Re-Thinking the Wealth Management Advisory Cycle through Advanced Analytics & Risk Management tools

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The world of wealth management is undergoing a revolution

Advisors are under immense pressure…

A new type of client

- Investors questioning value of advice, level of services, user experience, transparency, fees
- Change in demographics – greater emphasis on real-time information, accessed through multiple platforms (mobile, web)

Regulation

- Tighter regulatory environment placing much higher demands on client interactions, disclosure and transparency

Fee compression

- Downward pressure from clients, increased competition, low-fee products, robo-advisors

Complex markets

- Looming correction, lower returns & alpha, talks of recession…

Technology Gap & Operational Inefficiencies

Wealth management firms have been underserved by technology

Compared to institutional money & banking

1990s Banks
- Risk management & trading platforms
- Banking regulation

2000s Buy Side
- Asset managers & hedge funds
- Risk & portfolio analytics, trading strategies

2015+ Wealth Management
- Goal-based investment & portfolio management
- Risk & performance
- Communications: advisors & individual investors

And the Pressure is Mounting …

The online advisor platform, WealthDesk, brings to a single dashboard a consolidated view of client relationships and portfolios… it integrates portfolio advice, portfolio risk measurement, fee and pricing information and consolidated view of clients' plans and portfolios updated each quarter…

A New Advisory Model

The new advisory model *based on*

*a **transparent value add practice** which redefines and builds **long-term trust**…*

Digitally driven

- End-to-end workflow and enhanced client communication

Client–focused automated business processes

- PM, compliance, and communication defined by client's goals and portfolios… not the firm's products

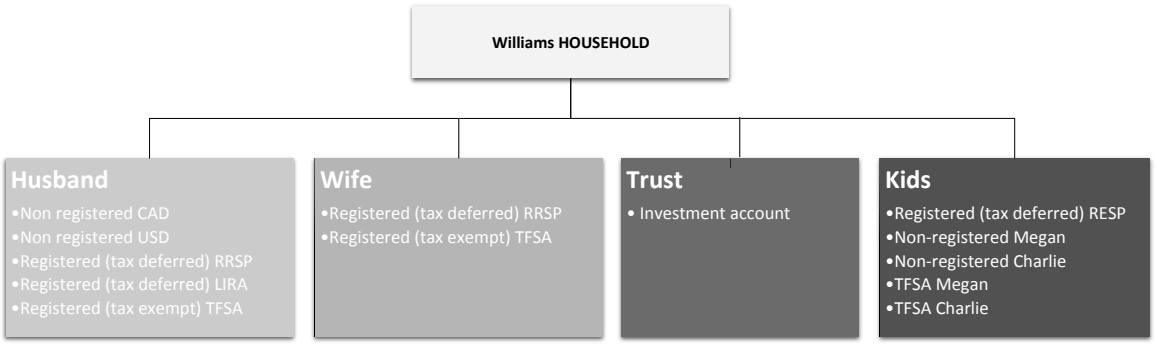
Investment sophistication

- Technology-driven investment process guided by analytics and rigorous risk management

High-touch services

- Personalized high-value, interactive client engagement, increased communication and trust

It All Starts with a Client/Family – Example…

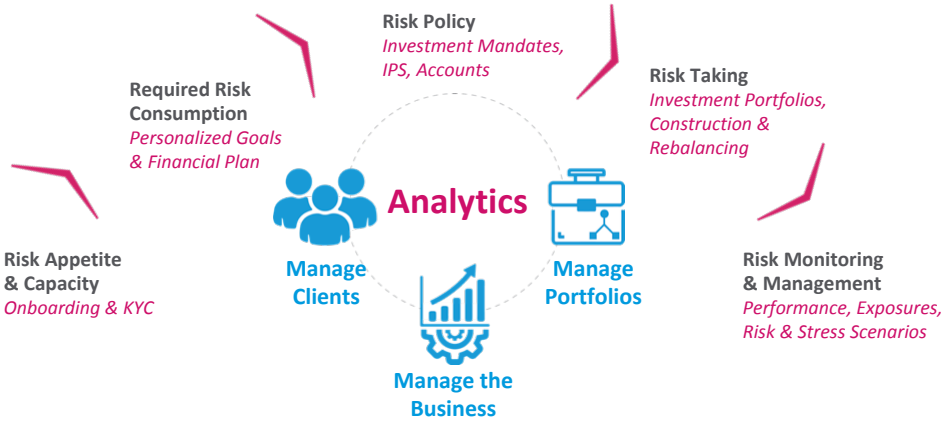


Multiple actors, risk tolerance/appetite, knowledge, interests, subjective views…

Multiple Dreams, wishes and needs → Goals (and horizons):

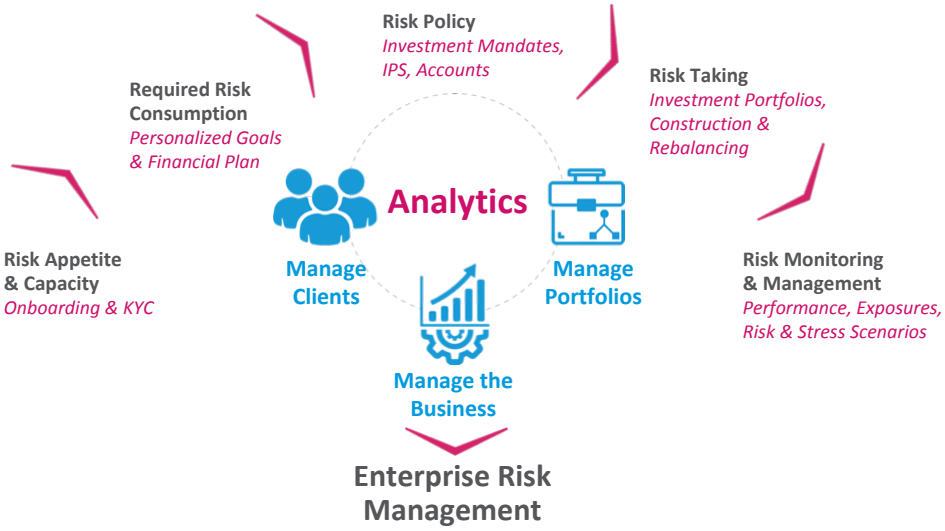
- College for kids, reno house, retirement at 65?, charity projects, etc…

The Wealth Management Risk Cycle

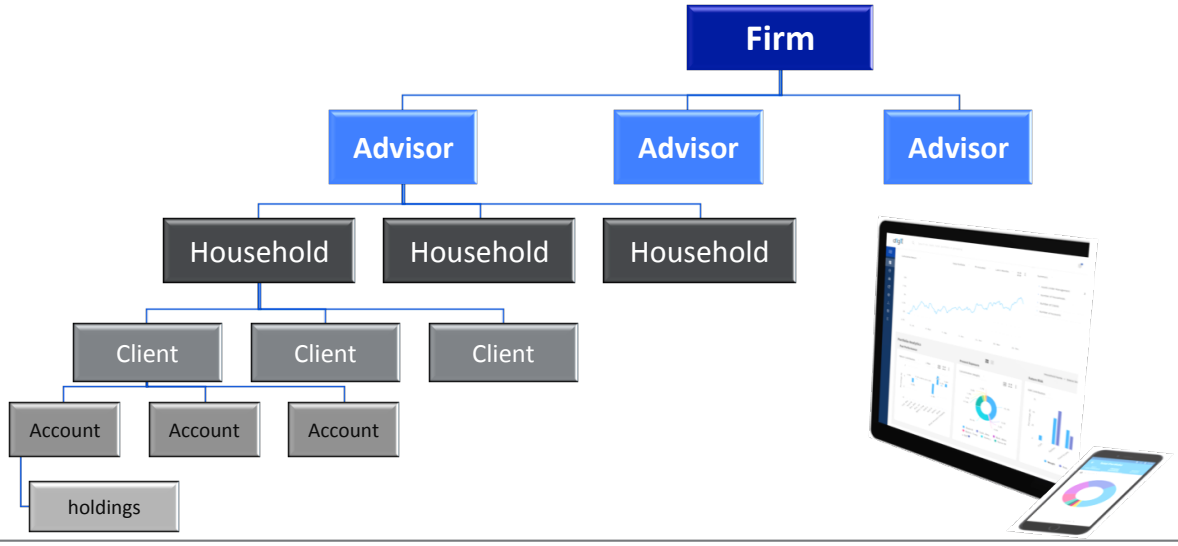


Aligning Risks across the Cycle

The Wealth Management Risk Cycle



Enterprise Wealth Management Powered by Analytics

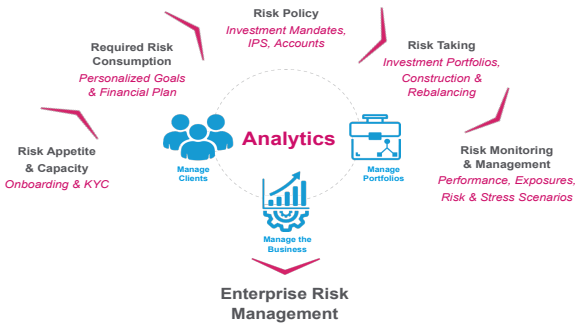


Analytics to Manage The Wealth Management Risk Cycle

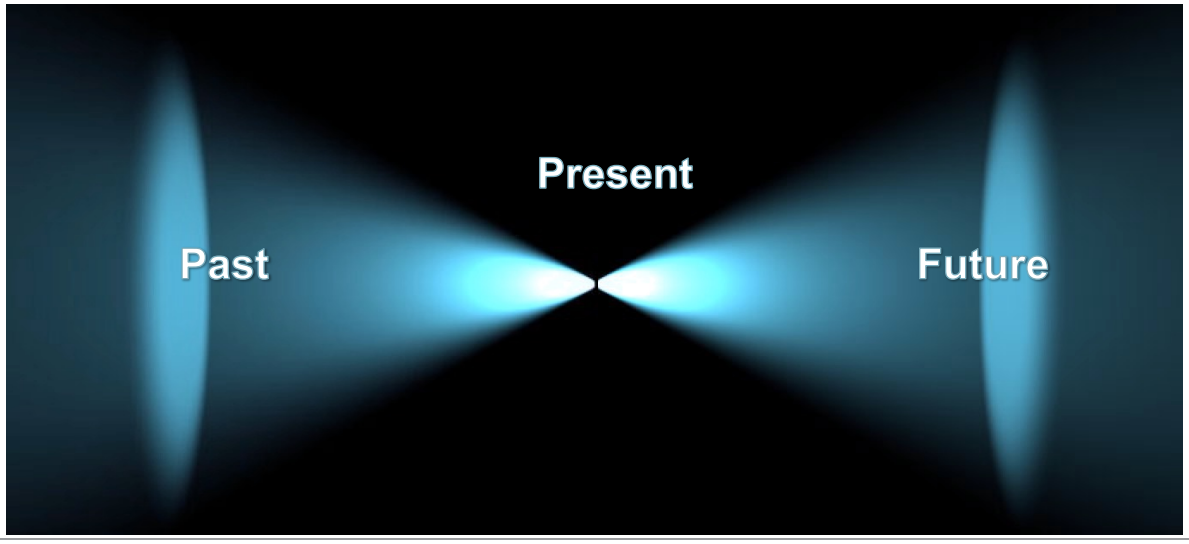
The modern Wealth Management analytics toolkit integrates

- Data Science / Machine Learning
- Behavioural finance
- Goal Based financial Planning
- Modern Portfolio Theory, Portfolio Optimization
- Risk management tools

- … Long-term investment focus



Analytics – The Investment Light Cone



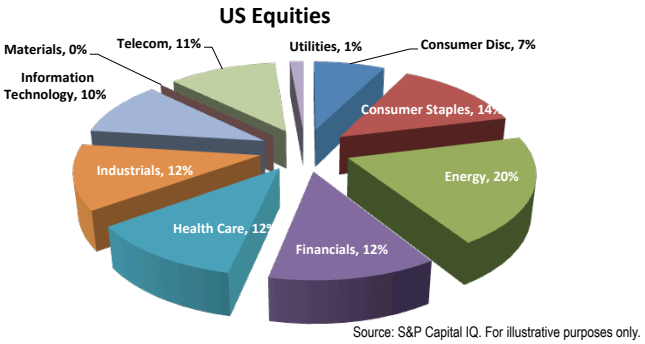
The Investment Light Cone

Portfolio Exposures – Example

$ USD (Million)	NMV	Long	Short
Portfolio	457.5	567.8	110.3
EQ	221.4	225.5	4.1
IR	111.2	111.2	0.0
CR	124.9	231.1	106.2

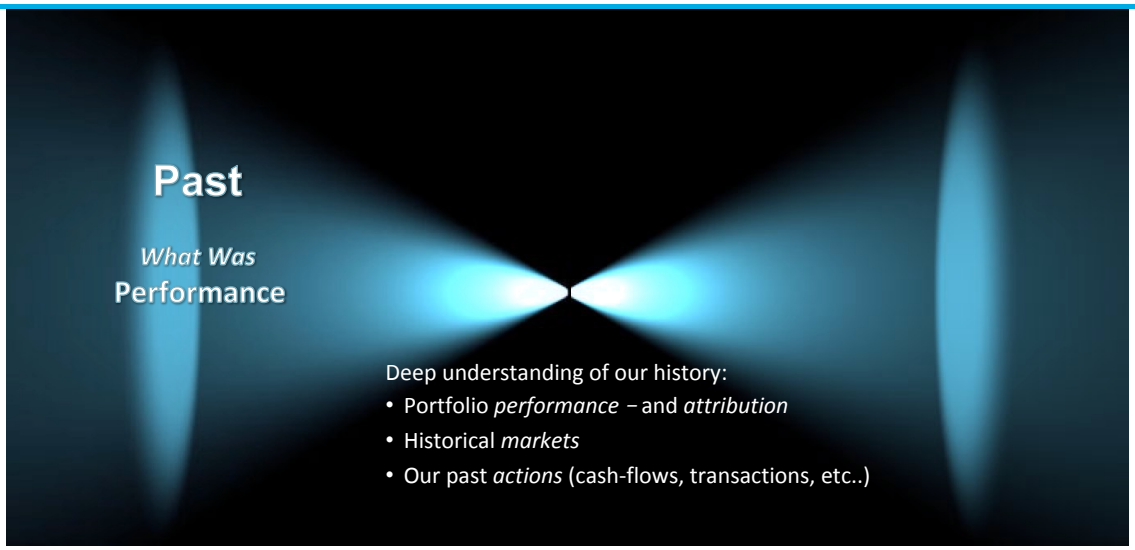
Portfolio		**458**
EQ		*221*
	USD-EQ	136
	EUR-EQ	48
	GBP-EQ	16
	JPY-EQ	22
IR		*111*
	USD-GOV	52
	EUR-SOV	59
CR		*125*
	USD-IG	70
	USD-HY	60
	EUR-HY	32
	USD CDS	-38

NMV	USD	EUR	GBP	JPY	Total
EQ	32%	11%	4%	5%	52%
IR	10%	14%			24%
CR	18%	7%			24%
Total	59%	32%	4%	5%	100%

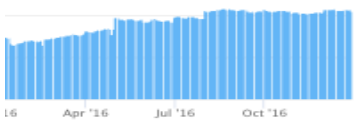


Source: S&P Capital IQ. For illustrative purposes only.

The Investment Light Cone



Performance Attribution – Example



$$\text{Risk-Free Rate} \equiv \overline{r_{f,t}}$$

$$\text{Risk Premia} \equiv \sum_{m=1}^{M} \overline{\beta_{p,m,t}} \cdot \overline{F_{m,t}}$$

$$\text{Security Selection} \equiv \sum_{i=1}^{N} \overline{w_{i,t}} \cdot \alpha_i$$

$$\text{Factor Timing} \equiv \sum_{m=1}^{M} \text{Cov}\langle \beta_{p,m,t}, F_{m,t} \rangle$$

$$\text{Security Timing} \equiv \sum_{i=1}^{N} \text{Cov}\langle w_{i,t}, \varepsilon_{i,t} \rangle \ .$$

Learning from History – Example: Regression Engine

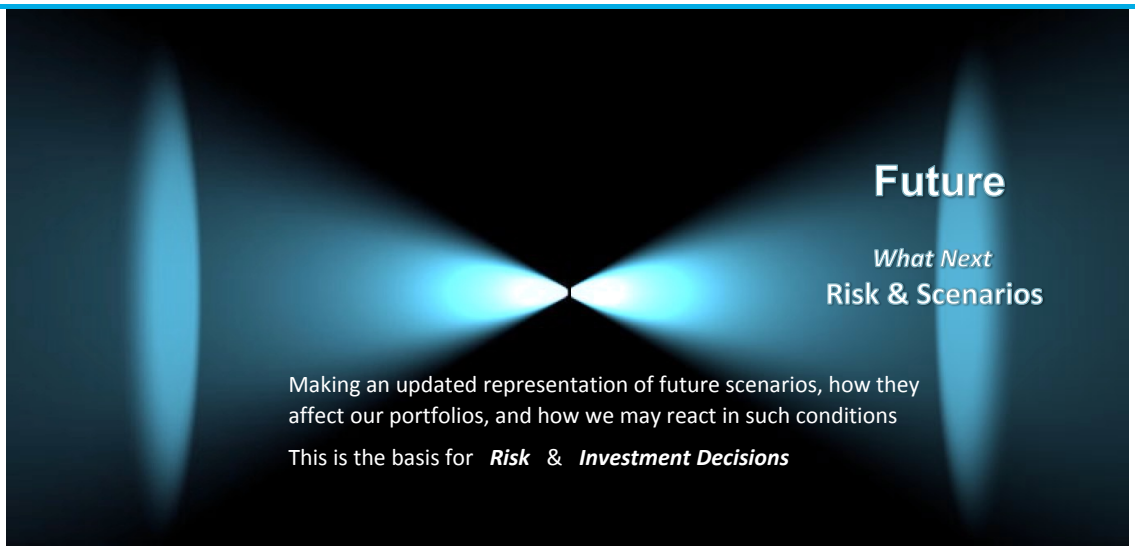
Objectives:

- Provide on-the-fly knowledge and attribution (***what, how, & why***) about client engagement
- Understand overall *Enterprise Business Drivers*
- Test and construct strategies

ML Engine is a combination of:

- Data generation and normalization: return computation and financial modeling (multiple sources)
  - Detailed client information (over time)
  - Client portfolios: multiple portfolios, hierarchies and holdings level information
    - Positions, transactions, prices – detailed feature generation and segmentation: e.g. currency, capital gains, realized-unrealized, taxes, dividends and cash-flows, …)
  - Market information (external portfolio/benchmarks), as well as events/news etc.
  - Factor analysis and economic indicators
- Econometrics and Machine Learning toolkit (unsupervised learning, regression, NNs, RL)

The Investment Light Cone



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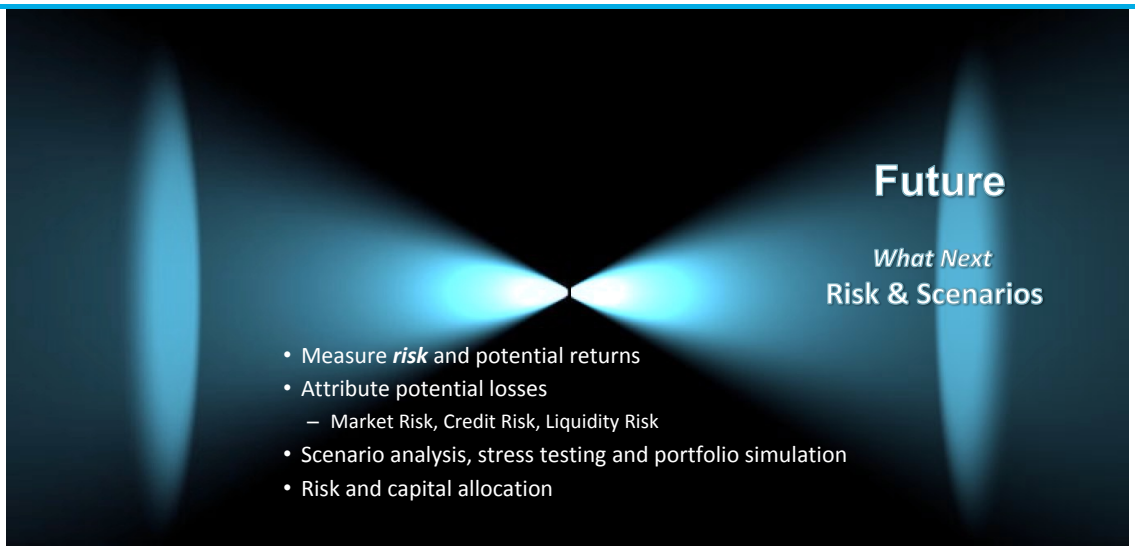
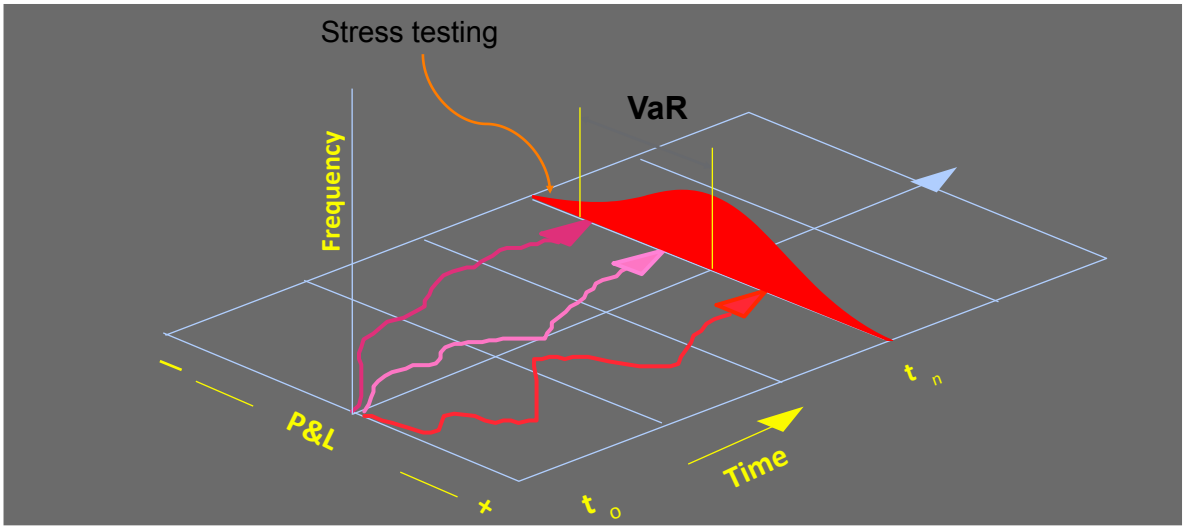
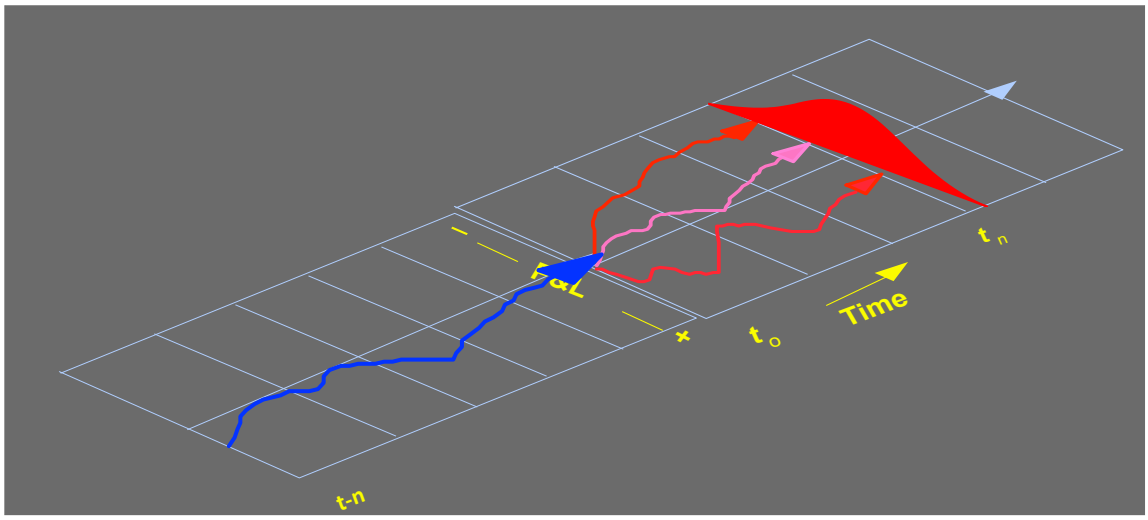


Risk Measurement



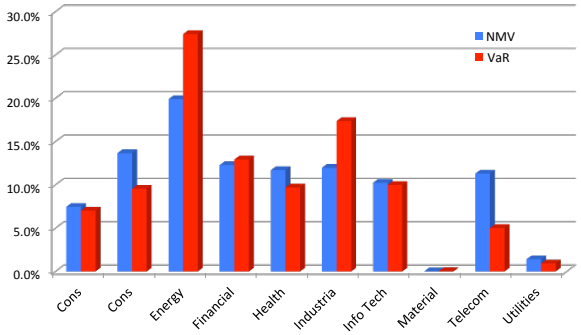
Risk and Performance Measurement



Portfolio Risk

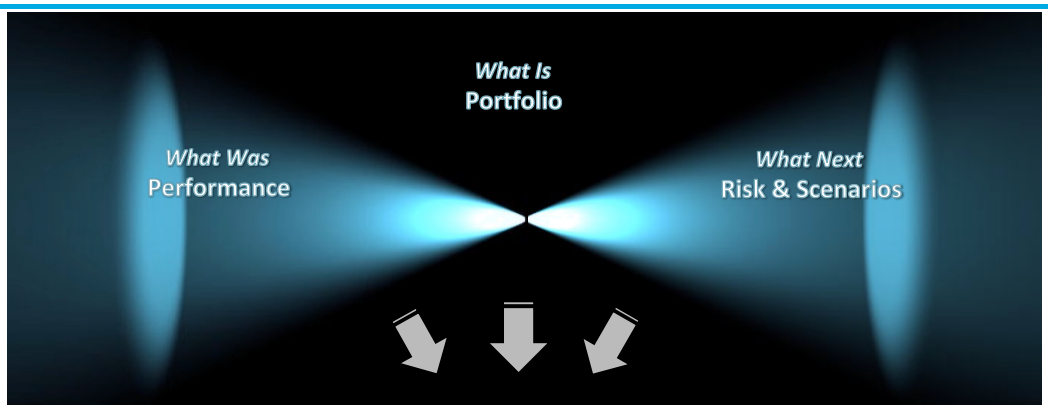
$ USD (Million)	NMV	VaR	VaR (Marginal)
Portfolio	457.5	22.3	22.3
EQ	221.4	17.1	14.4
IR	111.2	6.3	3.6
CR	124.9	6.5	4.3
Portfolio	***458***	***22.3***	***22.3***
EQ	*221*	*17.1*	*14.4*
US-EQ	136	11.5	8.3
EU-EQ	48	6.2	4.6
UK-EQ	16	1.5	1.0
JP-EQ	22	2.7	0.6
IR	*111*	*6.3*	*3.6*
US-GOV	52	2.4	0.7
EU-SOV	59	4.6	2.9
CR	*125*	*6.5*	*4.3*
US-IG	70	2.1	0.8
US-HY	60	3.4	2.0
EU-HY	32	2.1	1.5
US CDS	-38	1.9	0.0

	USD	EUR	GBP	JPY	Total
EQ	37%	21%	4%	2%	65%
IR	3%	13%			16%
CR	13%	7%			19%
Total	53%	40%	4%	2%	100%



VaR at 99% confidence, one month

The Investment Light Cone



Design and testing of *strategies*, *reactions* and *intervention* measures (management, policy modelling, portfolio construction, governance)

What If
Strategies & Actions

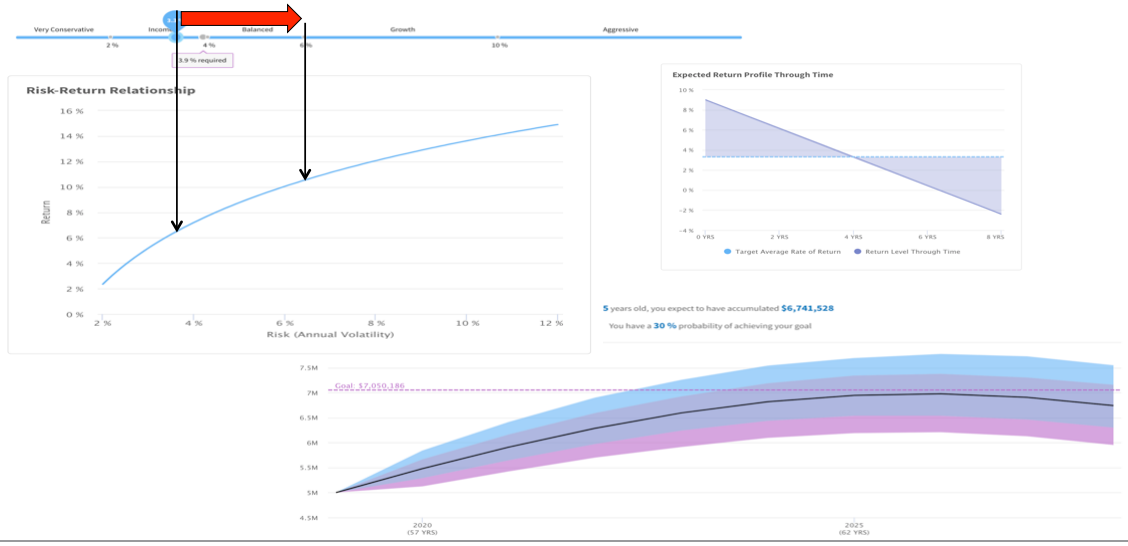
Example: Linking Risk & Goal Based Wealth Management

Key points:

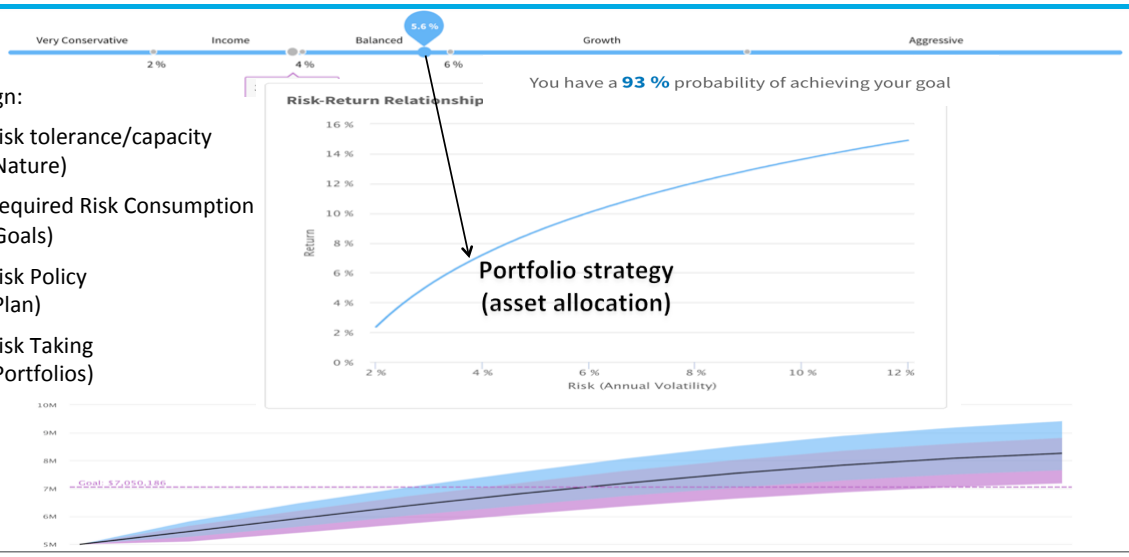
- We can consistently combine:
  - Goal Based financial Planning
  - Modern Portfolio Theory, Portfolio Optimization tools
  - Behavioural finance
- Focus on (long-term) risk measures related to
  - Probability of achieving Goal(s)
  - Distance to achieve goal(s)
- Create explicit link to portfolio risk measures (volatility, VaR, drawdown, etc…)

Risk & Goal Based Wealth Management

The Future: Linking Financial Goals and Portfolio Management



Risk & Goal Based Wealth Management



Align:

- Risk tolerance/capacity (Nature)
- Required Risk Consumption (Goals)
- Risk Policy (Plan)
- Risk Taking (Portfolios)

Goal base Wealth Management

Goal Based Portfolio Optimization – intuitive and actionable for financial advisors

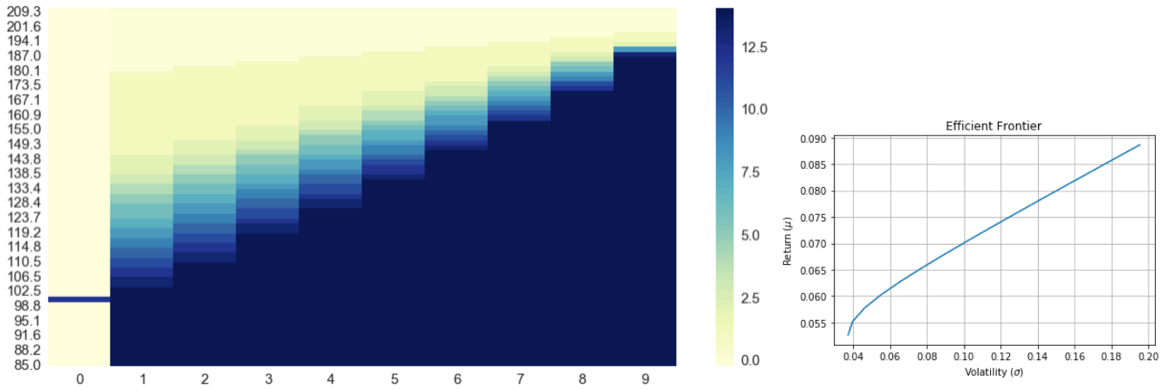
- Maximize the likelihood of achieving the goal (or set of goals)
- Minimize a distance function (e.g. mean squared errors) to achieving goal

Key insight: integrate MPT by choosing portfolio set on the efficient portfolio (splitting optimal asset allocation and the required risk taking to achieve a goal)

Example – Das et al

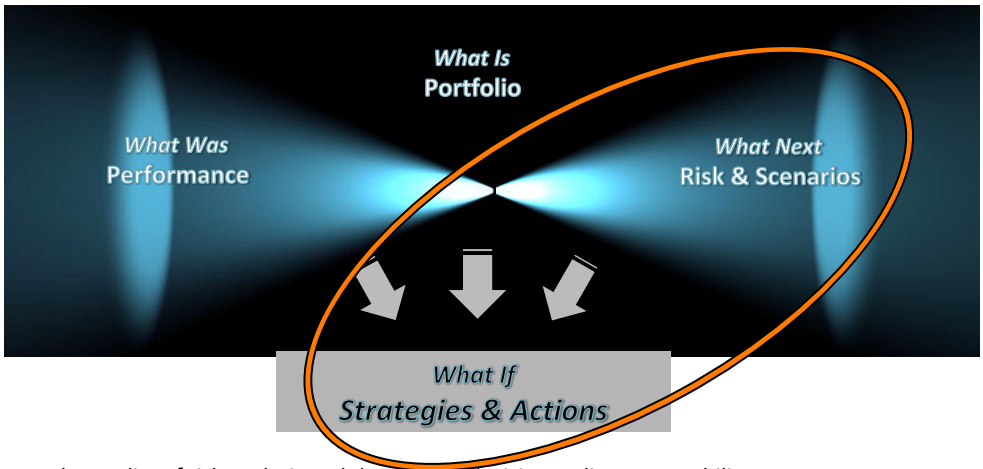
- Static (constant risk) solution
- Dynamic goal based portfolios (using stochastic dynamic programming)
- Trading off Multiple goals
- Dynamic portfolios via Reinforcement Learning

Example: Dynamic Portfolio Optimization (Das et al.)



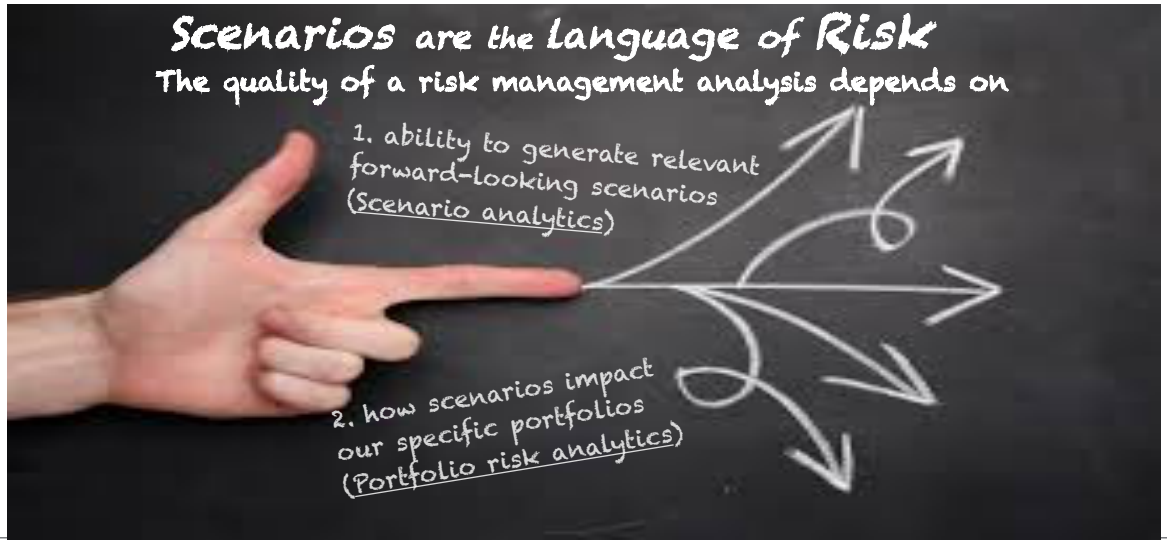
Optimal portfolio strategy at each wealth node and time
(lighter color corresponding to less risk and darker to higher risk portfolios in the Efficient Frontier)

The Investment Light Cone – Scenarios

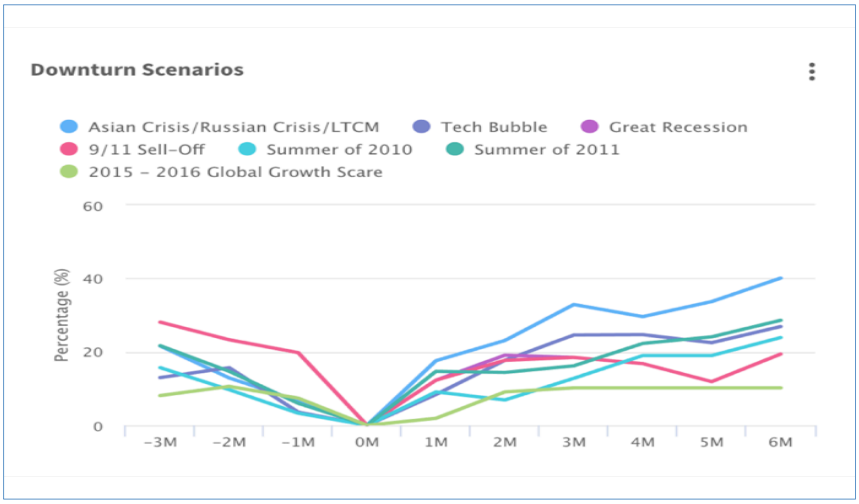


The quality of risk analysis and the actions/decisions relies on our ability to generate
relevant, ***plausible*** and ***comprehensive***, ***forward-looking scenarios*** that properly represent the future

Risk and Scenarios



Example: Historical Scenarios



Scenario Analytics

The development of relevant forward-looking scenarios requires the combination of

- Detailed understanding of portfolios, clients and goals
- Good economic analysis
- Grounded financial models
- Data science and econometrics

Example: Scenarios from Economic Report

Source: Standard & Poor's Ratings Services CreditWeek, April 22 2015

Economic Outlook – Global Scenario

GLOBAL ECONOMIC OUTLOOK

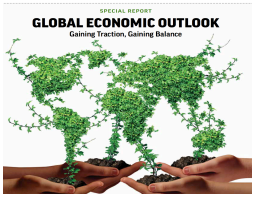
Gaining Traction, Gaining Balance

GLOBAL Scenario 2015	US	EURO	UK	JPN
Real GDP (% change)	3	1.5	2.8	0.8
Inflation (% change)	-0.3	-0.3	0.1	0.4
IR Short	0.3	0.1	0.5	0.05
IR Long	2.3	0.3	2.0	-
FX		0.9	0.7	120.0

Source: Standard & Poor's Ratings Services economic research report dated April 22 2015. Indexes are unmanaged, statistical composites and it is not possible to invest directly in an index. These results are inherently limited because they do not represent the results of actual trading and were constructed with the benefit of hindsight. The returns shown do not reflect payment of any sales charges or fees an investor would pay to purchase the securities they represent. The imposition of these fees and charges would cause actual and back tested performance to be lower than the performance shown. Returns exclude dividends.

Joint Factor Simulation Model

Economic Research Scenarios



Portfolio

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US-EQ	136	11.5
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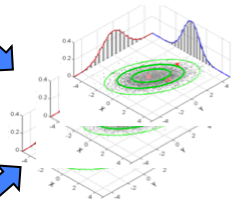
US-IG	70	2.1
US-HY	60	3.4
EU-HY	32	2.1
US CDS	-38	1.9

Economic Factors

GLOBAL & U.S. Scenario Factors	U.S.	EURO	UK	JPN
Real GDP	X	X	X	X
Inflation	X	X	X	X
Unemployment	X			
IR Short	X	X		
IR Long	X	X		
EQ (S&P500)	X			
Oil (WTI)	X			
FX		X	X	X

Market Factors

Equity Indices	IR Curves	Credit	FX
US Sectors	USD Gov	CDS: US IG, HY Bond Spreads: US IG, HY	
XE	EUR Sov	EUR Spread HY	EUR
GB			GBP
JP			JPY

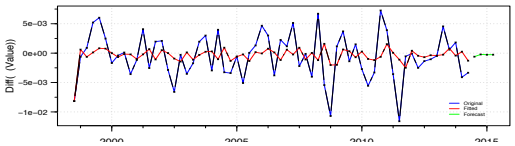


Example: Joint Factor Simulation Model

Input: quarterly data for all the factors (20+ years)

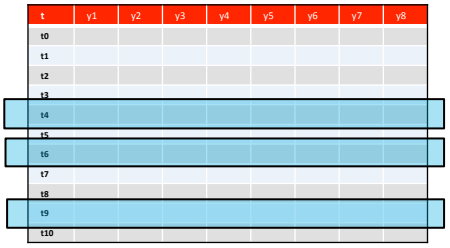
1. Marginal processes for each factor: ARMA GARCH model (filtering)

$$y_t = a_0 + a_1 y_{t-1} + b_1 \epsilon_{t-1} + \epsilon_t$$
$$\epsilon_t = \sigma \eta_t, \quad \sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$



2. Historical codependence of residuals

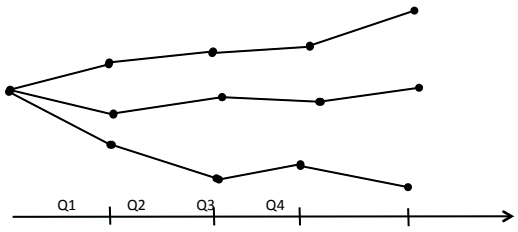
   (allows for non-Gaussian fat tails and tail dependence)

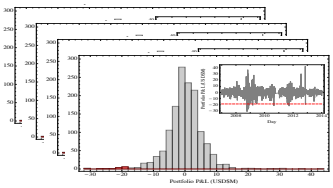


Joint Factor Simulation Model

Empirical (simulated) factor terminal distribution (horizon = 1 year)

- Monte Carlo simulation of *N* scenarios of the joint factor processes over 4 quarterly steps (*N = 1K – 10K)*





$$y_t = a_0 + a_1 y_{t-1} + b_1 \epsilon_{t-1} + \epsilon_t$$
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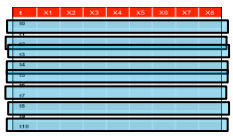
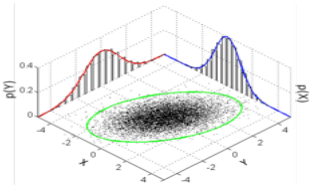
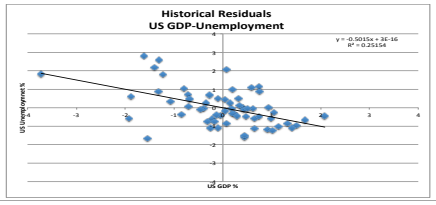
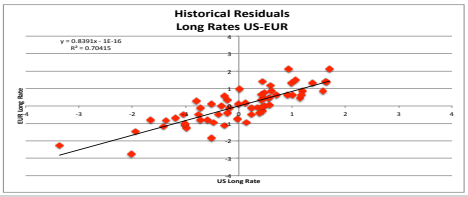


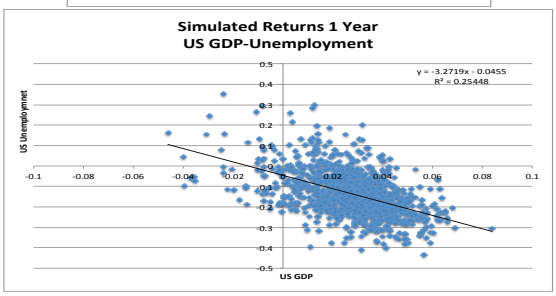


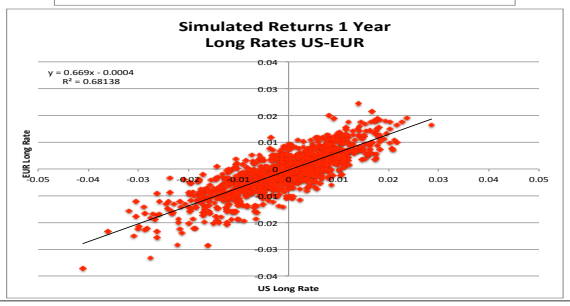
Joint Factor Simulation Model

Example – Empirical and simulated factor terminal distribution









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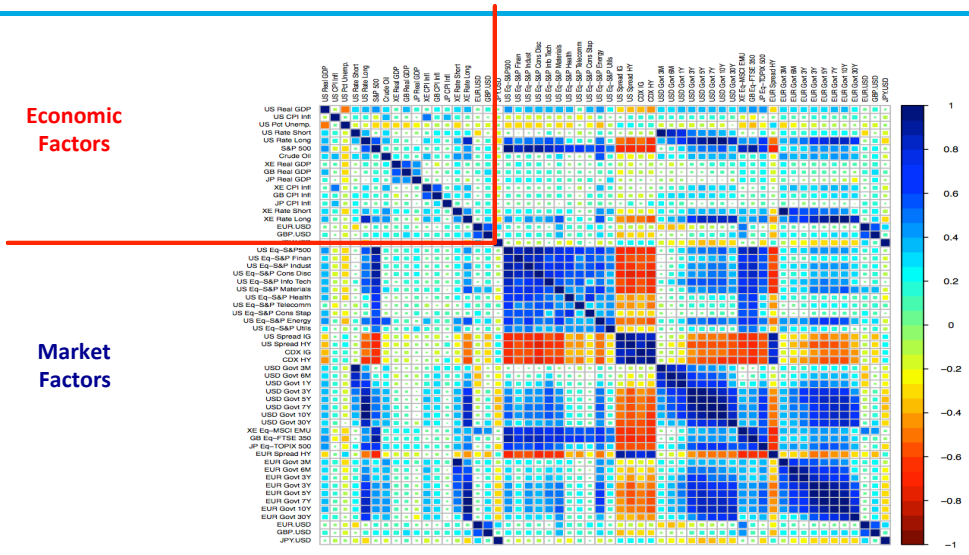
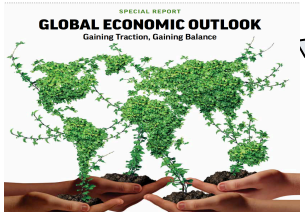
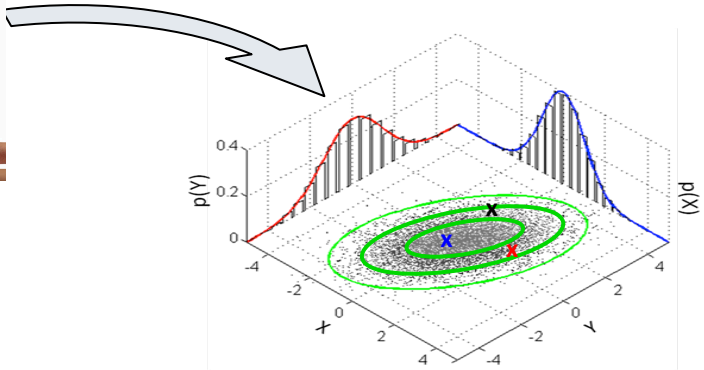


Economic Scenarios – Model Mapping

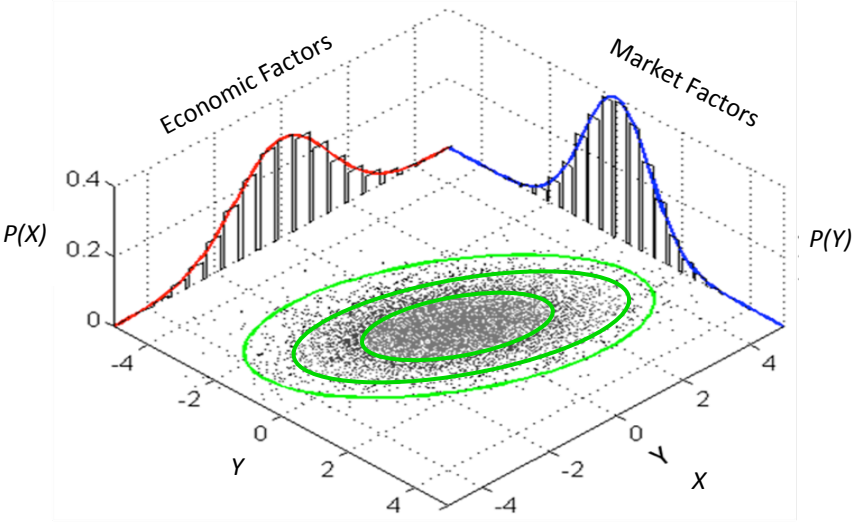
Objective: express forecasted scenarios in the context of joint factor simulated distribution

- Standardized economic scenarios (expressed as number of standard deviations of factors, and also in terms of likelihood within the model)





Conditional Scenarios



Conditional Scenarios

Economic Scenario
Economic Factors X Fixed

- *Expected Conditional Scenario of Y*
- *Full Conditional Scenario Distribution*

Conditional Scenarios: Analytical Methods

Conditional factor distributions are available analytically for certain joint distributions

e.g. Multi-variate Gaussian

$$X = \begin{pmatrix} X^{(1)} \\ X^{(2)} \end{pmatrix} \sim N(\mu, \Sigma)$$

$$\mu = \begin{pmatrix} \mu^{(1)} \\ \mu^{(2)} \end{pmatrix}, \qquad \Sigma = \begin{pmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{pmatrix}$$

Conditional distribution of $X^{(2)}$ given $X^{(1)} = x^{(1)}$ is *multivariate normal* with mean *m* and covariance matrix *B*

$$m = \mu^{(2)} + \Sigma_{21}\Sigma_{11}^{-1}(x^{(1)} - \mu^{(1)})$$
$$B = \Sigma_{22} - \Sigma_{21}\Sigma_{11}^{-1}\Sigma_{12}$$

Conditional Scenarios: Least Squares Stress Testing (*LSST*)

Regress Under Stress

A Simple Least-Squares Method for Integrating Economic Scenarios with Risk Simulations

Dan Rosen,[1] David Saunders [2]

Journal of Risk Management in Financial Institutions, 9(4)

Conditional Scenarios: Least Squares Stress Testing (*LSST*)

Key insight: conditional expectation of all the factors (and more generally the full conditional distribution) can be estimated directly from a pre-computed simulation using Least Squares Regression (LSR) or more sophisticated ML methods

- Conditional scenario analytics, including risk factor contributions, can be derived from the regression results
- The application of LSR on the cross-sectional information of a simulation to obtain conditional expectations is the key component of LSM to price American options (Longstaff and Schwartz 2001)
- Applied here to portfolio risk management and stress testing

Other ML examples: application of Neural Networks to simulate derivatives portfolios, compute greeks, etc…

Conditional Scenarios: *Least Squares Stress Testing*

Regression model

$$y_i = \beta_{i0} + \sum_j \beta_{ij} x_j + \sigma_i \varepsilon_i$$

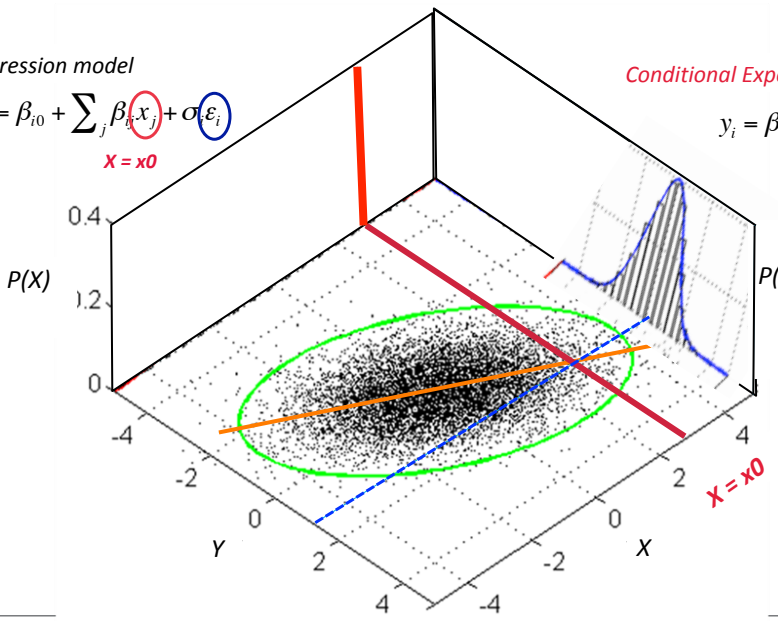
X = x0

Conditional Expected Scenario of Y

$$y_i = \beta_{i0} + \sum_j \beta_{ij} x_j$$

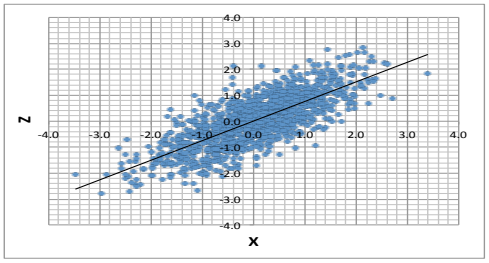
X = x0

Conditional Scenario Distribution $+ \sigma_i \varepsilon_i$

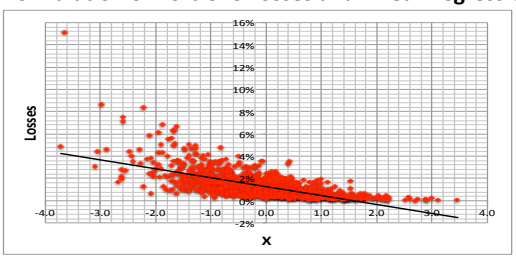


Non-Linear LSST – Example Credit Risk

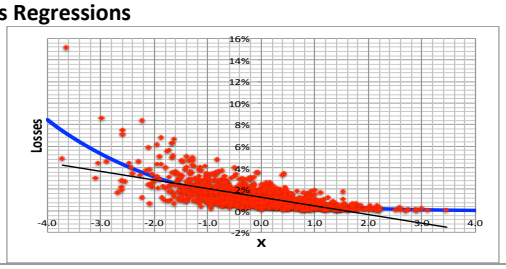
Correlation of Credit Factor to Market Factor = 77%



Simulation of Portfolio Losses and Linear Regression



Loss Regressions



$$PD(z) = G(a + b\,z)$$
$$= G\left(\frac{H^{-1}(PD) - \sqrt{\rho}\,z}{\sqrt{1-\rho}}\right)$$

Risk and Scenario Analytics through Regression (ML) Engine

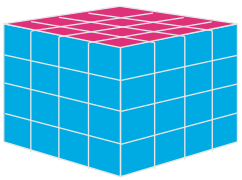
Data generation and normalization: Pre-computed simulation Cubes (expensive step)

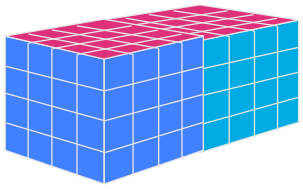
- Holdings- and factor-level simulations from risk engine
- Detailed portfolios: multiple portfolios, hierarchies and holdings level information
  - Positions, transactions and prices, with detailed feature generation and segmentation: e.g. currency, capital gains, realized-unrealized, taxes, dividends and cashflows, …)
- Enriched Cube: risk factors economic indicators

Full Machine Learning toolkit (unsupervised learning, regression models, reinforcement learning, …)

Applications: scenario analysis, strategy construction/validation, optimization, goals-based portfolios

Mark to Future





Portfolio Simulation And Analysis – Global Scenario

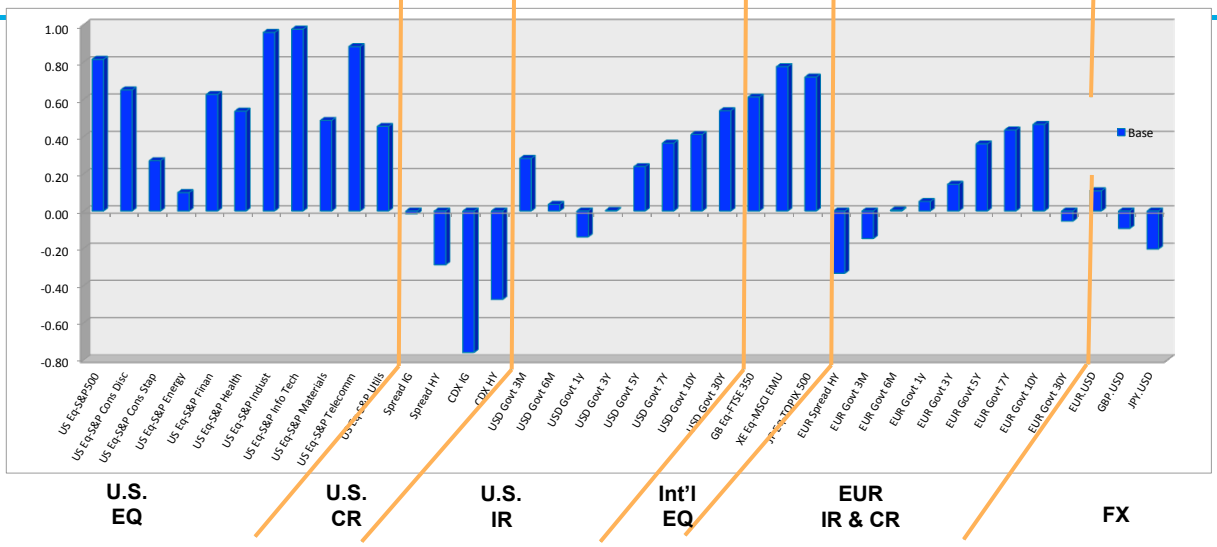
	NMV	VaR (Annual)	P&L Mean	Global Scenario	Rel. Return
Portfolio	457.5	16.0%	3.7%	8.1%	4.4%
EQ	221.4	29.0%	6.7%	17.1%	10.4%
IR	111.2	14.4%	1.6%	-0.1%	-1.8%
CR	124.9	16.8%	0.4%	-0.5%	-0.8%

GLOBAL ECONOMIC OUTLOOK
Gaining Traction, Gaining Balance

GLOBAL Scenario 2015	US	EURO	UK	JPN
Real GDP (% change)	3	1.5	2.8	0.8
Inflation (% change)	-0.3	-0.3	0.1	0.4
IR Short	0.	0.1	0.5	0.1
IR Long	2.3	0.3	2.0	0.3
FX		0.9	0.7	120.0

$US Million		NMV	P&L Mean	Global Scenario
Portfolio		**458**	**15.9**	**37.0**
EQ		*221*	*14.5*	*37.8*
	US EQ	136	9.7	22.1
	EU EQ	48	2.6	9.8
	GB EQ	16	0.8	1.8
	JP EQ	22	1.3	4.1
IR		*111*	*1.5*	*-0.1*
	US GOV	52	0.3	-0.7
	EU SOV	59	1.3	0.6
CR		*125*	*-0.1*	*-0.6*
	US IG	70	-0.1	-1.0
	US HY	60	-0.6	0.2
	EU HY	32	0.4	1.1
	US CDS	-38	0.2	-1.0

Global Outlook – Conditional Scenarios



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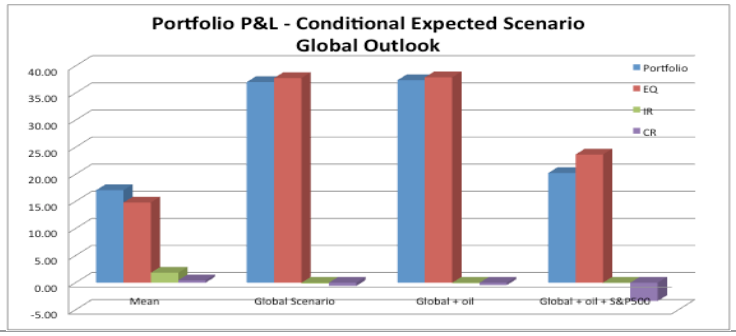

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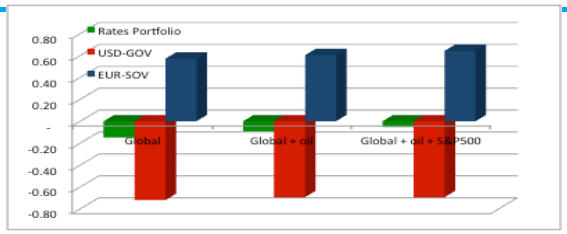
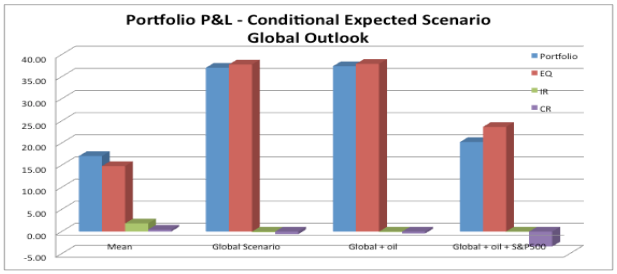
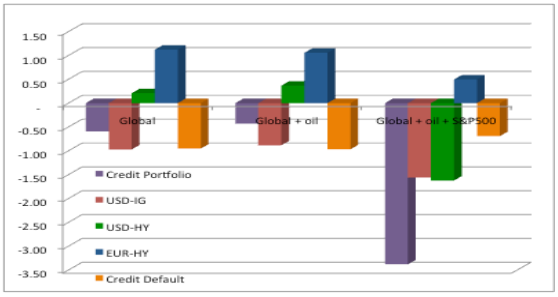
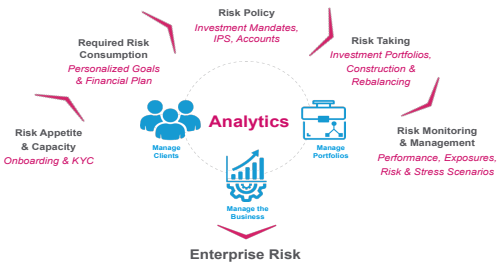


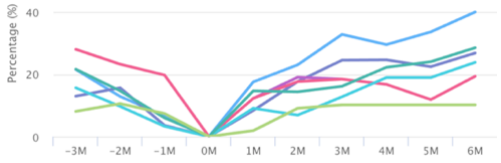




Remarks: Scenario Analysis as Advisory Tool Over the Entire Cycle

- Elicit and define client's risk appetite and tolerance, clarify goals, and design investment/risk policies and IPSs
- Portfolio management
  - Design specific client portfolios
  - Monitor and attribute risk
- Powerful communication tool to help engage and manage clients
  - On-going client communication around life events, market downfalls, crises, economic opportunities
- Engage prospects: investment and advisory proposals for new clients or new plans





Technology will empower
wealth management firms
to scale up the high-value, human services
that can set them apart
in an increasingly automated & digital world.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