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Solvency II long-term guarantee measures

Solvency II long-term guarantee measures are aimed at reducing the effect of artificial volatility for long-term insurance products. In this article, the effectiveness of long-term guarantee measures, in particular the volatility adjustment (VA), will be analysed. First, we replicate the VA over the past crisis periods and test its effectiveness for an average insurance undertaking. We find that, despite the mitigating impact of the VA, spread movements still cause a significant volatility of own funds. Furthermore, we critically analyse the composition of the euro VA reference portfolio. Finally, the illiquidity premium of equity investments and mortgage loans is discussed[1].

1. Volatility adjustment replication and impact

This chapter presents a replication of the volatility adjustment (VA) and provides a backtest of the VA impact on a Solvency II balance sheet. EIOPA has published values for the basic risk-free interest rate curve and the volatility adjustment since year-end 2014. Section 1.1. will explain how the values for the volatility adjustment were replicated during the years 2005 up to 2017. In section 1.2. the Solvency II balance sheet and SCR ratio of an average European insurer will be calculated over the past years. This backtest will include the effects of spread movements during the financial crisis of year-end 2008 and the sovereign crisis of year-end 2011. The final aim of this chapter is to analyse the effectiveness of the Solvency II volatility adjustment.

1.1. Volatility adjustment replication

The Solvency II volatility adjustment (VA) is an addition to the basic risk-free interest rate term structure used to discount insurance liabilities. It is based on the spread between the interest rate that could be earned from assets included in a reference portfolio and the rates of the basic risk-free interest rate term structure. The volatility adjustment for a given currency is calculated as:

$$VA_{crncy} = 65\% * \{w_{gov} * [max(S_{gov}, 0) - max(RC_{gov}, 0)] + w_{corp} * [max(S_{corp}, 0) - max(RC_{corp}, 0)]\} \quad (1)$$

Where the following notation is used:

- W_{gov} and W_{corp} are the part of government bonds resp. bonds other than government bonds, loans and securitisations included in the euro reference portfolio
- S_{gov} and S_{corp} (before risk correction) are the spread on government bonds resp. bonds other than government bonds, loans and securitisations included in the euro reference portfolio
- RC_{gov} and RC_{corp} are the risk corrections corresponding to the portion of the spread S_{gov} resp. S_{corp} that are attributable to the expected losses, unexpected credit risk or any other risk.

Figure 1 presents our replication of the euro currency VA. In this replication exercise, the portfolio weights W_{gov} and W_{corp} are based on the euro currency reference portfolio of 2016-2017, published by

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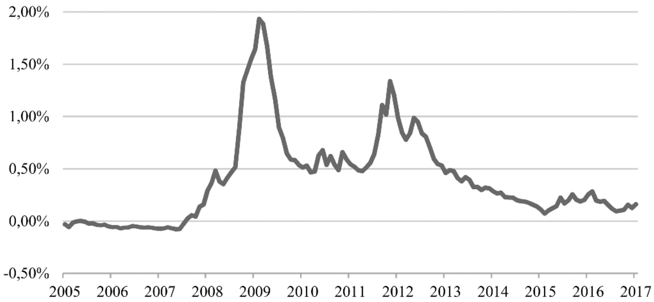
EIOPA. Our VA calculations fully replicate the methodology presented in the EIOPA technical documentation. We obtain the exact same levels of the VA as published by EIOPA during 2016-2017.

Figure 1: euro currency volatility adjustment



1.2. Volatility adjustment impact

The aim of the VA is to reduce the effect of artificial volatility of own funds for long-term insurance products. In this section, we will test how volatile the own funds of an average insurance undertaking may be, with and without the effect of the VA. Our approach is to replicate the Solvency II balance sheet and SCR ratio for an average insurance undertaking, based on the following assumptions:

– the insurance undertaking invests solely in bonds, with portfolio weights based on the euro VA reference portfolio of 2016-2017;
– assets are matched with technical provisions of the same duration;
– the market data used for the valuation of assets is based on the same indices used as an input for the VA calculations by EIOPA;
– assets and technical provisions are valued as zero coupon bonds that are rolled over each month.

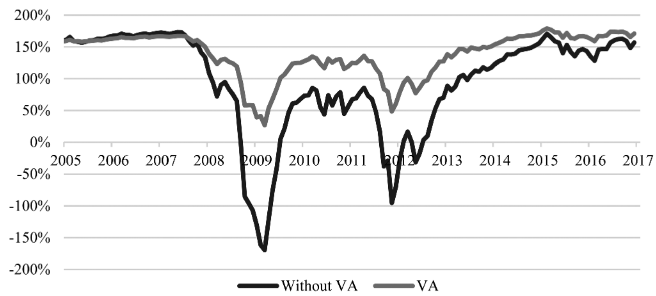
This method, albeit simple, has many advantages:

– the valuation method for assets and technical provisions replicates the VA calculation method;
– the duration of assets and technical provisions of the insurer remains constant over time;
– there is no asset-liability mismatch;
– there are no assumptions needed for new business, profit sharing, dividend payments…;
– changes in the SCR ratio over time are solely due to movements in spreads. Hence, results only show the impact of interest rate movements and are not influenced by other variables such as realized mortality or expenses.

Figure 2 presents the SCR ratio of an average insurer, with and without the VA over the years 2005-2017. The detrimental effect of the financial crisis at year-end 2008 and the sovereign debt crisis at year-end 2011 is clearly reflected in the SCR ratio without volatility adjustment. The very low SCR ratios observed during 2008-2009 and 2011-2012 are caused by the steep increases in spreads at that time.

The SCR ratios for an average insurer, displayed in figure 2, become more stable due to the mitigating effect of the volatility adjustment. As an example, during March 2009, the SCR ratio increases from -162% without VA, to 39% when the volatility adjustment is applied. Nevertheless, at an SCR ratio of 39%, supervisors are still likely to demand severe recovery actions from the insurance undertaking. Thus, a significant volatility of the SCR ratio remains, despite the use of the VA.

Figure 2: SCR ratio for a modelled insurer with and without VA



It can be questioned whether the remaining volatility in the SCR ratio, when the VA is applied, is reflective of the true risks to which an insurance undertaking is exposed. If an insurance undertaking has sufficiently predictable liabilities (*e.g.* lapses are predictable, market value adjustment can be reasonably applied etc.), the insurance undertaking will not be exposed to temporary movements in illiquidity spreads if those predictable liabilities are matched with assets of the same duration. Indeed, if assets and liabilities are matched properly, the insurance undertaking will be able to hold its bonds and loans until maturity, and thus will only be exposed to the risk of default of assets. In this case, the insurance undertaking is not exposed to intermediary spread movements. Therefore, the SCR ratio including VA, as displayed in figure 2, is likely too volatile for an insurance undertaking with sufficiently predictable liabilities and matched assets.

Finally, it should be noted that the volatility of the SCR ratio displayed in figure 2 is estimated rather conservatively. The duration of assets and liabilities assumed for this average insurer is 7,4 years. For many life insurers with important pension obligations, the duration of assets and liabilities may be much longer and the resulting volatility in own funds will be significantly higher.

2. Critical analysis of VA reference portfolio

2.1. Non-economic volatility

The euro currency VA is based on a reference portfolio of assets held by euro area insurers. This euro currency VA is then applied to all liabilities denominated in euro. Deviations for countries with particularly high spreads are only allowed in exceptional circumstances. The use of this euro reference portfolio may however lead to non-economic volatility for insurer's own funds if the assets of this particular insurer are different from the euro reference portfolio. Imagine a crisis where illiquidity premia on Belgian government bonds increase significantly, whereas financial markets in other countries remain unaffected. Belgian insurers, who often invest heavily in Belgian government bonds, will see an important decline in the market value of their assets. The VA reference portfolio, on the other hand, only has a very small allocation in Belgian government bonds and thus the VA will not change noticeably. In such a case, the VA will hardly provide any mitigating effect for Belgian insurers and a significant volatility in their SCR ratio will remain.

On the other hand, image a crisis in a large euro area country, *e.g.* Italy, whose government bonds make up a large part of the VA reference portfolio. If the illiquidity premia on Italian government bonds increase, the VA will also increase noticeably, even if the illiquidity premia in all other countries remain stable. Imagine the own funds of an insurer who does not have any exposure towards Italy; its asset value will remain constant, whereas its technical provisions will decrease due to the VA. The SCR ratio of this insurer will increase even though there is no economic reason for any solvency improvement for this insurer. Such examples demonstrate that non-economic volatility of own funds may arise if the assets of an insurer are different from the euro reference portfolio.

2.2. Risks in euro reference portfolio

Policymakers may want to apply a euro reference portfolio in order to incentivize a diversified asset allocation (*i.e.* no concentrations in a particular country) or in order to obtain a comparable measure across euro area insurers. However, incentivizing such an average euro area allocation would entail that Belgian insurers should invest in assets with a much higher risk profile. Table 1 compares the allocation of the euro area and Belgian reference portfolios.

Table 1: comparison of VA reference portfolios

	Euro portfolio	Belgium portfolio
Gov bonds	32,8%	47,0%
Corp bonds	40,5%	36,6%

	Euro portfolio	Belgium portfolio
Corp fin	64%	32%
Corp non-fin	36%	68%

	Euro portfolio	Belgium portfolio	Rating
Belgium gov	8%	63%	AA
Italy gov	24%	6%	BBB–
Spain gov	10%	4%	BBB+

The euro reference portfolio is more allocated towards corporate bonds (more specifically financial corporate bonds, which have been more volatile in recent history) and government bonds of PIIGS countries. On the other hand, the Belgian reference portfolio is more allocated towards government bonds (mainly Belgian government bonds) and non-financial corporate bonds. If policymakers support an average euro area allocation, then Belgian insurers are actually incentivized to have an asset allocation with a much higher risk profile compared to their current portfolio.

2.3. Unit linked assets in the reference portfolio

A final point of criticism regarding the reference portfolio is the low allocation to fixed income investments. The total allocation to fixed income within the euro reference portfolio equals 73,3% (32,8% government and 40,5% corporate fixed income). This entails that 26,7% of the portfolio is composed of alternative assets, mainly equity and property. A high percentage of alternative investments dilutes the VA since a zero illiquidity premium is assumed for these investments. A 26,7% portfolio weight for alternative assets is however unusually large compared to the actual allocation of an average insurer. This high allocation to alternative assets is due to the updated EIOPA methodology where unit linked investments are included in the reference portfolio. Unit linked assets are generally more invested towards equity compared to bonds, which explains the important share of alternative assets in the reference portfolio. The impact of the inclusion of unit linked assets can be derived from the changes of the reference portfolio between 31/12/2014 (when unit linked assets were excluded in the reference portfolio) and 30/9/2016 (when unit linked were included according to the updated methodology), as displayed in table 2.

Table 2: comparison of EUR portfolio weights

	Gov bonds	Corp bonds
From 31/12/2014 until 31/8/2016	38,7%	48,2%
From 30/9/2016 until 28/2/2018	27,4%	43,8%
From 31/3/2018 until 28/2/2019	32,8%	40,5%

It is quite surprising that unit linked assets were included in the calculation of the reference portfolios. In fact, there is hardly any link between unit linked technical provisions and any discount rate. Even when unit linked provisions are valued as a best estimate (as opposed to a valuation as a replicating portfolio) there will be almost no effect from the discount rate, and the unit linked provisions will hardly be different from the market value of unit linked assets. In sum, including unit linked assets in the reference portfolios is inappropriate and dilutes the VA.

2.4. Way forward: company-specific VA

Taking into account the criticism put forward in the chapter, the most appropriate way forward for the VA would be to have portfolio weights based on the own assets of the insurance undertaking. This would eliminate the non-economic volatility that results from the use of reference portfolios. Such a company-specific portfolio should leave out any unit linked assets. The resulting company-specific VA may be less comparable from one undertaking to another, but this measure will be more relevant compared to the current currency VA.

3. Equity illiquidity premium

According to the VA methodology, the illiquidity premium of equity is set to zero. This however seems to be a counterintuitive assumption. It is difficult to imagine that, in periods of high illiquidity, fixed income markets would show high illiquidity premia, whereas equity markets would be completely separated from fixed income markets, unaffected from illiquidity shocks and would keep zero illiquidity premia. Investors who are active in fixed income markets generally also invest in equity. Companies that issued bonds are in general also publicly quoted on stock markets. If fixed income and equity markets constitute of the same participants and market dynamics, it is difficult to image that fixed income may display high illiquidity premia whereas equity pricing always keeps a zero illiquidity premium.

Equity illiquidity premia are not allowed in the Solvency II long-term guarantee measures, but they are considered in the “Own Assets with Guardrails” (OAG) approach currently tested in the Insurance Capital Standard. The OAG approach allows to apply a corporate BBB illiquidity premium for equity and other alternative long duration assets. Two “guardrails” should ensure a prudent application of this equity illiquidity premium within the OAG:

- the illiquidity premium is limited to 200bps
- the application is limited to liabilities longer than 12 years.

Publications on the OAG approach however do not provide any justification why a BBB illiquidity premium would be appropriate for equity investments. In this chapter, we will try to provide the theoretical and empirical underpinning for this approach.

3.1. Equity illiquidity premium under Merton (1974)

In this section, the theoretical foundation is presented to justify a BBB illiquidity premium for equity. Following the framework of Merton (1974), it can be proven that the equity risk premium equals the bond spread multiplied by the equity/bond elasticity[2]:

$$E_t[R_{S,t}] - r_t = \frac{\partial S_t}{\partial B_t}\frac{B_t}{S_t}\left(E_t[R_{B,t}] - r_t\right) \qquad (2)$$

Where $R_{s,t}$ is the stock return at time t, $E_t\ [R_{s,t}] - r_t$ expected stock premium, S_t is the stock value at time t, B_t is the debt value at time t, $E_t\ [R_{B,t}] - r_t$ expected bond premium. Empirical observations generally show an equity/bond elasticity >1. As formula (2) demonstrates a link between the equity and bond *risk* premia, a similar relationship should hold for equity and bond *illiquidity* premia. Indeed, Solvency II implicitly defines illiquidity premia as a spread minus a fixed correction for fundamental risks. If spread and illiquidity premia are equal up to a fixed correction, then formula (2), corrected by a constant, should also be applicable to illiquidity premia. As such, a theoretical link between bond and equity illiquidity premia is established.

3.2. Equity earnings yield and bond illiquidity premium

It is often recognized in academic literature that the equity expected returns can be proxied by the equity earnings yield[3]. In this section, the empirical link between the

2. The proof is straightforward and is presented in *e.g.* Campello, Chen and Zhang (2008)
3. See *e.g.* Koutmos (2015)

equity earnings yield (as a proxy for equity expected returns) and bond illiquidity premia will be demonstrated. As a measure of equity expected returns, we choose the earnings yield of the Euro Stoxx 50 index[4]. As a measure for illiquidity, we calculate the illiquidity premium of BBB rated 10 year corporate bonds[5]:

$$BBB\ 10\ year\ illiquidity\ premium_t = BBB\ 10\ year\ yield_t - 10\ year\ swap_t - risk\ correction \qquad (3)$$

Figure 3 presents the part of equity expected returns that can be explained by bond illiquidity premia[6]. It is clearly displayed in Figure 3 that equity expected returns are strongly related to the BBB illiquidity premia.

Figure 3: equity expected returns (earnings yield) and BBB illiquidity premia are cointegrated

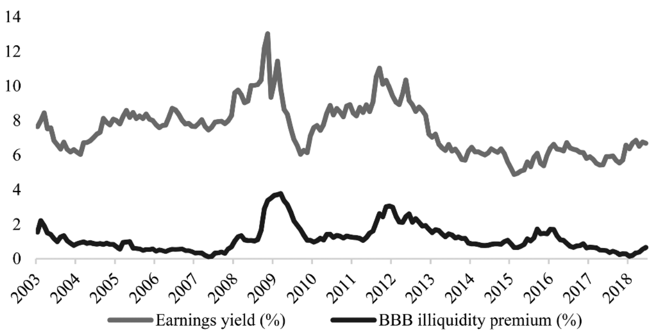
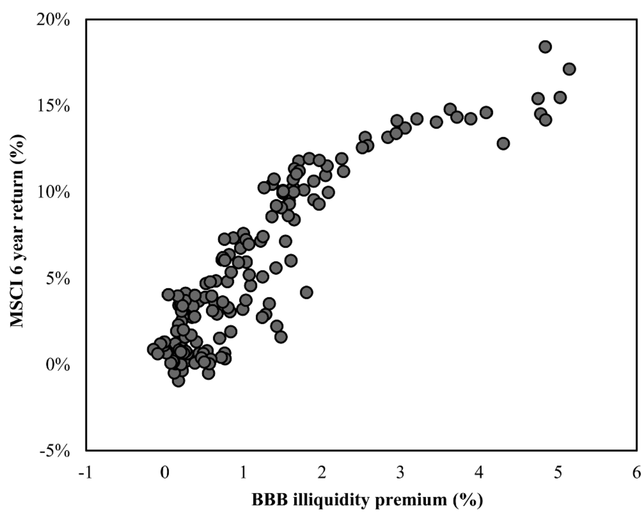


Figure 4: equity realized returns and BBB spread



3.3. Equity realized returns and bond illiquidity premia

The previous sections discussed the equity illiquidity premium based on equity expected returns. It should also be analysed whether equity *realized* returns display the same dynamics as expected returns. Figure 4 presents the MSCI 6 year realized returns together with BBB illiquidity premia over the period 1999-2018[7]. There is a clear dependence between both series; their correlation equals 88,8%. Figure 4 especially shows that high quantiles of the BBB illiquidity premia are associated with high quantiles for the equity realized returns, *i.e.* there is a positive upper tail dependence. This means that discounting with a BBB illiquidity premium for equity investments is reasonably prudent for insurers since high BBB illiquidity premia are associated with especially high equity returns.

This chapter provided theoretical and empirical evidence on the illiquidity premium of equity investments. We however recognise that assigning a BBB illiquidity premium for equity would be a major and improbable departure from the current VA specifications. Assigning a 100% allocation to fixed income investments in the VA reference portfolio may be a reasonable compromise.

4. Mortgage loans and long-term guarantee measures

Mortgage loans may constitute an attractive investment for insurers due to their long maturity and relatively high illiquidity premium. However, many mortgage loans have embedded options to refinance or redeem early and are thus inadmissible for *e.g.* a matching adjustment portfolio. In this chapter, we discuss how mortgage loans may be included within long-term guarantee measures in a prudent manner.

4. More precisely, we use the reciprocal of the variable "Adjusted Positive Price/Earnings" (indx_adj_positive_pe) from Bloomberg. The adjusted positive price/earnings are calculated as the last price divided by the positive earnings per share.
5. We choose BBB corporate bonds as these are proposed as an illiquidity premium for equities under the OAG approach of the Insurance Capital Standard. We choose the 10 year maturities, the longest maturity available, as equities are generally considered to be long-term investments, supposed to back long-term insurance liabilities. The BBB yield is the annual yield of the iBoxx € Corporates BBB 10+ index, obtained from the Markit website. The risk correction is published by EIOPA.
6. The figure displays the results of the regression $Earnings\ yield_t = \alpha + \beta_1 * Swap10_t + \beta_2 * BBB\ 10\ year\ illiq\ premium_t + \varepsilon_t$. It can be proven that the error terms ε_t are stationary, i.e. that the regression variables are cointegrated. The grey line in figure 4 represents $Earnings\ yield_t$, the black line represents $\beta_2 * BBB\ 10\ year\ illiq\ premium_t$.
7. The BBB illiquidity premium is defined as the annual yield of the iBoxx € Corporates BBB index minus the 5 year swap rate minus the BBB fundamental spread defined by EIOPA. Equity realized returns are the annualized MSCI world 6 year returns.

4.1. Mortgage loans and the (extended) matching adjustment criteria

The matching adjustment is an addition the risk-free rate curve that is mainly used for annuities. Article 77b § 1(h) of the Omnibus II Directive[8] requires that assets in matching adjustment portfolios have fixed cash flows that cannot be changed by the issuer. Issuer options are exceptionally allowed if these are combined with a make whole clause, *i.e.* a full prepayment penalty which allows the investor to obtain the same cash flows by re-investing in a similar asset. For the purposes of the extended matching adjustment, tested during the EIOPA long-term guarantee assessment (LTGA), admissible assets were also required to have no issuer options. Such criteria entail that mortgage loans are not admissible for (extended) matching adjustment portfolios. Indeed, many mortgage loans allow the issuer to refinance or redeem the mortgage loan early, without a severe prepayment penalty, and thus do not comply with the criteria of the (extended) matching adjustment.

4.2. Application ratio

The application ratio was a part of the extended matching adjustment tested during the EIOPA long-term guarantee assessment. The application ratio measures how well the assets and liabilities of an insurer are matched. An insurance undertaking that is not matched well will have a lower application ratio and will therefore have a lower illiquidity premium to apply to its liabilities. The application ratio is calculated as:

$$Application\ ratio = max\left(1 - \frac{discounted\ cash\ flow\ shortfall_{total}}{best\ estimate}; 0\right) \quad (4)$$

$$discounted\ cash\ flow\ shortfall_{total} = DCFS_{base} + \sqrt{\sum Corr_{i,j} * \Delta DCFS_{stress\ i} * \Delta DCFS_{stress\ j}} \quad (5)$$

Where $DCFS_{base}$ is the discounted cash flow shortfall in the base (*i.e.* unstressed) case and $\Delta DCFS_{stress\ i}$ is the increase in DCFS under a stressed case i, where the stressed case can take the form of an increase in mortality rates, a mortality catastrophe scenario or an increase in lapse rates, amongst others. Figure 5 displays a base case cash flow profile for an imaginary life insurer. Table 3 presents the application ratio calculations related to this cash flow profile.

Figure 5: example cash flow profile

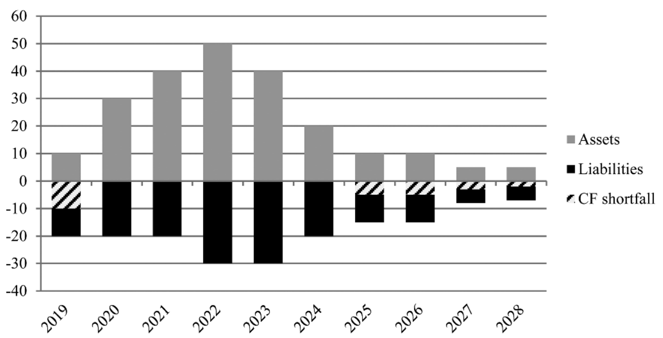


Table 3: application ratio calculation

	discounted CF shortfall	Δ discounted CF shortfall
Base	24,2	
CAT	30,5	6,3
Lapse	36,7	12,5
Mortality	35,7	11,5
Total diversified	44,3	
Best estimate	181,6	
Application ratio	75,6%	

The application ratio effectively shows how well the assets and liabilities of the insurer are matched. This explicit calculation of the application ratio also provides a better view on asset liability management compared to the 65% application ratio implicitly assumed in the VA. Overall, the calculation method of the application ratio can even be considered prudent because:

– The stress scenarios are calibrated at a 99,5% 1-year confidence interval. The proposal of EIOPA during the long-term guarantee assessment was to use the same calibrations of the Solvency II SCR, *i.e.* calibrations related to the 99,5% 1 year VaR. It can be questioned whether such severe calibrations are necessary for the purposes of calculating the application ratio. A valu-

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able alternative may be to check for cash flow shortfalls under stochastic simulations of assets an liabilities, rather than using specific stress scenarios.
- No carry over of cash flow surpluses is assumed. *E.g.* in figure 5, cash flow surpluses are shown in the years 2020-2023; those surpluses can effectively be used to cover shortfalls during the years 2025-2028. However, the standard calculation method tested during the LTGA was to assume that cash flow surpluses cannot be used to cover future cash flow shortfalls.
- No cash flows are considered for equity or property investments, not even at time = 0. Only cash flows from fixed income investments are used in the projection of asset cash flows.

4.3. Mortgage loans and application ratio

In the previous section, we implicitly assumed that the asset cash flows are fixed and cannot be changed by the issuer. This assumption does not hold if mortgage loans are included in the asset base. However, mortgage loans can be included in the asset cash flows in a prudent manner under the following conditions:
- first of all, mortgage loan cash flows are determined stochastically. This means that different interest rate scenarios are projected, refinancing probabilities are calculated based on these interest paths, and the resulting cash flows are calculated and averaged in each scenario;
- for additional prudence, an interest rate stress scenario may be applied, under which $\Delta DCFS_{interest\ rate\ stress}$ is calculated and used in the determination of the application ratio.

Such a proposal would effectively ensure that mortgage loans, despite their embedded options, can be considered in order to obtain a prudent and realistic application ratio.

5. Conclusion

This paper presented a critical reflection on the calculation method of the Solvency II long-term guarantee measures, in particular the volatility adjustment. We found that, despite the mitigating impact of the VA, spread movements may still cause a significant volatility of own funds. In order to achieve a truly effective long-term guarantee measure, we proposed the following changes to the VA:
- portfolio weights based on the own assets of the insurance undertaking;
- weight of fixed income in the portfolio set to 100%;
- application ratio based on the asset-liability management of the insurance undertaking;
- mortgage loans taken into account prudently in the calculation of the application ratio.

References

CAMPELLO, M., CHEN, L. and ZHANG, L., 2008, “Expected Returns, Yield Spreads, and Asset Pricing Tests”, *The Review of Financial Studies* 21, pp. 1297-1338.

EIOPA, 2013, *Technical Specifications part II on the Long-Term Guarantee Assessment*.

International Association of Insurance Supervisors, 2018, *Instructions for the May 2018 Quantitative Data Collection Exercise of the Field Testing Project*.

KOUTMOS, D., 2015, “Is there a Positive Risk-Return Tradeoff? A Forward-Looking Approach to Measuring the Equity Premium”, *European Financial Management* 21, pp. 974-1013.