COMPLIANCE WITH GLOBAL STANDARDS: BASEL, COSO, ISO, NIST, & SARBOX

The Enterprise Risk Management (ERM) methods deployed by any organization should at least consider compliance with global standards if not exactly mirroring COSO (Committee of Sponsoring Organizations of the Treadway Commission, with respect to their organizing committees at AAA, AICPA, FEI, IMA, and IIA), International Standards ISO 31000:2009, the U.S. Sarbanes–Oxley Act, the Basel III requirements for Operational Risk (from the Basel Committee through the Bank of International Settlements), and NIST 800-37. The parallels and applications of ROV methodologies closely mirror these regulatory and international standards and, at times, exceed these standards. Figures 1-10 illustrate some examples of compliance with ISO 31000:2009, and Figures 11-20 show compliance with Basel II and Basel III requirements. These figures and the summary lists below assume that the reader is already familiar with the IRM methodology employed by Real Options Valuation, Inc.

Compliance with International Standards Organization ISO 31000:2009

The following provides a quick summary pertaining to ISO compliance:

- The IRM methodology we employ is in line with ISO 31000:2009 Clauses 2.3 and 2.8 requiring a risk management process (Figure 1), as well as Clause 5 (5.4.2 requiring risk identification where we use Tornado analysis and scenario analysis; 5.4.3. requiring quantitative risk analysis where we apply Monte Carlo risk simulations; 5.4.4 where existing Excel-based evaluation models are used and overlaid with IRM methodologies such as simulations; etc.). See *Modeling Risk, 3rd Edition's* Chapter 1 for details on the IRM methodology.
- ISO 31000:2009 Clause 5.4.4 looks at the risk tolerance levels and comparing various risk levels in a portfolio optimization and efficient frontier analysis employed in our IRM methodology (Figure 2). See *Modeling Risk, 3rd Edition's* Chapters 10 and 11 for optimization and efficient frontier modeling.
- Figure 3 shows quantified consequences and the likelihoods (probabilities and confidence levels) of potential events that can occur using simulations, as required in ISO 31000:2009 Clauses 2.1 and 5.4.3.
- ISO 31000:2009 Clause 5.4.3 requires viewing the analysis from various stakeholders, multiple consequences, and multiple objectives to develop a combined level of risk. This perspective is achieved through a multicriteria optimization and efficient frontier analysis (Figure 4) in the IRM process. See *Modeling Risk, 3rd Edition's* Chapters 10 and 11 for optimization and efficient frontier modeling.
- ISO 31000:2009 Clause 3F requires that historical data and experience as well as stakeholder feedback and observation coupled with expert judgment be used to forecast future risk events. The IRM process employs a family of 16 forecasting methods (Figure 5 shows an example of the ARIMA model) coupled with risk simulations with high fidelity to determine the best goodness-of-fit when historical data exists, or using subject matter expert estimates and stakeholder assumptions, we can apply the Delphi method and custom distribution to run risk simulations on the forecasts. See *Modeling Risk, 3rd Edition's* Chapters 8 and 9 for forecast methods and analytical details.

- ISO 31000:2009 Clauses 3C, 5.4.3, 5.5, and 5.5.2 require risk evaluations on risk treatments, options to execute when there are different types of risks, and selecting and implementing various risk treatment strategic options that are not solely reliant on economics. The IRM's strategic real options methodology allows users to model multiple path-independent and path-dependent implementation strategies or alternate courses of action that are generated to mitigate downside risks and take advantage of upside potentials (Figure 6). See *Modeling Risk, 3rd Edition's* Chapters 12 and 13 for details on real options analysis modeling techniques.
- Figure 7 illustrates how ISO 31000:2009 Clauses 3D, 3E, and 5.4.3 are satisfied using the IRM process of probability distribution fitting of uncertain variables and how their interdependencies (correlations) are executed.
- Risk controls are required in ISO 31000:2009 Clauses 2.26, 4.43, and 5.4.3 (Figure 8). The control charts and Risk Effectiveness calculations in PEAT ERM help decision makers identify if a particular risk mitigation strategy and response that was enacted had sufficiently and statistically significantly affected the outcomes of future risk states.
- Scenarios, cascading, and cumulative effects (consequences) are also the focus of ISO 31000:2009 Clause 5.4.2. The IRM method employs Tornado analysis, scenario analysis, dynamic sensitivity analysis, and risk simulations (Figure 9) to identify which input(s) have the highest impact on the organization's risks and model their impacts on the total risks of the organization.
- ISO 31000:2009 Clause 5.2 requires proper communication of risk exposures and consequences, and an understanding of the basis and reasons of each risk. The PEAT ERM Risk Dashboards provide details and insights for a better understanding of the issues governing each of the risk issues in an organization (Figure 10).

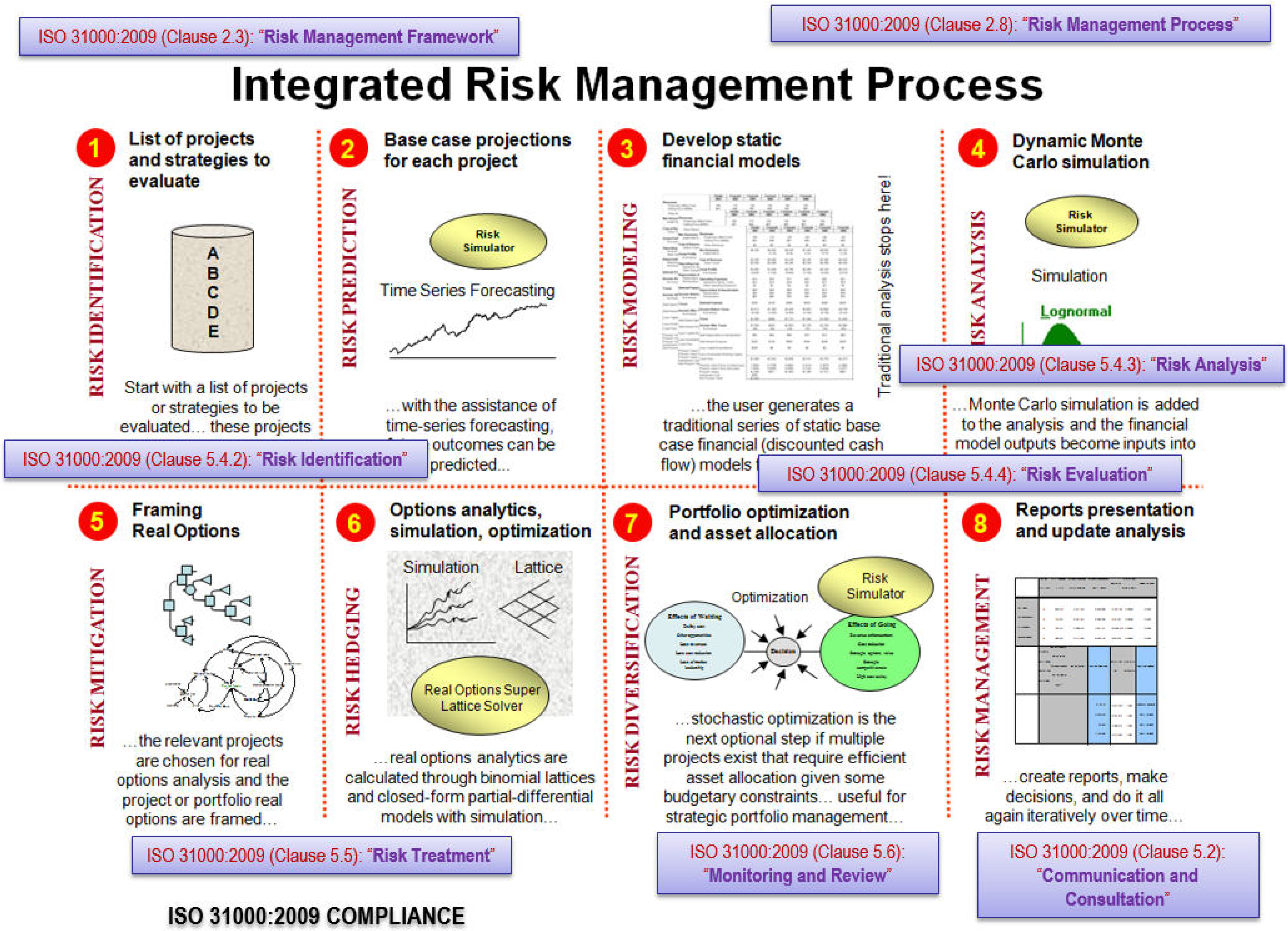


FIGURE 1 ISO 31000:2009—IRM.

Investment Efficient Frontiers analysis provides for a variety of budget scenarios when considering portfolios of options

Budget	Comprehensive Score	Tactical Score	Military Score	Allowed Projects	ROI-RANK Objective
$3,800.00	33.15	62.64	58.58	10	$470,235.60
$4,800.00	36.33	68.85	66.86	11	$521,645.92
$5,800.00	38.40	70.46	75.69	12	$623,557.79
$6,800.00	39.94	72.14	82.31	13	$659,947.99
$7,800.00	39.76	70.05	86.54	14	$676,279.81

ISO 31000:2009 (Clause 5.4.4): "Risk evaluation involves **comparing the level of risk found** during the analysis process with **risk criteria established** when the context was considered. Based on this comparison, the need for treatment can be considered. Decisions should take account of the wider context of the risk and include consideration of the **tolerance of the risk borne** by parties other then the org that benefits from the risk."

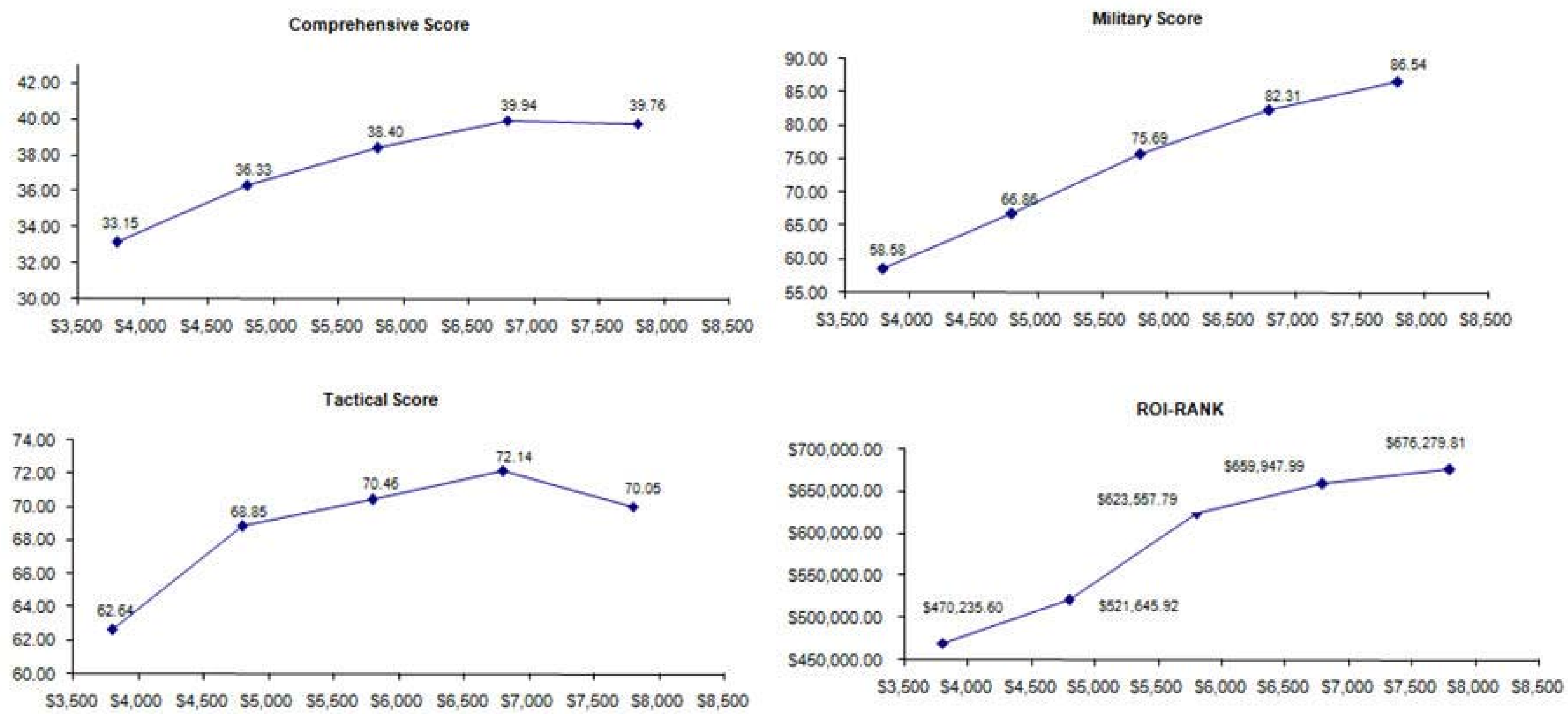


FIGURE 2 ISO 31000:2009—risk tolerance.

Risk Simulation provides the decision maker with additional data

ISO 31000:2009 (Clause 5.4.3): "Factors that affect **consequences and likelihood** should be identified. Risk is analyzed by determining consequences and their likelihood, and other attributes of the risk."

ISO 31000:2009 (Clause 2.1): "Risk is often characterized by reference to **potential events** (2.17) **and consequences** (2.18), or a combination of these."

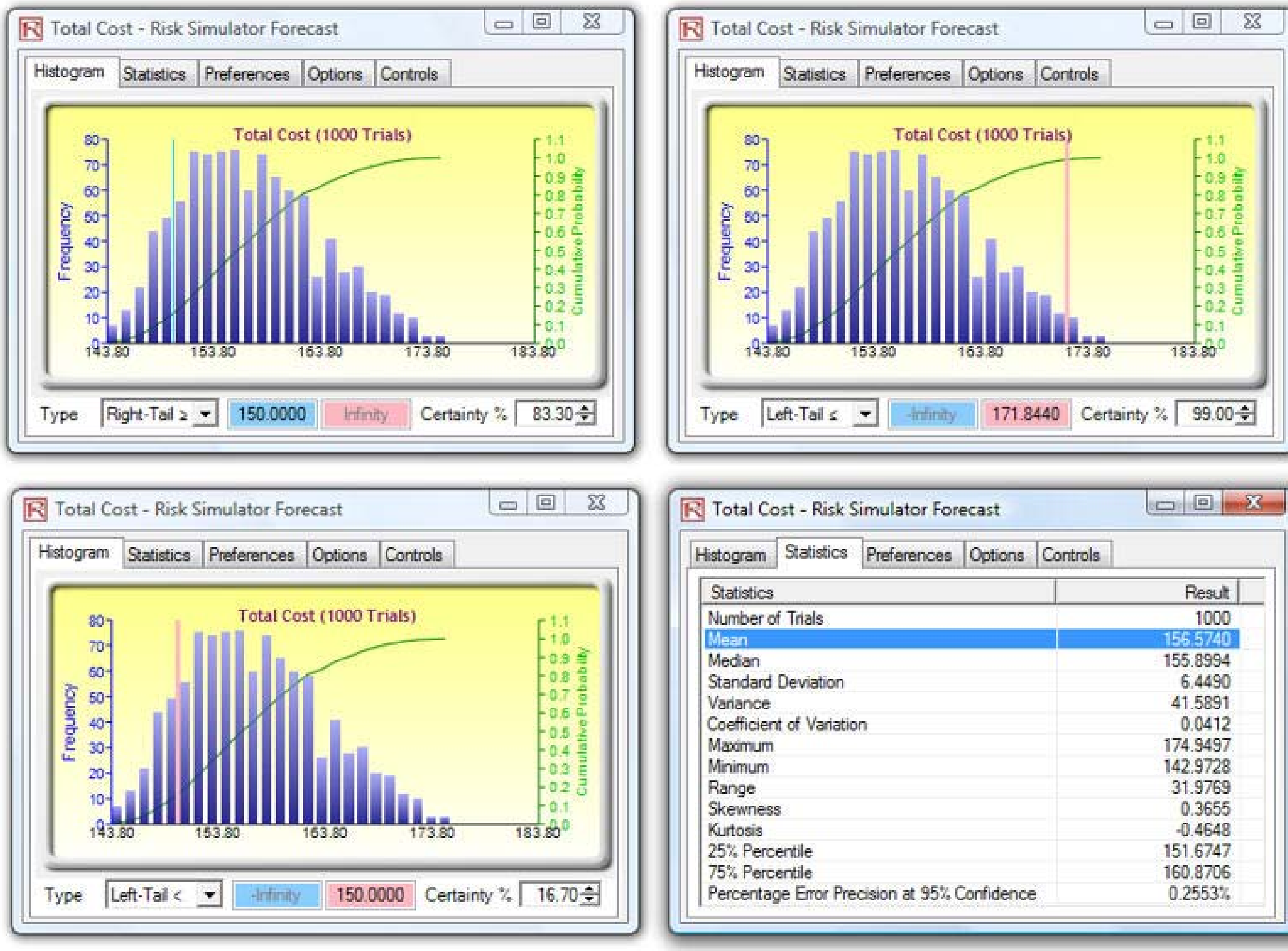


FIGURE 3 ISO 31000:2009—consequences and likelihood.

ISO 31000:2009 (Clause 5.4.3): "An event can have **multiple consequences** and can affect **multiple objectives**. The way in which consequences and likelihood are expressed and the way in which they are **combined determine a level of risk...**"

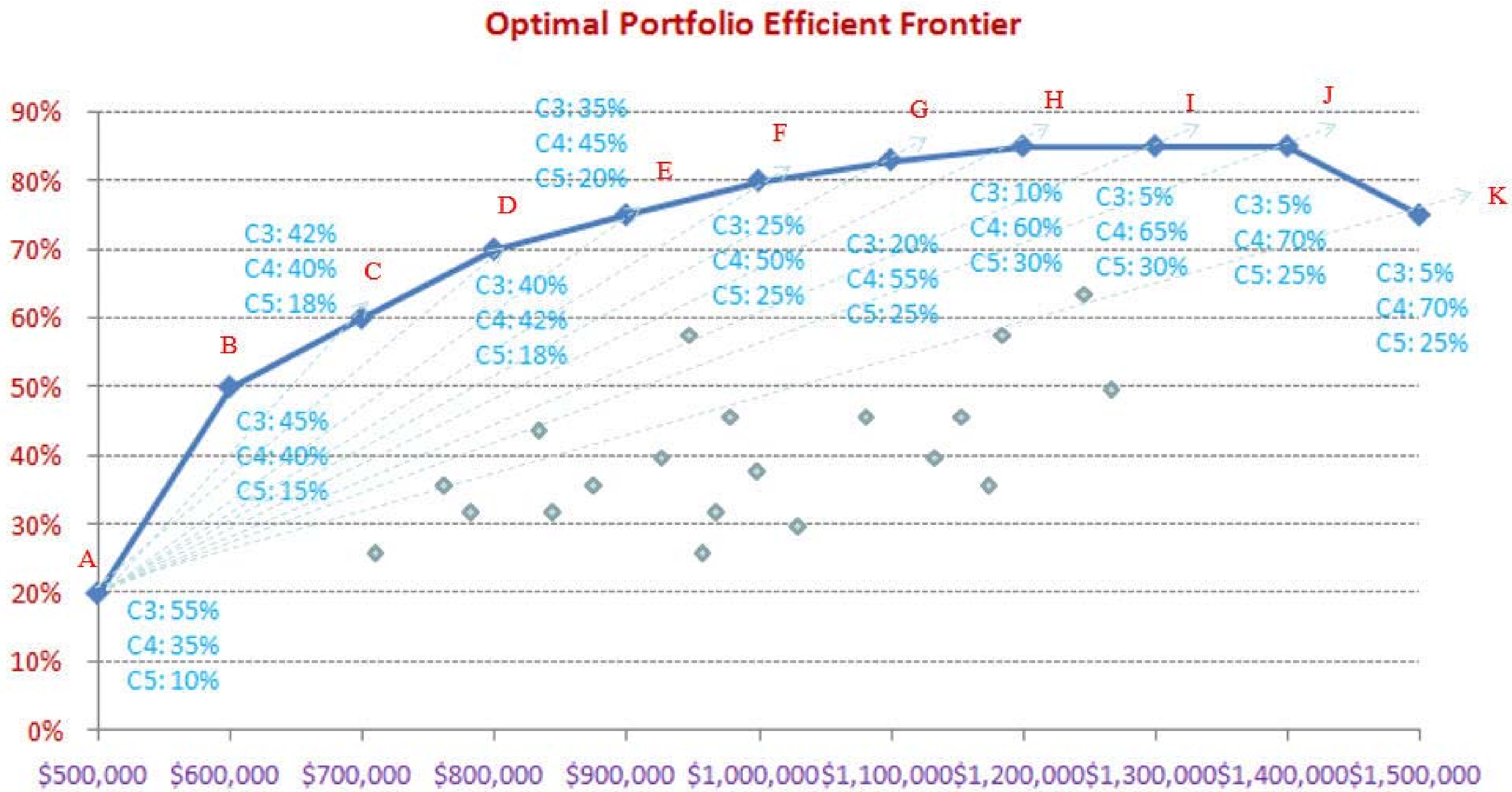


FIGURE 4 **ISO 31000:2009—multiple stakeholder objectives and consequences.**

ACTUAL SALES VS. ECONOMETRIC FORECAST
With linkage to the overall economy indicators

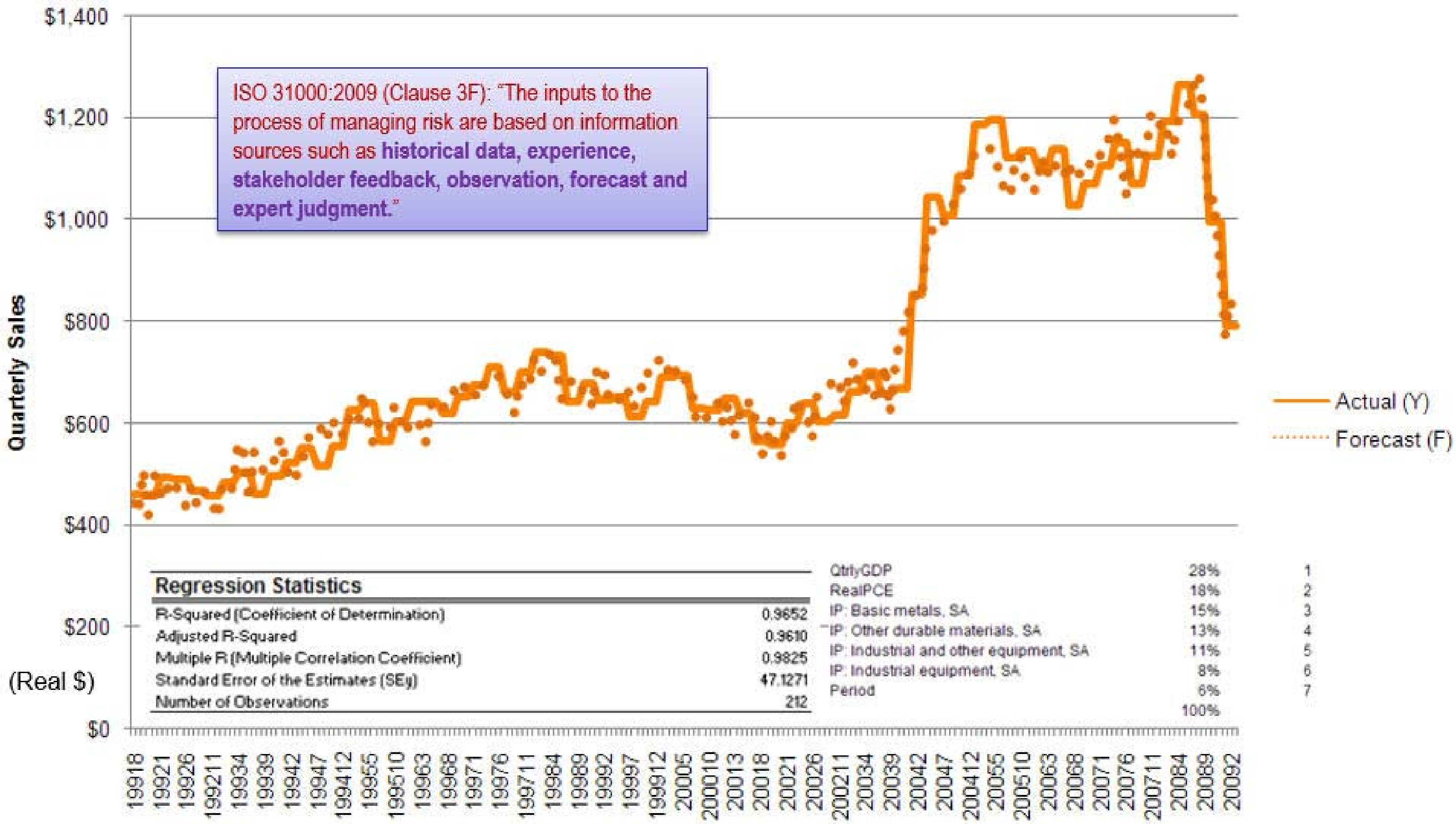


FIGURE 5 ISO 31000:2009—historical data and future forward forecast.

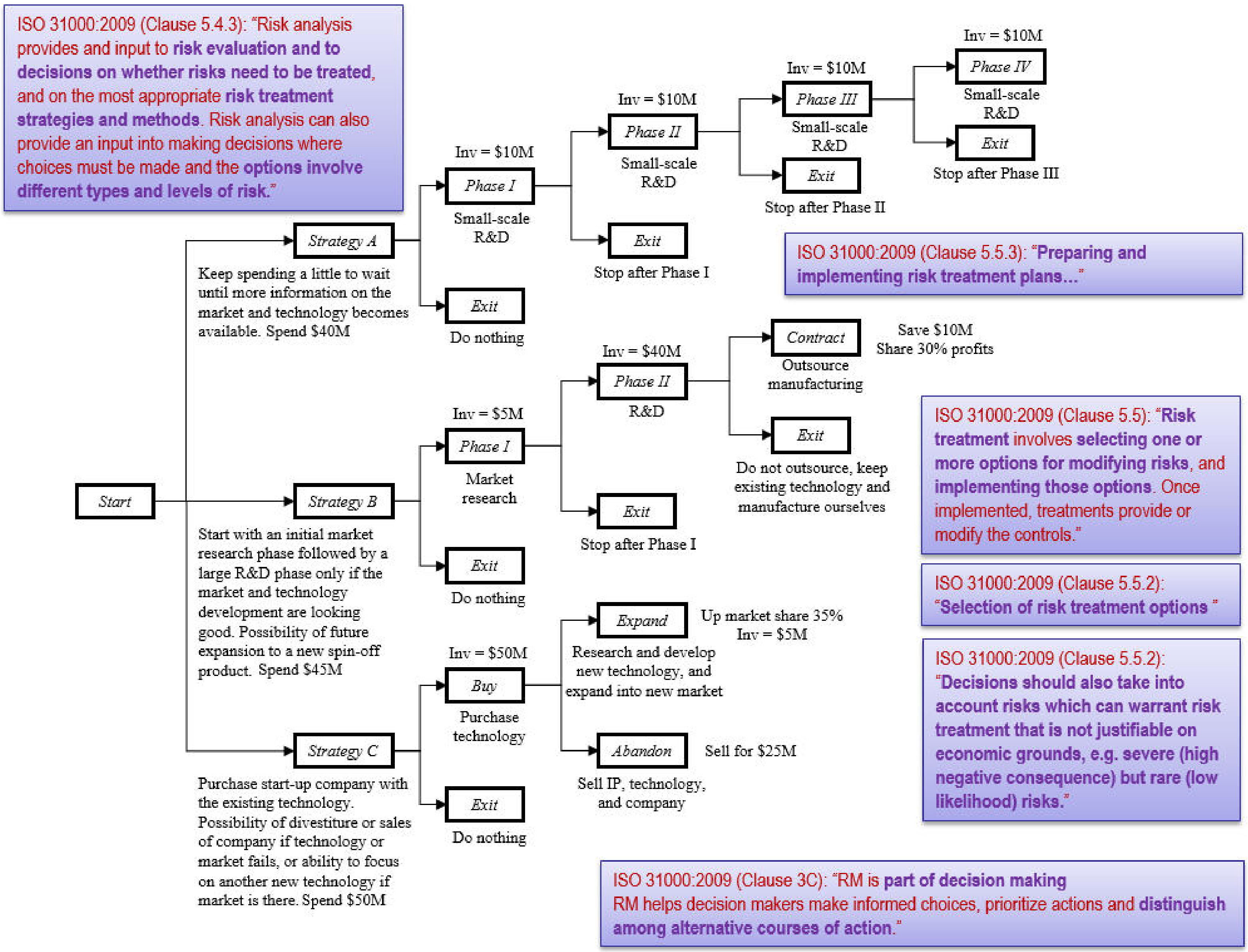


FIGURE 6 **ISO 31000:2009—multiple options, strategies, and alternatives.**

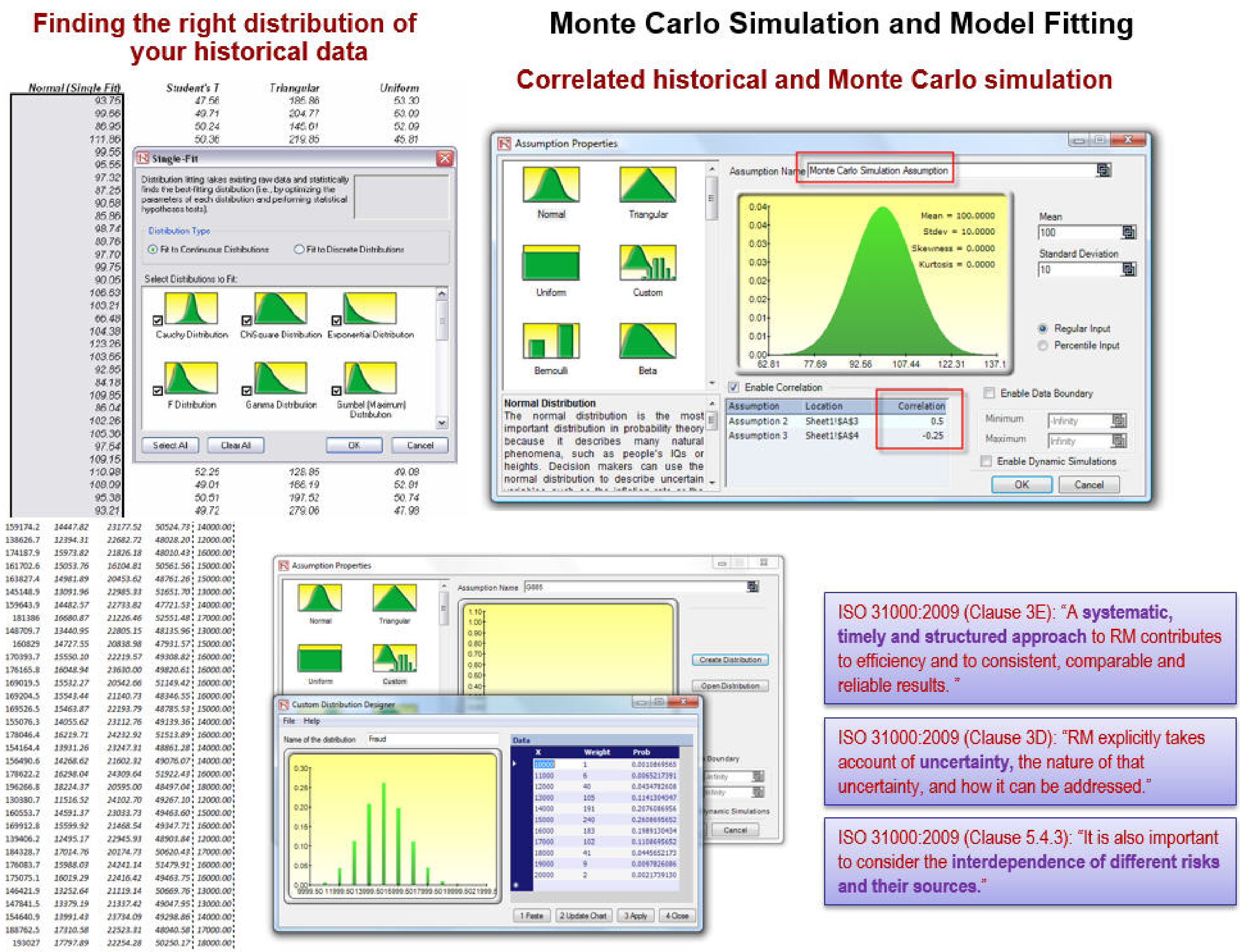


FIGURE 7 ISO 31000:2009 structured approach, fitting, and correlations.

FIGURE 8 **ISO 31000:2009—risk control efficiency and effectiveness.**

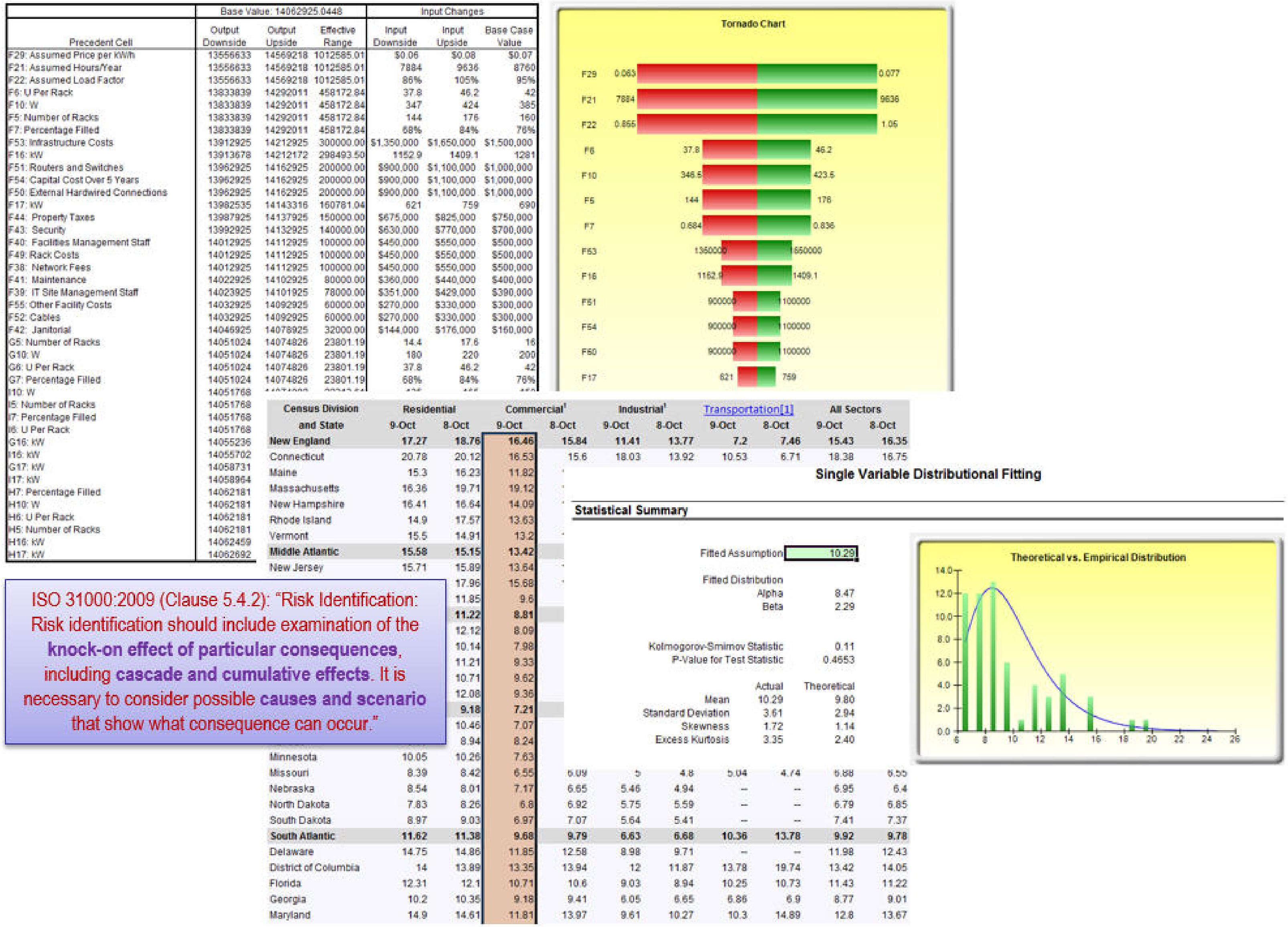


FIGURE 9 **ISO 31000:2009—consequences, cascades, and scenarios.**

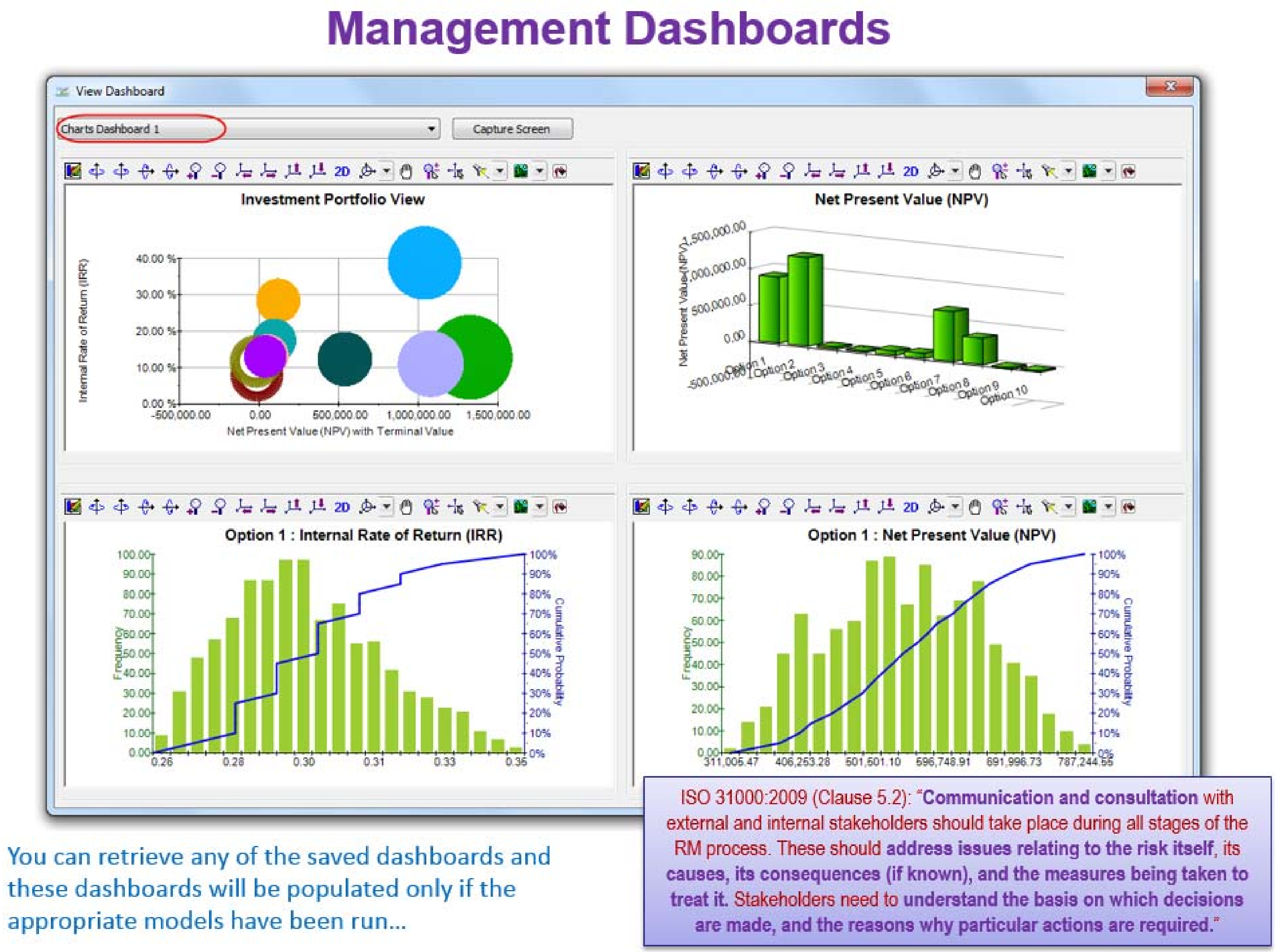


FIGURE 10 ISO 31000:2009—communication and consultation.

Compliance with Basel II and Basel III Regulatory Requirements

The following provides a summary of Basel II and Basel III compliance when using the IRM methodology:

- Figure 11 shows Monte Carlo risk simulations applied to determine confidence levels, percentiles, and probabilities of occurrence using historically fitted data or forecast expectations. These methods are in line with Basel II and Basel III requirements Sections 16 and 161 concerning the use of historical simulations, Monte Carlo simulations, and 99th percentile confidence intervals. See *Modeling Risk, 3rd Edition's* Chapters 5 and 6 for details on simulations and data fitting techniques.
- Figure 12 shows a correlated simulation of a portfolio of assets and liabilities, where asset returns are correlated against one another in a portfolio and optimization routines were run on the simulated results. These processes provide compliance with Basel II and Basel III requirements Sections 178, 232, and 527(f) involving correlations, Value at Risk or VaR models, portfolios of segments, and pooled exposures (assets and liabilities). See *Modeling Risk, 3rd Edition's* Chapter 5 for correlated simulations and Chapter 7's case study on Basel II and Basel III Credit, Market, Operational, and Liquidity Risks with Asset Liability Management for details on how VaR models are computed based on historical simulation results.
- Figure 13 shows Value at Risk percentile and confidence calculations using structural models and simulation results that are in line with Basel II and Basel III requirements Sections 179, 527(c), and 527(f). As noted above, see *Modeling Risk, 3rd Edition's* Chapter 7's case study for details on how VaR models are computed based on historical simulation results.
- Figure 14 shows the computations of probability of default (PD) as required in the Basel Accords, specifically Basel II and Basel III Section 733 and Annex 2's Section 16. PD can be computed using structural models or based on historical data through running basic ratios to more advanced binary logistic models. *Modeling Risk, 3rd Edition's* Chapter 7's case study as well as Chapter 14's *Credit and Market Risk* case study provide more insights into how PD can be computed using these various methods.
- Figure 15 shows the simulation and generation of interest rate yield curves using Risk Simulator and Modeling Toolkit models. These methods are in line with Basel II and Basel III requirements Section 763 requiring the analysis of interest rate fluctuations and interest rate shocks.
- Figure 16 shows additional models for volatile interest rate, financial markets, and other liquid instruments' instantaneous shocks using Risk Simulator's stochastic process models. These analyses conform to Basel II and Basel III requirements Sections 155, 527(a), and 527(b).
- Figure 17 shows several forecast models with high predictive and analytical power, which is a part of the Risk Simulator family of forecast methods. Such modeling provides compliance with Basel II and Basel III requirements Section 417 requiring models of good predictive power.
- Figure 18 shows the list of financial and credit models available in the ROV Modeling Toolkit and ROV Real Options SLS software applications. These models conform to Basel II and Basel III requirements Sections 112, 203, and 527(e) requiring the ability to value over-the-counter (OTC) derivatives, nonlinear equity derivatives, convertibles, hedges, and embedded options.
- Figure 19 shows the modeling of foreign exchange instruments and hedges to determine the efficacy and effectiveness of foreign exchange hedging vehicles and their impact on valuation, portfolio profitability, and VaR, in line with Basel II and Basel III Sections 131 and 155 requiring the analysis of different currencies, correlations, volatility, and hedges.
- Figure 20 shows the option-adjusted spread (OAS), credit default swaps (CDS), and credit spread options (CSO) models in ROV Modeling Toolkit. These models provide compliance with Basel II and Basel III requirements Sections 140 and 713 pertaining to modeling and valuing credit derivatives and credit hedges.

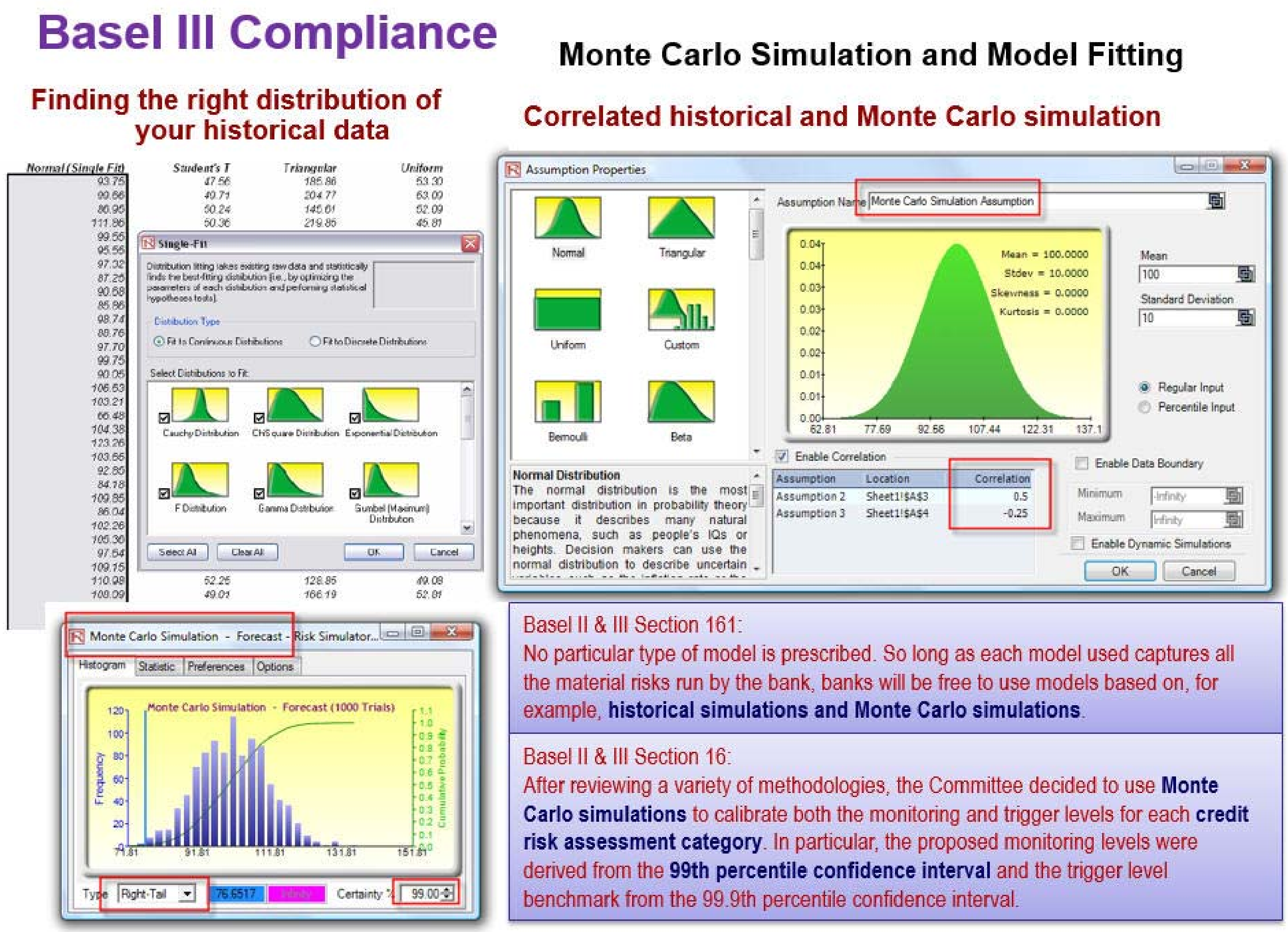


FIGURE 11 **Basel II/III confidence levels, Monte Carlo simulations, and credit risk.**

Basel III Compliance

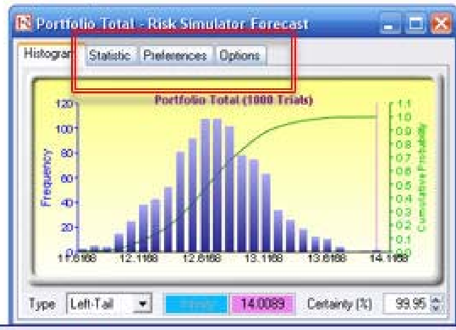
Correlated Portfolio Optimization

TAIL VALUE AT RISK MODEL (BASEL II REQUIREMENT)

Line of Business	Mean Required Capital	99.95th Percentile	Capital Required	Allocation Weights	Minimum Allowed	Maximum Allowed	
Business 1	$10.50	$36.52	$26.01	10.00%	5.00%	15.00%	3.48
Business 2	$11.12	$47.52	$36.39	10.00%	5.00%	15.00%	4.27
Business 3	$11.77	$48.99	$37.22	10.00%	5.00%	15.00%	4.16
Business 4	$10.77	$37.34	$26.56	10.00%	5.00%	15.00%	3.47
Business 5	$13.49	$49.52	$36.03	10.00%	5.00%	15.00%	3.67
Business 6	$14.24	$55.59	$41.35	10.00%	5.00%	15.00%	3.91
Business 7	$15.60	$60.24	$44.64	10.00%	5.00%	15.00%	3.86
Business 8	$14.95	$64.69	$49.74	10.00%	5.00%	15.00%	4.33
Business 9	$14.15	$61.02	$46.87	10.00%	5.00%	15.00%	4.31
Business 10	$10.08	$35.37	$25.29	10.00%	5.00%	15.00%	3.51
Portfolio Total	$12.67	$49.68	$37.01	*100.00%*			
Total Capital Required			$14.00				

Correlation Matrix

	1	2	3	4	5	6	7	8	9	10
1										
2	-0.20									
3	-0.13	0.35								
4	-0.05	0.01	0.00							
5	0.23	0.50	0.15	0.00						
6	0.00	0.00	-0.15	0.00	0.03					
7	0.25	0.00	-0.26	0.01	0.10	-0.10				
8	0.36	-0.25	-0.60	-0.30	0.00	0.00	-0.15			
9	-0.01	-0.20	0.16	0.04	-0.01	0.01	0.00	0.00		



This model shows the capital requirements per Basel II (99.95 percentile capital adequacy based on a specific holding period). Without running risk-based historical and Monte Carlo simulation using Risk Simulator, the required capital is $37.01M as compared to only $14.00M is required. This is due to the cross-correlations between assets and business lines, and can only be modeled using Risk Simulator. To run the model click on Simulation and select Run Simulation (if you had other models open, make sure you first click on Simulation, Change Simulation Profile, and select the Tail VaR profile before starting). This model will not run unless Risk Simulator is installed.

Basel II & III Section 178:
As an alternative to the use of standard or own-estimate haircuts, banks may be permitted to use a **VaR models** approach to reflect the price volatility of the exposure and collateral for repo-style transactions, taking into account **correlation** effects between security positions. This approach would apply to repo-style transactions covered by bilateral netting agreements on a counterparty-by-counterparty basis.

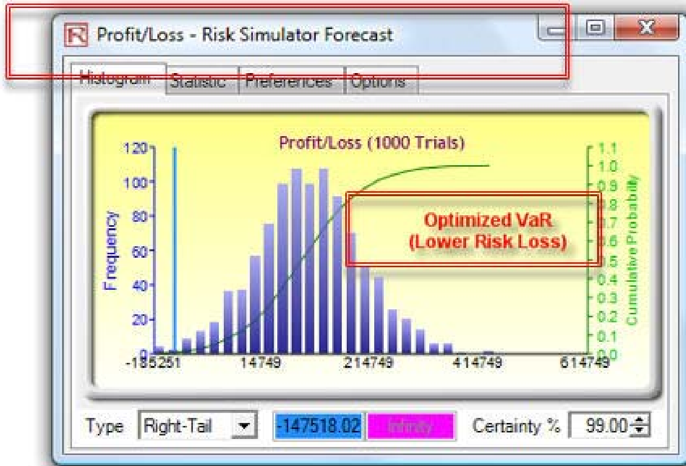
Basel II & III Section 232
The exposure must be one of a large pool of exposures, which are managed by the bank on a pooled basis… Furthermore, it must not be managed individually in a way comparable to corporate exposures, but rather as part of a **portfolio** segment or pool of exposures with similar risk characteristics for purposes of risk assessment and quantification.

Basel II & III Section 527 (f):
Subject to supervisory review, equity portfolio correlations can be integrated into a bank's internal risk measures. The use of explicit correlations (e.g., utilization of a **variance/covariance VaR model)** must be fully documented and supported using empirical analysis. The appropriateness of implicit **correlation** assumptions will be evaluated by supervisors in their review of model documentation and estimation techniques.

FIGURE 12 **Basel II/III correlated portfolios and correlated simulations.**

Basel III Compliance

Value at Risk



VALUE AT RISK WITH ASSET ALLOCATION OPTIMIZATION MODEL

Real Options Valuation
www.realoptionsvaluation.com

Asset Class Description	Annualized Returns	Volatility Risk	Allocation Weights	Required Minimum Allocation	Required Maximum Allocation
S&P 500	7.10%	9.80%	25.00%	10.00%	40.00%
Small Cap	9.51%	14.35%	25.00%	10.00%	40.00%
High Yield	15.90%	22.50%	25.00%	10.00%	40.00%
Govt Bonds	4.50%	7.25%	25.00%	10.00%	40.00%
		Total Weight:	*100.00%*		

Correlation Matrix	S&P 500	Small Cap	High Yield	Govt Bonds
S&P 500	1.0000	0.7400	0.6500	0.5500
Small Cap	0.7400	1.0000	0.4200	0.3100
High Yield	0.6500	0.4200	1.0000	0.2300
Govt Bonds	0.5500	0.3100	0.2300	1.0000

Covariance Matrix	S&P 500	Small Cap	High Yield	Govt Bonds
S&P 500	0.0096	0.0104	0.0143	0.0039
Small Cap	0.0104	0.0206	0.0136	0.0032
High Yield	0.0143	0.0136	0.0506	0.0038
Govt Bonds	0.0039	0.0032	[illegible]	0.0053

VALUE AT RISK (VARIANCE-COVARIANCE METHOD)

Real Options Valuation
www.realoptionsvaluation.com

Asset Allocation	Amount	Daily Volatility
Asset A	$1,000,000.00	1.20%
Asset B	$2,000,000.00	2.00%
Asset C	$3,000,000.00	1.89%
Asset D	$4,000,000.00	3.25%
Asset E	$5,000,000.00	4.20%

This model is used to compute the portfolio's Value at Risk at a given percentile for a specific holding period, after accounting for the cross-correlation effects between the assets. The daily volatility is the annualized volatility divided by the square root of trading days per year.

Correlation Matrix	Asset A	Asset B	Asset C	Asset D	Asset E
Asset A	1.0000	0.1000	0.1000	0.1000	0.1000
Asset B	0.1000	1.0000	0.1000	0.1000	0.1000
Asset C	0.1000	0.1000	1.0000	0.1000	0.1000
	0.1000	0.1000	0.1000	1.0000	0.1000
	0.1000	0.1000	0.1000	0.1000	1.0000

Basel II & III Section 179:
The quantitative and qualitative criteria for recognition of internal market risk models for repo-style transactions and other similar transactions are in principle the same as under the Market Risk Amendment. With regard to the holding period, the minimum will be 5-business days for repo-style transactions, rather than the 10-business days under the Market Risk Amendment. For other transactions eligible for the **VaR models** approach, the **10-business day holding period** will be retained.

Basel II & III Section 527 (c):
No particular type of **VaR model** (e.g., **variance-covariance, historical simulation, or Monte Carlo**) is prescribed. However, the model used must be able to capture adequately all of the material risks embodied in equity returns including both the general market risk and specific risk exposure of the institution's **equity portfolio.** Internal models must adequately explain historical price variation, capture both the magnitude and changes in the composition of potential concentrations, and be robust to adverse market environments. The population of risk exposures represented in the data used for estimation must be closely matched to or at least comparable with those of the bank's equity exposures.

Basel II & III Section 527 (f):
Subject to supervisory review, equity portfolio correlations can be integrated into a bank's internal risk measures. The use of explicit correlations (e.g., utilization of a **variance/covariance VaR model)** must be fully documented and supported using empirical analysis. The appropriateness of implicit **correlation** assumptions will be evaluated by supervisors in their review of model documentation and estimation techniques.

FIGURE 13 Basel II/III Value at Risk and percentiles.

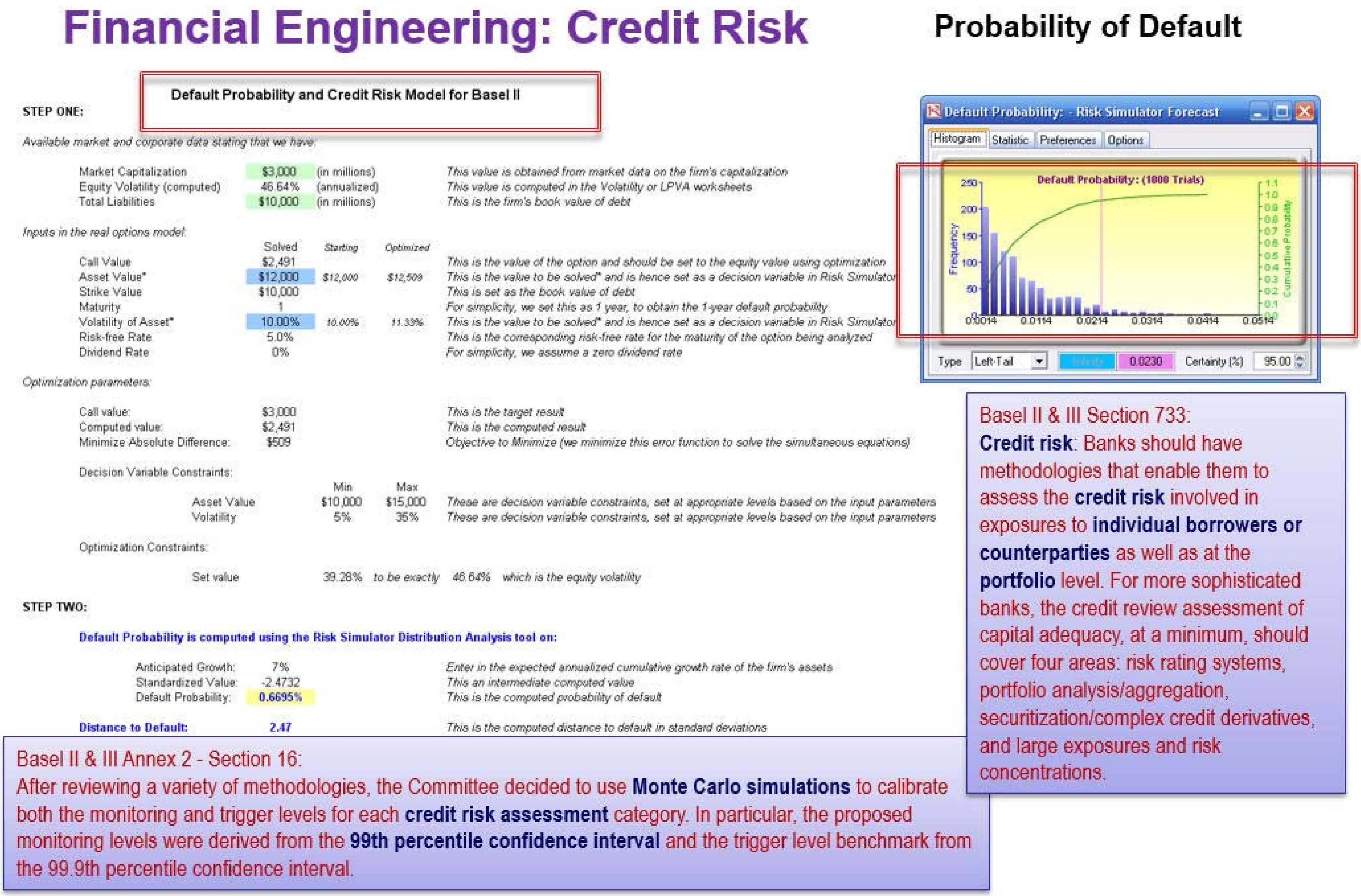
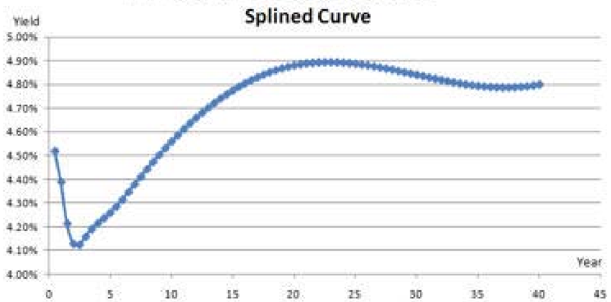
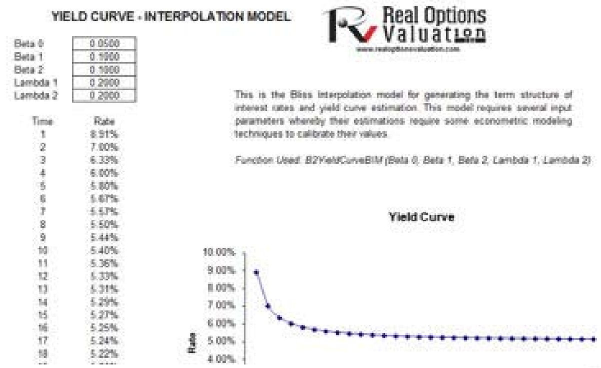


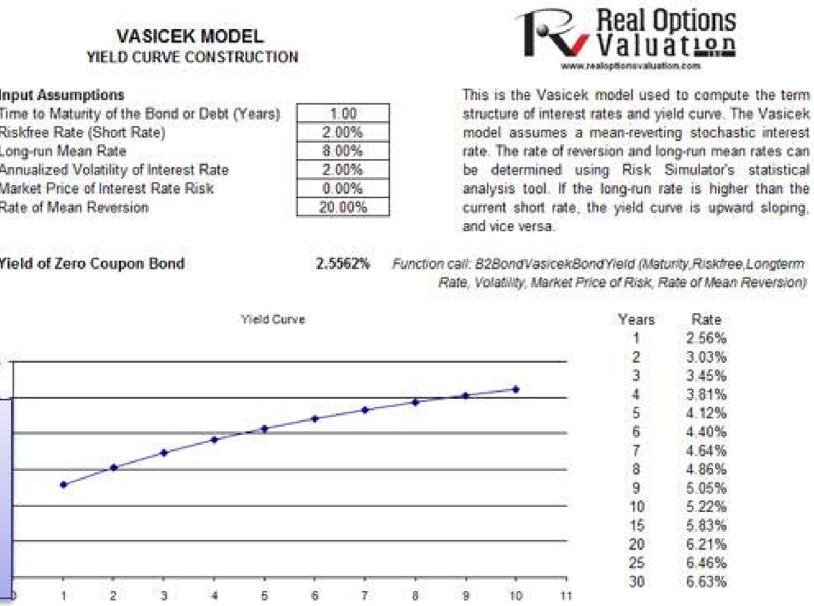
FIGURE 14 **Basel II/III credit risk analysis.**

Financial Engineering: Market Risk

Interest Rate and Yield Curve Analytics







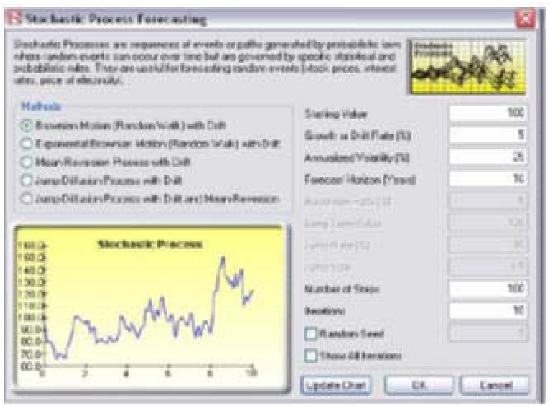
Basel II & III Section 763:
The revised guidance on interest rate risk recognizes banks' internal systems as the principal tool for the measurement of **interest rate risk** in the banking book and the supervisory response. To facilitate supervisors' monitoring of **interest rate risk exposures** across institutions, banks would have to provide the results of their internal measurement systems, expressed in terms of economic value relative to capital, using a standardized **interest rate shock**.

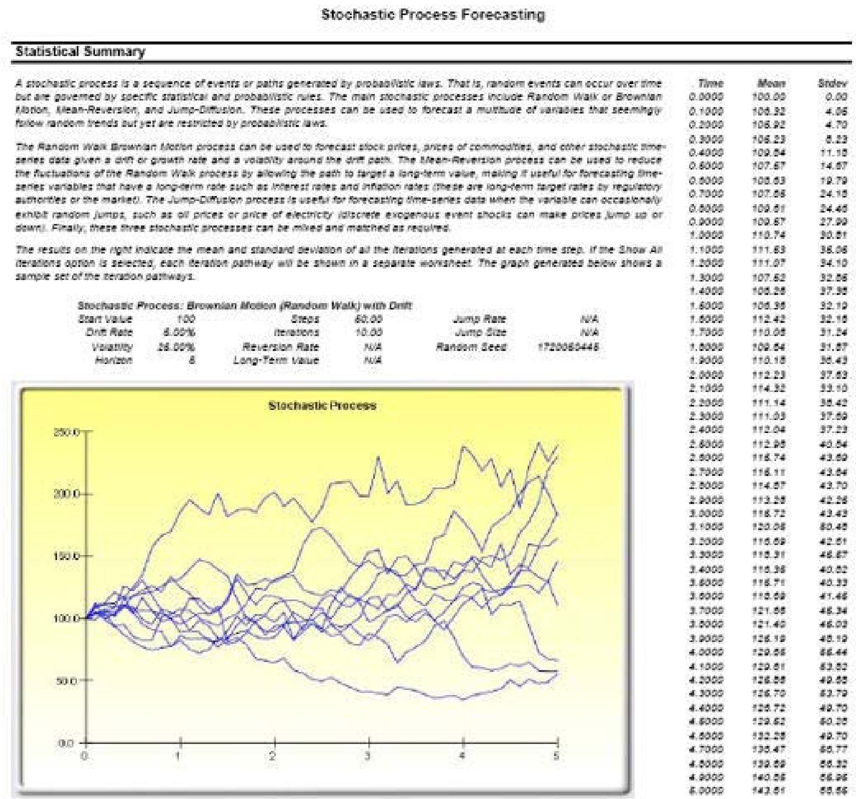
FIGURE 15 Basel II/III interest rate risk and market shocks.

Financial Engineering: Market Risk

Stochastic Forecasting

- ARIMA
- GARCH Volatility
- Brownian Motion Random Walk
- Cubic Spline Yield Curves
- Implied Yield Curves from Debt
- Mean-Reverting Interest Rates
- Jump-Diffusion Prices
- Mixed Stochastic Processes
- Time-Series Decomposition





Stochastic Process Forecasting

Statistical Summary

A stochastic process is a sequence of events or paths generated by probabilistic laws. That is, random events can occur over time but are governed by specific statistical and probabilistic rules. The main stochastic processes include Random Walk or Brownian Motion, Mean-Reversion, and Jump-Diffusion. These processes can be used to forecast a multitude of variables that seemingly follow random trends but yet are restricted by probabilistic laws.

The Random Walk Brownian Motion process can be used to forecast stock prices, prices of commodities, and other stochastic time-series data given a drift or growth rate and a volatility around the drift path. The Mean-Reversion process can be used to reduce the fluctuations of the Random Walk process by allowing the path to target a long-term value, making it useful for forecasting time-series variables that have a long-term rate such as interest rates and inflation rates (these are long-term target rates by regulatory authorities or the market). The Jump-Diffusion process is useful for forecasting time-series data when the variable can occasionally exhibit random jumps, such as oil prices or price of electricity (discrete exogenous event shocks can make prices jump up or down). Finally, these three stochastic processes can be mixed and matched as required.

The results on the right indicate the mean and standard deviation of all the iterations generated at each time step. If the Show All Iterations option is selected, each iteration pathway will be shown in a separate worksheet. The graph generated below shows a sample set of the iteration pathways.

Stochastic Process: Brownian Motion (Random Walk) with Drift

Start Value	100	Steps	50.00	Jump Rate	N/A
Drift Rate	5.00%	Iterations	10.00	Jump Size	N/A
Volatility	25.00%	Reversion Rate	N/A	Random Seed	1720050445
Horizon	5	Long-Term Value	N/A		

Time	Mean	Stdev
0.0000	100.00	0.00
0.1000	106.32	4.06
0.2000	106.92	4.70
0.3000	106.23	8.23
0.4000	109.84	11.18
0.5000	107.67	14.67
0.6000	108.63	19.79
0.7000	107.86	24.18
0.8000	109.61	24.46
0.9000	109.67	27.99
1.0000	110.74	30.61
1.1000	111.63	36.06
1.2000	111.07	34.10
1.3000	107.62	32.86
1.4000	108.28	37.38
1.5000	108.36	32.19
1.6000	112.42	32.16
1.7000	110.08	31.24
1.8000	109.84	31.87
1.9000	110.18	36.43
2.0000	112.23	37.63
2.1000	114.32	33.10
2.2000	111.14	36.42
2.3000	111.03	37.69
2.4000	112.04	37.23
2.5000	112.96	40.84
2.6000	116.74	43.69
2.7000	116.11	43.84
2.8000	114.87	43.70
2.9000	113.28	42.26
3.0000	116.72	43.43
3.1000	120.08	50.46
3.2000	116.69	42.61
3.3000	116.31	46.87
3.4000	116.38	40.82
3.5000	116.71	40.33
3.6000	118.69	41.46
3.7000	121.66	46.34
3.8000	121.40	46.03
3.9000	126.19	48.19
4.0000	129.66	56.44
4.1000	129.61	53.52
4.2000	126.68	49.66
4.3000	126.70	53.79
4.4000	126.72	49.70
4.5000	129.62	50.26
4.6000	132.28	49.70
4.7000	136.47	56.77
4.8000	139.69	56.32
4.9000	140.66	56.96
5.0000	143.61	55.56

Basel II & III Section 527 (a) and (b):
The capital charge is equivalent to the **potential loss** on the institution's equity portfolio arising from an assumed **instantaneous shock** equivalent to the 99th percentile, one-tailed confidence interval of the difference between quarterly returns and an appropriate risk-free rate computed over a long-term sample period. The **estimated losses** should be robust to **adverse market movements** relevant to the long-term risk profile of the institution's specific holdings.

Basel II & III Section 155:
Banks must **estimate the volatility** of the collateral instrument or foreign exchange mismatch individually: estimated volatilities for each transaction must not take into account the **correlations** between unsecured exposure, collateral and **exchange rates.**

FIGURE 16 Basel II/III volatility and adverse instantaneous shocks.

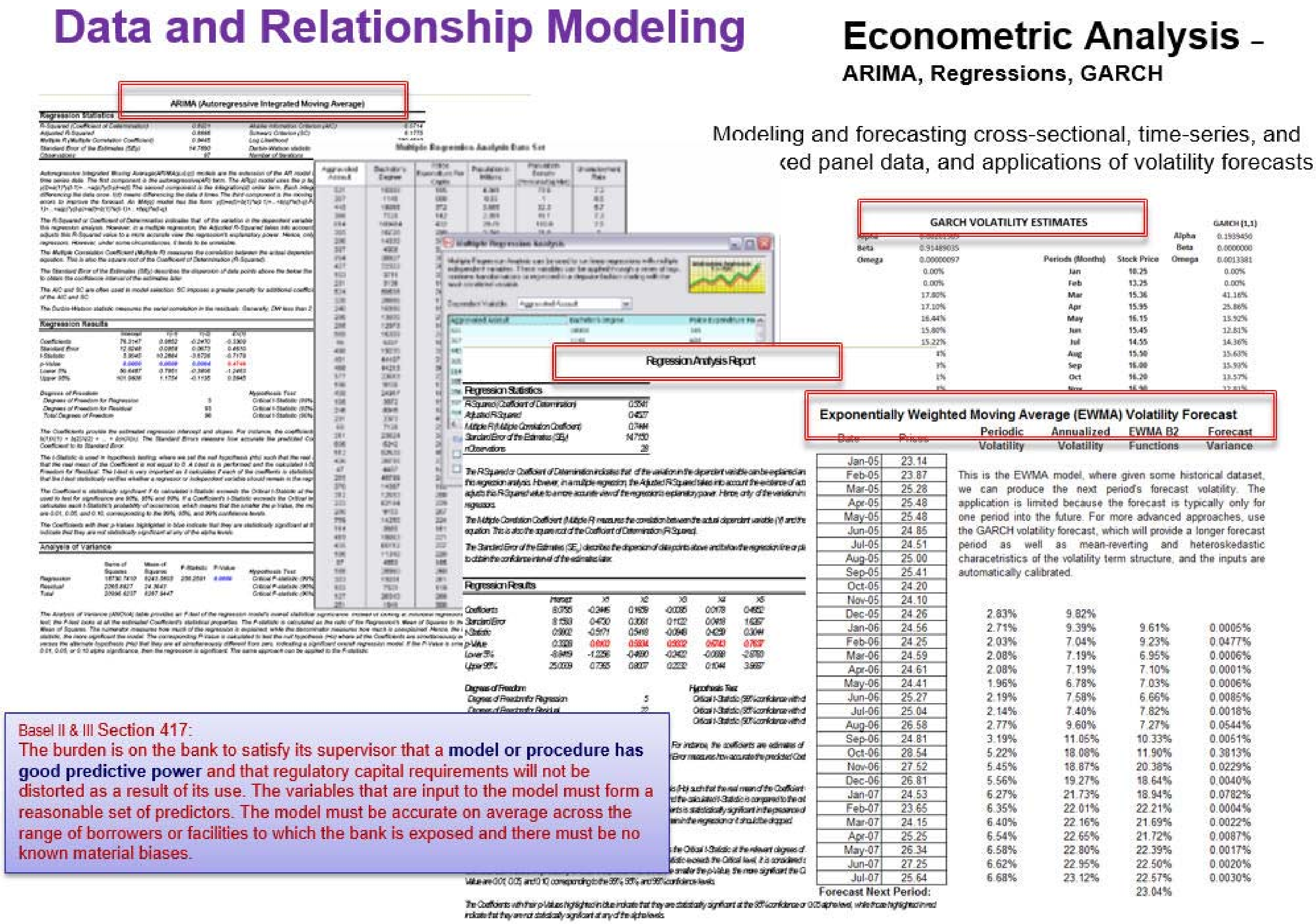
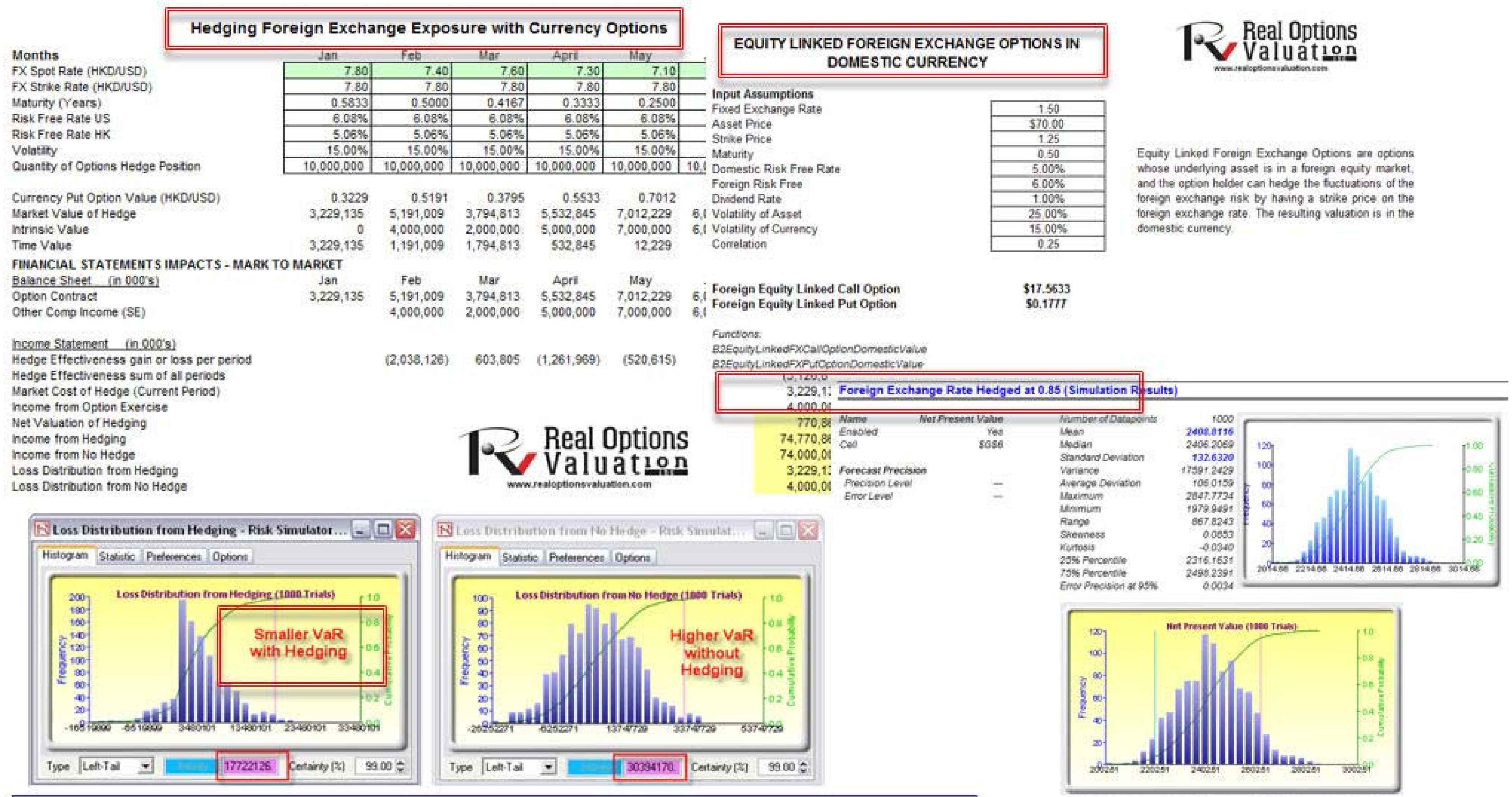


FIGURE 17 **Basel II/III forecast models with strong predictive power.**

FIGURE 18 **Basel II/III modeling OTC derivatives and exotic convertibles.**

Foreign Exchange Risk



Basel II & III Section 131: Additionally where the exposure and collateral are held in **different currencies** an additional downwards adjustment must be made to the volatility adjusted collateral amount to take account of **possible future fluctuations in exchange rates.**

Basel II & III Section 155. Banks must estimate the **volatility** of the collateral instrument or **foreign exchange** mismatch individually: estimated **volatilities** for each transaction must not take into account the **correlations** between unsecured exposure, collateral and **exchange rates.**

FIGURE 19 Basel II/III modeling foreign exchange fluctuations.

Credit Derivatives

OPTIONS ADJUSTED SPREAD WITH YIELD CURVE AND VOLATILITY TERM STRUCTURE

Real Options Valuation
www.realoptionsvaluation.com

Face Value	$100.00	**Coupon Per Period**	$2.50	**Delta T**	0.5000	**Modeling Toolkit Functions:**	
Maturity	4	**Market Price of Debt**	$100.00	**Straight Spread**	0.0000%	2.3387%	
Total Steps	8	**Callable Price**	$101.00	**Callable Spread**	0.0000%	2.3896%	
		Callable Step	6	Compute Spreads			

Certain types of debt come with an option-embedded provision, for instance, a bond might be callable if the market price exce… it more profitable for the issuing company to call the debt and reissue new ones at the lower rate) or prepayment allowanc… compute the option adjusted spread, i.e., the additional premium that should be charged on the option provision. You can ext…

Interest Rates (Yields)	2.60%	2.60%	2.60%	2.60%	2.60%	2.60%	2.60%	2.60%
Interest Volatilities	N/A	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
Steps	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Short Rate Lattice								
0	2.60%	2.86%	3.14%	3.46%	3.80%	4.19%	4.61%	5.07%
0		2.34%	2.57%	2.83%	3.11%	3.43%	3.77%	4.15%
0			2.11%	2.32%	2.55%	2.81%	3.09%	3.40%
0				1.90%	2.09%	2.30%	2.53%	2.79%
0					1.71%	1.88%	2.07%	2.28%
0						1.54%	1.69%	1.87%
0							1.39%	1.53%
0								1.25%
8								
Straight Price Lattice	**Using Function:**		**110.06**					
0	110.06	107.95	106.01	104.26	102.73	101.45	100.48	99.87
1		110.04	108.00	106.13	104.43	102.95	101.72	100.78
2			109.66	107.68	105.85	104.19	102.74	101.53
3				108.97	107.02	105.22	103.59	102.15
4					107.99	106.07	104.29	102.66
5						106.77	104.86	103.08
6							105.34	103.43
7								103.71
8								
Callable Debt Price Lattice	**Using Function:**		**110.03**					
0	110.03	108.25	106.63	105.15	103.77	102.32	100.48	99.87
1		109.68	107.99	106.48	105.21	104.20	103.50	100.78
2			108.97	107.29	105.80	104.52	103.50	103.50

Basel II & III Section 140: Where guarantees or **credit derivatives** are direct, explicit, irrevocable and unconditional, and supervisors are satisfied that banks fulfill certain minimum operational conditions relating to risk management processes they may allow banks to take account of such **credit protection in calculating capital requirements.**
Basel II & III Section 713: Specific **risk capital charges for positions hedged by credit derivatives**… Full allowance will be recognized when the values of two legs (i.e., long and short) always move in the opposite direction and broadly to the same extent.

CREDIT DEFAULT SWAP (CDS) SPREADS

Input Assumptions	
Bond Yield	7.00%
Annual Coupon Rate	10.00%
Coupon Payments Per Year	2
Risk-free Yield	5.00%
Recovery Rate at Default	80.00%
Credit Default Swap Spread	**1.7690%**

Real Options Valuation
www.realoptionsvaluation.com

A credit default swap or CDS which allows the holder of the instrument to sell a bond or debt at par value when a credit event or default occurs. This model computes the valuation of the CDS spread. A CDS does not protect against movements of the credit spread (only a credit spread option can do that), but

CREDIT SPREAD OPTIONS (CSO)

Input Assumptions	
Credit Spread	3.00%
Strike Spread	2.90%
Duration (Spread to Currency Conversion Ratio)	1000.00
Probability of Default	2.50%
Maturity	1.00
Riskfree Rate	5.00%
Volatility	25.00%
Credit Spread Call Option	**$3.2102**
Credit Spread Put Option	**$2.2828**

B2CreditSpreadCallOption
B2CreditSpreadPutOption

Forward Asset Price at Maturity	$1,000.00
Strike Price	$900.00
Probability of Default	2.50%
Maturity	1.00
Riskfree Rate	5.00%
Volatility	25.00%
Credit Asset Spread Call Option	**$141.6406**
Credit Asset Spread Put Option	**$48.8957**

Real Options Valuation
www.realoptionsvaluation.com

Credit spread options or CSO are exotic options where the payof depends on a crredit spread or the price of the underlying asset that is sensitive to interest rate movements such as floating or inverse floating rate notes and debt. A CSO call provides a return to the holder if the prevailing reference credit spread exceeds the predetermined strike rate, and the duration input variable is used to translate the percentage spread into a notional currency amount. The CSO expires when there is a credit default event.

CSO can only protect against any movements in the reference spread and not a default event. Only a credit default swap (CDS) can do that. Typically, to hedge against defaults and spread movements, both CDS and CDO are used. In some cases, when the CSO covers a reference entity's underlying asset value and not the spread itself, the credit asset spread options are used instead.

FIGURE 20 **Basel II/III credit derivatives and hedging.**

Compliance with COSO Integrated ERM Framework

The following provides a quick summary of COSO Integrated ERM Framework compliance when using the IRM methodology:

- Figure 21 (16.45) shows the PEAT ERM module's Risk Register tab where mitigation costs and benefits (gross risks reduced to residual risk levels), likelihood and impact measures, and spreads with varying precision levels ready for Monte Carlo risk simulation are situated, in compliance with COSO ERM Framework Sections 5 & 6.
- Figure 22 (16.46) shows the PEAT ERM module where the likelihood and impact within a risk map is generated, in compliance with COSO AT/Exhibit 5.13.
- Figure 23 (16.47) shows compliance with COSO AT/Exhibit 6.5 and COSO ERM Integrated Framework Section 6, where entity-wide portfolio and business unit, department, and functional areas' gross and residual risks are computed.
- Figure 24 (16.48) continues by showing a sample of the Risk Dashboard reports also in compliance with COSO AT/Exhibit 6.5 and COSO ERM Integrated Framework Section 6, where entity-wide portfolio and business unit, department, and functional areas' gross and residual risks are computed and compared against each other.
- Figure 25 (16.49) shows the PEAT DCF module's efficient frontier model, consistent with COSO AT/Exhibit 3.7 requiring an analysis of the capital investment in relation to the returns within a diversified (optimized) portfolio.
- Figure 26 (16.50) shows the PEAT ERM and DCF modules' simulated results, where Value at Risk, percentiles, and statistical probabilities can be obtained, in compliance with COSO AT/Exhibit 5.5 requiring a range of outcomes based on distributional assumptions, and COSO ERM Integrated Framework Exhibit 5.2 requiring historical or simulated outcomes of future behaviors under probabilistic models.
- Figure 27 (16.51) shows compliance with COSO AT/Exhibit 3.1 requiring the use of scenario modeling and stress testing.
- Figure 28 (16.52) shows the CMOL module in PEAT where scenario analysis, stress testing, and gap analysis are performed, in compliance with COSO AT/Exhibit 5.10, to complement probabilistic models.
- Figure 29 (16.53) shows compliance with COSO AT/Exhibits 5.8 & 5.9 requiring the modeling of operational and credit loss distributions with back-testing or historical simulation, sensitivity analysis, and Value at Risk calculations.

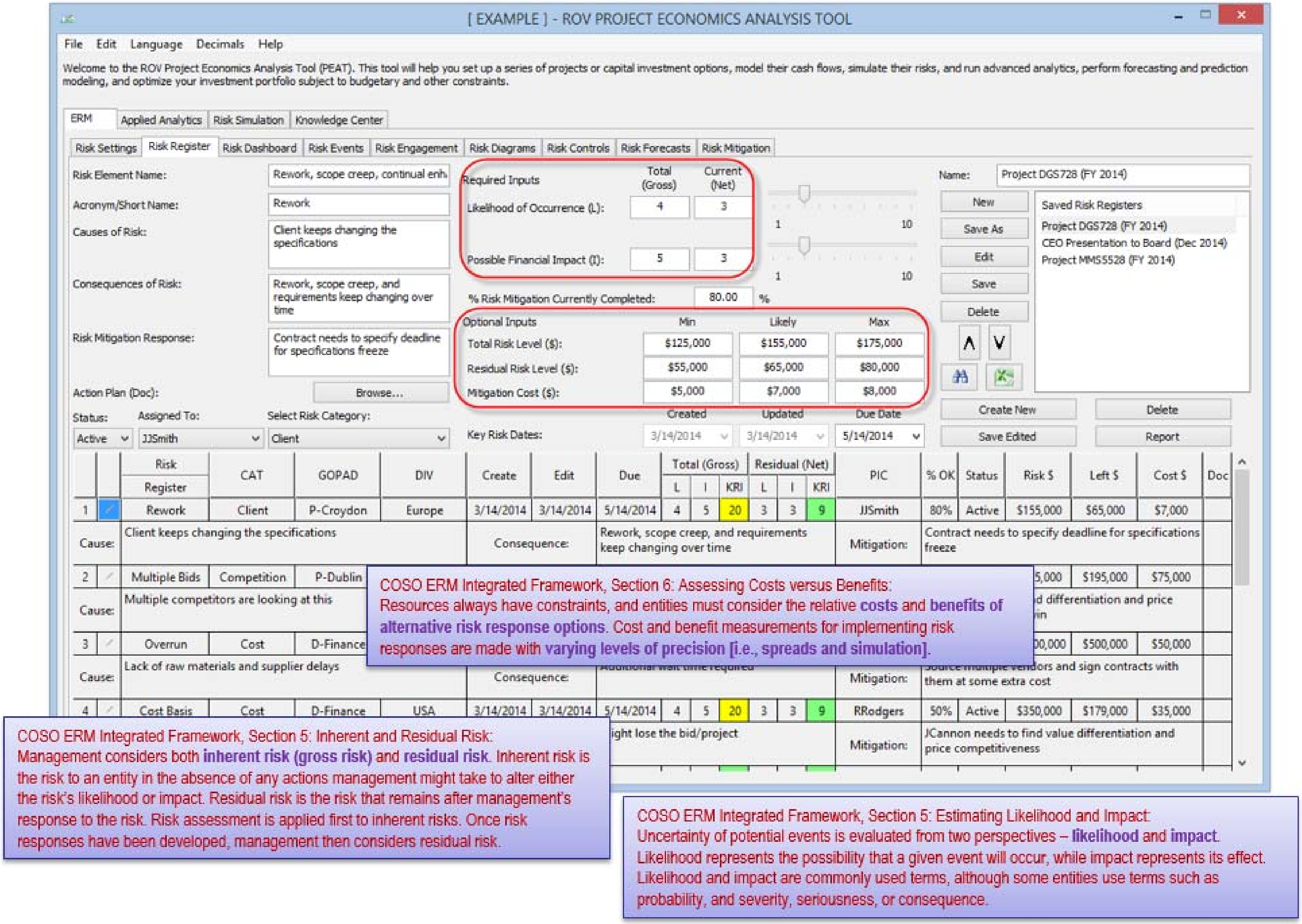


FIGURE 21 PEAT ERM and COSO Integrated Framework.

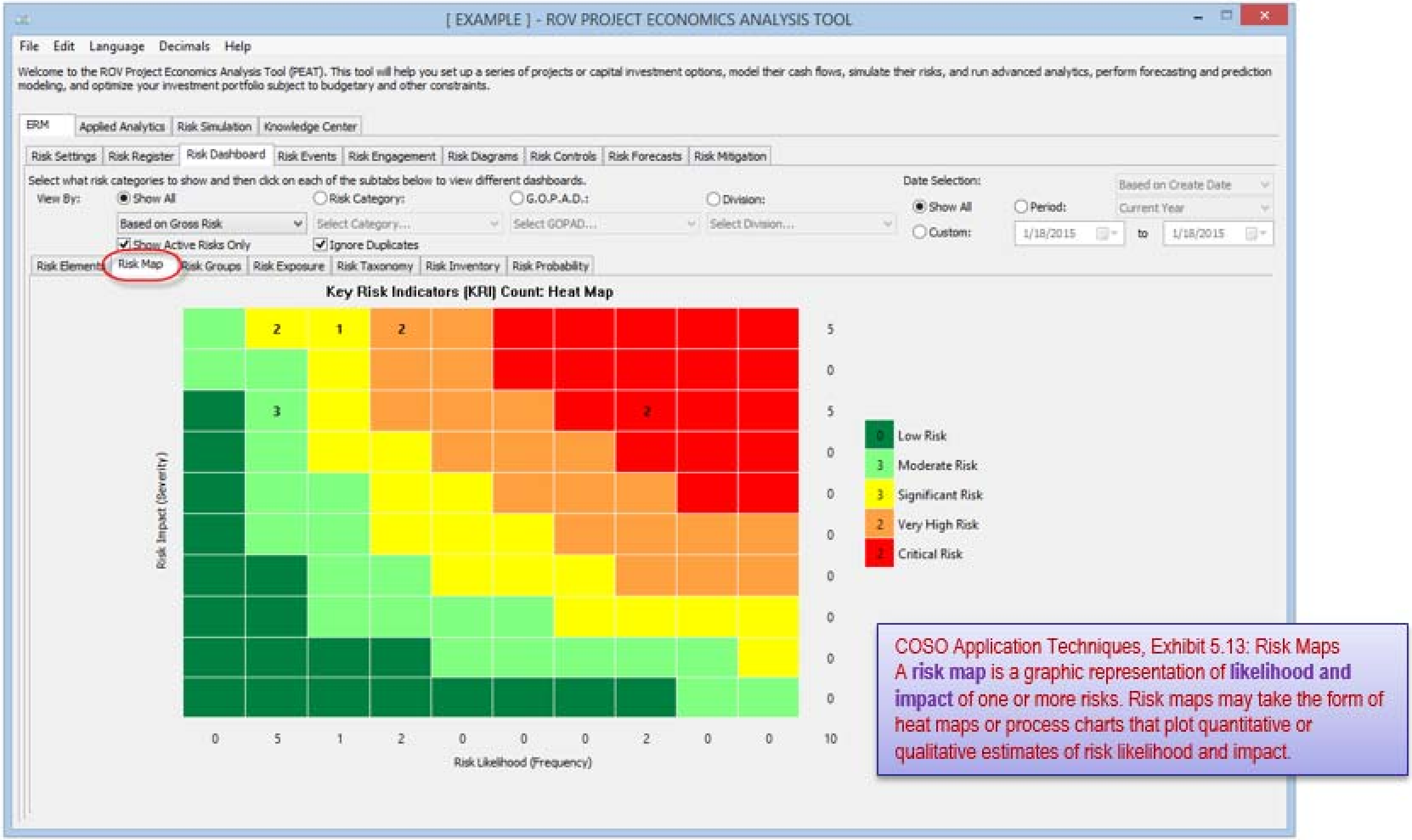
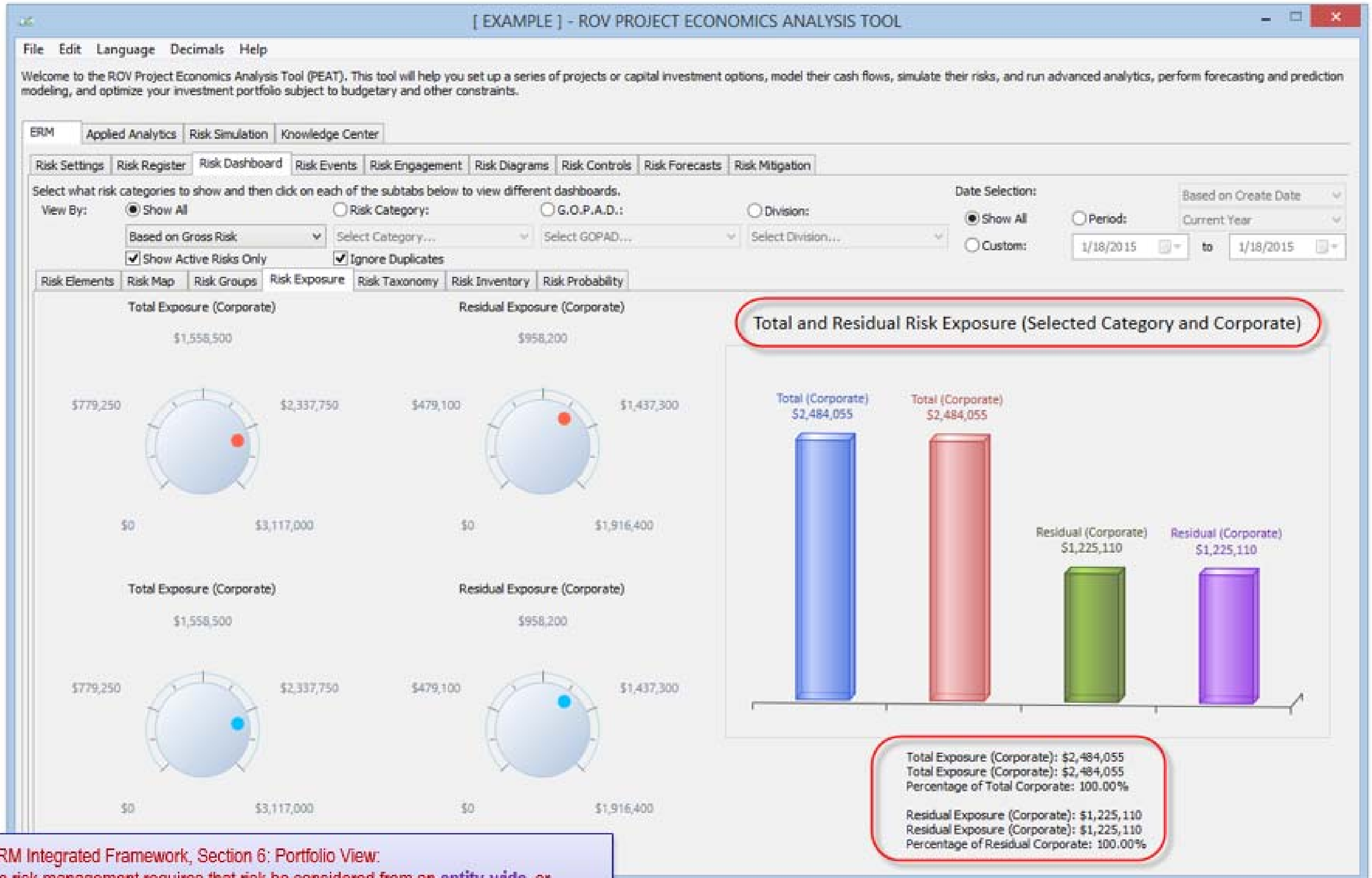


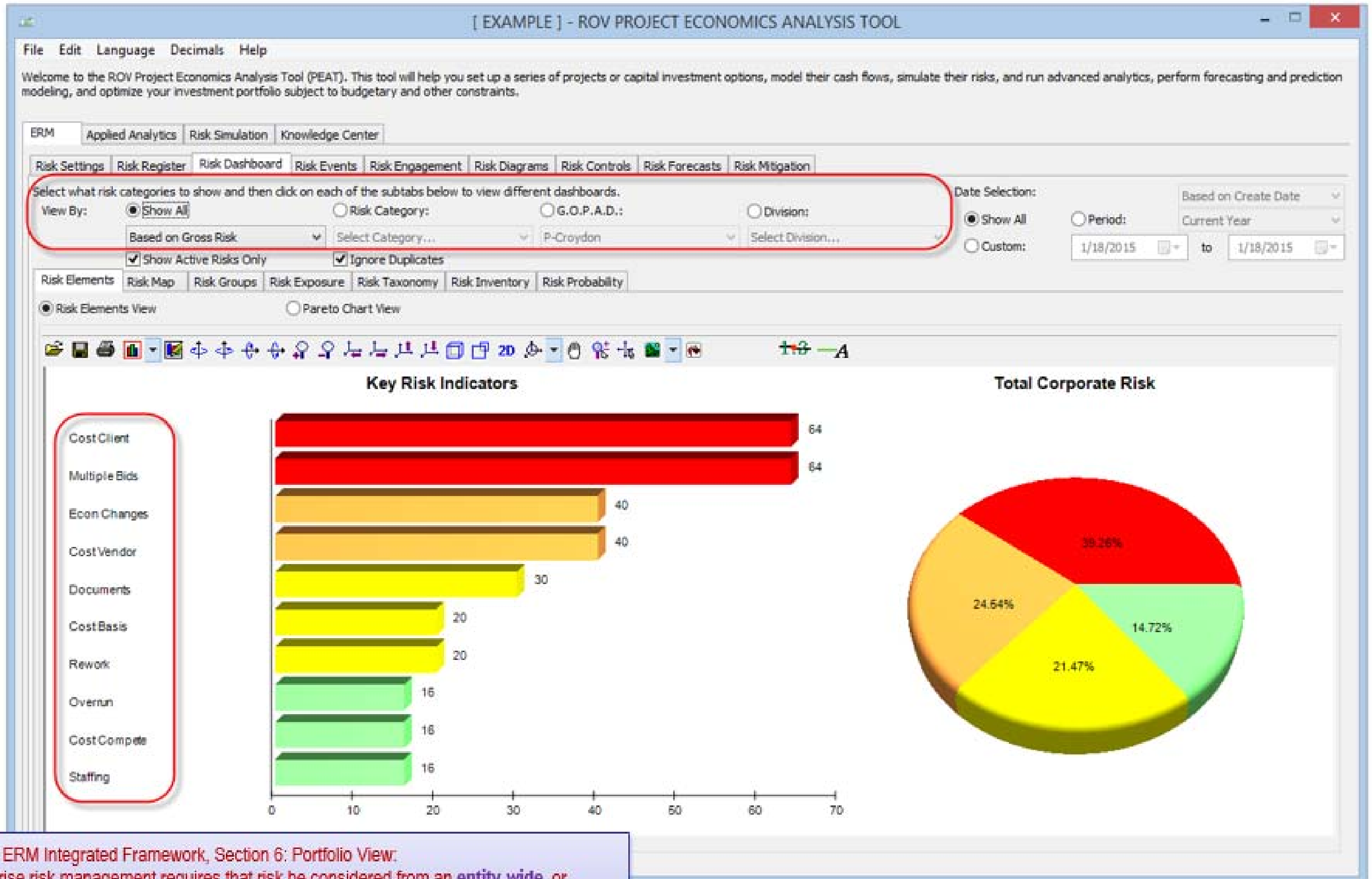
FIGURE 22 **PEAT ERM heat map and risk matrix.**



COSO ERM Integrated Framework, Section 6: Portfolio View:
Enterprise risk management requires that risk be considered from an **entity-wide**, or **portfolio perspective**. Management typically takes an approach in which risk first is **considered for each business unit, department, or function**, with the responsible manager developing a **composite assessment of risks for the unit** reflecting the unit's residual risk profile relative to its objectives and risk tolerances.

COSO Application Techniques, Exhibit 6.5: Portfolio View of Residual Risk:
With a view of risk for individual units, an enterprise's senior management is well positioned to take a **portfolio view**, to determine whether the **entity's residual risk** profile is commensurate with its overall risk appetite relative to its objectives.

FIGURE 23 PEAT ERM portfolio and corporate view or residual risk.



COSO ERM Integrated Framework, Section 6: Portfolio View:
Enterprise risk management requires that risk be considered from an **entity-wide**, or **portfolio perspective**. Management typically takes an approach in which risk first is **considered for each business unit, department, or function**, with the responsible manager developing a **composite assessment of risks for the unit** reflecting the unit's residual risk profile relative to its objectives and risk tolerances.

COSO Application Techniques, Exhibit 6.5: Portfolio View of Residual Risk:
With a view of risk for individual units, an enterprise's senior management is well positioned to take a **portfolio view**, to determine whether the **entity's residual risk** profile is commensurate with its overall risk appetite relative to its objectives.

FIGURE 24 PEAT ERM portfolio, business unit, department, function view

COSO Application Techniques, Exhibit 3.7: Efficient Frontier:
The analysis illustrates how a company views **capital at risk versus return in relation to risk appetite**. The company strives to **diversify its portfolio** to earn a return that lines up along the target profile.

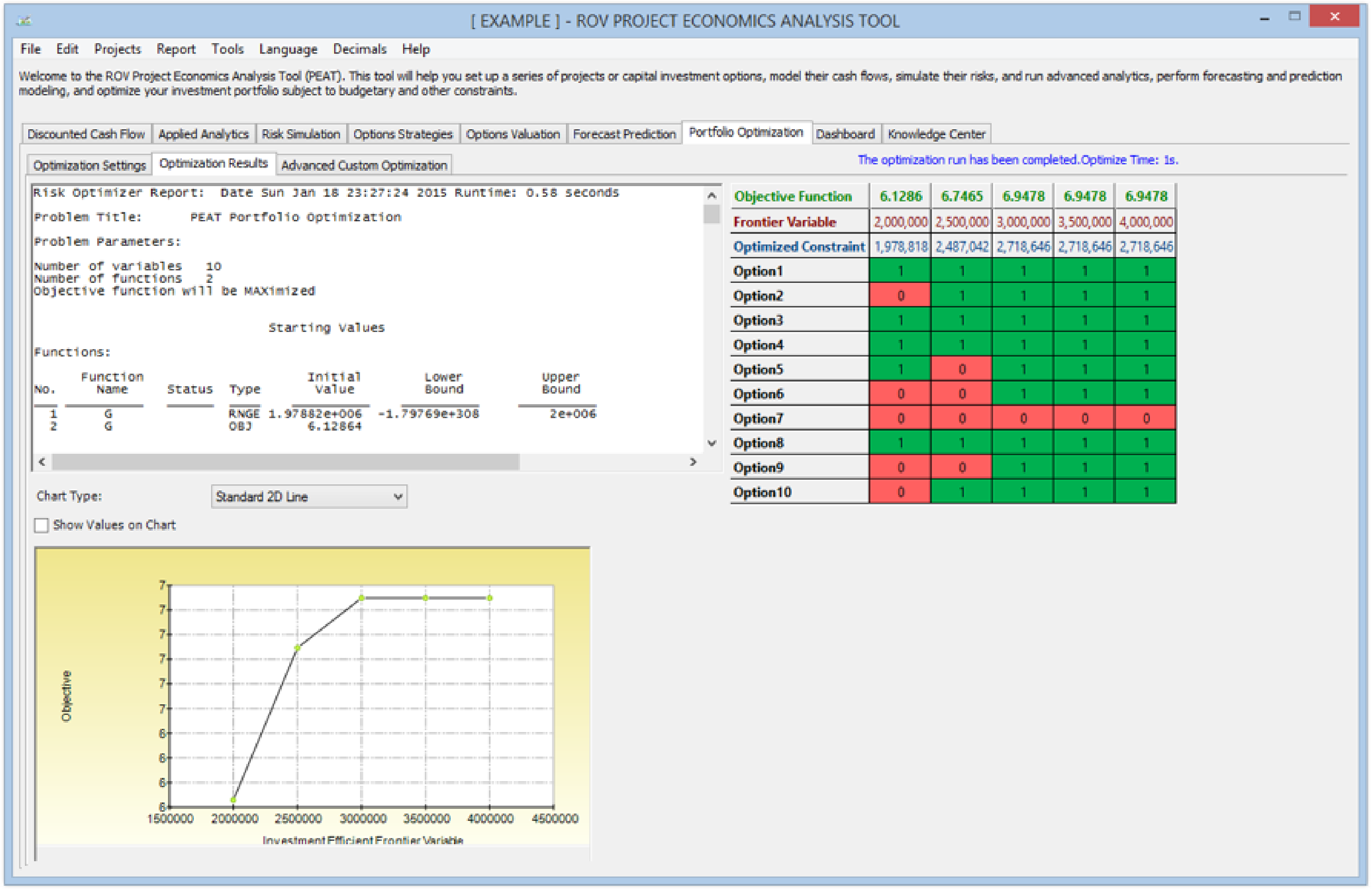


FIGURE 25 **PEAT DCF module featuring capital versus returns efficient frontier**

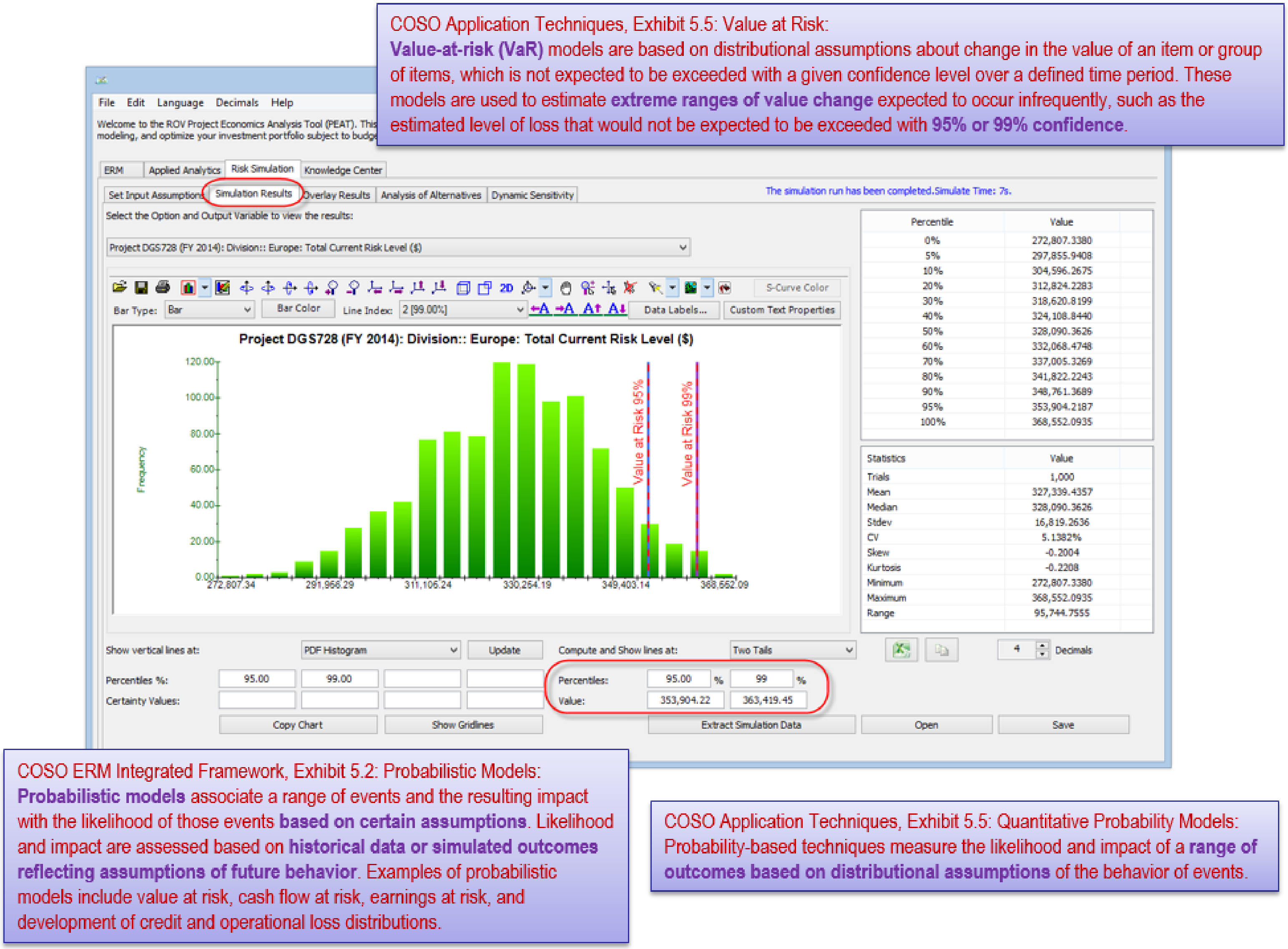
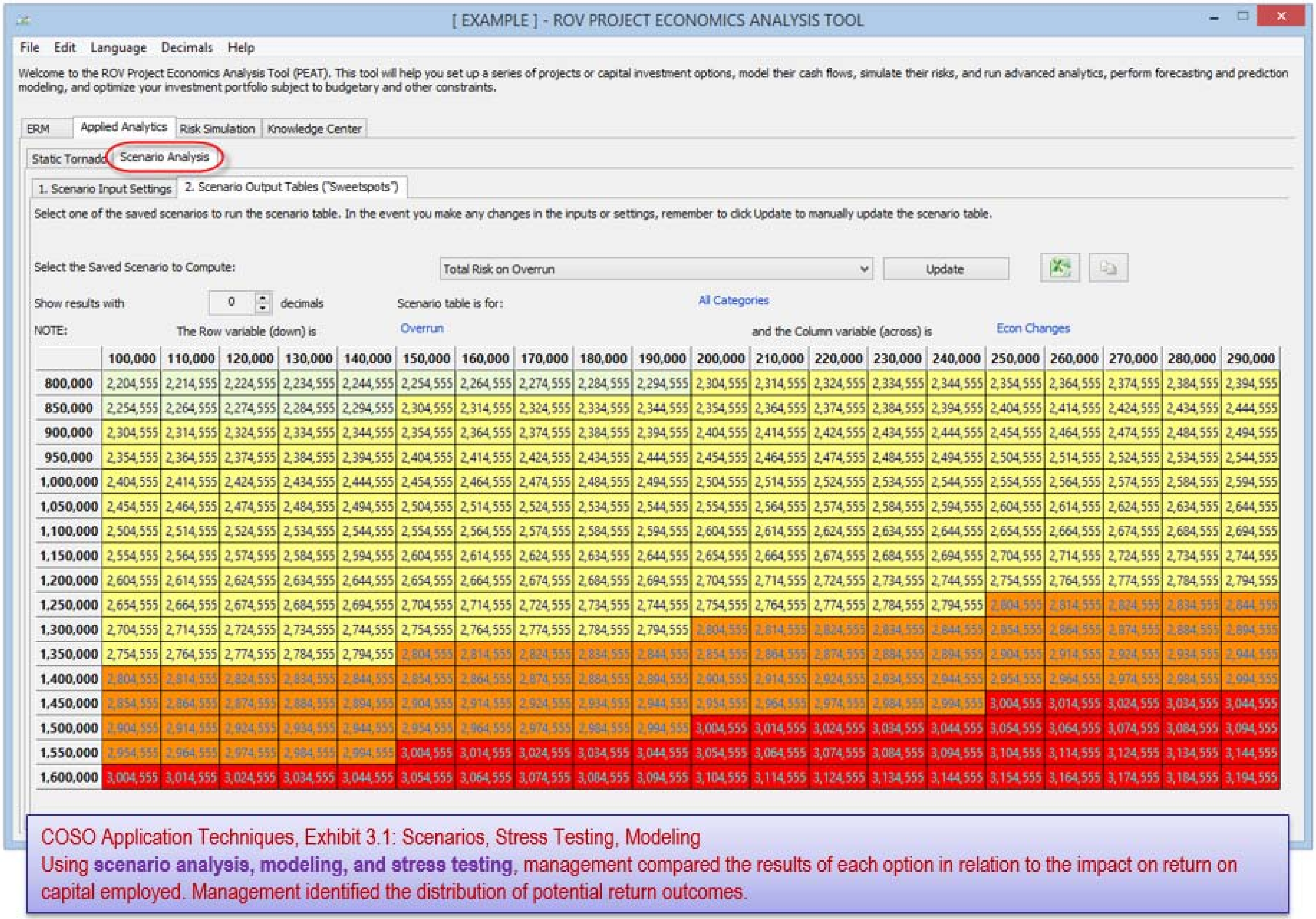


FIGURE 26 PEAT ERM & DCF modules with risk simulation results with Value at Risk



	100,000	110,000	120,000	130,000	140,000	150,000	160,000	170,000	180,000	190,000	200,000	210,000	220,000	230,000	240,000	250,000	260,000	270,000	280,000	290,000
800,000	2,204,555	2,214,555	2,224,555	2,234,555	2,244,555	2,254,555	2,264,555	2,274,555	2,284,555	2,294,555	2,304,555	2,314,555	2,324,555	2,334,555	2,344,555	2,354,555	2,364,555	2,374,555	2,384,555	2,394,555
850,000	2,254,555	2,264,555	2,274,555	2,284,555	2,294,555	2,304,555	2,314,555	2,324,555	2,334,555	2,344,555	2,354,555	2,364,555	2,374,555	2,384,555	2,394,555	2,404,555	2,414,555	2,424,555	2,434,555	2,444,555
900,000	2,304,555	2,314,555	2,324,555	2,334,555	2,344,555	2,354,555	2,364,555	2,374,555	2,384,555	2,394,555	2,404,555	2,414,555	2,424,555	2,434,555	2,444,555	2,454,555	2,464,555	2,474,555	2,484,555	2,494,555
950,000	2,354,555	2,364,555	2,374,555	2,384,555	2,394,555	2,404,555	2,414,555	2,424,555	2,434,555	2,444,555	2,454,555	2,464,555	2,474,555	2,484,555	2,494,555	2,504,555	2,514,555	2,524,555	2,534,555	2,544,555
1,000,000	2,404,555	2,414,555	2,424,555	2,434,555	2,444,555	2,454,555	2,464,555	2,474,555	2,484,555	2,494,555	2,504,555	2,514,555	2,524,555	2,534,555	2,544,555	2,554,555	2,564,555	2,574,555	2,584,555	2,594,555
1,050,000	2,454,555	2,464,555	2,474,555	2,484,555	2,494,555	2,504,555	2,514,555	2,524,555	2,534,555	2,544,555	2,554,555	2,564,555	2,574,555	2,584,555	2,594,555	2,604,555	2,614,555	2,624,555	2,634,555	2,644,555
1,100,000	2,504,555	2,514,555	2,524,555	2,534,555	2,544,555	2,554,555	2,564,555	2,574,555	2,584,555	2,594,555	2,604,555	2,614,555	2,624,555	2,634,555	2,644,555	2,654,555	2,664,555	2,674,555	2,684,555	2,694,555
1,150,000	2,554,555	2,564,555	2,574,555	2,584,555	2,594,555	2,604,555	2,614,555	2,624,555	2,634,555	2,644,555	2,654,555	2,664,555	2,674,555	2,684,555	2,694,555	2,704,555	2,714,555	2,724,555	2,734,555	2,744,555
1,200,000	2,604,555	2,614,555	2,624,555	2,634,555	2,644,555	2,654,555	2,664,555	2,674,555	2,684,555	2,694,555	2,704,555	2,714,555	2,724,555	2,734,555	2,744,555	2,754,555	2,764,555	2,774,555	2,784,555	2,794,555
1,250,000	2,654,555	2,664,555	2,674,555	2,684,555	2,694,555	2,704,555	2,714,555	2,724,555	2,734,555	2,744,555	2,754,555	2,764,555	2,774,555	2,784,555	2,794,555	2,804,555	2,814,555	2,824,555	2,834,555	2,844,555
1,300,000	2,704,555	2,714,555	2,724,555	2,734,555	2,744,555	2,754,555	2,764,555	2,774,555	2,784,555	2,794,555	2,804,555	2,814,555	2,824,555	2,834,555	2,844,555	2,854,555	2,864,555	2,874,555	2,884,555	2,894,555
1,350,000	2,754,555	2,764,555	2,774,555	2,784,555	2,794,555	2,804,555	2,814,555	2,824,555	2,834,555	2,844,555	2,854,555	2,864,555	2,874,555	2,884,555	2,894,555	2,904,555	2,914,555	2,924,555	2,934,555	2,944,555
1,400,000	2,804,555	2,814,555	2,824,555	2,834,555	2,844,555	2,854,555	2,864,555	2,874,555	2,884,555	2,894,555	2,904,555	2,914,555	2,924,555	2,934,555	2,944,555	2,954,555	2,964,555	2,974,555	2,984,555	2,994,555
1,450,000	2,854,555	2,864,555	2,874,555	2,884,555	2,894,555	2,904,555	2,914,555	2,924,555	2,934,555	2,944,555	2,954,555	2,964,555	2,974,555	2,984,555	2,994,555	3,004,555	3,014,555	3,024,555	3,034,555	3,044,555
1,500,000	2,904,555	2,914,555	2,924,555	2,934,555	2,944,555	2,954,555	2,964,555	2,974,555	2,984,555	2,994,555	3,004,555	3,014,555	3,024,555	3,034,555	3,044,555	3,054,555	3,064,555	3,074,555	3,084,555	3,094,555
1,550,000	2,954,555	2,964,555	2,974,555	2,984,555	2,994,555	3,004,555	3,014,555	3,024,555	3,034,555	3,044,555	3,054,555	3,064,555	3,074,555	3,084,555	3,094,555	3,104,555	3,114,555	3,124,555	3,134,555	3,144,555
1,600,000	3,004,555	3,014,555	3,024,555	3,034,555	3,044,555	3,054,555	3,064,555	3,074,555	3,084,555	3,094,555	3,104,555	3,114,555	3,124,555	3,134,555	3,144,555	3,154,555	3,164,555	3,174,555	3,184,555	3,194,555

FIGURE 27 PEAT ERM & DCF modules with scenario analysis and heat map regions

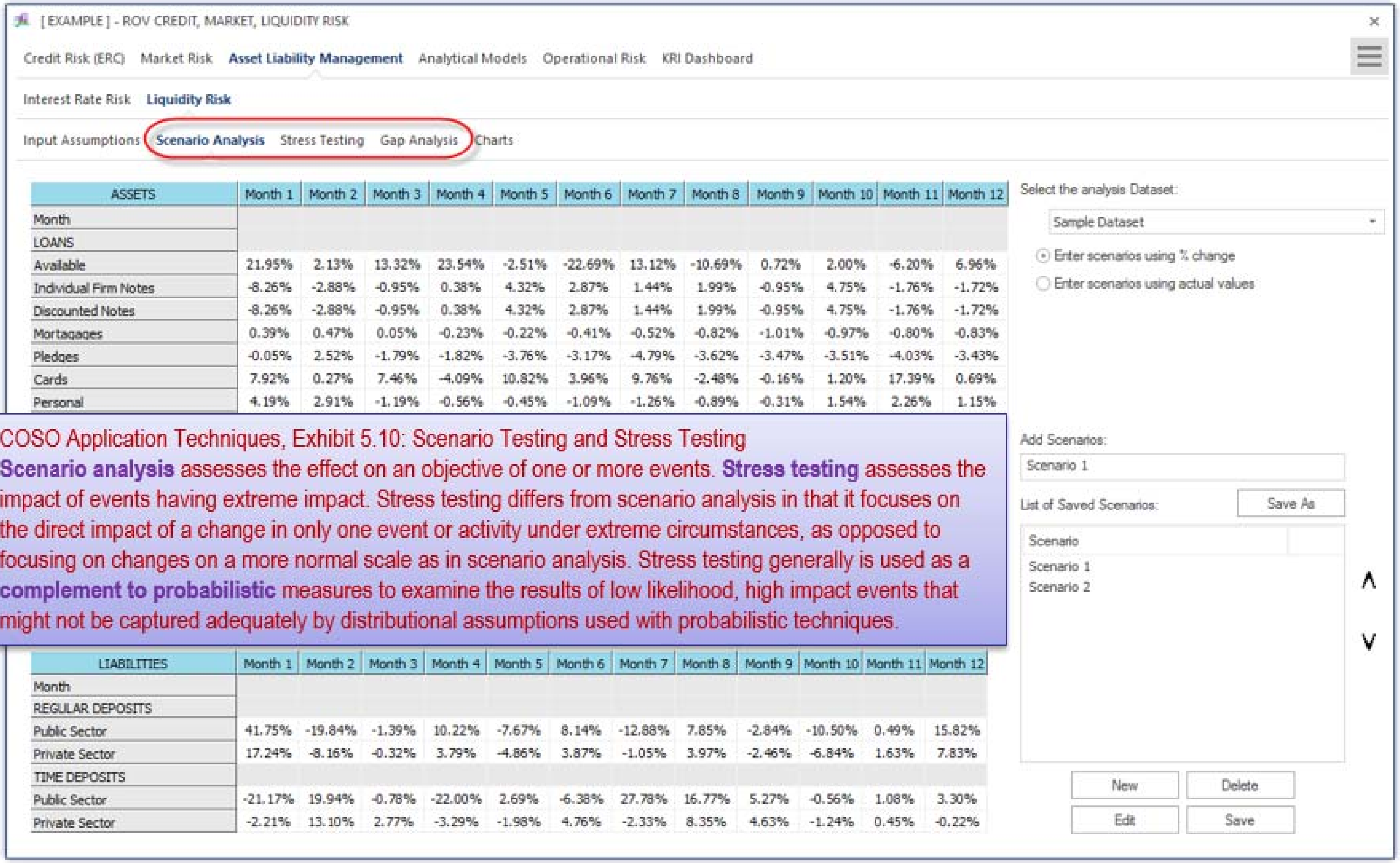
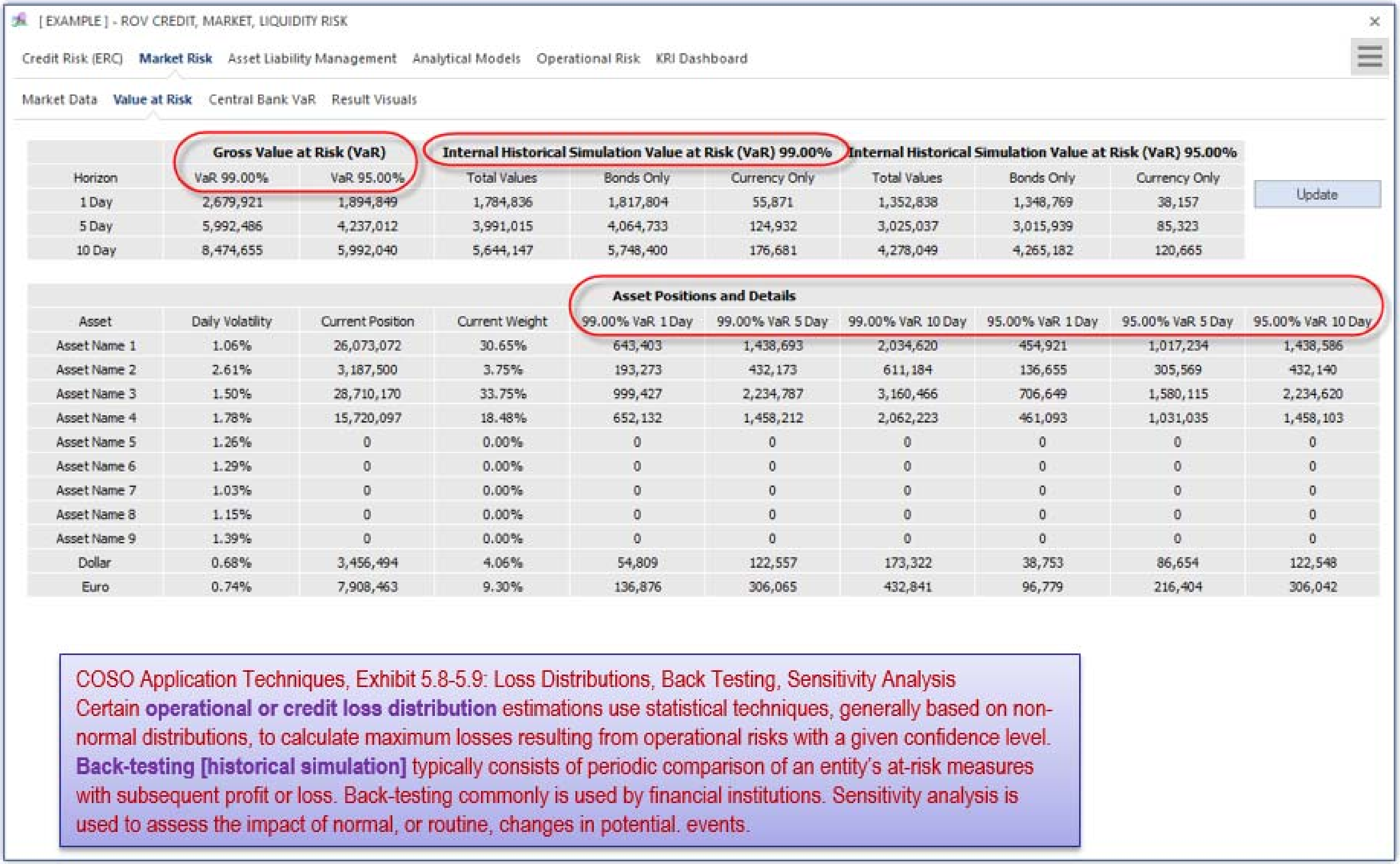


FIGURE 28 CMOL module with scenario analysis and stress testing



	Gross Value at Risk (VaR)		Internal Historical Simulation Value at Risk (VaR) 99.00%			Internal Historical Simulation Value at Risk (VaR) 95.00%		
Horizon	VaR 99.00%	VaR 95.00%	Total Values	Bonds Only	Currency Only	Total Values	Bonds Only	Currency Only
1 Day	2,679,921	1,894,849	1,784,836	1,817,804	55,871	1,352,838	1,348,769	38,157
5 Day	5,992,486	4,237,012	3,991,015	4,064,733	124,932	3,025,037	3,015,939	85,323
10 Day	8,474,655	5,992,040	5,644,147	5,748,400	176,681	4,278,049	4,265,182	120,665

				Asset Positions and Details					
Asset	Daily Volatility	Current Position	Current Weight	99.00% VaR 1 Day	99.00% VaR 5 Day	99.00% VaR 10 Day	95.00% VaR 1 Day	95.00% VaR 5 Day	95.00% VaR 10 Day
Asset Name 1	1.06%	26,073,072	30.65%	643,403	1,438,693	2,034,620	454,921	1,017,234	1,438,586
Asset Name 2	2.61%	3,187,500	3.75%	193,273	432,173	611,184	136,655	305,569	432,140
Asset Name 3	1.50%	28,710,170	33.75%	999,427	2,234,787	3,160,466	706,649	1,580,115	2,234,620
Asset Name 4	1.78%	15,720,097	18.48%	652,132	1,458,212	2,062,223	461,093	1,031,035	1,458,103
Asset Name 5	1.26%	0	0.00%	0	0	0	0	0	0
Asset Name 6	1.29%	0	0.00%	0	0	0	0	0	0
Asset Name 7	1.03%	0	0.00%	0	0	0	0	0	0
Asset Name 8	1.15%	0	0.00%	0	0	0	0	0	0
Asset Name 9	1.39%	0	0.00%	0	0	0	0	0	0
Dollar	0.68%	3,456,494	4.06%	54,809	122,557	173,322	38,753	86,654	122,548
Euro	0.74%	7,908,463	9.30%	136,876	306,065	432,841	96,779	216,404	306,042

COSO Application Techniques, Exhibit 5.8-5.9: Loss Distributions, Back Testing, Sensitivity Analysis
Certain **operational or credit loss distribution** estimations use statistical techniques, generally based on non-normal distributions, to calculate maximum losses resulting from operational risks with a given confidence level. **Back-testing [historical simulation]** typically consists of periodic comparison of an entity's at-risk measures with subsequent profit or loss. Back-testing commonly is used by financial institutions. Sensitivity analysis is used to assess the impact of normal, or routine, changes in potential. events.

FIGURE 29 CMOL module with historical simulation (back-testing) and Value at Risk

Real Options Valuation, Inc.
4101F Dublin Blvd., Ste. 425, Dublin, California 94568 U.S.A.
www.realoptionsvaluation.com admin@realoptionsvaluation.com

Real Options Valuation Inc