A Method for Measuring of Maximum Possible Loss of Catastrophic Risk[۱]

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Abstract

One of the important topics in financial is measurement of catastrophic risk such as earthquake and flood. Generally, there are three principle methods for measuring risk; these methods include Standard Deviation, Coefficient of Variance and Value at Risk (VaR). The VaR method has been used by Basle Committee from ۱۹۸۰ to estimate undesirable risk level for financial companies and to calculate economic capital (Capital Adequacy) in the financial markets. Another advanced method of risk measurement from VaR family named Conditional Tail Expectation (CTE).

The goal of this paper is an introduction of a method for measuring of maximum possible loss (MPL) of catastrophic losses (i.e. earthquake) in a confidence level.

In this paper, Monte Carlo simulation will be used for simulating catastrophic losses. Based on caculated VaRs and CTEs of simulated losses, we estimate maximum possible loss of catastrophic events.

Key Words: Value at Risk, Conditional Tail Expectation, Catastrophic Losses, Monte Carlo Simulation and Variance-Covariance Method.

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١. Introduction.

Nowadays, the distrust of future has increased because of the extension of different dangers and undesirable accidents, part of which results from economical, social activities. The concepts of "Peril" or "risk" in financial markets are basic issues which have special complexity. Since the exact conception of Peril appearance is not existing, financial markets need approaches to control and manage the risk. It has to be considered that the most important conception of peril appearance is feeling the financial loss appearance. In the other words, the risk of undesirable accidents appearance. In the new financial risk management literature, desirable risk is noticed more than the desirable and undesirable risks. Truly, in the new financial risk management standards, a company or enterprise first of all examines the undesirable risks, thus losses which are origin of risk (in literature, the value at risk) are arranged follow (figure ١.):

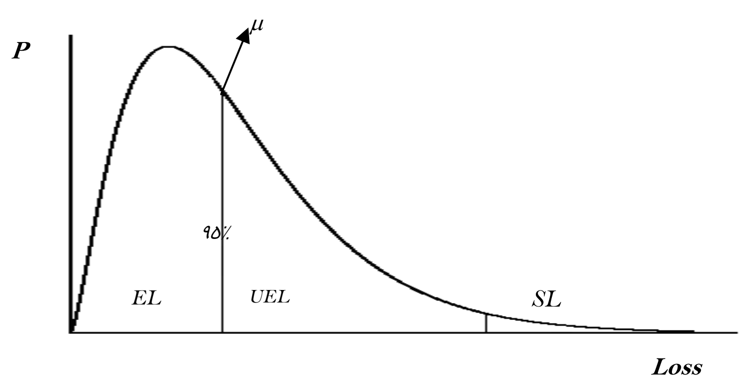
١. Expected Loss (EL): Contains losses which need business activities.

٢. Unexpected Loss (UEL): Contains losses which are unconventional but foreseeable. These are losses which company or enterprise has to accept within the business activities.

٣. Stress Loss (SL): Contains losses, although unsuspected but companies or enterprises have to be able to continue their activities with them.

It is important to notice that investment has a close relation with the risk of portfolio and this relation is shown in the probability distribution function of risk of portfolio.

Figure ١: Loss Distribution Function and



٢. Definition of Value at Risk (VaR)

The Value at Risk is one of the measuring standards of undesirable risk and is introduced by Till Guldimann in ١٩٨٠. This index shows the maximum expected loss of portfolio (or the worst possible loss) for the specific time, considering specific interval confidence.

The maximum expected loss of portfolio (VaR) is measured by density function of loss which is shown as f. Truly the Value at Risk is a quantile of F function in critical levels of (α = ٠.٠٥ or ٠.٠١). Therefore:

$$P\ (\text{Loss} < \text{VaR}) = \int_0^{VaR} f(L)dL = 1-\alpha \qquad (١)$$

$$\text{VaR}_{١-\alpha} = F^{-١}(١-\alpha) \qquad (٢)$$

The concept of VaR is accepted as a method for measuring the risk of portfolio. Basically optimization value of portfolio in the specific period of time with a specific confidence level that can face with loss or benefit is a goal for which this method is used.

٣. Definition of Conditional Tail Expectation (CTE)

The CTE goes by several names – expected shortfall (ES), Tail-VaR, Tail Conditional Expectation (TCE) and Expected Tail Loss. (The plethora of names arose, I believe, because it is an obvious risk measure which was simultaneously proposed by several researchers, each offering a different suggested name. "CTE" has become the common terminology in U.S. and Canadian actuarial circles.) The usual explanation is that, if $Q_{١-\alpha}$ is the (١−α)-quantile of a loss distribution, the CTE is the mean loss given the loss is greater than $Q_{١-\alpha}$ ($F^{-١}$ (١- α)), so that we have:

$$CTE_{1-\alpha} = E\left[L|L > F^{-1}(1-\alpha)\right] \qquad (٣)$$

This formula does not define the CTE, as it requires that there is no probability mass for the distribution at $Q_{١-\alpha}$ (For a more comprehensive definition, see, e.g., Hardy (٢٠٠٣)). The essential idea is that the CTE is the mean of the worst ١٠٠(١ - α) % of outcomes – where VaR represents the minimum of the worst ١٠٠(١ - α) % of outcomes.

٤. VaR Measuring Methods

٤.١ Variance-Covariance Method

This is a linear method which is used usually in measuring the VaR in financial markets. In this method, firstly, VaR is counted by the simple Variance-Covariance method in the base of ARCH and GARCH models.

٤.١.١ Simple Variance-Covariance Method

As we know the return of asset is counted from the rate of price growth of that asset ($R = \frac{P_s - P_{s-1}}{P_{s-1}}$) and is accordance with the definition we have:

$$E(R_s) = \sum_{s=1}^{s} R_s P_s \qquad (٤)$$

$$\sigma_s^2 = \sum_{s=1}^{s} (r_s - E(R))^2 P_s \qquad s = ١, \ldots, S \qquad (٥)$$

In the above equation, R_s , P_s , E(R) , σ_s^2 are Return, Probability, Expected Return and Return Variance of single assets, respectively (s is equal to observations of R_s time series). We can extent this equation for the portfolio which is consist of more than one asset. As we know return of portfolio is the average weight of portfolio constituent elements rate of changes. Therefore:

$$R_p = \sum_{i=1}^{n} W_i R_i \qquad (٦)$$

In the above equation, W_i is the weight of *i* th asset of portfolio. On the other hand we know the variance of portfolio is equal to:

$$\sigma_p^2 = \sum_{i=1}^{n} W_i \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} W_i W_j \sigma_{ij} \qquad i = ١, \ldots, n \qquad (٧)$$

σ_i^2 , σ_p^2 σ_{ij} and $W_{(s)}$ are Variance of *i* th asset return, Portfolio variance, the member of *i* th row and *j* th column of Ω Variance-Covariance matrix and the weights of the portfolio constituent elements (the share of investment in each asset). So we have:

$$\Omega = \begin{bmatrix} \sigma_1^{\ 2} & \sigma_{12} & \cdots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^{\ 2} & \cdots & \sigma_{2n} \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ \sigma_{n1} & \sigma_{n2} & \cdots & \sigma_n^{\ 2} \end{bmatrix}$$

Therefore, the portfolio variance is equal to:

$$\sigma_p^2 = V'\Omega V \qquad (٨)$$

In the above equation, V is the vector of weights and V' is transpose of this vector. In accordance with the definition, if ١-α is the confidence level of (٥٪ or ١%), the probability of portfolio changes would be less than the range of VaR and is equal to ١-α, id est.;

$$P(\Delta W \le VaR) = 1 - \alpha \qquad (٩)$$

If we multiple the both parts of above unequal, with the inverse of standard deviation of portfolio, we have:

$$P[(\Delta W \sqrt{(V'\Omega V)})^{-1} \le VaR(\sqrt{V'\Omega V})^{-1}] = 1 - \alpha$$

$$P[(\Delta W \sqrt{(V'\Omega V)})^{-1} \le VaR(\sqrt{V'\Omega V})^{-1}] = F[VaR(\sqrt{V'\Omega V})^{-1}]$$

$$F[VaR(\sqrt{V'\Omega V})^{-1}] = 1 - \alpha$$

$$\text{VaR} = F^{-١} (١- \alpha) \sqrt{(V'\Omega V)} \qquad (١٠)$$

In equation ٩, we can measure the degree of $F^{-١}$(١- α) from table which is related to the normal standard distribution function. So we have (α = ٠.٠٥):

$F^{-١}$ (١- α) = ١.٦٤

VaR = ۱.۶٤ $\sqrt{(V'\Omega V)}$

The produced VaR is named mean VaR or VaR from mean and if we add to the above equation, the average of portfolio, so-called zero VaR or VaR from zero.
The VaR measure for single asset is equal to:

$$VaR_i = F^{-1}\ (1-\alpha)\cdot\sigma_i \qquad (۱۱)$$

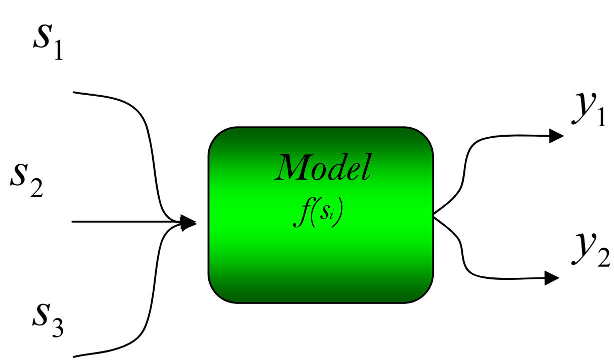
٤.۲ Monte Carlo simulation

Monte Carlo simulation method is based on the statistical models of risk factors. This method simulates the risk function behavior in time period [t, t+Δt], assuming that its probability distribution function is specified creating casual digits. After that, the VaR of portfolio is achieved by using the probability distribution function of portfolio value which is the result of simulation by computer. This method is being used when we do not have any statistics related to the risk of portfolio factors' behaviors. Before proposing this method, it is important to introduce the methodology and related factors. This methodology can be shown in picture ۲. In this picture S come in this equation $\begin{cases} y = f(s_i) = \alpha + \beta s + u \\ S = s_1, \dots, s_n \end{cases}$ and with creating casual digit u (disturbance terms), the casual y is created. For formulating the Monte Carlo simulation we must consider following factors:

S = risk factors vector
Δt = time horizon of counting VaR
ΔS = changes of risk factors in Δt
L = losses of portfolio, coming from changes (Δs) of risk factors in Δt.

Here loss is meant the difference between current value of portfolio and its value in the end of time horizon Δt of counting VaR, and in this situation portfolio value is changed from S to S +ΔS.

Figure ۲: General Format of Monte Carlo



There are two important issues related to the distribution of loss:

First: Threshold of losses distribution must be considered if P (L > $Q_{۱-\alpha}$).

Second: Quantile X_P for relation P (L > $Q_{۱-\alpha}$) must be gained (α = ۰.۰۵ or ۰.۰۱).

Actually, X_P is the numeral degree of VaR. Counting the probability of loss is the precondition of counting the quantile, therefore first of all, we have to get the merge of loss distribution and after that obtain the quantile for counting the VaR.

- the principles of the Monte Carlo simulation for counting the VaR:

Primal steps for Monte Carlo simulation in order to estimate the probability of loss are as follow:

۱. Generate N scenarios by sampling changes in risk factors $\Delta S(۱),...,\ \Delta S(N)$ over horizon Δt.

۲.Revalue portfolio at end of horizon Dt in scenarios $S + \Delta S(۱),...,\ S + \Delta S(N)$; determine losses L(۱),...,L(N) by subtracting revaluation in each scenario from current portfolio value.

۳. Calculate fraction of scenarios in which losses exceed x:

$$L : N^{-1}\sum_{i=1}^{n} I(L > Q_{1-\alpha})$$
$$\begin{cases} I = 1; & t < T < t + \Delta t \\ I = 0; & T < t \end{cases} \qquad (۱۲)$$

In the above equation, T is the end of period (t+Δt). Therefore, by making the different degrees (casual digits of loss) for portfolio value and estimating the distribution function and counting its quantile, numbered degree of VaR id est $Q_{۱-\alpha}$ can be counted.

It is important to say that by increasing the number of observation, the distribution function is predisposed to the normal situation and the central limit theory in this issue can be held.

۵. Analysis of Outcomes

As we said, if there are not data of random variables, Monte Carlo Simulation will be used for simulating losses. In this article, we assume that:

a- Before insurance company which works in Iran, have underwritten ۳۰ policies in one year.

b- We use fire insurance data for loss simulation, because earthquake insurance is one part of fire insurance in Iran.

c- The risk factors are earned premium, in this paper.

۵.۱. Monte Carlo Simulation Process

- Studying relationship between loss paid and premium in Iran:

Follow equation have been estimated by Using loss paid and earned premium in Iranian insurance market. Appendix ۱ shows estimation results of follow equation.

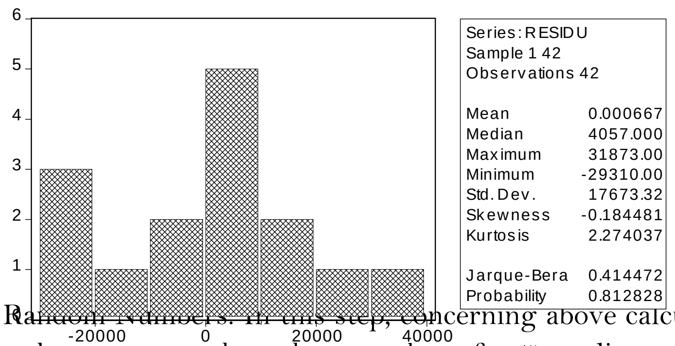
$$\text{Loss} = \underset{(0.0102)}{\overset{}{\underset{24.76}{0.2538}}}\,\text{Pr} \qquad (١٢)$$

Figure ٣ shows Frequency Histogram of equation (١٩) residuals.

In above figure, based on normality Jarque-Bera test statistic, residual are distributed by normal distribution as follow:

Resid ~ N (٠.٠٠٠٦٧, ١٧٦٧٣.٣)

Figure ٣: Frequency Histogram of



- Generating Random Numbers: In this step, concerning above calculated distribution parameters, we have generated random numbers for ٣٠ policy and ١٠٠٠ scenarios (Considering that the ratio of the company average loss over market average loss is equal to ٠.٠٣٦-appendix ٢). Normality Jarque-Bera test and the other statistics of simulated losses for policies are represented in appendix ٣.

- Calculation of VaR and CTE: In this step, we have calculated VaR and CTE for ٣٠ policies, VaRs and CTEs are shown in table١ (significant level is ٠.٩٥)[٢].

$$VaR_i = F(1-\alpha)^{-1} \cdot \sigma_i \qquad , \quad i = 1,\ldots,30$$
$$CTE_i \;=\; E\,[L_i | L_i > F^{-1}\,(1-\alpha)]$$

Table ١: Calculation of VaR and CTE for Each Policy

Policy No.	Province	Earned Premium	VaR	CTE	Policy No.	Province	Earned Premium	VaR	CTE
١	Ardabil	٠.٤٢٣٥٨١	١٠٠٤.٩٥٢	١٢٤٥.٨٤٧٨	١٦	Zanjan	٠.٢٠٥	١٠٥٨.٨٦٦	١٣٠٥.٦٠٥٦
٢	Esfahan	١٣٣.٤	١٠٥١.٥٦٦	١٣٣٨.٦١٥١	١٧	Fars	١٣٣.٧٧٦	١٠٦٢.٠٥	١٣٣٦.٨٩٢٣
٣	Ilam	٠.٢٧٥	١٠١٩.٢٩	١٣٦١.٤٠٨	١٨	Gazvin	١٥٢.٩٦٤٧	١٠٢٤.١٥٨	١٣٠٠.٦٤٤١
٤	East Azerbayjan	٧٠.٧٦٧٨٦	١٠٤٦.٤٩٩	١٣٦٩.٩٣٢٤	١٩	Gazvin	٥-Jan	١٠٤٨.٤٩٧	١٢٩٣.١٧١٨

٢. We assume that simulated losses are independent.

۵	West Azerbayjan	۰.۱۷۸	۱۰۶۳.۸۱۲	۱۳۰۷.۵۱۵	۲۰	Gazvin	۱۸۵.۳	۱۰۱۷.۱۱۲	۱۲۶۷.٤۷۷۱
۶	Boushehr	۱۶.۶۷۱۶۲	۱۰۲۳.۱۱۹	۱۲٤۷.۲٤۱۵	۲۱	Kordestan	۱.۵۲۸	۱۰۲٤.۱۳۵	۱۲۵۳.۸۲۰۲
۷	Tehran	۳.۷۰۳٤۷۷	۱۰۵۸.۸۳۸	۱۳۵۱.۵۰۳۵	۲۲	Kerman	۶۸۳.۳۲۷۹	۱۰۶۳.٤۷٤	۱۳۰۶.۷۰٤
۸	Tehran	۷۵.۸۰۶۲۲	۱۰۱۲.۲۵۷	۱۲۵۳.۸۷۷۱	۲۳	Kerman	May-۳٤	۱۰۱۷.۱۲۸	۱۲۳٤.۳۳۲۵
۹	Tehran	٤۲۵.۰۰٤۹	۱۰۸۵.۳۶۵	۱۳۷۸.۳۷۰۸	۲٤	Golestan	۵۹.۶۳۹۳۲	۱۰۶۵.۱٤۷	۱۲۸۹.۹۵۸٤
۱۰	Tehran	۲٤۳.۷۸۲۷	۱۰۸٤.۲۳۶	۱۳۳۶.۹۱٤۲	۲۵	Gilan	۲۵.۷	۱۰۵۰.۳۸۳	۱۳۰۳.۳۸۵
۱۱	Tehran	Aug-۵۵	۱۰۹۳.۸۰۹	۱۳٤۰.۵۸۹	۲۶	Mazandaran	۶۰.٤۸	۱۰۲٤.۷۱۲	۱۲۷۶.۱٤۷۸
۱۲	Tehran	۱۳۱.۳۸۲۳	۱۰۱۲.۸۲٤	۱۲۷۰.۲۳۹	۲۷	Mazandaran	۰.۹۶۵	۱۰۶۱.۲۷۶	۱۳۲۷.۵۹۶۹
۱۳	Chaharmahal	۱.۰۸۶۹۲٤	۱۰۱۷.۲۸۶	۱۲۷۳.۹۲۲۸	۲۸	Hormozgan	۲۲.۱۱۲	۱۰٤۶.۶۰۳	۱۳۳۷.۹۷۵۳
۱٤	Khorasan	۳.۵۰۳۹۰۳	۱۰٤٤.۱۵۷	۱۳۰۸.۳۸۲۵	۲۹	Hamedan	۶۷.۵	۱۰٤۷.۵۹۳	۱۳۶۵.۹۳۱۲
۱۵	Khuzestan	۰.۳۹۵	۹۹۲.۱۷٤۹	۱۲۲۰.۱٤٤۸	۳۰	Yazd	۰.۹۳	۱۰۸۹.۳۷	۱۳۷۳.۷۳۸٤

۵.۲. Earthquake MPL Calculation

For calculation of maximum possible loss (MPL) of earthquake, we can not sum VaRs or CTEs, because, considering Seismology, provinces of Iran are different. Based on Seismology studies, Central Insurance of Iran has classified this country to ۵ zones (۱ and ۵ are the least and the most seismic zones, respectively).

Therefore, the weight of each province and zone has been used in our calculation to measure the MPL, based on frequency tables ۲ and ۳.

Considering table ۳, based on VaR and CTE, MPL of earthquake is equal to ۹۵٤۰ MIRR (Million Iran Rials) and ۱۱۸۸۹ MIRR for this company in significant level ۰.۹۵. That means, if significant level is ۰.۹۵, MPL will be ۹۵٤۰ or ۱۱۸۸۹ MIRR for underwriting year. Notice that based on VaR and CTE, MPL shall be equal to weighted average of zones.

Table ۲: Earthquake Frequency of Iranian Province from ۱۹۰۰ to ۲۰۰۵

Province	zone	Earthquake Frequency	Earthquake relative Frequency	VaR	CTE	Province	zone	Earthquake Frequency	Earthquake relative Frequency	VaR	CTE
East Azerbayjan	۳	۶۲	۱.۳٪	۱۰٤۶	۱۳۷۰	Fars	٤	۱۰۷۲	۲۳.۲٪	۱۰۶۲	۱۳۳۷
West Azerbayjan	۳	۹۵	۲.۱٪	۱۰۶٤	۱۳۰۸	Gazvin	۵	۲۲	۰.۵٪	۳۰۹۰	۳۸۶۱
Ardabil	۳	۲۹	۰.۶٪	۱۰۰۵	۱۲٤۶	Kordestan	۳	۲۰	۰.٤٪	۱۰۲٤	۱۲۵٤
Esfahan	۱	۶۶	۱.٤٪	۱۰۵۲	۱۳۳۹	Kerman	٤	٤۵۸	۹.۹٪	۲۰۸۱	۲۵٤۱
Ilam	۳	۱٤۹	۳.۲٪	۱۰۱۹	۱۳۶۱	Golestan	٤	۷٤	۱.۶٪	۱۰۶۵	۱۲۹۰
Boushehr	۳	۳۳۷	۷.۳٪	۱۰۲۳	۱۲٤۷	Gilan	٤	۱۰۷	۲.۳٪	۱۰۵۰	۱۳۰۳

Tehran	۵	۶۷	۱.٤٪	۶۳٤۷	۷۹۳۱	Mazandaran	٤	۹۰	۱.۹٪	۲۰۸۶	۲۶۰٤
Chaharmahal	۳	۹۵	۲.۱٪	۱۰۱۷	۱۲۷٤	Hormozgan	٤	۶۲۰	۱۳.٤٪	۱۰٤۷	۱۳۳۸
Khorasan	٤	۵۸۶	۱۲.۷٪	۱۰٤٤	۱۳۰۸	Hamedan	۲	۳۱	۰.۷٪	۱۰٤۸	۱۳۶۶
Khuzestan	۳	٤۸۳	۱۰.٤٪	۹۹۲	۱۲۲۰	Yazd	۳	۱٤۷	۳.۲٪	۱۰۸۹	۱۳۷٤
Zanjan	۳	۱۹	۰.٤٪	۱۰۵۹	۱۳۰۶	total	-	٤۶۲۹	۱۰۰.۰٪	۳۱۳۱۱	۳۹۱۷۸

Resource: National Geoscience Database of Iran.

۶. Summary and Conclusion

In this article, we introduced VaR and CTE as two methods for measuring undesirable risks. Our goal of this paper was calculation of maximum possible loss of earthquake by using VaR and CTE methods; accordingly, we used MCS for simulating losses and calculated VaR and CTE of these losses. The most important feature of our approach is applying of weighted average of VaRs and CTEs of for measuring MPL of catastrophic events. Generally, our calculations improve that modeling insurance company would have minimum capital equals ۹۵٤۰ or ۱۱۸۸۹ million rials to cover only earthquake possible losses.

Table ۳: Earthquake Frequency of Iranian zones from ۱۹۰۰ to ۲۰۰۵

zone	Earthquake Frequency	Earthquake relative Frequency	Total VaR	Total CTE	MPL with VaR	MPL with CTE
۱	۶۶	۱.٤٪	۱,۰۵۲	۱,۳۳۹	۱۵	۱۹
۲	۳۱	۰.۷٪	۱,۰٤۸	۱,۳۶۶	۷	۹
۳	۱,٤۳۶	۳۱.۰٪	۱۰,۳٤۰	۱۲,۹۵۹	۳,۲۰۸	٤,۰۲۰
٤	۳,۰۰۷	۶۵.۰٪	۹,٤۳۵	۱۱,۷۲۱	۶,۱۲۹	۷,۶۱٤
۵	۸۹	۱.۹٪	۹,٤۳۷	۱۱,۷۹۳	۱۸۱	۲۲۷
-	٤,۶۲۹	۱۰۰.۰٪	۳۱,۳۱۱	۳۹,۱۷۸	۹,۵٤۰	۱۱,۸۸۹

Resource: National Geoscience Database of Iran and author calculations.

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Appendix ١: Regression Result for Relationship between Loss Paid and Earned Premium

Dependent Variable: LOSS
Method: Least Squares
Date: 02/13/07 Time: 11:49
Sample: 1 42
Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	0.244326	0.0073	33.47052	0.0000000

R-squared	0.976556	Mean dependent var	112395.10
Adjusted R-squa	0.976556	S.D. dependent var	122670.00
S.E. of regressic	18782.70	Akaike info criterion	22.583600
Sum squared re	4.9E+09	Schwarz criterion	22.630800
Log likelihood	-168.3770	Durbin-Watson stat	0.766101

Appendix ۲: Risk Simulation in *Excel* Software

POLICY NUMBER	1	2	3	4	5	25	26	27	28	29	30
RISK FACTOR / SENARIEOS	0.4	133.4	0.3	70.8	0.2	25.7	60.5	1.0	22.1	67.5	0.9
N1	-235.3	-25.3	-849.8	-40.3	-391.1	203.7	7.1	-459.9	-1,217.9	286.0	-483.0
N2	293.8	-22.7	4.8	-269.2	7.1	419.7	-348.4	-664.6	-800.9	153.9	134.8
N3	-1,036.1	-134.6	-156.5	-1,327.9	-442.4	-796.6	881.0	-280.6	-273.0	-685.5	-1,587.9
N4	-433.0	226.0	798.0	18.8	-297.8	-217.7	241.8	-454.1	376.2	314.8	-882.5
N5	428.6	-239.1	-373.9	107.4	-1,099.9	-803.9	424.7	428.2	512.7	-328.4	-249.4
N6	-216.1	-620.7	274.7	169.4	-23.8	683.2	147.2	263.4	-660.4	-333.9	120.3
N7	306.9	124.6	990.5	-455.5	431.7	-163.5	169.4	-196.2	-676.8	923.5	824.6
N8	-436.5	-118.9	-848.2	227.1	51.1	-551.4	437.8	-273.7	-81.1	359.0	-270.6
N9	185.1	249.3	-259.5	1,538.0	554.6	56.3	505.9	177.6	967.6	273.8	-209.7
N1000	95.5	93.2	-76.1	-72.7	-720.6	-20.0	-460.7	177.4	681.7	-260.5	-566.6
VaR	-1005.0	-1051.6	-1019.3	-1046.5	-1063.8	-1050.4	-1024.7	-1061.3	-1046.6	-1047.6	-1089.4
CTE	-1,245.8	-1,338.6	-1,361.4	-1,369.9	-1,307.5	-1,303.4	-1,276.1	-1,327.6	-1,338.0	-1,365.9	-1,373.7

Input Values

Location Parameter	*0.0000*	*Coefficient*	*0.254*
Shape parameter	*636.24*		

Appendix ۳: Normality Jarque-Bera Test and the Other Statistics of Simulated Losses

	1	2	3	4	5	6	7	8	9	10
Mean	5.1699	50.2789	-1.5894	46.9755	5.3169	2.5811	-6.1728	26.5232	89.3786	104.6204
Median	2.9	47.5	-5.4	42.8	26.75	-2.45	-14.15	17.8	84.7	110.8
Maximum	1769.5	2290.6	2368.6	2457.4	1886	1847.7	2306.9	2200.6	2298.8	2139.6
Minimum	-2041.6	-1975.8	-2035.1	-2013.1	-1718.4	-1900.2	-1885.6	-1894.9	-1908.6	-1528.3
Std. Dev.	610.913	639.2506	619.6295	636.1703	646.6924	621.9572	643.6694	615.3544	659.7961	659.11
Skewness	-0.003805	0.039965	0.082645	0.084621	0.018097	-0.01487	0.003863	-0.048392	-0.006125	0.000845
Kurtosis	2.949093	3.16316	3.188351	3.200008	2.695002	2.742574	3.046593	2.912024	3.02125	2.55845
Jarque-Bera	0.110394	1.375412	2.616545	2.860249	3.93057	2.79805	0.092943	0.712785	0.025067	8.123733
Probability	0.946299	0.502728	0.270287	0.239279	0.140116	0.246837	0.954592	0.700198	0.987545	0.2
Observations	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

	11	12	13	14	15	16	17	18	19	20
Mean	4.3266	19.8291	-7.9005	-7.6223	14.0856	-15.0601	54.154	45.6665	-12.2343	44.2823
Median	15.6	35.95	-4.45	-9.65	9.25	-38.05	67.8	27.4	-1.65	60.95
Maximum	2011.8	1882.1	2279.8	2064.1	1744.9	2272	1971.9	1920.6	2070.5	1807.5
Minimum	-2416.8	-2277.6	-1934.9	-1910.3	-2272	-2392.2	-2238.2	-1774.9	-2191.9	-1995.9
Std. Dev.	664.9303	615.6976	618.4112	634.7463	603.1463	643.689	645.6226	622.5886	637.3831	618.3051
Skewness	-0.062884	0.002485	0.018241	0.030221	-0.053814	-0.01617	-0.009561	0.093068	-0.056025	-0.131063
Kurtosis	2.93228	3.03986	2.972193	2.925875	3.128848	3.10692	3.039097	2.904341	3.031076	2.90005
Jarque-Bera	0.850155	0.06723	0.087675	0.381155	1.174393	0.519928	0.078927	1.824902	0.563364	3.279184
Probability	0.653719	0.966944	0.95711	0.826482	0.555884	0.771079	0.961305	0.401539	0.754514	0.194059
Observations	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

	21	22	23	24	25	26	27	28	29	30
Mean	1.3479	171.0393	18.2376	1.242	47.1601	15.3205	-22.7424	9.9861	24.3035	-8.8403
Median	-20.75	170.7	28	-13	62.75	-2.6	-10.15	16.2	4.15	18.85
Maximum	1647.3	1979.3	2371.4	1874.1	2099.5	2023.5	2575.2	2260.1	2240.8	2322.7
Minimum	-2150.6	-1780.3	-2236.6	-2392.1	-1612	-1917.9	-2233.3	-1876.1	-1927.4	-2110.6
Std. Dev.	622.575	646.4887	618.3158	647.5058	638.5299	622.925	645.151	636.2331	636.8345	662.2301
Skewness	0.001086	-0.102202	-0.025909	-0.068816	0.062884	0.003086	-0.088488	0.074341	0.195908	-0.062596
Kurtosis	2.822747	2.824056	3.0508	3.068576	2.714294	3.047804	3.333084	3.049112	3.12078	2.963684
Jarque-Bera	1.309309	3.030716	0.219405	0.985226	4.060223	0.096806	5.927715	1.021607	6.004488	0.708004
Probability	0.519622	0.21973	0.896101	0.611028	0.131321	0.95275	0.151619	0.600013	0.13013	0.701874
Observations	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000