Market risk based capital for Brazilian insurance companies: A stochastic approach[☆]

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ABSTRACT

Solvency II defines minimum capital requirements from insurance companies, due to their exposure to risk. Regulatory bodies of the Brazilian insurance market issued regulations based on a deterministic model for the calculation of risk based capital. In this study, we discuss a simple alternative stochastic model that may be more adequate to measure the minimum capital, based on an asset and liability management mechanism. By allowing the estimation of a probability distribution of losses, the model is useful to identify not only average results but also extreme results for the portfolio. Focusing on the market risk associated with interest rate exposures, we apply a stochastic model to investigate risks from a pension plan product of an insurance company operating in Brazil. The Brazilian case is relevant, since due to its high interest rate levels, high interest volatility and the usual investment in inflation–index bonds, deterministic models can poorly reflect the effective risk exposure of insurers. For the analysis of the actuarial liabilities, we use demographic data from the insurer. For the analysis of the assets, we investigate different hypothetical portfolios of investments in government bonds, analyzing how interest rates changes and indexes mismatch impact the potential loss. The results of the simulation of the stochastic model, for all scenarios, show potential losses that are substantially higher than the values established by the regulatory model. Estimate of potential loss can reach differences of up to 419%. The results suggest that the deterministic model defined by the regulatory agencies may be a fragile reference to the real capital needs of an insurance company, especially when considering the economic environment of emerging countries.

1. Introduction

The National Council of Private Insurance (*CNSP*) and the Superintendency of Private Insurance (*SUSEP*), regulatory bodies of the Brazilian insurance market, have established risk-based capital assessment mechanisms for the solvency of insurance companies, following *Solvency II* guidelines. Aiming to promote greater safety of the insurance industry, notably to prevent systemic crises, *Solvency II* represents a series of standards for insurance and reinsurance operations, notably in the international market. Similarly to the *Basel II* guidelines applicable to the banking system, *Solvency II* is based on the principle that insurance institutions must have sufficient capital to cope with potential losses in their operations, thereby avoiding that financial difficulties of individual risk could

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disseminate to the market as a whole.

Considering the focus of *Solvency II* on the international market, *SUSEP* and *CNSP* have sought to make adaptations in the guidelines in order to make regulatory models more adequate to the context of the Brazilian insurance market. However, although adjustments could be necessary, given the high levels of interest rates and the high volatility of the country's economic environment, it is argued that the model indicated by Brazilian regulatory agencies may be fragile.

In particular, the calculation of market risk capital may not necessarily reflect the true exposure of the insurers to risk arising from their operations. Since the insurance market in Brazil has not gone through stressed conditions, even during the 2007–2008 global financial crisis, it is not clear whether the regulatory agencies provide a safe capital requirement for insurers.

The objective of this study is to discuss a methodology of analysis of capital requirements that more realistically reflects the exposure to which an insurer is exposed, considering particularly a high volatile economic environment. Through simulations based on actual data from an insurer with operations in Brazil, the results generated by the stochastic model are compared with those of the regulatory model based on a deterministic approach, taking into account a product similar to a participating life insurance. Management decisions about asset investment or portfolio selection (Eckert, Gatzert, & Martin, 2016; Gollier and Wibaut, 1992) in a participating life insurance can substantially impact the insurer's exposure to risk. Therefore, market risk analysis of the investment portfolio of insurers becomes relevant to the solvency of the insurance market.

From the point of view of regulators, deterministic approaches are usually based on simple calculation of capital requirements, but at the same time, should be conservative. Since deterministic models do not incorporate probabilistic stress scenarios, requirements may be established at exaggerated levels to avoid financial distress due to unanticipated events. Therefore, by being conservative, a regulatory deterministic model will not necessarily lead to a lower capital requirement than internal models based on a stochastic approach.

One can argue that, by taking into account extreme events, stochastic models could naturally lead to measures of higher risk exposure. However, comparing deterministic regulatory requirements with a more realistic probabilistic approach is still relevant, especially to assess the magnitude of the difference of risk assessment. More specifically, if differences are substantial, regulatory guidelines based on deterministic and simplistic models are underestimating the real risk level of the insurance industry. In addition, even if insurance companies would be allowed to choose more accurate, internal risk models, they would not be willing to adopt stochastic models due to a higher capital allocation.

Using Monte Carlo simulation techniques, the study comparatively evaluates results of capital requirements from the stochastic model with the results generated using the formula defined by the Brazilian regulator. Studies on the life insurance market using simulation are relatively frequent, such as Faust, Schmeiser, and Zemp (2012) for performance analysis of participating life insurance, Zaglauer and Bauer (2008) for the pricing of participating life insurance contracts considering stochastic interest rates, and Bohnert and Gatzert (2012) that analyzes surplus appropriation schemes. However, the study of highly unstable markets is not usual. More specifically, the Brazilian economic environment presents high base interest rates as well as high volatility of interest rates and therefore should be a relevant environment to be studied by risk-bearing institutions.

Although interest rates are high, allowing financial assets to have a high return, when compared to the actuarial liability, the high market volatility implies that gaps between asset and liability cash flows can generate large losses. In addition, our findings indicate that the regulatory model of the Brazilian market leads to underestimated market risk requirements for an insurer's portfolio. This result implies a fragility of the insurance segment, reflecting the need for a more thorough discussion of the Brazilian regulatory model for *Solvency II*. The results of our study suggest that, even with a stable actuarial liability, insurers may face solvency problems simply because they operate in a lower capital requirement environment than would be necessary to face their real exposure to market risk.

More specifically, the simulations allow not only the identification of mean values but also unlikely, yet possible, values, which are important elements for risk analysis, especially in highly volatile environments such as Brazil. Finally, it is important to highlight that studies for specific insurance markets were explored by other works such as Eling and Holder (2013) in Germany, Jevtić and Regis (2015) with data from the United Kingdom.

The paper is structured as follows. In the next section, we present a brief review of themes associated with risk capital in the insurance industry. Then, we describe the methodology and data used to estimate the parameters for the simulations. We present the simulation results, comparing values from the stochastic model with data from the model suggested by the regulator. Finally, some implications of the stochastic model are discussed, showing advantages and limitations.

2. Theoretical background

An insurance company has as its main operation the sale of a product that makes it possible to transfer the risk of a party, the insured, to a counterparty, the insurer, upon payment of a premium value. According to Murphy (2011), the insurance allows sharing financial losses arising from the occurrence of an undesirable event. Thus, instead of an individual face the total loss of a possible claim, he can dilute at least his financial misfortune with all policyholders, by paying the insurance premium.

It is important to emphasize that risk transfer is not only linked to the existence of a material good. Operations associated with random rents from death, for example, also involve a risk transfer in exchange for premium payments. Thus, an individual can transfer, at least in financial terms, the risk of survival to an insurance company, disbursing premiums, so as to accumulate a technical reserve until the time of retirement, when he begins to obtain monetary benefits.

In this insurance product, the participant wishes to transfer the risk of financial loss, due to the survival, reducing his exposure in relation to the accumulation of a reserve that is insufficient to cover his expenses after retirement. Thus, when contracting this type of