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Solvency II for Real Asset Debt

Specificities of Real-Asset Debt under Solvency II

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This document deals with a specific class of Fixed-Income instruments: real asset debt. These debts show features which account for a specific calculation of the Solvency Capital Requirement (SCR) under Solvency II. This paper specifically deals with:

- Real estate debt
- Aircraft debt
- Infrastructure debt

These three categories share some common features. First, they represent debt instruments issued to finance the acquisition and the construction (if any), the operation of a specific asset (or pool of assets), generally by a Special Purpose Vehicle (SPV) or some equivalent structure. The operation of the asset generally provides the income used to pay, first, debt holders and, then, equity holders. The SPV do not, in general, issue other debt instruments. The first two categories (real estate and aircraft debt) are based on assets for which there exists a secondary market, and this should be taken into account in risk analysis of these categories. The third is based on a wide range of assets (power plant, rail, road, school, hospital…) so there is no specific secondary market.

Under certain conditions, specific calculation for the Spread Risk Sub-Module (SCR spread) may be applied to real asset debt: reduced shocks for infrastructure debt, mitigating effect of the collateral for real estate and aircraft debt… Thus, the present document mainly focuses on this sub-module and the various specificities set out for infrastructure and real asset debt in general.

The reduction of SCR spread for real asset debt is a consequence of the following specificities:

- Reduced shock for infrastructure debt: reduction by some 30% of the corporate shocks for rated notes, and by more than 40% for non-rated.
- Mitigation due to the collateral for non-rated collateralized bonds and loans. It represents a potential maximal reduction of 50% of the SCR spread. This mitigation is particularly useful for real estate debt, where the collateral has a specific shock defined according to the property risk sub-module.
- For aircraft secured debt, where no specific treatment has been defined despite the quality of the collateral, the mitigation shall arise through debt rating, which may be improved, compared to airline corporate rating, thanks to the recovery provided by the aircraft.

This document does not intend to be a comprehensive study of the standard formula for the SCR. A general overview of the standard formula – with a focus on fixed income markets - is available in "Solvency II Capital Requirements for Debt Instruments" [1].

After describing the Solvency II specificities, we investigate the profitability of these investments, compared to classic debt instruments (sovereign, corporate senior unsecured and subordinated…). For this purpose, we consider several profitability measures that we adapt to take into account the SCR spread of the investment. These measures can be assimilated to a Risk Adjusted Return On Capital (RAROC) and enjoy several suitable features to measure the profitability of Fixed Income Investment. First, the RAROC is relatively homogeneous among samples of similar debt instruments. Second, it takes into account the maturity of the instrument, the structure of historical default probability and the recovery rate. Moreover, simplified RAROC formulae are available.

Real asset debt tends to have higher RAROC than senior unsecured or subordinated debt. Three main reasons account for this improved profitability:

- Reduced SCR
- Higher expected recovery rates (due to the underlying real asset, the associated securities and the covenants)
- Limited liquidity of real asset debt, which induces higher margins.

The first section of this document provides a survey of the main feature of the standard formula for real asset debt. In particular, it displays examples for the categories of real asset debt listed above. The second section studies the measures of profitability of real asset debt under Solvency II Capital Requirement.

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I – Spread Risk Sub-Module and Specificities of Real Asset Debt

1. Generality on the Market Risk Module

The debt instruments are mainly concerned by the following sub-modules of the Market Risk Module:

- Interest rate risk: SCR_{IR},
- Spread risk: SCR_{SPREAD},
- Market risk concentrations: SCR_{CONC},
- Currency risk: SCR_{FX}.

The definition of the SCRs can be found in *Directive 2009/138/EC*, known as "Solvency II", and *Delegated Regulation (EU) 2015/35*, known as "Level 2". The reader can also refer to *[1]* for an overview.

When no FX rate is involved, the spread risk sub-module is generally the more significant for real-asset debt. Indeed, most of these instruments have floating rates coupons. This feature reduces the influence of the interest rate sub-module. For real estate notes in EUR, however, the existence of a floor at 0 on the underlying floating rate (Euribor 3M, for instance) tends to increase the sensitivity with respect to the interest rates, due to the current level of interest rates. Thus, the notes may behave like a fixed rate bond, as long as the forward rates remain below or close to 0. Nonetheless, the specificities concerning real asset debt are mainly involved in the spread risk and market risk concentration sub-module:

- The spread risk may be reduced (compared to corporate debt) under certain conditions,
- The market risk concentration is generally less meaningful than for a corporate debt instrument:
  - First of all, real asset debt is collateralized and, therefore, has a specific treatment under Solvency II. The threshold over which the exposure is taken into account is larger than for non-collateralized debts.
  - Moreover, these instruments are generally issued through SPVs and do not bear credit default risk from a specific corporate entity. Aircraft loans may represent an exception. In our opinion, it is not clear that the investor do not bear any exposure to the underlying airline, which is the lessee in the aircraft lease contract with the SPV.

Next sub-section provides further details on the spread risk sub-module for real-asset debt.

2. Spread risk sub-module for real asset debt

The SCR spread is the sum of 3 non-negative quantities:

- SCR spread for bonds and loans, denoted by SCR_{bonds}
- SCR spread for derivatives (CDS, CLN…), denoted by SCR_{cd}
- SCR spread Securitizations, denoted by SCR_{sec}

In our context, it is possible to restrict the framework to the first case, i.e. $SCR_{SPREAD} = SCR_{bonds}$.

The quantity SCR_{bonds}, for a given debt instrument, is based on the following elements:

- The Credit Quality Score (CQS) of the debt (basically, the second best rating of the instrument). A CQS of 0 represents the best credit notation (AAA), and the credit quality decreases as the CQS increases.
- The spread duration. In order to avoid ambiguity, we define the spread duration as the opposite of the derivative of the instrument price with respect to the credit spread (over risk-free rate), divided by the (dirty) price of the instrument. It is measured in years.

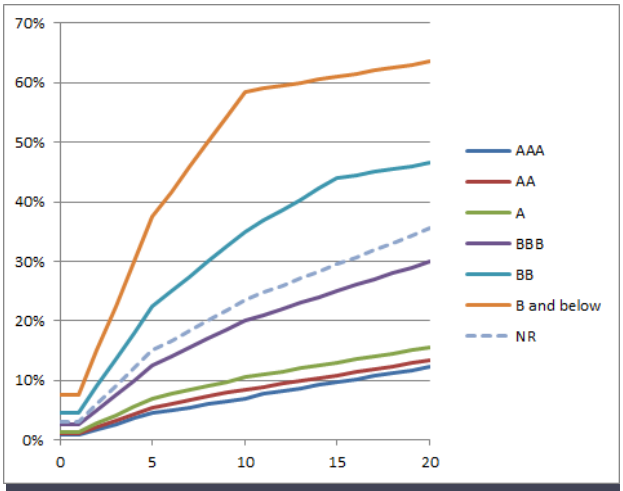

Figure 1: SCR_{SPREAD} for corporate bonds a function of the spread duration (Source: Natixis AM)

The quantity SCR_{bonds} is obtained as a function of the CQS and the spread duration, which is non-decreasing in both variables, and piecewise affine. An example is displayed in *Figure 1*, for standard corporate debt. Two specific cases are particularly important, for real-asset debt :

- Non rated, Collateralized bonds and loans Eligible infrastructure debt

a. Non-rated Collateralized Bonds and Loans

For bonds or loans for which no credit assessment by a nominated ECAI (a non-rated bond) is available, 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} in half.

The conditions for the collateral mechanism to be eligible include the following points:

- If a credit event occurs, the insurer can liquidate or retain the collateral
- The collateral has a sufficient 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. [1])
- 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.

If the collateral is deemed eligible, the reduction of the SCR_{bonds} is calculated using a complicated formula. 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 of the bond or loan (MV) 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:

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

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). In this context, it may be more interesting to deal with rated notes.

b. Infrastructure debt

Specific shocks for infrastructure debt apply since 2 April 2016 (see *Commission Delegated Regulation (EU) 2016/467*). A similar preferable treatment applies to infrastructure equity as well. It captures the fact that there are tangible assets, underlying these instruments, which accounts for less uncertainty on the future cash-flows and higher recovery rates in case of default.

Infrastructure debt benefits from reduced shocks of approximately 30% compared to corporate debt, of same CQS, if the underlying infrastructure project satisfies certain requirements. For debt without CQS the shock is reduced by some 44% from the corporate debt without CQS. 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.

If not eligible, the infrastructure debt is treated as standard corporate debt.

Figure 2 displays a comparison between the SCR spread for infrastructure (solid lines) and corporate bonds (dotted lines), for various ratings. In particular, we see that the SCR spread for corporate debt with rating AAA is larger than the shock for infrastructure debt with rating A.

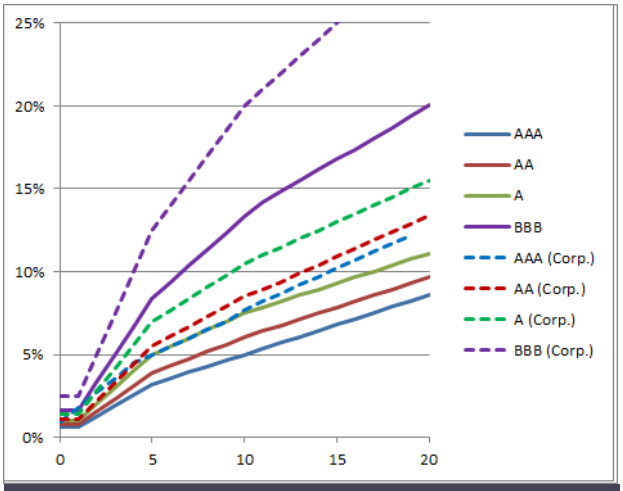

Figure 2: SCR spread comparison between infrastructure and corporate bonds (Source: Natixis AM)

II – 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 analyzed 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. First, we investigate some classic measures of profitability (without any SCR consideration). Then, we show that these measures can be adapted to involve the SCR. This shall lead to the definition of the RAROC to measure profitability under SCR.

1. Some standard measures of profitability

Let us consider a generic debt instrument, in domestic currency. Its pays at time T_i , $1 \le i \le n$, a flow of interest F_i , based on a nominal N_i. It also pays the amortizing nominal, i.e. $N_{i-1} - N_i$, with the convention $N_0 = N_1$. At maturity, the outstanding nominal N_n is redeemed. Let us denote by P(0) the current (dirty, ask) price of the instrument. In order to simplify the notations, we will assume that this price is paid at the current date, and not at the settlement date (or accordingly that the profitability is measured from the settlement date). The dates T_i are assumed to be represented in years from the as-of (or settlement) date.

As we are not mainly interested in interest rate risk in this note, we shall not set out whether F_i is based on a floating or fixed rate. In case of floating rate, a natural convention consists in taking the forward values of the flows.

a. Internal Rate of Return

A standard approach to define the profitability consists in looking at the internal rate of return (IRR). It is defined as the real number y, which solves the following equation:

$$P(0) = \sum_{i=1}^{n} [N_i \times F_i + (N_{i-1} - N_i)] \times e^{-y \times T_i} + N_n \times e^{-y \times T_n} \qquad (A)$$

The IRR is defined with the convention that it is a continuous (annualized) rate, which will be less cumbersome than actuarial rates when we will need to provide a breakdown of this rate into several components.

The IRR is the return that the investor can achieve provided that it is possible, at each payment date, to reinvest the flows at the same rate. This rather unrealistic assumption should be kept in mind when defining the profitability of an investment. Some of these ex ante measures cannot be realized ex post, as soon as there are intermediary flows, if the market conditions change.

b. Z-spread

Going one step further, it is generally interesting to measure the profitability of an investment, compared to a given reference rate (government rate or inter-banking rate). Let us consider such a risk-free reference curve and denote by B(0,T) its current zero-coupon price at time 0 with maturity T. It can be represented as follows:

$$B(0,T) = e^{-\int_0^T r(s)ds}$$

In this last equation, the mapping r represents the reference zero-coupon rate, at time 0. We can define the Z-spread as the number z to be added to the reference zero-coupon rate, in order to obtain the current price, i.e.

$$P(0) = \sum_{i=1}^{n}[N_i \times F_i + (N_{i-1} - N_i)] \times e^{-\int_0^{T_i} r(s)ds - z \times T_i} + N_n \times e^{-\int_0^{T_n} r(s)ds - z \times T_n} \quad \text{(B)}$$

As the reference curve involve a term-structure (i.e. r may not be constant over maturity), it may be complex to compare the notion of IRR given in (A) to the Z-spread. As a limit case, if the bond is a zero-coupon, its IRR should be equal to the forward rate plus the Z-spread (the forward rate is the average of r over time up to maturity).

Moreover, the Z-spread is particularly adapted when dealing with floating rate notes.

c. Default Adjusted Spread

A refinement consists in taking into account a probability of default of this investment. This probability may be some historical probability stemming from the rating of the structure or from an estimation of the default over the corresponding class of debt instruments.

At this stage, we need to set out two elements:

- The survival probability P(0,T), at 0, up to time T. As in the case of the zero-coupon rate, it is possible to write

$$P(0,T) = e^{-\int_0^T \lambda(s)ds}$$

  In this case, λ represents the default intensity at time 0.

- The recovery rate ρ (applied to the outstanding nominal amount), which is constant and in [0,1[. We insist on the fact that we rule out recoveries equal to 1 for numerical and formal reasons. The recovery is assumed to be paid at time of default (no delay).

As the default can occur at any time between 0 and T_n, we need to define the present value of the recovery paid at time of default. In order to simplify the framework, let us assume that the recovery can be paid only at the end of the first payment period after default.

The Default Adjusted Spread is the quantity to be added to the default intensity in order to obtain the current price. It is given by the quantity η which solves

$$P(0) = \sum_{i=1}^{n}[N_i \times F_i + (N_{i-1} - N_i)] \times e^{-\int_0^{T_i}[r(s)+\lambda(s)+\eta]ds} + N_n \times e^{-\int_0^{T_n}[r(s)+\lambda(s)+\eta]ds}$$

$$+\rho \times \sum_{i=1}^{n} N_i \times B(0,T_i) \times \left[e^{-\int_0^{T_{i-1}}[\lambda(s)+\eta]ds} - e^{-\int_0^{T_i}[\lambda(s)+\eta]ds}\right] \quad \text{(C)}$$

The last term in (C) represents the expected present value of the recovery, paid in case of default. In this term, each zero-coupon at time T_i is weighted by the probability that the default occurs between T_{i-1} and T_i, with an intensity equal to λ+η.

A positive Default Adjusted Spread represents a price cheaper than the price expected for this level of default risk, whereas a negative Default Adjusted Spread represents a price more expensive than the price expected for this level of default risk. From a practical point of view, this mismatch can be explained by other factors such as liquidity.

When ρ=0, Equation (C) is very similar to equation (B), where we have replaced r by r + λ. It could be possible to add the recovery term is Equation (B). In this case, the Z-spread would become an implied

constant default intensity associated to recovery R. We have not chosen this option, which is quite unusual in the context of Fixed Income Markets.

We can see from Equation (C) that the discount of the cash flows in the first line is made at a rate equal to r + λ+η. This provides a breakdown of the discount rate implied from the price into three parts:

- Reference (risk-free) discount rate
- Historical default probability
- Default Adjusted Spread

2. *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 in Part I, the interest rate risk module has a specific role for the insurer. Therefore, we exclude the SCR for interest rate risk from our 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
- Equity risk, for convertible bonds

In this approach, we do not take into account the SCR for currency risk, induced by debt instruments in foreign currencies. The returns of these instruments are not known. 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.

The capital add-on at time T_i , $1 \le i \le n$, is denoted by $S_i \ge 0$, and involves the sub-modules listed above. In order to deal with simpler notation, we shall set $\Delta S_i = S_{i-1} - S_i$, and $\Delta N_i = N_{i-1} - N_i$.

We can decline each of Equations (A) to (C) in order to adapt them to the analogy introduced in this section. For instance, Equation (A) would become

$$P(0) + S(0) = \sum_{i=1}^{n} [N_i \times F_i + \Delta N_i + \Delta S_i] \times e^{-R \times T_i} + (N_n + S_n) \times e^{-R \times T_n} \qquad (A')$$

In this case, the number R is the RAROC, expressed as a continuous (exponential) rate. It is a measure of profitability comparable to the IRR, but taking into account the SCR.

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

It is possible to use a simplified version of this formula. Assuming that y is IRR of the debt instrument, as given by Equation (A), and that the capital add-on S is constant up to maturity T, we can define the approximation of the RAROC as follows:

$$R := \ln\left[\frac{e^{yT}+S}{1+S}\right]\times\frac{1}{T}$$

This formula basically states that the capitalized income of the bond at maturity, i.e. e^{yT}, 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[1]

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

The term in S is negative as soon as the IRR y is positive. Now, let us turn to a definition of the RAROC taking into account the default probability. Let us adjust Equation (C) as follows:

$$P(0) = \sum_{i=1}^{n}[N_i\times F_i + \Delta N_i + \Delta S_i]\times e^{-\int_0^{T_i}[r(s)+\lambda(s)+E]ds} + (N_n+S_n)\times e^{-\int_0^{T_n}[r(s)+\lambda(s)+E]ds}$$

$$+\rho\times\sum_{i=1}^{n}(N_i+S_i)\times B(0,T_i)\times\left[e^{-\int_0^{T_{i-1}}[\lambda(s)+E]ds} - e^{-\int_0^{T_i}[\lambda(s)+E]ds}\right] \qquad (C')$$

The number E represents a RAROC taking into account the default probability. As above, with Equation (A'), we can propose a simplified formula:

$$E := ln\left[\frac{P(0,T)\times e^{yT}+\rho\times(1-P(0,T))+S}{1+S}\right]\times\frac{1}{T}$$

In the expression of E, we observe that in the numerator, the SCR Add-on S is not weighted by the survival probability, because it is redeemed in any case at maturity (default or not).

$$E = ln\left[P(0,T)\times e^{yT}+\rho\times\left(1-P(0,T)\right)\right] + \left[\frac{1}{P(0,T)e^{yT}+\rho\times(1-P(0,T))}-1\right]\frac{1}{T}\times S + o(S)$$

Contrary to R, the term in S in the development of E can be positive, even if y is negative. This depends on the survival probability and on the recovery. It can be observed that, for S=0 and ρ=0, the return is simply the IRR minus the average default intensity, i.e. $y-\frac{1}{T}\int_0^T\lambda(s)ds$.

3. *Comparisons to 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 28 June 2016, with and without default probability (respectively, the quantities R and E, defined above).

We split our sample of bonds into 4 sub-samples:

- Corporate and Financial, investment grade (IG), senior unsecured bonds
- Corporate and Financial, BB, senior unsecured bonds
- Banking subordinated (Tier 2) bonds
- Eurozone sovereign bonds

[1] The symbol o(S) denotes a quantity equal to S times a function of S which tends to 0 as S tends to 0.

We compute an average RAROC by bucket of duration (1 year) on each sub-sample.

We also compute the RAROC for 2 real-asset debt classes, represented by a theoretical debt instrument:

- Real estate debt, assuming a LTV smaller than 75% and no rating
- Eligible, non-rated infrastructure debt,

We also provide a comparison for the Aircraft loans is USD, for A and BBB ratings. The corresponding bond sample will be:

- Corporate and Financial, investment grade (IG), senior unsecured bonds, in USD, from by USA issuers
- Corporate and Financial, BB, senior unsecured bonds
- T-notes

In this case, we do not include the SCR for currency risk. Adding this quantity to the SCR (25%) would translate the RAROC of all these instruments downward, but would not change the relative value analysis.

The RAROC without probability of default (R), is given, for EUR instruments, in *Figure 3*. In this case, the real-asset classes show, mainly, larger RAROC than IG corporate bonds and sovereign bonds. The RAROC levels for BB and Tier 2 bonds are larger, which is coherent with the underlying risk of these assets. *Figure 3* shows a clear stratification between the various sub-samples of bonds used in this example. When dealing with RAROC integrating default probability (E), the various asset classes tend to mix, as shown in *Figure 4*. The real-asset debts show levels of RAROC equivalent to those of BB and Tier 2 bonds. The levels of return underlying the RAROC in Figures 3 and 4, as well as Figure 5 and 6 below, do not reflect executable prices. Moreover, for real asset debt, a part of the pick-up of profitability can be explained by a reduced liquidity. For these reasons, these examples should be considered as a measure of ex-ante profitability and not the levels of returns achieved ex-post by the investor.

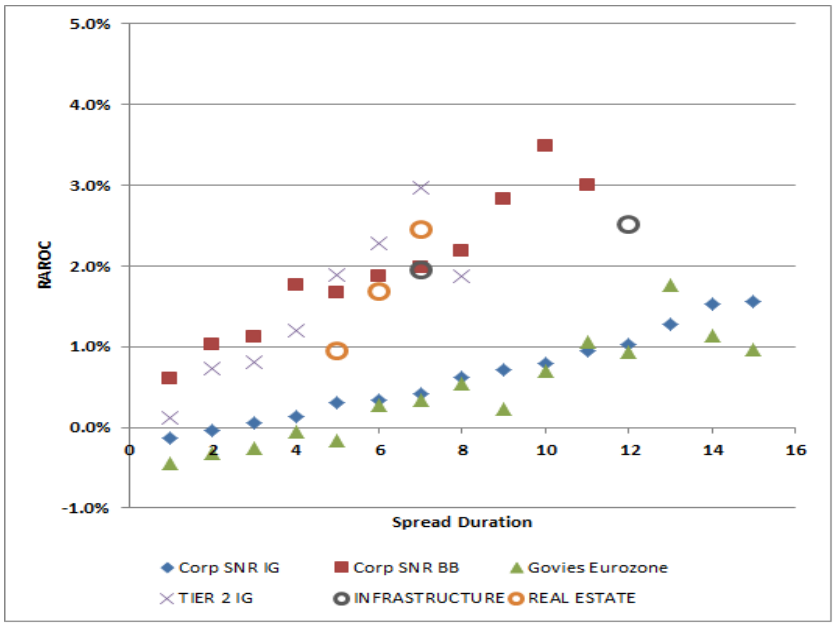

Figure 3: RAROC without default probability (R) for various samples of EUR bonds and theoretical real-asset debt. (Source: NAM. As-of: 09/09/2016)

For corporate bonds, the default probabilities used in the numerical application are the Standard's & Poor default probability, based on rating and maturity. The recovery is set at 40% for the senior bonds and at 20% for the subordinated bonds, which is a standard assumption for CDS. No default probability is applied to the government bonds.

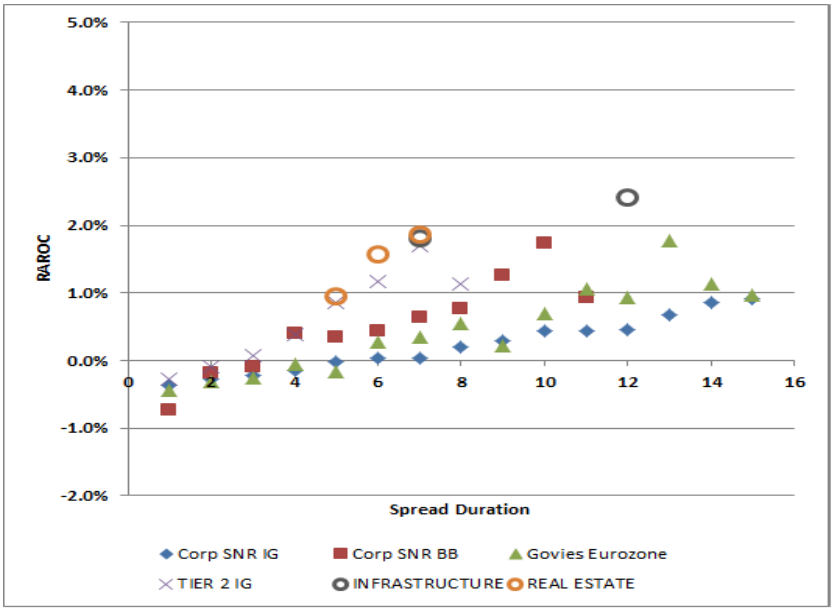

Figure 4: RAROC with default probability (E) for various samples of EUR bonds and theoretical real-asset debt. (Source: NAM. As-of: 09/09/2016)

For infrastructure debt the recovery and default probability stem from the Moody's Investor Service study of March 2016 [2].

For aircraft loans, we consider Standard & Poor's corporate default probabilities, according to the rating, with a recovery of 80%.

The integration of default probability has a different effect on real-asset and on Tier 2 debt. The former are collateralized and, hence, have a larger expected recovery than the latter. It explains why the RAROC of real asset debt is relatively less sensitive to the integration of default probabilities. It can be noticed that the sovereign debts are not affected by this change of methodology: we do not apply default probability on sovereign debt.

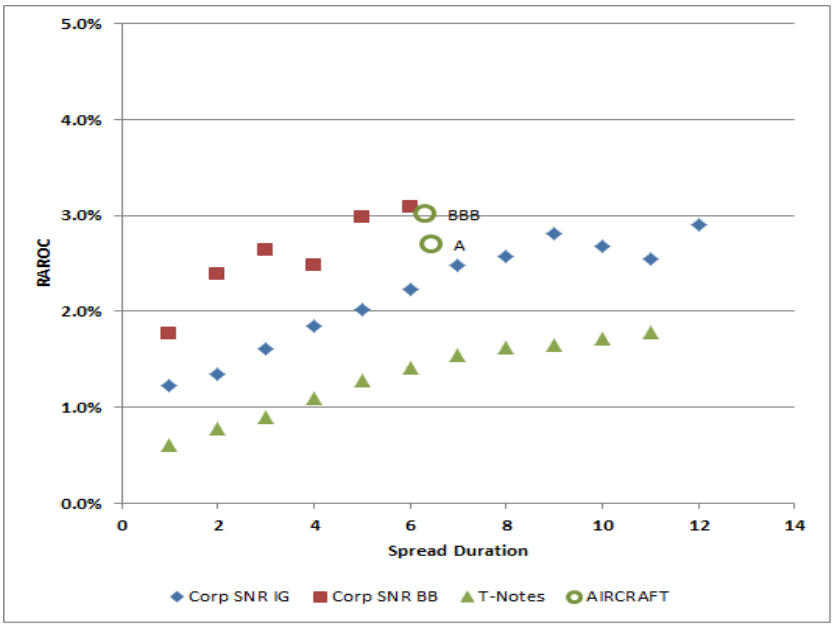

Figure 5: RAROC without default probability (R) for various samples of USD bonds and theoretical aircraft debt. (Source: NAM. As-of: 09/09/2016)

The integration of default in the RAROC formula gives rise to a different meaning for this formula. In this framework, it represents the additional default intensity to be added to the historical one, in order to match the price, given a level of SCR. If the RAROC is positive (respectively, negative), it means that the debt instrument is cheap (respectively, expensive), when compared to the historical levels of default.

The conclusions are similar in *Figure 5* and *6*, corresponding, respectively, to the case without default and with default, for the aircraft and USD debt instruments. We recall that we do not integrate the SCR for currency risk in the analysis. As already pointed out, the mechanism for non-rated collateralized bonds fails to reduce the SCR spread for standard levels of LTV. This is why we consider rated aircraft loans, with A and BBB ratings.

In the USD case, the segmentation is more glaring than in the EUR case. In particular, the government bonds are given by the T-notes and not a sample of bonds issued by various Eurozone countries.

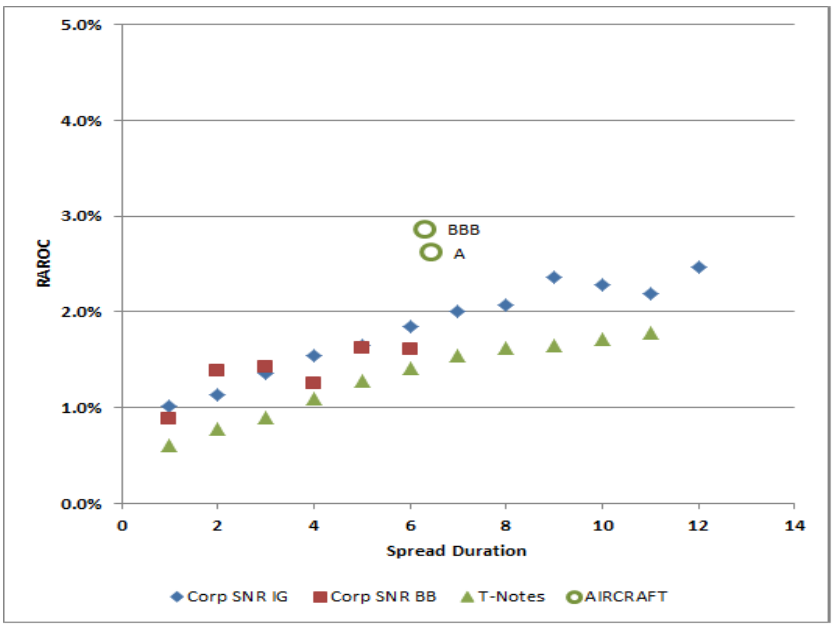

Figure 6: RAROC with default probability (E) for various samples of USD bonds and theoretical aircraft debt. (Source: NAM. As-of: 09/09/2016)

III – Conclusion

Real-asset debts show specific features under Solvency II. A significant reduction of the SCR spread can be obtained, under some specific eligibility conditions. This reduced shock reflects the underlying nature of these assets: they are mainly collateralized debt instruments, with a wide range of collateral (real estate, infrastructure, aircraft…).

In order to measure the profitability of these investments under Solvency II, we propose to use a notion of RAROC. This notion can be formulated either:

- To measure the profitability, given the level of SCR
- To measure the implied level of risk over the historical probability of default, given the level of SCR.

The latter formulation reveals the interest of the collateralized nature of the real-asset debt, because it takes into account the level of recovery of the underlying debt instrument.

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