers of his books "Risk Management" or "Options, Futures and Other Derivatives" was applied.

CVR_k^- = - (€4.8807 - option price €0.6058 + WSk €0.9077) = - €3.3672

Therefore, the curvature risk amounts to 1.8620 € and 1.4861 € for major currencies.

The sum of the option's delta, vega, and curvature risk is €3.15 for ordinary and for a reporting currency and the seven major currencies €2.40. However, for a portfolio, positions within buckets and across buckets must be aggregated using the CCs as described above.

1.2 Credit spread risk (CSR)

1.2.1 CSR of non-securitized positions

Here, the CR is computed for the delta risk of the bond portfolio discussed in 1.1, consisting of four positions in two currencies (table A2). For government bonds of bucket 1 (IG), the prescribed risk weight is 0.50%. The two corporates are assumed to be IG-rated industrial companies attributable to bucket 4. Thus, the risk weight is 3%.

Sector	Market value €	MD years	Change in value €	Sensitivity per bp: s_k	Risk weight RW_k	WS_k	WS_k^2
Government bonds							
Euro	100	1	0,01	100,00	0,50%	0,50	0,25
USD	100	2	0,1	200,00	0,50%	1,00	1,00
Corporate bonds							
Euro	100	10	0,02	1.000,00	3,00%	30,00	900,00
USD	100	6	0,06	600,00	3,00%	18,00	324,00

Table A2: Sample portfolio: CSR of non-securitized positions

The CC for the aggregation within the government bond and corporate bond buckets in the relevant high correlation scenario for different borrowers, maturities and yield curves amounts to 0.35*0.65*0.999*1.25 = 0.2841. For the two buckets one obtains

$K_b = \sqrt{0{,}25 + 1{,}00 + 2 * 0{,}281 * 0{,}25 * 1{,}00}$ = 1,24 € and

$K_c = \sqrt{900{,}00 + 324{,}00 + 2 * 0{,}281 * 30{,}00 * 18{,}00}$ = 39,13 €.

For the subsequent aggregation across buckets 1 and 4, the CC Υ_{bc} in the high correlation scenario is 0.2 * 1.25 = 0.25. The CR amounts to

$CR = \sqrt{\sum_b K_b^2 + \sum_b \sum_{b \neq c} \gamma_{bc} S_b S_c}$ and

$CR = \sqrt{1{,}24^2 + 39{,}13^2 + 2 * 0{,}25 * (0{,}50 + 1{,}00) * (30{,}00 + 18{,}00)}$ = 39,60 €

with S_b and S_c as the sum of WS_k in bucket b and c, respectively.

Compared to the sum of the WS_k of the four bonds of €49.50, this is a capital relief of 20%, which in the example is mainly due to the relief provided by the aggregation within the buckets.

In addition to the sensitivity-based CR, there is also the DRC, which depends on the rating, the maturity and the seniority. For a senior bond with a preset LGD of 75% and a remaining maturity of 1 year or more, the DRC ranges from 0.5% * 0.75 to 6% * 0.75 in the IG and from 15% * 0.75 to 50% * 0.75 in the NIG, depending on the rating. For defaulted positions, the DRC is 100% * 0.75. For government bonds, the DRC may be waived.

1.2.2 CSR of securitized positions ex CTP

The calculation of sensitivity-based CRs for securitizations follows the same rules as for non-securitized instruments, with different risk weights and CCs, however. In the example that follows, the CR is computed for the delta risk consisting of four positions of traditional securitizations and two buckets (table A3).

Rating	Market value €	MD years	Change in value €	Sensitivity per bp = s_k	Risk weight RW_k	WS_k	WS_k^2
RMBS Prime Bucket 1 Senior IG							
AAA	100	3	0,03	300	0,90%	2,70	7,29
AAA	100	5	0,05	500	0,90%	4,50	20,25
RMBS Prime Bucket 9 Non-senior IG							
A	100	3	0,03	300	1,13%	3,38	11,39
A	100	5	0,05	500	1,13%	5,63	31,64

Table A3: Sample portfolio: CSR of securitized positions ex CTP

The CC for the aggregation within the buckets in the relevant high correlation scenario is 0.40 * 0.80 * 0.999 * 1.25 = 0.3996 for different tranches, maturities and yield curves. For bucket 1, one obtains K_b = €6.10 and for bucket 9: K_c = €7.63. K_c exceeds K_b by 25% because the risk weight for RMBS Non-senior IG are 25% higher than for RMBS senior IG. The CC for the aggregation across buckets is always zero. Thus, the computation for CR is simplified to $\sqrt{6{,}10^2 + 7{,}63^2}$ = 9,77 €.

The computation of the DRC for securitizations in the trading book basically follows the SA for securitizations in the banking book, which is also used to calculate CRs under the SSA of the trading book.[45] However, while the risk weights and thus the CR for securitizations in the

[45] The calculation is presented below in the Excursus: Calculation of risk weights for securitizations in the banking book under the standardized approach and the external ratings-based approach.

banking book rise with increasing residual maturities between one and five years, only the lowest risk weights for residual maturities of one year are used to compute the DRC.

In the example, the DRC according to the SA TB for the two AAA-rated tranches of bucket 1 amounts to 1.20%. It is the product of the risk weight of 15%, which equals the regulatory floor, and 8% according to the banking book approach. For the two A-rated tranches of bucket 9, the DRC additionally depends on the thickness of the tranche D - A.[46] If for example D - A equals 10% for both tranches, the risk weights amount to 80% in either case and with the residual maturity set at 1 year one obtains: DRC = (1- MIN(D-A; 0.5)) * risk weight * 8% = (1-10%) * 80% * 8% = 5.76%. Overall, the DRC amounts to €200 * 1.20% for bucket 1 and €200 * 5.76% for bucket 9 and totals €2.40 + €11.52 = €13.92.

Thus, the DRC of €13.92 based on a much simpler and cruder computation is of greater importance than the elaborately computed sensitivity-based CR of €9.77. In total, the CR for securitizations in the trading book amounts to €23.69.

Contrary to the calculation of the DRC, the SA BB for tranches assigned to the banking book applies higher risk weights for residual maturities between 1 and 5 years. According to the ERBA, the risk weight also equals 1.20% for the tranches of bucket 1 as the regulatory floor of 15% applies to very high ratings. For the tranches of bucket 9, the longer maturities of 3 and 5 years require higher risk weights. For A-rated tranches, risk weights range from 80% for 1-year to 180% for 5-years. For a residual maturity of 3 years, the interpolated risk weight is 130%. The CR is thus (1-10%) * 130% * 8% = 9.36% or €9.36. For 5 years, one obtains (1-10%) * 180% * 8% = 12.96% or €12.96. Overall, the CR according to the SA BB using the ERBA totals €2.40 + €9.36 + €12.96 = €24.72. This would also be the CR according to the SSA TB.

In the example, the CR for AAA-rated senior tranches is lower in the banking book (€2.40) than in the trading book including the DRC (€6.10 + €2.40). Conversely, the CR for non-senior tranches in the IG rated A in the example is higher for the banking book (€9.36 + €12.96 = €22.32) than for the trading book (€7.63 + €11.52 = €19.15). This is even before the aggregation across buckets, which furthers reduce CRs.

1.2.3 CSR of securitized positions CTP

The calculations are similar to those described in 1.2.1 and 1.2.2, except that the risk weighting under the sensitivity-based approach is higher for the CTP. In addition, the multiplier used to

[46] D and A denote the detachment and attachment point.

determine the CC for aggregation within the buckets is 99% instead of 99.9%, provided that the yield curves are different.

1.3 Equity price risk

In the example that follows, the CR is computed for the delta risk of a portfolio consisting of two positions each for large caps in developing countries (EM) of bucket 1 and in developed countries (AM) of bucket 6 (table A4).

Rating	Market value €	Change in value €	Sensitivity per bp: s_k	Risk weight RW_k	WS_k	WS_k^2
EM Bucket 1						
BBB	100	1	100	55,00%	55,00	3.025,00
BB	100	1	100	55,00%	55,00	3.025,00
AM Bucket 6						
A	100	1	100	35,00%	35,00	1.225,00
BBB	100	1	100	35,00%	35,00	1.225,00

Table A4: Sample portfolio: Equities

The CCs for the aggregation within the buckets in the relevant high correlation scenario amount to 0.1875 for EM and 0.3125 for AM. For the two buckets, one thus obtains with the equation for K for bucket 1: K_b = 84.76 € and for bucket 6: K_c = 56.71 €. The CC for the aggregation across the buckets is always 0.1875 in the high correlation scenario. Thus, the CR amounts to €115.27 or 28.82% based on the market value of the portfolio of €400.00.

The DRC applies LGDs of 100% for equities and is dependent on the rating of the issuer. It is the total of 3% of the A-rated, 6% of the two BBB-rated and 15% of the BB-rated positions amounting to €30.00 or 7.50% of the portfolio value. In the example, the DRC exceeds the capital relief from the aggregation across buckets (€84.76 + €56.71 - 115.27 = €26.20).

The total CR under the SA TB including the DRC is €145,27 or 36,32%, which is significantly lower than the CR under the SSA amounting to €224.00 or 56%.

1.4 Foreign currency risk

Here, the CR is computed for the delta risk consisting of two positions in two major foreign currencies (table A5). For major currencies, the risk weight may be reduced from 15% to 15% * 1/√2 = 10.61%.

Currency	Market value €	Change in value €	Sensitivity per bp: s_k	Risk weight RW_k	WS_k	WS_k^2
USD	100	1	100	10,61%	10,61	112,50
CHF	100	1	100	10,61%	10,61	112,50

Table A5: Sample portfolio: Foreign currencies

Aggregation within currency buckets is not applicable. The CC for the aggregation across the buckets is always 0.75 in the high correlation scenario. With the equation for K, one obtains a CR of €19.84 or 9.92%. Under the SSA, the CR as the product of the position value times 8% multiplied by the scaling factor of 1,2 amounts to €19.20 or 9.60%.

1.5 Commodity price risk

In the example that follows, the CR is computed for the delta risk consisting of four positions and two different commodity types (table A6).

	Market value €	Change in value €	Sensitivity per bp: s_k	Risk weight RW_k	WS_k	WS_k^2
Bucket 2						
Oil	100	1	100	35,00%	35,00	1.225,00
Gas	100	1	100	35,00%	35,00	1.225,00
Bucket 7						
Platinum	100	1	100	20,00%	20,00	400,00
Silver	100	1	100	20,00%	20,00	400,00

Table A6: Sample portfolio: Commodities

The CC for the aggregation within the buckets in the relevant high correlation scenario is 1.00 for bucket 2 and 0.6875 for bucket 7. For the two buckets, one thus obtains with the equation for K for bucket 1: K_b = 70.00 € and for bucket 7: K_c = 36.74 €. The CC for the aggregation across the buckets is very low and is always 0.25 in the high correlation scenario. The CR amounts to €87.46 or 21.87% of the portfolio value of €400.00. The CR under the SSA in this simplified example is the position value times 15% multiplied by the scaling factor of 1.9. It amounts to 114.00 € or 28.50% of the portfolio value, which is 30% higher than under the SA TB.

1.6 Calculation of the default risk capital requirement

The DRC is to be computed only for positions with default risk. As the former examples applied to portfolios of long or short positions, the following examples show the netting of long and short positions with the HBR.

The first example shows the computation of the DRC for a portfolio of two non-subordinated corporate bonds from different borrowers (table A7). The market value of the bonds corresponds to the nominal value in the example.

Position	Debtor	Nominal value €	Residual maturity years	Rating	Loss Given Default LGD	Risk weight RW_k
Long	Corporate	200	1	A	75,00%	3,00%
Short	Corporate	-100	1	BBB	75,00%	6,00%

Table A7: Sample portfolio: DRC for non-securitized positions

The HBR is the sum of the non-risk-weighted net long positions multiplied by the LGD (200 * 0.75) divided by the sum of the non-risk-weighted net long positions and the absolute value of the net short positions, each also multiplied by the respective LGD (200 * 0.75 + 100 * 0.75), and amounts to 150 / 225 = 0.6667.

In addition, the risk-weighted net long and net short positions need to be determined. The specified risk weights depend on the rating category. For the long positions, one obtains 200 * 0.75 * 3% = €4.50 and for the short position 100 * 0.75 * 6% = €4.50.

The DRC for the bucket is the sum of the risk-weighted net long positions minus the product of HBR and the sum of the absolute values of the risk-weighted net short positions. The DRC is thus €4.50 - 0.6667 * 4.50 = €1.50. The DRC of the net long position is thus reduced from €4.50 or 2.25% of the position value to only €1.50 or 0.75%.

The next example shows the computation of the DRC for a portfolio with two securitized positions of different securitization pools, which prevents a direct netting of tranches (table A8).

Position	Type of securitization	Nominal value €	Residual maturity years	Rating	RW
Long	RMBS Prime 1	100	1	AAA	15,00%
Short	RMBS Prime 2	-100	1	AAA	15,00%

Table A8: Sample portfolio: DRC for securitized positions

Because LGDs are not required, the HBR is the sum of the net non-risk-weighted long positions (100) divided by the sum of the net non-risk-weighted long positions and the absolute value of the net short positions (100 + 100). The HBR is thus 100 / (100 + 100) = 0.50.

The risk weights are based on the rules for securitizations of the banking book. In the example, according to ERBA, the 15% floor applies to both tranches with rating AAA for non-STC securitizations. Thus, the risk-weighted positions amount to €15 each. The DRC for securitized positions as the total of the risk-weighted net long positions less the product of HBR and the total of the absolute values of the risk-weighted net short positions is therefore €15 - 15 * 0.5 = €7.50.

Excursus: Calculation of risk weights for securitizations in the banking book under the standardized and the external ratings-based approach (ERBA)

According to the SA BB the calculation of risk weights follows a predefined formula and is based in particular on the CR of the securitized assets had they not been securitized, the seniority and thickness of the tranches, and the proportion of defaulted assets in a securitized pool.[47] However, the risk weight is floored at 15% for traditional securitizations. For STC securitizations, the floor is set at 10% for senior tranches and 15% for non-senior tranches. These floors are particularly relevant for tranches of highest seniority of the securitization of very low risk-weighted receivables in the banking book (e.g. loans to retail customers). The risk weights may be as high as 1,250% either if the credit quality of a securitized pool declines and losses increase, or for low-rated non-senior tranches.

Determining the risk weights requires several calculation steps, as shown here using the example of a AAA-rated senior tranche using the standardized approach and ERBA.

For the standardized approach, the rulebook provides the following formula:

$K_{SSFA(KA)} = (e^{a*u} - e^{a*l}) / (a*(u-l))$

The parameters are defined as follows:

- $a = -(1 / (p * K_A))$ with p = 1 for securitizations and p = 1.5 for resecuritizations.
- $u = D - K_A$
- $l = MAX(A - K_A; 0)$
- $K_A = (1 - W) * K_{SA} + W * 0.5$
- W: Quotient of nominal amount of securitized receivables overdue and nominal amount of securitized receivables
- K_{SA}: CR of securitized exposures according to the standardized approach for loans in the banking book. For example, CR amounts to 2.8% for 35% risk-weighted real estate loans to retail customers, 6% for 75% risk-weighted consumer loans or 8% for 100% risk-weighted loans to corporates rated BBB+ to BB-.

[47] BCBS (2019c)

- K_A: The sum of K_{SA} multiplied by the share of non-defaulted exposures in the securitization pool and half of the share of defaulted exposures in the securitization pool. If no exposure has defaulted yet, which is the case at the beginning of a securitization, K_A equals K_{SA}.
- D: Detachment Point. It indicates the proportion of loss in % of a securitized pool that would completely absorb the tranche under consideration. For a AAA-rated tranche, D equals 100%.
- A: Attachment Point. It indicates the proportion of loss in % of the securitized pool before the tranche under consideration suffers a loss (loss buffer). For a AAA-rated tranche, which for example represents 80% of the securitized volume, A equals 20%.
- D – A: The difference shows the thickness of a tranche.

A distinction must now be made between three possible outcomes:

- If $A > K_A$, i.e. when the loss buffer is still comparatively large, then the risk weight equals $K_{SSFA(KA)}$ * 12.5. The risk weight largely depends on the risk weight of the securitized exposures. For a AAA-rated tranche and a thickness of D - A of 80%, the computed risk weight would only be 0.09% for securitized qualified retail real estate loans, 9.09% for qualified consumer loans and 27.89% for corporate loans rated BBB+ to BB- or CMBS. Therefore, risk weights are floored at 10% and 15%, respectively.
- If D is less than or equal to K_A, i.e. if the tranche would be absorbed by even a small loss, then the risk weight is 1,250%.
- If $A < K_A$ and $D > K_A$ applies, i.e. A < KA < D, the risk weight RW is computed as follows: $RW = 12.5 * (K_A - A) / (D - A) + 12.5 * K_{SSFA(KA)} * (D - K_A) / (D - A)$.

According to the ERBA, the risk weight of a short-term securitization tranche depends only on the rating, whereas the risk weight of a long-term tranche depends on the rating, the seniority, the maturity and, for non-senior tranches, also on the thickness of the tranche.[48] The preset risk weights range from 15% to 1,250% and from 10% to 1,250% for STC securitizations and are multiplied by the term: 1 – MIN(D-A; 0.5), i.e. 100% less the lower of the thickness and 50%. In addition, risk weights are similarly floored at 10% or 15% as in the standardized approach. For example, for a AAA-rated senior tranche and a thickness of 80%, the preset risk weight between 15% and 20%, depending on the maturity, or 10% regardless of the maturity in the case of a STC securitization, is multiplied by 1 – MIN(0.8; 0.5). Since the result would be 10% or less, the floors of 15% or 10% for STC securitizations would apply.

[48] BCBS (2019d). Under the SA TB, the maturity is generally set at 1 year.

2 The simplified standardized approach for market risk

2.1 Interest rate risk

2.1.1 General interest rate risk

There are two methods to compute the general interest rate risk. For a single position, the maturity method requires its market value to be multiplied by a specified maturity-dependent risk weight. The risk weights are intended to reflect interest rate sensitivities. Under the duration method, the risk is the product of a position´s market value, its MD and a predetermined maturity-dependent interest rate change. Both methods produce similar results.

Here is an example for a zero bond with a nominal value of €100. Its remaining maturity, duration and MD at a flat yield curve of 0% is supposed to be 3.2 years. The maturity corresponds to the mean value of the specified range of 2.8 to 3.6 years for bonds with coupons below 3%. Under the maturity method, the bond value is to be multiplied by the preset risk weight of 2.25%. Under the duration method, the bond value is multiplied by the predetermined interest rate change of 0.75% and by its MD of 3.2 totalling 2.40%. Both results need to be scaled up by 1.3 to obtain the CR. In general, the duration method leads to somewhat higher results for zero bonds than the maturity method.

Schierenbeck/Lister/Kirmße provide a comprehensive example of the calculation of the CR for the general interest rate risk of a portfolio according to the maturity method and the duration method including the horizontal and vertical offseting of long and short positions.[49] It should be taken into account that in the future the risk weights for the offsetting between zones 1 and 3 and for the not netted residual amount will be reduced from 150% to 100% and that the scaling factor of 1.3 will be introduced. With the duration method, the CR therefore increases in their example to €140.40 * 1.3 = €182.52 compared to €174.79. For the duration method, it increases to €137.58 * 1.3 = €178.85 compared to €172.08.

2.1.2 Specific interest rate risk:

The CR for specific interest rate risk is obtained by multiplying a position´s market value by the preset risk-weights in table A9. These must still be multiplied by the scaling factor 1.3. In contrast to the sovereign exposures, the CR for other debtors rated AAA to AA- is dependent on a position´s maturity.

[49] Schierenbeck/Lister/Kirmße (2008), pp 385.

Government debt			Other debtors		
Rating	Maturities	CR %	Rating	Maturities	CR %
AAA to AA-	all	0,00%	AAA to BBB-		
A+ to BBB-	up to 6 months	0,25%		up to 6 months	0,25%
	6 to 24 months	1,00%		6 to 24 months	1,00%
	over 24 months	1,60%		over 24 months	1,60%
BB+ to BB-	all	8,00%	BB+ to BB-	all	8,00%
B+ to B-	all	8,00%	B+ to B-	all	12,00%
Below B-	all	12,00%	Below B-	all	12,00%
Not rated	all	8,00%	Not rated	all	8,00%

Table A9: CR for specific interest rate risk

Excursus: Standardized approach for credit risk in the banking book

The calculation of CRs according to the standardized approach for credit risk in the banking book are presented and used for comparison with the CRs for positions with default risk in the trading book. According to the SSA, these include positions with specific interest rate risk, and according to the SA TB positions with credit spread risk and equities.

Contrary to the trading book approaches, risk-weighted assets are computed for banking book positions by multiplying the position value by a specified risk weight. Therefore, risk weights have a different meaning here. To compare the trading book and the banking book, one must therefore either multiply the risk-weighted assets of the banking book by 8.00%, as in table A10, or divide the CR of the trading book by 8.00%.[50]

	Governments		Banks (rated)		Corporates	
Credit Rating	Risk weight	CR	Risk weight	CR	Risk weight	CR
AAA to AA-	0%	0,0%	20%	1,6%	20%	1,6%
A+ to A-	20%	1,6%	50%	4,0%	50%	4,0%
BBB+ to BBB-	50%	4,0%	50%	4,0%	100%	8,0%
BB+ to BB-	100%	8,0%	100%	8,0%	100%	8,0%
B+ to B-	100%	8,0%	100%	8,0%	150%	12,0%
Below B-	150%	12,0%	150%	12,0%	150%	12,0%
Not rated	100%	8,0%	100%	8,0%	100%	8,0%

Table A10: Risk weights and CRs under the standardized approach for credit risk in the banking book

[50] BCBS (2019b). Under option 1, the risk weight for banks is one notch below that of the country´s government in which the bank is domiciled as shown in table A10. Under Option 2, the risk weight depends on the bank rating. Unlike option 1, it is 50% for BBB+ to BBB- rated and unrated banks.

Compared with the SSA, the (preliminary) CR for positions in the banking book is not dependent on maturities and is higher for A+ to BBB- rated exposures and, in the case of corporates, also for B+ to B- rated positions than under the SSA.

However, the actual CR is obtained for the banking and trading book only by multiplying the risk-weighted assets and a percentage which, including the capital conservation buffer of 2.50%, amounts to at least 10.50%. The preliminary CRs of the trading book according to SA TB or SSA must therefore first be divided by 8.00% and then multiplied by at least 10.50%. The SA BB computes risk-weighted assets.

2.2 Equity price risk

The CR for the general equity price risk is 8% of the net position and for the specific risk 8% of the gross position. The scaling factor is 3.5 in each case. Therefore, for a single long position (A) of €100, the CR totals 2 * €100 * 8% * 3.5 = €56.

If a portfolio consists of another long position (B) of 100 € and a short position (C) of 50 € and position (C) belongs to the same national market as either (A) or (B) then the gross position for the specific risk is €250 but the net position is only €150. The CR is thus €400 * 8% * 3.5 = €112. If the short position were related to another national market, netting would not be allowed and the CR would be €500 * 8% * 3.5 = 140 €.

2.3 Foreign currency risk

Here is an example to illustrate the calculation of the CR using the shorthand method based on the following assumption. A bank´s reporting currency is Euro. Its converted net long positions for USD, JPY and gold amount to +€100, +€50, and +€100. Furthermore, its converted net short positions for CHF and GBP are -€60 and -€40. The sum of the net long positions of the currencies is €150 and the absolute value of sum of the net short positions is €100. Under the shorthand method, the larger of the two sums of the currency positions of €150 and the gold position of €100, which is considered separately, is multiplied by 8% and the scaling factor of 1.2. The CR amounts to (€150 + €100) * 8% * 1.2 = €24.

2.4 Commodity price risk

The following example illustrates the computation of the CR for one commodity type using the maturity method and the simplified method. The calculations need to be made separately for each commodity type and are then added up. The sample portfolio consists of four positions of one commodity type, which are distributed over two of the seven maturity bands (table A11).

				Not matched		Carry forward	Matched between maturity bands
Maturity band	Long	Short	Matched within bands	Long	Short		
1	600	-300	300	300		300	
2	100	-275	100		-175		175

Table A11: Sample portfolio: commodities with maturity bands

Under the maturity method matched positions are weighted at 3%, positions carried forward at 0.6% and a remaining unmatched position at 15%. Within the two maturity bands (table A11, column 4), the matched positions total €300 + €100 = €400 and are weighted by 3% (€12.00). The remaining long position from maturity band 1 of €300 is carried forward by one maturity band and weighted by 0.6% (€ 1.80). Of the amount carried forward, €175 is matched against the open short position from maturity band 2 and weighted by 3% (€5.25). The residual unmatched position of €125 is weighted by 15% (€18.75). Thus, the CR totals €37.80.

Under the simplified method, the gross position of €1,275 (sum of the absolute amounts of the four positions) is weighted by 3% (€38.25) and the net position (difference between the sum of the long and the sum of the short positions) of €125 is weighted by 15% (€18.75). Thus, the CR amounts to €57.00.

Both results are to be multiplied by the scaling factor of 1.9. For portfolios consisting exclusively of long or short positions both methods lead to identical results (15% * 1.9 = 28.5%).

2.5 Treatment of options under the simplified approach

Derivative instruments are to be converted into positions of their underlying instruments. This conversion is not trivial in the case of options. Banks that only buy but do not write options, may use a simplified method. Banks that buy and sell options should use the delta-plus or scenario method.

2.5.1 Simplified method

According to this method, the CRs for options are calculated separately either stand-alone or together with their corresponding underlyings, if applicable. If an option is a long call or long put, the capital requirement before scaling is the lower of the following two values:

- Market value of the underlying multiplied by the corresponding risk weights for general and (if relevant) specific market risk or

- Market value of the option, which caps the CR at the maximum possible loss.

For example, the CR for an equity position with a market value of €100 before scaling is €100 * 2 * 8% = €16. If the market value of a call option on this equity position is less than €16, for example €15, then the lower value of €15 is multiplied by the scaling factor for equities of 3.5.

If the position is a combined long call and short cash position or long put and long cash position, the CR equals the market value of the underlying multiplied by the corresponding risk weights for general and (if relevant) specific risk less the amount the option is "in the money". In the above example, if the strike price of the call is €90, the call is €10 in-the-money and thus the CR before scaling of a short cash position decreases accordingly by €10 to €5. The result may not be negative, however.

2.5.2 Delta plus and scenario method

Under these two methods, the CR for the specific interest rate or equity price risk of an option is the product of the delta equivalent (market value of the underlying instrument multiplied by the delta of the option) and the corresponding risk weight per risk class. For options on bonds, for example, the risk weights of the maturity or duration method are applied, and for equity options it is 8%. For currencies and commodities, the rules for specific risk are not applicable.

The computation of general risk according to both methods is shown for an equity option with the following parameters: Market value of the underlying equity €99.50; strike price €100; option maturity 1 year; interest rate 0%; implied volatility 10%; call price €3.73; delta 0.5; gamma 0.04; vega 0.4.[51]

According to the delta-plus method general risk is determined as follows. The delta equivalent is treated like a non-derivative instrument. In addition, CRs are computed for gamma and vega risks. Gamma risk is the squared product of the market value of the underlying instrument and its corresponding risk weight per risk class, e.g. 8% for equity price risk, currency risk and gold or 15% for commodity price risk. This value is then multiplied by 0.5 and the option´s gamma. Only negative values are relevant for the calculation, as positive values represent a potential increase in value. Finally, the vega risk is obtained by multiplying the option´s vega by a change in volatility of +/- 25%.

- The delta equivalent is €99.5 * 0.5 = 49.75 €
- The CR for the specific risk is: €49.75 * 8% = €3.98

[51] The option price calculator provided by John C. Hull was also used for the following calculations.

- The CR for the general risk is the sum of the following requirements for the three sub-risks:
  - Delta risk: €49.75 * 8% = €3.98
  - Gamma risk: 0.5 * gamma * (99.5 * 8%)^2 = €1.27 for a long or -€1.27 for a short position
  - Vega risk: volatility * vega * 25 = €1.00

The CR for general risk is the sum of the absolute values and amounts to €4.98 for a long position and €6.25 for a short position. In total, taking into account the scaling factor for equity price risk, the CR is thus (3.98 + 4.98) * 3.5 = €31.36 for a long position and (3.98 + 6.25) * 3.5 = €35.80 for a short position.

According to the more elaborate scenario method for general risk, the option price is computed several times following simultaneous changes of the value of the underlying instrument and the option´s volatility. Since the calculations have to be performed for at least seven values of the underlying at equal intervals and three values for the volatility (current value as well as the values following an upward and downward shift by 25%), at least 21 computations are required. For each scenario, a profit or loss must be determined. The CR is equal to the highest loss of all scenarios.[52]

Here is an example (table A12): For the equity call option described above, the option price is to be computed at least seven times following upward and downshifts of the underlying equity price of €99.50 within a preset range for equity price risk of +/- 8%.[53] The corresponding range of values from €91.54 to €107.46 is to be decomposed into at least seven points of equal distance. In addition, three different scenarios for volatility are considered. These are the current value of 10% as well as the shifted values amounting to 12.5% and 7.5% (+/-25%). For all 21 scenarios, the changes in the option price compared to the current option price of €3.73 needs to be computed. In the example, for a long position, the highest loss would occur at the lowest underlying price of €91.54 and the lowest volatility of 7.5%. The value of the option would fall by €3.31 from €3.73 to €0.42. Accordingly, for a short position, the highest loss would occur at the highest underlying price of €107.46 and the highest volatility of 12.5% as the option value would increase by €6.00. As a result, the capital requirement for specific and general risk amounts to (3.98 + 3.31) * 3.5 = €25.52 for long positions and (3.98 + 6.00) * 3.5 = €34.92 for short positions, respectively. Other option price risks are not considered under either method.

[52] Hartmann-Wendels et al. (2019), pp.649

[53] The scenarios for the other risk classes are as follows: For interest rate instruments, the yield changes specified in the SSA apply, for currencies and gold the set range is also +/-8% and for commodities it is +/-15%.

	Equity price change	-8,00%	-5,33%	-2,67%	**0,00%**	2,67%	5,33%	8,00%
Volatility	Equity price	91,54	94,19	96,85	**99,50**	102,15	104,81	107,46
10%*(1+ 25%) = 12,50%	Call price	1,69	2,48	3,49	4,73	6,19	7,86	9,73
	Call price change	-2,05	-1,25	-0,24	0,99	2,45	4,13	**6,00**
10%	Call price	0,99	1,64	2,55	**3,73**	5,20	6,93	8,89
	Call price change	-2,74	-2,09	-1,18	**0,00**	1,47	3,20	5,16
10%*(1 -25%) = 7,5%	Call price	0,42	0,88	1,63	2,74	4,22	6,05	8,16
	Call price change	**-3,31**	-2,85	-2,10	-0,99	0,49	2,31	4,43

Table A12: Scenario method for an equity call option

The simple examples under 2.5.1 and 2.5.2 show another inconsistency in the rule book. The maximum potential loss for a holder of a long call is the call price. Nevertheless, the CR of an option position can be a multiple of the call price, as shown in the example.