



Stylus Pro v11.5 Risk

Advanced Risk Analysis

Contents

| | |
|---|----|
| Introduction | 2 |
| Regime Models | 2 |
| Stress Tests | 3 |
| Scenario Analysis..... | 4 |
| Regime Models & Stress Tests: Charts and Tables | 5 |
| Regime Analysis Charts and Tables..... | 5 |
| Background shading..... | 7 |
| Disclosures | 9 |
| Scenario Analysis..... | 11 |
| Scenarios Block | 11 |
| Scenarios Details Block | 13 |
| Disclosures | 14 |
| Creating your own Stress Tests, Regime Models, Scenarios – Stylus Workspace | 16 |
| Stress Tests | 17 |
| Regime Models | 19 |
| Rule Based Models..... | 20 |
| Complex Regimes..... | 22 |
| Custom Models | 25 |
| Scenario Analysis..... | 25 |
| Methodology Overview | 28 |
| Mapping of Factors | 28 |
| Prospector – Advanced Risk..... | 31 |
| Regime Analysis and Historical Stress Tests | 31 |
| Scenario Analysis..... | 31 |
| Custom Blocks..... | 32 |
| Dynamically Controlling Regime Model selection | 33 |

Introduction

In Version 11.4 we introduced new tools for performing advanced risk analysis of individual funds and portfolios. In 11.5 we have made significant updates to the functionality and user experience.

These tools focus on two types of analysis:

1. Analysis of performance and risk during various market conditions and historical periods of stress. We refer to these as Regime Models and Stress Tests.
2. Analysis of fund performance due to theoretical shocks. We refer to these as Scenario Analysis.

Regime Models

Regime models are used to group historical time periods together based on some common characteristic. At the very basic level, we may separate time periods into periods when a benchmark (e.g., S&P 500 Index) had positive performance versus the periods when the benchmark had negative performance. Regime models may also group periods based on performance of multiple indexes, or the relative performance of indexes to another.

Some common Regime models included with Stylus are:

1. Market Up/Down Months – Model based on the performance of S&P 500 Index
2. Volatility by Threshold – Model based on value of CBOE VIX Index
3. Size Small vs Large – Model based on relative performance of Russell Top 200 Index and Russell 2000 Small Stock indexes

Please note that regime models often contain series of dates that are not continuous. Figure 1 below shows the history of volatility regimes.

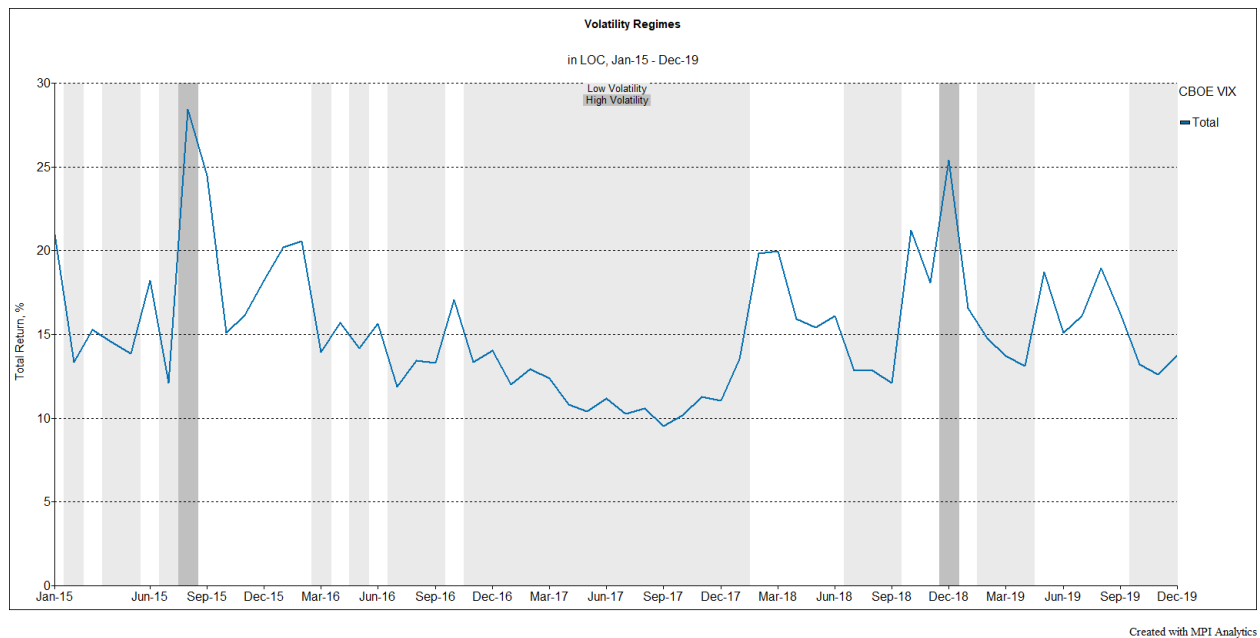


Figure 1

Stress Tests

Stress Tests can be thought of as simpler version of Regime Models. While market regimes may contain multiple non-continuous time periods, each historical stress test contains a single period that represents a significant market event. Examples of historical stress tests include:

| Event | Date |
|-------------------------------|--------------------------------|
| Black Monday | Oct. 19, 1987 |
| LTCM / Russian Crisis | August 1998 - October 1998 |
| Credit Crisis/Lehman Collapse | September 2008 - November 2008 |

Figure 2

Below is an example chart showing funds history during several stress events.

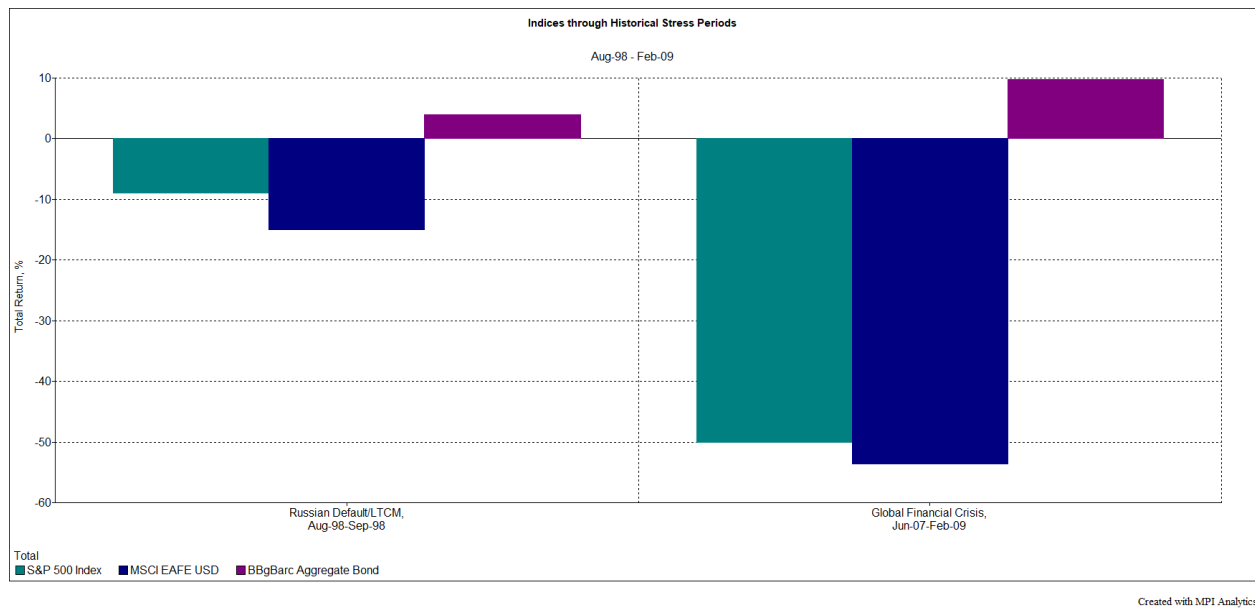
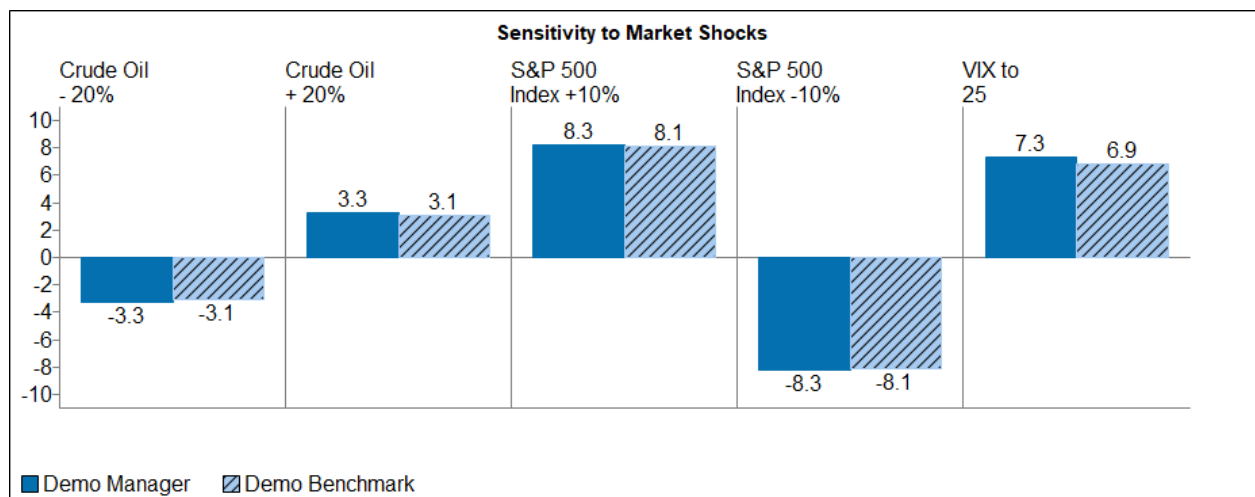


Figure 3

Scenario Analysis

Unlike Regime Models and Stress Tests, Scenario Analysis does not represent any specific historical time period. Rather it is a tool to estimate potential fund performance due to a shock in a specific factor(s). Examples of such shocks may include:

1. S&P 500 Index being down 20%
2. VIX level going to 30
3. Treasury yields going up by 50 basis points



Regime Models & Stress Tests: Charts and Tables

Regime Analysis Charts and Tables

Regime Models and Stress Tests have been implemented as an extension of the date parameters settings. Instead of specifying a regular window and aggregation parameters, users select the relevant Regime Models or Stress Tests from a new section of the chart/table designer. The Regime Analysis section is activated by selecting the checkbox next to it.

The screenshot shows a software interface for configuring charts and tables. The 'Regime Analysis' section is highlighted with a red box. It contains the following elements:

- ☒ Regime Analysis: ☒ Regime Models ☐ Stress Test
- Dropdown menu: 10-Year Treasury Yield->High 10-Year Treasury Yield
- Dropdown menu: Historical
- ☐ Use interval in labels
- ☐ Pre-process

Other visible interface elements include a 'Secondary Y-axis' section with a 'Performance' tab, a 'Return' dropdown, and various checkboxes for data aggregation and display options. A grid of buttons for different analysis types (e.g., Style Map, Asset Map, Performance Statistics) is also present.

Figure 4

Users can then choose between Regime Models or Stress Test and the available choices will appear in a dropdown box. Users must also choose between a Historical and Systematic analysis in another drop down window.

- Historical: The analysis takes the actual returns of the funds over the specified time period(s)
- Systematic: The analysis looks to the current asset loadings and based on those weights calculates the return using the performance of the underlying indices over the specified time period.

Additional Notes:

- Users can select multiple regimes or stress tests across different groups and have them appear in the same chart or table.
- Selecting either Stress Tests or Regime Models effectively changes the aggregation to "Total" over the time periods specified by the selection.

- Users can select “Use Interval in Labels”. This provides additional information in the label about the number of periods included in each regime.

Below is an example of a Regime model chart showing index performance in up market and down markets.

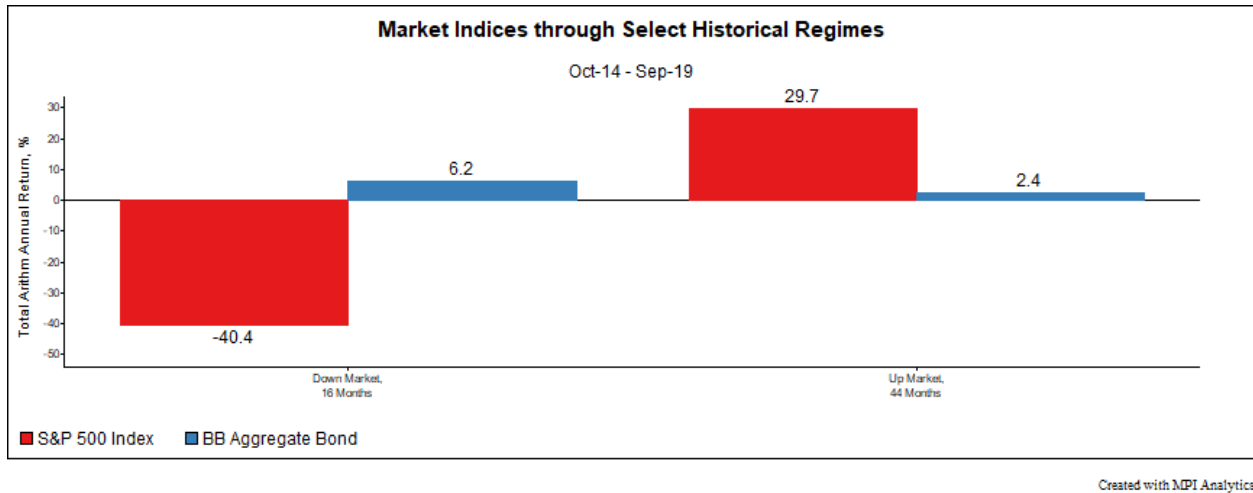


Figure 5

Below is an example of a Stress Test chart showing a fund’s performance during several stress periods.

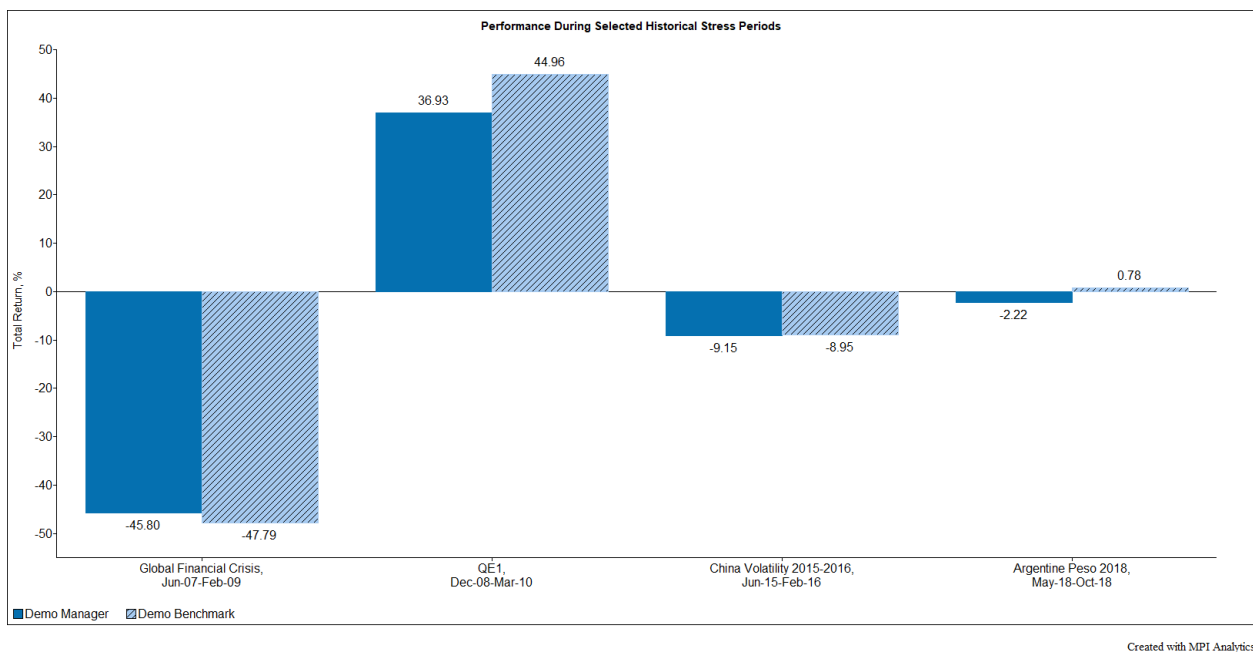


Figure 6

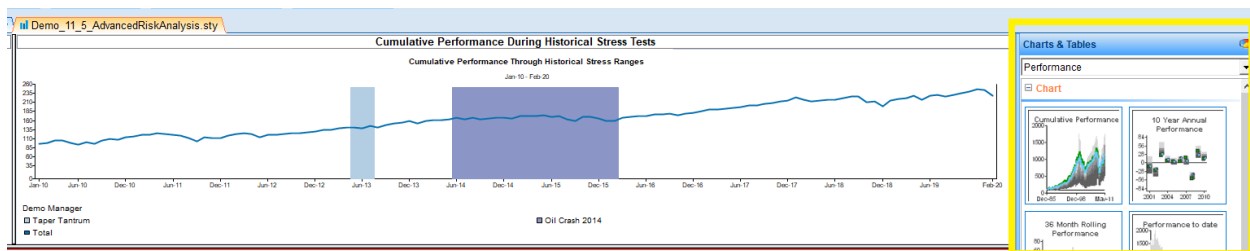
Not all Stylus blocks can be used with Regimes and Stress Tests. The following blocks are currently supported:

1. Asset Loadings
2. Performance
3. Min Max
4. Gain Loss
5. Risk
6. Downside Risk
7. Performance Statistics
8. Downside Statistics
9. MPT Statistics
10. R-Squared
11. Correlation
12. Scatter
13. Properties
14. Scenarios
15. Scenario Detail

Most of these blocks work well with multiple regime selections. The only exception is Scatter block. It is recommended that Scatter block is used with a single regime selection.

Background shading

We have made it easier to highlight the background on a chart to show the stress test or regime model periods. This is implemented through a Chart Object in the Gallery (Chart Objects >> Date Intervals >> Regime – background area or Stress Test – background area) by dragging the Chart Object onto an existing chart. The Gallery can be found on the right side of Stylus Views and Reports.



Note: The Chart Object can be dragged onto the chart multiple times to have more than one regime or stress test periods highlighted in the same chart. See Figure 7 below with High Volatility and Low Volatility shaded.

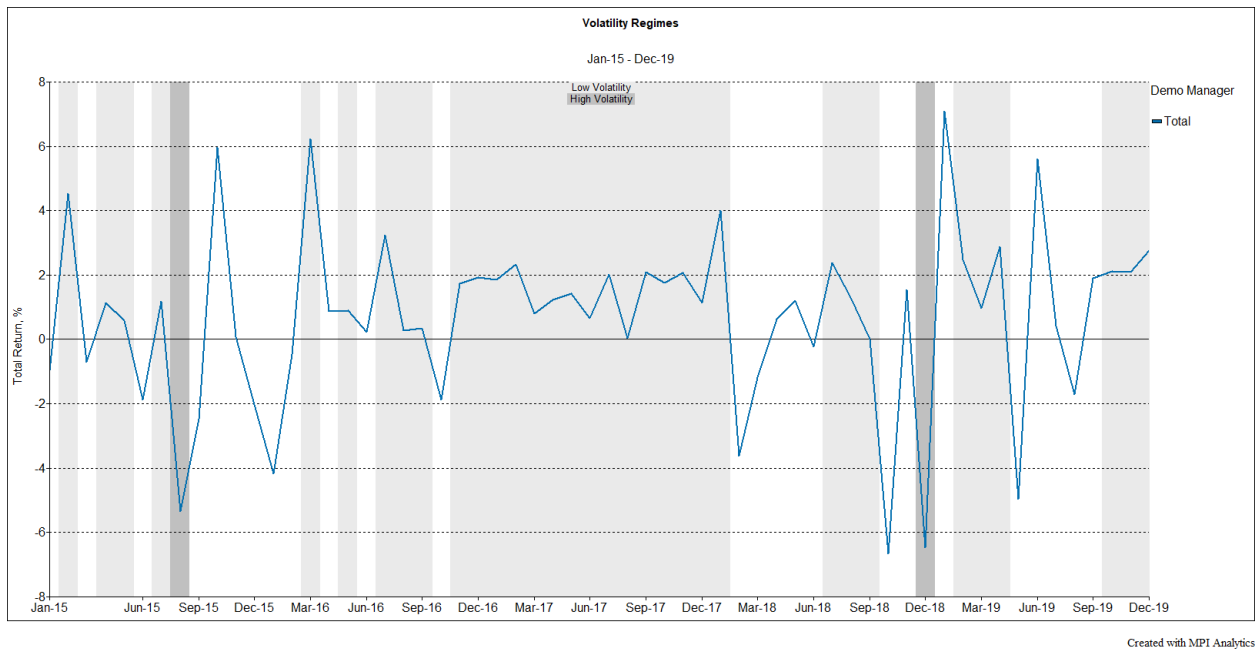


Figure 7

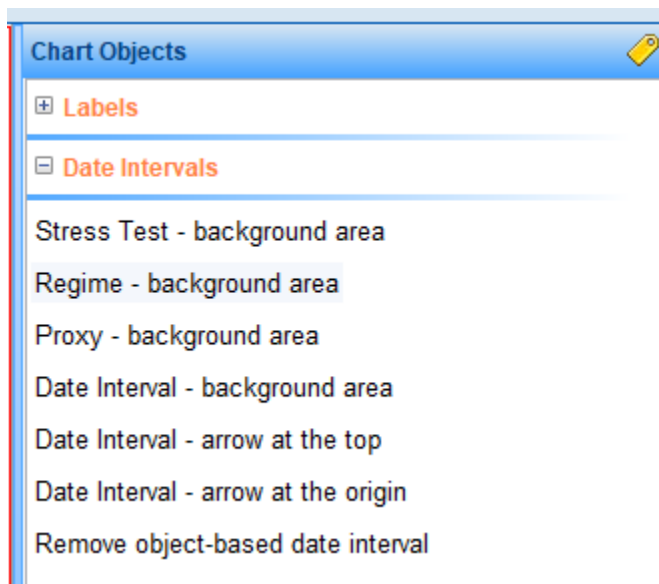


Figure 8

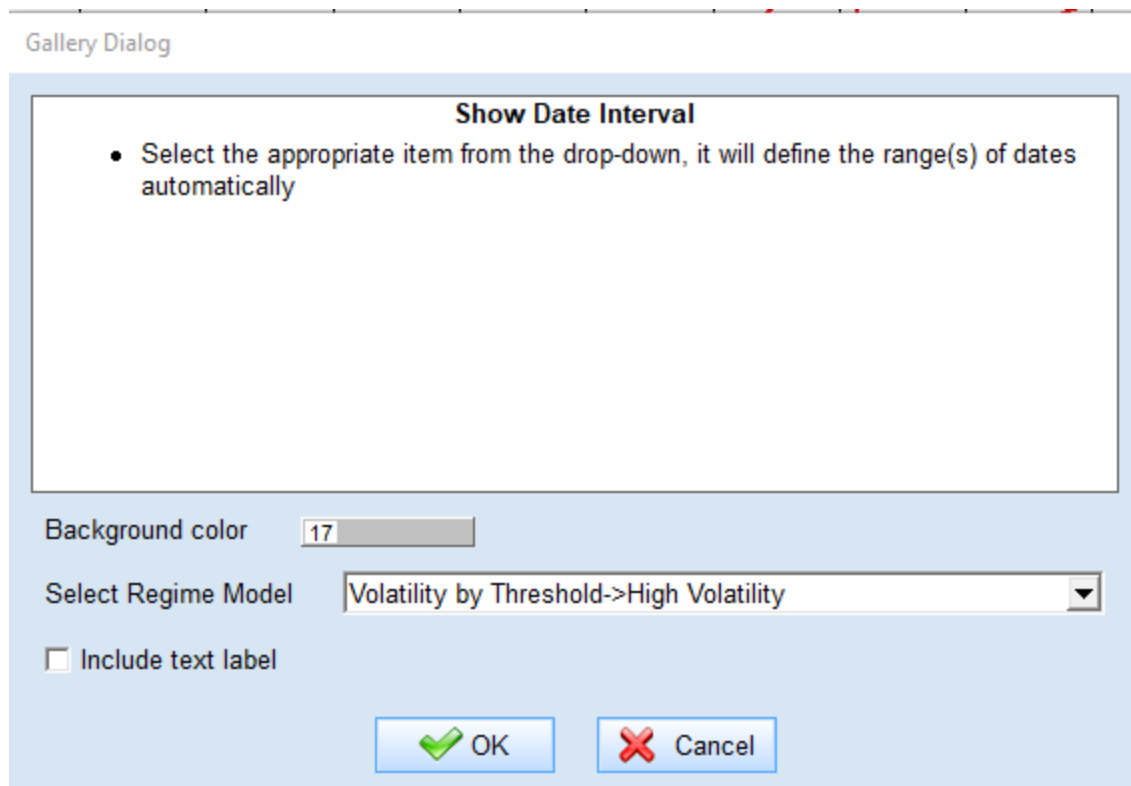


Figure 9

These graphics are created as objects and can be modified through the Object Editor.

Disclosures

Disclosures about the Regimes or Stress Tests can be easily added to your study through a new Gallery item, Regime Disclosure or Stress Test Disclosure. These can be found under the Charts/Tables >> Disclosures >> Workspace. You can drag in the appropriate disclosure type and then select the applicable regimes or stress tests you would like included.

Gallery Dialog

Select Regimes

- Select all the regimes to be included in the Regime Disclosure

☒ Generate customizable table

Figure 10

| Regime Disclosure | | | | |
|------------------------|---|---------------------------------|---|------------------|
| Regime Group | Description | Regime | Rule | Periods In Study |
| 10-Year Treasury Yield | Rate regimes by 10-Year Treasury Constant Maturity Rate with breaks at 3% and 7%. | High 10-Year Treasury Yield | 10-Year Treasury Constant Maturity Rate is greater than 7 | 0 |
| | | Moderate 10-Year Treasury Yield | 10-Year Treasury Constant Maturity Rate is between 3 and 7, inclusive | 152 |
| | | Low 10-Year Treasury Yield | 10-Year Treasury Constant Maturity Rate is less than 3 | 108 |

Figure 11

Scenario Analysis

Scenarios Block

Scenario Analysis has been implemented under a new Stylus Block called Scenarios and has been added to both Chart and Table Designer.

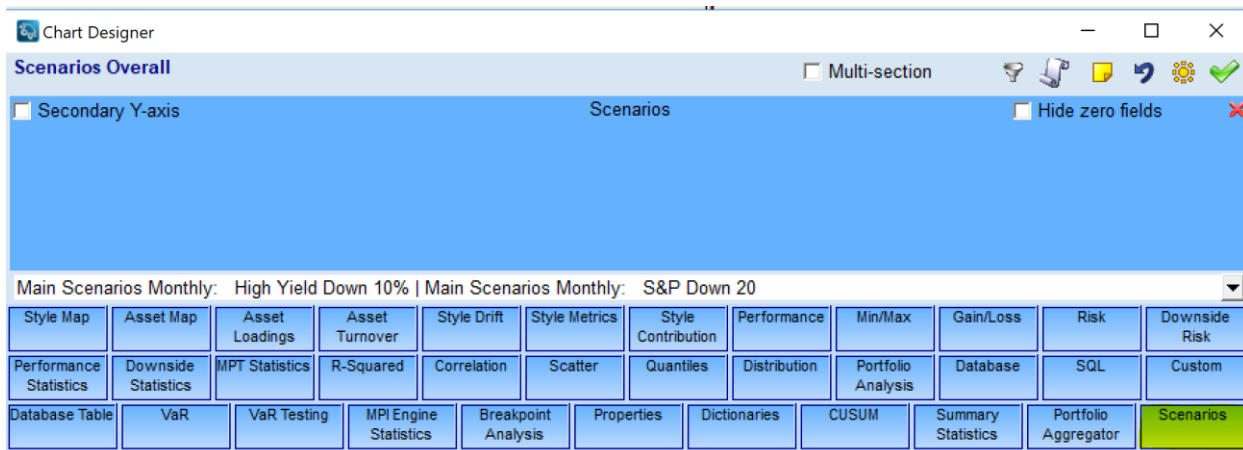


Figure 12

Users can select multiple scenarios from the dropdown box. The block calculates total performance of the series for the specified scenario(s).

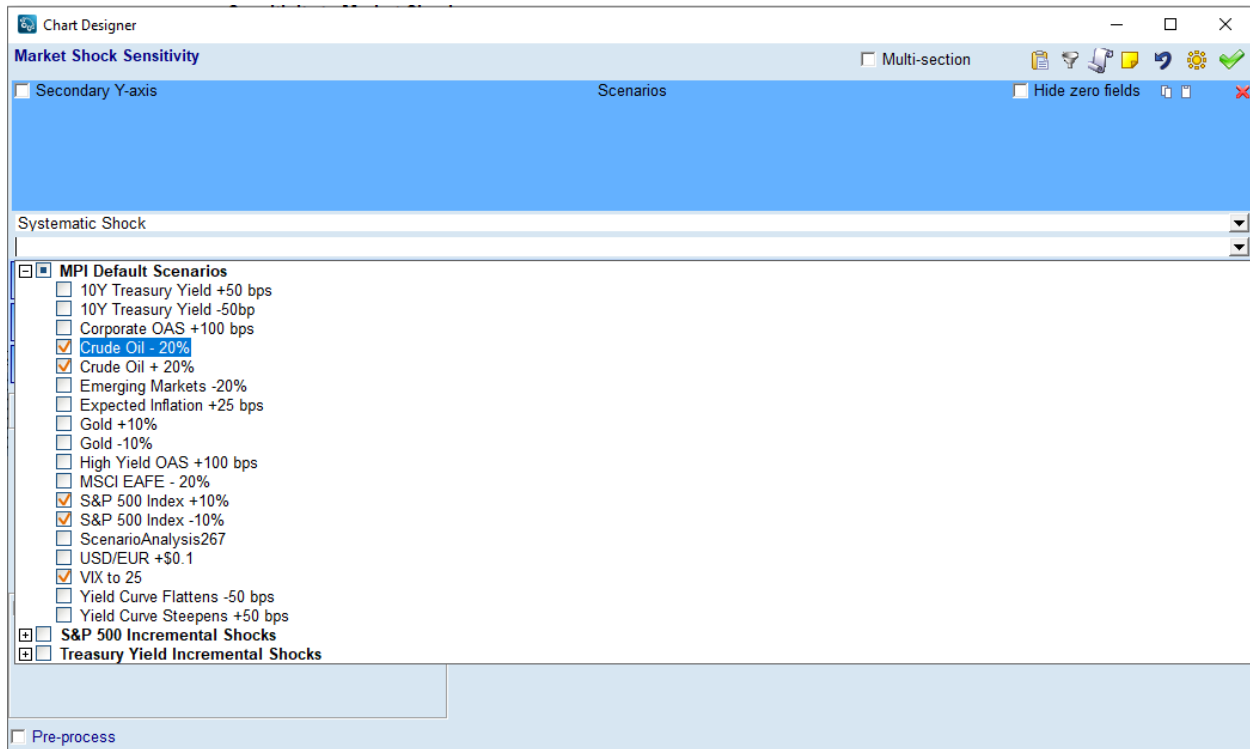


Figure 13

Multiple market shocks can be displayed on one chart.

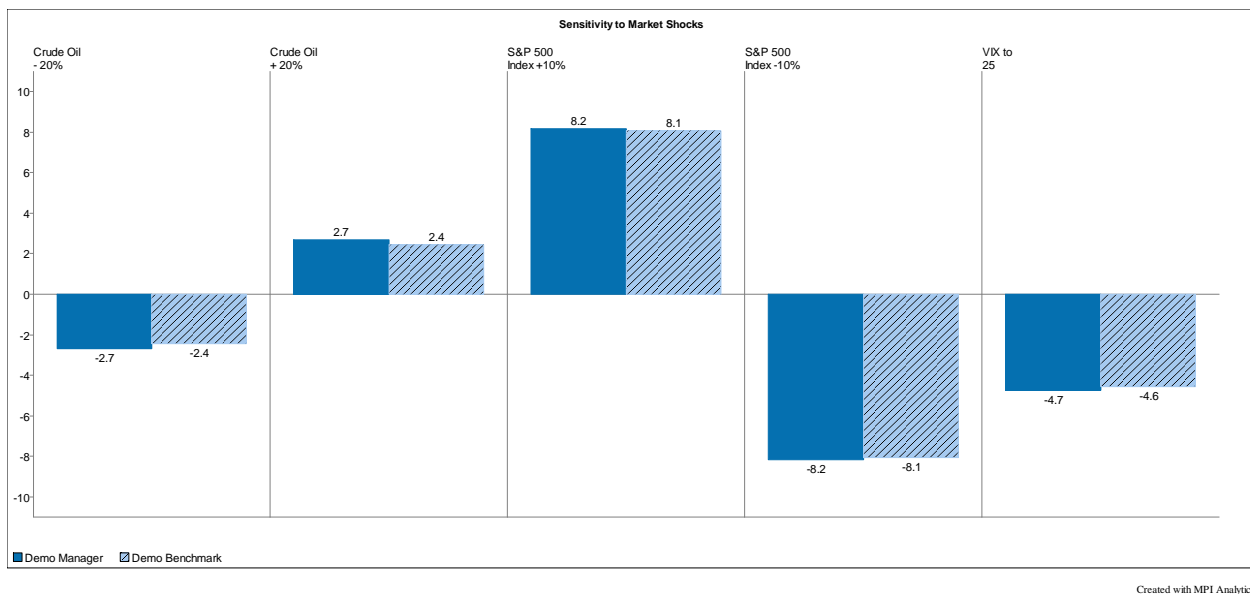


Figure 14

Users must also specify whether to apply a Systematic vs a Direct shock through another drop down:

- Systematic Shock: Regress the manager against the style outline and use the current asset loadings and the betas between the style outline and the shocked index to calculate the expected return
- Direct Shock: Regress the manager directly against the shocked index to calculate the expected return
- Shock Contribution: Provides the return contribution that each factor produces using the Systematic Shock methodology

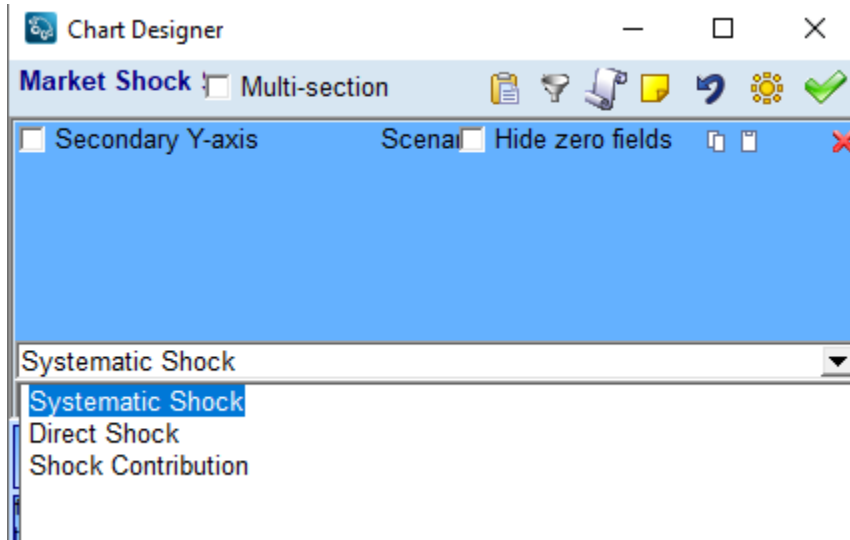


Figure 15

Below is an example of a Shock Contribution table.

| | Shock Contribution, % | | | |
|----------------|------------------------------|----------------------------|---------------------------------|---------------------------------|
| | Crude Oil - 20%,MSCI EAFE | Crude Oil - 20%,MSCI EM | Crude Oil - 20%,Russell 1000 | Crude Oil - 20%,Russell 2000 |
| Demo Manager | -1.1 | -0.3 | -1.8 | -0.7 |
| Demo Benchmark | 0.0 | 0.0 | -2.2 | -1.4 |

Figure 16

Scenarios Details Block

The Scenario Detail block provides additional information into the underlying scenario calculation.

- *Beta* – OLS sensitivity measure of series selected (primarily style outline but also manager and benchmark) to shock index(es)

- *p-value* – Measures the significance of the Beta estimate in a range of (0-100). A low value is considered significant.
- *R-Squared* – Measures the explanatory power of the regression
- *Shock, %* - The shock estimate to a specific series for the selected scenario
- *Scenario Map* – Indicates whether a particular index is configured to be shocked by the selected Scenario. 1=yes, 0=no
- *Applied Shock, %* - This is the shock that's actually used based on the mapping, as opposed to Shock, % which is calculated regardless of whether it is used or not. It's either the value of Shock, % or 0.
- *Total Shock, % and Total Applied Shock, %* - These are the sum of each of the scenario's component shocks. They are only different from the Shock %, and Applied Shock % when there is a Multivariate scenario.

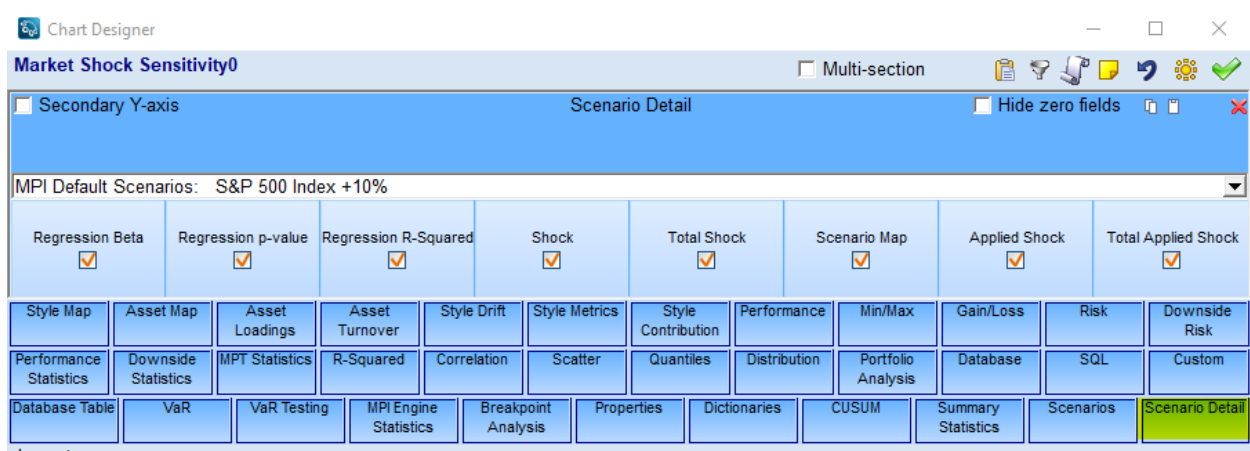


Figure 17

| | S&P 500 Index +10% | | | | | | | |
|-------------------------|--------------------|-----------|-------------|---------|---------------|--------------|-----------------|-----------------------|
| | Beta | p-value,% | R-Squared,% | Shock,% | Total Shock,% | Scenario Map | Applied Shock,% | Total Applied Shock,% |
| Demo Manager | 0.92 | 0.00 | 92.26 | 9.16 | 9.16 | NA | NA | NA |
| Cash | 0.00 | 17.52 | 0.71 | -0.03 | -0.03 | 0.00 | 0.00 | 0.00 |
| US Credit Bonds | 0.05 | 0.75 | 2.74 | 0.55 | 0.55 | 0.00 | 0.00 | 0.00 |
| US Govt Bonds | -0.08 | 0.00 | 9.61 | -0.84 | -0.84 | 0.00 | 0.00 | 0.00 |
| US MBS | -0.03 | 1.06 | 2.50 | -0.27 | -0.27 | 0.00 | 0.00 | 0.00 |
| EM Sovereign Bonds | 0.39 | 0.00 | 27.22 | 3.92 | 3.92 | 0.00 | 0.00 | 0.00 |
| Global Govt Bonds ex US | 0.05 | 14.80 | 0.81 | 0.49 | 0.49 | 0.00 | 0.00 | 0.00 |
| MSCI EAFE | 0.94 | 0.00 | 73.10 | 9.41 | 9.41 | 1.00 | 9.41 | 9.41 |
| MSCI EM | 1.16 | 0.00 | 57.09 | 11.57 | 11.57 | 1.00 | 11.57 | 11.57 |
| Russell 1000 | 1.01 | 0.00 | 99.57 | 10.12 | 10.12 | 1.00 | 10.12 | 10.12 |
| Russell 2000 | 1.11 | 0.00 | 69.34 | 11.10 | 11.10 | 1.00 | 11.10 | 11.10 |

Figure 18

Disclosures

Similar to the Regimes and Stress Tests, disclosures for Scenarios can be easily added to your study through a new Gallery item, Scenario Disclosure. These can be found under the Charts/Tables >>

Disclosures >> Workspace. You can drag in the appropriate disclosure and then select the applicable scenarios you would like included.

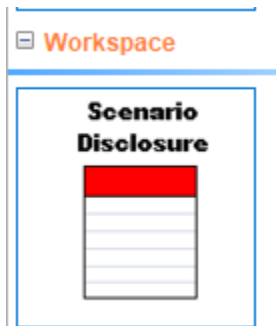


Figure 19

Gallery Dialog

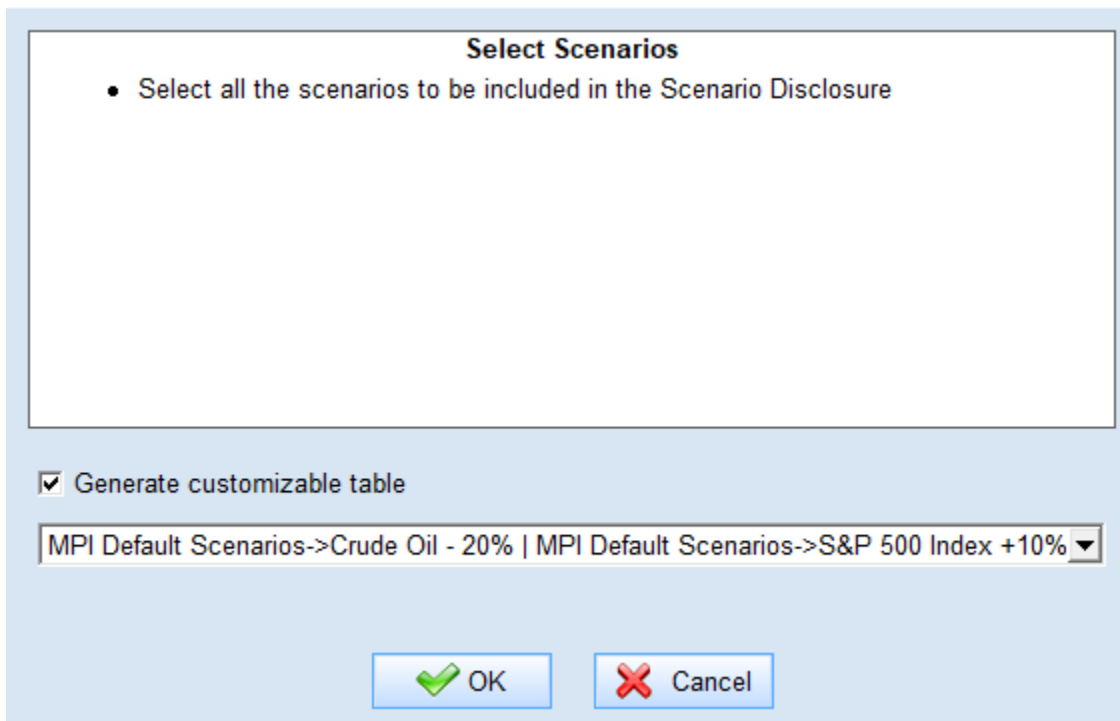


Figure 20

Scenario Disclosure

| Scenario Name | Shock Index | Affected Asset Classes | Affected Indexes |
|--------------------|--------------------------------------|--|--|
| Crude Oil - 20% | S&P Goldman Sachs US Crude Oil Index | Commodity, Equity, Other, Private Equity, Real Estate, Volatility | MSCI EM, Russell 1000, Russell 2000 |
| S&P 500 Index +10% | S&P 500 Index | Equity, Other, Private Equity, Volatility | MSCI EM, Russell 1000, Russell 2000 |
| VIX to 25 | CBOE Volatility Index: VIX | Commodity, Credit, Currency, Economy, Equity, Interest Rates, Other, Private Equity, Real Estate, Volatility | Cash, US Credit Bonds, US Govt Bonds, US MBS, EM Sovereign Bonds, Global Govt Bonds ex US, MSCI EM, Russell 1000, Russell 2000 |

Figure 21

Creating your own Stress Tests, Regime Models, Scenarios – Stylus Workspace

For users with the Advanced Analytics Package, you can create your own stress tests, regimes, and scenarios. These are all maintained in the Workspace. It is **strongly encouraged** that users do not modify any MPI created advanced risk features. If you would like to make changes to an MPI created feature, you should copy it and then make changes to the new version. This will ensure that any future updates to Workspace by MPI do not overwrite any changes that users may have added.

Workspace Design Tree

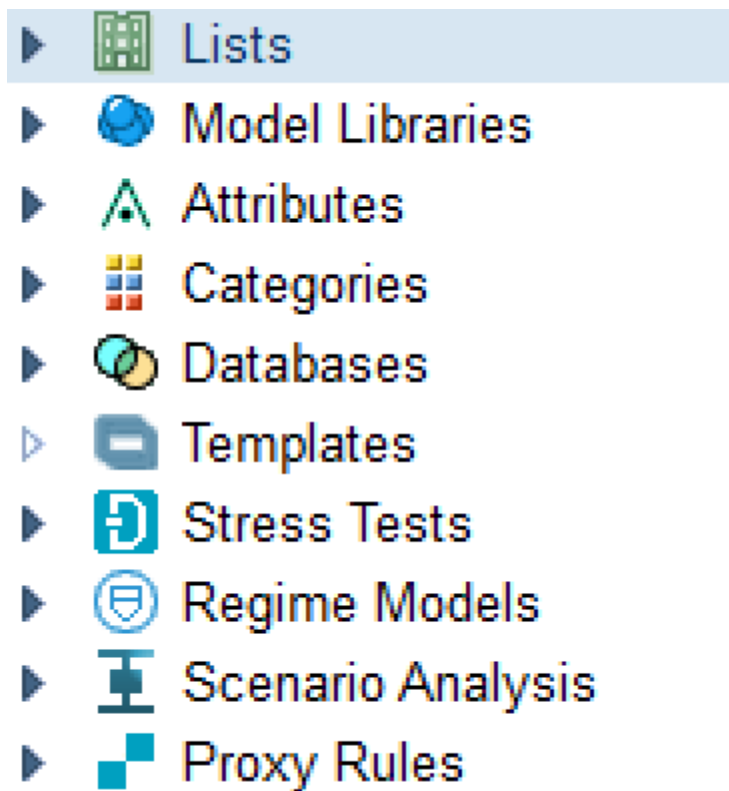


Figure 22

Stress Tests

Stress tests are maintained under the Stress Test node in Stylus Workspace. They are grouped together under common themes (i.e., Commodity and Currency, Global Equity, Volatility). Stress Test groups and individual Stress Tests can be added by right clicking on the tree on the left or using the “Add” button above the main grid.

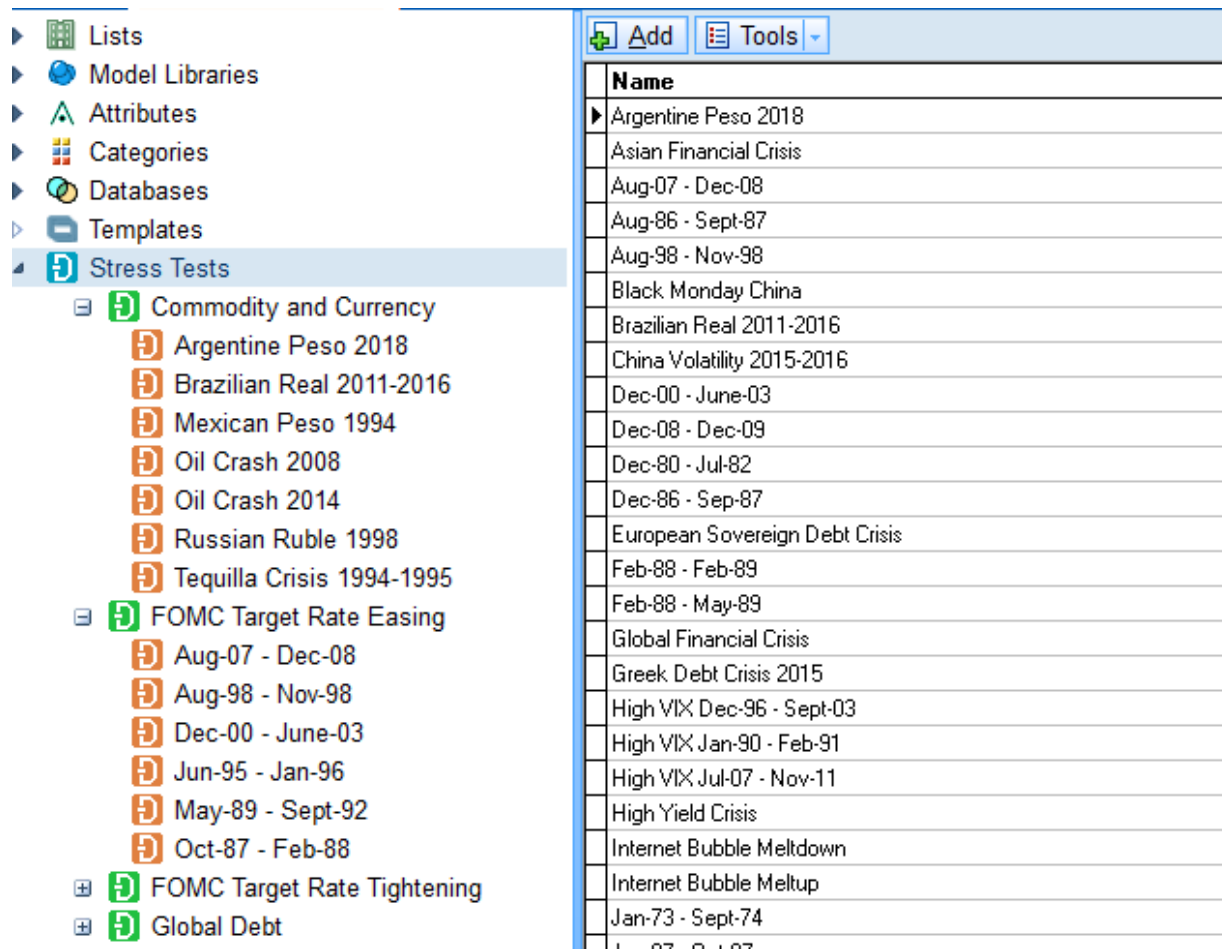


Figure 23

Clicking on an individual stress test will display the definition screen.

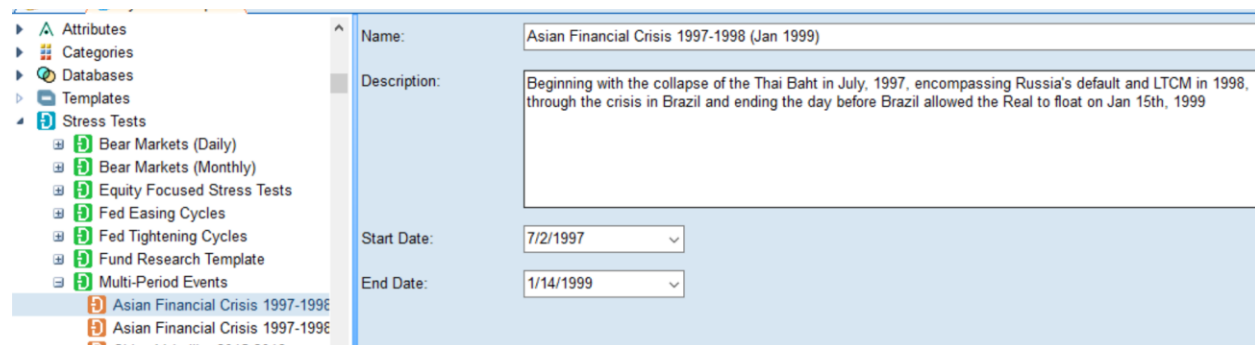


Figure 24

New Stress Tests can be created and require population of four fields:

- Name
- Start Date
- End Date

Regime Models

Regime Models are maintained under the Regime Models node in Workspace. Users can view the list of regime models by clicking on and expanding the Regime Models node. The tree on the left side will display a list of all regime models. The grid in the main section of the screen will display additional information about the models.

| Name | Memo | Rule Based | Info |
|-------------------------------------|------|------------|--|
| 10-Year Treasury Yield | (A) | ✓ | Moderate 10-Year Treasury Yield (frequency: monthly) (periods: 242); High 10-Year Treasury Yield (frequency: monthly) (periods: 245); Low 10-Year Treasury Yield (frequency: monthly) (periods: 105). |
| Credit Spreads | (A) | ✓ | Compressed OAS (frequency: monthly) (periods: 50); Normal OAS (frequency: monthly) (periods: 172); Wide OAS (frequency: monthly) (periods: 39). |
| Housing Starts - Relative High/Low | (A) | ✓ | Housing Starts Above 12M Moving Average (frequency: monthly) (periods: 391); Housing Starts Below 12M Moving Average (frequency: monthly) (periods: 326). |
| Industrial Production Index | (A) | ✓ | High IP Growth (frequency: monthly) (periods: 463); Low IP Growth (frequency: monthly) (periods: 141); Negative IP Growth (frequency: monthly) (periods: 305); Moderate IP Growth (frequency: monthly) (periods: 212); High Growth Low IP Growth (frequency: monthly) (periods: 18). |
| Inflation and Growth Quadrant | (A) | ✓ | High Growth High Inflation (frequency: monthly) (periods: 212); Low Growth High Inflation (frequency: monthly) (periods: 218); Low Growth Low Inflation (frequency: monthly) (periods: 212); High Growth Low Inflation (frequency: monthly) (periods: 18). |
| Inflation Expectations | (A) | ✓ | Low Expected Inflation (frequency: monthly) (periods: 41); Moderate Expected Inflation (frequency: monthly) (periods: 142); High Expected Inflation (frequency: monthly) (periods: 18). |
| Market - Up/Down Months | (A) | ✓ | Down Market (frequency: monthly) (periods: 209); Up Market (frequency: monthly) (periods: 352). |
| Market - Up/Down Years | (A) | ✓ | Down Year (frequency: none) (periods: 10); Up Year (frequency: none) (periods: 36). |
| Market - Up/Down Years (Rule-based) | (A) | ✓ | Down Year (frequency: annual) (periods: 10); Up Year (frequency: annual) (periods: 36). |
| Recession/Expansion | (A) | ✓ | Recession (frequency: monthly) (periods: 234); Expansion (frequency: monthly) (periods: 975). |
| Rising/Falling 10Y Rates | (A) | ✓ | Falling 10Y CMT (frequency: none) (periods: 174); Rising 10Y CMT (frequency: none) (periods: 242). |
| Rising/Falling USD | (A) | ✓ | USD Weakened (frequency: monthly) (periods: 252); USD Strengthened (frequency: monthly) (periods: 297). |
| Stock-Treasury Co-Movement | (A) | ✓ | neutral (frequency: none) (periods: 195); separate (frequency: none) (periods: 271); together (frequency: none) (periods: 504). |
| Stock-Treasury Correlation | (A) | ✓ | Positive Correlation (frequency: monthly) (periods: 189); Neutral Correlation (frequency: monthly) (periods: 180); Negative Correlation (frequency: monthly) (periods: 131). |
| Value vs Growth | (A) | ✓ | Value Outperforms (frequency: monthly) (periods: 242); Growth Outperforms (frequency: monthly) (periods: 247). |
| Volatility by Threshold | (A) | ✓ | High Volatility (frequency: monthly) (periods: 61); Moderate Volatility (frequency: monthly) (periods: 176); Low Volatility (frequency: monthly) (periods: 120). |
| Volatility Spikes | (A) | ✓ | VIX Spikes (frequency: monthly) (periods: 32). |
| Yield Curve Normal/Inverted/Flat | (A) | ✓ | Normal Yield Curve (frequency: monthly) (periods: 279); Flat Yield Curve (frequency: monthly) (periods: 172); Inverted Yield Curve (frequency: monthly) (periods: 69). |

Figure 25

Regime Models are organized as groups (e.g., Credit Spreads), where related models using the same criteria but different values (i.e., Wide OAS, Normal OAS, Compressed OAS) are grouped together. Regime model groups and individual Regime Models can be added by right clicking on the tree on the left or using the “Add” button above the main grid.

Clicking on an individual model node in the tree will bring the user to a detailed screen where he/she can create or edit the model.

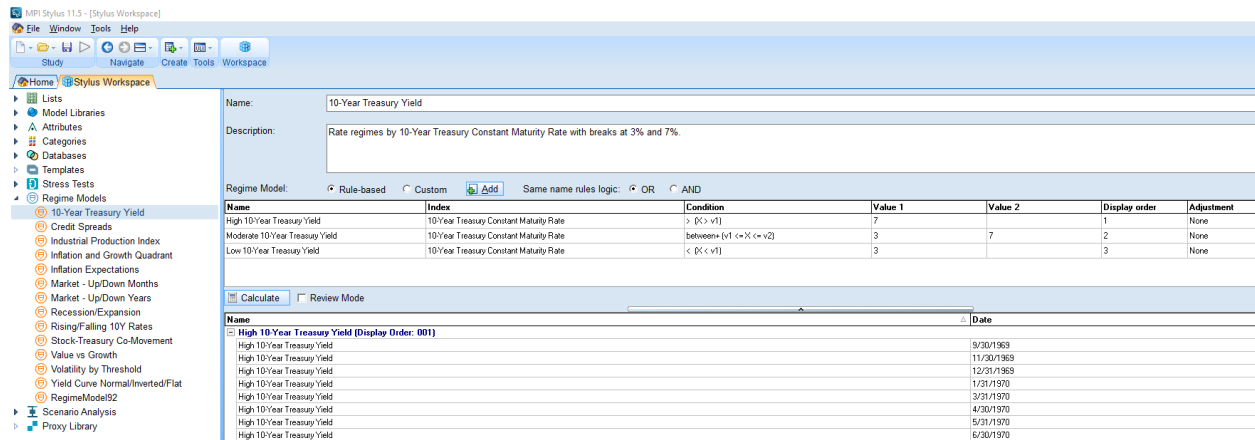


Figure 26

To start, the user should enter a Name and Description for the Regime.

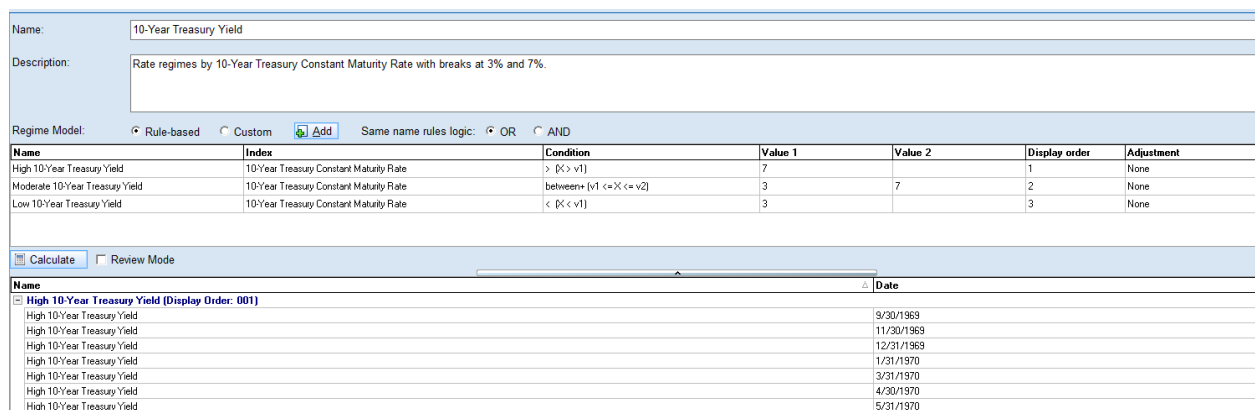
Regime Models can be designed in two ways:

- Rule Based – Regimes are built based on performance / level properties of various risk factors. Some examples may include:
 - Up Market / Down Markets – Regimes based on the performance of S&P 500 Index
 - Volatility Regimes – Regimes based on level of CBOE VIX index (e.g. <20, 20-35,>35)
 - Growth vs. Value regimes – Regimes based on the difference in performance between the Russell 3000 Value and Russell 3000 Growth indexes
- Custom – Regimes are built by specifically providing the dates covered in each regime. These dates don't need to be continuous time intervals.

Rule Based Models

In order to set up a rule-based model, the user first needs to select the “Rule-Based” mode and add one or more rules by clicking the “Add” button.

A grid will appear on the screen for the user to populate.



Name: RegimeModel92

Description:

Regime Model: ☒ Rule-based ☐ Custom Same name rules logic: ☒ OR ☐ AND

| Name | Index | Condition | Value 1 | Value 2 | Display order | Adjustment |
|-------|-------|-----------|---------|---------|---------------|------------|
| Rule1 | | | 0 | | 0 | None |

☐ Review Mode

Name △ Begins △ Ends

Figure 27

The following fields should then be populated to build the Regime Model:

| Column | Description |
|--------------------|--|
| Name | Name of the regime. |
| Index | Index used as a reference. Users can select by clicking on the cell and picking an index that either appears in a drop down or by clicking on the “add” item in the drop down and selecting any series from any of the databases available to the user. |
| Condition | <p>Users need to specify a relation used for the rule. v1 and v2 refer to Value 1 and Value 2 columns.</p> <p>Possible choices are:</p> <ol style="list-style-type: none"> 1. $< (X < v1)$ 2. $\leq (X \leq v1)$ 3. $> (X > v1)$ 4. $\geq (X \geq v1)$ 5. Between $(v1 < X < v2)$ 6. Between+ $(v1 < x \leq v2)$ 7. Outside $(X < v1 \text{ or } X > v2)$ 8. Outside+ $(X \leq v1 \text{ or } X \geq v2)$ 9. Percentile range $(v1 < X \leq v2\%)$ |
| Value 1 Value 2 | These columns specify the values against which the condition is checked. Either column can be entered as a numeric value, or they can be used to specify an Index/Series. If the series is specified, then the rule checks the value of the Series specified in the Index column versus the value of the specified series at each data point. |

| | |
|---------------|---|
| Display Order | Order in which the regimes will appear in the chart/table drop down lists and in charts/tables |
| Adjustment | <p>Enables advanced calculations:</p> <ol style="list-style-type: none"> 1. First Difference – converts to first difference, t minus t-1 2. Convert to Rolling % - primarily to use % change in level on a rolling basis, an additional parameter for the length of the rolling period needs to be entered. 3. Convert to Moving Average – primarily for levels, an additional parameter for the MA period needs to be entered. 4. Correlate With – Provides rolling correlation between indices. Level values are automatically converted to first difference before the correlation is calculated. An additional parameter for the period over which to calculated it needs to be entered. 5. Convert Frequency – Allows the regime to be defined at a lower frequency than the base series. |

Figure 28

In order to calculate and display the results of a new regime, the user must press the Calculate button.

Complex Regimes

Regimes defined by more than one component can also be created. The Inflation and Growth Quadrant is one example of this where we consider both the Industrial Production and Consumer Price Index to determine the regime. These are created by using multiple rows in the grid to define the regime. Workspace knows to apply these rules to the same Regime, when the exact same text is entered in the Name field of multiple rows (see below). The rows can be combined using either “AND” or “OR” operators as specified in the “Same name rules logic” section. Below are two such examples.

Example 1: “AND”


| Regime Model: <input checked="" type="radio"/> Rule-based <input type="radio"/> Custom  Add Same name rules logic: <input type="radio"/> OR <input checked="" type="radio"/> AND | | | | | | | |
|---|---|-----------------------------------|---------|---------|---------------|------------|--|
| Name | Index | Condition | Value 1 | Value 2 | Display order | Adjustment | |
| High Growth High Inflation | Industrial Production Index, Year over Year | percentile range (v1% < X <= v2%) | 50 | 100 | 0 | None | |
| High Growth High Inflation | Consumer Price Index for All Urban Consumers: All Items, Year over Year | percentile range (v1% < X <= v2%) | 50 | 100 | 0 | None | |
| High Growth Low Inflation | Industrial Production Index, Year over Year | percentile range (v1% < X <= v2%) | 50 | 100 | 0 | None | |
| High Growth Low Inflation | Consumer Price Index for All Urban Consumers: All Items, Year over Year | percentile range (v1% < X <= v2%) | 0 | 50 | 0 | None | |
| Low Growth High Inflation | Industrial Production Index, Year over Year | percentile range (v1% < X <= v2%) | 0 | 50 | 0 | None | |

Figure 29

In this example we are focused on four possible regimes:

| | High Inflation | Low Inflation |
|-------------|----------------|---------------|
| High Growth | 1 | 2 |
| Low Growth | 3 | 4 |

Figure 30

For each regime we specify two rows:

1. Industrial Production Index Level
2. CPI YoY index

Example 2: “OR”


| Regime Model: <input checked="" type="radio"/> Rule-based <input type="radio"/> Custom  Add Same name rules logic: <input checked="" type="radio"/> OR <input type="radio"/> AND | | | | |
|---|----------------------------|--------------|---------|---------|
| Name | Index | Condition | Value 1 | Value 2 |
| Extreme Volatility | CBOE Volatility Index: VIX | >= [X >= v1] | 25 | |
| Extreme Volatility | S&P 500 Index | <= [X <= v1] | 5 | |

Figure 31

In this example we define the Extreme Volatility regime as when EITHER:

1. VIX level exceeds 25
2. S&P 500 Index loses more than 5% (monthly)

Review Mode

When regimes are calculated using the “Calculate” button, the bottom grid will display a concise view of the regime history grouped by each regime. Users can click on the Review Mode checkbox to see a more detailed view.

Calculate

☒ Review Mode

Export as series

| Name | Date | Index Return | Value 1 |
|-------------|------------|--------------|----------|
| Down Market | 1/31/1973 | -1.486000 | 0.000000 |
| Down Market | 2/28/1973 | -3.519000 | 0.000000 |
| Up Market | 3/31/1973 | 0.094000 | 0.000000 |
| Down Market | 4/30/1973 | -3.841000 | 0.000000 |
| Down Market | 5/31/1973 | -1.637000 | 0.000000 |
| Down Market | 6/30/1973 | -0.403000 | 0.000000 |
| Up Market | 7/31/1973 | 4.056000 | 0.000000 |
| Down Market | 8/31/1973 | -3.416000 | 0.000000 |
| Up Market | 9/30/1973 | 4.274000 | 0.000000 |
| Up Market | 10/31/1973 | 0.128000 | 0.000000 |
| Down Market | 11/30/1973 | -11.122000 | 0.000000 |

Figure 32

In this view, users can see all regime data points in chronological order (not grouped by regime) and check the actual value of the index versus those values specified in the Value 1 and Value 2 columns.

Export Series

While in Review Mode, it is possible to extract the history of the regimes as a Stylus manager file by clicking on the “Export as series” button. Each series will be stored as a “.mng” file in the database location specified by the user (Figure 12). Users can also modify the Series ID and Series Description columns.

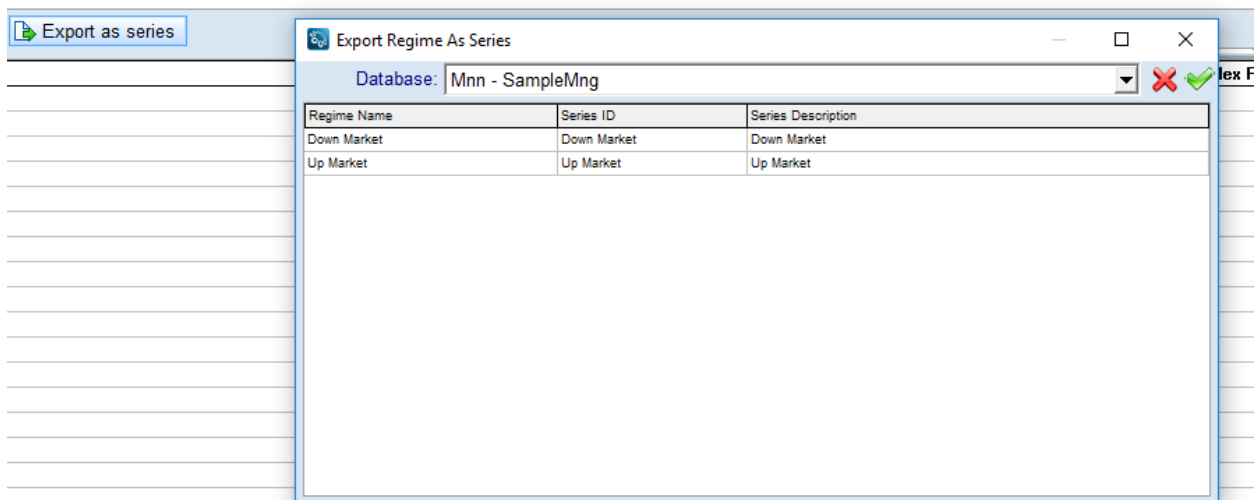


Figure 33

Each series will be extracted as a level type series. The series will have a value of 1.0 for each data point within the regime and 0 for data points outside of the regime.

Custom Models

Stylus also supports the ability to specify a regime model that is calculated outside the application. Using the custom mode, users can edit the grid or paste values from the clipboard (e.g., excel). When pasting values, the data must be configured with three columns corresponding to Name, Start Date and End Date columns as shown below.

| Name | Start Date | End Date |
|---------------|------------|------------|
| Negative Year | 1/2/1973 | 1/31/1973 |
| Negative Year | 2/1/1973 | 2/28/1973 |
| Negative Year | 3/1/1973 | 3/30/1973 |
| Negative Year | 4/2/1973 | 4/30/1973 |
| Negative Year | 5/1/1973 | 5/31/1973 |
| Negative Year | 6/1/1973 | 6/29/1973 |
| Negative Year | 7/2/1973 | 7/31/1973 |
| Negative Year | 8/1/1973 | 8/31/1973 |
| Negative Year | 9/4/1973 | 9/28/1973 |
| Negative Year | 10/1/1973 | 10/31/1973 |
| Negative Year | 11/1/1973 | 11/30/1973 |
| Negative Year | 12/3/1973 | 12/31/1973 |
| Negative Year | 1/2/1974 | 1/31/1974 |

Figure 34

Scenario Analysis

The Scenario Analysis node in Stylus Workspace is where the scenarios are defined.

Similar to Historical Stress Tests, scenarios can be separated into logical groups. Users can add Scenarios and Groups from either the tree (by right clicking) or from the main grid.

| Name | Memo | Group | Index | Value | Shock Type | Asset Class | Affected Asset Classes |
|----------------------------|------|-----------------------------------|--|-------|--------------|----------------|--|
| 10Y Treasury Yield +50 bps | (a) | MPI Default Scenarios | 10-Year Treasury Constant Maturity Rate | 0.5 | Level Change | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Treasury Yield -50bp | (a) | MPI Default Scenarios | 10-Year Treasury Constant Maturity Rate | -0.5 | Level Change | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield +100 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | 1 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield +25 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | 0.25 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield +50 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | 0.5 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield +75 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | 0.75 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield -100 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | -1 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield -25 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | -0.25 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield -50 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | -0.5 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| 10Y Yield -75 bps | (a) | Treasury Yield Incremental Shocks | 10-Year Treasury Constant Maturity Rate | -0.75 | Percent | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili |
| Corporate OAS +100 bps | (a) | MPI Default Scenarios | ICE BofAML US Corporate Master Option Adjust | 1 | Level Change | Credit | Credit Equity Private Equity Real Estate Volatility Other |
| Crude Oil + 20% | (a) | MPI Default Scenarios | S&P Goldman Sachs US Crude Oil Index | 20 | Percent | Commodity | Commodity Equity Private Equity Real Estate Volatility Other |
| Crude Oil - 20% | (a) | MPI Default Scenarios | S&P Goldman Sachs US Crude Oil Index | -20 | Percent | Commodity | Commodity Equity Private Equity Real Estate Volatility Other |
| Emerging Markets -20% | (a) | MPI Default Scenarios | MSCI EM (Emerging Markets) LOC | -20 | Percent | Equity | Equity Private Equity Volatility Other |
| Expected Inflation +25 bps | (a) | MPI Default Scenarios | 5-Year Breakeven Inflation Rate | 0.25 | Level Change | Interest Rates | Commodity Credit Currency Economy Interest Rates Volatili Cc |
| Gold +10% | (a) | MPI Default Scenarios | S&P Goldman Sachs US Gold Index | 10 | Percent | Commodity | Commodity Equity Private Equity Real Estate Volatility Other |

Figure 35

Clicking on an individual scenario will bring up the scenario definition screen.

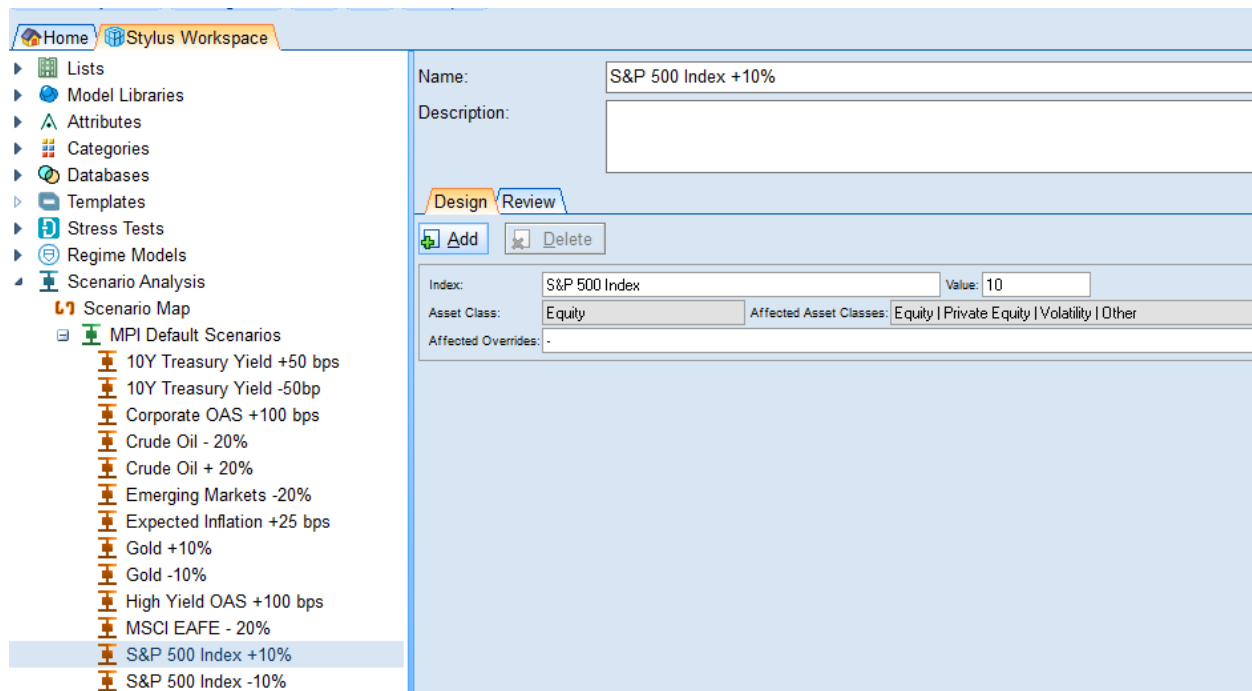


Figure 36

The following fields need to be populated for each Scenario

| Field | Description |
|-------------|--|
| Name | Scenario Name |
| Description | Basic description of the scenario. |
| Index | Index being shocked. |
| Value | <p>Value of the Shock. The example above demonstrates a scenario set up for a return type series. It is, however, possible to set up scenarios for level type series (levels of VIX or interest rates, credit spreads, etc.). For such series, more options would be presented in the Value row.</p> <p>The shock type for any return series is “Percent”. This means that the value represents a percent change in the index (0.5 would be 0.5%).</p> <p>For level type series, we can also select:</p> <ol style="list-style-type: none"> 1. Level Change: In this case, 0.5 would represent the change of 0.5 (50 basis points) from the reference level. 2. Target Level: In this case, 20 is the target level of VIX. |

| | |
|------------------------|---|
| Asset Class | Represents the asset class assigned to the factor. (Display Only) |
| Affected Asset Classes | Shows the list of asset classes affected by default. See discussion above about Asset Class mapping. (Display Only) |
| Affected Overrides | Allows user to override the default asset classes affected by the specific scenario. Note: You must select all asset classes you would like to be affected by the shock, not just the incremental one(s). |

Figure 37

| | | | |
|--------|---|-------------|--|
| Index: | 10-Year Treasury Constant Maturity Rate | | |
| Value: | 0.5 | Shock type: | <input type="radio"/> Percent <input checked="" type="radio"/> Level Change <input type="radio"/> Target Level |

Figure 38

| | | | |
|--------|----------------------------|-------------|--|
| Index: | CBOE Volatility Index: VIX | | |
| Value: | 20 | Shock type: | <input type="radio"/> Percent <input checked="" type="radio"/> Level Change <input type="radio"/> Target Level |

Figure 39

Multi-variate shocks

Stylus now supports the ability to create multi-variate shocks (i.e., a 10% decline in the S&P 500 Index coupled with a 5 unit increase in the VIX). These can be created by hitting the Add button and defining multiple shocks.

| | | | |
|--|---|-------------|--|
| Name: | Equity and Volatility Shock | | |
| Description: | Combined impact of 10% decrease in the S&P 500 along with a 5 unit increase in the VIX | | |
| <div>Design Review</div> <div> <input type="button" value="Add"/> <input type="button" value="Delete"/> </div> | | | |
| 1 of 2 | | | |
| Index: | S&P 500 Index | Value: | -10 |
| Asset Class: | Equity | Shock type: | <input checked="" type="radio"/> Percent <input type="radio"/> Level Change <input type="radio"/> Target Level |
| Affected Asset Classes: | Equity Private Equity Volatility Other | | |
| Affected Overrides: | - | | |
| 2 of 2 | | | |
| Index: | CBOE VIX | Value: | 5 |
| Asset Class: | Volatility | Shock type: | <input type="radio"/> Percent <input checked="" type="radio"/> Level Change <input type="radio"/> Target Level |
| Affected Asset Classes: | Commodity Credit Currency Economy Equity Interest Rates Private Equity Real Estate Volatility Other | | |
| Affected Overrides: | - | | |

Figure 40

In this case, the impact is determined by simultaneously regressing both factors against the indices in the Style Outline.

The Review tab allows you to see which asset classes are impacted but the shock, including those added via the Affected Overrides

Methodology Overview

Definitions:

1. Source Factor –Factor being shocked in the scenario
2. Style Factor –Factor used in the style outline of the study

Scenario analysis is used to analyze the potential impact of movement in a source factor on the fund's performance. The analysis relies on the historical relationships among the fund, style factors and the source factor.

The overall process for evaluating each scenario is as follows:

1. For each style factor, determine if the factor should be affected by a shock of the specified source factor. Whether or not the style factor should be affected is determined by the asset class of the factor. Please see below for details of how the mapping is done.
2. If it is determined that the style factor should be affected by the specified scenario, then the system evaluates the effect of the shock on the factor using basic regression:

$$R = \alpha + \beta X$$

Where X is the return of the source factor in the scenario and R is the return of the style factor.

3. The result from step 2 is then multiplied by the style factor's asset loading.
4. The overall result of scenario analysis is then a sum of performing steps 2 and 3 for all style factors:

$$S = \sum_{i=1}^N \beta_i R_i$$

Where:

1. S is the overall result of the scenario analysis.
2. N is the number of style factors.
3. β is the asset loading of each factor.
4. R is return of each style factor.

Mapping of Factors

A new Attribute called MPI Index Asset Class has been added to Stylus Workspace. The attribute defines a list of possible asset class names (Figure 41).

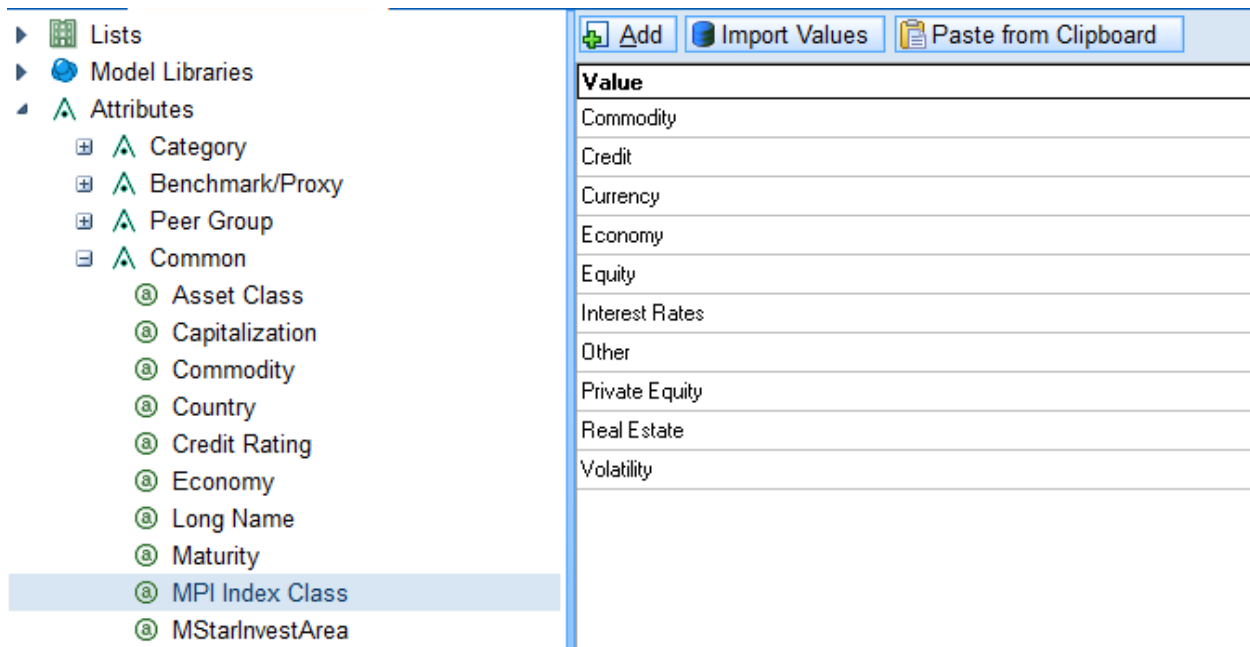


Figure 41

Each factor within the universe of factors used in default MPI models has been mapped (through appropriate attributes) to the MPI Index Asset Class Attribute.

The example in Figure 42 shows a mapping based on Type field within MPI Indices database.

The screenshot shows the Stylus Workspace interface with a table mapping fields to attributes. The table has two columns: 'Field: Type' and 'Attribute: MPI Index Class'. The table is populated with various financial indices and their corresponding asset classes. Above the table are buttons for 'Add', 'Import', and a dropdown menu labeled 'Assign attribute to highlighted:'. The left sidebar shows a tree view with 'MPI Index Class' highlighted under the 'Databases' section.

| Field: Type | Attribute: MPI Index Class |
|--|----------------------------|
| Aggregate Bond | Interest Rates |
| Agriculture | Commodity |
| All-Cap | Equity |
| All-Cap Growth | Equity |
| All-Cap Value | Equity |
| Asia | Equity |
| Average | Equity |
| Broad-Market | Equity |
| Business Cycle Expansions & Contractions | Economy |
| Buyout & Growth Equity | Private Equity |
| Buyouts | Private Equity |
| Buyouts & Growth Equity | Private Equity |
| Civilian Labor Force Participation Rate | Economy |
| Commodities | Commodity |
| Commodity | Commodity |
| Commodity Energy | Commodity |
| Composite | Equity |
| Consumer Discretionary | Equity |
| Consumer Price Indexes (CPI and PCE) | Economy |

Figure 42

The mappings, in terms of which factors are impacted when a shock occurs are stored under the Scenario Analysis >>Scenario Map node.

HomeStylus Workspace

▶ Lists

▶ Model Libraries

▶ Attributes

▶ Categories

▶ Databases

▶ Templates

▶ Stress Tests

▶ Regime Models

▶ Scenario Analysis

▶ Scenario Map

▶ MPI Default Scenarios

▶ S&P 500 Incremental Shocks

▶ Treasury Yield Incremental Shocks

▶ Proxy Library

| Index Class | Affected Index Classes |
|----------------|---|
| Commodity | Commodity Equity Private Equity Real Estate Volatility Other |
| Credit | Credit Equity Private Equity Real Estate Volatility Other |
| Currency | Currency Equity Interest Rates Private Equity Volatility Other |
| Economy | Commodity Credit Currency Economy Equity Interest Rates Private Equity Real Estate Volatility Other |
| Equity | Equity Private Equity Volatility Other |
| Interest Rates | Commodity Credit Currency Economy Interest Rates Volatility Real Estate Other |
| Other | |
| Private Equity | |
| Real Estate | |
| Volatility | Commodity Credit Currency Economy Equity Interest Rates Private Equity Real Estate Volatility Other |

Figure 43

This mapping dictates which components of a manager’s style are impacted when a factor is shocked. User can edit the “Affected Index Asset Classes” columns by double clicking and then using the following dialog box to add or remove values. This section provides users a way to determine whether a shock of a certain asset class affects other asset classes.

| Index Asset Class | Affected Index Asset Classes |
|-------------------|---|
| Commodity | Commodity Economy Equity |
| Credit | Credit |
| Economy | Equity Credit Fixed Income Volatility |
| Equity | Equity Volatility |
| Fixed Income | |
| Multi | |
| Private Equity | |
| Real Estate | |
| Volatility | |

Edit

✕ Clear All

≡ Remove Duplicates

⬇ Sort

Value

Equity

Volatility

✓ OK

✕ Cancel

Figure 44

Prospector – Advanced Risk

All the analysis described in the previous section can be performed in Prospector as well. The implementation is the same as in Stylus.

Regime Analysis and Historical Stress Tests

Users can add the same calculation blocks to the Analytics node and specify Regime Models or Historical Stress Tests to use.

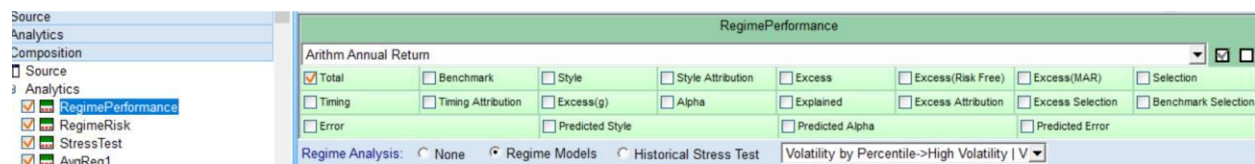


Figure 45

Each block will produce a number of fields that depends on calculations and models specified. The number of fields produced will be equal to Number of Fields * Number of Regimes (or Stress Tests).

The output fields will be named in the form of “Field name –Regime Name” or “Field Name –Stress Test”.

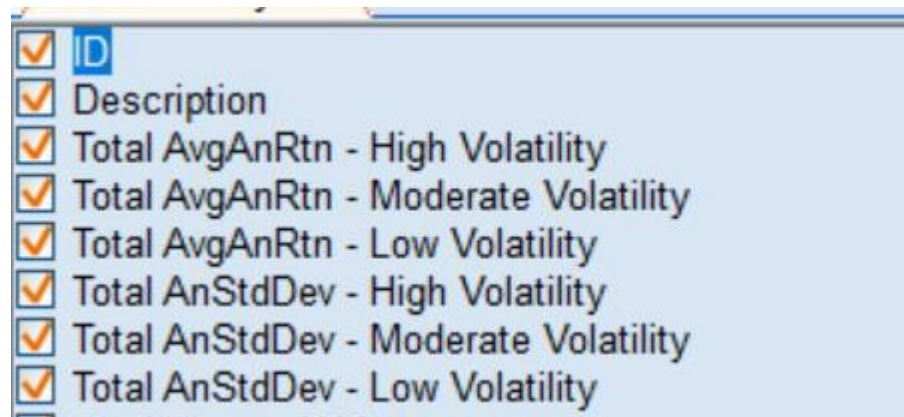


Figure 46

Scenario Analysis

Scenario Analysis is implemented in Prospector in a similar way as it is implemented in Stylus.

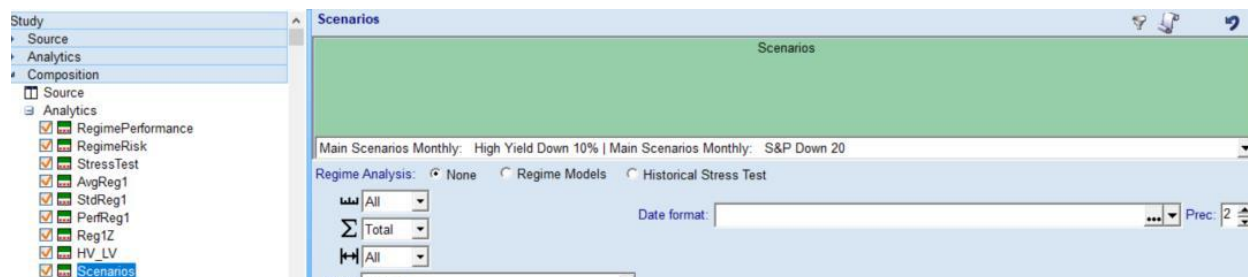


Figure 47

The block will produce fields named after each individual scenario.

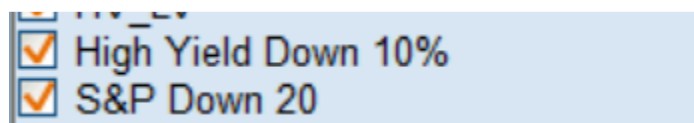


Figure 48

Custom Blocks

Prospector custom blocks can use output of regime models, historical stress tests and scenarios. For regime models and historical stress tests the syntax requires specification of the block name, field number and regime/stress test number in the following format: “Block Name | Field Number | Regime Index”.

For example:

If a performance block named RegimePerformance uses regimes that include (High Volatility, Moderate Volatility and Low Volatility regimes) then the output will create three fields:

1. Total AvgAnnReturn –High Volatility
2. Total AvgAnnReturn –Moderate Volatility
3. Total AvgAnnReturn –Low Volatility

These fields can be referred by custom block using the following syntax:

“RegimePerformance|1|1”, “RegimePerformance|1|2”, “RegimePerformance|1|3”.

In this case the first “1” refers to the field number. The numbers 1-3 refer to regime number specified in the output.

Scenario Analysis blocks contain only a single field so the syntax for referring to them in Custom Block is simpler: “Block Name | Scenario Index”

For example: for a block name called Scenarios and the two scenarios described shown in Figure 32 could be referred to as “Scenarios|1” and “Scenarios|2”.

Dynamically Controlling Regime Model selection

In studies where many charts or tables are used to perform market regime analysis, it may be practical to use dynamic script and macros to change which regime model is selected. For example: the following view shows four charts using the same regime model.

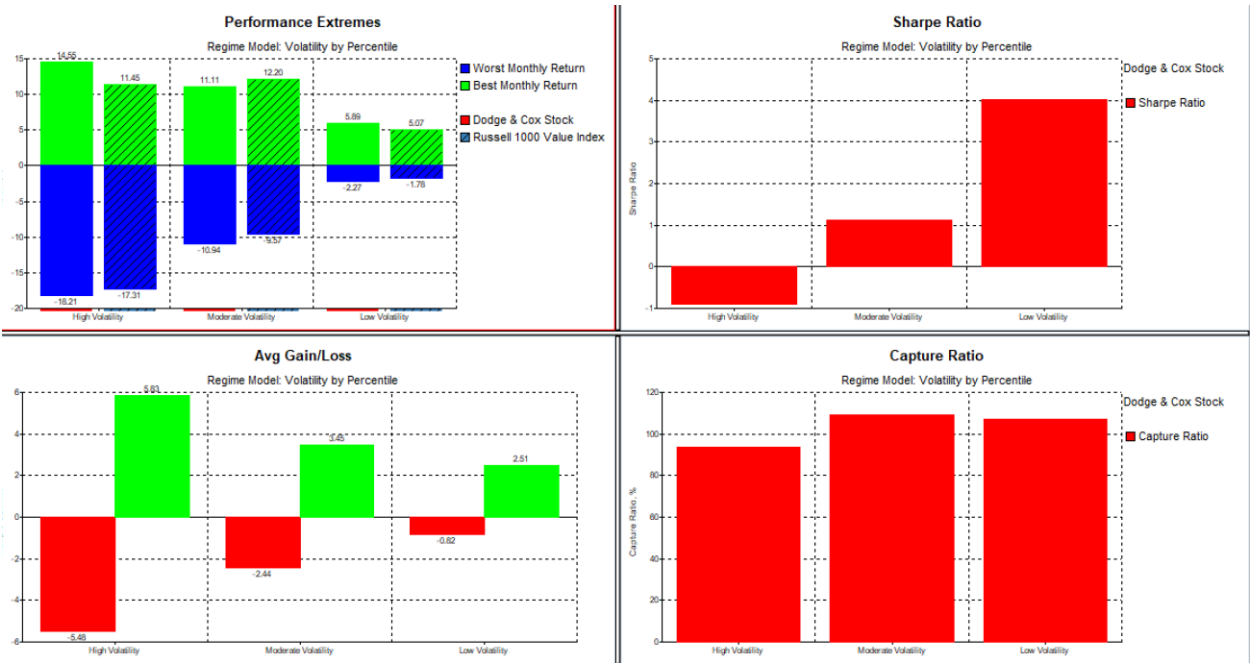


Figure 55

To switch to another model, users can manually switch each chart using designer. Alternatively, users can design each chart using Dynamic Script:

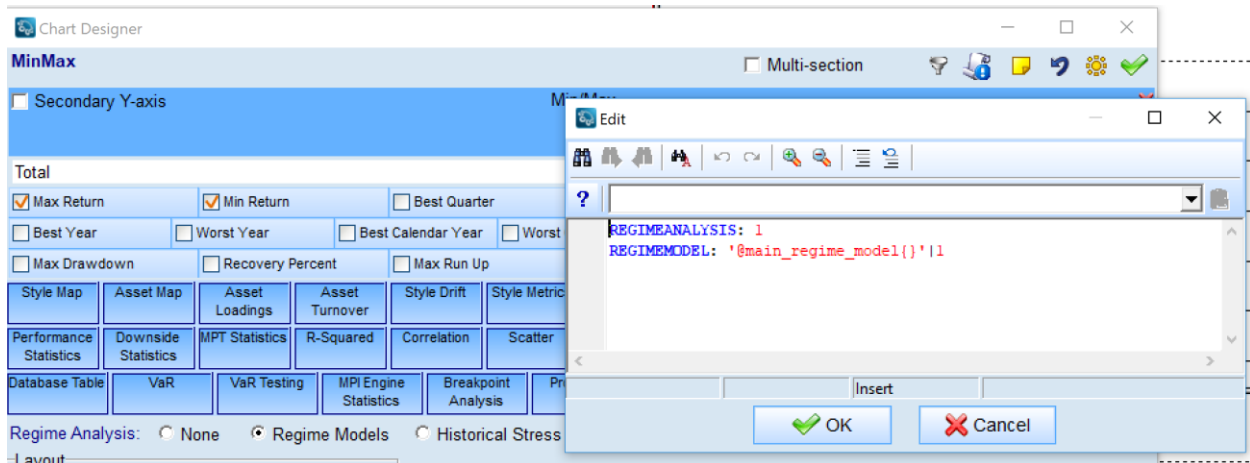


Figure 56

Here the @main_regime_model macro is defined as:

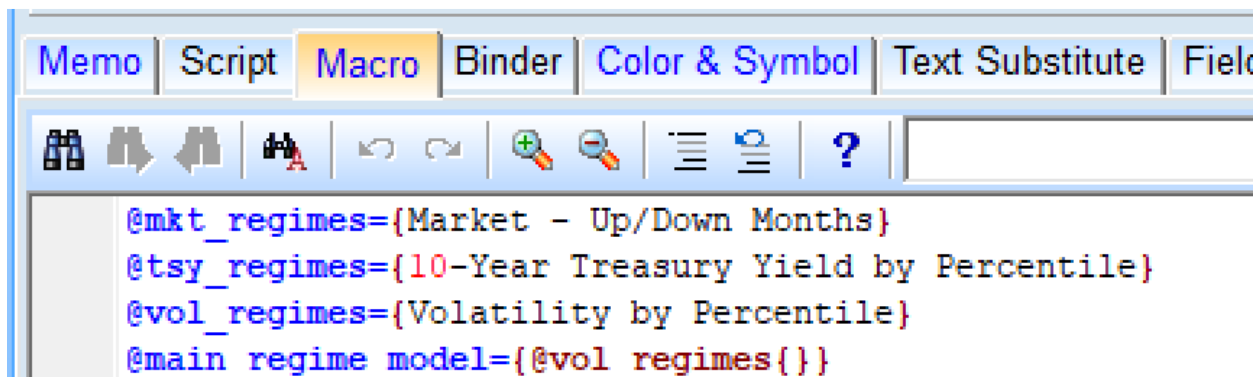


Figure 57