TWO SIGMA

www.twosigma.com

Two Sigma Risk Premia

October 1, 2015

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All of the information contained herein is believed to be accurate as of the date hereof, unless otherwise indicated.

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Products with No Operating or Actual Performance History:

The Two Sigma Risk Premia Strategy has no operating or actual performance history. *As discussed on the following page, simulated performance results should not be relied upon.*

Any statements set forth herein regarding future events constitute only subjective views or beliefs, should not be relied upon, are subject to change due to a variety of factors, both general and specific, many of which cannot be predicted or quantified and are beyond the control of Two Sigma Investments, LLC ("TSI"), the TSI-managed investment products, Two Sigma Advisers, LLC ("TSA"), TSA-managed investment products, and/or their respective affiliates and agents. Future actual results could differ materially from those set forth herein, and no assurances are given that these statements will prove to be accurate or complete, in whole or in any part.

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Shared Resources: Research, technology and other resources are shared among trading vehicles/investment products, as well as among Two Sigma and its affiliates, including among Two Sigma Investments, LLC, Two Sigma Advisers, LLC and Two Sigma Securities, LLC.

Portfolio Construction: Trading strategies (some of which are highly capacity constrained) may be shared among different trading vehicles/investment products and can be included or excluded in such trading vehicles/investment products at Two Sigma's discretion.

Investment of Firm Capital: Invested Firm capital is not distributed equally across trading vehicles/investment products and is more highly-concentrated in investment products utilizing strategies with shorter holding periods and/or strategies not available to external investors. Additionally, invested Firm capital often utilizes higher levels of effective leverage.

Fees: Investment products managed by Two Sigma utilize different fee structures.

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Important Information Regarding the Simulated Performance Shown

Two Sigma Risk Premia Strategy performance information included herein seeks to reflect the simulated performance of a hypothetical portfolio focused on liquid risk premia strategies in global equities and futures markets. The simulation was generated at approximated capacity for the period of January 1998 through July 2015 (the "Unadjusted Returns"). The Unadjusted Returns represent simulated trading utilizing a variety of risk premia models across various markets that entered the simulation at different times, as follows: Global Futures, Forwards, and U.S. Equity from 1998, European and Pan-American equity markets from 1999, and Asian equity markets from 2000. The Unadjusted Returns are utilized when discussing risk and performance attribution (pages 40-41). Unadjusted Returns utilized herein are presented gross of fees and estimated operating expenses and net of estimated trading expenses. These Unadjusted Returns are modified on a pro-forma basis to adjust performance based on certain historically-perceived variables by subtracting (i) 40% of the average monthly Unadjusted Result for the Equity portion and (ii) 50% of the average monthly Unadjusted Result for the Global Futures and Forwards portion, to derive the "Adjusted Returns." The Adjusted Returns are utilized when discussing simulated performance (pages 37-38) and correlation to indices (page 39). The Adjusted Returns utilized herein are net of a hypothetical 1.3% annualized management fee (accrued and paid monthly in advance), and net of estimated trading expenses, but gross of operating expenses. The simulated performance does not reflect the reinvestment of income.

The simulated performance results shown herein are for illustrative purposes. TSA has worked with its affiliated investment adviser, TSI (together with the TSA, "Two Sigma") to engineer certain software that attempts to simulate the trading patterns that would have resulted had TSA utilized certain quantitative trading models over the period of January 1, 1998 through July 2015. These simulated results should not be relied upon.

These simulated results are based largely on historical information available from certain proprietary databases of Two Sigma compiled, in part, from multiple commercially available data sources, as well as certain assumptions made by Two Sigma about, among other things, trade execution, financing and market impact costs. While Two Sigma has expended considerable efforts attempting to clean and cross-check these inputs, Two Sigma cannot and has not independently verified the accuracy or completeness of such information, nor have the results of the simulation been independently verified or audited. Should any information used in the above simulation prove to be inaccurate, the simulated results themselves may be inaccurate.

The simulated strategy's settings or investment methodology may not be representative of any future portfolio due to, among other things, the addition or deletion of trading models, changes in optimization settings, changes in model weightings and other variables. Certain factors will likely cause the simulations to generate better performance than live trading of the associated strategy. In fact, simulated results have many inherent limitations. In particular, simulated results are often prepared with the benefit of hindsight, meaning models utilized in these simulations may have been developed explicitly with the benefit of data from the time period covered by these simulations. Additionally, simulated results do not involve financial risk or reflect actual trading under actual market conditions and do not reflect the ability to withstand losses or to adhere to an investment program despite trading losses. The simulation was also performed using only a finite number of variables. The actual performance of any trading program TSA ultimately elects to employ in the future will from time to time be dependent on, and influenced by, any number of factors, many of which (i) have not been taken into account in performing the simulation; (ii) are inherently difficult to quantify; and (iii) are outside the TSA's control. Due to the nature of simulations, it is likely that actual trading performance will be materially lower than the simulated performance set forth herein.

Simulations were run using Two Sigma's tradable universe of global futures, currencies, and equities that met proprietary inclusion criteria intended to foster, among other goals, adequate liquidity and issuer uniqueness, as well as a number of other goals. The tradable universe of global futures, currencies and equities, as well as trading models used by Two Sigma have evolved and are likely to continue to evolve over time. There can be no assurance that the trading program pursued by TSA on behalf of any of its investment products in actual trading will be the same or substantially the same as the ones that were subjected to the above simulation. Future performance may be affected by existing and/or new events or factors, which may or may not have played any material role in the past. Therefore no assurance or guarantee can be given that the actual trading results achieved using those strategies and/or models employed during this simulation, and/or others that are being used and/or may be used in the future, are or will be as successful and/or achieve the same results as those presented above. PAST PERFORMANCE, ESPECIALLY SIMULATED PERFORMANCE, IS NOT AN INDICATOR OR GUARANTEE OF FUTURE RESULTS. The results of the simulation are being provided to you by TSA solely to assist you in considering your potential interest in making an investment in a potential future investment product to be managed by TSA.

An investment in any investment product is speculative and involves significant risk, including the risk of a total loss of capital. Opportunities for withdrawal or transfer of interests in a strategy may be limited and therefore an investor may not have access to its capital when it desires.

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Important Information Regarding on Index Performance Comparisons

Index and other strategy returns referenced in this presentation are for comparison and informational purposes only. The returns of any product managed by Two Sigma will differ from the performance of the indices or strategy to which a given comparison is made because, among other things, the Two Sigma Risk Premia Strategy is anticipated to be an actively managed investment strategy that does not (and will not) attempt to replicate the performance of a referenced index or other strategy, is expected to engage in a variety of investment strategies (that may not be part of a comparison index or strategy) and is generally subject to different expense ratios and expenses not reflected in a comparison index and/or strategy (including, in the case of index comparisons, management fees, incentive compensation, administration fees, operating expenses and transaction costs). References to a particular index or strategy should not, on their own, be taken to imply that the Two Sigma Risk Premia Strategy will necessarily comparable to such index or strategy either in composition or element of risk. In addition, due to voluntary reporting and other inclusion criteria used in the construction of indices, actual returns of referenced indices may be higher or lower than shown. Descriptions of specific referenced indices and strategies are included.

HFRX Global Hedge Fund Index - The HFRX Global Hedge Fund Index is designed to be representative of the overall composition of the hedge fund universe. It is comprised of all eligible hedge fund strategies; including but not limited to convertible arbitrage, distressed securities, equity hedge, equity market neutral, event driven, macro, merger arbitrage, and relative value arbitrage. The strategies are asset weighted based on the distribution of assets in the hedge fund industry. (Source: hedgefundresearch.com)

MSCI World TR - The MSCI World Index captures large and mid-cap representation across 23 Developed Markets (DM) countries. With 1,636 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country. As of December 31, 2014, DM countries include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the UK and the US. (Source: www.msci.com)

Barclays US Agg - The Barclays US Aggregate Bond Index is a broad-based flagship benchmark that measures the investment grade, US dollar-denominated, fixed-rate taxable bond market. The index includes Treasuries, government-related and corporate securities, MBS (agency fixed-rate and hybrid ARM pass-throughs), ABS and CMBS (agency and non-agency). Provided the necessary inclusion rules are met, US Aggregate eligible securities also contribute to the multi-currency Global Aggregate Index and the US Universal Index, which includes high yield and emerging markets debt. The US Aggregate Index was created in 1986 with history backfilled to January 1, 1976. (Source: http://index.barcap.com)

GSCI - The S&P GSCI® is a composite index of commodity sector returns representing an unleveraged, long-only investment in commodity futures that is broadly diversified across the spectrum of commodities. The returns are calculated on a fully collateralized basis with full reinvestment. Individual components qualify for inclusion in the S&P GSCI® on the basis of liquidity and are weighted by their respective world production quantities. (Source: www.goldmansachs.com)

VIX - The CBOE Volatility Index® (VIX®) is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. Since its introduction in 1993, VIX has been considered by many to be the world's premier barometer of investor sentiment and market volatility. Several investors expressed interest in trading instruments related to the market's expectation of future volatility, and so VIX futures were introduced in 2004, and VIX options were introduced in 2006. (Source: www.cboe.com)

Credit Suisse HY Index - Credit Suisse High Yield Bond Fund (ticker: DHY) is a non-diversified, closed-end management investment company incorporated in the USA. DHY objective is to seek high current income. DHY invests in securities offering high current income which generally will be in the lower rating categories of recognized ratings agencies. (Source: www.bloomberg.com)

Contents

What We Do

Two Sigma[1] aims to consistently generate alpha in liquid global markets across a range of conditions using a disciplined, systematic approach

- Deploy and seek to continuously improve **intelligent investment management systems** first created in 2001
- Manage approximately **$29.1 billion of assets for a global, diversified client base** in absolute return and benchmark-relative investment mandates[2]
- Trade equities, futures, FX, and derivatives in 40+ countries utilizing a **highly diversified set of systematic strategies**
- Tap the **talents of 850+ employees** headquartered in New York with additional offices in Houston, London, and Hong Kong[2]
- Operate as a **Registered Investment Adviser** with the SEC[3] and a **Qualified Professional Asset Manager** ("QPAM")[4]

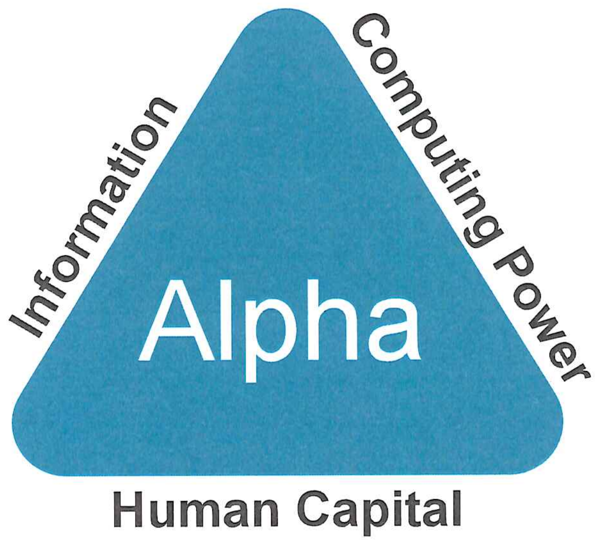
Created **positive net alpha every year** since our inception[5]

1. As referenced in this presentation, "Two Sigma" or "the Firm" generally refers collectively to Two Sigma Investments, LLC, and Two Sigma Advisers, LLC and their affiliates.
2. AuM and employee count are approximate as of October 1, 2015.
3. Two Sigma Investments, LLC and Two Sigma Advisers, LLC are registered with the U.S. Securities and Exchange Commission (the "SEC"). Registration does not imply review, endorsement or approval by the SEC.
4. QPAM designation applicable to Two Sigma Advisers, LLC only.
5. "Net alpha" is measured against zero for absolute return products and against the applicable benchmark for beta-1 products and is net of management fees, incentive allocations and all other fund and trading expenses, in each case, to the extent applicable. This figure is measured in the aggregated based upon fund by fund performance.

How We Serve Our Investors

Two Sigma's systematic approach combines financial markets expertise, massive amounts of data and world-class computing power in an effort to create a sustained advantage

Diverse and expanding library of **structured and unstructured information** housed in a proprietary data management system



Computing power that would rank in the world's top 275 supercomputer sites[1]

Experienced and diverse team of 550+ modelers and engineers, including 130+ PhDs, working collaboratively on an integrated platform to create alpha

1. Based on Two Sigma's SimFarm computing power compared with publicly-available data from http://www.top500.org, (November 2014 list) accessed January 12, 2015.

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Where We Are Today

Two Sigma believes that measurement leads to improvement, so we try to measure as much as possible

Computing Power

- 4,500+ servers in our computing environment with 75,000 vCPUs and 750 terabytes of memory
- 40+ petabytes of storage capacity
- Proprietary programming and data management platform

+

Information

- 10,000+ data sources including public and proprietary sources
- 14+ petabytes (14,000,000+ GB) of data and growing
- 1,200,000,000+ trades since 2001

+

Human Capital

- 2000+ person-years of R&D growing by 500+ person-years annually
- 97% voluntary employee retention since inception
- Professionals represent 60+ countries with 60% coming from outside finance

=

Two Sigma Performance[1]

- 99% of our investors have earned positive alpha
- 87% positive (net alpha) product quarters
- 12 consecutive years of positive alpha

1. "Net alpha" is measured against zero for absolute return products and against the applicable benchmark for beta-1 products and is net of management fees, incentive allocations and all other fund and trading expenses, in each case, to the extent applicable. Statistics regarding investor and product performance are dollar-weighted by AuM as of December 31, 2014. September 2015 performance is estimated. Performance statistics only include performance of unaffiliated investors. "Net product quarters" is an asset weighted figure derived by (i) adding the sum of the average notional AuM of each Two Sigma-managed product group by quarter and (ii) dividing the number of positive net alpha quarters by the total number of product quarters.

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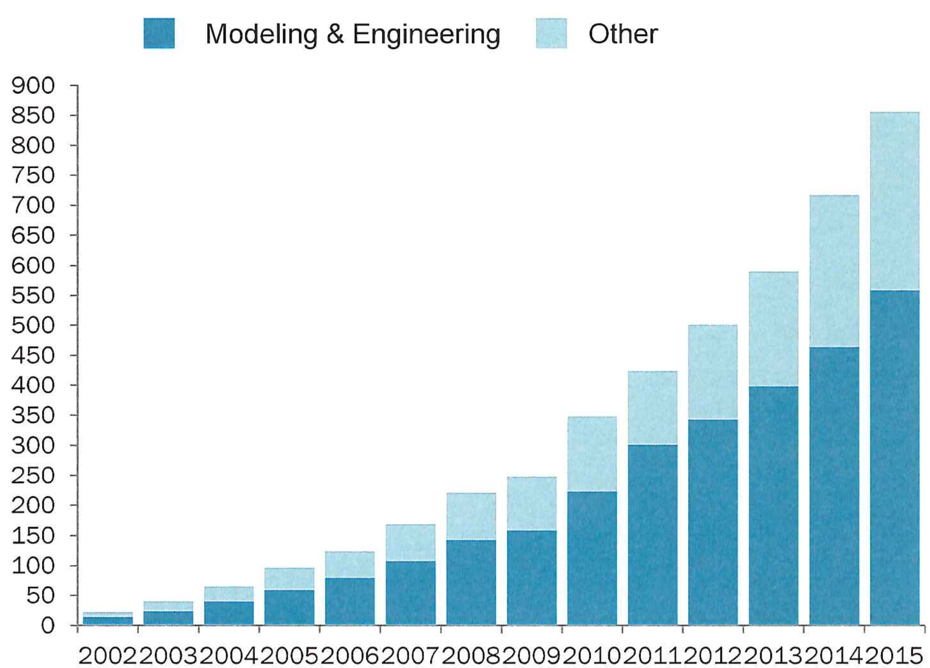
How We Grow

Commitment to investing in human capital, combined with a disciplined approach to capacity management, contributes to Two Sigma's success

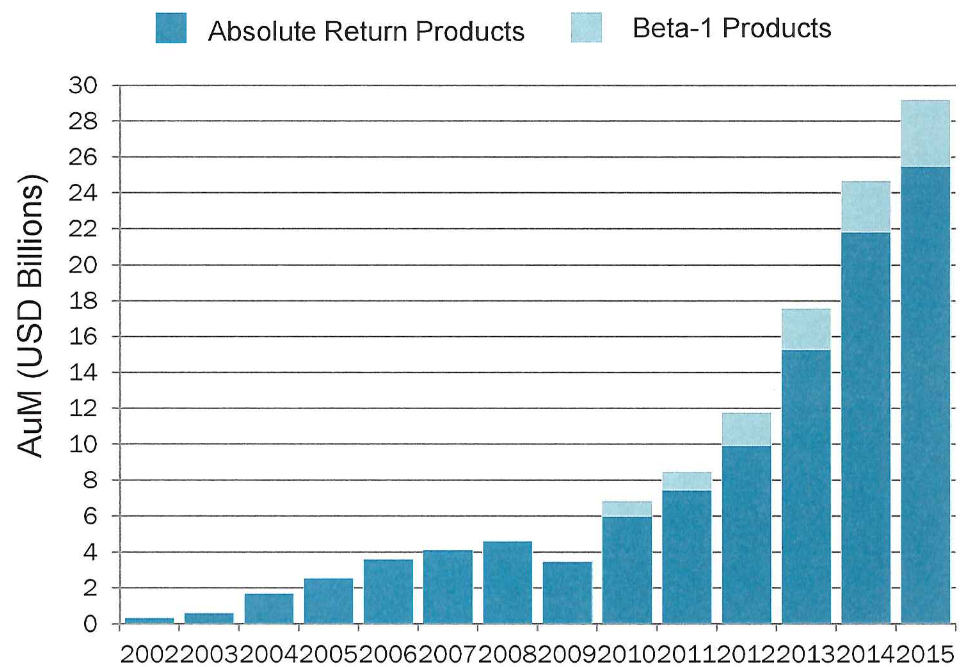
Human Capital[1]

- Rigorous recruiting process
- Voluntary turnover approx. 3% annually since inception



Firm AuM[2]

- History of closing funds that are near capacity to preserve alpha potential



1. Human capital numbers through 2014 shown as of the end of each calendar year. 2015 employee count is as of October 1, 2015.
2. 2015 AuM includes capital activity estimated as of the beginning of the month.

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How We Structure Our Firm

Two Sigma dedicates more than 550 people to modeling and engineering

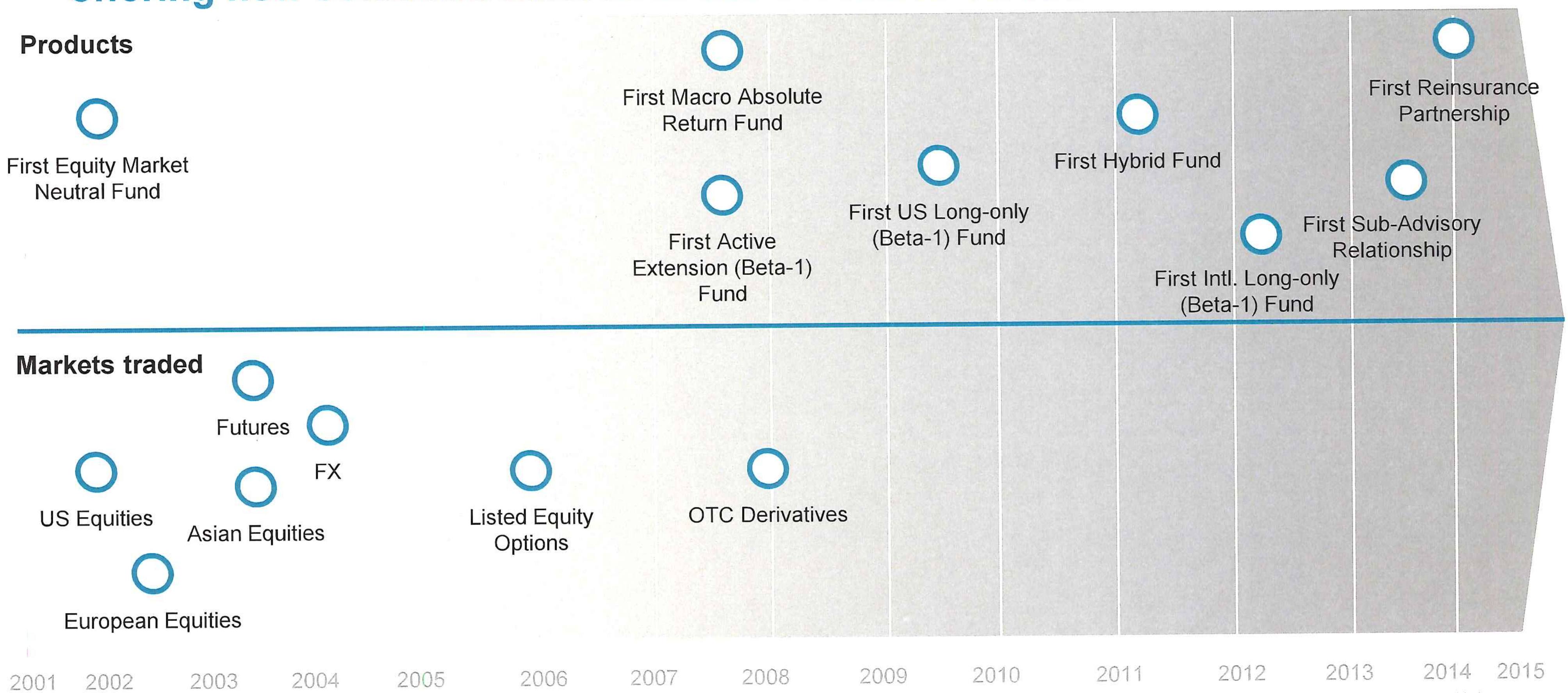
Legend: Modeling & Engineering and Risk Management | Client Service and Business Mgmt.

"Organization"	Size[1]	Activities[2]		
Engineering	~350	▪ Research Engineering ▪ Execution Infrastructure ▪ Strategic and Technical Projects	▪ Distributed Computing ▪ Knowledge Mgmt. ▪ Data Engineering	▪ Infrastructure ▪ Core Technologies ▪ Systems
Modeling & Execution	~125	▪ Equities ▪ Futures ▪ FX	▪ Derivatives ▪ Alpha Capture ▪ Execution	▪ Optimization
Trading, Risk & Portfolio Management	~35 (dedicated)	▪ Risk Management ▪ Portfolio Managers	▪ Portfolio Analytics ▪ Asset Management	▪ Trading
HR & Support	~120	▪ Human Resources ▪ Support ▪ Space		
Corporate	~60	▪ Investor Relations ▪ Client Portfolio Management ▪ Business Development	▪ Strategy ▪ Marketing & Communications	
Accounting & Operations	~50	▪ Accounting ▪ Financial Planning & Analysis	▪ Treasury ▪ Operations	
Legal & Compliance	~40	▪ Legal ▪ Compliance		

1. Headcount as of October 1, 2015.
2. Not all activities listed.

Our Continued Evolution

Two Sigma continues to evolve by expanding into new markets and offering new solutions tailored to our investors' needs



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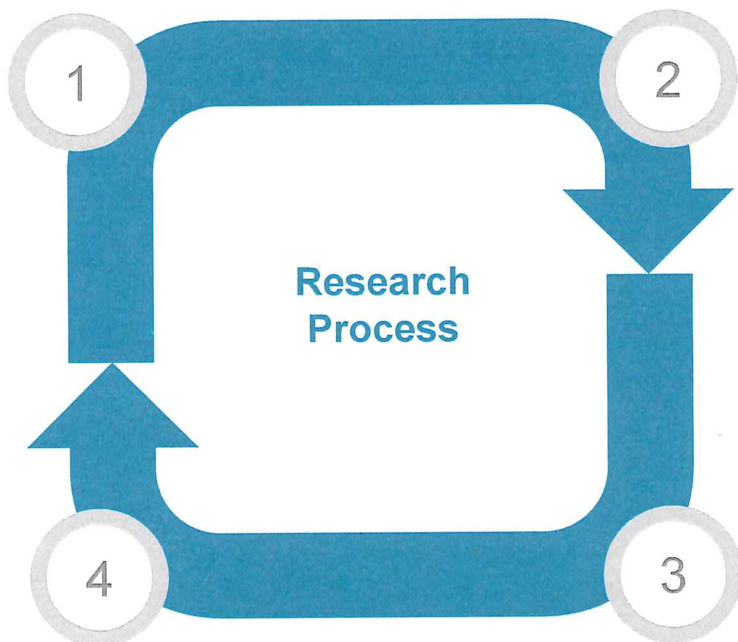
Research Process

Research combines intuitive thinking with rigorous data analysis in an effort to create accretive models of persistent effects

Ideas

Formulate ideas that make intuitive, economic, and financial sense



Data

Source, clean, and analyze petabytes of publicly available and proprietary data to test and refine ideas

Model Development

Develop models that systematically capture persistent effects

Integration

Evaluate impact of new models on the existing "portfolio of models" to determine added value and weight accordingly

Value of Clean Data – Garbage in, Garbage out

Source, clean, and analyze petabytes of publicly available and proprietary data to test and refine ideas

1000s of data sets are used for research and 100s for trading (examples)

- **Traditional “finance” data sets**
  - Pricing data in cash and derivatives markets
  - Fundamentals
  - Corporate actions
- **Unstructured data from public sources**
  - News
  - Analyst reports
  - Social media
- **Proprietary data**
  - Two Sigma “Alpha Capture” ideas
  - Two Sigma historical trading data

Data is vigorously cleaned, checked, and “time-matched” to larger databases (IBM Example)

Data Source 1

IBM: 206.31
+3.59 (1.77%)

Prev Close:	202.72	Day's Range:	204.15 - 206.44
Open:	204.57	52wk Range:	157.13 - 210.69
Bid:	206.30 x 100	Volume:	2,259,408
Ask:	206.32 x 100	Avg Vol (3m):	4,253,610
1y Target Est:	208.1	**Market Cap:**	**239.04B**
Beta:	**0.61**	**P/E (ttm):**	**15.70**
Next Earnings Date:	6/30/2012	**EPS (ttm):**	**13.06**

Data Source 2

IBM: 206.31
+3.59 (1.77%)

Range	204.15-206.44	**Mkt cap**	**239.10B**
52 week	157.13 - 210.69	**P/E**	**15.67**
Open	204.57	Div/yield	0.75/1/45
Vol. / Ave.	2.23M/3.93M	**EPS**	**13.08**
		Shares	1.16B
		Beta	**0.66**
		Inst. Own	61%

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Science and Art of Simulations

"Science" of Simulations

- Utilize **point-in-time data**
- Separate data history into **in- and out-of-sample periods for testing**
- Incorporate **all expected transaction costs including**
  - Trade commissions (commonly included)
  - Immediate market impact (sometimes included)
  - **Additional market impacts** that arise from successive trades in the same direction (rarely accounted for by others)

"Art" of Simulations

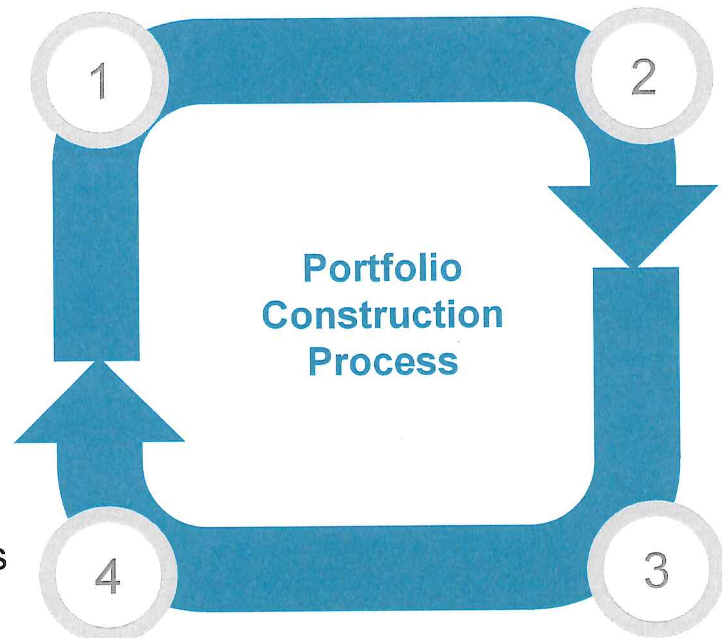
- Estimate **alpha decay**
- Understand sources and minimize **optimization bias**
  - Overfit models
  - Overfit risk factors (e.g., Barra)
  - Misunderstand correlations
- Seek to avoid and limit both explicit and **implicit look-ahead bias** (difficult to "unremember" financial crisis)
- Seek to account for **loss-aversion bias**

Portfolio Construction Process

Portfolio construction is a systematic process that translates information into an "optimal" portfolio in a consistent, repeatable, and scalable way

Data

Update and analyze data across hundreds of sources covering instruments in real time



Model utilization

Generate independent forecasts and form "consensus view" for each instrument in the portfolio's trading universe

Optimization

Create target allocation based on the "consensus view" of each instrument, trading costs, and risks in a systematic way

Execution

Develop and utilize efficient trading strategies to align current and optimal portfolio

Risk Management

Seek to systematically manage risk with human oversight (including a dedicated team) at multiple levels throughout the investment process

Ex Ante Risk Management

Research

Researchers test models over broad range of market conditions

Real-Time Risk Management

Portfolio Construction

Risk constraints monitored in real-time using a penalty-based approach with select use of hard limits

Ex Post Risk Management

Risk Management Team

- Experience and automated tools
- Adjust risk aversion levels as appropriate
- Identify unusual market conditions where historical data may not apply

Core risk principles:

- Stay liquid
- Utilize scenario-, stress-, and code-tests
- Reduce risk when in doubt
- Don't "double-down"

Execution

Develop and utilize efficient trading strategies to align the current and "optimal" portfolio

Two Sigma Execution

- Dedicated execution team across shared platform
- Proprietary technology
- Processes constantly tested, enhanced, and benchmarked to the Street's algorithms and platforms
- Human traders on trading floor working with algorithmic execution tools

Key Benefits

- **Significant cost savings**, especially with scale, relative to our benchmarks
- Can trade **automatically or manually** depending on trade and instrument
- **Adaptive**, especially in times of market stress
- Valuable source of **live-trading data**
- **On-going research** to optimize performance under different regulatory environments, market microstructures, and competitor behaviors

Our Solutions

Solutions-oriented approach to build products that leverage Two Sigma's shared platform and remains true to each strategy's mandate

	Two Sigma Strategies[1]	Inception	Description	AuM[2] ($M)
Absolute Return	Risk Premia	Aug 2015	Equity Market Neutral + CTA/Managed Futures (TSA)	203
	Absolute Return Macro	July 2014	CTA/Managed Futures (TSA)	1,750
	Absolute Return Equity	July 2014	Equity Market Neutral (TSA)	255
	Absolute Return	Nov 2011	Equity Market Neutral + CTA/Managed Futures (TSA)	5,895
	Compass	Jan 2005 (Strategy)	CTA/Managed Futures (TSI)	2,066
	Spectrum	Apr 2004	Equity Market Neutral + CTA/Managed Futures + Global Macro (TSI)	6,316
	Eclipse	Jan 2004	Equity Market Neutral + CTA/Managed Futures (TSI)	291
	Two Sigma	Apr 2002	Equity Market Neutral (TSI)	81
Hybrid	U.S. Equity Variable Exposure	Sept 2011	Variable Equity Exposure (TSA)	128
Beta-1	Active Extension U.S. Small Cap Equity 150/50	Oct 2012	150/50 (TSA)	418
	Active Extension U.S. All Cap Equity 130/30	Aug 2012	130/30 (TSA)	739
	World Core	July 2012 (Strategy)	Long-only (TSA)	446
	International Core	July 2012	Long-only (TSA)	438
	U.S. All Cap Core Equity	Dec 2010	Long-only (TSA)	612
	U.S. Small Cap Core Equity	Apr 2010	Long-only (TSA)	215
	U.S. Large Cap Core Equity	Nov 2009	Long-only (TSA)	207
	Constellation 130/30 U.S. Equity	May 2008	130/30 (TSA)	615

1. Two Sigma Strategies include strategies managing external capital and may exclude separately managed accounts and custom strategies, such as those deployed via fund-of-one. TSA denotes strategies managed by Two Sigma Advisers, LLC. TSI denotes strategies managed by Two Sigma Investments, LLC. Solutions not highlighted are near capacity.
2. This figure is presented as an aggregate of strategy feeder AuM as of October 1, 2015.

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Contents

What is a Risk Premium?

Risk factor: any variable that can explain a significant degree of co-movement across multiple assets

- **Market factors** include equity market beta and interest rate duration
- **Style factors** include value, size, momentum, and liquidity
- **Strategy factors** include merger arbitrage and convertible arbitrage

Risk premium: compensation in excess of the risk-free rate for holding exposure to a risk factor. The excess returns arise when other investors are unable or unwilling to bear certain risks, for example due to mandate constraints, operational complexity, or behavioral biases like risk aversion

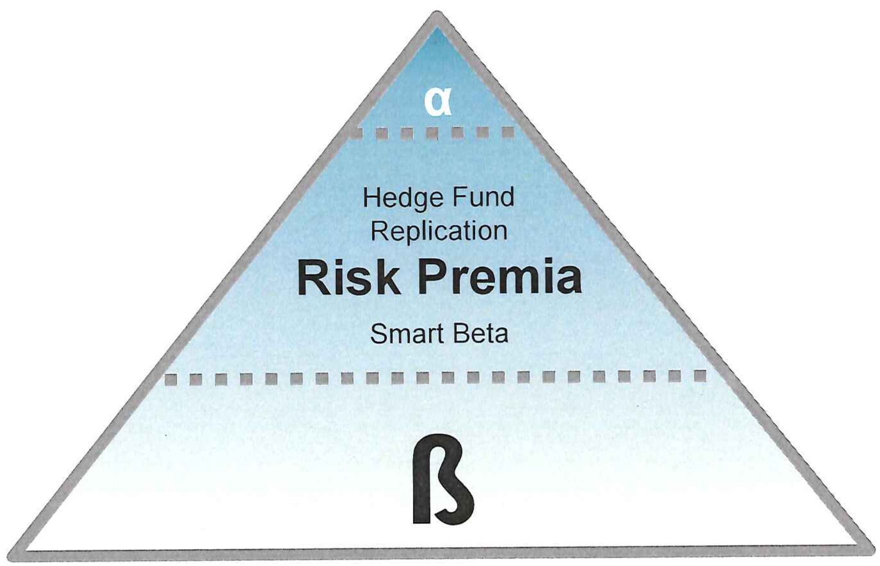
- **Style premium:** risk premium based on style factors. Sometimes called style beta, factor beta, or smart beta
- **Strategy premium:** risk premium based on commonly-known strategy factors historically employed by hedge funds

Risk parity: weighting strategy that seeks to balance exposures to multiple asset classes

What is a Risk Premia Strategy?

A strategy focused on providing optimal long-term exposure to a mix of canonical, fundamental or behavioral based risks

- **Distinct from traditional beta strategies** that focus on asset class exposure, often leading to suboptimal risk exposures (even if a risk parity approach is used)
- **Distinct from alpha strategies** that focus on timing idiosyncratic risk through better processing of information



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Why Should Investors Care?

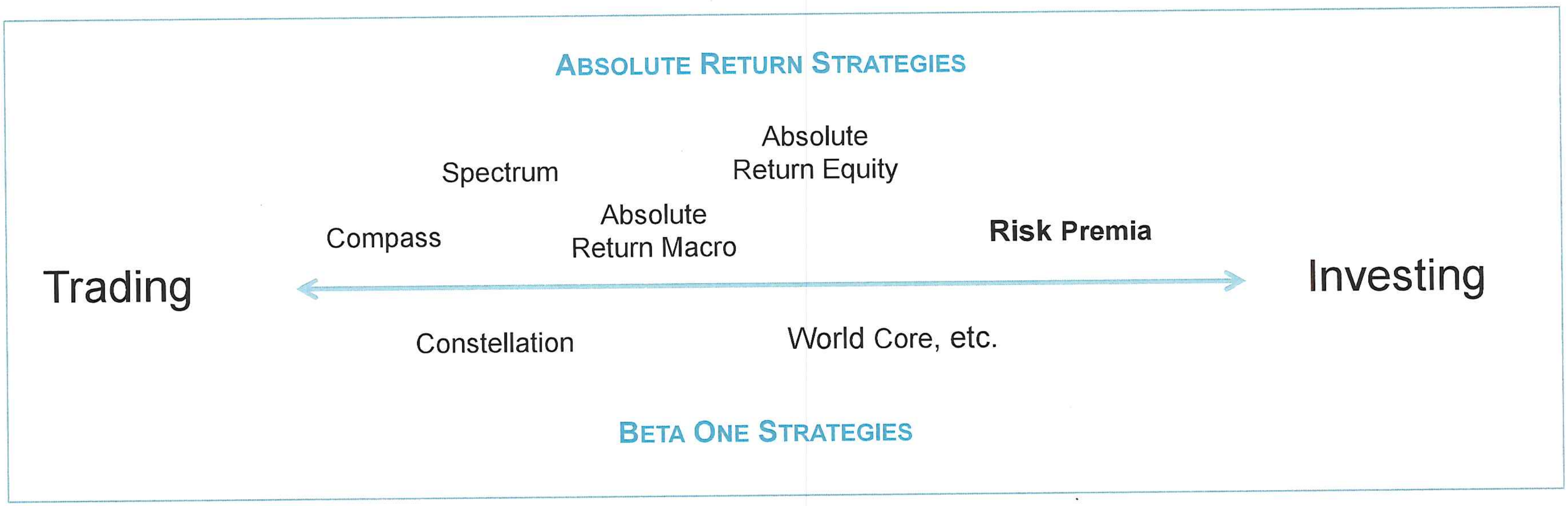
Risk premia strategies can offer larger capacity than alpha strategies with potentially better risk-adjusted returns than traditional beta strategies and attractive diversification characteristics

- Traditional beta strategies are abundant, but typically offer very little excess return per unit of risk
- While assets in the alternative space are growing, “true” alpha strategies with higher Sharpe ratios and risk diversification remain capacity constrained and hard to find.

Delivering Significance to Our Investors

Two Sigma has historically focused on delivering alpha and has offered a range of absolute return and beta one solutions.

Two Sigma Risk Premia seeks to capitalize on **Two Sigma's** strengths in modelling, optimization and execution to invest in a select and robust mix of risk premia across global equities and macro markets



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Two Sigma Risk Premia Research Process

- **Identify canonical risk premia** in liquid markets (see Appendix)
- **Select existing models and continue to develop new models** in an effort capture such risk premia
- **Run long-term (1998-2015) simulations** seeking to identify the optimal mix of models/risk premia and optimizer settings, taking into account Sharpe, correlation to major indices and capacity
- **Re-assess optimal mix at least semi-annually**, incorporating actual performance and new research

Two Sigma's Edge in Risk Premia

Common Beliefs	Two Sigma Beliefs
1 **Risk premia are "generic"** – commonly known and easily accessible	▪ **Careful definition and construction matters** and can lead to significant differentiation
2 **Equal weighting is sufficient** for a risk premia portfolio	▪ **Weighting optimization can add value** by reflecting views of historical information
3 **Combining individual risk premia** from separate providers is the best approach	▪ **Joint optimization improves performance** and allows for more cost-efficient risk hedging
4 **Monthly rebalancing is sufficient** to capture long-term risk premia	▪ **Intelligent and more frequent optimization can improve performance** by employing fresh signals and reducing market impact
5 **Execution costs are a non-factor** due to low turnover in (mostly) liquid markets	▪ **Smart execution can enhance returns** by reducing market impact

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1

Multiple Definitions, Different Constructions

Factors are not "generic" – different definitions exist. And within each definition, different constructions are possible

Example: Value Factor

- **Book Value Ratio =**

$$\frac{Accounting\ Value\ of\ Firm}{Market\ Value\ of\ Firm}$$

- Earnings Yield
- Cash Yield
- Free Cash Flow Yield
- …

Example: Book Value

Book

- Equity outstanding, year-end, current, or averaged
- With or without goodwill
- Valuation of other intangible assets
- Valuation of liabilities
- Impact of depreciation and amortization
- …

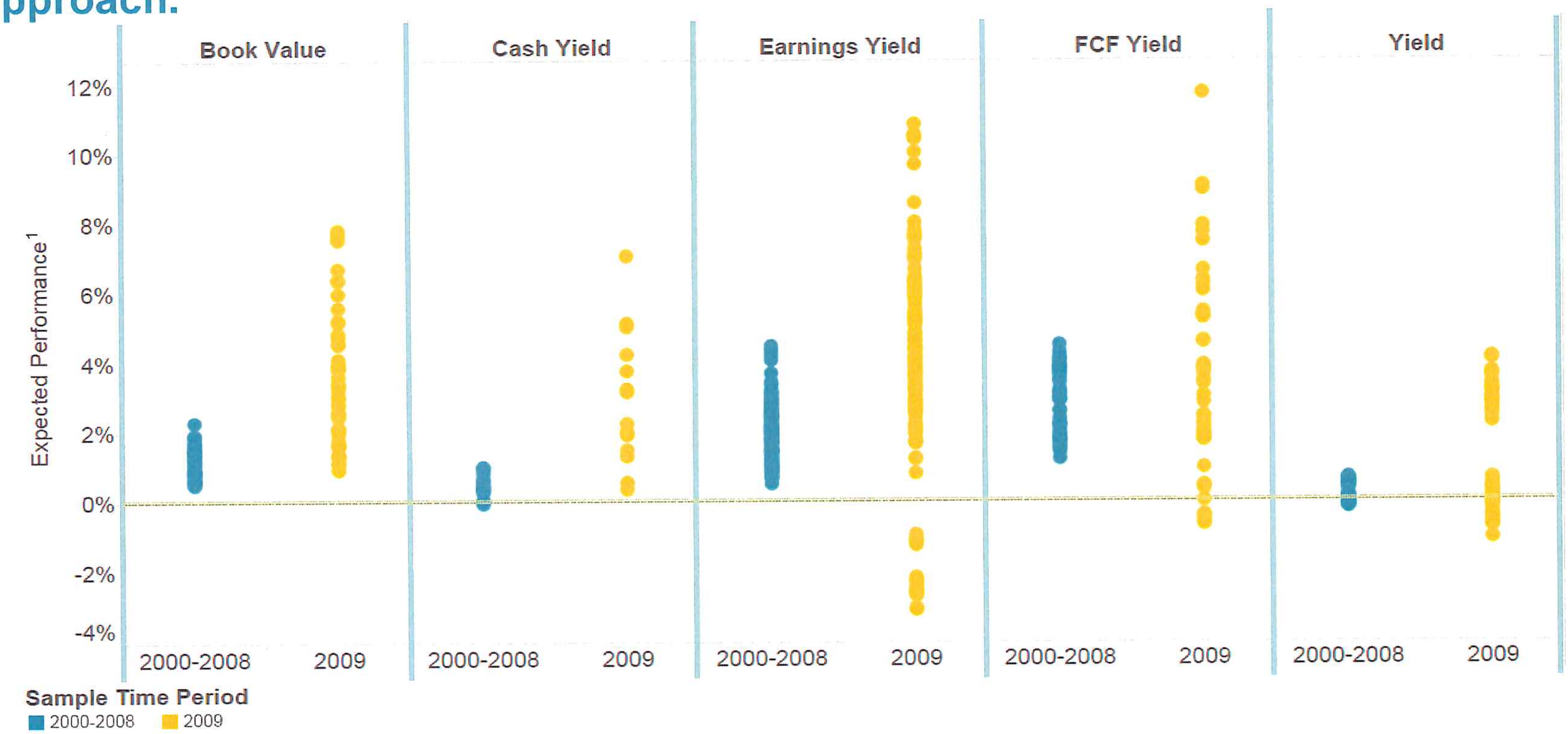
Market

- Total shares outstanding at year-end or current
- Include or exclude preferred shares
- …

1

Different Outcomes

Within the definitions of the "Value" factor, returns diverge, especially in periods of market dislocation. Over time, a carefully constructed portfolio combining select constructions of multiple definitions should outperform any individual approach.



1. Source of analysis is sample data from candidate strategies in a U.S. equity portfolio. Expected performance is an annualized figure calculated after residualizing for risk factors including market, style and industry tilts and excluding all execution costs.

1

Unstable Correlations

The variance in correlation even among differing definitions of the same risk factor reinforces the case for a portfolio approach

Rolling Factor Correlation between Book Value and Earnings Yield 2005-2013

1. Source of analysis is sample data from candidate strategies in a U.S. equity portfolio. Correlations are calculated over 252 days for long term and 63 days for short term correlation.

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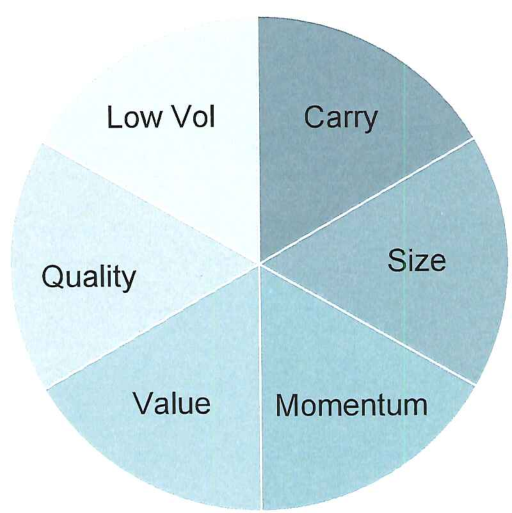
2

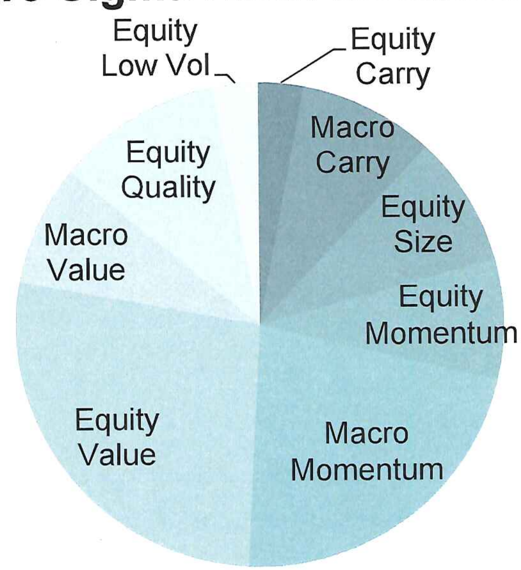
Long-Term Risk Optimization

Taking into account historical covariances of model buckets has the potential to increase Sharpe ratio by ~ 5% vs. a simple equal risk approach. Further improvement is possible by reassessing model weights on a periodic basis.

Equal Risk Allocation



Two Sigma Risk Allocation[1]



1. Anticipated weighting at portfolio launch; subject to change on a go-forward basis.

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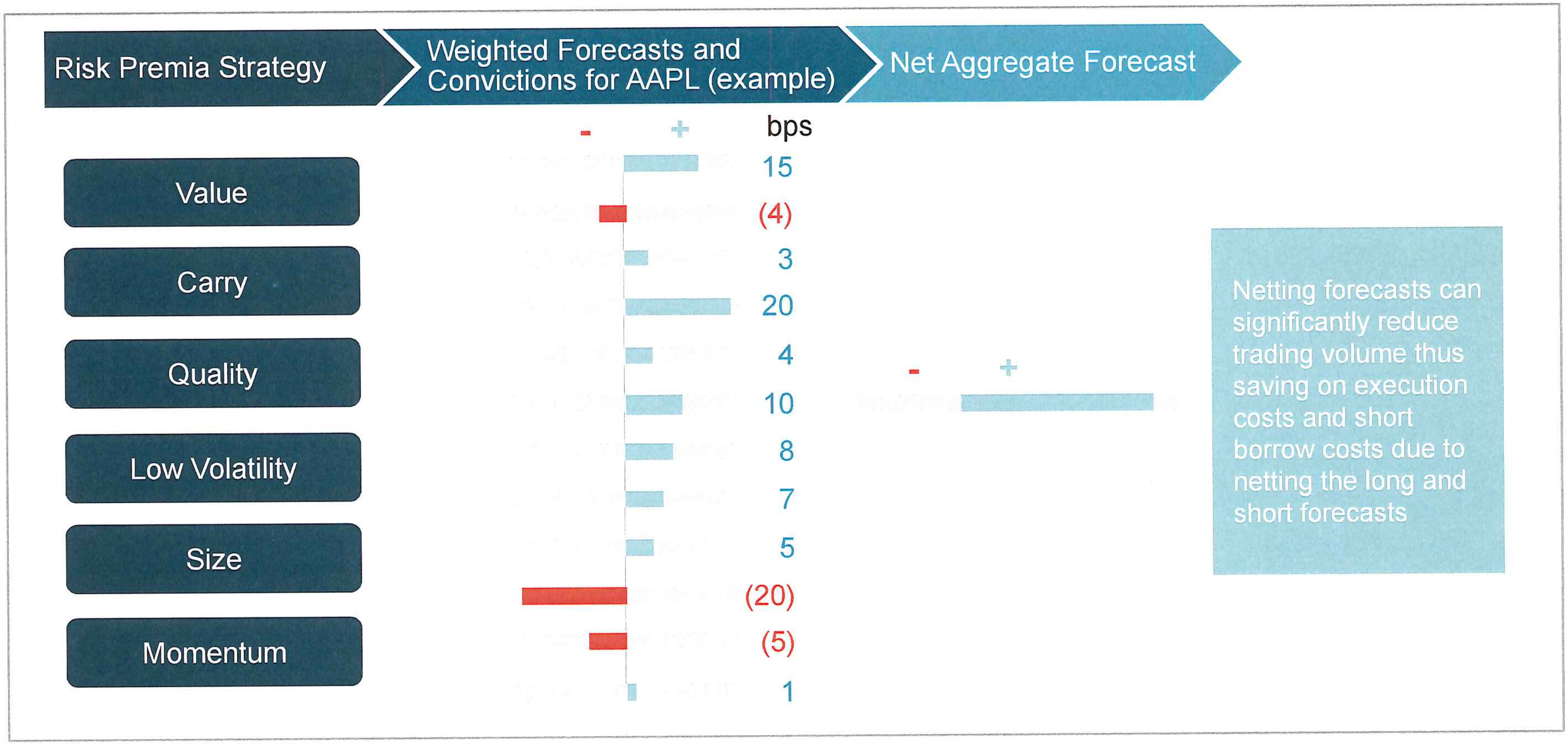
3

Optimization: Netting Forecasts (1 of 2)

Netting forecasts within and across risk premia generates benefits of reduced trading volumes and lower execution costs on a stock-by-stock basis



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3

Optimization: Netting Exposures (2 of 2)

Joint risk premia optimization also allows for better and more cost-effective hedging of risk exposures

Example: following an extended Technology stock rally, Value forecasts may be overly short the Tech sector while Momentum forecasts may be overweight Tech

Risk Premia Strategy	Resulting Net Exposure	Desired Net Exposure	Necessary Hedging Trades
Value (stand-alone)	**Long Value**	**Long Value**	-
	Short Momentum	-	*Buy Momentum*
	Short Technology	-	*Buy Technology*
Momentum (stand-alone)	*Short Value*	-	*Buy Value*
	Long Momentum	**Long Momentum**	-
	Long Technology	-	*Sell Technology*
Value & Momentum Jointly	**Long Value**	**Long Value**	-
	Long Momentum	**Long Momentum**	-
	-	-	-

Netting industry and style exposures when optimizing can reduce hedging-related trading by up to 1/3

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4

Daily vs. Monthly Optimization

Shifting from monthly to daily optimization frequency positively impacts a portfolio's performance due to decreased market impact and fresher signals

	Market Impact	Sharpe Ratio Gain		
Optimization Frequency	Total	Reduced Market Impact	Signal Freshness	Total
Monthly[1]	~ 110 bps	-	-	-
Daily	~ 80 bps	+4%	+6%	+10%

Daily optimization, if done properly, allows for an approximately 10% Sharpe improvement over monthly optimization, driven by both improved execution costs and benefit of fresher signals

1. Monthly optimization assumes optimizing every 21st trading day and filling the new orders across 5 trading days. To properly compare across simulated portfolios, Monthly Simulation is risk and volume-adjusted to be comparable to Daily Simulation portfolio targets. Test results simulated on US equity region only from 1998 - 2014, at approximately $20B GMV and a turnover of approximately once per year.

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5

Market Impact Minimization

Effectively modeling and accounting for market impact can result in significant execution cost savings while allowing for Sharpe-enhancing more frequent rebalancing

Daily Optimization	Market Impact (bps per year)	Sharpe Ratio Improvement
Naïve Simulation[1]	~ 110	-
Intelligent Simulation	~ 80	+5%

Considering all direct and indirect market impact costs allows for more efficient execution which saves the portfolio 30 bps per year in costs and improves the Sharpe ratio by 5%

1. "Naïve Simulation" (simulation that does not account for all versions of market impact) trades without knowing exactly what its market impact will be, and only takes into consideration partial market impact costs. However, the performance of the Intelligent Simulation accounts for all market impact which causes simulated results to be worse than initially expected. To properly compare across simulated portfolios, the Intelligent Simulation is risk and volume-adjusted to be comparable to Risk Premia portfolio targets. Additionally, portfolio is optimized once per day (same as Risk Premia simulation) and results are shown gross of all haircuts and investor fees.

Two Sigma Risk Premia Profile

Two Sigma Risk Premia offers institutional investors the opportunity to access a diversifying mix of risk premia across global liquid markets

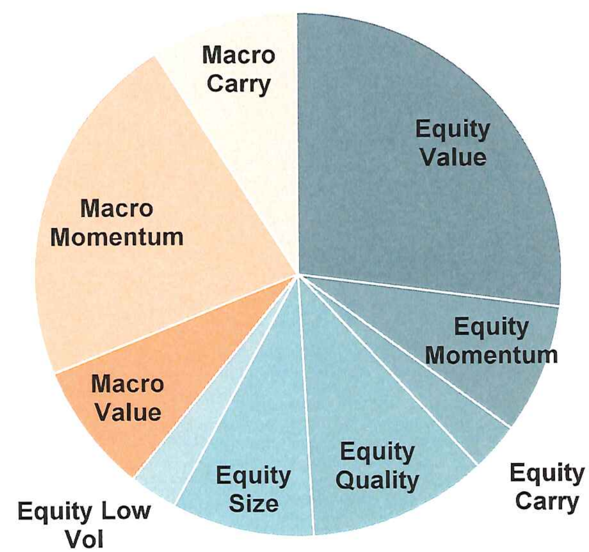
Strategy Objective

Deliver low-correlated absolute returns by targeting an optimal set of risk premia through the systematic application of longer-term fundamental and technical models to global liquid markets

Overview[1]

Launch date:	August 1, 2015
Mandate:	Risk Premia
Typical Markets/Instruments:	▪ Global Single-Name Equities ▪ Global Futures, IRS and Treasuries ▪ Global Currency Spot & Forwards ▪ US and European CDS Indices
Target Volatility:	7% annualized, net of fees ("standard" volatility) 10% annualized, net of fees ("enhanced" volatility)
Target Sharpe Ratio:	> 0.8 (net of fees)
Target Turnover:	Approximately once a year
Target Capacity:	$5 to $8 Billion
Liquidity:	Monthly, with 30 days' notice
AuM[3]	$203 million (as of October 1, 2015)
Strategy AuM[4]:	$266 million (as of October 1, 2015) (expressed in standard volatility terms)

Potential Risk Premia Allocation[2]



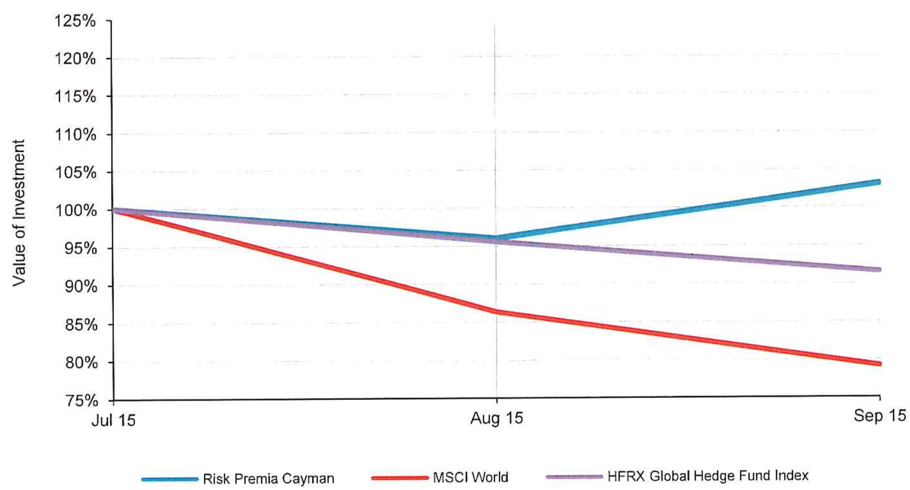
1. "Typical" statistics are approximations based on historical data. Such information is not intended to suggest that the investment product always has (or will continue to) perform in such a way.
2. Expected risk allocations shown are estimates only and are subject to change at any time.
3. This figure is presented as an aggregate of "standard" and "enhanced" feeder AuM as of October 1, 2015.
4. This figure is expressed in standard volatility terms (i.e., adjusted for leverage) for the Two Sigma Equity Risk Premia Portfolio, LLC ("ERPTV") and Two Sigma Macro Risk Premia Portfolio, LLC ("MRPTV").

Risk Premia Performance †

Key Performance Statistics[1]
Two Sigma Risk Premia Cayman Fund, Ltd.
August - September 2015 (est.)

	YTD 2015 August – September (est.)
Net Return	1.55%

Performance Comparison Since Inception[1]
Two Sigma Risk Premia Cayman Fund, Ltd., September 2015 (est.)



Monthly Return Statistics[1]
Two Sigma Risk Premia Cayman Fund, Ltd., September 2015 (est.)

Number of Months w/ Positive Return	1
Percentage of Months w/ Positive Return	50.0%
Avg. Return During Months w/ Positive Return	3.63%
Number of Months w/ Negative Return	1
Percentage of Months w/ Negative Return	50.0%
Avg. Return During Months w/ Negative Return	-2.01%

† In addition, TSA offers an "enhanced version" of the Risk Premia product with different fees, volatilities and performance (among other things). Additional information is available upon request.
1. All return statistics reflect the performance of Risk Premia Cayman Fund, Ltd. for the periods referenced and are net of 1.3% management fee, 0% incentive allocation and all other fund expenses and reflect the reinvestment of income. Each investor's rate of return may vary from Risk Premia Cayman's performance due to, among other things, the timing of capital transactions. Past performance is neither indicative of, nor a guarantor of, future results. Refer to Risk Premia Cayman's offering material for a complete description of investment terms and details. September 2015 performance is estimated.

Broad Asset and Strategy Base

	Momentum	Carry	Value	Size	Quality	Low Volatility	Trading Universe
Single-name Equities	✓	✓	✓	✓	✓	✓	>10,000 global stocks
Equity Indices	✓						~30 futures
Credit Indices	✓						5 CDS
Fixed Income	✓						~80 futures, swaps, bonds
Commodities	✓	✓	✓				~35 futures
FX	✓	✓	✓				~30 spot, forward, NDF

Simulated Performance Highlights

Two Sigma Risk Premia Adjusted Simulation Results vs. Benchmarks (January 1998 – July 2015, net of 1.3% management fee)

	Two Sigma (Simulation[1])	HFRX Global Index	MSCI World	Barclays US Agg	Traditional 60/40 Portfolio[2]
Annualized Return	7.5%	5.1%	6.7%	5.3%	5.8%
Annualized Volatility	6.9%	6.2%	15.7%	3.4%	9.5%
Sharpe Ratio	0.79	0.48	0.29	0.92	0.42
Max Drawdown Period[3]	Jan '09– May '09	Oct '07 – Dec '08	Oct '07 – Feb '09	Oct '08 – Dec '08	Oct '07 – Feb '09
Max Drawdown	8.9%	25.2%	54.0%	3.8%	35.0%

1. Even with careful procedures, simulated results have inherent limitations. Please see page 3 of this presentation for further information regarding the use of simulated results. Simulation results shown above based on monthly data in order to compare to HFRX. Daily simulated data show slightly higher volatility and drawdown, in part because the drawdown in August 2007 was primarily an intra-month effect.
2. Traditional 60/40 portfolio is constructed using MSCI World and Barclay US Agg. daily returns, rebalanced on a quarterly basis to keep a 60% equity and 40% fixed income split.
3. For the Two Sigma Risk Premia simulation results, drawdowns of similar magnitude (between 7 and 8%) occur in two other periods: Oct '98 - Sep '99 and Feb '03 – Oct '03. Daily simulated data show that the largest drawdown was -12.9% and occurred intra-month in August 2007.

Simulated Performance Highlights

Simulated Performance Rolling Statistics

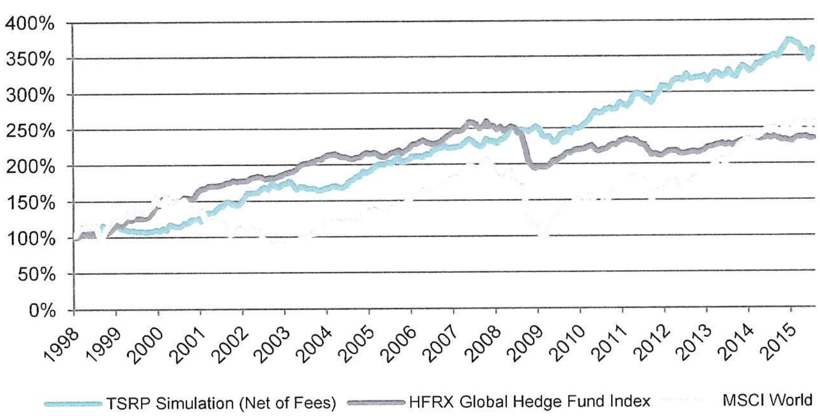
January 1998 – July 2015

TSRP Net of Fees Statistics (Simulated)

	1 Year	3 Year	5 Year	10 Year	Full Period
Annualized Return	3.18%	3.43%	5.75%	5.97%	7.56%
% Months Positive Return	50.00%	58.33%	58.33%	62.50%	61.72%
Standard Deviation	7.57%	6.00%	6.02%	6.06%	6.94%
Sharpe Ratio	0.44x	0.58x	0.95x	0.78x	0.79x

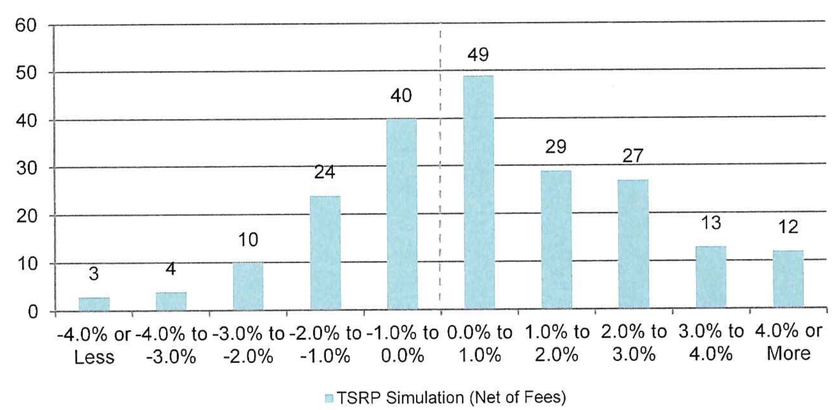
Simulated Performance Comparison Since Inception

January 1998 – July 2015



Distribution of Simulated Monthly Returns

January 1998 – July 2015



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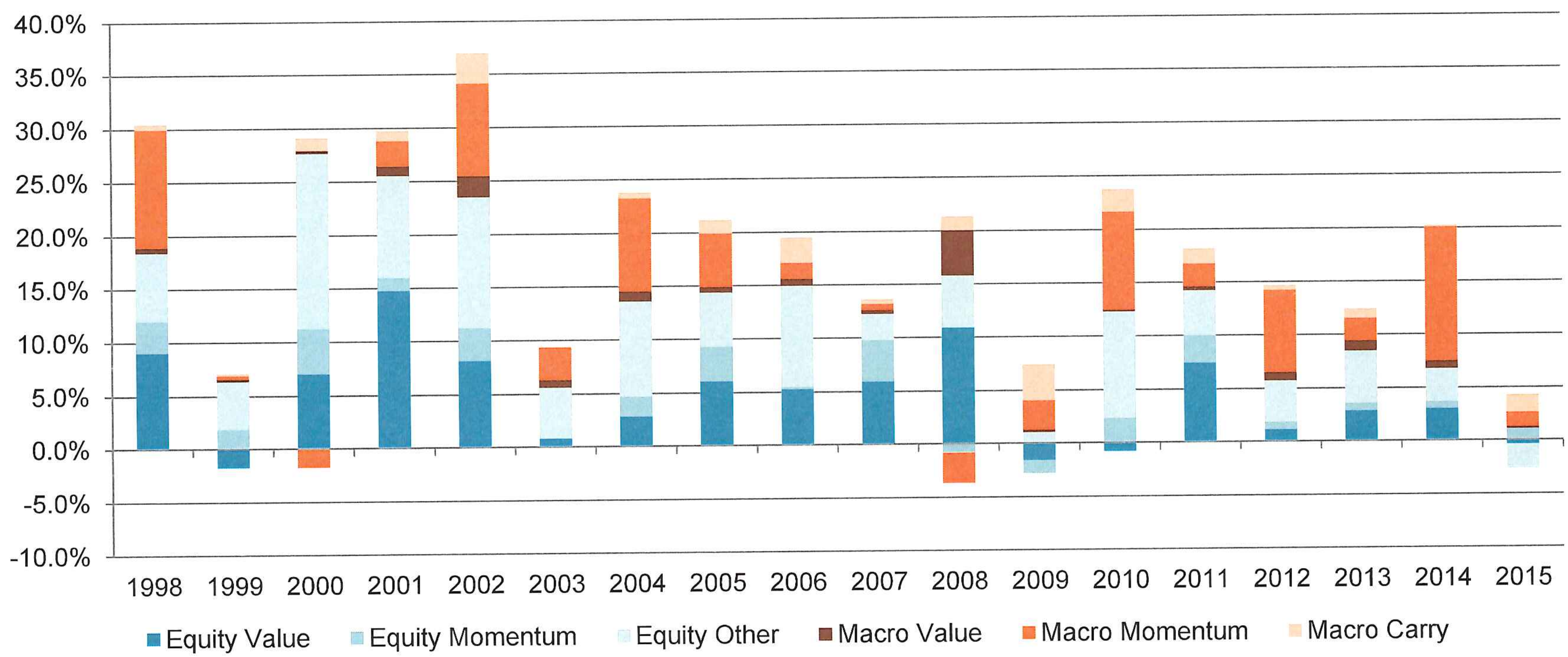
Simulated Correlations (Jan. ‘98 – Jul. ‘15)

	TS Risk Premia (Simulation[1])	HFRX Global Hedge Fund Index	MSCI World TR[2]	Barclays US Agg	Traditional 60/40[3]	GSCI	VIX	Credit Suisse HY Index	Newedge CTA Index
TS Risk Premia (Simulation[1])	1.00								
HFRX Global Hedge Fund Index	0.08	1.00							
MSCI World TR[2]	-0.07	0.62	1.00						
Barclays US Agg	0.23	0.08	-0.06	1.00					
Traditional 60/40[3]	-0.03	0.63	0.99	0.09	1.00				
GSCI	0.14	0.42	0.35	-0.01	0.35	1.00			
VIX	0.00	-0.42	-0.75	-0.01	-0.75	-0.29	1.00		
Credit Suisse HY Index	0.00	0.56	0.67	0.15	0.69	0.30	-0.58	1.00	
Newedge CTA Index	0.24	0.27	-0.08	0.22	-0.05	0.10	0.10	-0.13	1.00

1. Even with careful procedures, simulated results have inherent limitations. Please see page 3 of this presentation for further information regarding the use of simulated results
2. See page 4 for Index Comparison reference
3. Traditional 60/40 portfolio is constructed using MSCI World and Barclay US Agg. daily returns, rebalanced on a quarterly basis to keep a 60% equity and 40% fixed income split.

Simulated Performance Attribution by Strategy

Equity strategies contribute approximately 60% to total unadjusted performance over the entire simulation period while Macro strategies contribute nearly 40%



23.0%	8.0%	31.5%	4.2%	22.1%	5.8%

Average Percent Performance Attribution by Strategy Type

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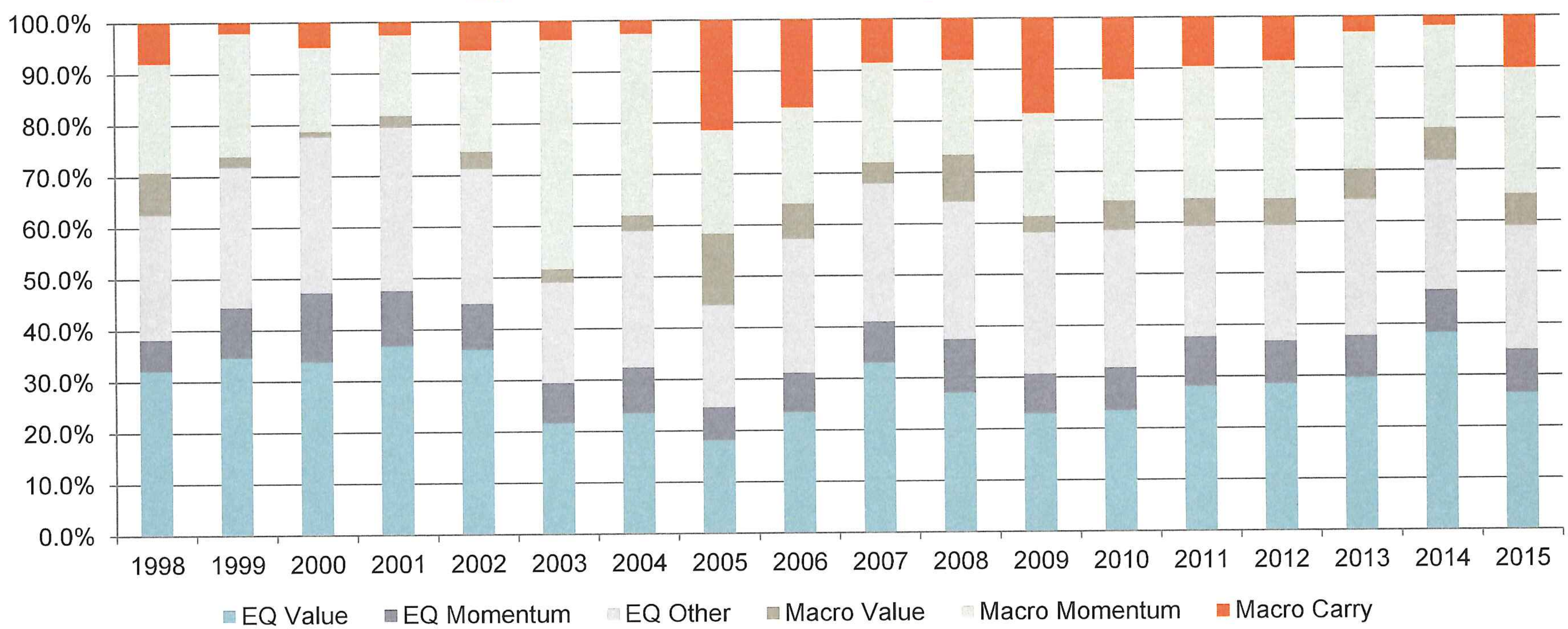
Simulated Risk Attribution by Strategy

Risk allocation reflects performance attribution, with approximately 60% in Equity and 40% in Macro strategy buckets over last 10 years



27.5%	8.5%	24.9%	6.9%	21.9%	10.3%

Average Percent Risk Attribution by Style Bucket

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Contents

Single-name Equity Risk Premia Rationale

Risk Premia	Description	Potential explanations	Example articles from academic debate
Equity Value	High value stocks (e.g., low P/E or high P/B) outperform low value stocks	▪ Cognitive bias ascribing firm outperformance to skill and not luck ▪ Time varying discount factors and costly reversibility of firm capital	▪ Graham and Dodd (1934) ▪ Fama and French (1992) ▪ Zhang (2005)
Equity Carry	High dividend yield (D/P) equities outperform low dividend yield equities	▪ Dividends subject to greater business cycle risk ▪ "Lottery" preference for higher upside (i.e., growth) equities	▪ Blume (1980) ▪ Fama and French (1988) ▪ Barberis and Thaler (2003)
Equity Size	Small cap stocks outperform large cap stocks	▪ Small cap stocks less liquid	▪ Fama and French (1992)
Equity Quality	Firms with high quality earnings (e.g., more predictable) are undervalued	▪ Investors overreact to short-term earnings news	▪ Barberis and Thaler (2003)
Equity Low Volatility	Low volatility stocks outperform highly volatile stocks	▪ Behavioral biases including leverage aversion, lottery preferences, and overconfidence	▪ Barberis and Thaler (2003)

Note that "potential explanations" are neither mutually exclusive nor collectively exhaustive

Macro Risk Premia Rationale

Risk Premia	Description	Potential explanations	Example articles from academic debate
Momentum	Positive returns to assets across classes tend to persist over time (and vice versa)	▪ Slow reaction to new information ▪ "Herding" behavior ▪ Cognitive bias to "lock in" winners and "wait out" losers"	▪ Jegadeesh & Titman (1993) ▪ Grinblatt, Titman, and Wermers (1995) ▪ Kahneman and Tversky (1979)
Commodity Carry / Value	Expected return from the steepness of the futures curve (absolute or relative to history) if the underlying curve does not change	▪ Commodity producers and consumers are risk averse to price changes (i.e., "buy price insurance" from market) ▪ Inventory holding "Convenience" fee	▪ Fama and French (1987) ▪ Koijen et al. (2013)
FX Carry	Borrowing low-interest-rate currencies and lending high-interest-rate currencies	▪ Compensation for FX tail risk ▪ Investor overconfidence induces greater overshooting of the futures rate than the spot rate	▪ Meese and Rogoff (1983) ▪ Fama (1984) ▪ Burnside, Han, Hirschleifer, and Wang (2011)
FX Value	Currencies with strong fundamentals (e.g., purchasing price parity, balance of payments, etc.) outperform over long horizons	▪ Non-profit maximizing entities (e.g., central banks, governments) intentionally distort prices that *eventually* correct based on fundamental drivers (e.g., trade)	▪ Obstfeld and Rogoff (2000)

Note that "potential explanations" are neither mutually exclusive nor collectively exhaustive

Sample Academic Sources for Risk Premia Economic Rationale

- Barberis, N. and R. Thaler, 2003. "A Survey of Behavioral Finance," in George Constantinides, Milton Harris, Rene Stulz eds., Handbook of the Economics of Finance, North-Holland.
- Blume, Marshall E., 1980. "Stock Returns and Dividend Yields: Some More Evidence," The Review of Economics and Statistics, 62(4), 567-577.
- Fama, Eugene F. and Kenneth R. French, 1988. "Dividend yields and expected stock returns," Journal of Financial Economics, 22, 3-25.
- Fama, Eugene F. and Kenneth R. French, 1992. "The Cross-Section of Expected Stock Returns," Journal of Finance, 47(2), 427-465.
- Grinblatt, Mark, Sheridan Titman, and Russ Wermers, 1995. "Momentum Investment Strategies, Portfolio Performance, and Herding: A Study of Mutual Fund Behavior." The American Economic Review, 85(5), 1088–1105.
- Jegadeesh, N., Titman, S., 1993. "Returns to buying winners and selling losers: implications for stock market efficiency." Journal of Finance 48, 65–91.
- Kahneman, D. and A. Tversky, 1979. "Prospect Theory: An Analysis of Decision Under Risk." Econometrica 47.
- Zhang, Lu, 2005. "The Value Premium, Journal of Finance 60(1), 67-103.
- Barberis, N. and R. Thaler, 2003. "A Survey of Behavioral Finance," in George Constantinides, Milton Harris, Rene Stulz eds., Handbook of the Economics of Finance, North-Holland.
- Fama, Eugene F., and Kenneth R. French, 1987. Commodity futures prices: Some evidence on forecast power, premiums, and the theory of storage, Journal of Business 60, 55–73.
- Fama, Eugene F. and Kenneth R. French, 1992. The Cross-Section of Expected Stock Returns, Journal of Finance, 47(2), 427-465.
- Graham, Benjamin, and David L. Dodd, 1934, Security Analysis (McGraw Hill, New York).
- Koijen, Ralph S.J., Tobias Moskowitz, Lasse Heje Pedersen, and Evert B. Vrugt, 2013. Carry. NBER Working Paper 19325.
- Burnside, Craig, Bing Han, David Hirschleifer, and Tracy Yue Wang, 2011. Investor Overconfidence and the Forward Premium Puzzle, Review of Economic Studies, 78, 523-558.
- Fama, E., 1984. Forward and spot exchange rates, Journal of Monetary Economics,114(3) 319–38
- Meese, R.A., and K. Rogoff, 1983. Empirical exchange rate models of the seventies:: Do they fit out of sample?, Journal of International Economics 14, 3–24.
- Obstfeld, Maurice and Ken Rogoff, 2000. The Six Major Puzzles in International Macroeconomics: Is There a Common Cause? In Ben S. Bernanke and Kenneth Rogoff, editors, NBER Macroeconomics Annual.