Financial Risk Assessment Part I.1

Dimitrios V. Lyridis

Assoc. Prof. National Technical University of Athens

Financial Risk Assessment, Part I.1

DEFINITION of 'Risk'

The chance that an investment's actual return will be different than expected. Risk includes the possibility of losing some or all of the original investment. Different versions of risk are usually measured by calculating the standard deviation of the historical returns or average returns of a specific investment. A high standard deviation indicates a high degree of risk.

Financial Risk Assessment, Part I.1

BREAKING DOWN 'Risk‘

A fundamental idea in finance is the relationship between risk and return. The greater the amount of risk that an investor is willing to take on, the greater the potential return. The reason for this is that investors need to be compensated for taking on additional risk.

For example, a Sovereign Treasury bond is considered to be one of the safest (risk-free) investments and, when compared to a corporate bond, provides a lower rate of return. The reason for this is that a corporation is much more likely to go bankrupt than a government. Because the risk of investing in a corporate bond is higher, investors are offered a higher rate of return.

Financial Risk Assessment, Part I.1

DEFINITION of 'Risk Assessment‘

The process of determining the likelihood that a specified negative event will occur. Investors and business managers use risk assessments to determine things like whether to undertake a particular venture, what rate of return they require to make a particular investment and how to mitigate an activity's potential losses.

Financial Risk Assessment, Part I.1

BREAKING DOWN 'Risk Assessment'

Examples of formal risk assessment techniques and measurements include conditional value at risk-cVaR (used by portfolio managers to reduce the likelihood of incurring large losses); loan-to-value ratios (used by mortgage lenders to evaluate the risk of lending funds to purchase a particular property); and credit analysis (used by lenders to analyze a potential client's financial data to determine whether to lend money and if so, how much and at what interest rate).

Financial Risk Assessment, Part I.1

Evaluate the portfolio of risks and determine risk responses.

Based on the defined risk tolerance and inherent risk assessment, management can determine how to address the identified risks. All organizations need to take on a certain level of risk when conducting business in order to generate returns for their stakeholders.

Appetite for risk and tolerance for deviation from objectives must form the basis for determining how to address risks, considering their expected impact and likelihood of occurrence.

Risk tolerance can vary from one risk type to another, depending on the importance to the organization's key mission, values, and objectives. Accordingly, responses to different "high" risks may vary, and a portfolio view of risk exposures should be considered to adequately determine risk responses, as further described below.

Financial Risk Assessment, Part I.1

DEFINITION of 'Risk-Return Tradeoff'

The principle that potential return rises with an increase in risk.

Low levels of uncertainty (low-risk) are associated with low potential returns, whereas high levels of uncertainty (high-risk) are associated with high potential returns. According to the risk-return tradeoff, invested money can render higher profits only if it is subject to the possibility of being lost.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

Monte Carlo analysis is one specific multivariate modeling technique that allows researchers to run multiple trials and define all potential outcomes of an event or investment. Running a Monte Carlo model creates a probability distribution or risk assessment for a given investment or event under review.

By comparing results against risk tolerances, managers can decide whether to proceed with certain investments or projects

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

Monte Carlo analysis is named after the Principality made famous by its casinos. With games of chance, all the possible outcomes and probabilities are known, but with most investments the set of future outcomes is unknown. It is up to the analyst to determine the set of outcomes and the probability that they will occur. In Monte Carlo modeling, the analyst runs multiple trials (often thousands) to determine all the possible outcomes and the probability that they will take place.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

Monte Carlo analysis is useful for analysts because many investment and business decisions are made on the basis of one outcome. In other words, many analysts derive one possible scenario and then compare it to return hurdles to decide whether to proceed.

Most pro forma estimates start with a base case.
By inputting the highest probability assumption for each factor, an analyst can actually derive the highest probability outcome.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

However, making any decisions on the basis of a base case is problematic, and creating a forecast with only one outcome is insufficient because it says nothing about any other possible values that could occur.

It also says nothing about the very real chance that the actual future value will be something other than the base case prediction.

It is impossible to hedge or insure against a negative occurrence if the drivers and probabilities of these events are not calculated in advance

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

Once designed, executing a Monte Carlo model requires a tool that will randomly select factor values that are bound by certain predetermined conditions.

By running a number of trials with variables constrained by their own independent probability of occurrence, an analyst creates a distribution that includes all the possible outcomes and the probability that they will occur.

There are many random number generators in the marketplace.
The two most common tools for designing and executing Monte Carlo models are @Risk and Crystal Ball. Both of these can be used as add-ins for spreadsheets and allow random sampling to be incorporated into established spreadsheet models.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

The art in developing an appropriate Monte Carlo model is to determine the correct constraints for each variable and the correct relationship between variables. For example, because portfolio diversification is based on the correlation between assets, any model developed to create expected portfolio values must include the correlation between investments.

In order to choose the correct distribution for a variable, one must understand each of the possible distributions available.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

For example, the most common one is a normal distribution, also known as a bell curve. In a normal distribution, all the occurrences are equally distributed (symmetrical) around the mean.

The mean is the most probable event. Natural phenomena, people's heights and inflation are some examples of inputs that are normally distributed.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

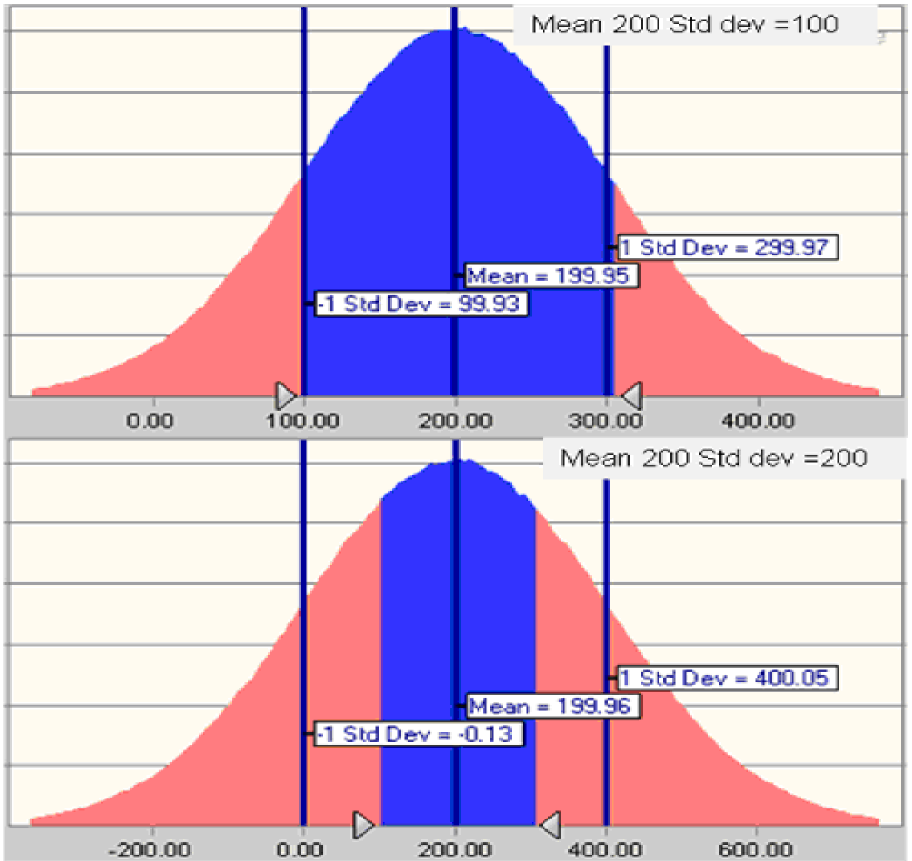
In the Monte Carlo analysis, a random-number generator picks a random value for each variable (within the constraints set by the model) and produces a probability distribution for all possible outcomes.
The standard deviation of that probability is a statistic that denotes the likelihood that the actual outcome being estimated will be something other than the mean or most probable event.

Monte Carlo Simulation

Assuming a probability distribution is normally distributed, approximately 68% of the values will fall within one standard deviation of the mean, about 95% of the values will fall within two standard deviations and about 99.7 % will lie within three standard deviations of the mean. This is known as the "68-95-99.7 rule" or the "empirical rule".

Financial Risk Assessment, Part I.1

Monte Carlo



Financial Risk Assessment, Part I.1

Monte Carlo Simulation

In both of the probability distributions, the expected value or base cases both equal 200. Without having performed scenario analysis, there would be no way to compare these two estimates and one could mistakenly conclude that they were equally beneficial.

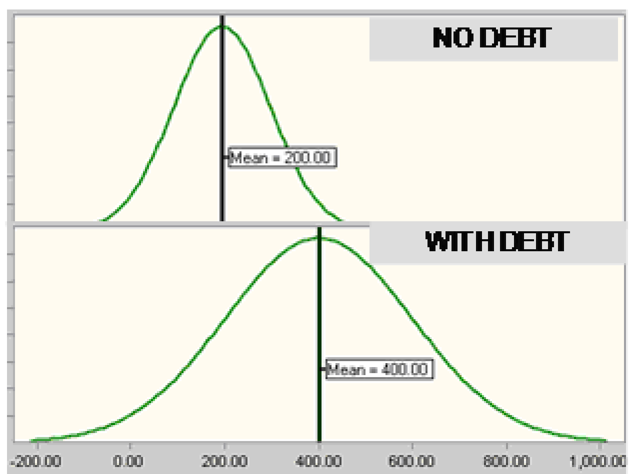
In the two probability distributions, both have the same mean but one has a standard deviation of 100, while the other has a standard deviation of 200.

This means that in the first scenario analysis there is a 68% chance that the outcome will be some number between 100 and 300, while in the second model there is a 68% chance that the outcome will be between 0 and 400.

With all things being equal, the one with a standard deviation of 100 has the better risk-adjusted outcome. Here, by using Monte Carlo to derive the probability distributions, the analysis has given an investor a basis by which to compare the two initiatives.

Monte Carlo Simulation

Monte Carlo analysis can also help determine whether certain initiatives should be taken on by looking at the risk and return consequences of taking certain actions. Let us assume we want to place debt on our original investment.

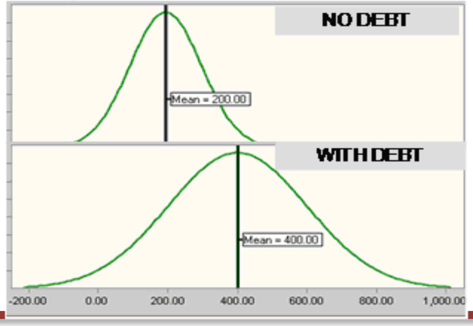


Financial Risk Assessment, Part I.1

Monte Carlo Simulation

The distributions in the Figure below show the original outcome and the outcome after modeling the effects of leverage. Our new leveraged analysis shows an increase in the expected value from 200 to 400, but with an increased financial risk of debt. Debt has increased the expected value by 200 but also the standard deviation.

Before 1 standard deviation was a range from 100 to 300. Now with debt, 68% of values (1 standard deviation) fall between 0 and 400. By using scenario analysis an investor can now determine whether the additional increase in return equals or outweighs the additional risk (variability of potential outcomes) that comes with taking on the new initiative.



Financial Risk Assessment, Part I.1

Monte Carlo Simulation

The probability distributions produced by a Monte Carlo model create a picture of risk. Because risk assessment must account for the value (gain or loss) resulting from each outcome as well as the corresponding probability of occurrence of that outcome, an appropriate performance measure must account for both of these quantities over the "sample space" of all possible outcomes. One such appraisal mechanism is the *expected present value*,

$$\mathrm{EV} = \sum_{g=1}^{m} p_g v_g$$

Financial Risk Assessment, Part I.1

Monte Carlo

where the number of possible outcomes is denoted by *m*; and for the value of outcome *g* is denoted by and the probability of outcome *g* is denoted by . For a risky investment, the performance measure analogous to rate of return is the *expected rate of return,*

$$\hat{k} = \sum_{g=1}^{m} p_g k_g$$

denotes the rate of return of outcome *g*

If we do not know the probabilities associated the various outcomes, then we may estimate and using the sample mean and the sample standard deviation from historical rate-of-return data as follows,

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

If we do not know the probabilities associated the various outcomes, then we may estimate and using the sample mean and the sample standard deviation from historical rate-of-return data as follows,

$$\hat{k} = \sum_{g=1}^{m} p_g k_g \qquad \hat{k}_{\text{est}} = \frac{1}{n}\sum_{t=1}^{n} \bar{k}_t \quad \text{and} \quad \sigma_{\text{est}} = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}\left(\bar{k}_t - k_{\text{est}}\right)^2}$$

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

Determination of Value at Risk (VAR) Using Simulation

Another important use of Monte Carlo simulation in financial risk assessment lies in the calculation of *Value at Risk* (VAR).

A convention has developed within the finance industry to quote VAR on the basis of the distribution of daily price movements. When we ask “What is our value at risk?” we are asking for the size of the loss associated with a 5% tail of daily price changes. In other words there is a 95% probability that the loss in one day will not exceed the VAR. In the Harley Davidson example, 1.96 standard deviations of 2.51% each results in a 4.92% price movement.

Financial Risk Assessment, Part I.1

Monte Carlo Simulation

Determination of Value at Risk (VAR) Using Simulation

Therefore on a $1,500 in-vestment, the VAR is about $74. A 100-share investment certainly has down days when it loses more than this, but over the past twenty plus years they have not been common. VAR has become the standard currency in answering the question about what can go wrong.

Spreadsheet-based Monte Carlo simulation can provide the user with a powerful tool for implementing financial models to perform risk assessment in complex applications. Second, Monte Carlo simulation enables the user to do the following: (i) check the validity of the assumptions underlying a financial model; (ii) explore the sensitivity of the model results to the input parameters whose values are uncertain or are sub-ject to random variation; and (iii) honestly represent the inherent variability of the final results.

Monte Carlo Simulation

Determination of Value at Risk (VAR) Using Simulation

Spreadsheet-based Monte Carlo simulation can provide the user with a powerful tool for implementing financial models to perform risk assessment in complex applications. Second, Monte Carlo simulation enables the user to do the following:

(i) check the validity of the assumptions underlying a financial model;
(ii) explore the sensitivity of the model results to the input parameters whose values are uncertain or are subject to random variation; and
(iii) honestly represent the inherent variability of the final results.

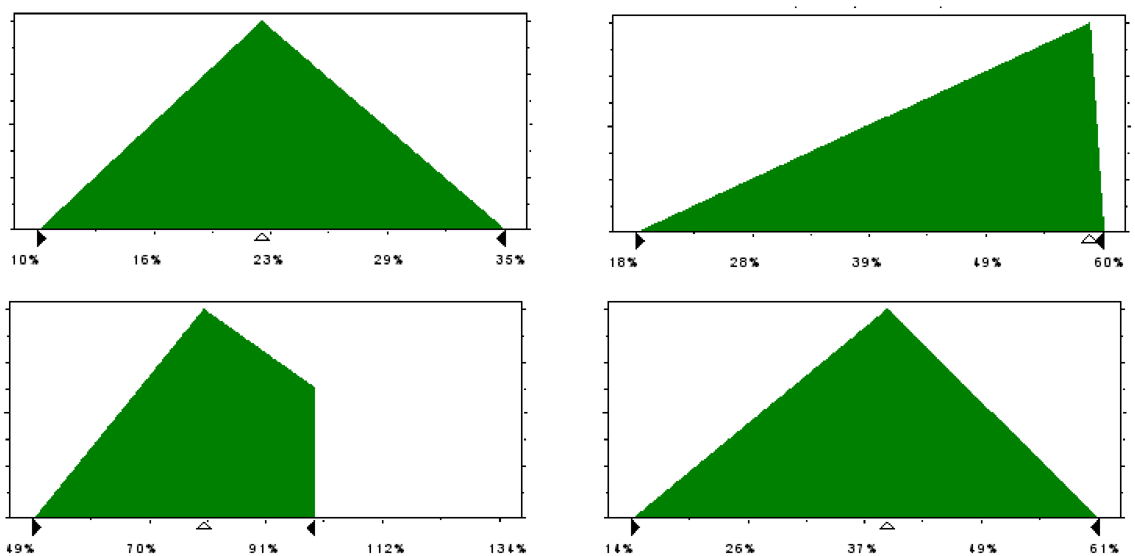
Financial Risk Assessment, Part I.1

Typical cash flow model subject to Monte Carlo financial assessment analysis

Parameter		Value
Service Speed (Kn)		27.0
Initial Cost (million €)		86
Power (kW)		44480.0
Fuel Consumption (t/h)		8.2
Passengers (Pax)		1600.0
Cars		640.0
Cabin beds		430.0
Financial Parameters	Owned Capital	40%
	Bank Loan	60%
	Interest Rate	Stochastic
Loan Period (years)		12
Vessel Fiscal Life (years)		20
Scrap Value (percentage of initial value)		5%
Administration Expenses (million €/year)		0.15
Insurance (percentage of initial value)		2%
Maintenance (million €/year)		Stochastic
Port Charges (€)		200
Dissemination Expenses (million €/year)		0.07
Annual Operational Days		300
Route Distance (n. miles)		147
1st Trimester	Operating Months	1
	Daily One Way Routes	2
	Complement of Pax/ Cars	Stochastic
2nd Trimester	Operating Months	3
	Daily One Way Routes	2
	Complement of Pax/ Cars	Stochastic
3rd Trimester	Operating Months	3
	Daily One Way Routes	2
	Complement of Pax/ Cars	Stochastic
4th Trimester	Operating Months	3
	Daily One Way Routes	2
	Complement of Pax/ Cars	Stochastic
Pax Fare (€)		22
Pax Fare/ Car Fare		0.5
Pax Fare/ Cabin Fare		1
Fuel Price (€)		Stochastic

Financial Risk Assessment, Part I.1

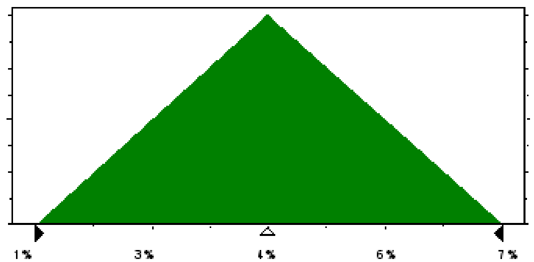
Typical cash flow model subject to Monte Carlo financial assessment analysis



Triangular Distributions for Passenger and Car Complement

Financial Risk Assessment, Part I.1

Typical cash flow model subject to Monte Carlo financial assessment analysis



Interest Rate i	
Minimum	1%
Likeliest	4%
Maximum	7%

Statistical parameters for interest rate Triangular Distribution

Financial Risk Assessment, Part I.1

Fiscal Year			-2	-1	1	2	3	4	5	6	7	8	9	10
Inflows	Earnings before Depreciation	Incomes	0.00	0.00	24.18	24.46	24.74	25.03	25.32	25.6	25.91	26.21	26.52	26.83
		Expenses	0.15	0.22	14.72	14.52	14.31	14.10	13.86	13.60	13.33	13.05	12.76	12.46
	Total Earnings		-0.15	-0.22	9.46	9.94	10.43	10.93	11.46	12.01	12.58	13.16	13.76	14.37
	Bank Loan		25.80	25.80										
	Asset Disposal (Scrap)		Not Applicable before the 20th Fiscal Year											
	Total Inflows		25.65	25.5	9.46	9.94	10.43	10.93	11.46	12.01	12.58	13.16	13.76	14.37
Outflows	Investment		43.00	43.00										
	Loan Installments				3.64	3.79	3.94	4.09	4.26	4.43	4.61	4.79	4.98	5.18
	Taxes												3.51	3.66
	Dividends												4.57	4.78
	Board of Director Payments												0.41	0.43
	Total Outflows		43.00	43.00	3.64	3.79	3.94	4.09	4.26	4.43	4.61	4.79	13.48	14.05
Free Cash Flow			-17.35	-17.42	5.82	6.16	6.50	6.84	7.20	7.58	7.97	8.37	0.28	0.31
Cumulative Cash Flow			-17.35	-34.77	-28.95	-22.79	-16.30	-9.46	-2.26	5.32	13.29	21.6	21.93	22.25

Cash flow for a scenario the mean values for a ten year fiscal period.

Financial Risk Assessment, Part I.1

Fiscal Year			-2	-1	1	2	3	4	5	6	7	8	9	10
Inflows	Earnings before Depreciation	Incomes	0.00	0.00	25.96	26.26	26.56	26.86	27.17	27.48	27.80	28.12	28.45	28.78
		Expenses	0.15	0.22	13.65	13.46	13.25	13.04	12.80	12.55	12.28	12.00	11.72	11.42
	Total Earnings			-0.22	12.31	12.80	13.31	13.82	14.36	14.93	15.52	16.12	16.73	17.36
	Bank Loan			25.80										
	Asset Disposal (Scrap)		Not Applicable before the 20th Fiscal Year											
	Total Inflows			25.58	12.31	12.80	13.31	13.82	14.36	14.93	15.52	16.12	16.73	17.36
Outflows	Investment			43.00										
	Loan Installments				3.64	3.79	3.94	4.09	4.26	4.43	4.61	4.79	4.98	5.18
	Taxes						0.65	0.78	0.92	1.07	1.22	1.37	4.27	4.43
	Dividends						0.85	1.02	1.20	1.39	1.58	1.78	5.56	5.77
	Board of Director Payments						0.08	0.09	0.11	0.13	0.14	0.16	0.50	0.52
	Total Outflows			43.00	3.64	3.79	5.52	5.99	6.49	7.01	7.55	8.10	15.31	15.90
Free Cash Flow			-17.35	-17.42	8.67	9.01	7.79	7.83	7.87	7.92	7.97	8.01	1.42	1.46
Cumulative Cash Flow			-17.35	-34.77	-26.10	-17.09	-9.30	-1.47	6.41	14.33	22.29	30.31	31.72	33.18

Cash flow for a second scenario the mean values for a ten year fiscal period.

Financial Risk Assessment, Part I.1

Deterministic output for owned capital NPV and IRR criteria

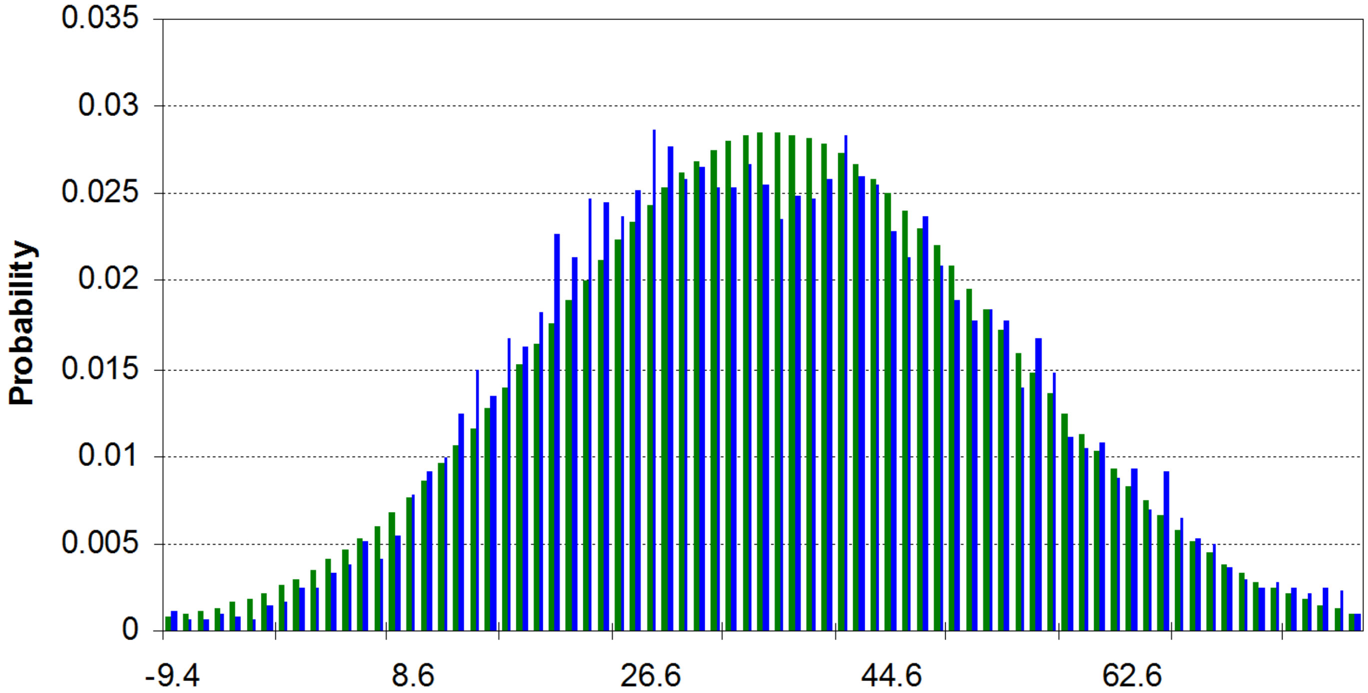
Deterministic Output	NPV	IRR
1st Scenario	38.58	14.56%
2nd Scenario	53.47	18.69%

Financial Risk Assessment, Part I.1

Descriptive Statistics for owned capital NPV and IRR criteria

Descriptive Statistics	NPV	IRR
Mean	35.99	13.85
Median	35.35	14.27
Standard Deviation	16.92	3.51
Variance	286.19	12.32
Skewness	0.17	-0.34
Kurtosis	2.84	2.56
Coeff. of Variability	0.47	0.25
Range Minimum	-21.15	1.44
Range Maximum	104.51	22.86
Range Width	125.65	21.42
Mean Std. Error	0.17	0.04

Financial Risk Assessment, Part I.1



Probability Distribution Function for NPV

Conclusions

Financial risk management is the practice of economic value in a firm by using financial instruments to manage exposure to risk, particularly credit risk and market risk. Other types include Foreign exchange, Shape, Volatility, Sector, Liquidity, Inflation risks, etc. Similar to general risk management, financial risk management requires identifying its sources, measuring it, and plans to address them.

Financial risk management can be qualitative and quantitative. As a specialization of risk management, financial risk management focuses on when and how to hedge using financial instruments to manage costly exposures to risk.