OSL Analytics Academy

Quantitative Risk Management

Fundamental Approaches

Fundamental Approaches

Quantitative Risk Management Business Simulations

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Content:

Fundamental Approaches

Quantitative Risk Management Business Simulations

- In this white paper, you can quickly visualise different techniques to perform quantitative risk management into business decisions
- The goal is to define **what** type quantitative methods, (including **when, how** and **why)** can be used to make informed decisions applying Monte Carlo Risk Simulations and Decision Analytics
- Understanding these quantitative approaches (static and dynamic analysis) you can identify and quantify risks, and develop relevant skills to be a successful risk management professional

INTRODUCTION

Understanding your numbers and models is a way to enhance better decisions

"Validate your assumptions"

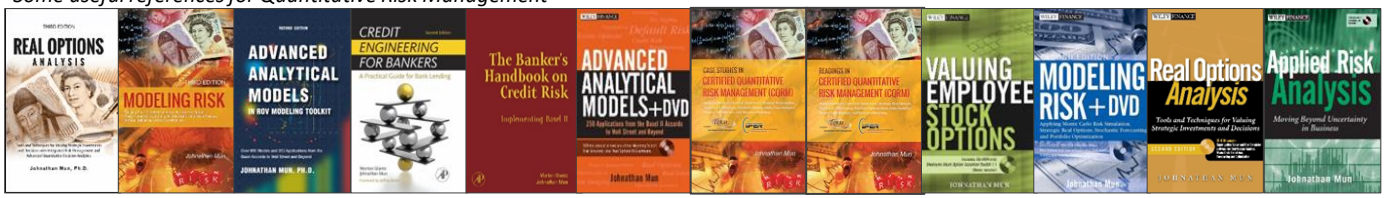
Dr. Elvis Hernandez-Perdomo,

PhD(Fin), PhD(EngSc), MIF, MSc, CQRM, AFHEA

LinkedIn

- Director and CEO of OSL Risk Management (UK)
- Academic Director of OSL Analytics Academy (UK)
- PhD in Finance (University of Hull) | PhD in Engineering Science
- 19+ years of experience in risk management and real options.
- Author | Inventor | Risk Specialist | Researcher

Some useful references for Quantitative Risk Management



Risk Quantification - A Sequential Path

1

DECISION MAKING MODEL

In the context of ***data-driven decision support***, Quantitative Risk Management relies on models (business, operational, financial or non-financial) to understand how uncertainty around inputs (variables) is propagated to outputs (Key Performance Indicators - KPIs). Without a numeric model, there is no risk quantification!

2

STATIC ANALYSIS & RISK IDENTIFICATION

This step is also called ***"What-if"*** analysis, a useful approach to determine how numeric variations in the model input impacts on the outputs (KPIs). These impacts can be ranked using Tornado Analysis to identify critical success factors across the decision-making model.

3

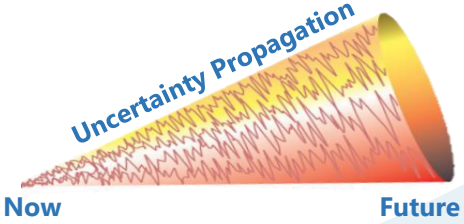
DYNAMIC ANALYSIS & RISK QUANTIFICATION

Using data, correlation, experiment design, theory, expert information, data fitting, and so on, you can identify and quantify how uncertainty in inputs can be propagated, using ***Monte Carlo Simulations***, to outputs (KPIs). To interpret these results, you require an understanding of statistical moments and percentiles.

4

SENSITIVITY ANALYSIS AND STRESS TESTING

While risk practitioners can use dynamic ***Sensitivity Analysis*** to determine the key risk drivers impacting the KPIs, ***Stress Testing*** helps to challenge assumptions, models, and results using extreme events and probabilistic scenarios



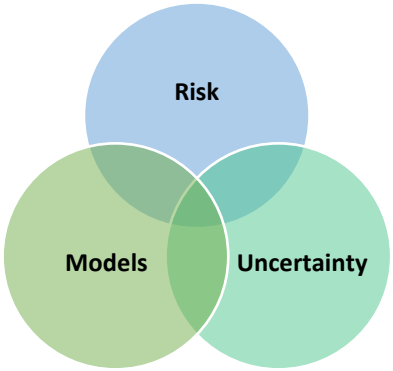
RISK-BASED DECISION MAKING

1

DECISION MAKING MODEL

Without uncertainty, there is no risk

- ✓ ***Risk Management*** needs to be integrated into business decisions. If managers are not considering risk management, then, in the end, it is going to be a risky decision.
- ✓ Without uncertainty, the output is fixed and known. No risk management is needed, unrealistic, isn't it?
- ✓ To support decisions when uncertainty exists and can be modelled and quantified, managers require understanding risk (down-side and up-side) and action to take. What can't be measured can't be managed!



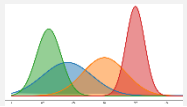
Risk quantification *relies on understanding uncertainty around inputs (Xi), and how it can be propagated toward output(s) (Y) by using a decision-making model (financial or non-financial) or process f(Xi). Any quantitative professional needs to set, validate and test the mathematical models and numerical relationships to describe the problem or system.*

2

STATIC ANALYSIS & RISK IDENTIFICATION

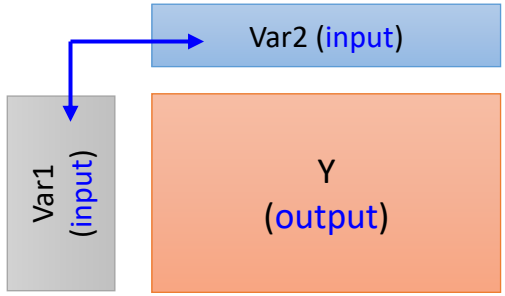
"What-if" analytical tools

- ✓ The ***first analytical tool*** is the well-known scenario analysis, which considers the variability of two inputs at-a-time.
- ✓ This type of static (deterministic) analysis allows obtaining numerical results associated with outputs or KPIs, usually reported in tables (matrices).
- ✓ *Key questions without answers*: How many scenarios can we consider?, What is the distribution associated with results?



Scenario Analysis (Process): select two inputs (variables), including ranges of variability, and see what happens with an output (KPI)

- Model: Y = Var1*Var2
- Var1 = [Min, Max]
- Var2 = [Min, Max]



Scenario Analysis (Example)

Var2

Var1	£70,000.00	£75,000.00	£80,000.00	£85,000.00	£90,000.00	£95,000.00	£100,000.00	£105,000.00
25.00%	£114,013.25	£110,013.25	£106,013.25	£102,013.25	£98,013.25	£94,013.25	£90,013.25	£86,013.25
30.00%	£66,274.15	£62,274.15	£58,274.15	£54,274.15	£50,274.15	£46,274.15	£42,274.15	£38,274.15
35.00%	£24,890.18	£20,890.18	£16,890.18	£12,890.18	£8,890.18	£4,890.18	£890.18	-£3,109.82
40.00%	-£10,592.60	-£14,592.60	-£18,592.60	-£22,592.60	-£26,592.60	-£30,592.60	-£34,592.60	-£38,592.60
45.00%	-£40,628.13	-£44,628.13	-£48,628.13	-£52,628.13	-£56,628.13	-£60,628.13	-£64,628.13	-£68,628.13
50.00%	-£65,670.35	-£69,670.35	-£73,670.35	-£77,670.35	-£81,670.35	-£85,670.35	-£89,670.35	-£93,670.35
55.00%	-£86,173.19	-£90,173.19	-£94,173.19	-£98,173.19	-£102,173.19	-£106,173.19	-£110,173.19	-£114,173.19
60.00%	-£102,590.60	-£106,590.60	-£110,590.60	-£114,590.60	-£118,590.60	-£122,590.60	-£126,590.60	-£130,590.60

Output (Y)

Risk Simulator

*Although numerical results associated with the outputs can validate risk models by providing ranges of impacts, **Scenario Analysis** does not show probabilistic information about these impacts. In real case studies, decision-makers can consider many combinations (data, range of variability, and key variables). Consequently, this type of static analysis can be time-consuming while the period to make a decision is usually short.*

SCENARIO ANALYSIS (DETERMINISTIC APPROACH)

2

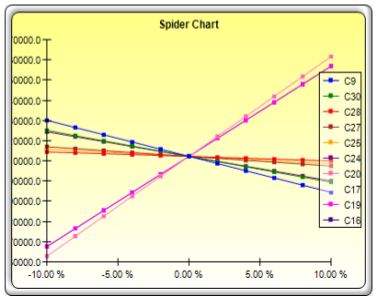
STATIC ANALYSIS & RISK IDENTIFICATION

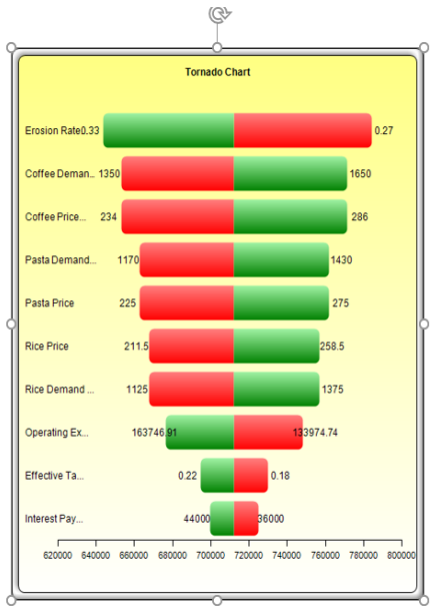
"What-if" analytical tools

- ✓ ***Tornado Analysis*** is also a type of static analysis. However, decision-makers can get the relevance of scenarios using the variability around inputs and their impacts on outputs.
- ✓ In a risk quantification context, tornado analysis helps to identify critical success factors. This approach can help decision-makers to focus on uncertainty analysis and support the risk quantification process.
- ✓ Tornado Analysis can help to identify correlations between inputs and outputs (*see spider charts*).

Risk Simulator

	Base Value: 712277.72712			Input Changes		
Precedent Cell	Output Downside	Output Upside	Effective Range	Input Downside	Input Upside	Base Case Value
C8: Erosion Rate COVID	784252.24	643680.51	140571.73	27.00%	33.00%	30.00%
C18: Coffee Demand (Q)	653005.53	771549.93	118544.40	1,350.00	1,650.00	1,500.00
C15: Coffee Price	653005.53	771549.93	118544.40	£234.00	£286.00	£260.00
C20: Pasta Demand (Q)	662884.23	761671.23	98787.00	1,170.00	1,430.00	1,300.00
C17: Pasta Price	662884.23	761671.23	98787.00	£225.00	£275.00	£250.00
C16: Rice Price	667633.6	756921.85	89288.25	£211.50	£258.50	£235.00
C19: Rice Demand (Q)	667633.6	756921.85	89288.25	1,125.00	1,375.00	1,250.00
D24: Operating Expenses	748004.32	676551.13	71453.20	£133,974.74	£163,746.91	£148,860.82
C9: Effective Tax Rate	730084.67	694470.78	35613.89	18.00%	22.00%	20.00%
C30: Interest Payments	725077.73	699477.73	25600.00	£36,000.00	£44,000.00	£40,000.00
C24: Operating Expenses	724429.63	700125.82	24303.81	£136,708.92	£167,088.68	£151,898.80
D25: SG&A Costs	722995.71	701559.75	21435.96	£40,192.42	£49,124.07	£44,658.25
C27: Depreciation	717077.73	707477.73	9600.00	£13,500.00	£16,500.00	£15,000.00
C25: SG&A Costs	715923.3	708632.16	7291.14	£41,012.68	£50,126.60	£45,569.64
C28: Amortization	714517.73	710037.73	4480.00	£6,300.00	£7,700.00	£7,000.00





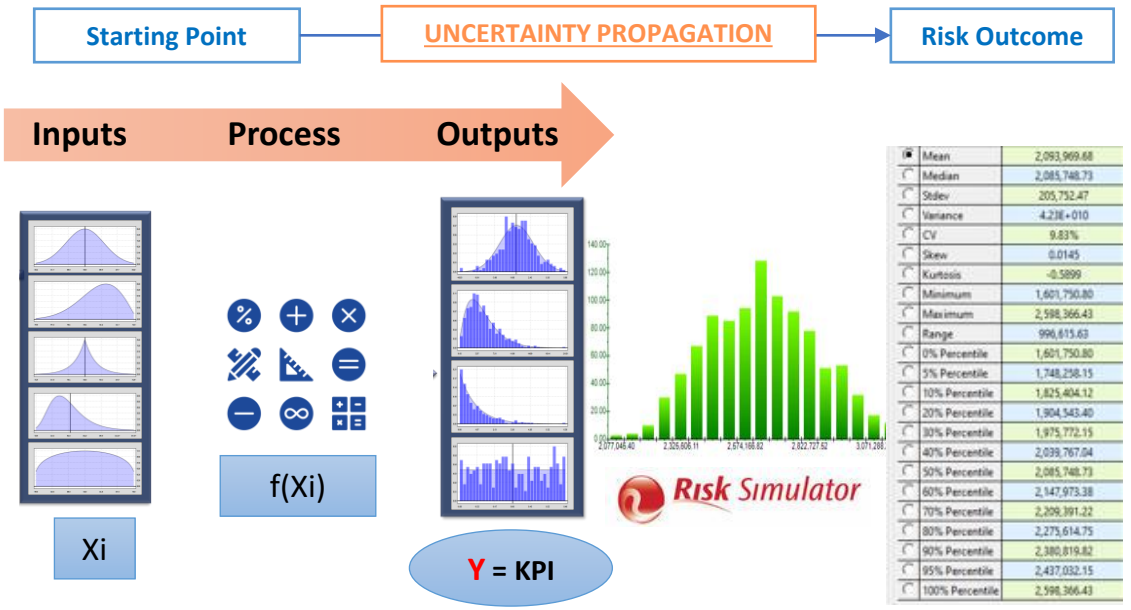
Tornado Analysis captures static impacts of each variable (input) on the outcome of the model (output). Each variable is perturbed (one-at-a-time) in the static (deterministic) model, and a tornado chart captures the fluctuation on the model's forecast. Please note that Static Analysis is implemented BEFORE running a simulation (no uncertainty analysis is required).

3

DYNAMIC ANALYSIS & RISK QUANTIFICATION

Monte Carlo Risk Simulation

- ✓ Using tornado charts, historical data, data fitting, correlation, experiments, theory, expert information, probability distribution functions and so on, is possible to understand and quantify uncertainty, and propagate it across the dynamic models to analyse risk profiles for outputs, forecasts, or KPIs.
- ✓ Monte Carlo Simulation is an important technique to quantify uncertainty by using random numbers around the inputs or random variables.
- ✓ It is your role in understanding the outcomes of the simulations!



*Using **Monte Carlo risk simulations**, it is possible to obtain risk profiles and determine confidence intervals and statistics measurements (i.e., expected values, most likely, volatility, percentiles, and so on) associated with outputs or KPIs. They are risk indicators for data analysis and risk quantification. Accordingly applying these metrics is vital to support decisions under risk and uncertainty.*

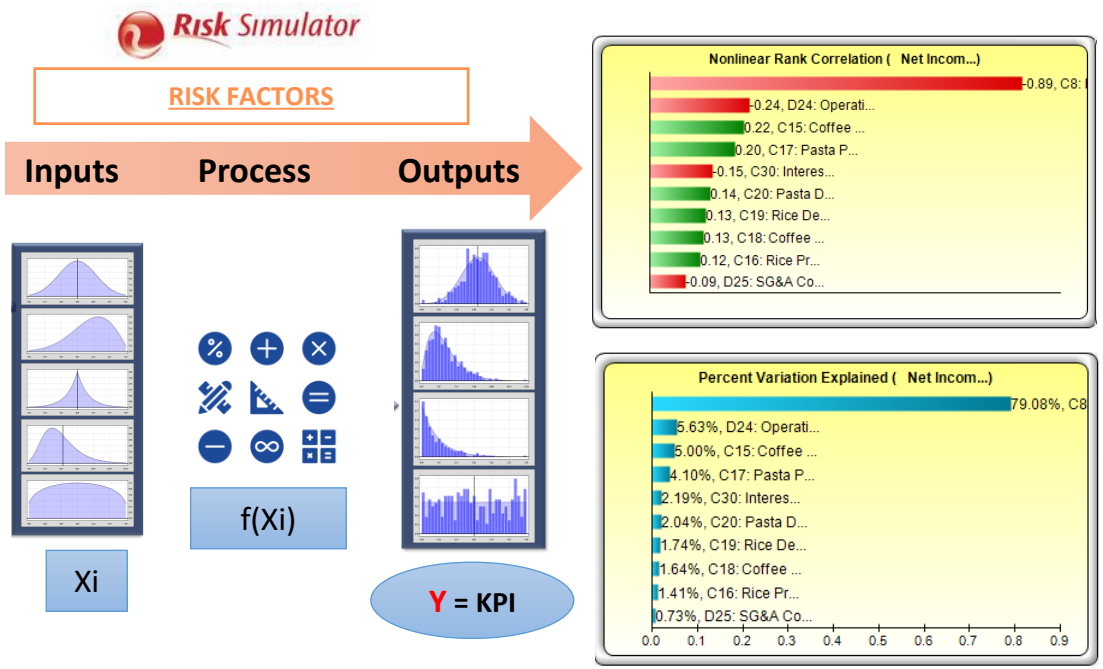
RISK QUANTIFICATION (PROBABILISTIC APPROACH)

4

SENSITIVITY ANALYSIS AND STRESS TESTING

Variance contribution (risk factors)

- ✓ After running Monte Carlo Simulations, risk practitioners need to use ***Dynamic Sensitivity Analysis*** to determine critical risk factors associated with those inputs affecting KPIs' variability.
- ✓ Note that the variance contribution is required to analyse risk factor and results, and nonlinear correlation coefficients are needed to determine the degree of relationship between inputs and outputs.
- ✓ Get what is definitively relevant to your mitigation plans!



Sensitivity Analysis *allows assessing perturbations created after the simulation run (dynamic analysis), where multiple assumptions (inputs) are perturbed simultaneously, and their interactions are captured in the fluctuations of the results (outputs). While Nonlinear Rank Correlation indicates correlations between each input and the output, Percent Variation Explained computes how much of the output variability can be explained by the variations in each of the assumptions during the uncertainty propagation.*

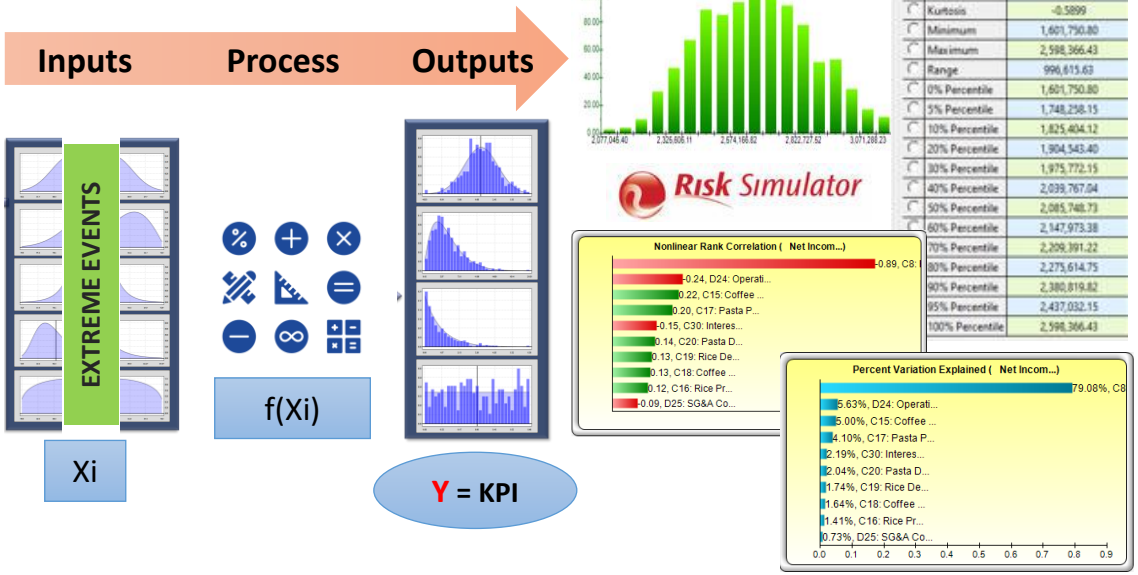
4

SENSITIVITY ANALYSIS AND STRESS TESTING

Challenging the Risk Quantification Process

- ✓ Either because there is a relevant input or variable that matters during the decision-making process, or because the theory or the dynamic sensitivity analysis emphasises a specific risk driver, ***Stress Testing*** helps to challenge assumptions, risk models, and results.
- ✓ In other words, stress testing helps to challenge the risk quantification process when extreme events can take place (i.e., disruption, pandemic, etc.)

FORWARD-LOOKING RISK MODELLING



Stress Testing *is a forward-looking risk management tool – allows estimating the potential impacts of extreme events, or scenarios, on your risk profiles or KPIs. Stress Testing cannot be confused with traditional scenarios analysis, both scenario analysis and tornado analysis are before simulations, and dynamic sensitivities and stress testing require Monte Carlo simulations.*

STRESS TESTING (PROBABILISTIC APPROACH)

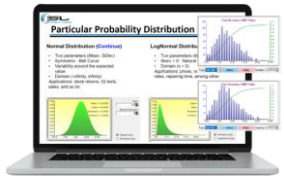
ONLINE MASTERCLASS

Quantitative Risk Management

Green Belt in Business Simulations

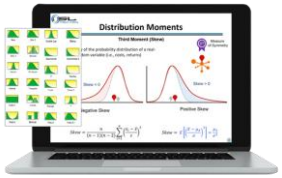
Find more about risk management and business simulations in this Free Masterclass: OSL Analytics Academy

5 Steps to
UNLEASHING YOUR POTENTIAL IN RISK MANAGEMENT



Unit I
Introduction to Risk Modelling

- Uncertainty and Risk Management
- Introduction to Probability and Monte Carlo Simulations
- Hands-on Risk Simulator Software



Unit II
Risk Measurements and Data Analysis

- Statistical Moments
- Risk Measurement
- Data Analysis
- Distribution Fitting

Unit III
Correlation and Sensitivity Analysis

- Correlation Analysis
- Correlation and Risk Management
- Tornado Analysis
- Dynamic Sensitivity Analysis
- Critical Success Factors and Risk Drivers

Unit IV
Risk Profiles and Stress Testing

- Risk Profiles
- Stochastic Dominance
- Analytical Tools
- Stress Testing
- Critical Success Factors and Risk Driver

Unit V
Applied Case Studies

- Final Review & Lessons Learned
- Performing Due Diligence
- Case Study 1: Pricing and Cost Analysis
- Case Study 2: Financial Performance and Business Forecasting

Quantitative Risk Management

Green Belt in Business Simulations

Testimonials

"As a Fellow CQRM, initially, I thought the Green Belt in Business Simulation was going to be a pushover, but it turned out to be a dynamo. The case studies and practical lessons were fantastic. The course will challenge your thinking and ensure you have a great grasp of quantifying your risk management practice, analysing and providing valid quantitative outcomes that support the decision-making process."

★★★★★

Chief Risk Officer
Monday Utomwen

"Dr. Elvis unique approaches of teaching and systematic presentation of key concepts and practical methods even makes the course more engaging and informative. I will absolutely recommend this course to everyone who wants an in-depth understanding about the best way of managing and mitigating risk."

★★★★★

Lecturer in Accounting and Finance
Dr. Rexford Attah-Boakye

"A good balance of statistical modelling for beginners, introducing more advanced techniques to aid understanding and application of quantitative risk management to support effective and intelligent decisions. The instructor is very knowledgeable and helpful. An overall enjoyable and educational course."

★★★★★

Civil Servant - UK Ministry of Defense
Adam Thiery

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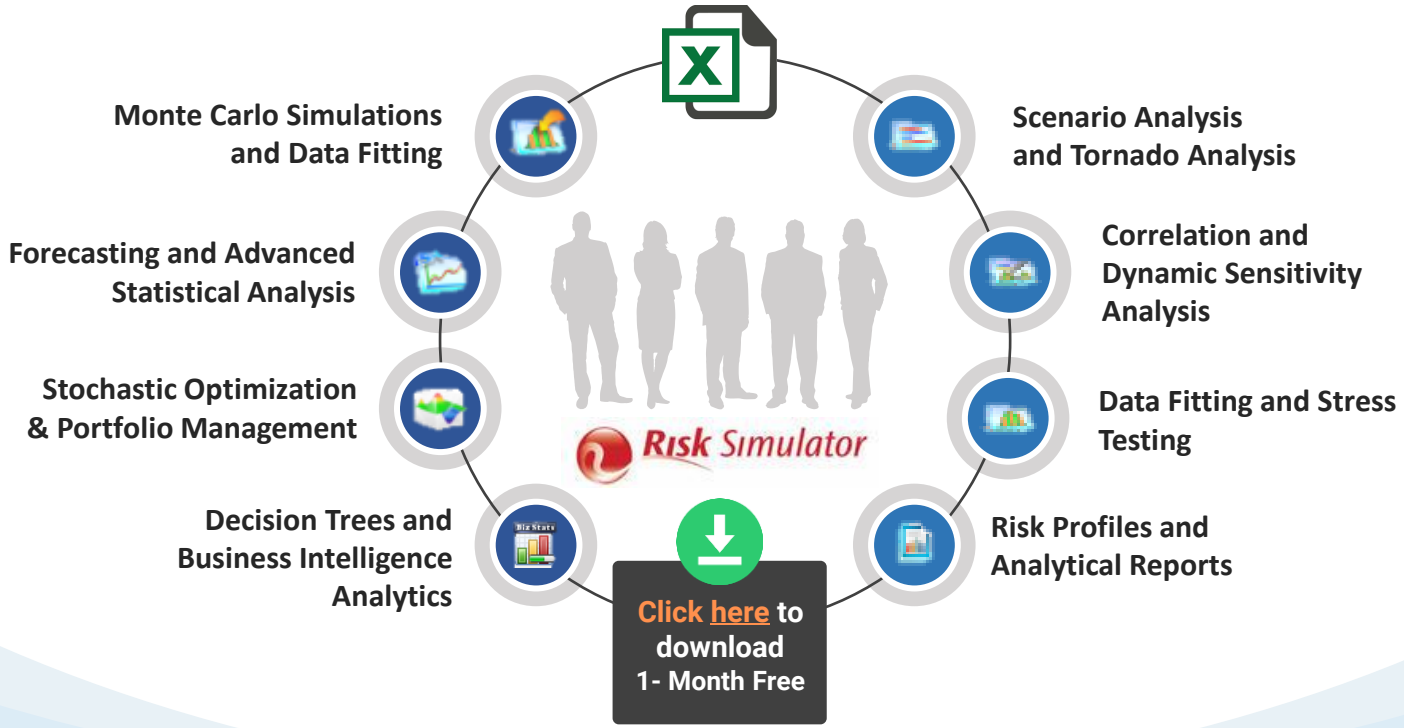
Risk Simulator

Integrate Risk Quantification into Business Decisions with this advanced analytics software and your existing Excel models.

RISK QUANTIFICATION SOFTWARE

Quantitative Methods

Analytical Tools



Never Stop Managing Your Risks!

Risk-Based Decisions

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