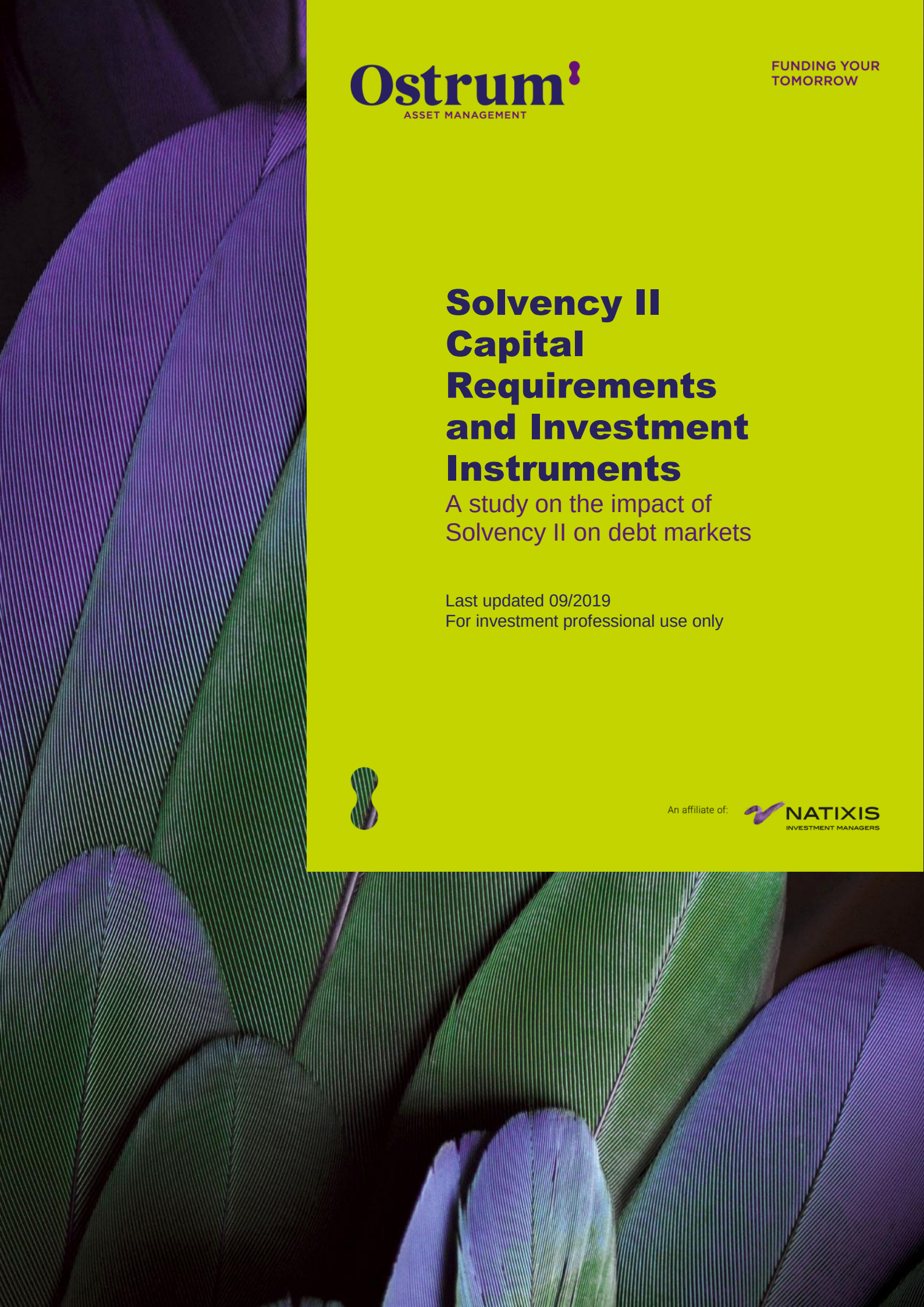


Ostrum ASSET MANAGEMENT

FUNDING YOUR TOMORROW

Solvency II Capital Requirements and Investment Instruments

A study on the impact of Solvency II on debt markets

Last updated 09/2019
For investment professional use only

An affiliate of: NATIXIS INVESTMENT MANAGERS

PRELIMINARY REMARKS

This study reviews the calculation of the Solvency Capital Requirement (SCR) and the impact of Solvency II on debt markets.

The following criteria have been used for our analysis:

- Standard formula
- Market risk module
- Counterparty default risk module

This study is not intended to be an exhaustive analysis of regulation. Instead, we aim to provide a detailed description of the key elements embedded in the calculation of the SCR applied to debt instruments.

Considering the wide range of debt asset classes and the variety of associated risks, there are multiple situations to consider: type of coupon, indexation and embedded options (callable, puttable…), convertible bonds, collateralized loans, securitisations, infrastructure debt…

We assume that credit risk stemming from debt instruments has no natural mitigant in the liabilities of an insurer outside of specific cases. As a result, the decision to invest in credit risk versus pure rate instruments (i.e. certain sovereign debts) is typically driven by an objective to find a balance between return, risk and the SCR. We address this issue in our study with a focus on the profitability of debt instruments under Solvency II.

We acknowledge that the SCR standard formula is complex, and it can be considered unclear or ambiguous on some very specific aspects of debt markets. We recommend that insurers consider this study as a summary of SCR calculations, reflecting our views and our interpretation of specific points and issues relative to Fixed Income instruments.

In the first section, we provide a “big picture” of the SCR standard formula. We then focus on the specificities of the SCR for debt instruments, with specific attention to the use of ratings and pricing models. The third section is dedicated to how profitability can be measured when considering the SCR.

The current version has been updated to the best of our knowledge on August 2019.

- Quick links:
  - Table of content *below*
  - *Acronyms and Definitions* page *37*.
  - *Index* page *38*.
  - For all the detailed reference about in force regulations see: *Reference* page *38*.

CONTENTS

1. OVERVIEW OF THE STANDARD FORMULA

The SCR calculation is split into several modules. In this study, we focus on two modules: Market Risk Module and Counterparty Default Risk Module.

We set out below the principles underlying the SCR calculation. The standard formula is scenario based and split into modules. The sub-modules are then aggregated using fixed correlations. The calculation of the Market Risk Module follows the same philosophy. It is also split into sub-modules, aggregated using fixed correlations.

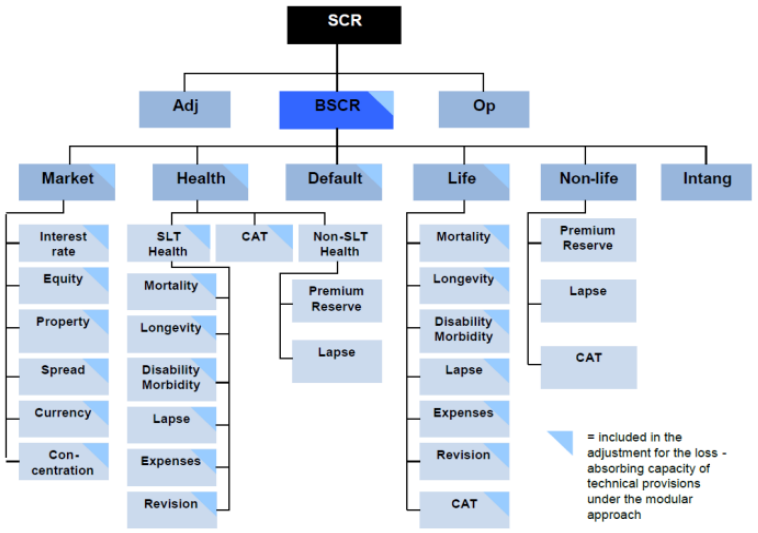


Figure 1: Standard Formula, source: EIOPA

One of the key points in the calculation of the SCR is the generalized use of a look-through approach. Financial instruments held by a mutual fund are considered to be held directly by the insurer invested in the fund, pro rata its investment. The same method applies to the financial instruments of mutual funds held by another mutual fund, etc.

The Market Risk Module is split into the following sub-modules:

- interest rate risk SCR_{IR},
- equity risk: SCR_{EQ},
- property risk: SCR_{PR},
- spread risk: SCR_{SPREAD},
- market risk concentrations: SCR_{CONC},
- currency risk: SCR_{FX}.

This study focuses on debt instruments; however, we briefly consider the equity risk sub-module. Nevertheless, this sub-module has a direct impact on fixed income instruments if the insurer invests in convertible bonds, which are truly hybrid products (mixing equity, spread and interest rate risks in a complex way).

The property risk sub-module is the slightest: SCR_{PR} is given by a loss given by an "instantaneous decrease of 25% in the value of immovable property" (Article 174). Not directly relevant for debt instruments, it can have a slight influence through real estate collateral.

An important point is that there is no sub-module for volatility risk. This means that hedging strategies with out-of-the-money options can present interesting opportunities from an SCR perspective. This remark applies to rate options (swaptions, caps and floors) as well as options on credit indices or on FX rates. Accordingly, there is no volatility cost for convertible bonds, which as a result provide cheap equity options when out of the money.

The Counterparty Default Risk Module applies to:

- Over-The-Counter (OTC) derivatives used for risk mitigation and contracts with Special Purpose Vehicles (SPV). These are included in the category "Type 1 exposures";
- Credit exposures not caught by the spread risk sub-module (or the Type 1 category above): These are included in the category "Type 2 exposures". These exposures are outside the scope of this note.

The main reference documents for calculation of the Solvency Capital Requirement modules are:

- Directive 2009/138/EC, known as "Solvency II",
- and Delegated Regulation (EU) 2015/35, known as "Level 2" regulation,
  - without specific reference, all the article numbers mentioned hereafter refer to the Delegated Regulation 2015/35.
- see *Reference p 38*. for a detailed list of most relevant regulation.

2. SCR FOR DEBT INSTRUMENTS

2.1. OVERVIEW

The following sub-modules apply to debt instruments:

- Interest rate risk sub-module (SCR_{IR}). This is an implicit risk in all fixed income instruments. This sub-module, unlike the others, can be set off against the insurer's liabilities.
- Spread risk sub-module (SCR_{SPREAD}). This is the main source of SCR for most debt instruments. It is driven by the credit quality (or credit rating) and the sensitivity of the instrument with respect to its spread (modified duration).
- Market risk concentrations sub-module (SCR_{CONC}). This sub-module considers the default risk in a portfolio by calculating the concentration of risky issuers (measured by the credit rating).
- Currency risk sub-module (SCR_{FX}). This sub-module measures the risk of debt instruments that are not in the currency of the insurer. It is also impacted by hedging strategies for such instruments (FX forwards or futures).
- Equity risk sub-module (SCR_{EQ}). For debt instruments, this sub-module applies to the equity risk on convertible bonds and transitory equity positions which result when convertible bonds are exercised.
- Counterparty default risk module. This module is not involved in the Market Risk Module, but it has an important impact on OTC derivatives, used as risk mitigation techniques or held through mutual funds. This module mainly considers the default of counterparties, which is not already taken into account in the Market risk concentrations. Its formulation is complex, since it has a combined effect with the Market risk capital requirement of the OTC instruments. In this paper, this is the only aspect of the counterparty default risk module that we shall describe, but it has deeper ramifications for insurers, because it also covers contracts between insurers and reinsurers.

Complex structured notes, indexed on various sources of risks, will not be discussed in this paper. However, when a proper pricing model is available for such notes, it will be possible to calculate their SCR.

Diversification effects are taken into account when capital requirements are aggregated by using a correlation matrix. Assume that the capital requirements for the various sub-modules (the property sub-module) are calculated, let $\overrightarrow{SCR_{MR}}$ be the following vector, where * denotes the transposition:

$$\overrightarrow{SCR_{MR}} = \left(SCR_{IR}, SCR_{SPREAD}, SCR_{CONS}, SCR_{FX}, SCR_{EQ}, SCR_{PR}\right)^{*}$$

The SCR for the market risk module is given by

$$SCR_{Market} = \left[\left(\overrightarrow{SCR_{MR}}\right)^{*} \cdot C \cdot \overrightarrow{SCR_{MR}}\right]^{\frac{1}{2}}$$

Coefficients depends on which IR shock is retained (upward or downward), they are given by article 164.3. The first figure (in red) represents the correlation to be used when the upward shock is selected. The second figure (in green) represents the correlation to be used when the downward shock is selected.

	SCR_{IR}	SCR_{SPREAD}	SCR_{CONC}	SCR_{FX}	SCR_{EQ}	SCR_{PR}
SCR_{IR}	1	↑0/↓0.5	0	0.25	↑0/0.5↓	↑0/0.5↓
SCR_{SPREAD}	↑0/↓0.5	1	0	0.25	0.75	0.5
SCR_{CONC}	0	0	1	0	0	0
SCR_{FX}	0.25	0.25	0	1	0.25	0.25
SCR_{EQ}	↑0/↓0.5	0.75	0	0.25	1	0.75
SC_{PR}	↑0/↓0.5	0.5	0	0.25	0.75	1

Table 1: correlation matrix C for SCR_{MARKET} sub modules aggregation

2.2. INTEREST RATE SUB-MODULE

- Reference: Articles 164 to 166, 43 to 48 and EIOPA-BoS-15/035 for the curve calculation

The interest rate sub-module is based on the calculation of losses under two opposite scenarios on the interest rate curves, which are given by the present value of the assets and liabilities minus, respectively:

- The present value of all interest rate curves subject to an upward shock (i.e. for all currencies)
- The present value of all interest rate curves subject to a downward shock (i.e. for all currencies)

It is important to note that these shocks concern both the assets and the liabilities of an insurer.

These shocks are defined currency by currency but are applied to each curve associated with the given currency.

The shocks are extracted from a set of instruments specified for each currency (either swaps or government bonds), for tenors longer than a year. They stem from an interpolation/extrapolation method (known as the Smith-Wilson method), which is described in detail in the document EIOPA-BoS-15/035[1]. Each month, EIOPA publishes the official curve for each currency. However, to monitor a portfolio on a daily basis, it is necessary to be able to produce such a curve under the current market conditions.

2.2.1 "Standard" Risk Free Reference curve

The key components of the risk-free rate are summarised as follows:

- The market rates of the instruments are decreased by the Credit Risk Adjustment (CRA). We will come back to the calculation of this quantity below.
- Last liquid point, LLP, is a given parameter for each currency (20 years for EUR).
- UFR, the ultimate forward rate, is calculated in accordance with a methodology on an annual basis and is updated when UFRs are sufficiently different from the then applicable UFRs.
- Convergence maturity is the maximum of (LLP +40) and 60 years. Consequently, the convergence period is the maximal of (60-LLP) and 40 years. For EUR, Convergence maturity is 60 years.
- The interpolation, where necessary, and extrapolation of the risk-free interest rates should be developed by applying the Smith-Wilson method. Of course, Smith-Wilson method is not the only possible method for the stripping of the interest rate curves.

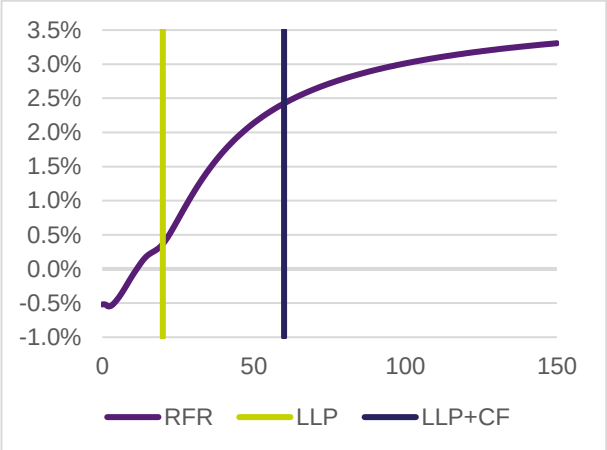


Figure 2: Zero-coupon RFR curve for EUR on 2019/07/31 (Source: EIOPA)

The upward and downward shocks are deduced from the interpolated / extrapolated curve by applying fixed relative value shocks, under two restrictive conditions:

- The upward shock is, as an absolute value, at least 1% (Article 166.2)
- The downward shock is 0 for negative risk-free rates (Article 167.2)

The shocks deduced from the previous steps are applied to each swap curve (through its zero-coupon form, i.e. stripped form) associated with the currency.

The shocks are given in the appendix *Relative Upward and Downward Shocks*.

[1] More information on EIOPA website, see *Other European regulations and implementing regulations applied*

Figure 2 displays the RFR curve as given by EIOPA on 31/07/2019. We have represented the LLP (20 years) and the LLP plus CF (20+40=60). The UFR is equal to 3.9%. After the LLP, the behaviour of the curve is not driven by the corresponding market tenors.

The credit risk adjustment (CRA) is defined in Article 45, which states that it must be in the range [10bps; 35bps]. It reflects the credit risk involved in swap rates. Its precise calculation is available in EIOPA's document BoS15/35 and is too long to be detailed here. However, let us say that, for the EUR, it is based on the difference between the 3-month Euribor rate and the rate of the 3-month EONIA swap.

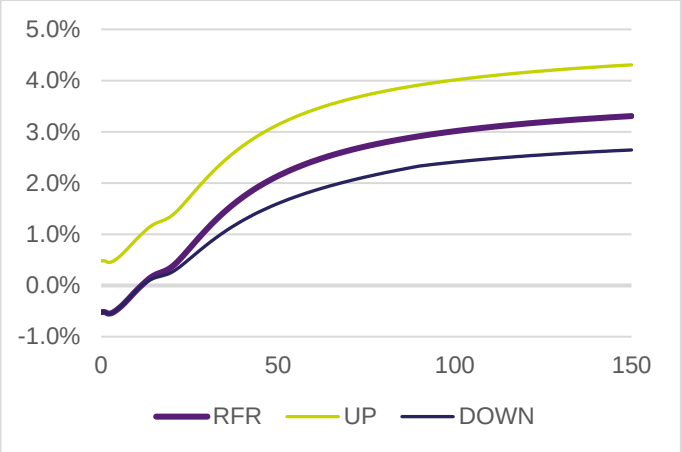


Figure 3: RFR curve with upward (UP) and downward (DOWN) shocks
EUR curve no volatility adjustment, 2019/07/31 (Source: EIOPA)

The shocked curves, for a given currency, are used to evaluate each instrument. It is interesting to note that even if the rates of the risk-free rate curve are extrapolated beyond the LLP, their extrapolated value only comes into play through the shocks on the rates after this point. However, for the liabilities of the insurer the risk-free rate curve is used as the discount curve. Under conditions the insurer can use a slightly different curve if he decides to use optional volatility adjustment or matching adjustment.

The shock (upward or downward) which is retained is the shock corresponding to the largest loss.

2.2.2 Risk free interest rate curve adjustment to calculate the best estimate.

Without entering into detailed explanations, we list here options available for insurance institutions.

2.2.2.1 Volatility adjustment

- Reference: article 49 to 51

Insurance institutions can apply a volatility adjustment to the relevant risk-free interest rate curve to be used to calculate the best estimate of their liabilities. For each currency, the adjustment depends on the difference between the interest rate that it would be possible to derive from the assets included in a reference portfolio in that currency and the rates from the relevant risk-free interest rate curve corresponding to that currency.

If they chose to apply the volatility adjustment, they must fulfil some conditions and disclose it: Their Solvency and Financial Condition Report must precise the application and quantify the effects of cancelling the volatility adjustment.

2.2.2.2 Matching adjustment

- Reference: article 49 to 51

Insurance and reinsurance institutions may, after authorisation, apply a matching adjustment to the relevant risk-free interest rate curve to calculate the best estimate of a portfolio. This measure is note compatible with the use of the Volatility adjustment nor the transitional measure on interest rates.

Between the qualifying criteria : "Insurance portfolios (…) must be subject to separate asset management arrangements from the rest of the institution and it must be possible to replicate liability flows using the interest rate products making up the asset portfolio" (*source ACPR website*)

2.2.2.3 Transitional measure

"The transitional measure concerning the relevant risk-free interest rate curve enables institutions to spread the impact on technical provisions of the change in interest rates from a calculation based on "Solvency I" standards to one based on "Solvency II" standards over 16 years". (*source ACPR website*)

2.3. SPREAD RISK SUB-MODULE: GENERAL

The spread risk sub-module concerns all assets, financial instruments and debt instruments which are directly sensitive to a credit spread. It excludes the indirect spread effect induced by counterparty risk, such as for an OTC derivative. There are three types of SCR Spread, which apply to:

- Bonds and loans (SCR_{BONDS} - see Articles 176 and 180). This covers government debt and corporate bonds and loans (excluding mortgage loans which are covered by the Counterparty Default Risk Module);
- Securitisations ($SCR_{SECURITISATION}$ - see Articles 178. This covers, in particular, ABS.
- Credit derivatives (SCR_{CD} - see Article 179). This covers, for example, CDS and structured products based on synthetic credit instruments.

The total SCR for the Spread Risk Sub-Module is given by

$$\mathrm{SCR}_{\mathrm{SPREAD}} = \mathrm{SCR}_{\mathrm{BONDS}} + \mathrm{SCR}_{\mathrm{CD}} + \mathrm{SCR}_{\mathrm{SECURITISATION}}$$

As all three quantities are only taken into account if they are positive, there can be no set off between, say, a bond and a CDS where the insurer is a protection buyer. However, under certain conditions, it is possible to set off the SCR spread for a bond against the SCR for its credit derivative hedge (see *Spread Risk Sub-Module: Derivatives*

Basically, the spread risk is made up of two elements:

- The credit quality, which is represented by a Credit Quality Step (CQS), which is equivalent to an aggregated rating class (a CQS of 0 amounts to a credit rating of AAA, of 1 to a credit rating of AA etc.). We will come back to the construction of the CQS later.
- The sensitivity of the instrument with respect to a shock on the credit spread:
  - For bonds, loans and notes, in general, the spread risk is a function of the spread duration, which is defined for each CQS. The function depends on the nature of the instrument, whether it is a government bond, corporate bond, covered bond or securitisation... For each security, the SCR Bond will take the form of :
    $$\mathrm{SCR}_{\mathrm{bonds}} = shock(nature, spread\ duration, CQS) \cdot PresentValue$$
    We have set out below the functions for the different categories.
  - For credit derivatives, it is the variation of the present value (PV) under certain upward and downward shocks, the size of which depend on the CQS. It is possible to set the SCR for certain derivatives off against each other (for example, long short CDS strategies). The shock which gives the maximum loss (after setoff) will apply.

At first glance, there seems to be a clear distinction between cash and synthetic debt. However, Credit Linked Notes (CLN) require particular attention. A CLN is, generally, a note issued by a bank or an SPV. The coupons and/or the capital take the risk under a synthetic credit derivative (on one or several entities). In this case, our interpretation is that:

- An SCR_{bonds} needs to be calculated in order to take into account spread of the issuer.
- An SCR_{cd} needs to be calculated in order to take into account the underlying credit derivative.

We have set out below some explanations about the CQS and the notion of spread duration.

2.3.1 Basic facts on Credit Quality Step (Articles 4 to 6)

The CQS of an asset is based on the second-best rating from 3 External Credit Assessment Institutions (ECAI) (or more). The choice of ECAI cannot be changed over the life of an instrument and must be the same for similar debts.

- If only one rating from an ECAI is available, this rating should be used. If only two ratings are available, the worst rating should be used.
- Securitisation positions with only one ECAI are considered to be unrated.

The correspondence between CQS and rating classes is as follows (samples from a few ECAIs for long term ratings):

CQS	0	1	2	3	4	5	6
Fitch	AAA	AA	A	BBB	BB	B	CCC, CC, C, RD, D
Moody's	Aaa	Aa	A	Baa	Ba	B	Caa, Ca, C
S&P	AAA	AA	A	BBB	BB	B	CCC, CC, C, D, SD/D, R

Table 2: CQS and rating classes correspondence (source EUR-Lex – OSTRUM)

The full mapping correspondence between credit quality steps and ECAI ratings has been adopted by the European commission under: Commission Implementing Regulation (EU) 2016/1800 of 11 October 2016[2]

2.3.2 Spread duration and embedded options

The spread duration represents the opposite of the derivative with respect to the spread of the price of the bond, divided by the (dirty) price of the bond. For a fixed rate bond, this quantity should not be materially different from the interest rate duration. If the bond has a floating rate, the spread duration is calculated by taking the forward value of each floating rate and considering that such rates are fixed. The interest rate duration can, in this case, be very different from the spread duration. The spread duration is expressed in years.

For the purpose of the SCR_{BONDS} calculation the spread duration is floored at 1.

For callable bonds, to our knowledge there are no explicit requirements as to how to calculate the duration. Even if it is possible to calculate the duration as at the next call date, it may be important to consider underlying Bermudian options to call the bond, implicitly sold by the investor to the issuer. This is particularly important for bonds with no maturity date (Tier 1) or bonds with a very long maturity (hybrid corporate bonds).

[2] See *Other European regulations and* implementing regulations applied for full reference.

2.4. SPREAD RISK SUB-MODULE: BONDS AND LOANS

For the Spread Risk sub-module for bonds and loans, there is a general case – basically for corporate senior-unsecured or subordinated debt – and several exceptions (government bonds, covered bonds, …).

2.4.1 General case (Article 176)

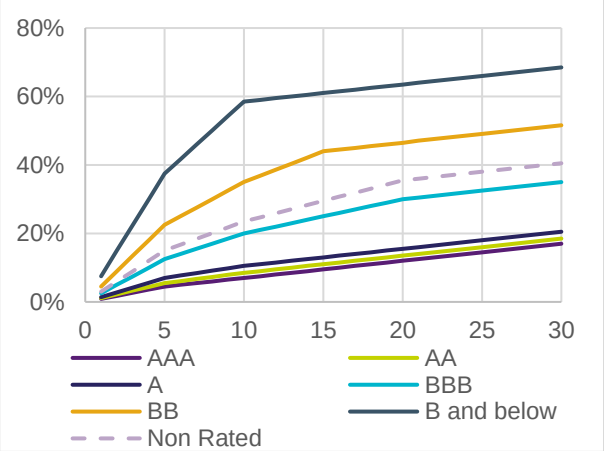


Figure 4: SCR_{BONDS} for corporate bonds a function of the spread duration (Source: Ostrum AM)

This case concerns corporate bonds and loans, other than those listed in the specific categories described below in sub-sections b) to e). In particular, it covers all bank or corporate bonds and loans (public or private), regardless of the subordination of the debt.

Figure 4 displays the evolution of the SCR_{BONDS} as a function of the spread duration (in years) and for the various CQS, represented by their equivalent rating class. These shocks are applied to the market value of the bond or loan.

It is important to note that the shock for non-rated instruments is only slightly above the BBB shock (CQS = 3), but well above the BB shock (CQS = 4). In other words, the BB shock is much larger than the shock for non-rated instruments.

Commission Delegated Regulation (EU) 2019/981[3] added the possibility of using internal rating when ECAI ratings are not available. Internal assessment of credit quality steps of bonds and loans, requirements and internal models are described in articles 176a to 176c.

2.4.2 Government bonds, central and development banks and local authorities (Article 180.2-3)

(i) Several bonds and loans are exempt from SCR_{BONDS}: bonds and loans of:

- The European Central Bank
- The central government and banks of Member States, issued in their own currency
- Certain multilateral development banks and international organizations

The exemption also *applies* to any bond or loan which is "fully, unconditionally and irrevocably guaranteed" by any of the above issuers.

Case study 1

In France, exposure to a *région*, *département* or *commune* is considered to be an exposure to the central government.

The same favourable treatment applies to certain local authorities located in the states listed above. The entities that benefit from this exemption are listed in the document EIOPA-Bos-15/119 and published under Commission Implementing Regulation (EU) 2015/2011[4].

[3] See *"solvency II" references*: for full reference.
[4] See *Other European regulations and* implementing regulations applied for full reference.

(ii) For the bonds and loans of central banks and states of countries which are not listed above (for instance, US or Japanese treasuries) and denominated in their own currency, specific shocks apply (Article 180.3). They are 0 for AAA and AA (CQS 0 and 1). The shocks for other CQS are displayed in *Figure 5*. We can see that, compared to corporate bonds, these shocks are much more favourable.

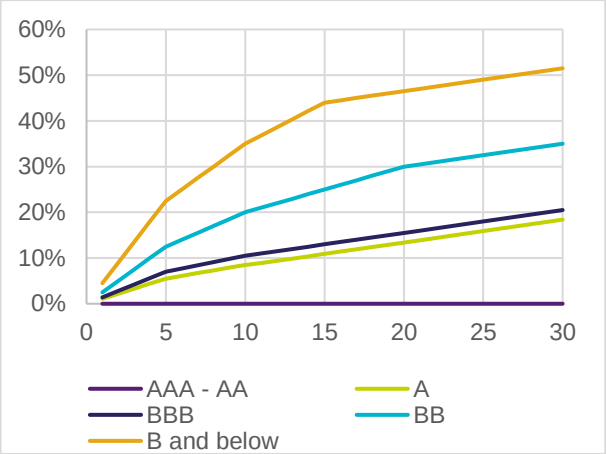


Figure 5: SCR_{BONDS} for non-European sovereign bonds as a function of the spread duration (Source: Ostrum AM)

For example, for a BBB with a spread duration of 10, the shock is 10.5% for this type of sovereign bond and 20% for a corporate bond (see *Figure 4*).

For ratings below BBB, the shocks for the sovereign bonds are equal to the shocks for a corporate with a CQS which is one notch more favourable: BB sovereign bonds are treated as if they were BBB corporate bonds, B and below sovereign bonds are treated as if they were BB corporate bonds.

All sovereign bonds with a CQS denominated in the local currency benefit from these more favourable shocks. The others (foreign currency or non-rated) are treated as corporate bonds.

2.4.3 Covered bonds (Article 180.1)

Covered bonds, which are dealt with in Article 180.1, are defined in the European Directive UCITS IV (N° 2009/65/EC). This Directive defines several conditions for a bond to qualify as a "covered bond". In particular, the covered bond must be issued by a credit institution which has its registered office in a Member State, in EURO, see examples below.

Covered bonds which are rated CQS 0 and 1 (AAA and AA) benefit from a favourable treatment.

Figure 6 illustrates the difference between the SCR_{BONDS} for covered bonds (continuous lines) and the SCR_{BONDS} for standard bonds (dotted lines), for AAA and AA rating classes.

The contribution to the SCR_{BONDS} of an AA covered bond is equivalent to the contribution of a AAA standard corporate bond.

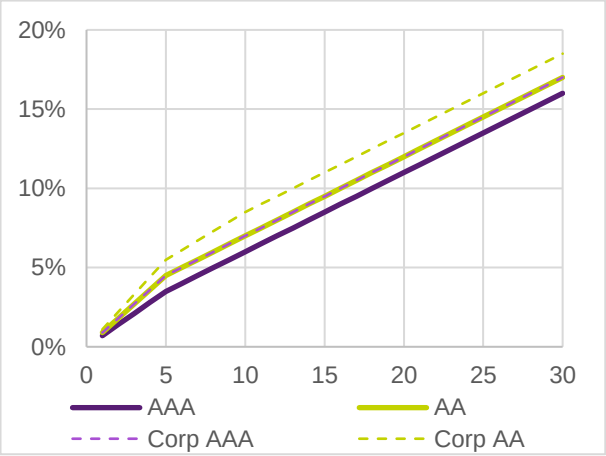


Figure 6- SCR_{BONDS} for AAA-AA standard and covered bonds, as a function of the spread duration (Source: Ostrum AM)

Case study 2

A bond from a French Agency (such as CADES) issued in EUR and guaranteed by the French Government does not attract an SCR spread. The same bond issued in CHF would have the same treatment as a corporate bond (see *Government bonds, central and development banks and local authorities (Article 180.2-3)*).

Case study 3

A covered bond issued by a US bank and denominated in EUR is not eligible for the reduced shock. A covered bond issued by a UK bank and denominated in EUR may benefit from the reduced shock, provided that the other conditions are fulfilled.

2.4.4 Non-rated collateralized bonds and loans

- Reference: Article 214 (collateral eligibility), 176.5 (shock reduction) and 197 Risk Adjusted Value of Collateral (RAVC).

For bonds or loans for which no credit assessment by a nominated ECAI is available (a non-rated bond), but which are collateralized, it is possible to decrease the amount of SCR_{BONDS}. In some circumstances, it is even possible to divide the classic SCR_{BONDS} by half.

The conditions for the collateral mechanism to be eligible are set out in Article 214 (together with Articles 209 and 210), most of which are very subjective. Some of the key points are summarized below:

- If a credit event occurs, the insurer can liquidate or retain the collateral
- The collateral has enough liquidity and a sufficient credit quality, and is stable in value
- It is guaranteed by a counterparty for which no risk factor for concentration applies (cf. *2.8*)
- There is no "material correlation" between the credit quality of the collateral and the credit quality of the counterparty

It is possible for a custodian to hold the collateral provided that certain criteria are met, as CQS minimum of 3.

If the collateral is deemed eligible, the reduction of the SCR_{BONDS} is calculated using a complicated formula given by article 176.5. The calculation is based on the Risk Adjusted Value of Collateral (RAVC). Depending on the RAVC, the SCR_{BONDS} may or may not be reduced. Let us consider the Market Value (MV) of the bond or loan and denote by "F^{up}" the shock corresponding to this bond or loan, without collateral, as a proportion of MV. Accordingly, we denote by "$F^{up}(collat)$" the shock corresponding to this bond or loan, with the collateral. There are three different situations:

- If RAVC ≥ MV, then the shock is divided by 2, i.e. $F^{up}(collat)=0.5\times F^{up}$
- If RAVC < MV × (1- F^{up}), then the shock is unchanged, $F^{up}(collat)= F^{up}$
- If RAVC < MV and RAVC ≥ MV × (1- F^{up}), then we calculate a new shock by linear combination between the two previous situations:

$$F^{up}(collat) = 0.5 \times F^{up} + 0.5 \times \frac{MV - RAVC}{MV}$$

In other words, we compare the value of the stressed collateral to the value of the bond or loan. If the valued of the stressed collateral is higher than the market value of the bond or loan, the impact on the SCR spread is very favourable.

Now, let us turn to the calculation of RAVC, as defined in Article 197. The RAVC is the difference between the Market Value of Collateral (MVC) and the Market Risk of Collateral (MRC)

$$RAVC = MVC - MRC$$

It is not clear in the Delegated Regulation whether the calculation of MRC is performed for a specific collateralized bond or loan or at an aggregated level (all collateralized bonds and loans). Our interpretation is that the calculation should be performed for each specific collateralized bond or loan. The MRC is the difference between:

- The theoretical SCR for Market Risk for the bond/loan without any collateral. This SCR is calculated by aggregating the various sub-modules using the correlation matrices.
- The theoretical SCR for Market Risk for the bond/loan with the collateral

The idea underlying this calculation is that the MRC must always be positive, because the collateral is intended to reduce the SCR. However, when the collateral is a real asset (aircraft, real estate etc.), and the risk on the collateral is significantly larger than the SCR for Market Risk that applies to the bond or loan, the direct application of this formula may result in a negative MRC, and therefore, a RAVC greater than MVC.

For example, let us consider the case of a floating rate loan collateralized by a real estate. We assume that "Loan to Value" (LTV) is smaller than one (value of the collateral larger than the value of the loan). The collateral is only affected to the Property risk sub-module, which is given by an instantaneous decrease of 25% in the value of the property. Therefore, the collateral induces a SCR for market risk which is significantly larger

than the SCR spread of the loan (the interest rate risk is not material for a floating rate note). Indeed, the SCR spread, for a duration of 5 years, would be 3%×5=15% of the value of the loan. Should the formula above apply, this would result in a negative MRC, and, therefore, a RAVC larger than the MVC, which is larger than the MV (because the LTV is smaller than 1). Hence, the strict application of the formula would always lead to a shock divided by 2. From our point of view, it seems more conservative to state that MRC = 25% × MVC (which is the risk of decrease of the collateral market value). This leads to RAVC = 75% × MVC.

This example could be extended by applying the Type 2 equity shock to the collateral, when it has no specific market shock (e.g. Aircraft debt). With this conservative approach, we see that the effect of the collateral on the spread risk depends on the LTV (increasing function of the LTV).

2.5. SPREAD RISK SUB-MODULE: INFRASTRUCTURE DEBT

- Reference: Articles 180.11, 180.12, 180.13

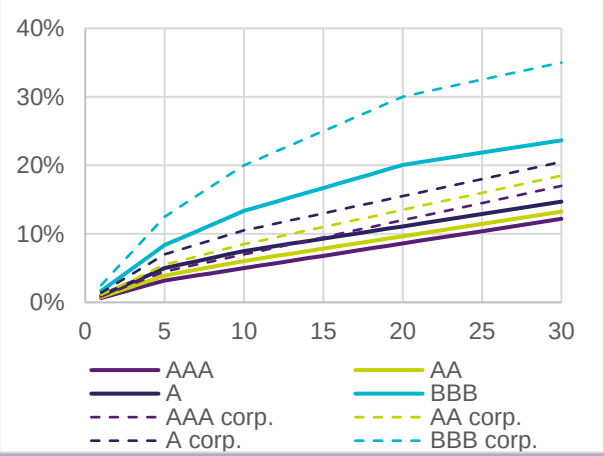


Figure 7: SCR_{BONDS} comparison between infrastructure and corporate bonds (Source: Ostrum AM)

Specific shocks for infrastructure debt apply since 2 April 2016 (see Commission Delegated Regulation (EU) 2016/467[5]).

Infrastructure debt benefits from reduced shocks of approximately 30% compared to corporate debt, if the underlying infrastructure project satisfies certain requirements. Among other conditions, the infrastructure and the debt instruments (bonds or loans) must meet the following criteria, which are included in Article 164.a:

- The infrastructure project is located in the European Economic Area (EEA) or the Organization for Economic Co-operation and Development (OECD)
- If no CQS is available, the bond is senior to all other claims. If no CQS is available, but the specific criteria are met, the bond is treated as if it has a CQS of 3 (BBB). Any instruments with a CQS of less than 3 (BBB) will not qualify.
- The bond holders are protected by a certain number of covenants concerning the use of the cash flows generated by the infrastructure.

[5] See *"solvency II" references*: for full reference.

2.6. SPREAD RISK SUB-MODULE: SECURITISATIONS

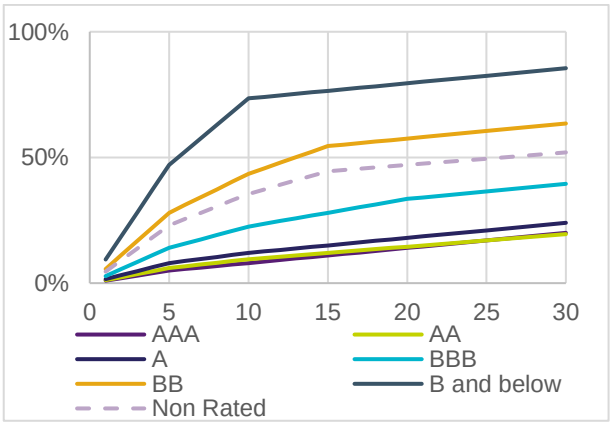
- Reference: Articles 178 “Spread risk on securitisation positions”

Regulation 2017/2402[6][7] lays down a general framework for securitisation and create a specific framework for simple, transparent and standardised securitisation, it applies since 1 January 2019[8].

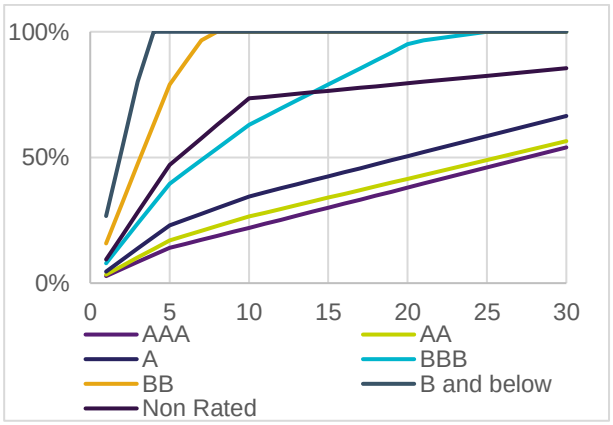
STS[9] Securitisations correspond to the less risky assets. An STS Securitisation qualify for differentiated capital treatment if it fulfils diversification criteria and / or risk weight criteria for the underlying exposures see Article 243 of Regulation (EU) No 575/2013[10].

The article 178 distinguish 7 categories:

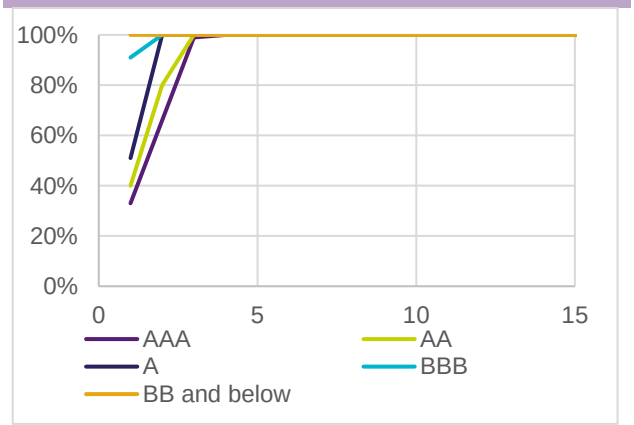
- Qualified Senior STS securitisations rated (178.3) and non-rated (178.5),
- Qualified Non-Senior STS securitisations rated (178.4) and non-rated (178.6),
- Rated re-securitisation (178.7)
- Rated securitisation not covered by 178.3 to 7 (178.8)
- Other securitisations (178.9) for which the stress factor is 100%.



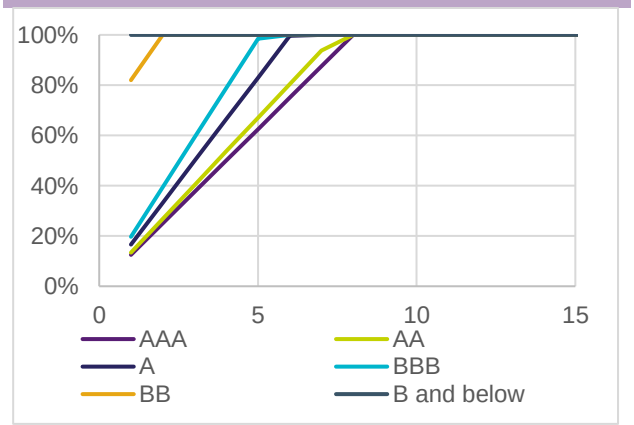
Qualified Senior STS (178.3-5)



Qualified Non-Senior STS (178.4-6)



Rated re-securitisation (178.7)



Other rated (178.8)

Figure 8: $SCR_{securitisation}$ (source Ostrum AM)

[6] More information on the European Commission position on securitisation on its portal : *https://ec.europa.eu/info/business-economy-euro/banking-and-finance/financial-markets/securities-markets/securitisation_en*
[7] See *Other European regulations and* implementing regulations applied for full reference.
[8] For Securitisations issued before 1/1/19 see appendix *Securitisation issued before 1/1/19*.
[9] STS stands for “Simple, Transparent, and Standardised” (Securitisations).
[10] See *Other European regulations and* implementing regulations applied for full reference.

2.7. SPREAD RISK SUB-MODULE: DERIVATIVES

- Reference: Article 179

2.7.1 Spread risk on credit derivatives

This part of the Spread Risk sub-module differs from the other parts because the shock is based on a difference of the present value (PV) under stressed and initial market conditions. The shock is the higher of the following:

- The loss of PV due to an increase in credit spreads, in absolute terms, and depending on the CQS of the underlying reference entity (in our view, the rating for the reference entity itself). The absolute shock in spreads is given in the following table

CQS	0 (AAA)	1 (AA)	2 (A)	3 (BBB)	4 (BB)	5 (B and below)	Non-rated
Shock (%)	1.3	1.5	2.6	4.5	8.4	16.2	5

Table 3: instantaneous increase in spread by CQS

- The loss of PV due to a decrease in credit spreads of the instruments underlying the credit derivative, in relative terms, equal to 75%, regardless of the CQS

When the underlying reference entity is one of the governmental entities which is exempted from SCR_{BONDS} (see section *2.4.2*), the shock for the derivative is equal to 0 (Article 180-9).

2.7.2 Hedging

> *Article 179.3: Credit derivatives which are part of the undertaking's risk mitigation policy shall not be subject to a capital requirement for spread risk, as long as the undertaking holds either the instruments underlying the credit derivative or another exposure with respect to which the basis risk between that exposure and the instruments underlying the credit derivative is not material in any circumstances.*

We assume that the credit derivative is used to hedge a risk (risk mitigation technique) on a specific investment. If there is no material basis risk between the initial exposure and the hedge, the credit derivative is not subject to Spread Risk. On this specific point (Article 179.3) it is not explicitly stated that we can also remove the Spread Risk for the instrument which is hedged. However, it would seem natural to do so. In the same way, there is no mention that such a hedge impacts the market risk concentrations sub-module. We will consider this question further in the section dedicated to this sub-module page *19*.

According to Article 209(3), the conditions to use risk mitigation techniques has been relaxed by the delegated act 2019/981 of March 2019[11] from the previous 'minimum 12 month' :

> *Where contractual arrangements governing the risk-mitigation techniques will be in force for a period shorter than the next 12 months and the insurance or reinsurance undertaking intends to replace that risk-mitigation technique at the time of its expiry with a similar arrangement or where that risk-mitigation technique is subject to an adjustment to reflect changes in the exposure that it covers, the risk-mitigation technique shall be fully taken[…]*
> *(h) the initial contractual maturity is not shorter than one month[…]*
> *(i) the initial contractual maturity is not shorter than three months[…]*

[11] See *"solvency II" references:* for full reference.

2.8. MARKET RISK CONCENTRATIONS SUB-MODULE

- Reference: (Articles 183 to 187)

This sub-module measures the exposure on direct investments (debt or equity), as opposed to indirect credit exposure through counterparty risk (e.g. on OTC derivatives).

It is different in nature from the other sub-modules, as it is based on non-linear calculations for each group of issuers. Contrary to the other sub-modules, a fund manager cannot only communicate the global figures for this sub-module at the level of a fund. The insurer must also have non-aggregated data on this sub-module at the level of each fund (average exposure, average rating…).

The expositions are calculated for different issuer groups. In our view, it seems natural to mix CDS and bond positions on the same issuer group, to allow risk mitigation. Although this is not clearly stated, Article 182.3 seems to indicate that this is acceptable.

The first step is to calculate the weighted average of the CQS among an issuer group. The weights are given by market value. The average CQS is rounded-up. Non-rated exposures are given an arbitrary CQS of 5.

There is no market risk concentration for government bonds for which the SCR_{bonds} component is 0, as described in Section 3-b) (i) (Article 187.3). For other government bonds, specific parameters apply, as set out below.

The market risk concentration for covered bonds, as described in section 3-c), is reduced (Article 187-1), as set out below. In the following, we consider each couple of issuer and level of guarantee (eligible covered or not).

Let us assume that the whole exposure of an issuer can be split into J issuer groups. For the couple (issuer, guarantee) number $j \in \{1, \cdots, J\}$, we have:

- The weighted average exposure to this issuer group and level of guarantee (“Ej”), and calculated as described above
- The weighted CQS of the issuer group and level of guarantee (“CQSj”)

The total value of all the assets covered by the market risk concentrations sub-module is denoted by A. The precise scope for the calculation of this quantity is described in Article 184.2. For fixed income assets, it excludes almost all the exposures covered by the counterparty risk sub-module. There are two mappings of the CQS, denoted by CT and g, which represent, respectively, the relative excess exposure threshold and a risk factor that magnifies the exposures on the worst CQS. They are given in the following table (except for the covered bonds described in Section 3-c):

CQS	0	1	2	3	4	5	6
CT	3%	3%	3%	1.5%	1.5%	1.5%	1.5%
g	12%	12%	21%	27%	73%	73%	73%

Table 4: relative excess exposure and risk factor by CQS

If the assets are covered bonds as described in Section 3-c), the threshold CT is equal to 15%.

If the assets are government bonds denominated in their local currency, as described in Section 3-b) (ii), the following mapping g shall be used (Article 187.4):

CQS	0	1	2	3	4	5	6
g	0%	0%	12%	21%	27%	73%	73%

Table 5: risk factor by CQS

The excess exposure threshold represents the exposure under which there is no concentration risk for an issuer and level of guarantee, given its weighted average CQS. It applies to the total value of assets, A. The capital requirement for the market risk concentrations sub-module is given by:

$$SCR_{conc} = \left[\sum_{j=1}^{J} g\left(CQS_j\right) \times max\left\{E_j - A \times CT\left(CQS_j\right); 0\right\}\right]^{\frac{1}{2}}$$

It is important to highlight that this formula is non-linear, as opposed to the interest rate or spread risk for bonds sub-modules. The aggregation for a given issuer group can be performed only at the level of the insurer and not at the level of the different funds held by this insurer. However, the exposures on the same issuer group are additive and the weighted CQS for the same issuer group can be compounded by weighting them by their exposures.

2.9. CURRENCY RISK SUB-MODULE

- Reference: Article 188

The currency risk sub-module is based on the reference currency of the insurer or domestic currency. For example, for an insurer based in the Euro Area, the Euro is the domestic currency. Every exposure to assets which only depend on the domestic currency does not contribute to this sub-module. Every other currency will be considered as a foreign currency, their FX rate will be represented against the domestic currency (number of units of the domestic currency for 1 unit of the foreign currency). The capital requirement is the sum over each currency of the larger of the following quantities:

- An instantaneous increase in the value the foreign currency against the domestic currency
- An instantaneous decrease in the value the foreign currency against the domestic currency

The increase and decrease are, respectively, 25% and -25%, of the current value of the FX rate.

There are exceptions for currencies pegged to the domestic currency: Article 188.5, implemented in Commission Implementing Regulation (EU) 2015/2017, for currencies[12] DKK, BGN, XOF, XAF and KMF pegged to Euro. The chock is reduced to 0.39% to 2% between EUR and a pegged currency and down to 2.24% to 4.04% between two pegged currencies. See Commission Implementing Regulation (EU) 2015/2017[13] for the comprehensive list of relative shocks.

The existence of an increase and a decrease captures the mitigation effect of products such as FX forward agreements or FX futures used to hedge assets in foreign currencies.

[12] See *Acronyms and Definitions* for Currencies full name
[13] See *Other European regulations and* implementing regulations applied for full reference.

2.10. EQUITY RISK SUB-MODULE

- Reference: Article 168 to 173

The equity risk sub-module is itself composed by 4 sub-modules: Equities Type 1, Type 2 and qualifying infrastructure equities and corporate equities. Type 2 is used as a fall-back category for all risks not explicitly covered by the Regulation. More precisely:

- Type 1 equities cover equities listed on regular markets of the EEA and OECD[14] or traded in the EU[15], are also considered as type 1 as described in Article 168.6:
  - equities held through specific collective investment vehicles social entrepreneurship or venture capital funds,
  - exceptions for funds where look-through is not possible
  - qualifying unlisted equity portfolio (article 168a): ordinary shares, head office in a country which is a member of the EEA, minimum balance sheet size, diversification conditions and beta of the portfolio limited…
- Type 2 equities cover:
  - Equities listed in countries not in the EEA and the OECD
  - Non-listed equities
  - Commodities and other alternative investments
  - All assets not covered in the other sub-modules (interest rate, property, spread), including those for which the look-through approach is impossible
- Qualifying infrastructure equities (article 164a):
- Qualifying infrastructure corporate equities[16] (article 164b)

The capital requirement for the equity sub-module, denoted by SCR_{equity}, is obtained by aggregating capital requirements

- for Type 1 equities (SCR_{E1}) on one hand,
- Type 2 equities (SCR_{E2}), qualifying infrastructure equities (SCR_{quinf}) and qualifying infrastructure equities (SCR_{quinfc}) on the other, with a correlation factor of 0.75:

$$SCR_{equity} = \sqrt{SCR_{E1}{}^2 + \left(SCR_{E2} + SCR_{quinf} + SCR_{quinfc}\right)^2 + 2 \times 0.75 \times SCR_{E1} \times \left(SCR_{E2} + SCR_{quinf} + SCR_{quinfc}\right)}$$

In the following, we only consider the standard equity risk sub-module (Article 169) and not the duration-based equity sub-module (Article 170), which is not relevant to fixed income instruments.

The equity risk sub-module is based on an instantaneous decrease of the value of the equity markets. The size of the decrease depends on the type of equity, it is composed by a fixed instantaneous decrease and a varying symmetric adjustment (SA).

Equity sub module	Standard choc	Strategic investment Long term Investment
Equity Type 1	39% + SA	22%
Equity Type 2	49% + SA	22%
Infrastructure Equity	30% + 77% x SA	22%
Infrastructure Corporate Equity	36% + 92% x SA	22%

Table 6: Equity shocks (article 169)

The Symmetric Adjustment (SA), sometimes mentioned as "Dampener" (article 172), varies between -10% and +10%. It takes into account the 36-month average of the equity markets, represented by the weighted

[14] See *Acronyms and Definitions* for EEA and OECD full name.
[15] Article 168.2: "or traded on multilateral trading facilities, as referred to in Article 4(1)(22) of Directive 2014/65/EU, whose registered office or head office is in EU Member States".
[16] Infrastructure corporates category was created "(…) *principally to remove the restriction to project financing via a single SPVs and making some amendments to the security package requirements. This is intended to allow "project like" corporates to qualify for the same treatment as projects (e.g. a 30 % risk charge for equity), where the risk is equivalent*". source: Final report on Consultation Paper no.16/004.

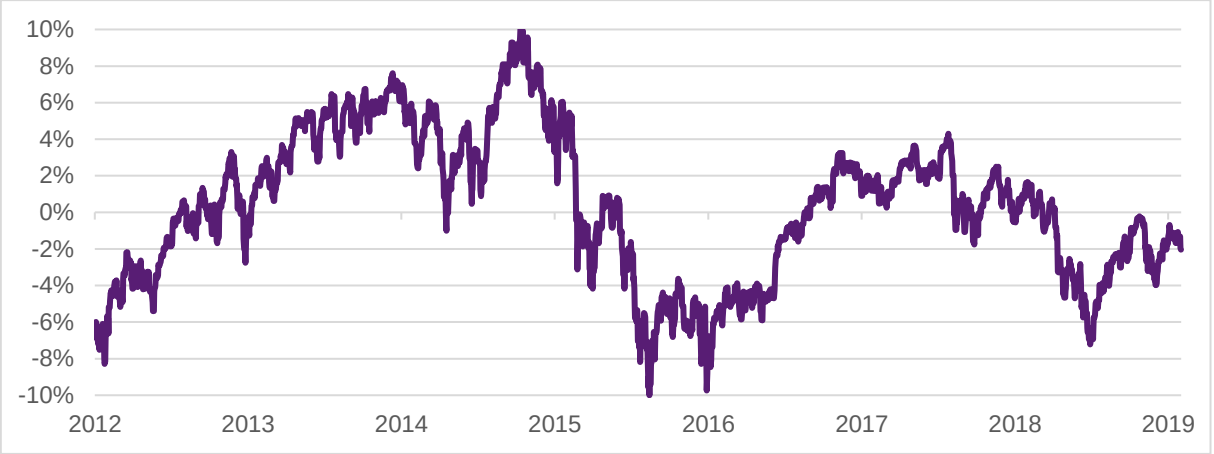


Figure 9: Symmetric adjustment to the equity capital charge
01/01/12 to 31/07/19, Source: EIOPA

average of a few indices (CAC 40, DAX, S&P 500, Nikkei 225 etc.). The list of indices and weights can be found in the Appendix *5.2*. The SA is published every month by EIOPA. However, it can also be calculated, if necessary on a daily basis...

As a transitional measure (article 173) a decrease of 22% is applied to Type 1 equities purchased on or before 1 January 2016.

Strategic investments must fulfil article 171 criteria such as existence of a clear decisive strategy to continue holding the participation for a long period. Long-term equity investments[17] must fulfil 8 conditions specified in article 171a, such as: portfolio assigned to cover one or several clearly identified insurance portfolios representing only a part of total liabilities, holding period at least 5 years...

The only fixed income assets for which equity risk is relevant are convertible bonds. Given the size of the equity shock, convertible bonds must be priced under stressed equity conditions in order to calculate the loss on the bond (as opposed to a delta-based method). For convertible bonds which are unlikely to be converted (where the price is therefore mainly driven by the spread risk), the impact of the equity shock is not material. These bonds are mainly affected by the spread sub-module and not the equity sub-module. For bonds which are likely to be converted, the impact of the equity shock has a substantial effect on the price. In this case, the main contribution to the SCR comes from the equity sub-module.

To our knowledge, no stress is applied to instruments such as futures on dividends.

[17] Created by Commission Delegated Regulation (EU) 2019/981 of 8 March 2019, see *"solvency II" references*: for full reference.

2.11. COUNTERPARTY DEFAULT RISK MODULE

- Reference: Article 189-202

2.11.1 Variance for Type 1 Exposures

As mentioned in the introduction, the scope of this paper is covered in the "Type 1" exposures of the counterparty default risk module:

- Risk mitigation contracts involving SPV and derivatives.
- Deposits from banks, that can be encountered, for instance, in money market funds

Some repo agreements proposed by banks, to remove from its balance sheet securitisation transactions, may fall in this module. A typical form is a repo by which the insurer lends, for a given period, good quality assets (government bonds) to obtain a pick-up on its return and receives securitisations as collateral.

The mechanism of the counterparty default risk of Type 1 exposures involves the following important features:

- The collateral is taken into account with a stress. This mechanism is the same as the one already seen in Section *2.4.4* (non-rated, collateralized bonds)
- The exposure is taken at the level of single name entities, in a way similar to the approach of the market risk concentrations sub-module (Section *2.8*).
- The probability of default of the counterparties, deduced from their CQS, and the probability of joint default of these counterparties are taken into account.

The variance V of the loss distribution of Type 1 exposures is split into V_{inter} and V_{intra}. These quantities are based on the whole set of single name exposures. Let us denote by N the number of different Type 1 single name exposures and M the number of different probabilities of default among these single name exposures (M is smaller than N). For any single name exposure, k $\in$[1, …, N}, we denote by L[k] its loss given default, and by P[k] its default probability. We define V_{inter} and V_{intra} as follows:

$$V_{inter} = \sum_{1 \le i,j \le M} TL_i TL_j \frac{P_i(1-P_i)P_j(1-P_j)}{1.25 \times (P_i + P_j) - P_i P_j}$$

$$V_{intra} = \sum_{1 \le j \le M} \frac{1.5 \times P_j(1-P_j)}{2.5 - P_i} \times \sum_{k=1}^{N} L[k]^2 \times \begin{cases} 0 \ if \ P[k] \neq P_j \\ 1 \ if \ P[k] = P_j \end{cases}$$

In this formula, TLi represents the sum of the loss-given default over single name exposures with default probability Pi, i $\in${1, …, M}. In our conventions, the set of the P_i, where i ranges from 1 to M, is exactly the set of the P[k], where k ranges from 1 to N. In the following, L will be the total loss-given default of the Type 1 exposures. The capital requirement is based on V = V_{inter} + V_{intra} through the following stratification of the variance (Article 200):

$$SCR_{def,1} = \begin{cases} 3\sqrt{V} & if \ \sqrt{V} \le 7\% \times L \\ 5\sqrt{V} & if \ 7\% \times L < \sqrt{V} \le 20\% \times L \\ L & if \ \sqrt{V} > 20\% \end{cases}$$

The capital requirement for counterparty default risk is then obtained by aggregation of Type 1 and Type 2 capital requirements, with a correlation of 0.75.

In order to apply the previous formulae, the form of the probabilities of default as well as the loss-given default should be clarified. This is dealt with in the following sub-sections.

2.11.2 Loss-Given Default (Article 192)

The loss-given default represents the amount of loss in case of default of the counterparty, mitigated by the collateral and the market effects of the default. We shall focus on derivatives (Article 192-3), which is the most important in the context of this note. The other cases concern reinsurance arrangements and mortgage loans which do not fall within the SCR Spread for securitisations.

The loss-given default is calculated at the level of a single name exposure as the sum of all loss-given default of derivatives related to this single name exposure.

The loss-given default for a derivative or a set of derivatives with the same bank and covered by the same collateral agreement is given by

$$LGD = max\{90\% \times (D + RM) - F \times C; 0\}$$

This equation uses the following variables:

- The value of the derivative(s), D
- The risk mitigating effect of the market risk of the derivative(s), RM (cf. Article 196). This adjustment takes into account the impact on the Market Risk SCR of a default of the counterparty. This is because, if the counterparty defaults, the derivative no longer acts as a risk mitigation instrument which can decrease the Market Risk SCR.
- The risk-adjusted value of the collateral, C (cf. *2.4.4*)

The constant F is chosen according to Article 197.7 and can be either 100% or 90%.

Example 4

Assume that an insurer invests in two funds, each of them holding OTC derivatives with the same bank (or entities of the same bank). Each fund has its own Credit Support Annex (CSA), which covers the counterparty risk for the derivatives, through collateral exchange. Our interpretation is that the loss-given default is calculated for each fund, using the level of collateral used in this fund, and aggregated in the total loss-given default for the single name exposure corresponding to the bank.

2.11.3 Default Probability (Article 199)

The default probability is calculated at the level of a single name entity as the average of the default probabilities on exposures to counterparties included in this single name exposure, weighted by the loss given default.

In the following, we only consider the case where the counterparty is a bank, which is the central case for OTC derivatives. In particular, we do not cover the case where the counterparty is an insurer or a reinsurer. If a CQS is available on a single name exposure, the following default probabilities P apply:

CQS	0	1	2	3	4	5	6
P	0.002%	0.01%	0.05%	0.24%	1.20%	4.20%	4.20%

Table 7: default probabilities by CQS class

Financial institutions without CQS – but which satisfy some restrictive solvency conditions (cf. references in Article 199.6) – are assigned a default probability of 0.5%.

Counterparties corresponding to the entities listed in Section 3.b.ii (ECB, EEA governments and central banks, development banks…) are assigned a probability of 0%.

A counterparty which does not fall into one the previous cases is assigned a probability of 4.2%.

3. PROFITABILITY UNDER SOLVENCY CAPITAL REQUIREMENT

For an insurer, the profitability of a debt instrument should take into account the SCR. Even if the impact of an instrument on the SCR should probably be analysed on an aggregate basis, it is possible to draw some conclusions as to the profitability of stand-alone debt instruments. The purpose of this section of the paper is to define the methods for determining the profitability of a stand-alone instrument and to illustrate how these methods behave when applied to certain classes of debt instruments.

3.1. RISK ADJUSTED RETURN ON CAPITAL

The idea is to consider that the internal rate of return of a given debt instrument is affected by the SCR that applies specifically to this instrument. Our approach is based on the following analogy, on the following fictitious instrument:

- The instrument is purchased by the investor at its market price plus a capital add-on (depending on the SCR, as discussed below).
- The investor receives the scheduled cash flows of the instruments of both capital and interest (for instance, calculated on a forward curve for floating rate notes)
- The investor receives the variation of the capital add-on induced by the reduction of the capital (in case of amortization) and of the duration (time decay on the spread risk module, for instance)
- At maturity, the investor receives the remainder of the capital add-on.

This approach is very similar to the concept of Risk Adjusted Return On Capital (RAROC), generally used by banks to determine the profitability of their investments.

As explained previously, the interest rate risk module has a specific role for the insurer. Therefore, we exclude the SCR for interest rate risk from this analysis. The capital add-on of the instrument is the sum (using the relevant correlation coefficients) of the SCR stemming from the other sub-modules Spread risk and Equity risk, for convertible bonds

In this approach, we exclude debt instruments in foreign currencies. The returns of these instruments are not known and would require more complex methods. However, if a bond in a foreign currency is hedged (forward or swap), we can calculate a return in the domestic currency and use the approach below with this return.

Let us consider a finite sequence of increasing dates (expressed in years) $(T_i)_{0\leq i\leq N}$, corresponding to the payments (capital and interest) under the debt instrument. The date $T_0 = 0$ is assumed to be the settlement date, where the instrument is purchased. The flow at time T_i , $1\leq i\leq N$, is denoted by $F_i > 0$, and includes both capital and interest. The buying price is $P_0 > 0$. The capital add-on at time T_i , $1\leq i\leq N$, is denoted by $S_i \geq 0$, and involves the sub-modules listed above. By convention, $S_N = 0$, meaning that there is no more add-on at maturity. The RAROC is defined by the rate R which solves

$$P_0 + S_0 = \sum_{i=1}^{N} \frac{F_i + (S_{i-1} - S_i)}{[1+R]^{T_i}}$$

If there is no capital add-on (for a government bond with no SCR spread, for instance), the RAROC is equal to the internal rate of return.

It is possible to use a simplified version of this formula. Assuming that y is the internal rate of return of the debt instrument, and that the capital add-on S is constant up to maturity T, we can define the RAROC as follows:

$$R = \left[\frac{(1+y)^T + S}{1+S}\right]^{\frac{1}{T}} - 1$$

This formula basically states that the capitalized income of the bond at maturity, i.e. $(1+y)^T$, and the capital add-on S, are considered as the outcome of an investment at cost 1+S, with maturity T.

A first-order development, for small values of S, provides

$$R = y - \frac{(1+y)}{T} \times \left[1 - \frac{1}{(1+y)^T}\right] \times S + o(S)$$

3.2. EXAMPLES ON BOND MARKETS

In order to illustrate the use of the RAROC for bonds, we calculated this quantity for a sample of EUR, fixed rate, corporate bonds (not including covered bonds) on 12 July 2019. We grouped the bonds by rating class, to get a clear view of the rating on the RAROC. We then looked at the quantity equal to RAROC/yield as a function of the spread duration. This represents the impact of the SCR on the RAROC. We can see in *Figure 10* that the rating class samples are clearly separated. Their general shape s decreases with the duration, even if there is certain dispersion around the general trend of each sample, especially for BBB-rated assets. This is due to the large scale of returns (y) in the BBB sample, ranging from 30bps to some 600bps, for spread durations around 5 years. The difference between the return and the RAROC is substantial for the BBB class: there is a decrease of more than 10% for a spread duration of 5 years.

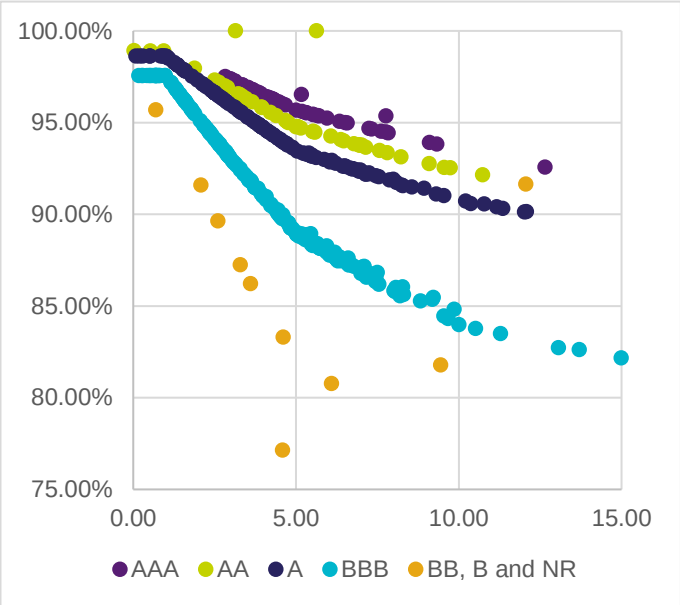


Figure 10: RAROC on return for a sample of corporate EUR bonds, as a function of the spread duration (Source: Ostrum AM, data as-of 12 July 2017)

The BBB class is the most highly represented in the sample and has a large dispersion. Roughly speaking, a lot of BBB and A rated assets have the same level of RAROC, whatever the spread duration. This is particularly evident in this period of tension in some sectors of the credit markets (utilities, energy and materials).

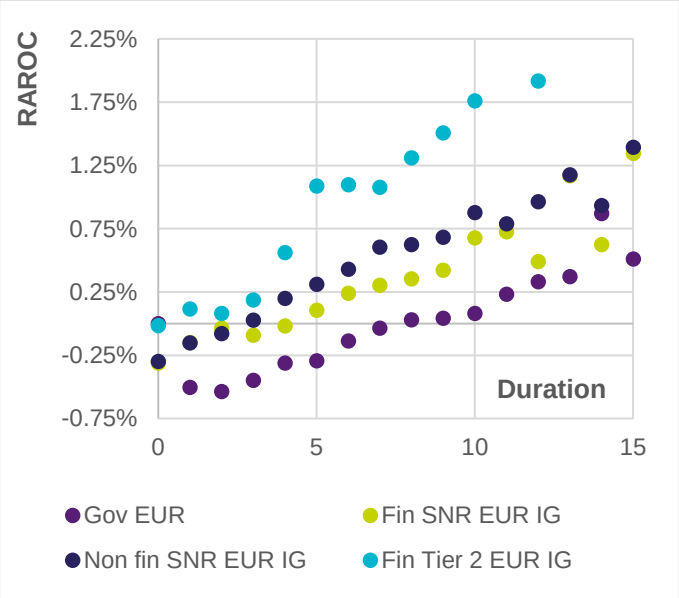


Figure 11: RAROC for several samples of bonds and securitisation, as a function of the spread duration (Source: Ostrum AM. Data as of 11 April 2016)

The RAROC can be also a useful way to analyse the profitability among various classes of assets. An example of this approach is displayed in *Figure 11*, where the RAROC of several types of assets are represented as functions of the spread duration: Eurozone sovereign bonds, senior unsecured corporate investment grade (IG) bonds financial and non-financial, Tier 2 IG corporate financial bonds in EUR. The RAROC is calculated on 12th July 2019. The samples are represented by their averages on every interval of duration of 1 year. We see a stratification of the categories: sovereign bonds under senior unsecured corporate bonds, and senior unsecured corporate bonds under Tier 2 bonds. This stratification tends to be consistent over time. However, the average on senior unsecured IG corporate bonds tends to limit the dispersion, and, therefore, the variability of this sample.

4. CONCLUSION

Under the Solvency II Capital Requirements for Fixed Income instruments, and in particular debt instruments, there are many treatments for very specific risks taken by the insurer: spread risk, market risk concentrations, etc. Some classes of debt instruments benefit from a more favourable spread risk capital requirement, such as infrastructure debt and, to a certain extent, collateralized non-rated bonds or loans. Other classes – particularly securitisation – are penalized.

Certain characteristics of debt instruments are not taken into account under Solvency II. For example, the seniority of the bond is only captured through the rating of the instrument. The treatment of other risks is not clearly described, such as call options embedded in subordinated bonds.

The capital requirement is only one aspect of an investment in a debt instrument. More important is the relationship between the capital requirement and the return, which gives the overall profitability. In this study, we suggest using the RAROC to measure the profitability, as it is a simple way of quantifying the trade-off between profitability and the cost of capital.

5. APPENDIX

5.1. RELATIVE UPWARD AND DOWNWARD SHOCKS

The part of the following table highlighted in grey is based on the linear interpolation of the shocks. The other part is given directly in Articles 165 and 166. These shocks are applied to the zero-coupon RFR curve.

Source: Delegated Regulation (EU) 2015/35[18] & Ostrum AM

Tenor (year)	Upward	Downward	Tenor (year)	Upward	Downward
1	70.0%	-75.0%	18	29.0%	-29.0%
2	70.0%	-65.0%	19	27.0%	-29.0%
3	64.0%	-56.0%	20	26.0%	-29.0%
4	59.0%	-50.0%	25	25.6%	-28.4%
5	55.0%	-46.0%	30	25.1%	-27.7%
6	52.0%	-42.0%	35	24.7%	-27.1%
7	49.0%	-39.0%	40	24.3%	-26.4%
8	47.0%	-36.0%	45	23.9%	-25.8%
9	44.0%	-33.0%	50	23.4%	-25.1%
10	42.0%	-31.0%	55	23.0%	-24.5%
11	39.0%	-30.0%	60	22.6%	-23.9%
12	37.0%	-29.0%	65	22.1%	-23.2%
13	35.0%	-28.0%	70	21.7%	-22.6%
14	34.0%	-28.0%	75	21.3%	-21.9%
15	33.0%	-27.0%	80	20.9%	-21.3%
16	31.0%	-28.0%	85	20.4%	-20.6%
17	30.0%	-28.0%	90	20.0%	-20.0%

Table 8: relative Upward and Downward Shocks

5.2. INDICES AND WEIGHTS FOR THE CONSTRUCTION OF THE SYMMETRIC ADJUSTMENT

Source : Implementing Regulation (EU) 2015/2016[19]

Equity indices	Weights
AEX	0.14
CAC 40	0.14
DAX	0.14
FTSE All-Share Index	0.14
FTSE MIB Index	0.08
IBEX 35	0.08
Nikkei 225	0.02
OMX Stockholm 30 Index	0.08
S&P 500	0.08
SMI	0.02
WIG30	0.08

Table 9: indices and weights for the construction of the symmetric adjustment

[18] See *"solvency II" references*: for full reference
[19] See *Other European regulations and* implementing regulations applied for full reference.

5.3. SECURITISATION ISSUED BEFORE 1/1/19

For securitisations issued before 1 January 2019, older version of the delegated act applies. Hereafter find out about the first version on the delegated act.

There are (were) two categories of securitisations: Type 1 and Type 2. A third approach, which is even more conservative, applies to re-securitisations.

5.3.1 Type 1 Securitisations

Type 1 securitisations correspond to the less risky assets. Even if the capital requirement is higher than the requirement for corporate bonds (for the same CQS), the capital requirement for Type 1 securitisations are still much lower than those that apply to Type 2 securitisations. This distinction between Type 1 and 2 has a major impact on the value of SCR_{sec}. Some of the key features that must be respected by a Type 1 securitisation include:

- The securitisation must have a CQS of 3 or less.
- It must be listed on a market located in the EEA or OECD, although it may also be listed on an organized trading venue which is sufficiently liquid and for which the infrastructure is sufficiently robust.
- It is the most senior tranche or one of the senior tranches if several tranches are pari passu. In our view, a tranche which is currently the most senior and will be so during the remaining life of the structure can be deemed to be the most senior, even if in the past this tranche was subordinated to another tranche which has been completely amortized.
- The notes are issued by a Special Purpose Entity and the note holders do not bear any risk on the seller of the note.
- The pool of underlying loans is homogeneous and of one of the following types:
  - Residential loans (with mortgages or collateral)
  - Commercial loans, leases and facilities to finance operations other than for the acquisition of commercial real estate, provided that at least 80% of the borrowers are small and medium size firms (80%)
  - Auto loans and leases
  - Loans to individuals for personal, family or household consumption purposes
- It is not a re-securitisation
- The pool does not include impaired obligors on the date of issue of the securitisation

Surprisingly, it seems that Collateralized Loans Obligations (CLO) of Senior Secured Loans are excluded from Type 1, but CLO of loans for small and medium sized firms are eligible. Commercial Real Estate securitisations are also excluded from Type 1.

The contribution to SCR_{sec} of a Type 1 securitisation, with a CQS c of {0,…,3}, is obtained by multiplying its market value by:

$$min\{b_1(c) \times max\{duration; 1\}; 1\}$$

Here, $duration$ represents the spread duration of the securitisation, as defined for bonds in Section 3-d, and b1 is equal to the value set out below for the relevant CQS:

CQS	0	1	2	3
b_1	2.1%	3%	3%	3%

Table 10: b_1 value by CQS

However, when a Type 1 securitisation is fully guaranteed by the European Investment Fund or the European Investment Bank, its contribution to SCRsec is 0, provided that the conditions on the guarantee, set out in Article 215, apply.

5.3.2 Type 2 Securitisations

A securitisation which is not Type 1 and which is not a re-securitisation is Type 2. The contribution to SCR_{sec} of a Type 2 securitisation, with a CQS c, is obtained by multiplying its market value by:

$$min\{b_2(c) \times max\{duration, 1\}; 1\}$$

Here, b2 is equal to the value set out below for the relevant CQS:

CQS	0	1	2	3	4	5	6	Non-rated
b_2	12.5%	13.4%	16.6%	19.7%	82%	100%	100%	100%

Table 11: b_2 value by CQS

5.4. TABLE OF ILLUSTRATIONS

5.5. ACRONYMS AND DEFINITIONS

BGN: Bulgarian lev (currency)
CF: Convergence Factor
CLN: Credit Linked Note
CHF: Swiss Franc (currency)
CRA: Credit Risk Adjustment
CQS: Credit Quality Step
DKK: Danish Krone (currency)
ECAI: External Credit Assessment Institutions
EIOPA: European Insurance and Occupational Pensions Authority
EEA: European Economic Area
EUR: Euro (currency)
KMF: Comoro franc (currency)
LGD: Loss Given Default
LLP: Last Liquid Point
OECD: Organisation for Economic Co-operation and Development
RAVC: Risk Adjusted Value of Collateral
RFR: Risk Free Rate
RAROC: Risk Adjusted Return on Capital
RAVC: Risk Adjusted Value of Collateral
SCR: Solvency Capital Requirement
SCR_{EQ}: SCR for Equities see *Equity Risk Sub-Module*
SCR_{IR}: SCR for Interest Rate see *Interest Rate Sub-Module*
SCR_{SPREAD}: SCR for Spread see *Spread Risk Sub-Module: General*
SCR_{PR}: SCR for Property, downward shock of 25%
SCR_{CONC}: SCR for Concentration see *Market Risk Concentrations Sub-Module*
SCR_{FX}: SCR for Currency see *Currency Risk Sub-Module*
SPV: Special Purpose Vehicle
STS: Simple, Transparent, and Standardised (applies to Securitisation
UFR: Ultimate Forward Rate
XOF: CFA franc BCEAO, West African CFA Franc (currency)
XAF: CFA franc BEAC, Central African CFA Franc (currency)

5.6. INDEX

5.7. REFERENCE

All the legislation documents can be found on the European regulation portal: Eur-lex:	https://eur-lex.europa.eu/
More information (such as risk-free rate curves, dampener calculation) can be found on the EIOPA website :	https://eiopa.europa.eu/

5.7.1 "solvency II" references:

The European Solvency II regulation is structured by two main documents:

- Directive 2009/138/EC: fixing objectives of the regulation
- Delegated Acts UE 2015/35 (CELEX:02015R0035) precise the rules and is updated frequently.

Detailed references:

- Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II):
  - CELEX:32009L0138
  - https://eur-lex.europa.eu/eli/dir/2009/138/oj
  - Consolidated directive 2009/138/EC : French and English version as end of January 2019 : http://data.europa.eu/eli/dir/2009/138/2019-01-13

- Commission Delegated Regulation (EU) 2015/35 of 10 October 2014 supplementing Directive 2009/138/EC of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II) Text with EEA relevance
  - CELEX:32015R0035
  - http://data.europa.eu/eli/reg_del/2015/35/oj
  - Latest consolidated version: January 2019 (does not include 2019/981 of 8 March 2019 amendment)
    - http://data.europa.eu/eli/reg_del/2015/35/2019-01-01
- Main modifiers to the 2015/35 delegated act:
  - "Infrastructure" amendment: Commission Delegated Regulation (EU) 2016/467 of 30 September 2015 (CELEX:32016R0467)
  - "Corporate Infrastructure" amendment: Commission Delegated Regulation (EU) 2017/1542 of 8 June 2017 (CELEX:32017R1542)
  - "STS Securitisations" amendment : Commission Delegated Regulation (EU) 2018/1221 of 1 June 2018 (CELEX: 32018R1221)
  - "1st SII review" amendment: Commission Delegated Regulation (EU) 2019/981 of 8 March 2019 (CELEX:32019R0981), not consolidated on EUR-Lex as of August 2019.
    - Long-term equity investment
    - Own rating assessment
    - …

5.7.2 Other European regulations and implementing regulations applied

5.7.2.1 Regulations

- Regulation (EU) 2015/2365 of the European Parliament and of the Council of 25 November 2015 on transparency of securities financing transactions and of reuse and amending Regulation (EU) No 648/2012 (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg/2015/2365/oj*
- Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012 (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg/2013/575/2019-06-27*
- Regulation (EU) 2015/2365 of the European Parliament and of the Council of 25 November 2015 on transparency of securities financing transactions and of reuse and amending Regulation (EU) No 648/2012 (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg/2015/2365/oj*

5.7.2.2 Implementing regulations

- Commission Implementing Regulation (EU) 2015/2011 of 11 November 2015 laying down implementing technical standards with regard to the lists of regional governments and local authorities, exposures to whom are to be treated as exposures to the central government in accordance with Directive 2009/138/EC of the European Parliament and of the Council (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg_impl/2015/2011/oj*
- Commission Implementing Regulation (EU) 2015/2016 of 11 November 2015 laying down the implementing technical standards with regard to the equity index for the symmetric adjustment of the standard equity capital charge in accordance with Directive 2009/138/EC of the European Parliament and of the Council (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg_impl/2015/2016/oj*
- Commission Implementing Regulation (EU) 2015/2017 of 11 November 2015 laying down implementing technical standards with regard to the adjusted factors to calculate the capital requirement for currency risk for currencies pegged to the euro in accordance with Directive 2009/138/EC of the European Parliament and of the Council (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg_impl/2015/2017/oj*
- Commission Implementing Regulation (EU) 2016/1800 of 11 October 2016 laying down implementing technical standards with regard to the allocation of credit assessments of external credit assessment institutions to an objective scale of credit quality steps in accordance with Directive 2009/138/EC of the European Parliament and of the Council (Text with EEA relevance)
  - *http://data.europa.eu/eli/reg_impl/2016/1800/2018-05-15*

5.7.3 EIOPA – Solvency II main technical information

- Risk-Free interest rate term structures
  - *https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii-technical-information/risk-free-interest-rate-term-structures*
  - Technical documentation of the methodology to derive EIOPA's risk-free interest rate term structures : *EIOPA-BoS-15/035* (document regularly updated)
- Symmetric adjustment of the equity capital charge
  - *https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii-technical-information/symmetric-adjustment-of-the-equity-capital-charge*

This document is intended for professional clients in accordance with MIFID. It may not be used for any purpose other than that for which it was conceived and may not be copied, distributed or communicated to third parties, in part or in whole, without the prior written authorization of Ostrum Asset Management.

None of the information contained in this document should be interpreted as having any contractual value. This document is produced purely for the purposes of providing indicative information.

This document consists of a presentation created and prepared by Ostrum Asset Management based on sources it considers to be reliable. Ostrum Asset Management reserves the right to modify the information presented in this document at any time without notice, and in particular anything relating to the description of the investment process, which under no circumstances constitutes a commitment from Ostrum Asset Management.

Ostrum Asset Management will not be held responsible for any decision taken or not taken on the basis of the information contained in this document, nor in the use that a third party might make of the information.

Figures mentioned refer to previous years. Past performance does not guarantee future results. Any reference to a ranking, a rating or an award provides no guarantee for future performance and is not constant over time. Reference to a ranking and/or an award does not indicate the future performance of the UCITS/AIF or the fund manager.

Under Ostrum Asset Management's social responsibility policy, and in accordance with the treaties signed by the French government, the funds directly managed by Ostrum Asset Management do not invest in any company that manufactures, sells or stocks anti-personnel mines and cluster bombs.

This material has been provided for information purposes only to investment service providers or other Professional Clients, Qualified or Institutional Investors and, when required by local regulation, only at their written request. This material must not be used with Retail Investors.

In the E.U. (outside of the UK and France): Provided by Natixis Investment Managers S.A. or one of its branch offices listed below. Natixis Investment Managers S.A. is a Luxembourg management company that is authorized by the Commission de Surveillance du Secteur Financier and is incorporated under Luxembourg laws and registered under n. B 115843. Registered office of Natixis Investment Managers S.A.: 2, rue Jean Monnet, L-2180 Luxembourg, Grand Duchy of Luxembourg. Italy: Natixis Investment Managers S.A., Succursale Italiana (Bank of Italy Register of Italian Asset Management Companies no 23458.3). Registered office: Via San Clemente 1, 20122 Milan, Italy. Germany: Natixis Investment Managers S.A., Zweigniederlassung Deutschland (Registration number: HRB 88541). Registered office: Im Trutz Frankfurt 55, Westend Carrée, 7. Floor, Frankfurt am Main 60322, Germany. Netherlands: Natixis Investment Managers, Nederlands (Registration number 50774670). Registered office: Stadsplateau 7, 3521AZ Utrecht, the Netherlands. Sweden: Natixis Investment Managers, Nordics Filial (Registration number 516405-9601 - Swedish Companies Registration Office). Registered office: Kungsgatan 48 5tr, Stockholm 111 35, Sweden. Spain: Natixis Investment Managers, Sucursal en España. Serrano n°90, 6th Floor, 28006, Madrid, Spain. **In France:** Provided by Natixis Investment Managers International – a portfolio management company authorized by the Autorité des Marchés Financiers (French Financial Markets Authority - AMF) under no. GP 90-009, and a public limited company (société anonyme) registered in the Paris Trade and Companies Register under no. 329 450 738. Registered office: 43 avenue Pierre Mendès France, 75013 Paris. **In Switzerland:** Provided for information purposes only by Natixis Investment Managers, Switzerland Sàrl, Rue du Vieux Collège 10, 1204 Geneva, Switzerland or its representative office in Zurich, Schweizergasse 6, 8001 Zürich. **In the British Isles:** Provided by Natixis Investment Managers UK Limited which is authorised and regulated by the UK Financial Conduct Authority (register no. 190258) - registered office: Natixis Investment Managers UK Limited, One Carter Lane, London, EC4V 5ER. When permitted, the distribution of this material is intended to be made to persons as described as follows: in the United Kingdom: this material is intended to be communicated to and/or directed at investment professionals and professional investors only; in Ireland: this material is intended to be communicated to and/or directed at professional investors only; in Guernsey: this material is intended to be communicated to and/or directed at only financial services providers which hold a license from the Guernsey Financial Services Commission; in Jersey: this material is intended to be

communicated to and/or directed at professional investors only; in the Isle of Man: this material is intended to be communicated to and/or directed at only financial services providers which hold a license from the Isle of Man Financial Services Authority or insurers authorised under section 8 of the Insurance Act 2008. **In the DIFC**: Provided in and from the DIFC financial district by Natixis Investment Managers Middle East (DIFC Branch) which is regulated by the DFSA. Related financial products or services are only available to persons who have sufficient financial experience and understanding to participate in financial markets within the DIFC, and qualify as Professional Clients or Market Counterparties as defined by the DFSA. No other Person should act upon this material. Registered office: Office 603 - Level 6, Currency House Tower 2, PO Box 118257, DIFC, Dubai, United Arab Emirates. **In Japan:** Provided by Natixis Investment Managers Japan Co., Ltd., Registration No.: Director-General of the Kanto Local Financial Bureau (kinsho) No. 425. Content of Business: The Company conducts discretionary asset management business and investment advisory and agency business as a Financial Instruments Business Operator. Registered address: 1-4-5, Roppongi, Minato-ku, Tokyo. **In Taiwan:** Provided by Natixis Investment Managers Securities Investment Consulting (Taipei) Co., Ltd., a Securities Investment Consulting Enterprise regulated by the Financial Supervisory Commission of the R.O.C. Registered address: 34F., No. 68, Sec. 5, Zhongxiao East Road, Xinyi Dist., Taipei City 11065, Taiwan (R.O.C.), license number 2018 FSC SICE No. 024, Tel. +886 2 8789 2788. **In Singapore:** Provided by Natixis Investment Managers Singapore (name registration no. 53102724D) to distributors and institutional investors for informational purposes only. Natixis Investment Managers Singapore is a division of Ostrum Asset Management Asia Limited (company registration no. 199801044D). Registered address of Natixis Investment Managers Singapore: 5 Shenton Way, #22-05 UIC Building, Singapore 068808. **In Hong Kong:** Provided by Natixis Investment Managers Hong Kong Limited to institutional/ corporate professional investors only. **In Australia:** Provided by Natixis Investment Managers Australia Pty Limited (ABN 60 088 786 289) (AFSL No. 246830) and is intended for the general information of financial advisers and wholesale clients only . **In New Zealand:** This document is intended for the general information of New Zealand wholesale investors only and does not constitute financial advice. This is not a regulated offer for the purposes of the Financial Markets Conduct Act 2013 (FMCA) and is only available to New Zealand investors who have certified that they meet the requirements in the FMCA for wholesale investors. Natixis Investment Managers Australia Pty Limited is not a registered financial service provider in New Zealand. **In Latin America:** Provided by Natixis Investment Managers S.A. **In Uruguay:** Provided by Natixis Investment Managers Uruguay S.A., a duly registered investment advisor, authorised and supervised by the Central Bank of Uruguay. Office: San Lucar 1491, oficina 102B, Montevideo, Uruguay, CP 11500. The sale or offer of any units of a fund qualifies as a private placement pursuant to section 2 of Uruguayan law 18,627. **In Colombia:** Provided by Natixis Investment Managers S.A. Oficina de Representación (Colombia) to professional clients for informational purposes only as permitted under Decree 2555 of 2010. Any products, services or investments referred to herein are rendered exclusively outside of Colombia. This material does not constitute a public offering in Colombia and is addressed to less than 100 specifically identified investors. **In Mexico** Provided by Natixis IM Mexico, S. de R.L. de C.V., which is not a regulated financial entity, securities intermediary, or an investment manager in terms of the Mexican Securities Market Law (Ley del Mercado de Valores) and is not registered with the Comisión Nacional Bancaria y de Valores (CNBV) or any other Mexican authority. Any products, services or investments referred to herein that require authorization or license are rendered exclusively outside of Mexico. While shares of certain ETFs may be listed in the Sistema Internacional de Cotizaciones (SIC), such listing does not represent a public offering of securities in Mexico, and therefore the accuracy of this information has not been confirmed by the CNBV. Natixis Investment Managers is an entity organized under the laws of France and is not authorized by or registered with the CNBV or any other Mexican authority. Any reference contained herein to “Investment Managers” is made to Natixis Investment Managers and/or any of its investment management subsidiaries, which are also not authorized by or registered with the CNBV or any other Mexican authority.

The above referenced entities are business development units of Natixis Investment Managers, the holding company of a diverse line-up of specialised investment management and distribution entities worldwide. The investment management subsidiaries of Natixis Investment Managers conduct any regulated activities only in and from the jurisdictions in which they are licensed or authorized. Their services and the products they manage are not available to all investors in all jurisdictions. It is the responsibility of each investment service provider to ensure that the offering or sale of fund shares or third party investment services to its clients complies with the relevant national law.

The provision of this material and/or reference to specific securities, sectors, or markets within this material does not constitute investment advice, or a recommendation or an offer to buy or to sell any security, or an offer of any regulated financial activity. Investors should consider the investment objectives, risks and expenses of any investment carefully before investing. The analyses, opinions, and certain of the investment themes and processes referenced herein represent the views of the portfolio manager(s) as of the date

indicated. These, as well as the portfolio holdings and characteristics shown, are subject to change. There can be no assurance that developments will transpire as may be forecasted in this material. Past performance information presented is not indicative of future performance.

Although Natixis Investment Managers believes the information provided in this material to be reliable, including that from third party sources, it does not guarantee the accuracy, adequacy, or completeness of such information. This material may not be distributed, published, or reproduced, in whole or in part.

All amounts shown are expressed in USD unless otherwise indicated.

https//www.ostrum.com

Ostrum Asset Management

Asset management company regulated by AMF under n° GP-18000014 – Limited company with a share capital of 27 772 359 euros – Trade register n°525 192 753 Paris – VAT: FR 93 525 192 753 – Registered Office: 43, avenue Pierre Mendès-France, 75013 Paris – www.ostrum.com

Ostrum ASSET MANAGEMENT

An affiliate of: NATIXIS INVESTMENT MANAGERS