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Quantitative assessment of common practice procedures in the fair evaluation of embedded options in insurance contracts

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ABSTRACT

This work analyses the common industry practice used to evaluate financial options written on with-profit policies issued by European insurance companies. In the last years regulators introduced, with the Solvency II directive, a market consistent valuation framework for determining the fair value of asset and liabilities of insurance funds. A relevant aspect is how to deal with the estimation of sovereign credit and liquidity risk, that are important components in the valuation of the majority of insurance funds, which are usually heavily invested in treasury bonds. The common practice is the adoption of the certainty equivalent approach (CEQ) for the risk neutral evaluation of insurance liabilities, which results in a deterministic risk adjustment of the securities cash flows. In this paper, we propose an arbitrage free stochastic model for interest rate, credit and liquidity risks, that takes into account the dependences between different government bond issuers. We test the impact of the common practice against our proposed model, via Monte Carlo simulations. We conclude that in the estimation of options whose pay-off is determined by statutory accounting rules, which is often the case for European traditional with-profit insurance products, the deterministic adjustment for risk of the securities cash flows is not appropriate, and that a more complete model such as the one described in this article is a viable and sensible alternative in the context of market consistent evaluations.

1. Introduction

The most recent and widely adopted European Embedded Value (EEV) and Solvency II principles and standards require a market consistent approach for determining the fair value of asset and liabilities of insurance funds (see CFO-Forum, 2016a, b).

According to the standard formula approved by the European Insurance and Occupational Pension Authority (EIOPA) and local regulators, government bonds issued by countries belonging to European Union all have the same risk,[1] i.e. the credit and liquidity risk that they carry is not accounted in the valuation of insurance products. In order to cope with this assumption, it is a common practice by insurance companies to introduce a deterministic adjustment on assets cash flows, so that their present value, calculated discounting over the risk-free curve, and their market value, are equal. This approach, in the context of market consistent evaluation, is called certainty equivalent (CFO-Forum, 2016a, principle 13).

Hence, in the common model, credit and liquidity risk factors do not affect the volatility of the assets portfolio and the correlation between credit and liquidity spreads of different issuers is not considered at all. This has the further consequence that the tools generally adopted by insurance companies for Solvency II related valuations are not adequate for risk management, where these factors are usually included.

In this paper we propose a stochastic model for credit and liquidity risks, which allows for correlated movements across different issuers. Therefore, it is more suitable for risk management than the approach suggested by regulators.

In addition, we also disentangle the two sources of risk, credit and liquidity, in order to assess their relative importance. In fact, some econometric literature suggests that the liquidity effect is quite important in crisis period (see for instance Beber et al., 2009). An example of liquidity spread is reported qualitatively in Fig. 1 for the German sovereign case. The historical series show that in several periods the Bund yield becomes smaller than the overnight rates in spite of a positive CDS premium. This behaviour can be interpreted as a *fly-to-liquidity* effect as explained in Beber et al.

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[1] For a more precise definition of bonds that are treated like government bonds under Solvency II standards see https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii/solvency-ii-technical-specifications.

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0167-6687/

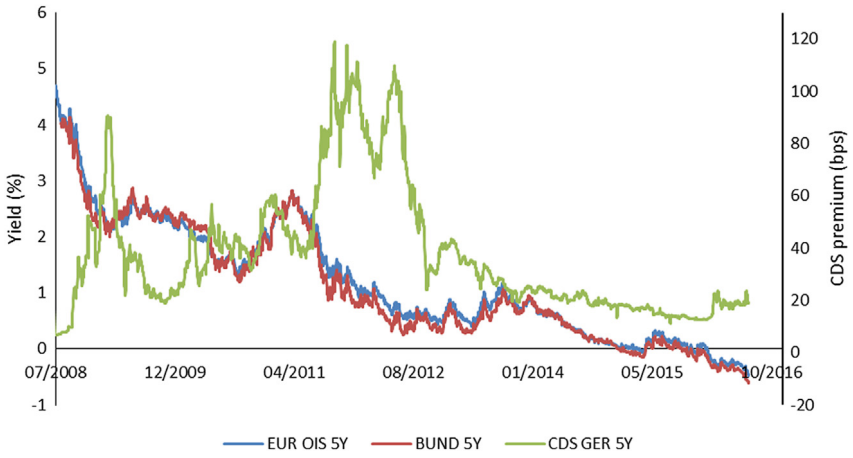

Fig. 1. The figure shows the historical series of the 5 year German Bund BVAL yields (red line), the Eur OIS 5Y rate (blue line) and the 5 year German CDS premium (green line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).

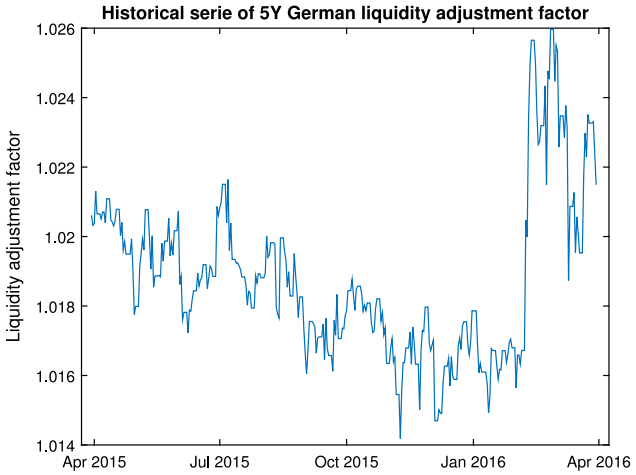

Fig. 2. The figure shows the historical series of the 5 year German liquidity adjustment factor for ZCBs from April 2015 to April 2016.

(2009), i.e. there is a liquidity component in the bond spread and it turns out to be negative, hence the liquidity adjusting factor for zero coupon bonds (ZCBs) is greater than one as shown in Fig. 2. This behaviour is also consistent when explained in terms of the re-denomination risk as suggested in a working paper of the European Central Bank (Santis, 2015). By viewing the liquidity risk as a *flight-to-quality* effect, we can avoid to deal with the financial market micro-structure, and focus on the *relative* importance of liquidity across European sovereign issuers.

In order to separate the effects of the two sources of risk, we consider firstly a model where the stochastic spread is driven by only one factor and we calibrate it on the Credit Default Swap (CDS) quotations; then we add a second stochastic factor to the spread and we calibrate it on the bonds yields. Assuming that CDS quotations are not affected by liquidity risk,[2] we can isolate the contribution of the two stochastic components in the valuation of the portfolio.

For our numerical test, we focus on the case of segregated funds whose performance is determined by statutory accounting rules. This choice is due to the fact that the deterministic adjustment on cash flows, due to the application of the CEQ approach, is particularly inappropriate in this case. Therefore, we test the impact of our new model versus the CEQ approach also with mark to market rules. Moreover, although we use Italian specific accounting rules for the segregated fund in order to produce our numerical results, very similar products are popular in other European countries (Germany and France are a good example), where they are traditionally used for saving or retirement.[3]

The paper is organized as follows. Section 2 describes a with-profit segregated fund and explains the generally adopted (in market consistent evaluations) certainty equivalent approach used to evaluate the minimum guaranteed option. In Section 3 we describe our jointly stochastic model for interest rate, credit and liquidity risks and we perform the calibration of this model on market data. Section 4 presents the numerical evaluation of the embedded options. Results obtained with the common procedure are compared to the ones obtained with our model, inclusive of credit and liquidity risk. Conclusive remarks are presented in the last section.

2. Quantitative assessment of the common practice

Fundamental aspects in the evaluation of insurance products and in particular of segregated funds are the statutory accounting rules which drive the profit sharing mechanism (between policyholder and shareholder) and ultimately, the shareholder obligations towards policyholders.

The common practice for the implementation of a market consistent framework consists in using a certainty equivalent approach (CEQ) to evaluate assets, which for risky securities boils down to applying a risk adjustment to their cash flows. Therefore, in practical valuations, it becomes critical to deem which assets are risk free (and therefore risk adjusted according to CEQ), and which are not. In the latter case, the certainty equivalent approach may not be applied, depending on the sophistication of the calculators implemented. Unfortunately, according to Solvency II standard formula, all government bonds issued by sovereign countries belonging to the European Monetary Union are risk free.[4]

This contrasts with the view of capital markets, which quote very different government bonds spreads (e.g. over the Euro

[2] This assumption is widely used in literature, see for instance Duffie and Singleton (2003) and Longstaff et al. (2005).

[3] See Appendix A for details on Italian accounting rules. A good description of German traditional with-profit insurance, similar to the case treated in this paper, can be found in Kling and Andreas Richter (0000). Another example covering the French case can be found in Borel-Mathurin and Darpeix (0000).

[4] https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii/solvency-ii-technical-specifications.

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