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A NEW PATH TO ACCURATE RISK ADJUSTMENT: APPLYING CREVAR FOR BETTER FINANCIAL REPORTING UNDER IFRS 17

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Abstract. IFRS 17 is an international financial reporting standard that emphasizes the principles of consistency, transparency, and comparability. It divides reserve recording into Present Value of Future Cash Flows (PVFCF), Risk Adjustment (RA), and Contractual Service Margin (CSM). As IFRS 17 does not prescribe a specific calculation method, companies have the flexibility to define their own risk assessment approaches. Value-at-Risk (VaR) is widely used due to its simplicity and ease of application. However, its limitations in handling large datasets can lead to reduced accuracy. Moreover, variations in methods across companies can compromise the comparability of financial standards. This study proposes an enhanced VaR calculation based on credibility theory—Credible Value-at-Risk (CreVaR)—to improve accuracy and promote greater consistency across corporate entities. The Diebold-Mariano (DM) test demonstrates that CreVaR provides a more accurate estimation of RA without overestimation, making it a suitable alternative for calculating RA under IFRS 17.
Keywords: IFRS 17, Risk Adjustment, Comparability, CreVaR

I. INTRODUCTION

The IFRS 17 standard is an international financial reporting standard developed to replace IFRS 4 [1]. Previous standards, such as IFRS 4, have been criticized for their inability to adequately reflect uncertainties in the insurance industry and economic risk conditions in a timely manner [2]. Furthermore, calculations under IFRS 4 fail to identify clear drivers of profit, whether reported in the current period or projected for future receipt. To address these limitations, IFRS 17 introduces reporting standards that emphasize transparency, consistency, and comparability [2].

The primary distinction between IFRS 17 and other financial reporting standards lies in the treatment of insurance reserves. These reserves are divided into three main components: Present Value of Future Cash Flow (PVFCF), Risk Adjustment (RA), and Contractual Service Margin (CSM). The PVFCF represents the expected net cash flows anticipated in the future, the RA serves as compensation for non-financial uncertainties in fulfilling insurance contract obligations, and the CSM reflects the profit margin that will be recognized gradually over the contract's life [3]. The RA is a crucial element for insurance companies to assess the compensation for risks arising from changes in non-financial assumptions, such as shifts in policyholder behavior or unexpected claim events [4]. Moreover, the RA plays a key role in providing a more accurate assessment of the inherent risks in an insurance contract, thereby ensuring that the company maintains adequate reserves to meet its obligations [5]. Its recognition significantly impacts the balance sheet and financial performance of insurance companies, as emphasized by El Alami et al. [6]. Conservative calculations of the RA can result in lower initial profits recognized at contract inception but offer more stable profits over time. Conversely, excessive profit recognition at the outset may distort long-term financial reporting and affect strategic decisions concerning risk management and profit recognition.

Under IFRS 17, RA calculations follow a principle-based approach, which grants insurance companies the flexibility to choose an appropriate calculation method tailored to their risk characteristics and business strategies [7]. While this flexibility allows for customization, it also poses challenges for comparability across companies. Different calculation methods hinder stakeholders' ability to directly compare financial performance among insurance entities [8]. Recognizing this limitation, the IFRS Foundation acknowledges the lack of comparability in the IFRS 17 amendments (paragraphs B86-B92), but no clear solution has been proposed to standardize the RA calculation [4].

Various studies have explored methods for calculating the RA. For instance, Johansson [9] discusses the Provision for Adverse Deviation (PAD) method, while Chevallier et al. [10] introduce the Cost of Capital (CoC) method. Arató and Martinek [11] examine the Value-at-Risk (VaR) approach in their analysis of reserve risk models under Solvency II and IFRS 17. Furthermore, a survey by the European Insurance and Occupational Pensions Authority (EIOPA) found that the most commonly used method is the confidence level or VaR approach (60% of companies), followed by the CoC method (47%), and Tail VaR (2%). Some companies apply a combination of methods based on internal discussions [12]. The VaR method, which calculates the RA using the distribution of PVFCF at a specific probability level, is widely used due to its ease of application and interpretation, and is considered the best method that explicitly aligns with the definition of RA [13]. This method provides consistent results and is conducive to long-term IFRS 17 implementation.

However, despite its widespread adoption, VaR has limitations in processing large datasets, as it is highly sensitive to the magnitude of losses [14]. To address this, Pitselis [15] proposed the Credible Value-at-Risk (CreVaR) model, which integrates VaR with credibility theory. CreVaR mitigates the sensitivity of VaR to historical data movements by incorporating the dynamics of the distribution model. Moreover, CreVaR is straightforward to apply, enabling efficient and accurate RA calculations. Although CreVaR presents potential advantages, no prior research has applied this method specifically to RA calculations. Therefore, this study proposes CreVaR as an alternative approach for calculating the RA under IFRS 17.

The remainder of this paper is structured as follows: Section 2 presents the model and research methodology, outlining the steps taken to calculate RA using CreVaR. Section 3 discusses the results of the simulations and the comparison of CreVaR with other methods. Finally, Section 4 concludes the study and discusses the implications and potential areas for future research.

II. MODEL AND RESEARCH METHODOLOGY

This research begins by collecting relevant data, including claims, mortality rates, and economic indicators. Once gathered, the data undergoes preprocessing to ensure accuracy and usability for subsequent calculations. Next, economic data is backcasted to retrieve interest rates applicable to the policy issue years. With this information, the Present Value of Future Cash Flows (PVFCF) is calculated, starting with the present values of claims, gross premiums, and surrender benefits (or cash values). Following this, the PVFCF is recalculated to account for non-financial risk shocks, specifically mortality and expense shocks, which are applied to reflect potential deviations from expected risk scenarios. The effects of these shocks are then quantified by comparing the PVFCF after applying the shocks to the baseline PVFCF, effectively isolating the impact of non-financial risks.

To determine the RA, the differences resulting from the shocks are used to calculate the Value-at-Risk (VaR) through Monte Carlo Simulation. Subsequently, the Credible Value-at-Risk (CreVaR) is applied to each identified shock using the specified formula (Equation (12)). Finally, the individual CreVaR values are aggregated using a correlation matrix to produce a comprehensive assessment of the RA under IFRS 17. This approach aims to enhance the accuracy and reliability of the RA calculation by integrating the principles of credibility theory with the traditional VaR method.

A flowchart visualizing the research methodology is presented in Figure 1..

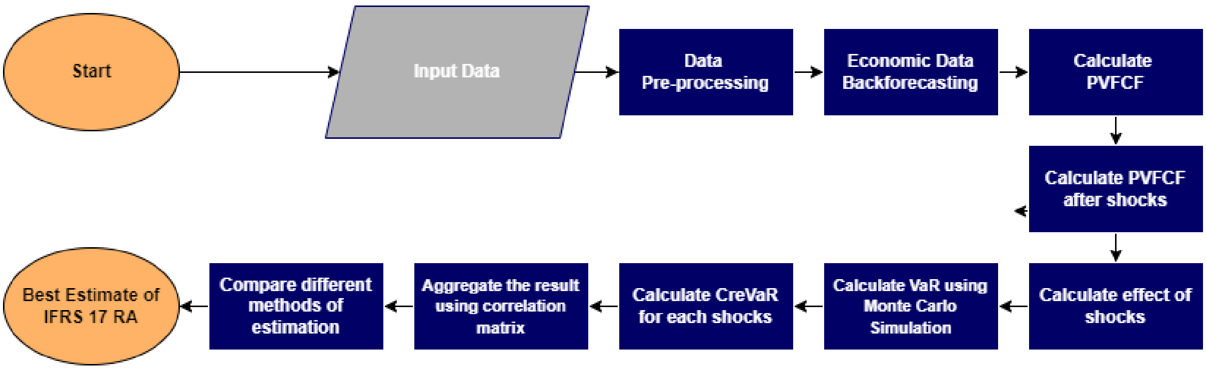
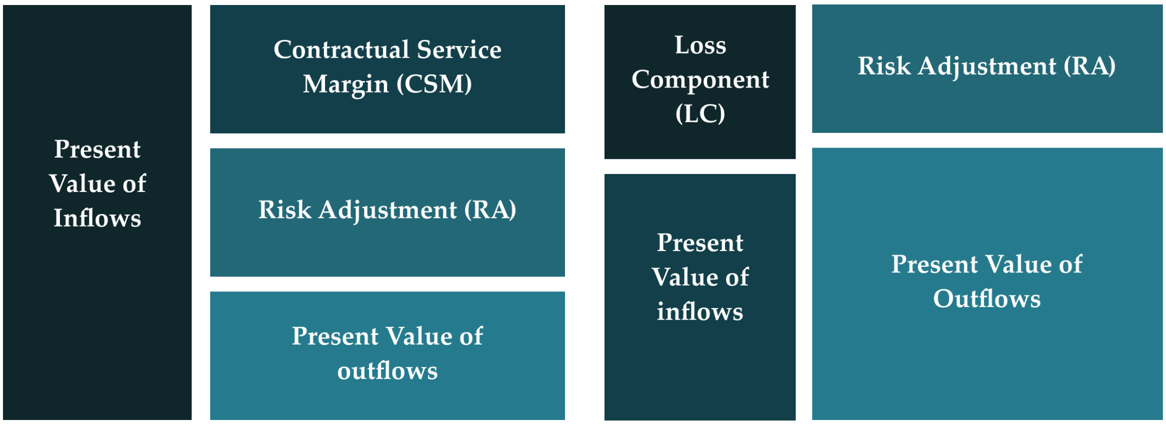


Figure 1. Methodology Flowchart

To begin, [4] describes the concept of IFRS 17 using a general model to calculate the liabilities of insurance contract groups by summing up the components depicted in Figures 2.a and 2.b. A key difference between IFRS 4 and IFRS 17 standards is the division of liabilities. Under IFRS 17, liabilities at the inception of the contract are divided into three main components: the Present Value of Future Cash Flows (PVFCF), which is obtained by subtracting cash outflows from cash inflows; the Risk Adjustment (RA); and the Contractual Service Margin (CSM) for profitable contracts, or the Loss Component (LC) for onerous contracts. An insurance contract is defined as ”profitable” if the subtraction of PVFCF and RA is negative. Conversely, if the result is positive, the insurance contract is considered ”onerous.”

The first component of the liabilities is the PVFCF. Defined by [1], PVFCF is an explicit, unbiased, and probability-weighted estimate of the present value of cash outflows minus cash inflows, arising from fulfilling obligations under the insurance contract. In this study, cash inflows consist of premiums, and cash outflows include claims and surrender cash value payments. [19] provides a method for calculating the present value of premiums, claims, and surrenders for an n-year term product as follows:



(a) Profitable Contracts Liabilities

(b) Onerous Contracts Liabilities

Figure 2. Components of PVFCF under IFRS 17

$$A^1_{x:\overline{n}|} = \sum_{k=0}^{n-1} v^{k+1} {}_kp_x q_{x+k} \tag{1}$$

where $A^1_{x:\overline{n}|}$ denotes the present value of the claim, $v = \frac{1}{1+i}$ is the discount factor, ${}_kp_x$ is the probability that a person aged x will survive k years into the future, and q_{x+k} is the probability that a person aged $(x + k)$ will die within one year. The net premium, denoted as $P^1_{x:\overline{n}|}$, is calculated as follows:

$$P^1_{x:\overline{n}|} = \frac{A^1_{x:\overline{n}|}}{\ddot{a}_{x:\overline{n}|}} \tag{2}$$

where $\ddot{a}_{x:\overline{n}|}$ denotes the n-year term annuity, which can be calculated as

$$\ddot{a}_{x:\overline{n}|} = \sum_{k=0}^{n-1} v^k {}_kp_x. \tag{3}$$

The calculation of PVFCF also involves the life insurance cash value, which is paid if the insured withdraws from the insurance policy at time t. The cash value is denoted as ${}_tCV_x$ and is calculated as:

$${}_tCV_x = A^1_{x+t:\overline{n-t}|} - P^1_{x:\overline{n}|}\, \ddot{a}_{x+t:\overline{n-t}|}. \tag{4}$$

Finally, PVFCF is calculated as:

$$PVFCF = PV\,\text{Claims} + PV\,\text{Surrender Benefit} - PV\,\text{Premium}. \tag{5}$$

A negative PVFCF indicates a ”profitable” insurance contract, whereas a positive PVFCF signifies an ”onerous” contract.

Following the PVFCF calculation, the next step is to calculate the RA. As described in [1], the RA is the additional compensation for uncertainty in the amount and timing of cash flows arising from non-financial risks. According to paragraphs B86-B92 of IFRS 17, the RA calculation encompasses non-financial risks such as insurance risk, lapse risk, expense, and other non-financial uncertainties. Each entity must prudently define the RA to satisfy the following criteria:

1. A large risk with low frequency results in a higher RA than a small risk with high frequency.
2. For similar risks, insurance contracts with longer durations yield a higher RA for non-financial risks compared to shorter-term contracts.
3. Risks with broader probability distributions have a higher RA than those with narrower distributions.
4. Events that reduce uncertainty in cash flow amounts and timing decrease the RA for non-financial risks, and vice versa.

Although IFRS 17 does not prescribe a specific RA calculation method, [12] reports that the most commonly used method is the quantile or Value-at-Risk (VaR) approach, used by 60% of companies. The CoC method is used by 47%, and the Tail Value-at-Risk (TVaR) is applied by 2%, with some companies employing more than one method based on internal discussions. The VaR method calculates the RA using the distribution of PVFCF at a specified probability level [13], representing the maximum expected loss over a given period with a certain confidence level. [23] defines VaR for a random variable X at the $100p\%$ level as $VaR_p(X)$ or π_p, expressed as:

$$VaR_p(X) = \inf_{x \geq 0}[x|F_X(x) \geq p], \quad 0 < p < 1. \tag{6}$$

Several methods exist for calculating VaR, such as the historical method using Monte Carlo simulations, deterministic methods, and variance-covariance approaches [22]. Monte Carlo simulation, introduced by Boyle (1977), involves generating random variables based on specific probability distributions. The CreVaR model calculates VaR by incorporating Bühlmann Credibility Theory. According to [23], a random variable $X = X_1, ..., X_n$ is assumed to be i.i.d. with a conditional parameter Θ, sharing the same mean and variance. The Bühlmann prediction model is given by:

$$X_{n+1} = Z\bar{X} + (1 - Z)\mu, \tag{7}$$

where $\bar{X}$ is the mean of the random variable X, μ is the expected value of the *hypothetical means*, defined as:

$$\mu = E[\mu(\Theta)], \tag{8}$$

$$\mu(\theta) = E(X_j|\Theta = \theta), \tag{9}$$

and Z is the credibility factor obtained by

$$Z = \frac{n}{n + k}, \tag{10}$$

where n is the number of random variables and k is calculated as

$$k = \frac{v}{a} = \frac{E[Var(X_j|\Theta)]}{Var[E(X_j|\Theta)]}. \tag{11}$$

By combining VaR with Bühlmann Credibility Theory, the CreVaR model is formed. According to [14], the CreVaR model enhances VaR accuracy by considering it as a random variable $\varepsilon = \varepsilon_1, ..., \varepsilon_j$, modeled through the general credibility Bühlmann equation:

$$CreVaR = Z\bar{\varepsilon} + (1 - Z)\mu. \tag{12}$$

After applying the CreVaR model, its performance is evaluated using the Diebold-Mariano (DM) test. As described in [14], this test statistically compares the prediction accuracy of two models by examining the difference in projection errors. The DM statistic is given by:

$$DM = \frac{\bar{d}}{\sqrt{\hat{V}_d/n}}, \tag{13}$$

where $\bar{d}$ is the average difference in projection errors between the two models, $\hat{V}_d$ is the estimated variance of the differences, and n is the number of projection values. The benchmark for the DM test is the Risk Margin as defined by Solvency II requirements. The Risk Margin is calculated using the CoC method with a CoC rate of 6%, as stated in Commission Delegated Regulation (EU) 2015/35, Article 39 [24]:

$$RM = 6\% \cdot \sum_{t \geq 0} \frac{SCR(t)}{(1 + r(t+1))^{t+1}}, \tag{14}$$

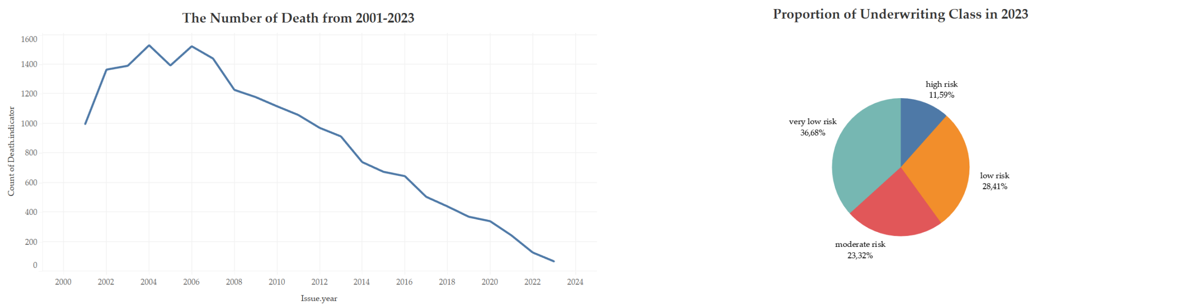
where $SCR(t)$ is the Solvency Capital Requirement at time t, and $r(t + 1)$ is the prevailing interest rate at time $(t+1)$. The SCR base is determined by multiplying the charges for specific non-financial risks by the correlation matrix as stated in Directive 2009/138/EC of the European Parliament and of the Council, Article 104 [25].

III. RESULTS AND DISCUSSION

The data used in this study consists of life insurance claims data released by [16], the Indonesian Mortality Table IV (TMI IV) by [17], and interest rates from the Indonesian Government Securities Yield Curve (IGSYC) provided by the Indonesian Bond Price Agency (IBPA) [18]. A descriptive visualization of the claims data is presented in Figure 3., while Figure 4. shows the visualization of the IGSYC yield curve from 2001 to 2023. The product analyzed in this study is a 20-year term life insurance policy.

3.1. PVFCF Calculation

The calculation of PVFCF involves determining the PV of Claims, PV of Premiums, and PV of Surrender Benefits. The PV of Claims is derived using equation (1), which is then multiplied by the Sum Assured (SA) as stated in the policy. The PV of Premiums is calculated by



(a) Number of Deaths from 2001 to 2023 **(b)** Proportion of Underwriting Class in 2023

Figure 3. Claim Data Visualization

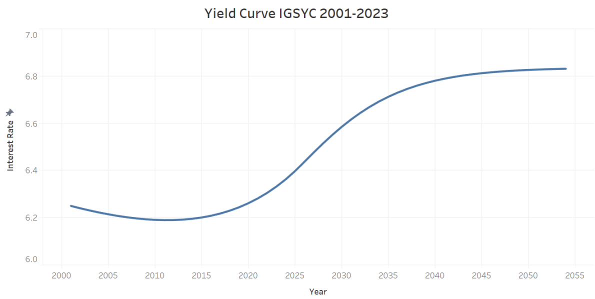


Figure 4. *Yield Curve* of IGSYC from 2001 to 2023

first determining the annual pure premium that each customer must pay. Premium cash flow is derived using equation (2). As described by [20], industry premiums consist not only of pure premiums but also include additional costs such as expenses and commissions. Therefore, the gross premium is obtained by adding the pure premium cash flow to expenses and commissions. Operational expenses and commissions in this study are based on assumptions drawn from Manulife's 2023 annual financial statements [21]. The premium cash flow is then capitalized using equation (3). Finally, the PV of the Surrender Benefit, which is the amount paid to customers who withdraw from the insurance contract, is calculated using equation (4). Figure 5. presents the results of the PVFCF component calculations.

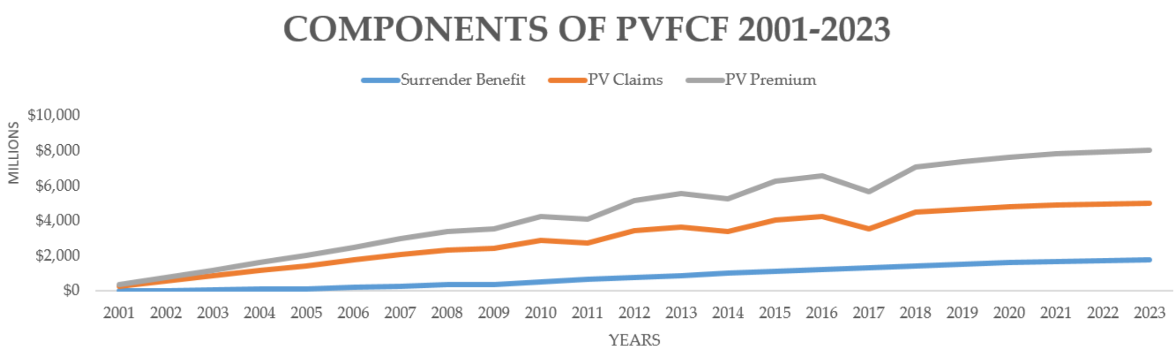


Figure 5. Components of PVFCF from 2001 to 2023

The components of PVFCF are then aggregated to calculate the PVFCF itself using equation (5). The results of the PVFCF calculations for the 20-year term product from 2001 to 2023 are negative, indicating that this product is profitable. The absolute values are visualized in

Figure 6..

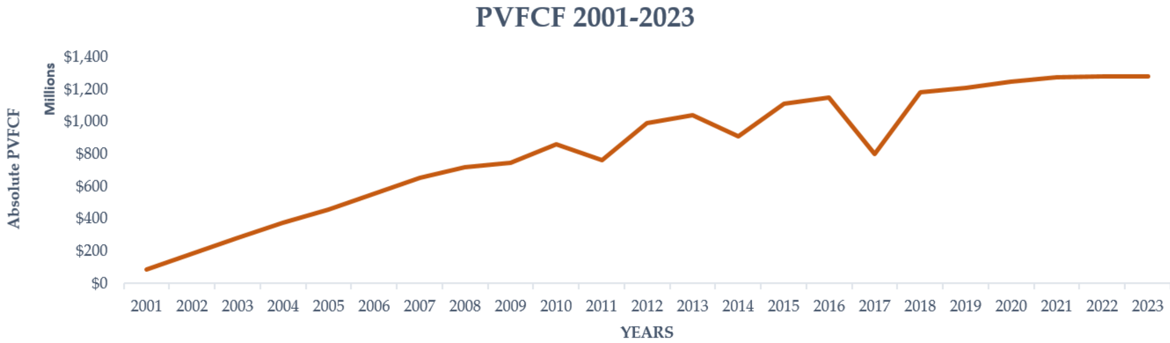


Figure 6. Total PVFCF for the Valuation Years 2001-2023

3.2. Risk Adjustment Calculation

The calculation of the Risk Adjustment begins with assessing the effect of non-financial risks on liabilities. According to IFRS 17, as defined by [1], non-financial risks include insurance risks and other factors such as mortality risk and expenses. Therefore, shocks are applied to the PVFCF based on assumptions provided in the [4] illustration: a 1% decrease in the mortality rate and a 5% increase in expenses.

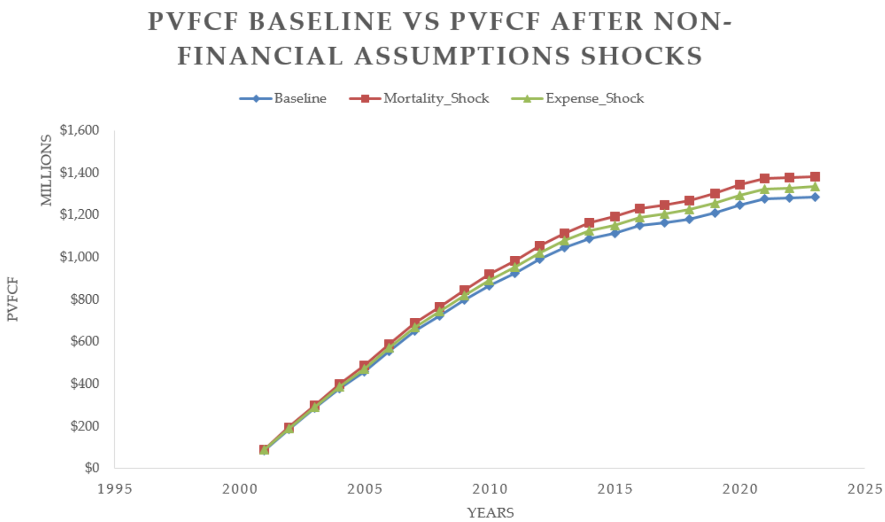


Figure 7. Baseline PVFCF vs. PVFCF After Non-Financial Risk Shocks

In this study, the Risk Adjustment is calculated at an 80% confidence level, following the majority of companies surveyed by EY in 2023. The calculation starts by determining the VaR using Monte Carlo simulation. The VaR for each non-financial risk is then treated as a random variable in the Bühlmann credibility equation, as shown in equation (7).

The baseline for the Risk Adjustment calculation is the Risk Margin figure from Solvency II provisions. The table shows that the Risk Adjustment estimate using CreVaR is closer to the baseline than that using VaR, suggesting that the CreVaR method is more accurate. This

Method	*Risk Adjustment*
CoC (Solvency II)	491.2969
CreVaR	557.6789
VaR	772.7109

Table 1. Risk Adjustment Calculations Using CoC, CreVaR, and VaR

argument is supported by the Diebold-Mariano (DM) test, which tests the null hypothesis that the CreVaR method is less accurate than the VaR method. The DM statistic of 6.7838, which is greater than $Z_{\alpha/2}$ = 1.644854, and a p-value of 6.47×10^{-06}, lead to the rejection of the null hypothesis. Therefore, sufficient evidence exists to conclude that the CreVaR method is more accurate than the VaR method.

IV. CONCLUSIONS

The IFRS Foundation's principle-based approach for calculating Risk Adjustment (RA) grants insurance entities the flexibility to define their own risk assessment methodologies. Among the methods utilized for this purpose are Value-at-Risk (VaR), Cost of Capital (CoC), and Provision for Adverse Deviation (PAD). While VaR is the most commonly adopted due to its ease of use, it faces challenges in accurately processing large datasets, which can impact the reliability of RA calculations. To address these limitations, this research proposes combining VaR with credibility theory to form the Credible Value-at-Risk (CreVaR) model, enhancing the precision of RA estimation. The simulation results indicate that CreVaR provides a closer alignment of RA with the Risk Margin as defined by Solvency II requirements, outperforming the traditional VaR method in terms of accuracy. This improved alignment suggests that CreVaR offers a more reliable and robust approach for RA calculation under IFRS 17. Consequently, the use of CreVaR can enhance the comparability and consistency of financial reporting across insurance entities, mitigating the shortcomings of the VaR method. In conclusion, the CreVaR model stands as a promising alternative for RA calculation, addressing the limitations inherent in existing methods and supporting the principle-based framework of IFRS 17. Future research could explore the broader applicability of CreVaR across diverse insurance products and markets, as well as its potential impact on strategic financial decisions and risk management practices in the insurance industry.

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