

Public Agenda Item #6

Review and Discussion of the Risk Management and Applied Research Program(RMAR)

December 1, 2016

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Stuart Williams, CFA, Risk Management Portfolio Manager

Risk Management and Applied Research Program



“Investing in the capital markets brings with it an uncertainty of returns”

Risk refers to the distribution of these uncertainty of returns

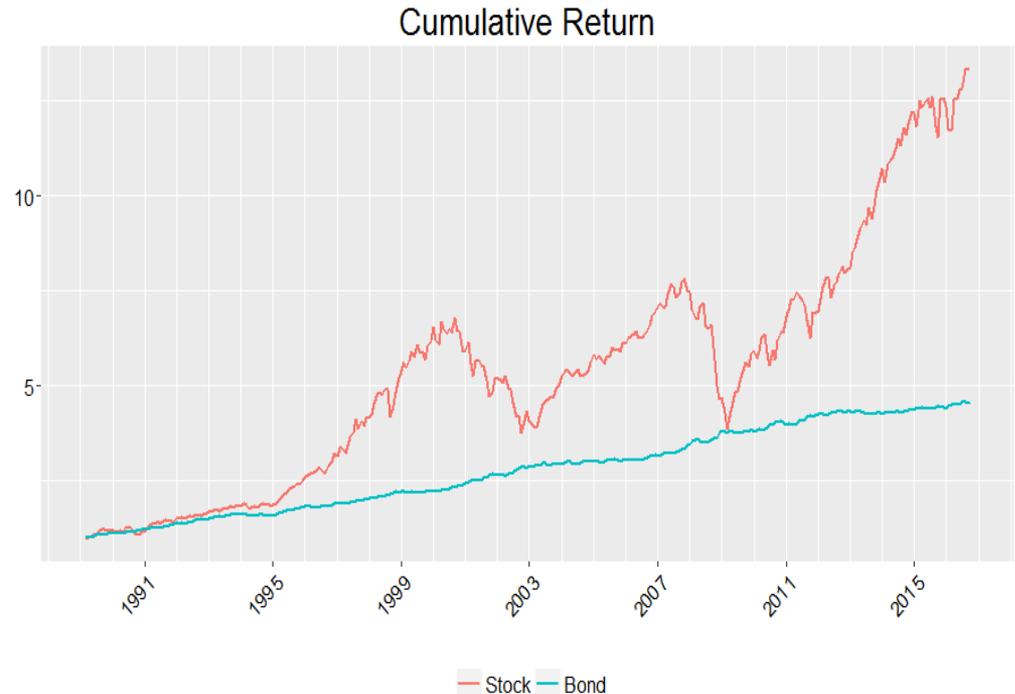
- A high risk investment is more volatile than a low risk investment
- A measure of the estimation of this risk is the standard deviation
- The standard deviation measures the size of these fluctuations

Diversification - potential losses can be mitigated by investing in assets that do not move in the same direction at the same time “Do not put all your eggs in one basket”

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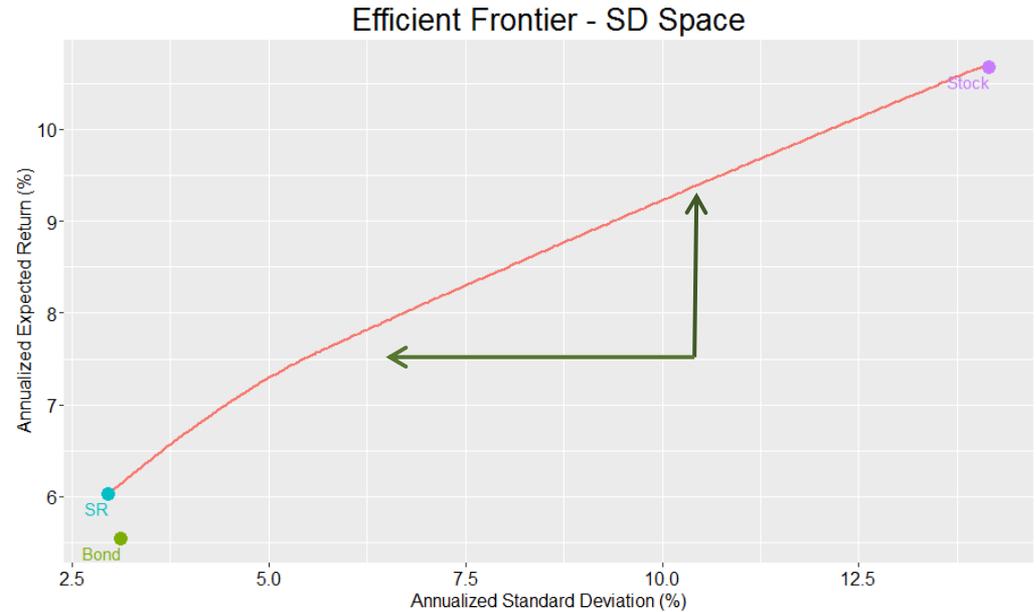
- Red line = risky asset
- Green line = riskless asset
- Do not move in the same direction at the same time
- We have the potential to diversify and mitigate risk



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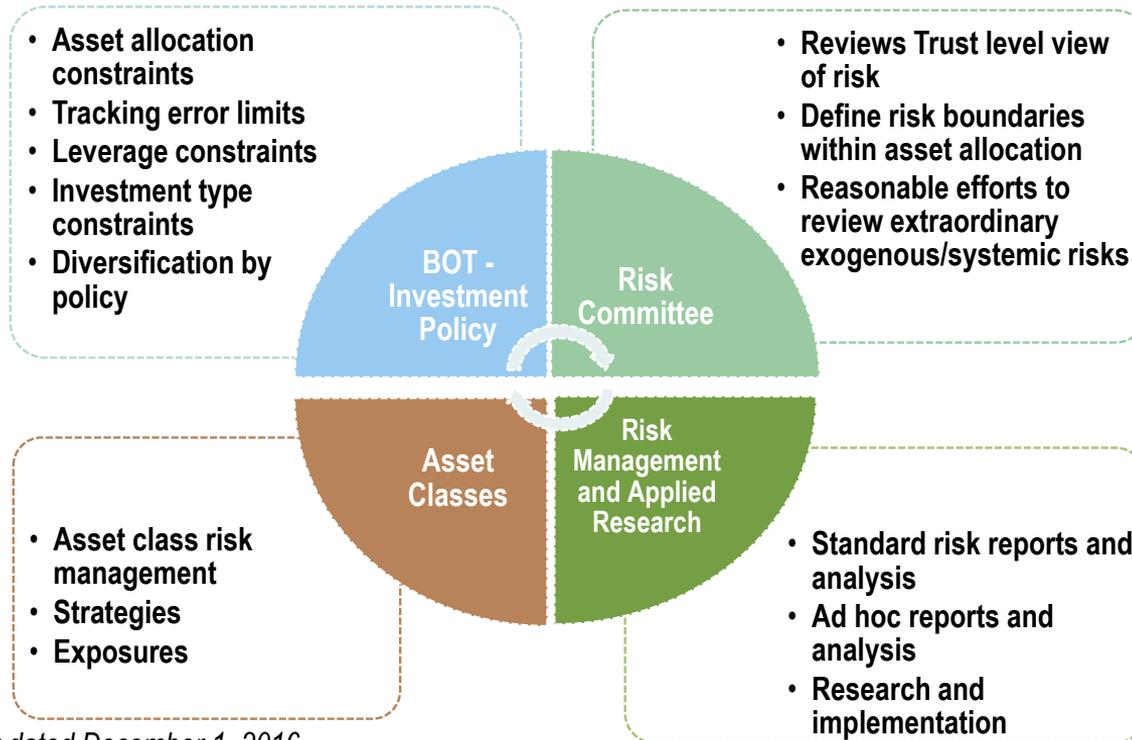
- Efficient frontier depicts a trade off between risk and returns
- Higher expected returns are associated with higher risk
- Diversification can be achieved by the combination of risky and riskless assets
 - Helps to balance the amount of return per unit of risk



Risk Management and Applied Research Program



Integrated Aspects of Risk Management



RMAR Team

- **Carlos Chujoy, CFA** - Sr. Portfolio Manager
- **Stuart Williams, CFA** - Portfolio Manager
- **Joy Seth** - Investment Analyst
- **Satitpong Chantarajirawong** - Investment Analyst
- **Yu Tang** - Intern

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Risk Committee Members

Voting Risk Committee Members

- Tom Tull, CFA,
Chief Investment Officer
- Sharmila Kassam, Esq., CPA,
Deputy Chief Investment Officer
- Carlos Chujoy, CFA,
Portfolio Manager
- Leighton Shantz, CFA,
Director of Fixed Income
- John Streun, CFA, CPA,
Director of Public Equities
- Anthony Curtiss, CFA,
Interim Director of Hedge Funds

Non Voting Risk Committee Members

- Wesley Gipson
Director of Private Equity
- Robert Sessa, CFA,
Director of Real Estate

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Asset Class and Trust Risk Monitoring



	Asset Allocation	Active Risk	Tail Risk	Sector/ Factor Risk	Currency	Stress Test	Financial Leverage	Derivatives	Counterparty	Liquidity
Global Equity										
Public Equity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Private Equity	✓			✓	✓		✓		✓	
Fixed Income										
Global Credit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cash	✓				✓				✓	✓
Real Assets	✓	✓		✓	✓		✓		✓	✓
Absolute Return	✓	✓	✓	✓		✓	✓		✓	✓
Overall Trust	✓	✓	✓	✗	✓	✓	✗	✓	✓	✓

✓ Risk is currently measured and monitored
 ✗ Tools and standards under development
 Not currently monitored or available

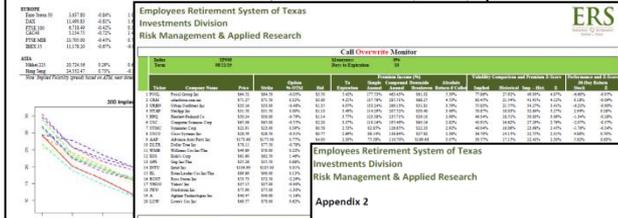
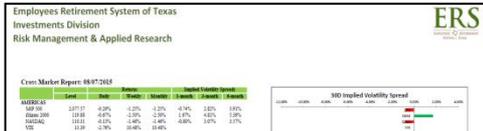
Risk Management and Applied Research Program

FY2016 in review

- Continued to address plan-wide investment risk – Monthly Risk Committee Meetings
- Enhanced and expanded analytical capabilities of the group
- Developed tools for the equity team that enable a disciplined evaluation of companies' financial ratios
- Led research efforts in equity derivative strategies
 - Developed framework to generate relative volatility equity option ideas
 - Research paper published by CBOE on the use of options-based strategies
 - Launch of a Tactical Asset Allocation Quantitative driven fund with options overlay

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FY2016 in review



Appendix 2

Definitions

Call A call option is a financial contract between two parties. The buyer of the call option has the right, but not the obligation, to buy a specified quantity of a particular security or financial instrument (the underlying) at a certain price (the strike price) on or before a certain date (the maturity date).

Put A put option is a financial contract between two parties. The buyer of the put option has the right, but not the obligation, to sell a specified quantity of a particular security or financial instrument (the underlying) at a certain price (the strike price) on or before a certain date (the maturity date).

Mathematics

$$\text{Price Delta} = \frac{SN(d_1) - Ke^{-rt}N(d_2)}{N(d_1)} \quad \text{Call} \quad \frac{Ke^{-rt}N(-d_1) - SN(-d_2)}{-N(-d_1)} \quad \text{Put}$$

$$\text{Gamma} = \frac{Ke^{-rt}N(d_1)}{S^2\sigma\sqrt{T}} \quad \text{Call} \quad \frac{Ke^{-rt}N(-d_1)}{S^2\sigma\sqrt{T}} \quad \text{Put}$$

$$\text{Theta} = -Ke^{-rt}\sigma N(d_1) + \frac{\sigma^2 SN(d_1)}{2\sqrt{T}} \quad \text{Call} \quad -Ke^{-rt}\sigma N(-d_1) - \frac{\sigma^2 SN(-d_2)}{2\sqrt{T}} \quad \text{Put}$$

$$\text{Rho} = rKe^{-rt}N(d_1) \quad \text{Call} \quad -rKe^{-rt}N(-d_2) \quad \text{Put}$$

$$\text{Vega} = \sqrt{TKe^{-rt}N(d_1)} \quad \text{Call} \quad \sqrt{TKe^{-rt}N(-d_1)} \quad \text{Put}$$

• $d_1 = \frac{\ln(\frac{S}{K}) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}}$

• $d_2 = d_1 - \sigma\sqrt{T}$

- Custom publication for equity derivatives
- Assess opportunities across multiple markets
- Display assets that look attractive/unattractive
- Added flexibility through Excel for Option ideas

Ticker	Current Price	Skew	Spread_3M	PE	Percentile	ZScore	Recommended Trade	Delta	Premium
CAT	72.25	8.10		12.68	1.00	1.460609	4.16	0.57	2.20
JNO	93.50	9.71		15.96	1.00	1.129046	4.13	0.54	1.51
BROM	52.81	8.81		22.27	0.98	0.406211	4.05	0.35	-0.05
PFE	32.86	8.57		17.91	0.96	3.883546	3.88	0.39	0.32
AAPL	114.39	7.99		13.02	0.94	3.706621	3.71	0.56	1.13
CA	27.80	7.60		15.18	0.93	3.660508	3.66	0.43	0.25
BA	136.17	7.52		15.97	0.92	3.602386	3.60	0.53	0.56
SBUX	57.50	6.14		34.88	0.92	3.596255	3.60	0.49	0.36
CSCO	25.63	6.76		14.57	0.92	3.548146	3.55	0.42	0.18
F	14.35	6.49		10.72	0.91	3.524656	3.52	0.42	0.20
MKX	51.69	6.76		30.38	0.89	3.372660	3.37	0.55	1.33
MZ	116.17	5.99		30.20	0.89	3.335212	3.34	0.43	1.10
GS	182.99	7.68		9.48	0.89	3.328619	3.33	0.48	1.27
CHK	8.54	11.68		56.51	0.88	3.305043	3.31	0.88	0.22
COF	74.48	8.83		10.67	0.88	3.301429	3.30	0.43	0.61

Motivation for the Tactical Quantitative Portfolio with Options Overlay

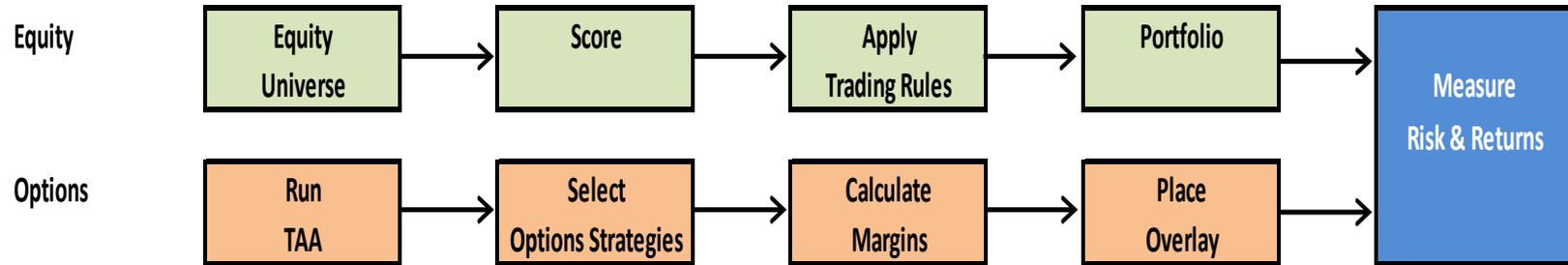
- **Economic** model predicts the near-term economic environment, then picks industries based on how they performed in similar environment in the past
- **Industry** financial statement model predicts industry performance using financial statement ratios and stock price and sentiment indicators
- **Company** financial statement model picks stocks within each industry
- **Derivative** models improve returns and reduce risk

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FY2016 in review



Investment Process - Tactical Quantitative Portfolio with Options Overlay



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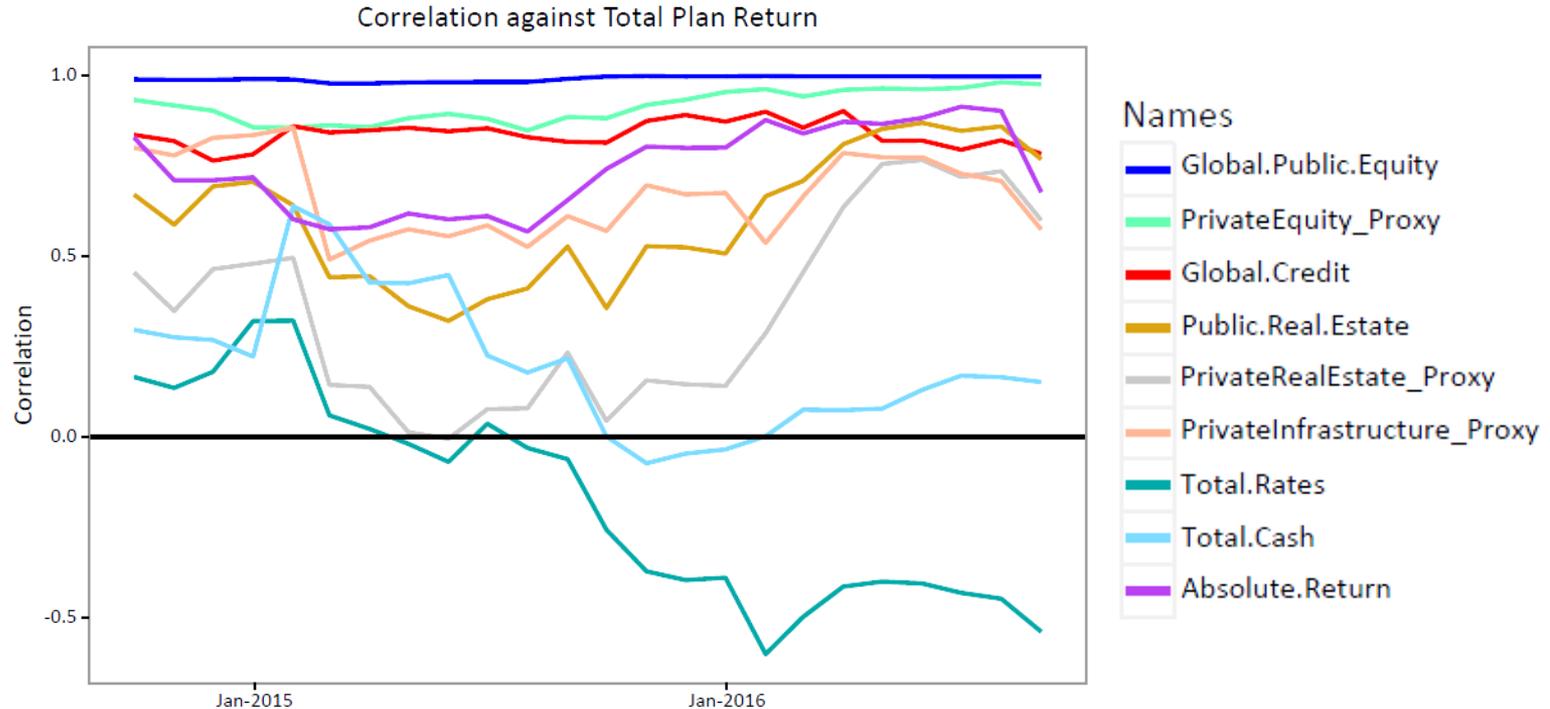
FY2016 in Review



- Improve upon reporting requirements (Ongoing)
- Asset Class Reviews
- Risk Committee Response to Exogenous/Systematic Risks
 - November 2015, analysis of Total Plan's sensitivity to the market (Beta)
 - March 2016, effect of negative interest rates and probability of default in energy oil companies
 - July 2016, effect of Brexit on world markets
 - August 2016, valuation of currency market risk and drivers of diversification/concentration risk
 - September 2016, drivers of tracking error and review of market signals

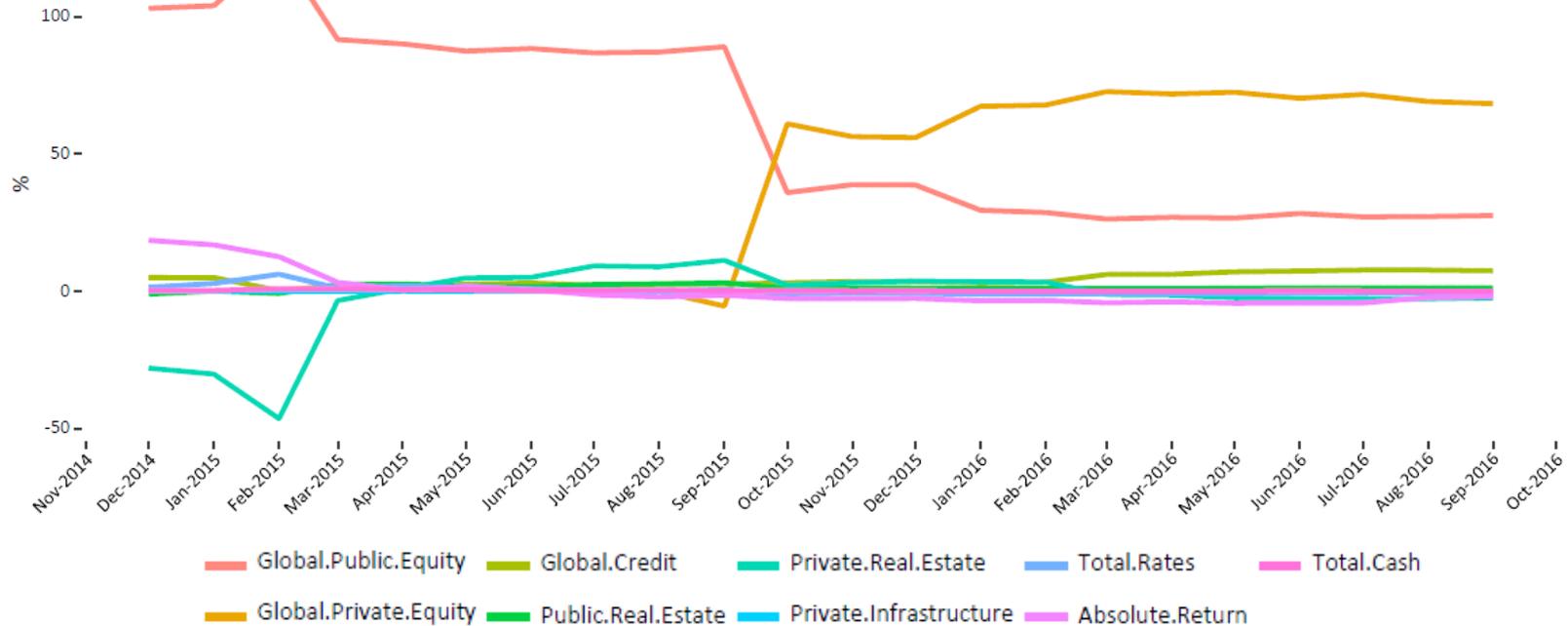
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FY2016 in Review – Rolling 12M % Contribution to Tracking Error



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FY2016 in Review



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Outlook – FY 2017



- Measure / Monitor / Manage
 - Continued emphasis measurement development
- Expand the risk management capabilities
 - Systemic Risk and Financial Contagion Risk
 - Measure exposures at factor and position level
 - Relative Value Trades
 - Systematic investment strategies for risk and exposure management
 - Currency Overlay

Questions?