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成果報告

共變矩陣在產險業資本要求的重要性

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中文摘要

文獻顯示風險基礎資本預測保險公司破產與否的準確度相當低。造成準確度低的一個可能原因，是風險基礎資本對風險間的相關性方面採用了不合常理的假設。在本計畫中，我們調查風險基礎資本公式中，大類風險（R0-R5）相關性的假設會如何地影響風險基礎資本預測產險公司破產與否的準確度。我們設定幾種不同相關性假設的風險基礎資本，然後在一個模擬的世界中計算這些資本要求，從而比較它們預測的準確度。我們意外地發現相關性的假設並不影響風險基礎資本預測保險公司破產與否的準確度，主要原因是風險基礎資本的大類風險個數太少。因此，單單改變風險基礎資本中大類風險間的相關假設，將無法增進其有效性。

關鍵詞：風險基礎資本，相關性，模擬

Abstract

The literature shows that RBC is ineffective in predicting solvency. One reason for the ineffectiveness may be the unrealistic assumptions about correlations among risks. In this project we investigate how the correlation specification in obtaining Total RBC after Covariance affect the effectiveness of RBC for property-casualty insurers. We conduct simulations to compare the effectiveness of capital requirements with assorted correlation specifications. Simulation results show that correlation specification does not affect the effectiveness. The number of risk categories in RBC is probably too small for correlation to have significant impact. Therefore, modifying the covariance formula will not improve the effectiveness of RBC.

Keywords: risk-based capital, correlation, simulation

The National Association of Insurance Commissioners (NAIC) established risk-based capital requirements (RBC) for insurers in the U.S. jurisdictions in 1990s. The effectiveness of RBC has been called into question by recent research however. Cummins, Harrington, and Klein (1995) were the first to analyze the ability of RBC in predicting insurer's solvency. They found that the predictive accuracy of RBC was very low. Grace, Harrington, and Klein (1998) (GHK) compared the predictive power of RBC with that of Financial Analysis and Surveillance Tracking (FAST) audit ratio system. They found that few companies that later failed had RBC ratios within the NAIC's ranges for regulatory actions. They further found that FAST scores provided superior predictive power to RBC and RBC added no information to FAST. Cummins, Grace, and Phillips (1999) (CGP) extended GHK's paper by adding scenario analysis into the comparison list. They first confirmed that RBC and its components provided low solvency predicting power. Also, RBC was dominated by FAST and a model containing FAST scores alone was as good at predicting solvency as a model with both FAST and RBC. Finally, scenario analyses performed with their cash flow simulation model dominated RBC and FAST. RBC is the worst, according the literature.

The incapability of RBC in predicting solvency could be due to four reasons. First, the factors applied to various asset, premium, and reserve items may simply be wrong. They might not be accurate measures for the corresponding risks. Second, RBC is a local valuation method instead of a full valuation one. RBC is linear fundamentally since the potential loss in a portfolio's value V is computed as $\Delta V = V_0 \times \ _0 \times \Delta P$, where $_0$ is the portfolio's sensitivity to changes in prices evaluated at the current position V_0 and ΔP is the potential change in prices[1]. Linear approximation is valid only for a narrow range of price movements, whereas insolvencies usually result from large changes in asset and/or liability values. Third, the imposed correlation structure could be wrong. The assumption that risks are either perfectly correlated or not correlated might significantly distort the risk measuring. Finally, RBC is static in nature rather than dynamic. It profiles the risk of a company mainly based on a snap shot of the company without capturing the dynamic relations among positions.

In this paper we investigate the impact of the correlation specification in obtaining Total RBC after Covariance on the effectiveness of RBC for property-casualty insurers. CGP demonstrated that dynamic cash flow simulation using full valuation outperformed static RBC using local valuation in solvency prediction. Preliminary results in Pottier and Sommer (1999) showed that the Best Capital Adequacy Ratio (BCAR), a risk-based capital system developed by A. M. Best Company, was more accurate than RBC as a solvency predictor. Therefore, the only reason mentioned in the above paragraph that is left without

[1] Hence, risk factors in RBC = $_0 \times \Delta P$.

examination is the third one: correlation specification. The current formula to obtain Total RBC after Covariance for property-casualty insurers, $R0 + \sqrt{R1^2 + R2^2 + R3^2 + R4^2 + R5^2}$, implicitly assumes that R1 through R5 are not correlated with each other while the sum of these risks is perfectly and positively correlated with R0. The assumptions apparently deviate from the real world. Since the risk of a portfolio with many components depends more on the covariances among individual components than on the variances of individual ones, the impact of mis-specifying correlation structure on the effectiveness of RBC could be material and deserve further study.

To examine how correlation affects the effectiveness of RBC, we conduct simulations to compare the effectiveness of capital requirements with assorted correlation specifications under different market assumptions. We first construct a simulated world that has stock market risk, interest rate risk, and underwriting risk. Then we calculate several capital requirements based on the simulated "historical" data (paths) for a simplified property-casualty insurer. The calculated capital requirements have different correlation specifications including independence, perfect correlation, and estimated correlation. As simulation goes on, the financial status of the insurer as well as the capital requirements evolves and the insurer may become insolvent. We then compare the effectiveness of these capital requirements in terms of their solvency predicting accuracy and demanded capital ratios for target solvent probabilities.

Surprisingly, we find that correlation specification does not affect the effectiveness of capital requirements in predicting solvency. All capital requirements have comparable type I error rates, given type two error rates. Furthermore, all requirements demand equivalent capital ratios to achieve target solvent probabilities. The above results hold under various simulation assumptions including different volatilities, means, and correlations about the underlying risks.

The main reason for the above finding is that all capital requirements are highly correlated with coefficients ranging from 0.90 to 0.95. In other words, capital requirements with different correlation specifications are like constant multiples of one another across simulated cases. Experimental RBC requirements with various correlation specifications among risk categories (R0 to R5) also show that the required capital is highly correlated. Further experiments that add three random variances using random correlations result in high correlation among the sums too. Therefore, we conclude that the covariance formula does not affect the effectiveness of RBC.

Our results imply that modifying the covariance formula alone will not improve the effectiveness of RBC. The number of risk categories has to be increased significantly to make correlation matter. On the other hand, increasing the number of risk categories may not be beneficial because estimating a large correlation matrix is usually subject to significant estimation error. It may even be infeasible due to the lack of adequate data, which is possible for underwriting risks especially. Regulators therefore may have to take different routes to improve current capital requirements, e.g., fine tuning risk factors or move to a dynamic full-valuation method.

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