

# Axioma United States Equity Factor Risk Models

## MODEL OVERVIEW

---

<b>Asset Coverage</b>	As of end of 2015, the models cover over 8850 securities (over 25,000 historically) listed on various U.S. stock exchanges, including ADRs. The models also cover more than 250 ETFs and more than 300 EIF contracts.
<b>Estimation Universe</b>	Dynamic selection criteria are employed to identify stocks on NYSE and NASDAQ with sufficient size and market liquidity. Typically, only common stocks are eligible (ADRs and foreign issuers excluded) but a few exceptions may arise from time to time (e.g. REITs). Grandfathering logic is applied to ensure stability and robustness. Throughout the model history, the estimation universe amounts to roughly 2861 stocks on average.
<b>Model Variants (4)</b>	Medium-horizon and short-horizon, fundamental and statistical factor models available.
<b>Model History</b>	Daily history from January 1982 onwards.
<b>Forecast Horizon</b>	Medium-horizon model: 3-6 months. Short-horizon model: 1-2 months.
<b>Estimation Frequency</b>	Factor exposures and covariances, asset specific risks estimated daily.

# Fundamental Factor Model

## Style Factors

## AXUS4-MH(13)

## AXUS4-SH(14)

### MARKET-BASED FACTORS

Liquidity	Ln 3 month average daily volume over market capitalization	Ln 1 month daily volume over market capitalization
Market Sensitivity	1 year daily beta	6 month daily beta
Volatility	6 month average of absolute returns over cross-sectional standard deviation, fully orthogonalized to Market Sensitivity	3 month average of absolute return over cross-sectional standard deviation, fully orthogonalized to Market Sensitivity
Short-Term Momentum	N/A	Cumulative return over past month
Size	Natural logarithm of market capitalization	
MidCap	Binary exposure for midcap assets	
Medium-Term Momentum	Cumulative return over past year excluding most recent month	
Exchange Rate Sensitivity	Two year weekly beta to returns of currency basket containing USD, EUR, GBP, JPY	

### FUNDAMENTAL FACTORS

Value	Book-to-price
Earnings Yield	Earnings-to-price, and estimated earnings-to-price
Leverage	Total debt (current and long-term liabilities) to total assets and Total debt to Equity
Growth	Sales growth, estimated sales growth, earnings growth, estimated earnings growth
Profitability	Return-on-equity, return-on-assets, cash flow to assets, cash flow to income, gross margin, and sales-to-assets
Dividend Yield	Ratio of sum of the dividends paid (excluding non-recurring, special dividends) over the most recent year to average market capitalization ( <i>see the AXUS4 Style Factor Handbook for exact factor definitions</i> )

### INDUSTRY FACTORS (68)

GICS®-based industry classification with 0/1 assignments.

### RETURNS MODEL

Uses a market factor as well as style and industry factors to model local excess returns. The US Market factor return, industry returns and style factor returns are estimated from a single-stage root-cap weighted regression (with constraint on industries) of the daily excess local returns.

### RETURNS HISTORY

Medium-horizon model: 4 years of daily returns for factor correlations, 2 years of daily returns for factor volatilities.  
Short-horizon model: 4 years of daily returns for factor correlations, 2 years of daily returns for factor volatilities.

### ESTIMATION

Robust linear regression using Huber weight function and square-root market capitalization weights.

# Statistical Factor Model

FACTOR STRUCTURE	15 statistical factors.
ESTIMATION	2-Pass Asymptotic Principal Components factor analysis with residual variance weighted returns.
RETURNS HISTORY	One year of daily asset returns are used to estimate statistical factor exposures. Four years of statistical factor returns are used to estimate statistical factor covariances.
ADJUSTMENTS	A proprietary algorithm enables a more intuitive understanding of the statistical factors by maintaining the ordering and sign of the factor returns over time.

## Factor Volatilities / Covariances

ESTIMATION	Covariance of exponentially-weighted daily factor returns.
HALF-LIFE PARAMETERS	Medium-horizon model: 125 days for variances, 250 days for correlations. Short-horizon model: 60 days for variances, 125 days for correlations.
AUTOCORRELATION	Newey-West adjustment accounting for 2 days of autocorrelation. (a fixed lag of 1 day is used for statistical factors).
ADJUSTMENTS	Axioma's proprietary <i>Dynamic Volatility Adjustment</i> (DVA) procedure is used to analyze trends in factor returns dispersion and adjust risk estimation accordingly to allow for heightened responsiveness in risk forecasts and adaptability to the prevailing volatility regime.

## Specific Risks

ESTIMATION	Variance of exponentially-weighted daily specific returns.
HISTORY	Medium-horizon model: 250 days. Short-horizon model: 250 days.
HALF-LIFE PARAMETER	Medium-horizon model: 125 days. Short-horizon model: 60 days.
AUTOCORRELATION	Newey-West adjustment accounting for 1 day of autocorrelation.
OTHER ADJUSTMENTS	Issuer Specific Covariance (ISC) captures covariances between security lines of the same issuer, using a cointegration model of price behavior. Applies only to portfolios containing two or more securities from the same issuer.

# Data Deliverables

AVAILABILITY	Updated daily and downloadable via FTP/HTTPS.
HISTORICAL COVERAGE	Daily history from January 1982 onwards.
DATA FORMAT	Delimited text file ("flat files") or proprietary database format for seamless integration into Axioma Portfolio and Axioma Backtester.
BENCHMARKS	Local market benchmarks are available in a format compatible with Axioma software products.
EXCHANGE TRADED FUNDS (ETFs)	Broad coverage of ETFs and index linked ETFs. ETF coverage for the model is determined by the model's full coverage of the underlying constituents in order to ensure consistency in the instruments risk and exposure measures.
EQUITY INDEX FUTURES (EIFS)	Broad coverage of EIF contracts with daily history as far back as January 2008. Risk characteristics for EIFs are inherited from underlying indices, or ETF proxies when indices are unavailable.
FACTOR MIMICKING PORTFOLIOS (FMPS)	For Fundamental model Style factors (daily update).
STATISTICAL MODEL FACTOR RETURNS (PRET)	250 days of Statistical factor returns history (daily update).
ASSET IDENTIFIERS	Axioma ID, 7-digit SEDOL, 9-digit CUSIP, ISIN, local ticker, and security name.
MARKET & FUNDAMENTAL DATA	<p>Asset-level data including:</p> <ul style="list-style-type: none"><li>• Price and market capitalization</li><li>• 1-, 5-, 20-, and 60-day returns</li><li>• 5- and 20-day average daily volume</li><li>• Historical and predicted beta</li><li>• 1-year earnings growth, 1-year income growth</li><li>• Debt-to-equity, dividend yield, EBITDA</li><li>• Price-to-book, price-to-earnings, price-to-sales</li></ul> <p>Some items of asset data may not be available in delimited text file format. Sample flat files are available upon request.</p>

# Appendix: AXUS4 Results Overview

## Model Fit and Factor Performance

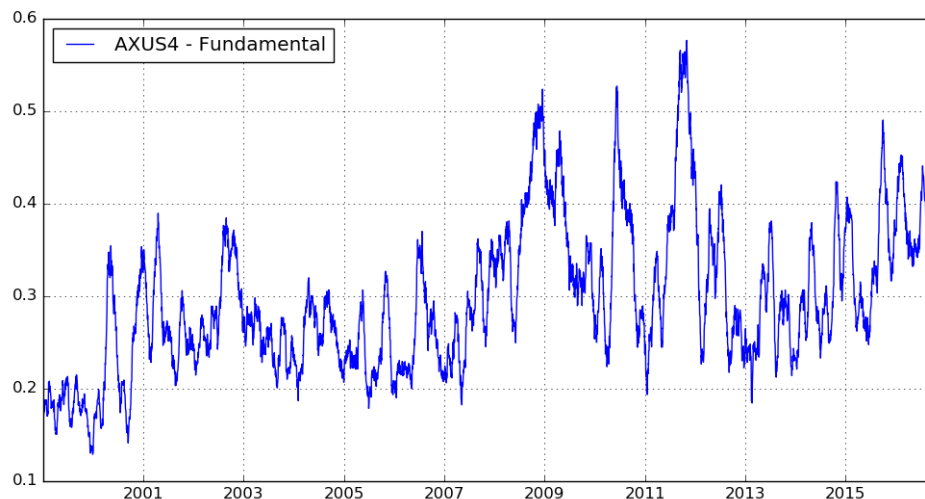


Figure 1: Average 1-month adjusted R-squared for the model estimation universe, 1999-2016. The results for the medium- and short-horizon Fundamental models are very similar so only the results for the Fundamental-MH model are shown.

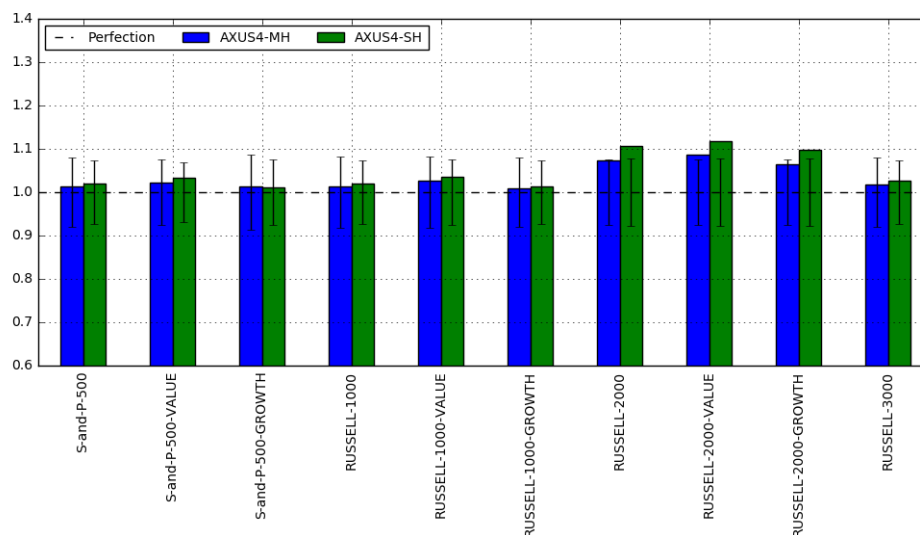


Figure 2: Total risk bias statistics for selected benchmark portfolios, 2002-2016. The vertical lines represent the bounds of the 95% confidence interval. Bias statistics beyond these lines are significantly different from 1.00.<sup>1</sup>

<sup>1</sup> The Russell 1000QR Index, Russell 2000QR Index and Russell 3000QR Index are trademarks/service marks of the Frank Russell Company. Russell is a trademark of the Frank Russell Company. S&P INDICES are registered trademarks of Standard & Poor's Financial Services LLC.

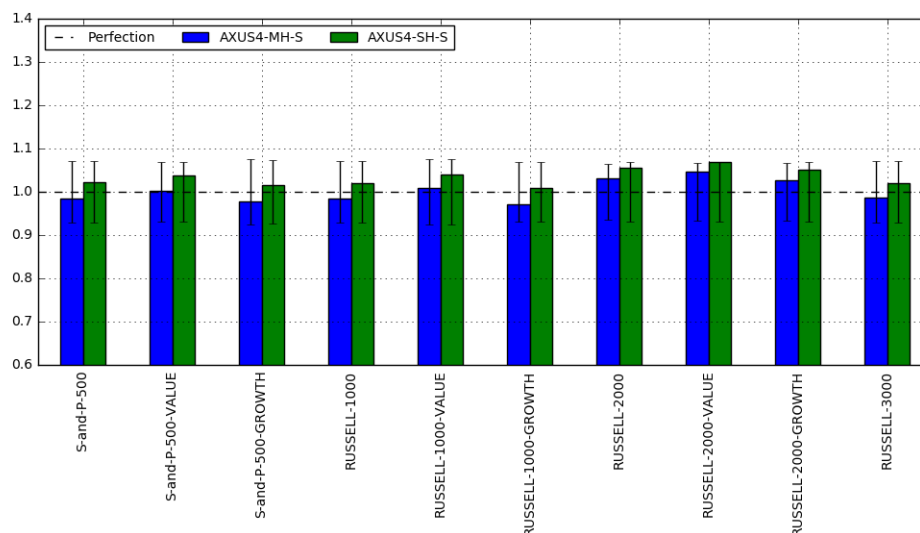


Figure 3: Total risk bias statistics for selected benchmark portfolios, 2002-2016. The vertical lines represent the bounds of the 95% confidence interval. Bias statistics beyond these lines are significantly different from 1.00.<sup>1</sup>

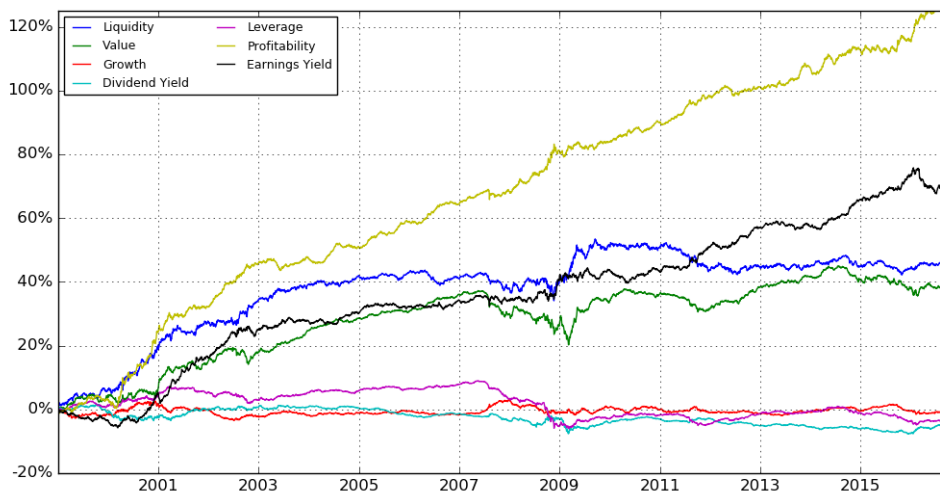


Figure 4: Cumulative return to each of the AXUS4-MH Fundamental Style factors, 1999-2016.

<sup>1</sup> The Russell 1000QR Index, Russell 2000QR Index and Russell 3000QR Index are trademarks/service marks of the Frank Russell Company. Russell is a trademark of the Frank Russell Company. S&P INDICES are registered trademarks of Standard & Poor's Financial Services LLC.

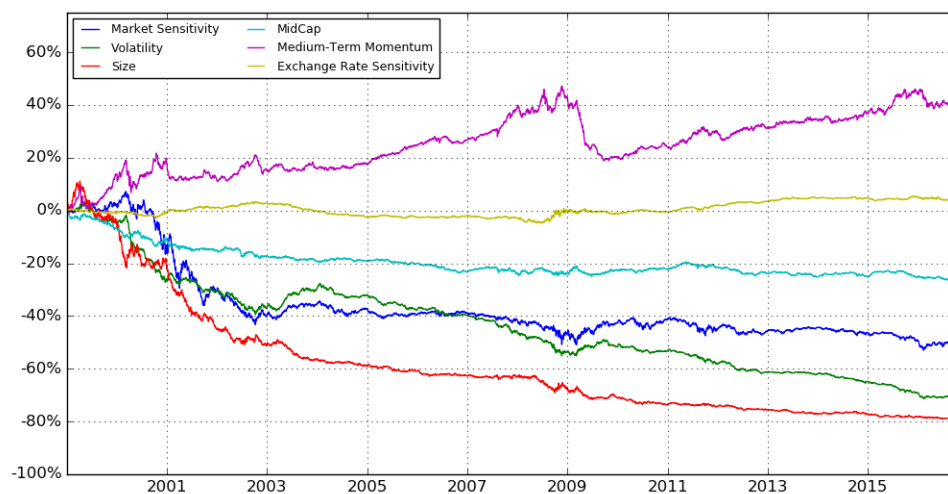


Figure 5: Cumulative return to each of the AXUS4-MH Market based Style factors, 1999-2016.

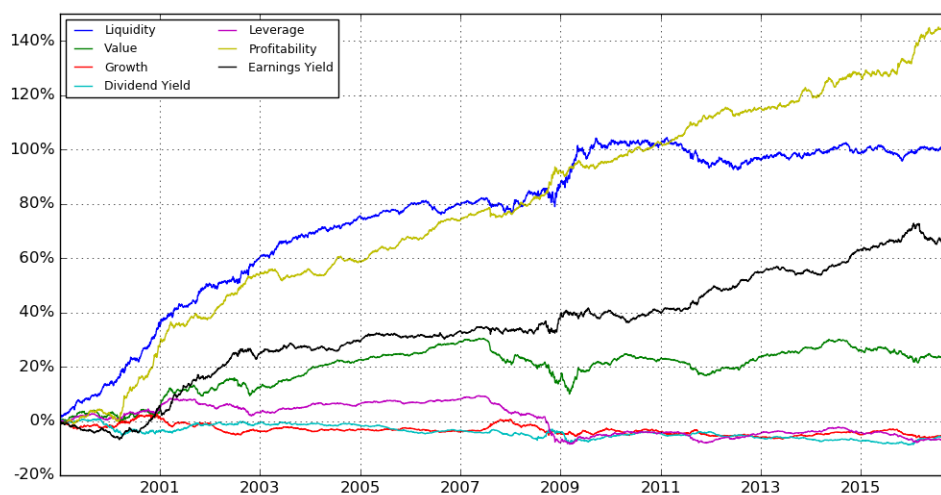


Figure 6: Cumulative return to each of the AXUS4-SH Fundamental Style factors, 1999-2016.

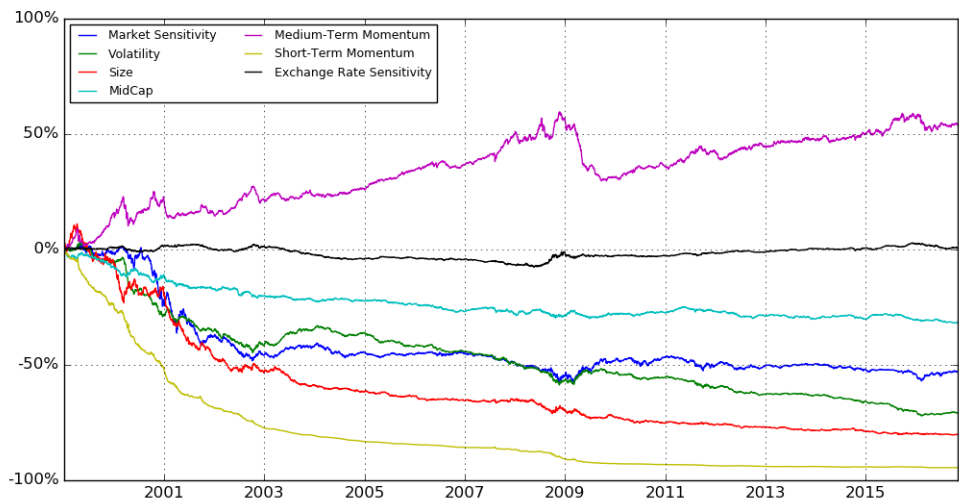


Figure 7: Cumulative return to each of the AXUS4-SH Market based Style factors, 1999-2016.

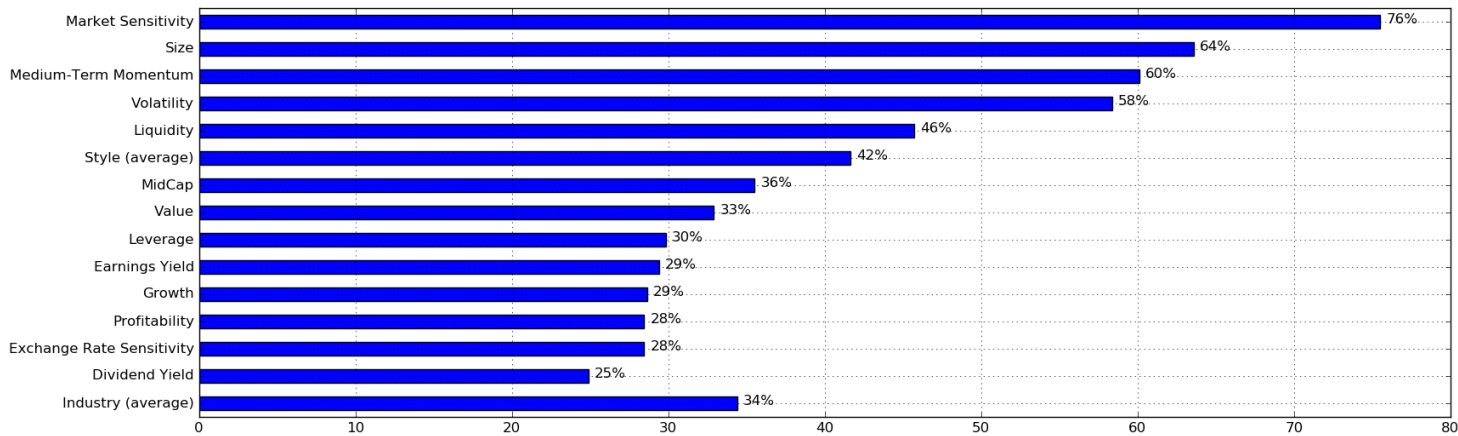


Figure 8: AXUS4-MH factors' frequency of statistical significance, 1999-2016. Market Sensitivity, for example, is statistically significant 76% of the time.



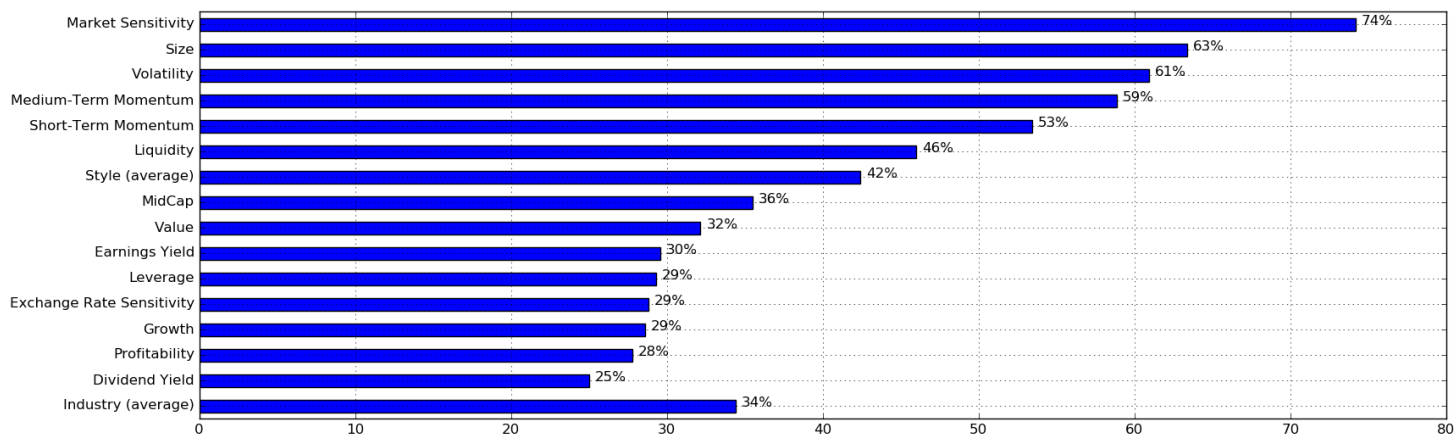


Figure 9: AXUS4-SH factors' frequency of statistical significance, 1999-2016. Market Sensitivity SH, for example, is statistically significant 74% of the time.

### New York

**AXIOMA, INC.**  
17 State Street  
Suite 2700  
New York, NY 10004  
**Phone:** 212-991-4500  
**Fax:** 212-991-4539

### Atlanta

**AXIOMA, INC.**  
400 Northridge Road  
Suite 550  
Atlanta, GA 30350  
**Phone:** 678-672-5400  
**Fax:** 678-672-5401

### Chicago

**AXIOMA, INC.**  
2 N LaSalle Street, Suite 1400  
Chicago, IL 60602  
**Phone:** 312-448-3219  
**Fax:** 877-385-8919

### Frankfurt

**AXIOMA DEUTSCHLAND  
GMBH**  
Mainzer Landstrasse 41  
D-60329 Frankfurt am Main  
Germany  
**Phone:** +49-(0)-69-95-925-162

### Geneva

**AXIOMA CH**  
Rue du Rhone 69, 2nd Floor  
1207 Geneva, Switzerland  
**Phone:** +41-22-700-83-00

### Hong Kong

**AXIOMA, (HK) LTD.**  
Unit B, 17/F, Entertainment Bldg  
30 Queen's Road Central  
Hong Kong  
**Phone:** +852-8203-2790  
**Fax:** +852-8203-2774

### London

**AXIOMA, (UK) LTD.**  
St. Clements House  
27-28 Clements Lane  
London, UK EC4N 7AE  
**Phone:** +44-207-856-2424  
**Fax:** +44-(0)-20-3006-8747

### Melbourne

**AXIOMA (AU) LTD**  
31st Floor  
120 Collins Street  
Melbourne, VIC 3000  
Australia  
**Phone:** +61-(0)3-9225-5296

### Paris

**AXIOMA (FR)**  
19 Boulevard Malesherbes  
75008, Paris, France  
**Phone:** +33-(0)-1-55-27-38-38

### San Francisco

**AXIOMA, INC.**  
201 Mission Street  
Suite 2150  
San Francisco, CA 94105  
**Phone:** 415-614-4170  
**Fax:** 415-614-4169

### Singapore

**AXIOMA, (ASIA) PTE LTD.**  
30 Raffles Place  
#23-00 Chevron House  
Singapore 048622  
**Phone:** +65-6233-6835  
**Fax:** +65-6233-6891

### Tokyo

**AXIOMA, JAPAN**  
Tekko Building 4F  
1-8-2 Marunouchi, Chiyoda-ku  
Tokyo 100-0005  
Japan  
**Phone:** +81-3-6870-7766

For more information visit [axioma.com](http://axioma.com) for more information.

**Contact us to learn more about how Axioma Risk Models  
can bring more information and insights to your investment process.**

**United States and Canada:** +1 212-991-4500

**Europe:** +44 (0)20 7856 2424

**Asia:** +852-8203-27904

**Sales:** [sales@axioma.com](mailto:sales@axioma.com)

**Client Support:** [support@axioma.com](mailto:support@axioma.com)

**Careers:** [careers@axioma.com](mailto:careers@axioma.com)