

PEER ANALYTICS

EQUITY RISK ANALYSIS

SAMPLE

FOR THE PERIOD ENDING DECEMBER 2016

EQUITY PORTFOLIO / MANAGER RISK AND SKILL ANALYTICS

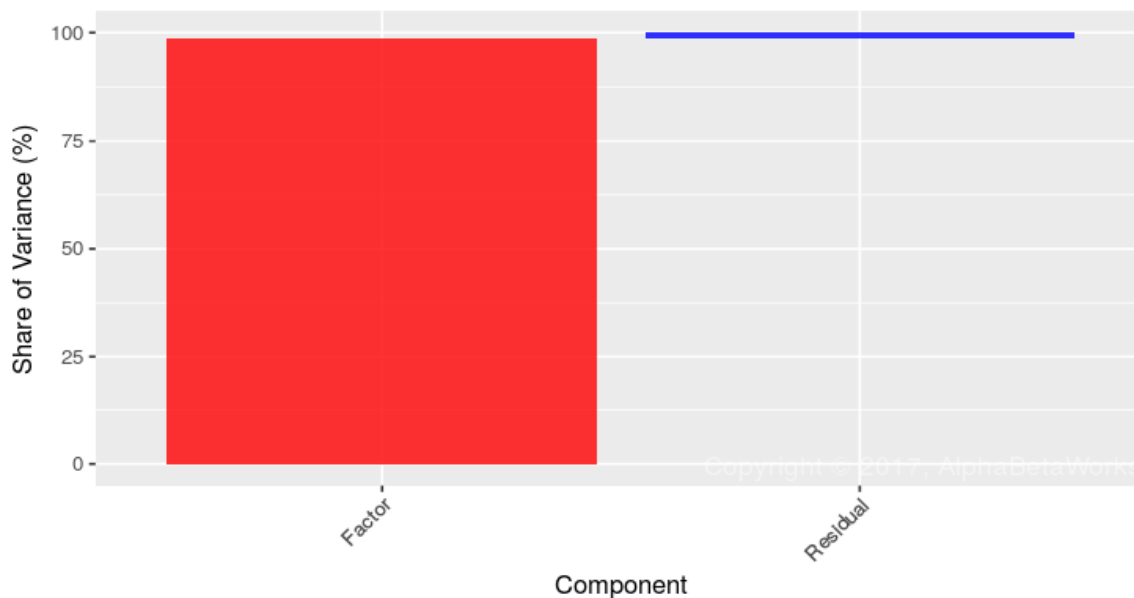
This analysis uses a risk model built to separate the impact of passive market exposures from stock selection, timing, and trading.

Isolating manager contribution reveals:

- Skill, when properly measured, **persists**. Negative skill strongly persists.
- One-third of active equity funds are **closet indexers** taking too little real active risk to overcome active fees, even with skill.
- Current, point-in-time, market risk **varies substantially** across institutional portfolios, explains the majority of incremental return, and can be readily controlled.

The following data are included for both total equity portfolio and individual managers. Complete granularity is available.

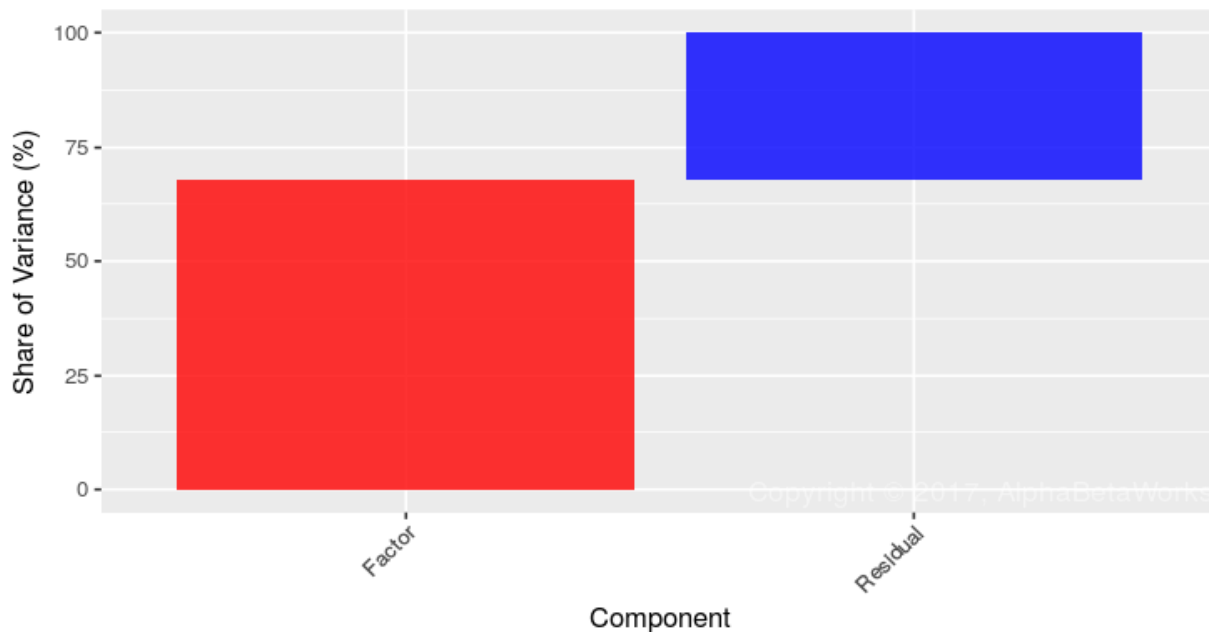
Absolute Risk Components: Median Equity Portfolio



<u>Source</u>	<u>Volatility (ann. %)</u>	<u>Share of Variance (%)</u>
Passive Factors	9.1	98.7
Active Mgmt.	1.1	1.3
Total	9.1	100.0

Percentage of current equity portfolio risk explained by passively available factors, and that due to active management (stock selection, timing, and trading).

Relative Risk Components: Median Equity Portfolio



<u>Source</u>	<u>Volatility (ann. %)</u>	<u>Share of Variance (%)</u>
Passive Factors	2.2	67.3
Active Mgmt.	1.0	32.7
Total	2.4	100.0

Percentage of current equity risk, relative to benchmark, explained by passively available factors, and that due to active management (stock selection, timing, and trading).

Two-thirds of the median portfolio's incremental risk is obtainable with a fixed blend of passive ETFs.

Portfolios that take too little real active risk relative to benchmark will be unable to overcome active fees, even with skill.

Changes in Market Exposure: Sample Equity Portfolio

Factor

Market



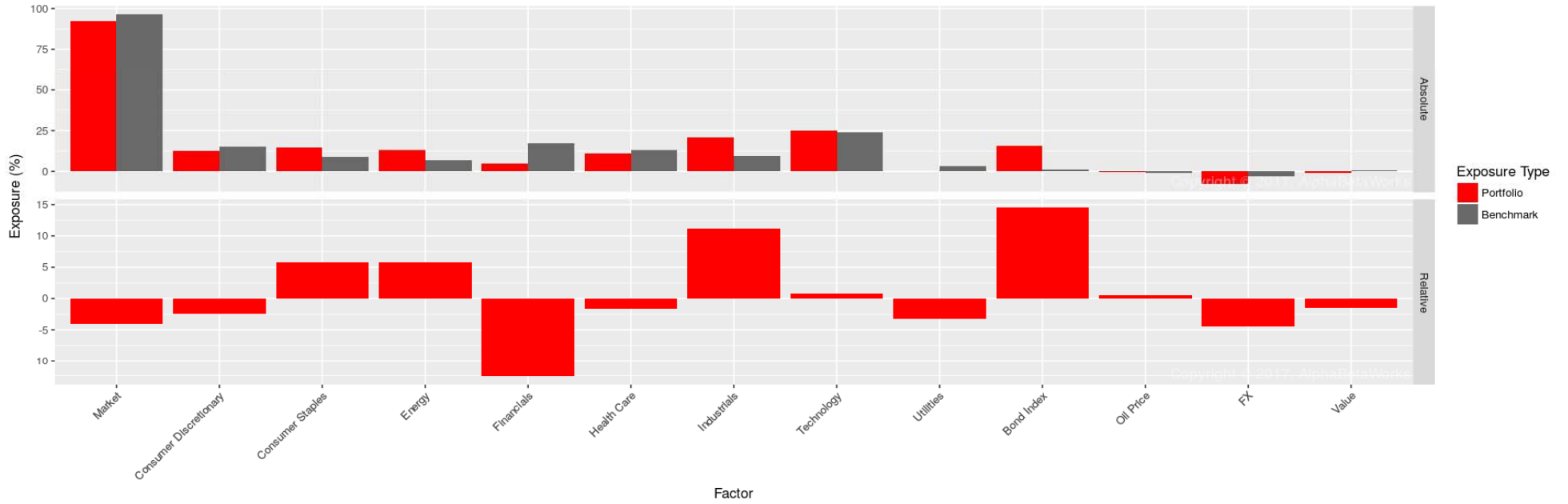
Current point-in-time market risk, based on individual security risk and covariances.

Market risk difference from the benchmark explains the majority of incremental return for most portfolios.

Separating the impact of market risk (and other passive risk) from incremental return isolates active contribution and reveals skill.

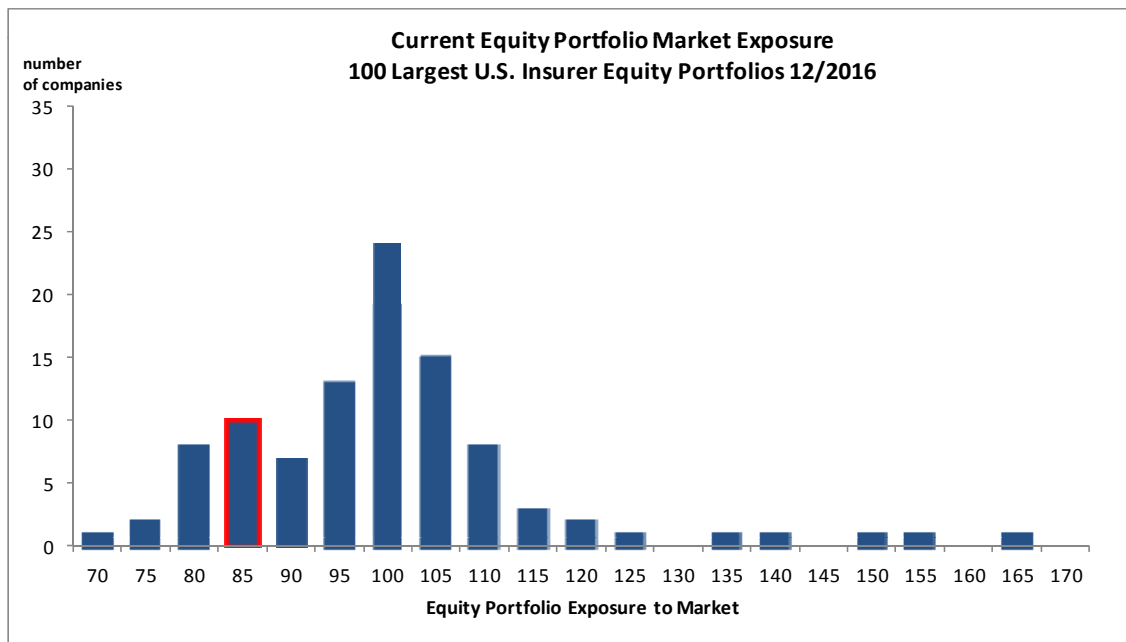
Current Equity Risk Factor Exposures

Absolute and Relative to Benchmark



Current Market Exposure (market beta) Relative to Peers

Sample Equity Portfolio

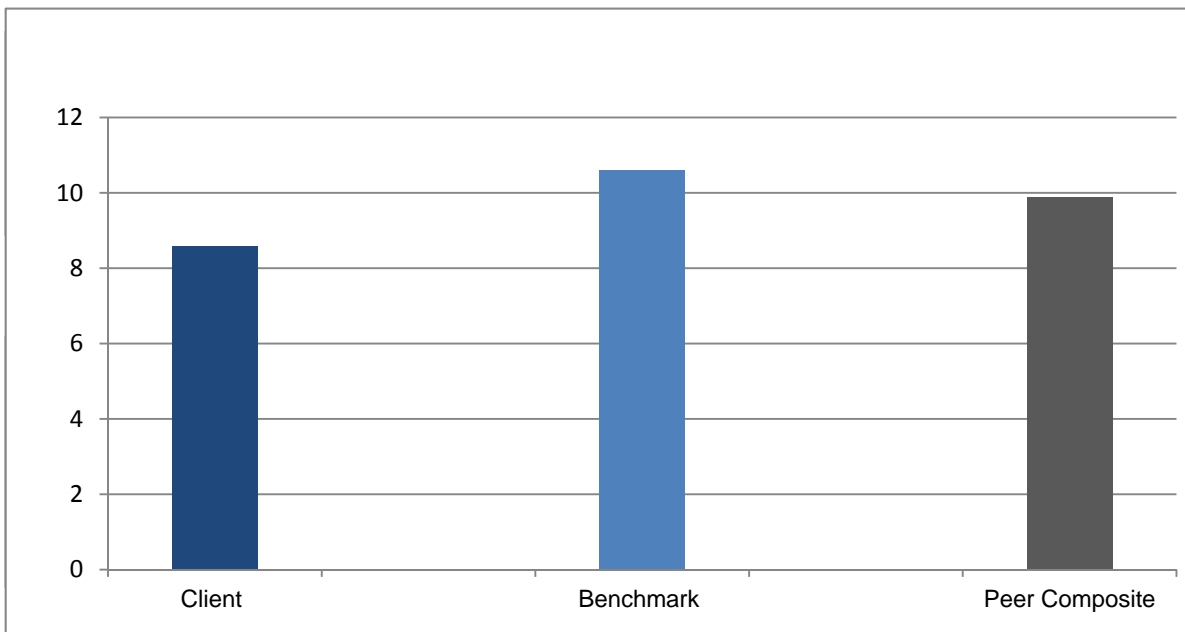


Client's current market exposure relative to a distribution of peer company exposures.

Most companies had market betas significantly different than the benchmark.

Isolating the impact of market exposure differences from the benchmark is a critical first step in identifying manager skill and real active risk.

Current Risk: Sample Equity Portfolio



Current Risk

Client	8.6%
Benchmark	10.6%
Peer Composite	9.9%

Total equity portfolio's current risk compared to benchmark and the composite peer company portfolio.

Return Attribution: Sample Equity Portfolio**Relative to Benchmark**

	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>Cumulative</u>
Incremental Return	-1.7	-5.2	-0.4	-3.7	5.3	-1.6
Components:						
Passive	-1.7	-2.9	-1.1	0.4	-4.8	-9.6
Alpha Return						
Security Selection	-0.4	-2.6	-1.1	-4.3	8.4	3.1
Factor Timing	0.3	0.1	1.9	0.4	2.0	4.9
Trading/ undefined	0.1	0.2	-0.1	-0.2	-0.3	0.0

Incremental return decomposed into return due to fixed differences in passively available exposures and return due to security selection and timing (changes in exposures over time).

Security selection skill, when properly defined, persists.

Domestic Manager and Portfolio Risk Return Attribution

Three-Year Annualized Return

	<u>WF Growth</u> <u>R 1000 Growth</u>	<u>MFS Value</u> <u>R 1000 Value</u>	<u>GS SC Value</u> <u>R 2000 Value</u>	<u>Domestic Equity</u> <u>R 3000</u>
Total Return	2.0	7.3	6.2	
Benchmark Return	<u>8.6</u>	<u>8.6</u>	<u>8.3</u>	
Incremental Return	-6.6	-1.3	-2.1	
Components: ¹				
Passive	1.3	-0.7	-0.5	
Timing	-0.4	0.2	-1.4	
Security Selection	-7.1	0.6	0.2	
Trading/undefined	<u>-0.4</u>	<u>-1.4</u>	<u>-0.4</u>	
	-6.6	-1.3	-2.1	
Probability of Skill ²	7.2	79.2	32.9	
Active Risk (net of passive differences)	2.7	0.9	1.6	2.2
Current Market Exposure				
Portfolio	103	98	105	103
Benchmark	98	97	117	99
Historical Range	83 to 138	90 to 105	100 to 119	94 to 123
Current Risk				
Portfolio	12.0	10.5	11.4	11.5
Benchmark	10.8	10.5	14.3	10.5

Comments:

WF Growth -- with probability of skill below ten percent -- is twice as likely to underperform as outperform over the next three years (before fees).³

MFS Value is taking too little active risk (net of passively available differences) to ever compensate for its active fee -- even with skill.⁴

Non-US Managers / Portfolio Risk Return Attribution

Three-year Annualized Return

	Dodge&Cox Eafe	Harbor Int'l Eafe	Acadian MSCI EM	WF Emerging MSCI EM	Non-US Portfolio ACWI ex US
Total Return	-1.3	-3.8	-3.7	-2.7	
Benchmark Return	<u>-1.6</u>	<u>-1.6</u>	<u>-2.6</u>	<u>-2.6</u>	
Incremental Return	0.3	-2.2	-1.1	-0.1	
Components:					
Passive	1.3	0.5	-0.9	0.8	
Timing	1.1	0.2	0.0	-0.3	
Security Selection	-3.7	-2.3	-0.4	-0.1	
Trading/undefined	<u>1.6</u>	<u>-0.6</u>	<u>0.2</u>	<u>-0.5</u>	
	0.3	-2.2	-1.1	-0.1	
Probability of Skill	6.9	21.0	7.3	50	
Incremental Risk	4.1	4.2	3.8	2.9	3.6
Active Risk	2.2	2.3	1.6	2.2	2.1
Pct. Risk Explained by Passive Exp.	76.1	68.6	82.2	44.9	63.8
Current Risk					
Portfolio	14.9	13.4	12.0	14.1	13.8
Benchmark	12.8	12.8	15.1	15.1	13
Primary Passive Exposure differences from Benchmark	LA, US, Financials	Japan, US, Value, Size	Dev. Asia, LA, BRL	Dev. Asia, Size, Value	US/Canada, Size, Oil

EQUITY PORTFOLIO / MANAGER RISK AND SKILL ANALYTICS

Notes:

1. Return components:

Passive: return due to average period exposures to passive market factors.

Timing: return due to exposure deviations from average.

Stock selection: total calculated return less return due to passive and timing.

Trading/unexplained: difference between calculated return and reported return.

2. Probability of Skill: percentile rankings of security selection information ratios. Portfolios in the top decile are twice as likely to outperform as underperform over subsequent three years; portfolios in the bottom decile are twice as likely to underperform as outperform.

3. [Performance Persistence Within Style Boxes](#) and [Performance Persistence Within International Style Boxes](#)

4. [Mutual Fund Closet Indexing](#) and [Hedge Fund Closet Indexing](#)

Other:

[Three Holdings-Based Style Analysis Tests](#)

[Why Investment Risk and Skill Analytics Matter](#)

[Property Casualty Industry Crowding](#)

[Testing Predictions of Equity Risk Models](#)

[Returns-Based Style Analysis: Overfitting and Collinearity](#)

[Testing Equity Risk Models](#)

[Testing Global Equity Risk Models](#)

[Equity Risk: Is the Tail Wagging the Dog?](#)

[Performance Persistence of Top US Stock Pickers 2016](#)

[What Fraction of Smart Beta is Dumb Beta?](#)

[Hedge Fund Mean Reversion](#)

U.S. Equity Statistical Risk Model Reference

1 Overview

ABW/Peer Analytics' Risk and Skill Analytics rest on the foundation of our Equity Risk Models.

Equity risk models define current portfolio risks by modeling individual security returns against underlying risk factors. For the typical stock, risk factors explain about half the security's risk, the remaining risk is security-specific. But when combined in a portfolio, most security-specific risk is diversified away; and passively available risk factors explain almost 99% of absolute return and two-thirds of incremental return for the typical portfolio.

Equity risk models can be complex and hard to interpret. Fortunately, these models are easily tested.

To evaluate the predictive accuracy of an equity risk model, we compare returns predicted by past factor exposures to subsequent portfolio performance: We calculate *factor exposures* using estimated holdings at the end of each month and predict the following month's returns using these *ex-ante* factor exposures and *ex-post* factor returns.

The correlation between predicted and actual returns 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*.

Prospective clients need not rely on the out-of-sample testing we've [published](#); we can provide passive ETF alternative portfolios for any of your managers and you can evaluate our models' accuracy over subsequent months.

The ABW/Peer Analytics models solve practical problems encountered by asset owners beyond the scope of generally available products. We tested thousands of hedge and mutual fund portfolios over decades of history to sharpen our models, eliminating important shortcomings that plague existing systems. Among the critical flaws of statistical (time-series) equity risk models addressed are the following:

- Collinearity among Market, Industry/Sector, and Style factors – Dependence among factors leads to misleading covariance matrix estimate and flawed performance attribution.¹²
- Incomplete coverage of systematic risk – Traditional factors fail to account for most of the systematic risk of certain portfolios.
- Macro inconsistency – Popular approach to weighting securities using square-root of market capitalization leads to flawed performance attribution for passive market and sector portfolios.

2 Model Construction

2.1 Factors

The U.S. Equity Statistical Risk Model (the Model) captures systematic risk using the following factors:

- Market – Aggregate equity market performance
- Sectors – Equity performance specific to the following sectors:
 - Consumer
 - Energy Minerals
 - Finance
 - Health
 - Industrial
 - Miscellaneous
 - Non-Energy Minerals
 - Technology
 - Utilities
- Bonds – Return for the Barclays US Aggregate Government Bond Index
- Oil – Change in the crude oil price
- FX – Return for the United States Dollar Index
- Size – Equity performance specific to company size. The capitalization-weighted performance of the top decile of residual equity returns minus that of the bottom decile, ranked by their market capitalizations.
- Value – Equity performance specific to company valuation. The capitalization-weighted performance of the top decile of residual equity returns minus that of the bottom decile, ranked by their book value to price ratios.

- Statistical Factors (Stat Factors) – Returns for linearly uncorrelated variables that explain the largest possible variance of portfolio securities not captured by the above factors. Stat Factors identify observable systematic risks not explicitly named by the model.
 - StatFactor1 – The first statistical factor
 - StatFactor2 – The second statistical factor
 - StatFactor3 – The third statistical factor

2.2 Fitting Linear Models

Factor exposures are estimated by robust regression using the M estimator. Fitting is done by iterated re-weighted least squares (IWLS) using the Huber psi function.³⁴⁵⁶

Observations are exponentially weighted with 0.02 monthly decay. Observation weight is reduced by approximately half after 36 months.

2.3 Factor Return and Exposure Estimation

The Model estimates factor returns and factor exposures hierarchically. Residuals from the previous regression step are used to estimate factor returns and exposures in the following step, thus avoiding the collinearity problems that plague most commercial statistical risk models:

- Market
 - Estimate the Market return as the capitalization-weighted return of index securities.
 - Fit linear models to estimate market exposures: $\text{SecurityReturns} \sim \text{MarketReturn}$.
 - Save residuals as `MarketResiduals` for the following step.
- Sectors
 - Estimate Sector factor returns as capitalization-weighted returns of index securities' `MarketResiduals`.
 - Fit linear models to estimate Sector exposures: $\text{MarketResiduals} \sim \text{SectorReturn}$.
 - Save residuals as `SectorResiduals` for the following step.
- Bonds, Oil, and FX
 - Fit linear models to estimate Bonds, Oil, and FX exposures: $\text{SectorResiduals} \sim \text{BondsReturn} + \text{OilReturn} + \text{FXReturn}$.
 - Save residuals as `BondsOilFXResiduals` for the following step.
- Size, Value
 - Estimate Size factor returns as capitalization-weighted returns of the top decile minus the bottom decile of index securities' `BondsOilFXResiduals`, ranked by their capitalization.
 - Estimate Value factor returns as capitalization-weighted returns of the top decile minus the bottom decile of index securities' `BondsOilFXResiduals`, ranked by their Book to Price ratios.
 - Fit linear models to estimate Size and Value exposures: $\text{BondsOilFXResiduals} \sim \text{SizeReturn} + \text{ValueReturn}$.
 - Save residuals as `SizeValueResiduals` for the following step.
- Statistical Factors
 - Statistical factors are estimated on each portfolio's `SizeValueResiduals`.
 - Perform maximum-likelihood factor analysis on the portfolio's `SizeValueResiduals` matrix, estimating three dominant Stat Factors.⁷
 - Fit linear models to estimate the exposures of all securities to the Stat Factors: $\text{SizeValueResiduals} \sim \text{StatFactor1} + \text{StatFactor2} + \text{StatFactor3}$

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1. Chatterjee, S.; Hadi, A. S.; Price, B. (2000). Regression Analysis by Example (Third ed.). John Wiley and Sons. ISBN 0-471-31946-5.
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