Axioma AXWW4 World-Wide Equity Factor Risk Model

Equity Factor Risk Models

October 2017

Contents

Model Overview

Asset Coverage	As of 2017, the model covers roughly 42,700 securities (over 77,700 histori-cally), primarily from the following 48 markets:

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 was included in 2003 and the second in 2009 and the third in 2015:

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	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	Meant to capture strong residual structure in certain markets not captured by others factors. The model currently has one such factor: Domestic China.
Returns Model	Models local asset excess returns using five sets of factors: a global market factor, countries, industries, styles, and local factors. Currency factors are only introduced in the risk estimation stage.
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 year of daily returns for factor volatilities.
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	Two-Pass Asymptotic Principal Components factor analysis with residual variance adjusted returns. One 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 three days of autocorrelation. A fixed lag of 1 day is used for statistical factors.
Returns Asynchronicity	*Returns-timing* technique is applied to the factor estimation process to compensate for non-synchronous trading between world stock markets.
Adjustments	Axioma's proprietary *Dynamic Volatility Adjustment* (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 and 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   Asset-level data including:

> Price, market capitalization

> 1-, 5-, 20-, and 60-day returns

> 5- and 20-day average daily volume

> Historical and predicted beta

Some items of market data may not be available in delimited text file format.

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	Thrifts & 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

Appendix: AXWW4 Results Overview

Model Fit and Factor Performance
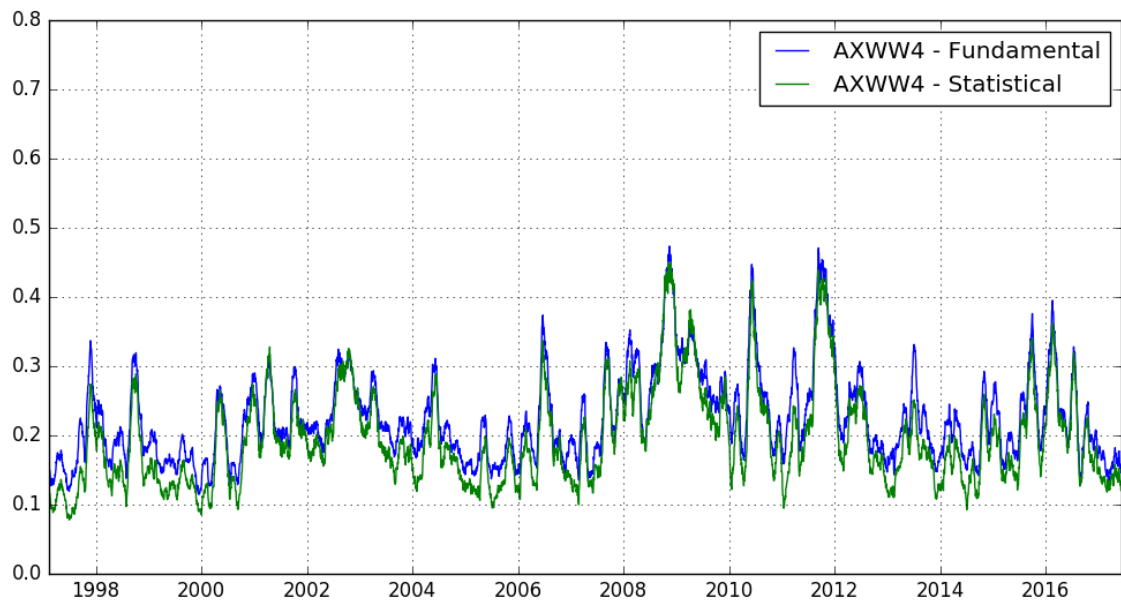
Figure 1: Average 1-month adjusted R-squared for the model estimation universe, 1997-2017. The results for the medium- and short-horizon Fundamental models are very similar, so we have only shown the results for the Fundamental-MH model.
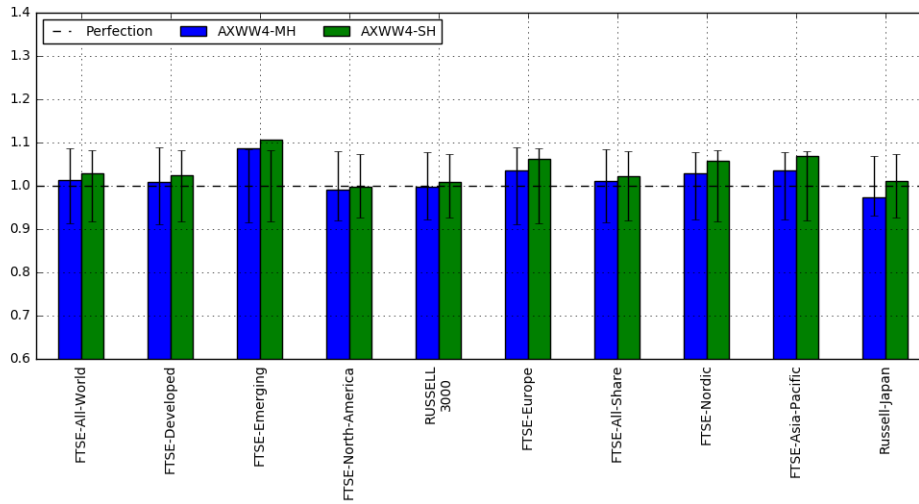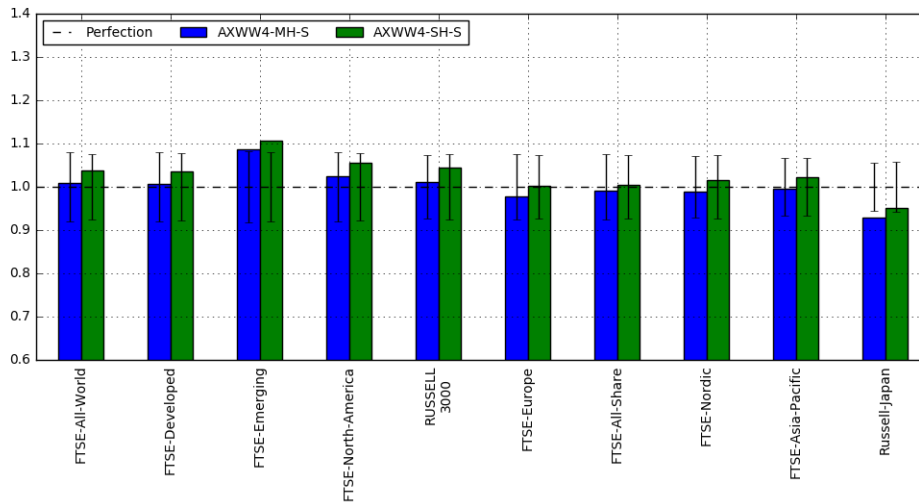
Figure 2: Total risk bias statistics for selected benchmark portfolios, 1997-2017. The vertical lines represent the bounds of the 95% confidence interval. Bias statistics beyond these lines are significantly different from 1.00.

Figure 3: Total risk bias statistics for selected benchmark portfolios, 1997-2017. The vertical lines represent the bounds of the 95% confidence interval. Bias statistics beyond these lines are significantly different from 1.00.
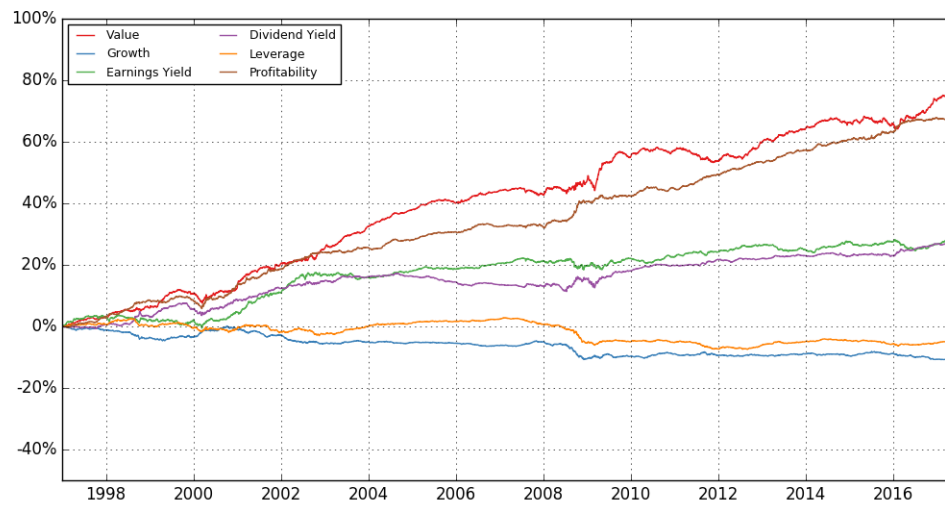
Figure 4: Cumulative return to each of the AXWW4-MH Fundamental Style factors, 1997-2017.
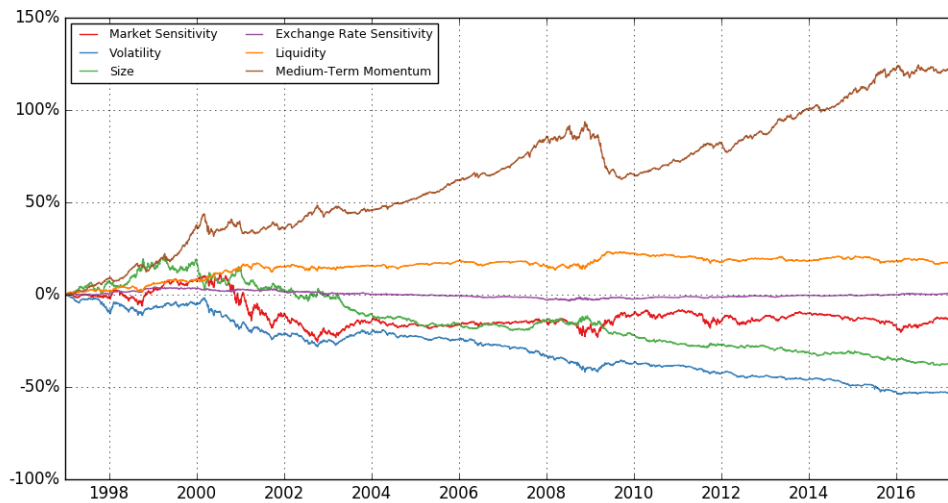
Figure 5: Cumulative return to each of the AXWW4-MH Market-based Style factors, 1997-2017.
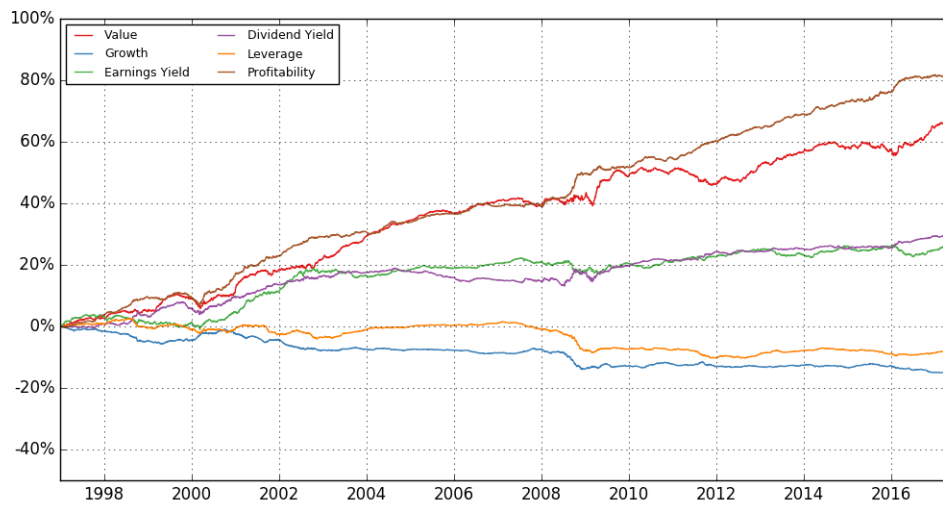
Figure 6: Cumulative return to each of the AXWW4-SH Fundamental Style factors, 1997-2017.
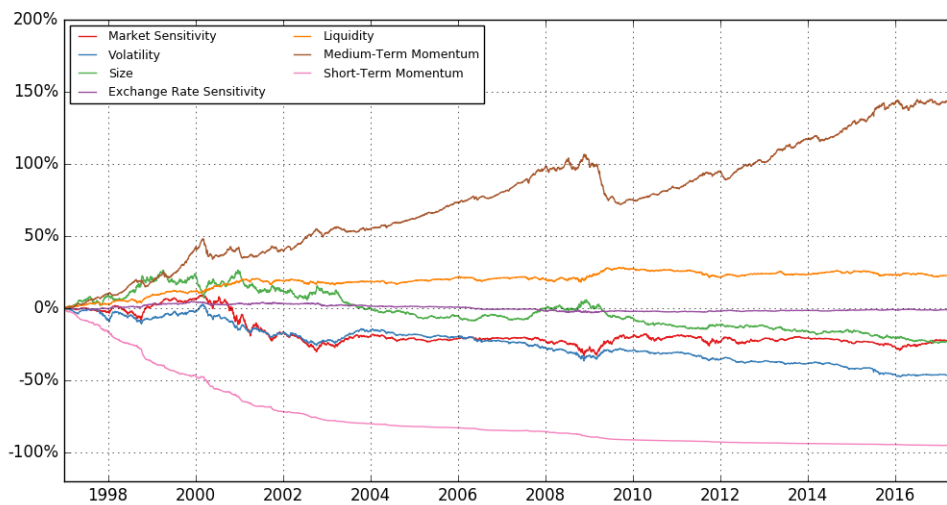
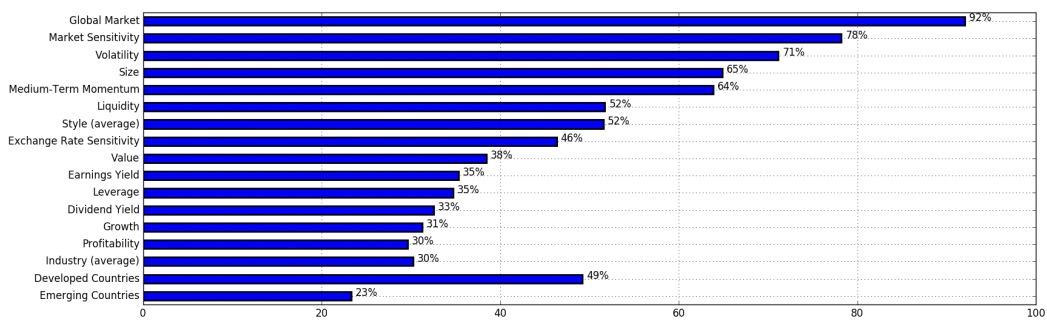Figure 7: Cumulative return to each of the AXWW4-SH Market-based Style factors, 1997-2017.

Figure 8: AXWW4-MH factors' frequency of statistical significance, 1997-2017. Market Sensitivity, for example, is statistically significant 78% of the time.
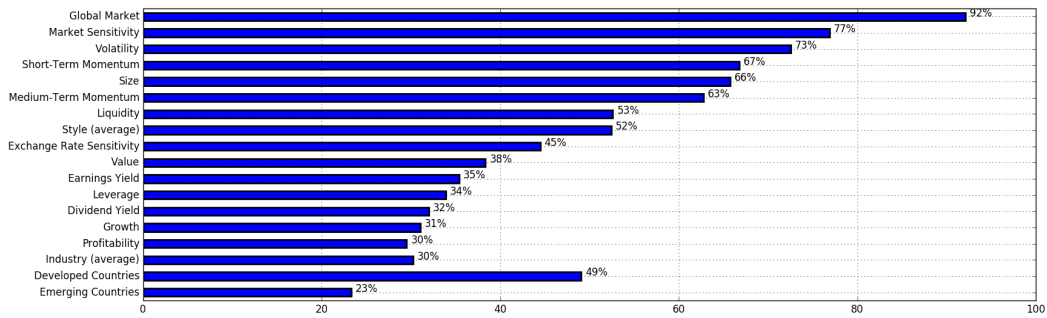

Figure 9: AXWW4-SH factors' frequency of statistical significance, 1997-2017. Market Sensitivity SH, for example, is statistically significant 77% of the time.

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