Equity Risk Models Built to Isolate Active Risk and Skill

Passively-available beta differences with a benchmark are a byproduct, typically unintentional, of any stock-selection process. Since consistent passive differences, once properly identified, can be freely obtained or offset, they are not part of active contribution.

Isolating active performance from the impact of passive differences offers tremendous oversight advantages. Unfortunately, current approaches all fail to accurately define passive exposures.

> **If risk analytics are valid, they're predictive. Analytics that fail to predict future performance are not valid.**

This paper discusses the limitations of current methodologies and introduces an alternative: highly predictive statistical risk models built to isolate active contributions from passively-available exposures -- revealing security-selection skill that persists, true active risk, opportunities to reduce relative risk without sacrificing active risk, as well as to offset any unintentional bets that may endanger performance.*

Market Noise Overwhelms Skill

The problem with assessing skill using nominal performance is that the effects of random, typically mean-reverting, market fluctuations overwhelm any effects of manager skill. For example, a typical mutual fund's volatility attributable to security-selection accounts for less than 10% of the total. Market noise accounts for more than 90%

With such a high level of market noise, traditional techniques relying on nominal returns require decades of data to detect statistically significant evidence of skill. Over individual market cycles, the relative ranking of a fund's returns in one sample of history is negatively correlated with its relative ranking in the other. When "skill" is evaluated naively, "the best" funds in one period tend to become "the worst" in another, and vice versa.

* Over 0.96 median correlation between predicted and subsequent realized returns

Existing Approaches to Isolating Active Risk and Return

In order to select managers likely to outperform, and to know if managers should be replaced, the challenge is to look beneath the surface to determine whether the true source of return is investment skill (stock picking, market timing, etc.) or some combination of luck, high beta, and out-sized risk. Two attribution approaches attempt to separate active and passive contributions: holdings-based and returns-based analyses.

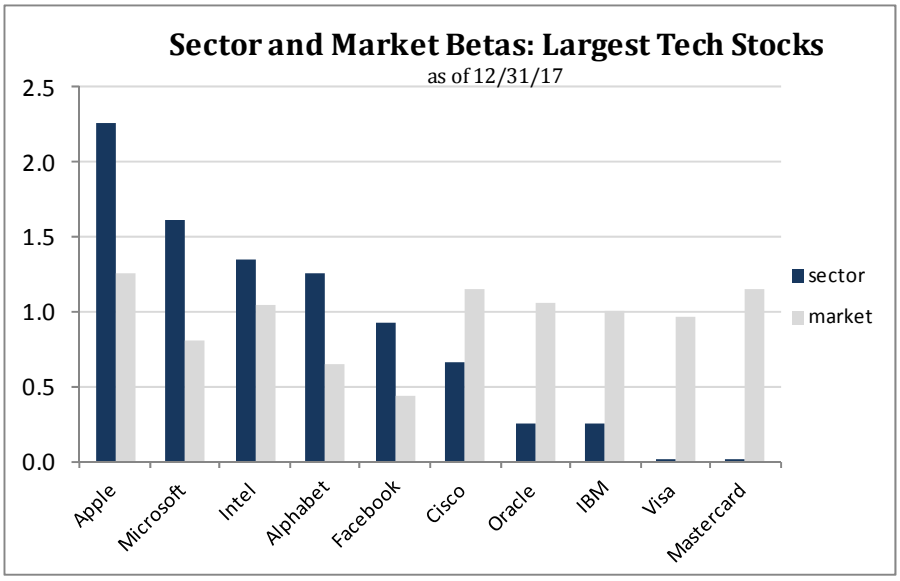
Holdings-Based Approaches: Brinson and Active Share

Holdings-based approaches to performance attribution typically rely on the principles first discussed in Brinson and Fachler, Journal of Portfolio Management, 1985. The approach attributes relative returns to sector allocation relative to the benchmark and to stock selection, defined as outperformance of a stock's sector.

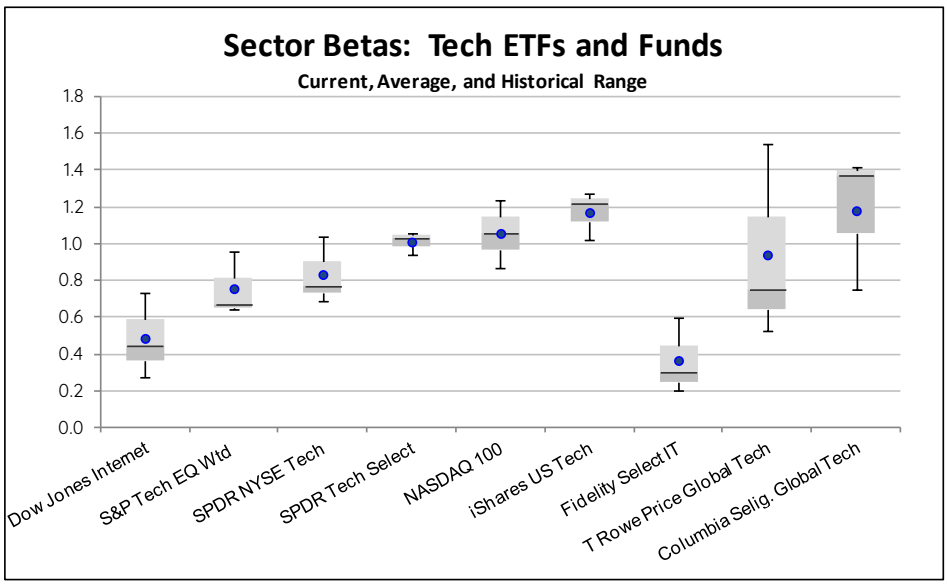
Providers, including FactSet, Morningstar, Caissa, Novus, and others, offer attribution and risk analysis using the Brinson approach and Active Share.

The Brinson method – as well as the Active Share approach to active risk - assumes that all stocks have the same market risk and all stocks within a sector have the same sector risk (e.g, a dollar in Apple and a dollar in Facebook have the same market, sector, and other systematic exposures).

Unfortunately, sector and market risks vary widely across securities,* as do sector betas -- even among the largest sector indexes and funds:



* individual security market and sector beta distributions are shown on page 9



Fortunately, any performance attribution system that claims to identify active return is easily tested.

Since security-selection return is a residual, free from systematic risk, it is by definition uncorrelated with passive benchmarks. To the extent security-selection return and passive return calculated by a given system are correlated, the system has failed (see: three additional tests).

Returns-Based Style Analysis

Returns-based style analysis and returns-based performance attribution techniques perform regressions to compute portfolio betas (exposures to systematic risk factors) and alphas (residual returns unexplained by systematic risk factors).

The simplicity of the returns-based approach has made it popular. It is often the only practical method for evaluating multi-asset-class portfolios that span commodities, public securities, derivatives, and private investments. However, this simplicity comes at a heavy cost.

The limiting assumption of returns-based analyses is the constancy of factor exposures. This assumption breaks down for active managers. In Flaws of Returns-based Style Analysis we show:

- When an active manager varies bets, a returns-based analysis typically yields flawed estimates of portfolio risk and may not even accurately estimate average portfolio risk.
- Errors will be most pronounced for the most active funds:
  - Estimates of a manager's historical and current systematic risks will be flawed.
  - Skilled funds may be deemed unskilled and unskilled funds may be deemed skilled.

Equity Risk Models

Multi-factor equity risk models measure portfolio risk by calculating individual security factor exposures and can distinguish between systematic risk (due to endogenous factors that affect multiple securities) and idiosyncratic risk (specific to an individual security).

Equity risk models are classified as fundamental models, macroeconomic models, and statistical models.

As these models are designed to estimate risk as precisely as possible for even the most narrow portfolios, popular models today often use well over 100 risk factors, most of which are not directly investable.

Bloomberg's Port function uses a fundamental risk model similar to but more rudimentary than Barra's and Blackrock's. Our tests found that Bloomberg's portfolio risk model typically captured less than half of the relative systematic (factor) risk explained by the more robust models.

Bloomberg and other fundamental models have two key limitations when used for oversight:

1) Fundamental models use 100+ individual risk factors, most of which are not directly investable. Attributing performance to exposure differences in momentum, leverage or the dozens of other non-investable factors, while useful for portfolio construction and optimization, is neither meaningful nor actionable for oversight since exposures cannot be passively obtained or offset.

2) Fundamental models assume that exposures to country, currency, and sector factors are either zero or one for all securities. There is no distinction in sector risk between the least risky stock in a sector and the most risky one. Since individual security sector risks vary widely (Apple, for example, recently had a Technology sector beta of 2.2 while IBM's sector beta is 0.2). Bloomberg and other providers provide a very misleading picture of sector, country, currency, and at times even market risk.

The fact that these models do not provide meaningful attributions for manager and portfolio oversight is due to an explicit design decision to target portfolio optimization and risk forecasting, rather than performance attribution.

A Statistical Risk Model Built for Oversight

Statistical factor models use various maximum likelihood and principal-components analysis procedures on time-series security return samples to identify the significant underlying drivers of returns, or factors. Statistical factor models rely on fewer assumptions and use robust statistical processes to estimate factor betas.

A statistical equity risk model built specifically for oversight, using a limited number of factors that map to common passive portfolios such as index funds and ETFs, explains risk as well as the most robust fundamental models in most cases, but can also distinguish skill from random market fluctuations.

For most portfolios, differences from the benchmark in exposures to Market, Sector, Regional, and Style factors, all available via passive investments, explain over 96% of absolute return and over 65% of relative return.

Consistent passive beta-differences from the benchmark, whether or not intentional, are not part of a manager's active return and do not deserve compensation, since such exposures are available through cheap index funds or ETFs -- easily obtained if intentional or offset if unintentional.

Findings

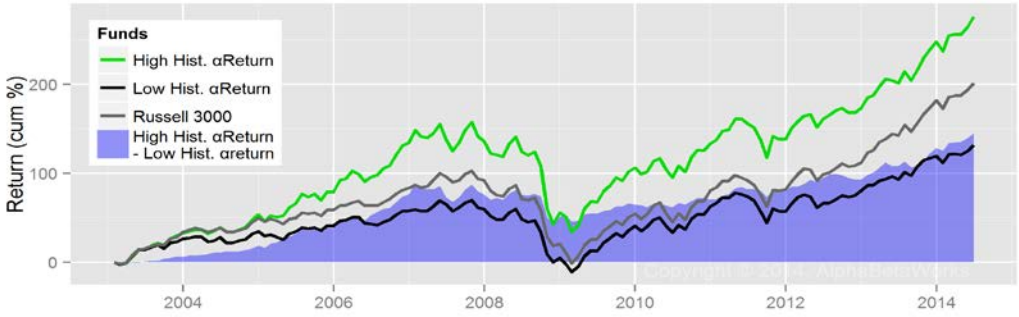
Security selection skill persists

By isolating returns due to security selection and market timing from those due to passive differences in factor (systematic) risk from the benchmark, the ABW Peer Analytics risk models mitigate the impact of noise and reveal skill.

Top-decile stock-pickers are twice as likely to generate positive stock-picking returns as negative in the subsequent few years.

Bottom decile managers are more than twice as likely to generate negative stock-picking returns as positive ones in subsequent years (see: performance persistence within style boxes and performance persistence within international style boxes).

In a recent study spanning 12 years, high αReturn funds outperformed the market by 75%; low αReturn funds underperformed by 70%



Returns of mutual funds with highest and lowest trailing 36-month αReturns – equal risk

Closet indexing is prevalent

Closet indexing is the practice of charging active fees for passive management. Over a third of active mutual funds and half of active mutual fund capital appear to be investing passively: Funds tend to become less active as they accumulate assets. Skilled managers who were active in the past may be closet indexing today. These active managers take too little active risk to compensate for an average fee, even assuming top-decile skill.

Quantitative insights inform qualitative assessments

Statistical risk oversight models quantify all current exposures that fully explain future return relative to a benchmark –- both passively-available market exposures and individual idiosyncratic security exposures –- and rank them in order of contribution to variance. Users can ensure managers' relative risk exposures are consistent with expressed strategies and mandates, and manager discussions can focus on those decisions that most impact portfolio risk and return.

Risk can be reduced while retaining active contribution

Asset owners can reduce risk relative to the benchmark without sacrificing the active risk worth paying for (by offsetting consistent passive differences with ETFs or better manager allocations), avoid unintentionally reinforcing passive bets or offsetting active bets among individual managers, avoid closet indexing the aggregate portfolio, and better assess how individual managers contribute to portfolio risk.

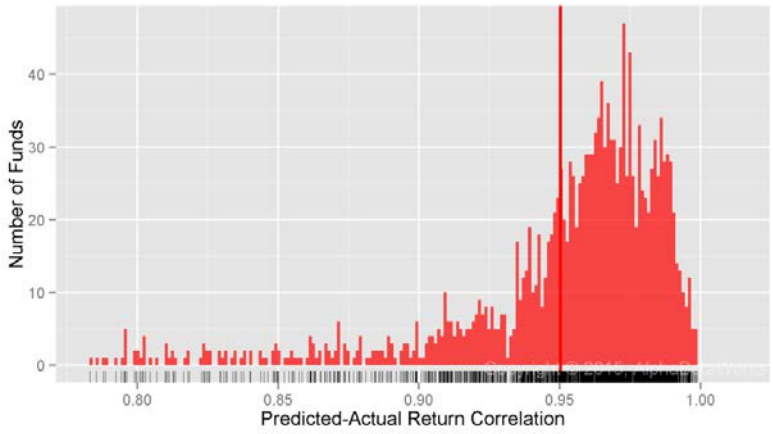
Model Validation

Though mathematically complex and hard to compare, equity risk models are easily tested.

To evaluate the accuracy of an equity risk model, we compare returns predicted by past factor exposures to subsequent portfolio performance: We measure factor exposures using end-of-month holdings and predict the following month's return as a function of index returns.

The correlation between predicted and actual return measures a model's accuracy. The higher the correlation, the more effective a model is at hedging, stress testing, and scenario analysis, as well as evaluating investment *risk* and *skill*.

Our risk models are highly predictive and deliver over 0.96 median correlation between predicted ex-ante and reported ex-post portfolio returns for both U.S. and Global Equity mutual funds (see: testing predictions of equity risk models and testing global equity risk models).



Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.666	0.942	0.962	0.950	0.977	0.999

Prospective clients need not rely on our out-of-sample tests, we're happy to provide passive ETF replicating portfolios for any of your managers and you can validate the models' accuracy independently. A few weeks of observations can provide dozens of observations and establish a high statistical confidence in the models' predictive accuracy.

Due Diligence Questions Accurately Answered with Predictive Analytics

- **Does performance exhibit statistical evidence of positive or negative skill?**
  Managers with top-decile security selection skill (information ratios of isolated security-selection performance) are twice as likely to outperform over the following three years. Bottom decile managers are more than twice as likely to underperform.

- **How much risk- and what types - is the manager taking relative to the benchmark?**
  All individual exposures that fully explain future relative performance

- **How much does risk vary over time … and why?**

- **What part of relative risk is due to active decisions, and what part is due to passive exposures which are an unintended consequence?**
  Relative risk can be reduced, by offsetting unintended passive risk exposures, without sacrificing the active risk worth paying for.

- **Are individual managers taking sufficient active risk to justify active fees?**
  One-third of managers take too little active risk to ever compensate for fees - even with skill.

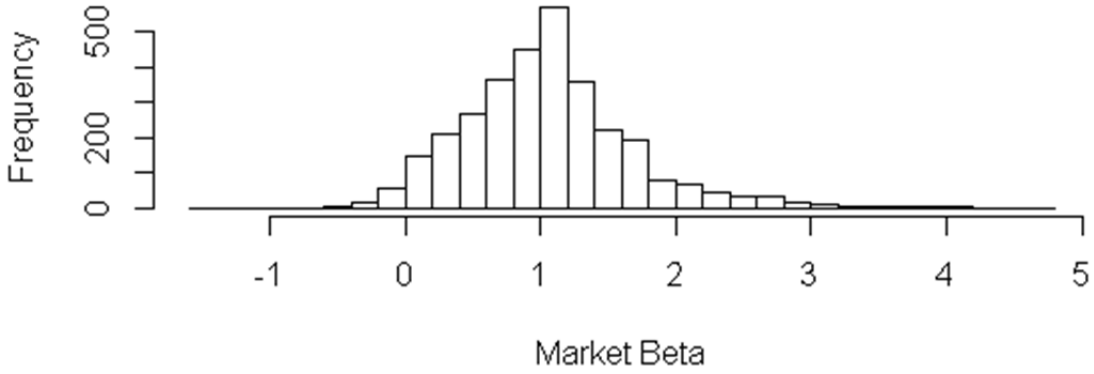
- **What are the most significant current exposures that explain future performance?**
  All statistical exposures – both passive market exposures and individual security exposures – that completely explain future return. Ranked in order of contribution to future variance.

- **Are these exposures consistent with the manager's mandate and expressed philosophy?**
  Quantitative insights that contribute to qualitative assessments

- **How do individual managers contribute to aggregate equity portfolio risk?**
  Combining managers with offsetting passive exposures reduces risk relative to the aggregate benchmark without sacrificing desirable active risk.

U.S. Market and Sector Beta Distributions as of 12/31/2018

The distribution of Market betas for individual securities:

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   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-1.4236  0.6462  1.0216  1.0491  1.3408  4.6518
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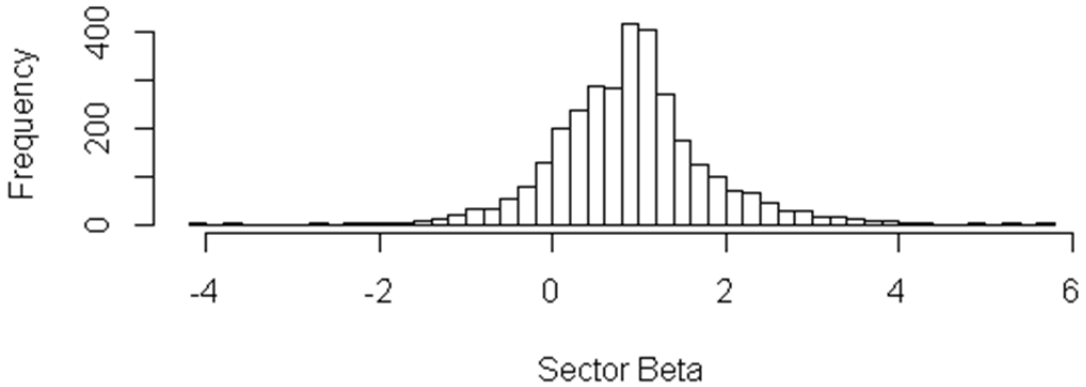
The distribution of Sector betas for individual securities:

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   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-4.1230  0.3842  0.9247  0.9076  1.3222  5.6598
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The wide variation of individual security market and sector betas is the primary reason market value weightings are not valid proxies for risk exposures, as well as the fatal flaw with Brinson and Active Share methodologies.

EQUITY RISK AND SKILL ANALYSIS

SAMPLE HIGHLIGHTS

FUND (VDIGX) WITH TOP 5% SECURITY SELECTION SKILL, DESPITE UNDERPERFORMING ITS BENCHMARK

FOR THE PERIOD ENDING DECEMBER 2017

Selected Risk and Skill Analytics

based on predictive Statistical Equity Risk Models built to isolate active contribution from passive differences, that explain 97% of out-of-sample variance and - uniquely - statistically prove persistent skill

Skill Analytics

Components of Incremental Return Isolate Passive returns (consistent passive exposure differences with benchmark), Timing returns (changes in passive exposures from long term average), and Security-selection returns.

This fund (VDIGX) has top five percentile security selection skill, despite significantly underperforming the benchmark:

	2013	2014	2015	2016	2017	5 Years
Incremental Return	**-0.9**	**-2.5**	**-2.8**	**0.3**	**-6.4**	**-2.5**
Components:						
Passive*	-4.1	-2.6	-1.9	-2.9	-7.4	-3.8
Security Selection	**3.8**	**0.3**	**0.1**	**4.1**	**1.5**	**1.9**
Timing	-0.6	0.0	-0.9	-1.1	-0.6	-0.6
Trading/Undefined	0.2	-0.2	-0.1	0.2	0.1	0.0

* Consistent market, sector, and style beta differences from index

Predictive Skill Metrics Properly measured, past performance is a predictive indicator of future performance.

> Managers with top (bottom) decile security selection performance during the prior three years are approximately twice as likely to deliver positive (negative) security selection performance as not over subsequent three years.

Position-sizing Performance The difference between actual security-selection return and the return which would have been achieved if all positions had been equal weighted.

Significant position-sizing losses are an indication of an over-capitalized manager.

Risk Analytics

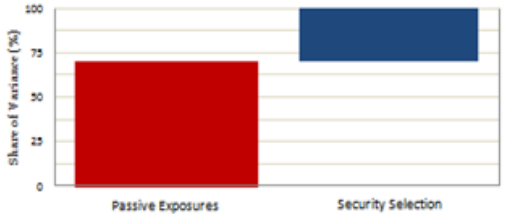
Current Absolute Risk Risk (expected volatility of portfolio returns) due to systematic factor exposures and idiosyncratic security risk.

Current Risk Relative to benchmark Relative risk (expected volatility of portfolio returns relative to the benchmark/tracking error) due to systematic passive exposures and idiosyncratic security risk. Monitoring this risk accomplishes the following:

- Ensures that managers take sufficient security selection risk to justify active fees.
- Identifies one-third of managers who are closet indexers, taking so little active risk that they are unlikely to generate active returns to clients, even if highly skilled.

Absolute Risk Components

Relative Risk Components



Absolute Annual Volatility and Variance

Source	Volatilty (%)	Share of Variance (%)
Passive	8.29	96.17
Security Selection	1.65	3.83
Total	8.45	100.00

Relative Annual Volatility and Variance

Source	Volatilty (%)	Share of Variance (%)
Passive	2.66	70.18
Security Selection	1.73	29.82
Total	3.18	100.00

Passive factors are market, sector, and style ETFs. Residuals are isolated security-selection impacts.

Manager Contribution to Portfolio Risk both absolute risk and variability of return relative to benchmark (tracking error)

Manager Impact on Aggregate Equity Risk

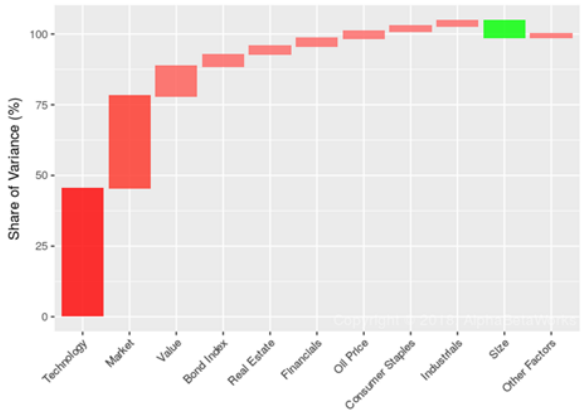
Aggregate Risk	w/o Mgr.	with Mgr.
Absolute	9.3	8.9
Relative to Benchmark	4.4	3.9
Share of Relative Varience		
Passive Factors	81	74
Security Selection	19	26

Current Risk Exposures Passive exposures ranked by their expected contribution to portfolio risk (absolute) and relative risk/tracking error (relative)

For this fund, two ETFs could offset over 75% of the tracking error not due to security selection.

Significant Passive Exposures Relative to Benchmark

Factor	Relative Exposure	Factor Volatility	Share of Relative Factor Variance	Share of Relative Total Variance
Technology	-42.0	6.2	50.6	37.5
Market	-18.7	10.0	29.8	22.1
Value	5.3	15.0	8.3	6.2
Bond Index	18.4	3.5	4.1	3.0
Industrials	6.9	4.6	3.0	2.2
Energy	2.6	14.7	2.6	1.9
Real Estate	2.0	12.7	2.3	1.7
Consumer Staples	5.9	8.3	1.6	1.2
Oil Price	-1.1	29.7	1.3	1.0
Size	4.9	10.4	-4.5	-3.4



Historical Point-in-Time Market, Sector, and Style Risk Exposures

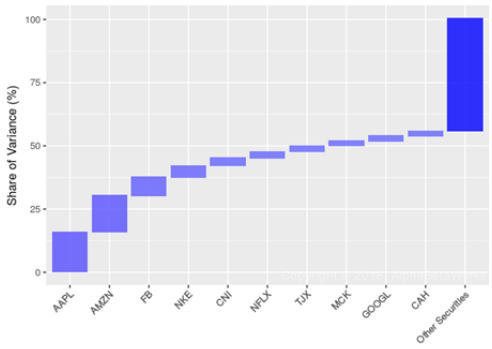
Significant Historical Risk Exposures

	Latest	Mean	Min.	Max.
Market	82.31	75.28	66.81	83.20
Health Care	13.17	16.17	12.58	20.48
Energy	3.13	8.32	2.53	17.30
Consumer Staples	11.39	12.91	9.67	16.85
Consumer Discretionary	19.72	13.70	5.69	23.85
Oil Price	-2.33	-0.66	-3.49	1.70
Industrials	15.44	13.35	10.44	18.07
Technology	6.29	8.25	6.08	12.56

Current Individual Security Contributions to Risk Top-ten securities shown ranked by expected contribution to relative risk (tracking error)

Significant Relative Security Exposures

Symbol	Name	Relative Exposure	Residual Volatility	Relative Residual Variance	Relative Total Variance
NKE	NIKE, Inc. Class B	3.8	12.8	7.8	2.3
AAPL	Apple Inc.	-3.8	12.7	7.7	2.3
AMZN	Amazon.com, Inc.	-2.6	17.9	7.1	2.1
CNI	Canadian Nat'l Railway	3.0	12.1	4.5	1.3
TJX	TJX Companies Inc	3.2	10.6	3.9	1.2
FB	Facebook Class A	-1.7	19.6	3.7	1.1
UNP	Union Pacific	2.4	13.1	3.2	1.0
AMT	American Tower Corp.	2.6	11.8	3.0	0.9
COST	Costco Wholesale	2.4	11.6	2.6	0.8
CAH	Cardinal Health, Inc.	2.0	14.4	2.6	0.8



Current and Historical VaR Expected value at risk for various horizons/ probability of loss

Figure 0.9: Portfolio *Absolute* VaR

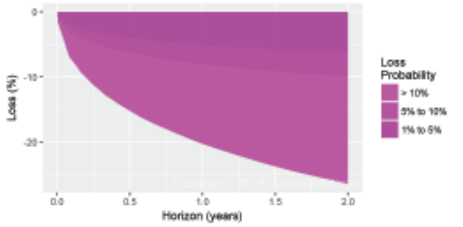


Figure 0.10: Portfolio *Relative* VaR

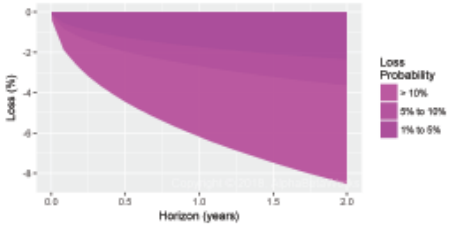


Table 0.3: Estimated *Absolute* Value at Risk (%)

Probability	Daily	Monthly	Annual
10%	0.88	3.88	12.28
5%	1.12	4.93	15.23
1%	1.58	6.83	20.26

Table 0.4: Estimated *Relative* Value at Risk (%)

Probability	Daily	Monthly	Annual
10%	0.23	1.05	3.63
5%	0.29	1.34	4.66
1%	0.42	1.90	6.59

Stress Tests Expected portfolio performance under various return scenarios. Any custom stress tests are readily available

Figure 0.1: The 2008 Crash: *Absolute* Return Estimate

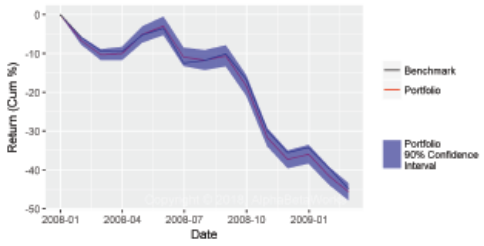


Figure 0.2: The Chinese Commodity Boom: *Relative* Return Estimate