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Estimation of VaR in insurance companies listed on the Tehran Stock Exchange with RBC and EC approaches

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Abstract

The capital level of insurance companies to meet shareholders' and the regulator's expectations is very important. This study was to estimate the VaR (Value at Risk) of insurance companies on the TSE (Tehran Stock Exchange) with RBC (Risk-Based-Capital) and EC (Economic Capital) approaches, nine insurance companies in TSE during 2011-2019 were selected. Historical simulation and MCS (Monte Carlo Simulation) methods were used to calculate VaR. In historical simulation, the probability of an insurance company's loss of more than 2.02% of the asset value is 1%. Meanwhile, the VaR obtained from MCS, at the confidence level of 99%, VaR is 3.28%. In CBA (Cost-Benefit-Analysis), the amount of capital desired by the shareholders is 1.25-1.3 of the existing capital. In SMR (Solvency Margin Ratio) the amount of capital desired by the regulator is 1.3 -1.4 of the existing capital. Finally, the target capital is 1.25-1.4 of the existing capital.

Keywords: Value at Risk (VaR), Monte Carlo Simulation (MCS), historical simulation, optimal capital, stock exchange
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Introduction

The importance of insurance is rising due to the increasing contribution of the insurance sector in the entire financial sector. Insurance market activity influences economic growth not only by itself but also as a complement to other financial sectors. In this way, based on two important aspects of insurance companies' activities (risk management and investment of resources), they focus on the implementation of two serious responsibilities: monitoring financial strength and protecting stakeholders' rights (particularly insurers). Insurance companies make money from two sources: premiums collected from customers and earnings from investing a portion of premiums. However, these investments, in turn, carry certain risks.

Risk as the primary concern of investors is deemed as an important criterion in investment decisions. Making an investment without considering risk may result in an adverse situation. In fact, successful investors are those who accept a reasonable level of risk because uncertainty does not always mean a detrimental future [13].

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If uncertainty conditions can't promise a positive future, it will be reasonable to take risks. For example, in the stock market, uncertainty conditions do not always mean a decrease in stock prices [18]. Therefore, the concept of risk plays a key role in financial markets; hence, identification of risk types, measurement, and management is essential; risk measurement is a vital topic in financial science. There are three main methods for measuring risk: standard deviation, coefficient of variation, and value at risk (VaR) [20]. Fostering an organized and structured way to accurately assess the risk is the biggest advantage of VaR. Financial institutions use an independent risk management system to take full control of their performance via VaR. On the other hand, insurance companies must have the minimum RBC and SMR to fulfill their obligations. In this way, risk managers are bestowed with a more realistic view to determine the capital they need for assessing the level of solvency margin. Therefore, by a precise examination of the assets risk ratios, the insurer will be able to balance the liabilities and assets. This is to be studied here according to the information collected about the insurance companies of the Tehran Stock Exchange in 2009-2010. To this end, the amount of capital desired by the regulator according to the risks accepted, SMR, the amount of capital desired by shareholders based on VaR (through historical simulation and MCS), the return on investment, and capital cost are to be calculated. Finally, according to CBA results, a decision will be made on the amount of target capital for the insurance companies listed on the Tehran Stock Exchange.

Theoretical foundations and explanation of methods

Based on the literature, this study uses two approaches to evaluate and determine EC:

1. RBC approach with a surplus (regulatory restrictions)
2. EC approach (based on risk appetite)

In RBC, surplus includes the shield plus the capital required to implement strategic plans. But in EC, strategic plans and risk appetites may contradict. Therefore, first, we define risk appetite and its relationship with strategy. Risk appetite states that in order to achieve the desired value and return, we should answer:

- What risks should we take?
- How much of the selected risks should we accept?

The research is to integrate the above approaches to obtain the maximum and minimum amount of capital and to determine the optimal capital level via CBA. Capital cost forms a benefit-cost framework in this study. Also, the capital required to cover market risk, insurance risk, credit risk, catastrophic accident risk, liquidity risk, and in general, all the risks mentioned in Regulation No. 69 approved by the Supreme Insurance Council (2011) must be calculated. According to the regulations on calculating and monitoring the financial strength of insurance companies [5], Iran Insurance Industry Supervisory Body states that insurance firms are obliged to calculate the existing capital by adding the value of acceptable assets plus the excess of the ratio of day value to book value of fixed assets minus liabilities of the insurance firm. The regulator also emphasizes that the current value of the insurance company's fixed assets should be determined and included in the calculations of the available capital in accordance with the opinion of the official expert of the judiciary or any other method approved by the Central Insurance of the Islamic Republic of Iran. Also, in accordance with the regulations on calculating and monitoring the financial strength of insurance companies [5], insurance companies are required to calculate RBC according to the following formula:

$$\text{RBC} = \sqrt{R_1^2 + R_2^2 + R_3^2 + R_4^2} \tag{0.1}$$

It should be noted that in the mentioned regulation, the Solvency Margin Ratio (SMR) is defined according to the following formula:

$$\text{solvency margin} = \frac{\text{Working capital}}{\text{Risk Bassed Capital (RBC)}} \times 100$$

After calculating the capital required to cover the accepted risks by the regulator's approach, the necessary capital for the accepted risks in case of strategic plans realization is calculated and added. However, the EC approach uses the VaR method to calculate the capital required to cover the risks (99.5% of the losses). This method is also used to calculate the number of resources at risk for the realization of the strategic plan.

In this study, historical simulation and MCS methods are used to calculate VaR, which is being briefly explained below:

Historical simulation

Historical simulation is one of the methods for calculating VaR. This method includes data on returns, losses, and data change rates over time. It does not need to assume a portfolio of change rate and loss distribution. It uses historical time series of portfolio change rate and loss to calculate VaR. Historical simulation is a non-parametric method and has no model. It assumes that the behavior of change rate and portfolio loss is the same as the past behavior, and the properties of numbers and distribution function remain the same as it was in the past. In other words, past changes are evaluated, then the risk is calculated accordingly. In fact, only the standard deviation is simulated historically.

The method operates in the following way: if P_t is the value of the portfolio at the present time, its future value at the time $t + \Delta t$ will be determined through historical value and reflection in current values. The term Δt represents the time period of historical change rate distribution of the portfolio constituents. Prediction of portfolio value change at $t + \Delta t$ will be possible by determining portfolio value changes at $t + \Delta t - 1$. In fact, hypothetical future prices are based on the past historical prices changes:

$$P_{t+\Delta t} = P_{t+\Delta t-1} + \Delta P_{t+\Delta t-T}$$

T represents the time period of return compared to previous periods and $\Delta P_{t+\Delta t-T}$ represents price changes at T. The VaR portfolio obtained through the simulation is as the following:

$$F_{T,\ \Delta p}(\text{VaR}) = P(\Delta p_{t+\Delta t-1} \leq \text{VaR}) = 1 - a$$

Monte Carlo simulation

The Monte Carlo Simulation (MCS) method operates based on statistical modeling of portfolio risk factors. This behavior simulates risk factors at the time period $[t, t + \Delta t]$ by generating random numbers, assuming that their probability distribution function is known. The VaR portfolio is then obtained using the distribution function of portfolio value probability, which is the result of a computer simulation. This simulation method is used when no statistics on the behavior of portfolio risk factors is available. Before explaining how to simulate, the methodology and related variables need to be defined. This methodology can be presented as Figure 1, where senter the relation $\begin{cases} y = f(s_i) = \alpha + \beta S + u \\ S = s_1, s_2, \ldots, s_n \end{cases}$ as risk factors and generate random ys by producing random u numbers (disorder terms). MCS is formulated by the following variables:

S = Risk factors vector
VaR = Δt of the calculation time period
Δt = ΔS of risk factors changes
Δt = Risk factors' L in ΔS of the portfolio value losses caused by changes

The loss here is the difference between the current value of the portfolio and its value at the end of the time Δt of the VaR calculation, in which case the portfolio value changes from S to $S + \Delta S$.

It should be noted that there are two critical issues related to the sequence of loss distribution:

First, the loss probability and estimating loss distribution threshold should be considered if $(P(L > Xp)$.

Second, the Xp quantile must be obtained for the relation $(P(L > Xp, (a = 0.01, 0.05))$

Xp is actually the numerical value of VaR. However, calculating loss probability is a prerequisite for calculating the quantile. Therefore, the first issue is prioritized. This means the loss distribution threshold needs to be obtained, and then the desired quantile should be found to calculate VaR [3, 21].

MCS steps for VaR measurement

The main MCS steps to estimate loss probability are as follows:

1. Generating N scenario by sample changes of risk factors $(\Delta\ S^{(0.1)}, \ldots, \Delta\ S^{(n)})$ in the time period Δt.
2. Revaluating the portfolio at the end of the time period Δt in different scenarios $(S + (\Delta S^{(1)}, \ldots, S + \Delta S^{(n)}))$ and loss determination $(L^{(1)} \ldots L^{(n)})$ by reducing portfolio value in all scenarios based on the current value of the portfolio.

3. Calculating the distribution function of scenarios according to different levels of loss, in other words:

$$L: \ N^{-1}\sum_{i=l}^{n} I(L > X_p)$$
$$\begin{cases} I = 1; & t < T < t + \Delta t \\ I = 0; & T < t \end{cases}$$

where T is the end of the period $(t + \Delta t)$, therefore, the numerical value of VaR (i.e., Xp) can be calculated by constructing multiple values (random loss numbers) for the portfolio value, estimating the distribution function, and calculating the quantile. It should be noted that with increasing observation numbers, the distribution function tends to normalize and Central Limit Theorem (CLT) establishes.

In general, a combination of capital calculation approach based on market risk and capital calculation for insurance activities within the framework of the strategic scenario is used to calculate capital. If the insurance companies have a codified strategic plan, the amount of capital required to cover the codified strategic plan is calculated (assuming the realization of strategic plans, the amount of capital is estimated according to different risks); otherwise, the strategic plan of the company is considered equivalent to the organic growth of the organization, and therefore the time series analysis of the financial variables of the insurance firm is used to estimate the capital to advance the strategic plans. Then, according to the forecasts, the amount of capital to cover strategic plans is estimated. However, CBA requires capital cost analysis. In this approach, the cost of capital is linked to insurance and investment activities. Hence, the following assumptions and conditions are involved in calculating the cost of capital:

- Investment opportunity cost is considered.
- There is a difference between insurance risks and investment risks, and the insurance firm's capital cost is assumed for investment activities and coverage of insurance risks. To achieve this, an alternative to accepting the insurance portfolio is given (the number of insurance policies sold each year is likely the same as the last year).

  However, calculation of the capital cost requires a long-term study of the stock market. To this end, the following items are given here:
- Analysis of high- risk- assets investment impacts on the return of the insurance firm

  Such an analysis is run taking into account the hypotheses confirmed by Casualty Actuarial Society (CAS), published in a documentary entitled Risk Management in 2005. The assumptions are:
- CAPM model underestimates the capital cost of insurance companies because the model does not involve the effect of company size on the capital cost; so, to deal with this shortcoming, the Fama-French three-factor model is used to evaluate the cost of capital.
- Capital cost can be independent of SMR. [15, 17].

Fama-French three-factor model for estimating capital cost

The traditional asset pricing model, known as Capital Asset Pricing Model (CAPM), only uses the variable *total-market-return* to describe the stock portfolio or single-quota return. In contrast, the Fama-French model uses three variables. Fama and French initially observed that in pricing, considering two classes of stocks is better than considering the entire market [23].

- Stocks with less capital
- Stocks with a lower price-to-value ratio (P/B), commonly called value stocks (as opposed to growth stocks).

Fama and French then added two factors to CAPM to reflect the risk the portfolio is exposed to:

$$r = R_f + \beta\,(K_m - R_f) + b_s \times \mathrm{SMB} + b_v \times \mathrm{HML} + \alpha$$

Where r represents the expected return of the portfolio, Rf is the risk-free return, and Km is the return on the market portfolio. The three-factor β is similar to the classical β but not equal because there are two additional factors of

SMB and HML, which respectively measure the historical return on surplus stocks with low capital relative to high capital and the return on surplus-value stocks relative to growth stocks. They are calculated by combining portfolios of rated stocks (book value to market value (B/M) and capital rating) and available historical data of the market.

In addition, when Small Minus Big (SMB) and High Minus Low (HML) are defined, their corresponding coefficients, b_s and b_v, are obtained by linear regression, with both negative and positive values. In 1996, Fama and French showed Fama-French three-factor operating system accounted for more than 90% of the returns of diversified portfolios, compared to 70% returns as described by CAPM (within the sample). They found that small size, as well as value factors, a high B/M ratio, other related ratios and yield positive returns. Analyzing β and size, they found that higher returns, smaller size, and higher beta are all correlated [12].

It should be noted that all capital market risk analysis is run using different VaR approaches. Therefore, by considering the cost of financial crises (including assets non-liquidity cost and the regulator's capital constraints) and the cost of capital (profit expected by shareholders), it is possible to estimate the optimal capital level via the regulator's approach and EC approach [19, 22, 9].

Calculating financial crisis cost and the impact of financial institutions' capital on it

In order to calculate financial crisis cost, Mills et al. (2013) defined the loss imposed by any financial crisis as well as the expected loss in output Per Crisis (LPC) as a percentage of GDP reduction as follows [1, 8, 16]:

$$\text{LPC} = \left(\frac{3}{4} \times \frac{1-\delta^5}{1-\delta} + \frac{1}{4} \times \frac{1}{1-\delta}\right) \times 10\%$$

Where δ represents the discount factor that is equal to $(1-r)$; r is the interest rate. Moreover, per 1% increase in the capital of financial institutions, the probability of a financial crisis is reduced by $1\% \times \text{LPC} \times \frac{1}{1-\delta}$.

Cost-Benefit Analysis (CBA)

Given whatever mentioned so far, CBA includes the following components from the shareholder and the regulator's perspective:

1. Capital cost (expected shareholder profit)
2. The capital required to cover the risks from the regulator's perspective
3. The capital required to cover risks using the EC approach
4. Impacts of capital on reducing financial crisis likelihood

Therefore, based on the capital amount and crisis likelihood elimination, the regulator generally estimates the capital required to cover the risks, and the shareholder uses the cost of capital and the amount of capital required to cover the risks to analyze. Now, the amount of capital required to cover the accepted risks is estimated using these approaches and considering the real desire of the shareholder and the regulator.

Method, statistical population, and sample

This is an applied study in terms of purpose since it is to estimate VaR of Bourse-listed insurance companies. This is also library research in terms of data type and data collection method, as well as a modeling study in terms of implementation.

The statistical population includes all insurance companies, and the statistical sample includes the insurance firms listed on Tehran Stock Exchange during 2011-2019. The companies are Asia, Alborz, Dana, Dey, Razi, Saman, Sina, Mihan, and Novin insurance firms.

The data was gathered from the financial statements and reports submitted by companies to the stock exchange as well as "Tadbir Pardaz" and "Rahavard Novin" accounting software, the financial data CD of companies listed on the official website of Tehran Stock Exchange (www.Rdis.ir), and Codal website (www.codal.ir). It was then processed in Excel and analyzed via Eviews.

Findings

Since this study mainly aims at capital optimization of insurance companies according to the accepted risks, information, and financial statements of the insurance companies listed on the Tehran Stock Exchange (Asia, Alborz, Dana, Dey, Razi, Saman, Sina, Mihan, and Novin) have been collected during 2011-2018. First, the data on the assets and liabilities of insurance companies are processed, and RBC is calculated from the regulator's perspective. Then, using the VaR method (based on historical simulation and MCS), the capital desired by the shareholders is calculated. Then, return on Investment (ROI), as well as the capital cost of the firms, are calculated. CBA is used to summarize the performed methods and to select the targeted capital for the firms.

Calculation of RBC and SMR from the regulatory bodies' perspective

In this section, based on the information of insurance companies listed on the Tehran Stock Exchange in Rahavard Novin 3 statistical software, RBC and SMR are calculated. Table 1 presents the solvency margin of the firms in 2011-2019. It should be noted that the calculated statistics are adjusted based on the constant rate of 2011.

Table 1: Solvency margin of insurance firms in 2010-2019

Year	Asia	Alborz	Dana	Dey	Razi	Saman	Sina	Mihan	Novin
2011	48	136	50	80	98	100	97	153	
2012	55	159	63	167	146	108	102	446	86
2013	104	143	111	42	94	114	159	118	71
2014	90	101	102	-74	166	113	91	56	91
2015	100	107	111	13	138	132	84	43	78
2016	100	102	86	71	100	146	77	58	33
2017	100	101	94	70	70	121	91	46	122
2018	107	101	110	73	75	132	86	70	172
2019	145	122	121	81	71	115	90	101	137
Average SMR	94.3	119.1	94.2	74.6	106.4	120.1	97.4	121.2	98.1
Average SMR of all insurance firms									102.8

According to the table, Mihan Insurance Firm, with solvency of 121.2, has the highest solvency margin compared to other firms. Saman, Alborz, and Razi insurance firms also have a high average. Dana insurance firm has the lowest average. The average solvency of all the firms is equal to 102.8.

Calculation of VaR by historical simulation

Based on the existing literature and according to the EC approach, in order to cover risk, the amount of capital required to cover 99.5% of the losses is calculated via the VaR method. In this study, VaR is calculated by historical simulation and Monte Carlo simulation. The results of the calculations are as follows:

Calculations by the historical simulation are presented in Excel and in accordance with the definitions of the relevant functions (Table 2). Based on the table, VaR is equal to 4.02% at the confidence level of 99%. This means the insurance firm, with a probability of 99%, experiences the maximum loss of 4.02%. In other words, the firm may experience a loss higher than 4.02%, with a probability of 1%. If the confidence level changes to 95%, the loss will equal 3.28%; that is, the firm will lose more than 3.28% of the value of the assets with the chance of 5%.

Table 2: VaR calculation by historical simulation method

Confidence level	99%	95%
VaR	-4.02	-3.28

VaR calculation using Monte Carlo method

Then, Monte Carlo statistical modeling method is used to calculate VaR. The method is implemented by using the desired functions in Excel. Table 3 shows the results of VaR calculation via MCS.

According to the table, per one million tomans of investment, at the confidence level of 99%, VaR is equal to 3.28%. It will be equal to 2.32% at the confidence level of 95%.

Table 3: VaR calculation by MCS

Observations	**107**	**Confidence level**	**Confidence level**
Stock current value	9468	99%	95%
Number of trading days	35.9	Investment level	Investment level
Time development per day (Δt)	0.027885	1,000,000	1,000,000
Average daily returns	0.07%	VaR amount	VaR amount
Daily standard deviation	1.47%	-3,280,994	-2,321,606
Annual returns	2.68%	VaR percent	VaR percent
Annual deviation	8.78%	-3.28%	-2.32%
Expected Return (K)	2.30%		

ROI calculation

The information provided in the software Rahvard Novin 3 is used to calculate the ROI of the insurance firms. The results are presented in Table 4. The table shows that Dey, Saman, and Alborz insurance companies have the highest ROI, respectively, while Mihan, Dana, and Novin firms have the least ROI. The average ROI of all the firms is 2.48.

Table 4: Investment returns of insurance companies

Year / Firm	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**
Asia	1.76	1.63	1.11	1.11	0.80	0.85	0.89	1.03	0.99	1.13
Alborz	7.00	4.97	2.57	2.57	2.80	2.71	2.40	2.31	2.01	3.26
Dana	0.39	1.35	0.47	0.47	2.28	0.47	0.74	1.27	1.02	0.94
Dey	6.19	2.36	8.38	8.38	8.38	10.14	9.27	5.55	2.08	6.75
Razi	2.64	0.94	0.64	0.64	0.11	4.40	7.59	1.87	0.00	2.09
Saman		6.91	4.48	4.48	3.55	2.79	4.24	6.25	2.43	4.39
Sina	2.43	1.61	4.33	4.33	0.57	1.75	3.97	1.68	2.34	2.56
Mihan	10.90	3.33	3.82	3.82	2.73	1.91	0.86	-11.20	-13.85	0.26
Novin	-	6.10	2.75	2.75	6.35	0.23	-14.14	1.00	2.57	0.95
Average ROI of all firms										2.48

Capital cost calculation

Capital cost for a particular investment is, in fact, an opportunity cost or the percentage of expected return from any other investment opportunity with the same risk. In this study, time-series statistics of financial variables of insurance companies, long-term study of the stock market, and Fama-French three-factor model are used to estimate the capital for advancing strategic plans. Table 5 displays calculations of capital cost. The last two rows of the table present the average cost of capital in the years under review. According to the table, Saman Insurance Firm has the highest cost of capital 24.19. Dana, Insurance Firm with 17.98, Sina with 15.55, and Alborz with 14.87 occupy the next ranks, respectively. The average total capital cost for all of the firms is equal to 3.11.

Cost-Benefit Analysis (CBA)

Cost-benefit analysis, also defined as the profitability index, represents the discounted profits of each unit of discounted costs. CBA can be defined as the ratio of discounted profits to the discounted costs of an investment with reference to a specific point in time (Mixel, 1991). In project evaluation, the benefits of the project should be identified to detect the desired results of any specific project. Also, the relationship between the project and the goal must be descriptive in order to provide a sound evaluation. Therefore, CBA is performed to answer the questions raised in this article. To this end, the following components from the shareholder and the regulator's perspective are addressed:

1- Capital required by shareholders according to the desired return
2- The capital required to cover the risks from the regulator's perspective
3- Return on investment
4- Capital cost

Table 5: Capital cost of insurance companies during 2011-2019

Year / Firm	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Asia	15.07	18.75	7.57	7.57	6.55	8.49	9.16	11.64	12.84	10.85
Alborz	38.09	29.72	7.02	7.02	8.92	11.00	10.62	10.73	10.69	14.87
Dana	9.10	44.18	4.03	4.03	22.34	6.96	15.56	32.83	22.76	17.98
Dey	17.48	5.24	30.14	30.14	30.14	-154.96	56.10	33.64	42.60	10.06
Razi	11.07	4.44	2.33	2.33	0.25	12.97	27.44	8.15	0.01	7.67
Saman		23.50	20.38	20.38	18.14	18.62	27.59	47.62	17.26	24.19
Sina	10.51	9.06	28.40	28.40	-54.44	70.74	24.96	9.02	13.33	15.55
Mihan	14.21	4.44	13.84	13.84	14.03	19.42	3.94	-57.90	-84.05	-6.47
Novin		33.02	20.40	20.40	36.45	1.27	-669.40	6.76	17.81	-66.66
The average capital cost of all firms										3.11

With the amount of capital and the reduction of crisis chance, the regulator estimates the capital required to cover risks. The shareholder uses the capital cost and the required capital according to the desired return to analyze. Now, using these approaches and considering the real desire of the shareholder and the regulator, the amount of capital required to cover the accepted risks is estimated. Table 6 summarizes the amount of capital required by the shareholders, the capital required to cover the risks, the return on investment, and the cost of capital:

Table 6: CBA to estimate the capital required to cover risks

VaR		SMR
Historical stimulation	-4.02	102.8
MCS	-3.28	
Average ROI		Average capital cost
2.48		3.11

As seen in the table and according to the historical simulation, per 100 million Tomans investment in insurance companies, VaR increases by 4.02% at the confidence level of 99%. Moreover, VaR is equal to 3.28% at the confidence level of 99% via MCS. In other words, the chance of losing asset value higher than 4.02 or 3.28% is only 1%.

According to regulators and the laws, the average SMR is equal to 102.8; i.e., the existing capital of insurance companies is 102.8% of the required capital, indicating a 3% increase in the required capital. The average ROI is equal to 2.48. The capital cost, or the cost of investment opportunity, is equal to 3.11 %. Therefore, and according to the opportunity costs, accepted risks and expected profits, and existing rules regarding the profitability of investing in insurance companies, the optimal capital of each company is considered to be about 1.25 to 1.4 times higher than the available capital.

Comparison VaR measurement methods to select the best for capital calculation

In this section, the final decision is made on the best method for calculating the capital of insurance companies. For this purpose, the VaR model and parameters of Mean Squared Error (MSE) and Squared-R (R^2) are used.

According to the literature, the VaR model has the following form:

$$Y_t = \alpha_1 Y_{t-1} + \cdots + \alpha_p Y_{t-p} + U_t$$

The self-explanatory model is applied over 85% of the data, and prediction is performed for 15% of the data. Then, the prediction (y) is compared with 15% of the original data (y). The prediction error is obtained by

$$\text{MSE} = \sqrt{\frac{\sum (y-y)^2}{n}}$$

Then, the model with the least MSE is selected.

By obtaining the predicted values for the data using two VaR models, the accuracy and validity of the models are evaluated and compared via MSE and R^2 (Table 7).

According to the findings, MCS has much less error than other methods, indicating more accurate results from prediction.

Table 7: MSE and R2 values for VaR models

Models	**MSE**	R^2
Historical stimulation	8.06	0.13
MCS	0.04	0.99

Conclusion

Economic actors transfer part of the accepted risks to insurance companies in the form of contracts and in exchange for premiums. Risk acceptance by insurance companies may concern insurers whether the firm afford obligations [10]. Hence, the regulatory body (government) has defined risk-based capital to cover the accepted risks and has imposed restrictions on the ratio of available capital to risk-based capital for insurance firms. Iranian Central Insurance has defined SMR in accordance with the ratio of existing capital to risk-based-capital [6]. According to this regulation, insurance companies must calculate SMR and send it to Central Insurance after the approval of the board of directors and the auditor. Therefore, insurance companies, in order to be able to fulfill the commitment and meet shareholders' expectations, make various investments and play an important role in the country's economy as an essential source of financing and investment. Thus, investing from the capital and technical reserves have become one of the pivotal tasks of insurance companies.

On the other hand, insurance companies must have the minimum RBC and SMR to fulfill their obligations. In this way, risk managers are provided with a more realistic view in estimating the capital they need to assess SMR. Therefore, by carefully examining the assets risk ratio, the insurer will be able to balance the liabilities and assets. In this regard, the amount of capital desired by the regulator according to the risks accepted and financial strength, the amount of capital considered by shareholders based on VaR (via historical simulation and MCS), ROI, and capital cost are calculated. Finally, the amount of targeted capital for insurance companies is decided according to CBA results. The results are summarized as follows:

- According to the statistics of 2011-2019, Mihan Insurance Firm has the highest SMR, followed by Saman, Alborz, and Razi Insurance Firms.
- According to the calculations based on the historical simulation, the chance of losing more than 4.02% of the asset value is only 1%. This will be equal to 3.28% if the confidence level changes to 95%; i.e., the chance of losing more than 3.28% of the asset value is 5%. VaR results from MCS indicate that per one million tomans of investment, at the confidence level of 99%, VaR will be equal to 3.28%.
- The average ROI of the insurance companies listed on the stock exchange is equal to 2.48%. Dey, Saman, and Alborz firms have the highest ROI, respectively, and Mihan Firm has the least ROI.
- According to the calculations of capital cost, Saman Insurance Firm has the highest cost of capital (24.19), followed by Dana (17.98), Sina, and Alborz firms, respectively. The total average capital cost is equal to 3.11.
- According to CBA results, the amount of capital desired by the shareholders is proposed to be 1.25 to 1.3 of the existing capital in accordance with the expected return. However, according to the level of accepted risks and SMR, the amount of capital desired by the regulator is about 1.3-1.4 of the existing capital.
- Finally, the amount of target capital is 1.25 to 1.4 of the capital that is expected to meet shareholders' and the regulator's expectations. This is in line with the study of Hitchcox et al. [14] and Basher et al [2].

In sum, in addition to banks, which are known as short/medium-term credit providers of economic units, insurance companies as an important source of financing and investment play a crucial role in the country's economy. Thus, investing from the capital and technical reserves is one of the serious tasks of insurance companies. The investment enables insurance companies to cover their potential liabilities and earn significant profits [11]. However, due to the inappropriate structure and supply of insurance services by a few limited companies, insurance companies' commitment to comply with general and restrictive government laws, low-risk capacity, and finally, lack of tools to effectively regulate the market, the insurance industry has failed to be favored with a suitable position in the set of financial activities. Moreover, due to the lack of capital market development, the statehood of large insurance companies, and as a result, the normal reluctance of companies to increase profitability, a large portion of financial resources concentrated in insurance companies are held as inventory and deposits with the banking system instead of productive investments through the capital market. This is significant in studying the asset composition of Iranian insurance

companies. However, insurance companies of developed countries contribute about 80% of the financial resources to the capital market in various ways. It goes without saying that in the case of changing the decision makers' preferences and the rules and regulations governing insurance companies' investment, it will be possible to provide efficient accountability through sensitivity analysis, new modeling, and modern, dynamic, and varying needs of the insurance industry. Therefore, directing the surplus resources of insurance companies towards productive investments may modify their roles in dynamizing the country's economy.

For more information the paper structure and its findings were drawn in Figure 1.

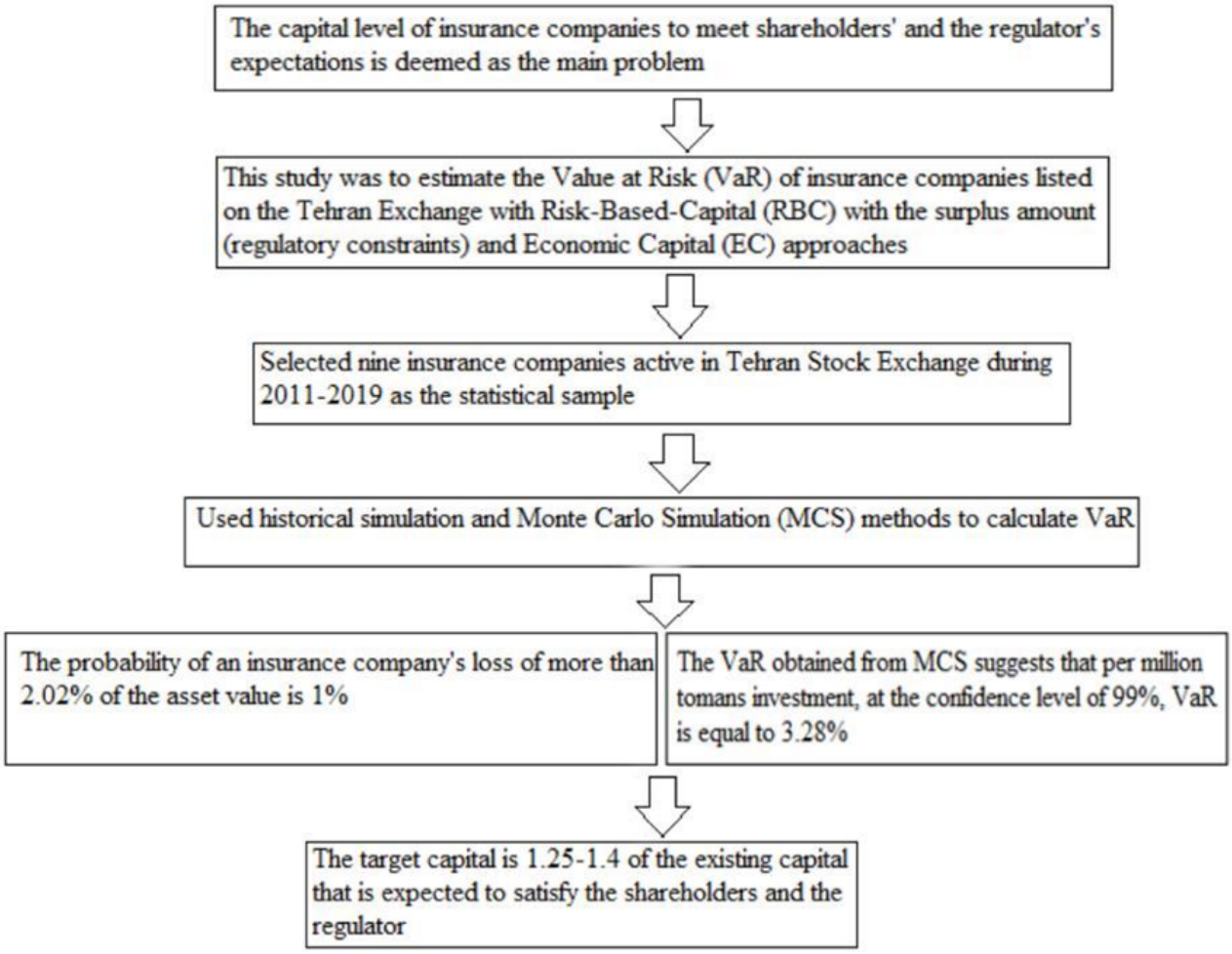

Figure 1: MCS overview

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