

Frequently Asked Questions

S&P DJI – Axioma Collaboration: The S&P Optimized Factor Indices

- 1. Who is S&P Dow Jones Indices (S&P DJI)?** S&P Dow Jones Indices is the largest global resource for essential index-based concepts, data and research, and home to iconic financial market indicators, such as the [S&P 500®](#) and the [Dow Jones Industrial Average®](#). More assets are invested in products based on our indices than products based on indices from any other provider in the world. Since Charles Dow invented the first index in 1884, S&P DJI has been innovating and developing indices across the spectrum of asset classes helping to define the way investors measure and trade the markets.
- 2. Who is Axioma?** Axioma is globally recognized as the leading provider of innovative risk-management and portfolio-construction solutions to financial institutions worldwide. Axioma was founded in 1998 and has established a global presence with over 350 clients, more than USD 2 trillion AUM optimized daily, over 7,000 professional users, and more than 75 daily risk models. Axioma has a “flexible is better” philosophy, providing custom tools that help clients better manage risk and to quickly and accurately design and analyze their investment strategies.
- 3. Why did S&P DJI collaborate with Axioma to develop a suite of optimized factor indices?** As factor-based investing has grown and continues to play an important role in client portfolios, the demand for factor indices that satisfy specific client objectives and constraints has increased. The collaboration with Axioma provides the modeling flexibility to truly service this demand and, thus, develop indices that target specific exposures. Furthermore, S&P DJI serve as a “one-stop shop” for clients looking to develop tailored factor indices—clients can work with one all-encompassing provider to seamlessly launch a new tailored factor index.
- 4. What key capabilities does the collaboration offer?** The collaboration combines S&P DJI’s leading index innovation, data, and research resources with Axioma’s best-in-class risk modeling and optimization capabilities. As such, the collaboration enables S&P DJI to launch the S&P Optimized Factor Indices that leverage Axioma’s modeling capabilities. These capabilities include: controlling factor exposures, targeting a specific tracking error, limiting industry and country risk, controlling index turnover, improving trading capacity, and more.

KEY SPECIFICATIONS OF THE S&P OPTIMIZED FACTOR INDICES

- 1. What are the S&P Optimized Factor Indices?** The S&P Optimized Factor Indices are a new generation of indices that leverage Axioma’s portfolio optimizer and risk model to provide controlled exposure to S&P DJI equity factor scores, while constraining other targets around risk, diversification, and liquidity. The S&P Optimized Factor Indices have specific objectives and constraints incorporated into their methodology with the goal of providing the desired exposure to the S&P DJI equity factor scores.

2. What are the key specifications and tools used to construct the S&P Optimized Factor Indices? Exhibit 1 highlights the key specifications and tools used to construct the S&P Optimized Factor Indices.

Exhibit 1: Key Specifications and Tools Used to Construct the S&P Optimized Factor Indices	
SPECIFICATION/TOOL	DESCRIPTION
Underlying Index	The pool of securities (e.g., all stocks in the S&P 500) that the optimizer can select from
Objective Function	The main objective of the optimization model. It is an equation that is optimized (typically to find a maximum or minimum value) subject to predefined constraints
Constraints	Constraints are conditions that either must be satisfied or ideally should be satisfied when optimizing the objective function. They are either hard constraints (e.g., cannot be breached) or soft constraints (e.g., can be breached subject to a constraints hierarchy)
Optimizer	Defined in question 3.
Risk Model	Defined in question 4.
Constraint Hierarchy	Defined in question 7.
Rebalancing Frequency	The frequency with which the portfolio is rebalanced to reflect the weights of the securities output by the optimizer. The rebalance is typically quarterly or semiannually

Source: S&P Dow Jones Indices LLC, Axioma. Table is provided for illustrative purposes.

3. What does an optimizer do? An optimizer employs mathematical techniques in an attempt to find an optimal solution (typically the maximum or minimum value) for a set objective function, while satisfying other constraints. An optimizer is an important tool in portfolio construction and is commonly used to determine constituent weights in a portfolio. For example, an optimizer may be tasked with identifying a portfolio of stocks with the lowest volatility (the objective function) from a pool of stocks (e.g., the S&P 500) subject to the constraint that the portfolio must contain 10 stocks. In this case, the optimizer will systematically select portfolios of 10 stocks, until it has identified the portfolio with the lowest historical volatility.

The S&P Optimized Factor Indices utilize Axioma’s portfolio optimizer to conduct the optimization process to select a portfolio of stocks and their respective weights. For each S&P Optimized Factor Index, a unique objective function will be set (e.g., maximize the weighted-average exposure to the S&P DJI factor score) subject to other constraints (e.g., control the GICS® sector weights to within 75%-125% of underlying index weight).

4. What is a risk model used for? Measuring, interpreting, and forecasting risk are critical elements of portfolio construction. For a single security, risk is most commonly measured using the standard deviation of its historical return series. For a portfolio of securities, the overall portfolio standard deviation can be calculated using the weights and variance of each security, along with the covariance between each security. However, this measure of risk is not ideal, given it uses “noisy” historical returns, and has little explanatory power or forecastability, as well as the fact that estimating a robust covariance matrix becomes problematic when the universe of stocks is large. A better approach is to use factor risk models that measure risk in a more nuanced way and are focused on forecasting risk.

Factor risk models utilize factors that explain the main drivers of asset risk (for example, an economic factor such as inflation or a style factor such as momentum). Securities (or a portfolio of securities) are then assessed in terms of how they are expected to behave relative to these factors. Factor risk models can typically be divided into three categories: 1) fundamental, 2) macroeconomic, and 3) statistical, based on how the factors are determined and calculated. The main advantages of factor risk models are that they give a more complete breakdown of

risk, present risk in a more intuitive way, and provide more stable risk estimates, which help with forecasting.

In the context of the S&P Optimized Factor Indices, Axioma’s risk models are primarily used to help maximize active exposure to the S&P DJI equity factor score(s) and minimize unintended factor exposures. Additionally, Axioma’s risk model is used to limit predicted tracking error to a predefined level with respect to the underlying index.

5. What are the common objectives in constructing the S&P Optimized Factor Indices?

Exhibit 2 details some of the common objectives used in the S&P Optimized Factor Indices.

Exhibit 2: Objectives Used in the S&P Optimized Factor Indices	
OBJECTIVE	DESCRIPTION
Maximize the Weighted-Average Exposure to the S&P DJI Multi-Factor Score	Utilizing Axioma’s optimizer and risk model to maximize the factor exposure across the five factors within the S&P Optimized Multi-Factor Index
Maximize the Weighted-Average Exposure to the S&P DJI Factor Score	Utilizing Axioma’s optimizer and risk model to maximize the “targeted” factor exposure for the S&P Optimized Single Factor Index
Minimize Portfolio Volatility	Utilizing Axioma’s optimizer and risk model to solve for the portfolio of stocks that has the lowest portfolio volatility for the S&P Optimized Minimum Volatility Index

Source: S&P Dow Jones Indices LLC, Axioma. Table is provided for illustrative purposes.

6. What constraints are incorporated into the methodology of the S&P Optimized Factor Indices? Exhibit 3 summarizes some of the common constraints that are incorporated into the construction of the S&P Optimized Factor Indices.

Exhibit 3: Constraints on the S&P Optimized Factor Indices	
CONSTRAINT	DESCRIPTION
Isolate Intended Active Exposures	Constraining unintended active factor exposures (and thus maximizing the intended active factor exposure)
Balanced Active Exposures	Targeting a balanced active exposure for each factor in a multi-factor index. This ensures score correlations and distributions do not cause unintended and persistent bias to certain factors
Tracking Error	Specifying a desired tracking to a defined benchmark
Turnover	Limiting the amount of portfolio turnover that can occur during a rebalance
TRADING CONSTRAINTS	
Stock Bounds	Setting specific bounds on individual stocks in order to improve overall diversification, avoiding overly concentrated bets, avoiding extreme underweight bets, etc.
Industry	Limiting industry bets and therefore limiting industry risk in decomposition of active risk
Sector	Limiting sector bets and therefore limiting industry risk in decomposition of active risk

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

7. What is a constraint hierarchy? If the applicable constraints do not allow a feasible solution to the optimization process, then soft constraints are relaxed in accordance with a constraint hierarchy. The constraint hierarchy ranks the constraints in order of importance to specify the order in which they can be relaxed.

Hierarchical optimization finds a solution to infeasible cases by solving a successive series of optimization problems in an attempt to minimize the violation of the soft constraints. In each successive problem, the hard constraints are combined with the next highest priority soft constraint, which can be relaxed until a solution is found. The relaxed soft constraint is then

considered to be a hard constraint for the purposes of the subsequent steps. The process is repeated until all soft constraints from the constraints hierarchy are included in the optimization.

STANDARD S&P OPTIMIZED FACTOR INDICES

- 1. What standard S&P Optimized Factor Indices are available?** The indices shown in Exhibit 4 are the available S&P Optimized Multi-Factor Indices.

INDEX	UNDERLYING INDEX
S&P Global LargeMidCap Optimized Multi-Factor Index	S&P Global LargeMidCap
S&P 500 Optimized Multi-Factor Index	S&P 500
S&P Europe 350 [®] Optimized Multi-Factor Index	S&P Europe 350
S&P Japan LargeMidCap Optimized Multi-Factor Index	S&P Japan LargeMidCap

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

- 2. What S&P DJI equity factor scores are used in the S&P Optimized Factor Indices?** The factor methodologies used in the standard S&P Optimized Factor Indices are the proprietary methodologies developed by S&P DJI. The five-factor methodologies are summarized in Exhibit 5.

FACTOR	DESCRIPTION
Quality	Average of three z-scores: Return on equity, accruals ratio, and financial leverage ratio
Value	Average of three z-scores: Sales-to-price, book-value-to-price and earnings-to-price ratios
Momentum	12-month price change in local currency (9 months is used if the 12 months of price history is not available)
Volatility (Low)	Inverse of the standard deviation of the security's daily price returns over the prior one year of trading days in local currency
Size (Small)	Additive inverse of total company market capitalization in common currency

* See the corresponding methodology document for a precise description of the factor scores.

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

- 3. Which Axioma risk models are used in the S&P Optimized Factor Indices?** Exhibit 6 shows the Axioma risk models that are used in the S&P Optimized Factor Indices.

UNDERLYING INDEX	RISK MODEL
S&P Global LargeMidCap	Axioma World-Wide Fundamental Equity Risk Model MH4 (USD)
S&P 500	Axioma U.S. Fundamental Equity Risk Model MH4 (USD)
S&P Europe 350	Axioma Europe Fundamental Equity Risk Model MH4 (EUR)
S&P Japan LargeMidCap	Axioma Japan Fundamental Equity Risk Model MH4 (JPY)

Source: S&P Dow Jones Indices LLC, Axioma. Table is provided for illustrative purposes.

S&P OPTIMIZED MULTI-FACTOR INDICES

- 1. What are the S&P Optimized Multi-Factor Indices?** The S&P Optimized Multi-Factor Indices measure the performance of a diversified group of stocks selected and weighted to maximize balanced, active exposures to five S&P DJI equity factor scores. The optimizations also satisfy

other constraint conditions, including targeting a predefined level of tracking error (active risk) to their corresponding benchmark, while controlling turnover, liquidity, and holding limits.

Axioma's portfolio optimizer is employed to conduct the optimization process, while Axioma's Regional and World-Wide Fundamental Equity Risk Models are utilized for controlling the indices' predicted tracking errors.

The S&P DJI equity factor scores available for inclusion as targeted factors in the optimizer are as follows.

- Quality
- Value
- Momentum
- Volatility (Low)
- Size (Small)

2. What are the benefits of the S&P Optimized Multi-Factor Indices?

- I. Diversified Factor Exposure:** Multi-factor indices significantly diversify the risk characteristics of the single-factor indices, which improves risk-adjusted returns and reduces drawdowns.
- II. Efficient and Balanced Factor Exposure:** The methodology imposes optimization constraints to ensure correlations across single factor scores do not cause unintended and persistent bias to certain factors.
- III. Minimized Unintended Factor Dilution:** The methodology imposes optimization constraints to control unintended factor exposures.
- IV. Mitigated Factor Cyclicity:** Multi-factor indices remove the need to time single factors that are inherently cyclical and driven by different phenomena.
- V. Controlled Tracking Error:** The methodology imposes optimization constraints to control predicted tracking error with respect to the underlying index.
- VI. Minimized Unintended Industry, Sector, Country, and Region Exposures:** The methodology imposes optimization constraints to control industry, sector, country, and regional weights with respect to the underlying index.
- VII. Reduced Turnover:** The methodology imposes optimization constraints to limit turnover to a predefined level.

3. How do the S&P Optimized Multi-Factor Indices differ from the existing S&P Multi-Factor Indices? Exhibit 7 highlights the key differences between the S&P Optimized Multi-Factor Indices and the existing S&P Multi-Factor Indices that do not implement factor optimization.

Exhibit 7: Differences Between the S&P Optimized Multi-Factor Indices and S&P Multi-Factor Indices		
CATEGORY	S&P OPTIMIZED MULTI-FACTOR INDICES	S&P MULTI-FACTOR INDICES
Targeted Factors	<u>Five Factors:</u> Quality Value Momentum (Price) Low Volatility Small Size	<u>Three factors:</u> Quality Value Momentum (Risk-Adjusted)
Balanced Active Exposures	Constraint attempts to balance the exposures across each of the five targeted factors (see question 5)	Unconstrained
Tracking Error	Constrained (see question 5)	Unconstrained
Country, Region, Industry, and Sector Exposures	Constrained (see question 5)	Unconstrained
Turnover	Constrained (see question 5)	Unconstrained (subject to a 20% buffer rule)
Momentum Factor Score	12-month price return	12-month risk-adjusted return
Stock Selection	Optimization-driven (maximize objective function subject to constraints)	Top quintile
Stock Weighting	Optimization-driven (maximize objective function subject to constraints)	Factor Score * Float Market Cap

Source: S&P Dow Jones Indices LLC. Table is provided for illustrated purposes.

4. What objective function is the optimizer attempting to optimize for the S&P Optimized Multi-Factor Indices? The objective of the optimizer for the S&P Optimizer Multi-Factor Indices is shown in Exhibit 8.

Exhibit 8: Objective of the Optimizer for the S&P Optimizer Multi-Factor Indices	
OBJECTIVE	DESCRIPTION
Maximize the S&P Multi-Factor Score Exposure	The objective of the optimizer is to maximize the weighted average exposure to the S&P DJI multi-factor score (subject to other constraints).

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

5. What optimization constraints have been incorporated into the methodology of the S&P Optimized Multi-Factor Indices? Exhibit 9 shows the optimization constraints for the S&P Optimized Multi-Factor Indices.

Exhibit 9: Optimization Constraints for the S&P Optimized Multi-Factor Indices**		
CONSTRAINT		RATIONALE
Balanced Active Exposures	Limits the active exposure of each targeted single factor to $\pm 2.5\%$ from the average active multi-factor exposure	Ensures score correlations, and distributions do not cause unintended and persistent bias to certain factors. Minimal cost to objective function
Tracking Error	Limits predicted tracking error (active risk) to 2%	Highest tracking error constraint, at which full active risk budget is consistently utilized (given other constraints). Similar results in all three regions
Turnover	Limits the one-way turnover at each optimization rebalance to 20%	Provides plenty of room to refresh portfolios, while providing reasonable turnover constraints. Turnover will be lower as a result of the constraint, but with minimal impact on the objective function and excess return.
Trading Constraints	One day to trade asset turnover	Rebalance portfolio turnover over one day.
Stock Upper Bound	Min(20x underlying index weight, 5%, 10 days to sell)	Improves diversification and avoids overly concentrated bets
Stock Lower Bound	0.05%	Improves diversification and avoids extreme underweight bets or overly small positions
Stock Relative Bound	$\pm 2\%$ from the underlying index weight	Improves diversification and avoids overly concentrated bets
Region	90%-110% of the underlying index weight	Limits region risk in decomposition of active risk. Allows flexibility to maximize objective function
Country	Controls the optimized indices' country of domicile weights to within 75%-125% of the underlying index weight	Limits country risk in decomposition of active risk. Allows flexibility to maximize objective function
Sector	Controls the optimized indices' GICS sector weights to within 75%-125% of the underlying index weight	Limits sector risk in decomposition of active risk. Allows flexibility to maximize objective function
Industry Group	Controls the optimized indices' GICS industry group weights to within 0%-150% of the underlying index weight	Limits industry bets and therefore limits industry risk in decomposition of active risk. Allows considerable flexibility to maximize objective function. No minimum to mitigate stocks with low scores entering the relevant basket.

** See the corresponding methodology document for a precise description of the constraints.
Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

6. What is the constraint hierarchy for the S&P Optimized Multi-Factor Indices? If the applicable constraints do not allow a feasible solution to the optimization process, then soft constraints are relaxed in accordance with the constraint hierarchy below.

Constraint Hierarchy (from highest to lowest priority):

- I. Stock Holdings (e.g., stock weights, liquidity position size limit)
- II. GICS Industry Group Weights
- III. GICS Sector Weights
- IV. Country Weights
- V. Region Weights
- VI. Index Turnover
- VII. Stock Turnover (e.g., liquidity turnover limit)

- 7. How often are the S&P Optimized Multi-Factor Indices rebalanced?** The S&P Optimized Multi-Factor Indices are rebalanced quarterly.

TAILORED S&P OPTIMIZED FACTOR INDICES

- 1. Does S&P DJI have the ability to build tailored optimized factor indices?** Yes, S&P DJI is actively looking to collaborate with clients to develop and launch tailored optimized factor indices. Such indices can be launched using an S&P DJI branded or custom approach.
- 2. How can clients work with S&P DJI to build a tailored optimized factor index?** S&P DJI is now a “one-stop shop” for building tailored optimized factor indices. Clients looking to create a tailored index can expect to follow the process as follows.
 - I. S&P DJI will consult with the client to understand the desired exposures, objectives, and constraints.
 - II. S&P DJI will work with Axioma to incorporate the objectives and constraints into the optimization model and to formalize them into a methodology.
 - III. S&P DJI will launch and maintain the index and provide ongoing client service.

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