

Axioma AXWW4 World-Wide Equity Factor Risk Model

September 2017

Model Overview

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------|--|--------------|-----------------------|-------------------|-------------|----------|-----------|---------|--------|--------|-----------|----------|---------|-----------|----------|-------------|---------|--------|-----------|----------|-----------|------------|------------|---------|-------------|-------------------|---------|--------|------------|---------|--------|-------|-----------|--------------|----------|----|---------|---------|--------|--------|-----|-------------|------------|-----------|-----------|--|------------|-----------|-------------|-----------------------|--|----------------------|--|--|--|--|
| Asset Coverage | As of 2017, the model covers roughly 42,700 securities (over 77,700 historically), primarily from the following 48 markets: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="0"> <tr> <td>Argentina</td> <td>Denmark</td> <td>Ireland</td> <td>New Zealand</td> <td>Spain</td> </tr> <tr> <td>Australia</td> <td>Egypt</td> <td>Israel</td> <td>Norway</td> <td>Sweden</td> </tr> <tr> <td>Austria</td> <td>Finland</td> <td>Italy</td> <td>Pakistan</td> <td>Switzerland</td> </tr> <tr> <td>Belgium</td> <td>France</td> <td>Japan</td> <td>Peru</td> <td>Taiwan</td> </tr> <tr> <td>Brazil</td> <td>Germany</td> <td>Korea</td> <td>Philippines</td> <td>Thailand</td> </tr> <tr> <td>Canada</td> <td>Greece</td> <td>Luxembourg</td> <td>Poland</td> <td>Turkey</td> </tr> <tr> <td>Chile</td> <td>Hong Kong</td> <td>Malaysia</td> <td>Portugal</td> <td>UK</td> </tr> <tr> <td>China</td> <td>Hungary</td> <td>Mexico</td> <td>Russia</td> <td>USA</td> </tr> <tr> <td>Colombia</td> <td>India</td> <td>Morocco</td> <td>Singapore</td> <td></td> </tr> <tr> <td>Czech Rep.</td> <td>Indonesia</td> <td>Netherlands</td> <td>South Africa</td> <td></td> </tr> </table> | Argentina | Denmark | Ireland | New Zealand | Spain | Australia | Egypt | Israel | Norway | Sweden | Austria | Finland | Italy | Pakistan | Switzerland | Belgium | France | Japan | Peru | Taiwan | Brazil | Germany | Korea | Philippines | Thailand | Canada | Greece | Luxembourg | Poland | Turkey | Chile | Hong Kong | Malaysia | Portugal | UK | China | Hungary | Mexico | Russia | USA | Colombia | India | Morocco | Singapore | | Czech Rep. | Indonesia | Netherlands | South Africa | | | | | | |
| Argentina | Denmark | Ireland | New Zealand | Spain | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Australia | Egypt | Israel | Norway | Sweden | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Austria | Finland | Italy | Pakistan | Switzerland | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Belgium | France | Japan | Peru | Taiwan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Brazil | Germany | Korea | Philippines | Thailand | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Canada | Greece | Luxembourg | Poland | Turkey | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chile | Hong Kong | Malaysia | Portugal | UK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| China | Hungary | Mexico | Russia | USA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colombia | India | Morocco | Singapore | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Czech Rep. | Indonesia | Netherlands | South Africa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | In addition, the following 46 emerging markets are included; the first group starting in 2003 and the second in 2009 and the third in 2015: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="0"> <tr> <td>Bahrain</td> <td>Cyprus</td> <td>Kuwait</td> <td>Oman</td> <td>Slovenia</td> </tr> <tr> <td>Botswana</td> <td>Estonia</td> <td>Latvia</td> <td>Qatar</td> <td>Sri Lanka</td> </tr> <tr> <td>Bulgaria</td> <td>Iceland</td> <td>Lithuania</td> <td>Romania</td> <td>UAE</td> </tr> <tr> <td>Croatia</td> <td>Jordan</td> <td>Mauritius</td> <td>Slovakia</td> <td>Venezuela</td> </tr> <tr> <td>Bangladesh</td> <td>Kazakhstan</td> <td>Namibia</td> <td>Tunisia</td> <td>Trinidad & Tobago</td> </tr> <tr> <td>Ecuador</td> <td>Kenya</td> <td>Nigeria</td> <td>Ukraine</td> <td></td> </tr> <tr> <td>Ghana</td> <td>Lebanon</td> <td>Saudi Arabia</td> <td>Vietnam</td> <td></td> </tr> <tr> <td>Jamaica</td> <td>Malta</td> <td>Serbia</td> <td>Zambia</td> <td></td> </tr> <tr> <td>Ivory Coast</td> <td>Montenegro</td> <td>Macedonia</td> <td>Malawi</td> <td></td> </tr> <tr> <td>Tanzania</td> <td>Uganda</td> <td>Zimbabwe</td> <td>Palestinian Territory</td> <td></td> </tr> <tr> <td>Bosnia & Herzegovina</td> <td></td> <td></td> <td></td> <td></td> </tr> </table> | Bahrain | Cyprus | Kuwait | Oman | Slovenia | Botswana | Estonia | Latvia | Qatar | Sri Lanka | Bulgaria | Iceland | Lithuania | Romania | UAE | Croatia | Jordan | Mauritius | Slovakia | Venezuela | Bangladesh | Kazakhstan | Namibia | Tunisia | Trinidad & Tobago | Ecuador | Kenya | Nigeria | Ukraine | | Ghana | Lebanon | Saudi Arabia | Vietnam | | Jamaica | Malta | Serbia | Zambia | | Ivory Coast | Montenegro | Macedonia | Malawi | | Tanzania | Uganda | Zimbabwe | Palestinian Territory | | Bosnia & Herzegovina | | | | |
| Bahrain | Cyprus | Kuwait | Oman | Slovenia | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Botswana | Estonia | Latvia | Qatar | Sri Lanka | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bulgaria | Iceland | Lithuania | Romania | UAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Croatia | Jordan | Mauritius | Slovakia | Venezuela | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bangladesh | Kazakhstan | Namibia | Tunisia | Trinidad & Tobago | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecuador | Kenya | Nigeria | Ukraine | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ghana | Lebanon | Saudi Arabia | Vietnam | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jamaica | Malta | Serbia | Zambia | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ivory Coast | Montenegro | Macedonia | Malawi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tanzania | Uganda | Zimbabwe | Palestinian Territory | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bosnia & Herzegovina | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Estimation Universe | Includes assets with sufficient size and liquidity, using selection criteria similar to those employed by major index providers. More granular, localized rules are also applied on a per-market basis to filter certain exchanges, asset types, etc. In early 2017, the estimation universe comprised 12,700 securities on average. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Forecast Horizon | Medium-horizon model: 3-6 months; Short-horizon model: 1-2 months. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Model Variants (4) | Medium- and short-horizon, fundamental and statistical factor models are available. Using Axioma Portfolio®, the fundamental factor models can be re-based into country- or industry-focused versions, for risk decomposition or performance attribution tailored to a specific investment process. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Estimation Frequency | Factor exposures, returns, covariances and asset specific risks estimated daily. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Fundamental Factor Model

| Style Factors | AXWW4-MH (12) | AXWW4-SH (13) |
|--|--|---|
| Market-Based Factors | | |
| Market Sensitivity | 2-year weekly beta versus the global market | 1-year weekly beta |
| Volatility | 6-month average of absolute returns over cross-sectional standard deviation, fully orthogonalized to Market Sensitivity | Same (3-month average) |
| Short-Term Momentum | N/A | Cumulative return over past month |
| Liquidity | Natural logarithm of the ratio of 3-month average daily volume and 1-month average market capitalization, inverse of 6-month Amihud illiquidity ratio, and proportion of returns-traded over last calendar year | Same (1-month average daily volume, 3-month Amihud ratio) |
| Exchange Rate Sensitivity | 2-year weekly beta to returns of currency basket containing USD, EUR, GBP, JPY, CNY | Same (1-year weekly beta) |
| Medium-Term Momentum | Cumulative return over past year excluding the most recent month (same for MH and SH models) | |
| Size | Natural logarithm of market capitalization (same for MH and SH models) | |
| Fundamental Factors (same for MH and SH models) | | |
| 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 | |
| | (See the AXWW4 Model Supplement Document for exact factor definitions) | |
| Industry Factors (68) | GICS®-based, corresponding to GICS® 2016 Industries with 0/1 assignments. Assets with no official GICS® are given industry membership based on internal research and are explicitly labeled as such in product deliverables. | |
| Global Market Factor (1) | Regression intercept term; all assets have unit exposure. Allows the model to better distinguish between country and industry risk contribution effects. | |
| Country Factors | 0/1 assignments based on an asset's country of quotation, business activities or domicile. In most cases this is equivalent to the market where an asset trades; the issuer's home country is used for foreign listings, depository receipts, and similar instruments. | |
| Currency Factors | 0/1 assignments to the primary currency of an asset's country. | |
| Local Factors (1) | Meant to capture strong residual structure in certain markets not captured by others factors. The model currently has only one such factor: Domestic China. | |

| | |
|---------------------------|--|
| Returns Model | Models local asset excess returns using 5 sets of factors: a global market factor, countries, industries, styles, and local factors. Currency factors are only introduced in the risk estimation stage. |
| Estimation | Constrained robust linear regression using Huber weight function and square-root USD capitalization weights. Style, industry and country factors are included in the regression. Local factors are estimated via an auxiliary regression on the residuals. The capitalization-weighted industry and country factor returns are each constrained to sum to zero. Currency factor returns are computed directly from exchange rates against USD. |
| Numeraire Currency | Currency risk is expressed from a U.S. Dollar (USD) perspective, but advanced features in Axioma Portfolio enable users to dynamically re-base the model into various other currencies. |

Statistical Factor Model

| | |
|---------------------------------|--|
| Statistical Factors (20) | All assets have exposure to the statistical factors. |
| Currency Factors | 0/1 assignments to the primary currency of an asset's country. |
| Estimation | 2-Pass Asymptotic Principal Components factor analysis with residual variance adjusted returns. 1 year of daily local excess returns are used. Currency factor returns are taken from the same currency risk model used by the fundamental factor model. |
| Numeraire Currency | Currency risk is expressed from a U.S. Dollar (USD) perspective, but advanced features in Axioma Portfolio enable users to dynamically re-base the model into various other currencies. |

Factor Volatilities / Correlations

| | |
|-------------------------------|---|
| 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 3 days of autocorrelation. A fixed lag of 1 day is used for statistical factors. |
| Returns Asynchronicity | <i>Returns-timing</i> technique is applied to the factor estimation process to compensate for non-synchronous trading between world stock markets. |
| 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. |

Currency Risk

| | |
|----------------------|--|
| Miscellaneous | Currency risks in all models are taken from the Axioma Global Currency Risk Model, ensuring that all regional/global risk models share consistent estimates of currency risks and covariances. |
| Estimation | Principal components analysis using 1 year of exchange rate returns and 12 statistical factors, estimated from a pool of core currencies: USD, EUR, GBP, JPY, CHF, CAD, AUD, BRL, MXN, SGD, KRW, ZAR, PLN. |

Specific Risks

| | |
|-----------------------------|--|
| Estimation | Variance of exponentially-weighted daily specific returns. |
| Half-life Parameters | Medium-horizon model: 125 days, short-horizon model: 60 days. |
| History | Medium-horizon model: 500 days. short-horizon model: 500 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 and SFTP. |
| Historical Coverage | Daily history from Jan. 1997 onwards. |
| Data Format | Delimited text file (“flat files”) or proprietary database format for seamless integration into Axioma Portfolio and Axioma Backtester®. |
| Benchmarks | Global and regional benchmarks are available in a format compatible with Axioma software products. |
| Exchange Traded Funds (ETFs) | Broad coverage of regional, single country, 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 instrument’s risk and exposure measures. |
| Factor Mimicking Portfolios (FMPs) | For MH Fundamental Model Style factors (daily update). |
| Statistical Model Factor Returns (PRET) | 250 days of Statistical factor returns history (daily update). |
| Asset Identifiers | Axioma ID, SEDOL, CUSIP, ISIN, local ticker, issuer/company ID. |
| Market Data | <p>Asset-level data including:</p> <ul style="list-style-type: none"> • Price, market capitalization • 1-, 5-, 20-, and 60-day returns • 5- and 20-day average daily volume • Historical and predicted beta <p>Some items of market data may not be available in delimited text file format.</p> |

Appendix: AXWW4 Industry Factors vs. GICS®

| GICS® Industry Groups (24) | | Axioma Industry Factors (68) | |
|----------------------------|--|------------------------------|---|
| 1010 | Energy | 101010 | Energy Equipment & Services |
| | | 101020 | Oil, Gas & Consumable Fuels |
| 1510 | Materials | 151010 | Chemicals |
| | | 151020 | Construction Materials |
| | | 151030 | Containers & Packaging |
| | | 151040 | Metals & Mining |
| | | 151050 | Paper & Forest Products |
| 2010 | Capital Goods | 201010 | Aerospace & Defense |
| | | 201020 | Building Products |
| | | 201030 | Construction & Engineering |
| | | 201040 | Electrical Equipment |
| | | 201050 | Industrial Conglomerates |
| | | 201060 | Machinery |
| | | 201070 | Trading Companies & Distributors |
| 2020 | Commercial & Professional Services | 202010 | Commercial Services & Supplies |
| | | 202020 | Professional Services |
| 2030 | Transportation | 203010 | Air Freight & Logistics |
| | | 203020 | Airlines |
| | | 203030 | Marine |
| | | 203040 | Road & Rail |
| | | 203050 | Transportation Infrastructure |
| 2510 | Automobiles & Components | 251010 | Auto Components |
| | | 251020 | Automobiles |
| 2520 | Consumer Durables & Apparel | 252010 | Household Durables |
| | | 252020 | Leisure Products |
| | | 252030 | Textiles Apparel & Luxury Goods |
| 2530 | Consumer Services | 253010 | Hotels Restaurants & Leisure |
| | | 253020 | Diversified Consumer Services |
| 2540 | Media | 254010 | Media |
| 2550 | Retailing | 255010 | Distributors |
| | | 255020 | Internet & Direct Marketing Retail |
| | | 255030 | Multiline Retail |
| | | 255040 | Specialty Retail |
| 3010 | Food & Staples Retailing | 301010 | Food & Staples Retailing |
| 3020 | Food, Beverage & Tobacco | 302010 | Beverages |
| | | 302020 | Food Products |
| | | 302030 | Tobacco |
| 3030 | Household & Personal Products | 303010 | Household Products |
| | | 303020 | Personal Products |
| 3510 | Health Care Equipment & Services | 351010 | Health Care Equipment & Supplies |
| | | 351020 | Health Care Providers & Services |
| | | 351030 | Health Care Technology |
| 3520 | Pharmaceuticals, Biotechnology & Life Sciences | 352010 | Biotechnology |
| | | 352020 | Pharmaceuticals |
| | | 352030 | Life Sciences Tools & Services |
| 4010 | Banks | 401010 | Commercial Banks |
| | | 401020 | Thriffs & Mortgage Finance |
| 4020 | Diversified Financials | 402010 | Diversified Financial Services |
| | | 402020 | Consumer Finance |
| | | 402030 | Capital Markets |
| | | 402040 | Mortgage Real Estate Investment Trusts (REITs) |
| 4030 | Insurance | 403010 | Insurance |
| 4040 | Real Estate | 404020 | Equity Real Estate Investment Trusts (REITs) |
| | | 404030 | Real Estate Management & Development |
| 4510 | Software & Services | 451010 | Internet Software & Services |
| | | 451020 | IT Services |
| | | 451030 | Software |
| 4520 | Technology Hardware & Equipment | 452010 | Communications Equipment |
| | | 452020 | Technology Hardware, Storage & Peripherals |
| | | 452030 | Electronic Equipment, Instruments & Components |
| 4530 | Semiconductors & Semiconductor Equipment | 453010 | Semiconductors & Semiconductor Equipment |
| 5010 | Telecommunication Services | 501010 | Diversified Telecommunication Services |
| | | 501020 | Wireless Telecommunication Services |
| 5510 | Utilities | 551010 | Electric Utilities |
| | | 551020 | Gas Utilities |
| | | 551030 | Multi-Utilities |
| | | 551040 | Water Utilities |
| | | 551050 | Independent Power & Renewable Electricity Producers |



Americas: 212-991-4500
EMEA: +44 (0)20 3621 8241
Asia Pacific: +852-8203-2790

New York

Axioma, Inc.
17 State Street
Suite 2700
New York, NY 10004
United States
Phone: **212-991-4500**

San Francisco

Axioma, Inc.
201 Mission Street
Suite #2150
San Francisco, CA 94105
United States
Phone: **415-614-4170**

Paris

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

Tokyo

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

Atlanta

Axioma, Inc.
400 Northridge Road
Suite 550
Atlanta, GA 30350
United States
Phone: **678-672-5400**

London

Axioma, (UK) Ltd.
St. Clements House
27-28 Clements Lane
London, EC4N 7AE
United Kingdom
Phone: **+44 (0)20 3621 8241**

Geneva

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

Singapore

Axioma, (Asia) Pte Ltd.
30 Raffles Place
#23-00 Chevron House
Singapore 048622
Phone: **+65 6233 6835**

Chicago

Axioma, Inc.
2 N LaSalle Street
Suite 1400
Chicago, IL 60602
United States
Phone: **312-448-3219**

Frankfurt

Axioma Deutschland GmbH
Mainzer Landstrasse 41
D-60329 Frankfurt am Main
Germany
Phone: **+49-(0)69-5660-8997**

Hong Kong

Axioma, (HK) Ltd.
Unit B, 17/F 30 Queen's Road
Central Hong Kong
China
Phone: **+852-8203-2790**

Melbourne

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

Sales: sales@axioma.com
Client Support: support@axioma.com
Careers: careers@axioma.com