Dynamic Skew™ Algo

For Vela's Metro 6.3 trading platform
Version 4.48 (10-12-2020)

Introduction By Developer

The volatility curve is one of the most critical components of any options trading operation. It has a direct and immediate effect on options pricing, yet is the only options pricing model input that is not clearly defined and that is constantly fluctuating. Academic research suggests that complex volatility curves result from price trajectories that may be unit root processes or jump processes. Indeed, equity options traded in American markets did not show "volatility smiles" until *after* the Crash of 1987 when investors made substantial reassessments on the probabilities of extreme events. This implies that volatility curves are a constantly evolving emergent property due to the realtime consensus of various open-ended risks (both preexisting and those newly identified) to the underlying.

The Dynamic Skew™ tool is a cutting-edge algorithm for Vela's Metro platform and is designed to help relieve the burden of setting and maintaining vol curves. By automating this process in a robust and quantitative manner, the options trader or market maker is freed to focus more on the trading and high-level strategy. The Dynamic Skew algo alleviates nagging doubts on the validity of perceived edge, allowing the trader to make consistent, quick, and confident execution decisions. Feedback from options traders using the algo suggests that it is "game changing" and has quickly become an irreplaceable component. The algo exposes fleeting vol trading opportunities that previously could not be realized. Robust market data handling and modeling logic provide superior vol curves during volatile conditions. This allows the trader to focus on opportunities with substantially less vol risk than if constant manual updates were required.

-Kevin Reeves (kevin@axonetric.com)
Axonetric LLC, Senior quantitative algorithmic trading engineer

Testimonials

"The groundbreaking Dynamic Skew algo (DSA) is a fully automated, intelligently designed, indispensable tool for today's unforgiving, cutthroat, algo-driven trading environment. Reliable, fast and exceptionally accurate, the DSA allows me to trade with clarity, conviction, and confidence.

My vol curves and wing slopes have never looked better or more precise. My theoreticals on my Trade Sheets are always spot on. And I never get 'picked off' on sudden moves in IV or skew anymore. The DSA performs remarkably well during busy volatile market environments. No more looking at a 'sea of red' on my Trade Sheets and trying to figure out which strike is the one that's off. I see every isolated pricing anomaly immediately with consistently accurate levels of theoretical edge. And best of all, I never have to manually adjust any vol curves or term structure slope during a busy trading session.

In retrospect, I feel I was simply wasting valuable time and energy manually adjusting and recalibrating my vol curves and Trade Sheets all day long. The Dynamic Skew algo now handles this task faster and more accurately than is humanly possible. The DSA gives me the complete freedom to solely concentrate on the most important tasks—position risk management and opportunistic trading."
-Rich D., 25+ years Independent Options Trader (also beta tester & collaborator)

"We're very happy with the Dynamic Skew Algorithm and consider it an all-in-one tool for auto-fitting and tweaking the theoretical price of option market skews of all types. We use the DSA to smoothly fine tune the fitting process for over 40 expirations at once, ranging from very tight near-term options to wide markets two years out.

Configuring the various settings is relatively intuitive and offers a satisfying balance of precision and flexibility. Kevin and his team are consistently available to help diagnose, explain, and remedy any issues related to the algo—going above and beyond to ensure customer satisfaction."
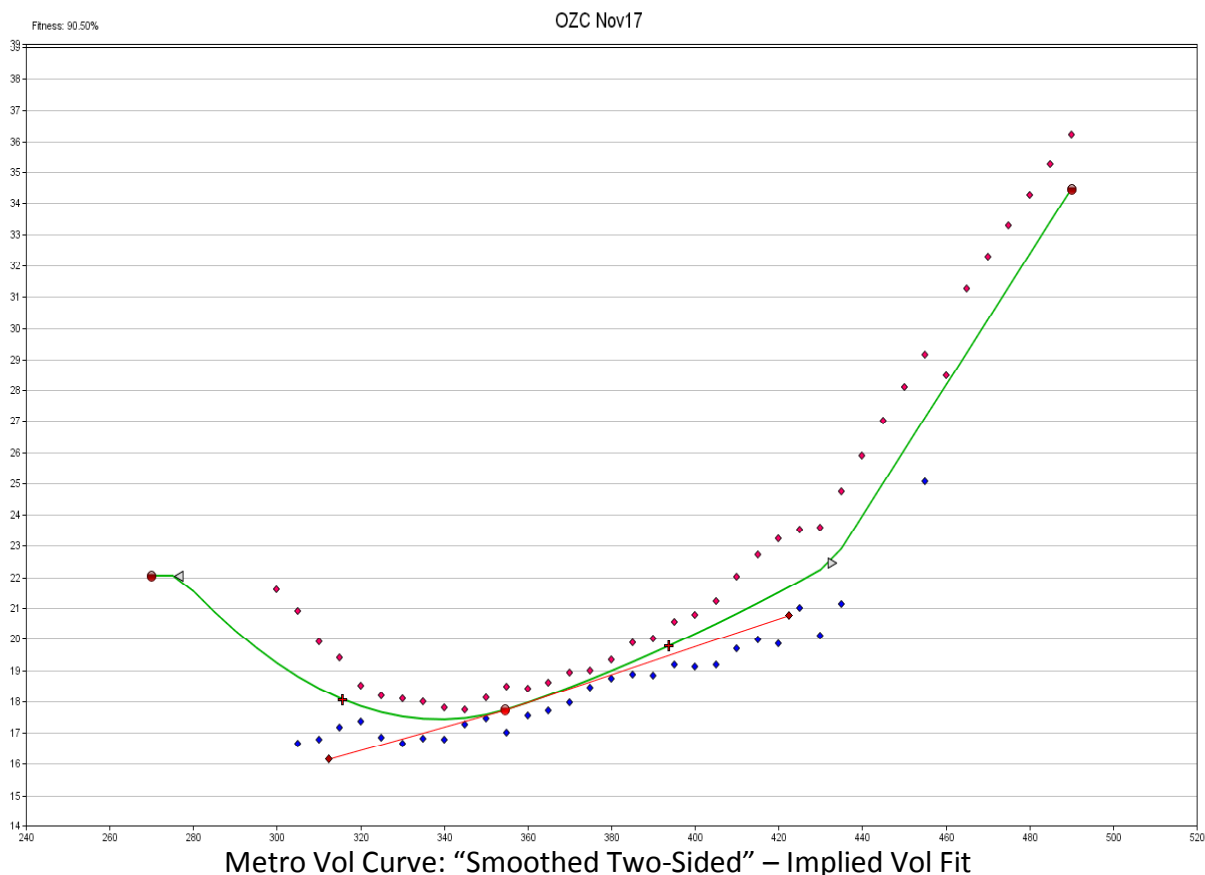*-US Equity Index Options Trading Desk*

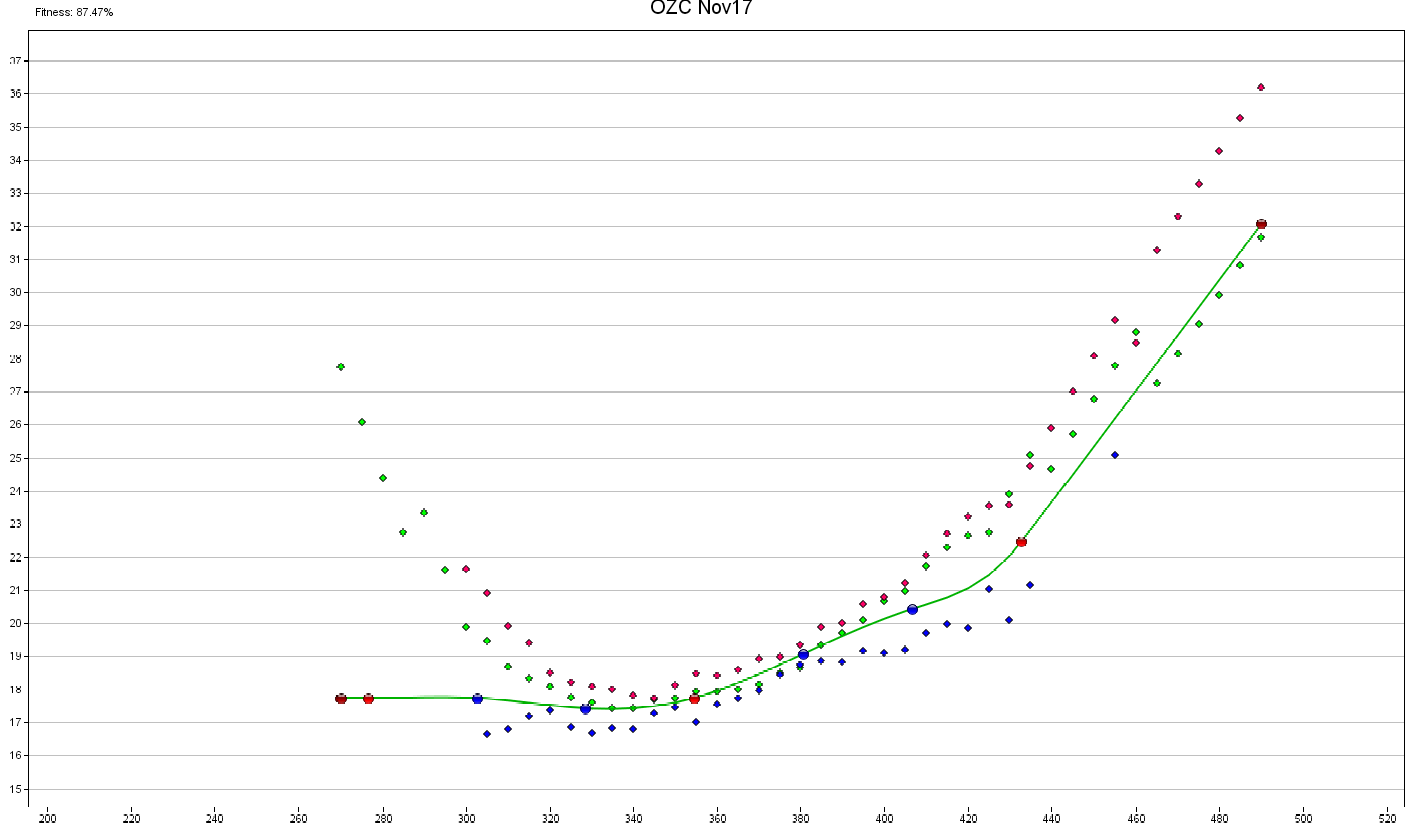"The Dynamic Skew algo has become an extremely valuable tool in our trading operations."
-Crude Oil Options Trading Desk

Visual Comparisons

The screenshots below show side-by-side comparisons of various possible vol curve modeling approaches in the November 2017 corn options. The screenshots were taken within minutes of each other during an evening session so they are all comparable. It is the opinion of the author, and seconded by traders using the algo, that Dynamic Skew provides the superior performance across the board.

Metro Vol Curve: "Smoothed Two-Sided" – Implied Vol Fit

Fitness: 87.47%

Metro Vol Curve: "Flexible Spline" – Implied Vol Fit

Fitness: 88.45%
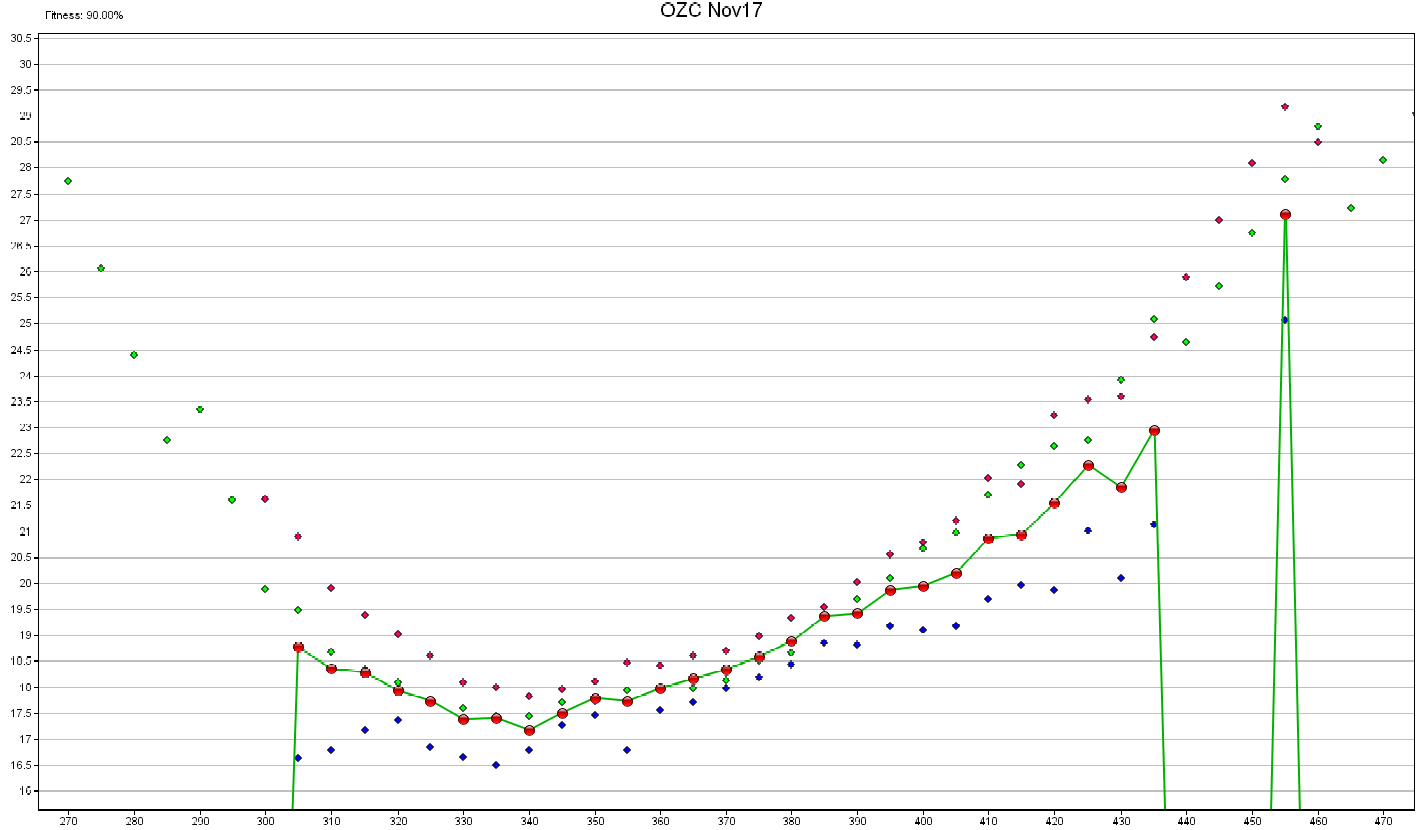
Metro Vol Curve: "Flexible Spline" – Manual Fit (trader dragging control points)
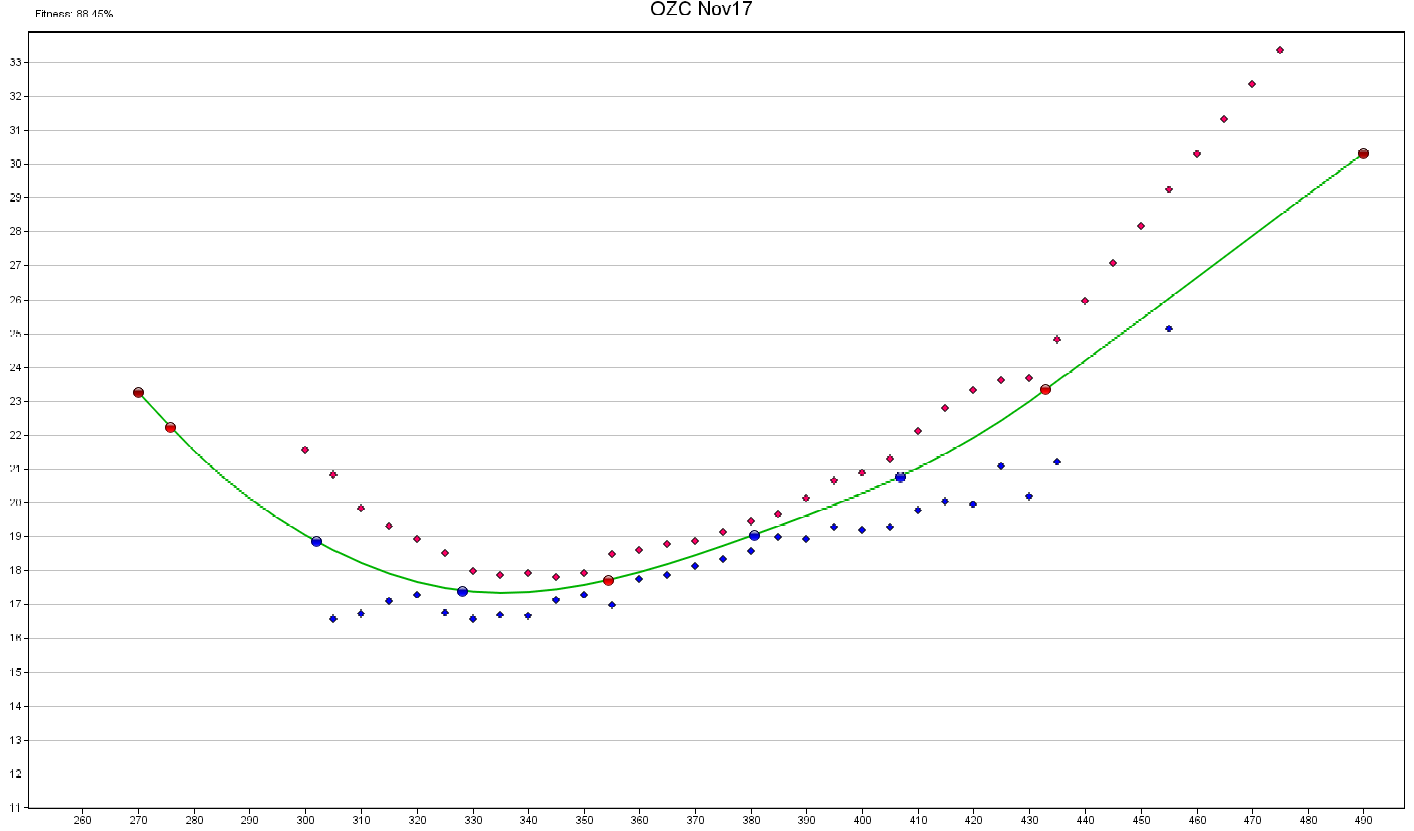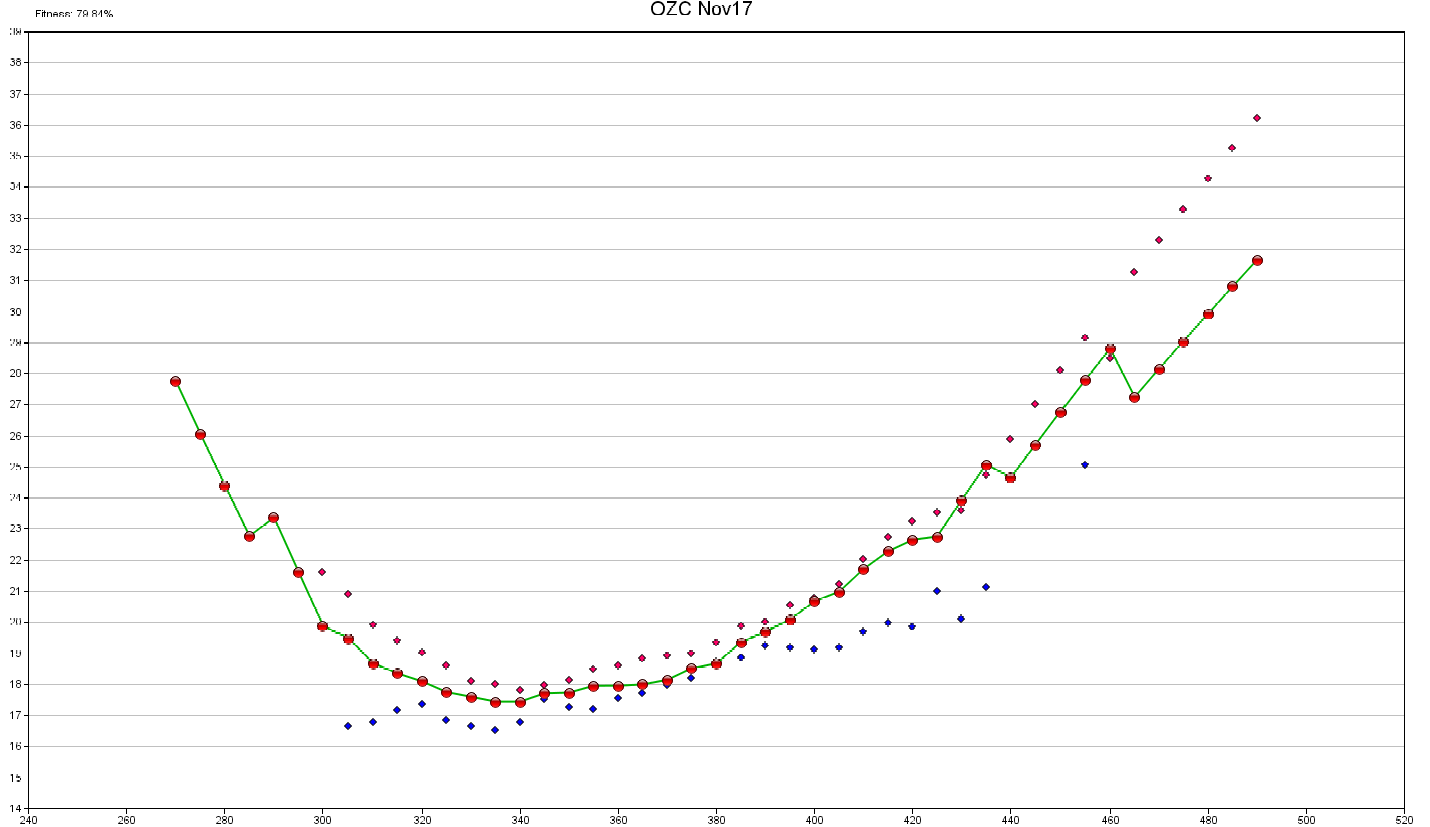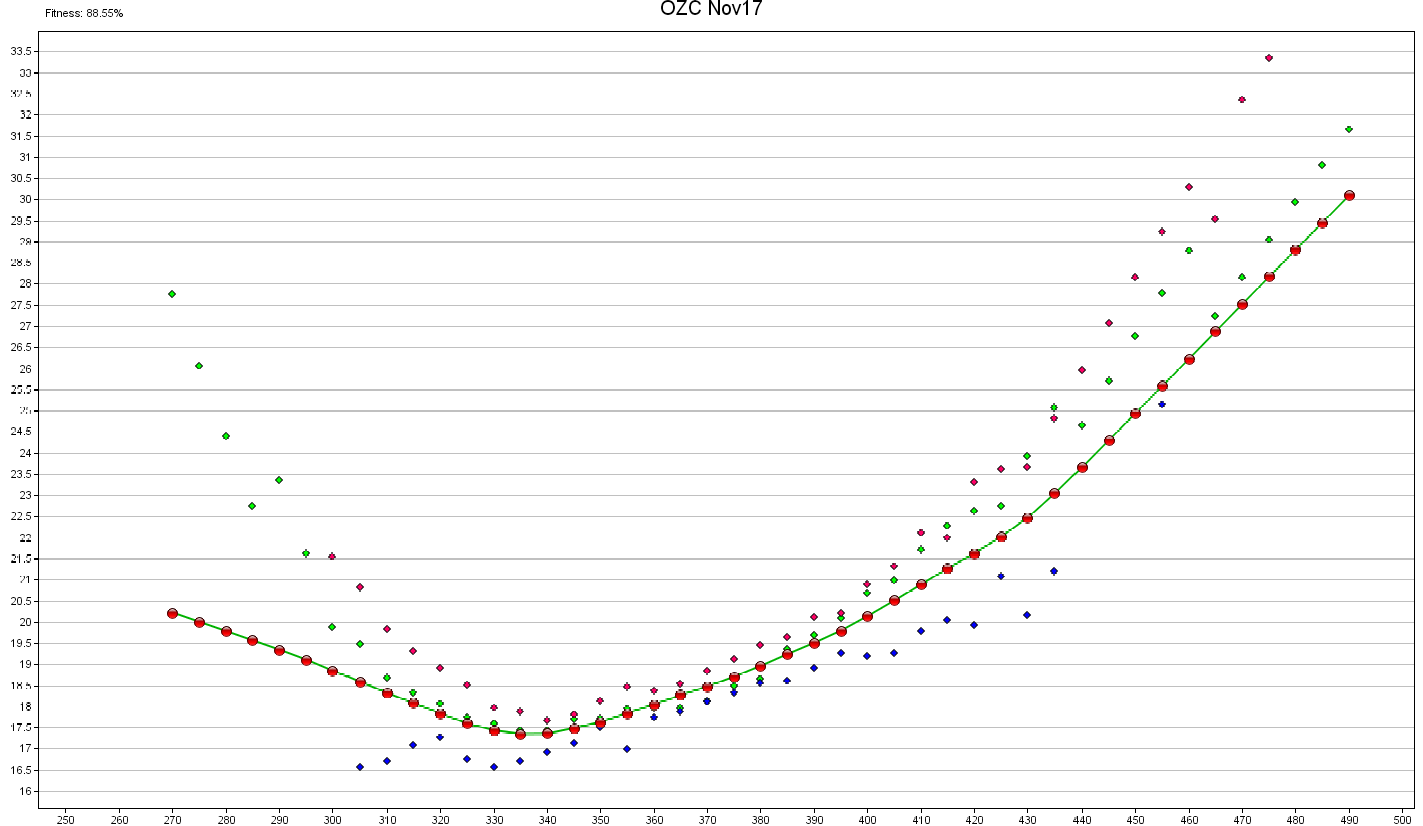
Metro Vol Curve: "Assigned" – Implied Vol Fit

Metro Vol Curve: "Assigned" – Latest Settlement Fit

Metro Vol Curve: "Assigned" – Dynamic Skew Fully Automated Realtime Fit

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Features & Benefits

- Fully automates the management and maintenance of volatility curves across all actively quoted expirations with unsurpassed precision and accuracy. This eliminates the painful task of manual adjustments throughout the day.
- Generates near perfect "fair value" implied volatility curves with customizable levels of smoothness and outlier removal. These curves are unbiased and reflect the collective opinion of the marketplace. New curves are published at a user-defined frequency that can be as often as once per second.
- Compatible with both fixed and floating skew types. For the floating skew type, the Vol Slide's path midpoint is recalibrated with every curve update. The Assigned curve type allows for maximum modeling resolution.
- Unique "multi-skew risk" functionality that enables the user to accurately track position risk with one skew type, while simultaneously trading and quoting off another.

- Fully configurable with numerous options to match the product dynamics, market conditions, and trader preferences:
  - Configurable outlier removal and curve smoothing techniques avoid over-fitting and allow excellent curve generalization.
  - Configurable curve stabilization feature allows better evolution of the vol curve through time. The Dynamic Skew algo can resist overreactions by filtering out high-frequency IV noise.
  - Two different wing treatment modes. One mode uses a robust and automatically determined linear slope ("auto-sloping"). The second mode allows a horizontal extension past the most extreme two-sided markets ("tabletopping") that is more suitable for near-expiration options.
  - Various market data filtering options allow the algo to exclude noisy or extraneous input based on book liquidity and spread width.
- Advanced tiered logic allows accurate curve reconstruction and publication during liquidity crises, even with potentially wide or missing markets.
- Includes an informative grid report that tracks significant IV data for each expiration driven by the Dynamic Skew algo. This grid exposes vol trading opportunities with objective precision.
- Perfect integration with our new complementary **"Vol Levels"** algo, for even more sophisticated tracking of IV, skew, and kurtosis. The **"Vol Levels"** algo also tracks high/low information and can display levels from multiple baseline curves. Please contact the developer at kevin@axonetric.com for more information.

Supported Metro Vol Curve Types

The DSA algo currently supports the following three Metro curve types in the Theoretical Model Wizard dialog:
- **"Thirteen Point Flexible Spline"**
  - Recommended for most products/expirations with 75+ strikes.
  - Supported "Point Type" values:
    - "Strike Price"
    - "Standard Moneyness"
    - "Standard Deviation"
  - Supported "Skew Dimension" values: "Strike" (required)
  - Supported "Pivot Type" values: "Fixed Skew" or "Float By Strike"
- **"Flexible Spline"**
  - Recommended for most products/expirations with less than 75 strikes.
  - Supported "Point Type" values:
    - "Strike Price"
    - "Standard Moneyness"
    - "Standard Deviation"
  - Supported "Skew Dimension" values: "Strike" (required)

- o   Supported "Pivot Type" values: "Fixed Skew" or "Float By Strike"
- **"Assigned"**
  - o   Has one vol curve degree of freedom per strike. Recommended for troubleshooting only.
  - o   Supported "Pivot Type" values: "Fixed Skew" or "Float By Strike"

The "Thirteen Point Flexible Spline" curve type (parameterization) is recommended for most products / expirations with 75+ strikes. The simpler "Flexible Spline" curve type may be more convenient for products / expirations with less than 75 strikes. Both of the Flexible Spline-type curves support the following two additional optional settings:
- *"control_pt_vals"*
  - o   An optional comma-separated list of X-axis values. These are ordered standard moneyness, standard deviations, or strikes, depending on the value of "Point Type." If left blank, these will be auto-assigned by the algo.
  - o   For the "Thirteen Point Flexible Spline", there must be exactly 15 values, in order, including the put and call wing slope setting points, as well as the center point.
  - o   For the "Flexible Spline", there must be exactly 9 values, in order, including the put and call wing slope setting points, as well as the center point.
- *"fs_wing_slopes"*
  - o   Optional comma-separated overrides for the put and call wing slopes, in the same units as displayed in the Model Settings page.
  - o   Specify "put wing slope, call wing slope". Either value can be blank to use the algo's automatically determined wing slope. For example, ",0.103" would set the call wing slope to 0.103, while auto-sloping the put wing.

Theoretical Model Wizard dialog

LO July 2020 WTI Crude Options – Thirteen Point Flexible Spline Curve

OZS March 2020 Soybeans Options – Flexible Spline Curve
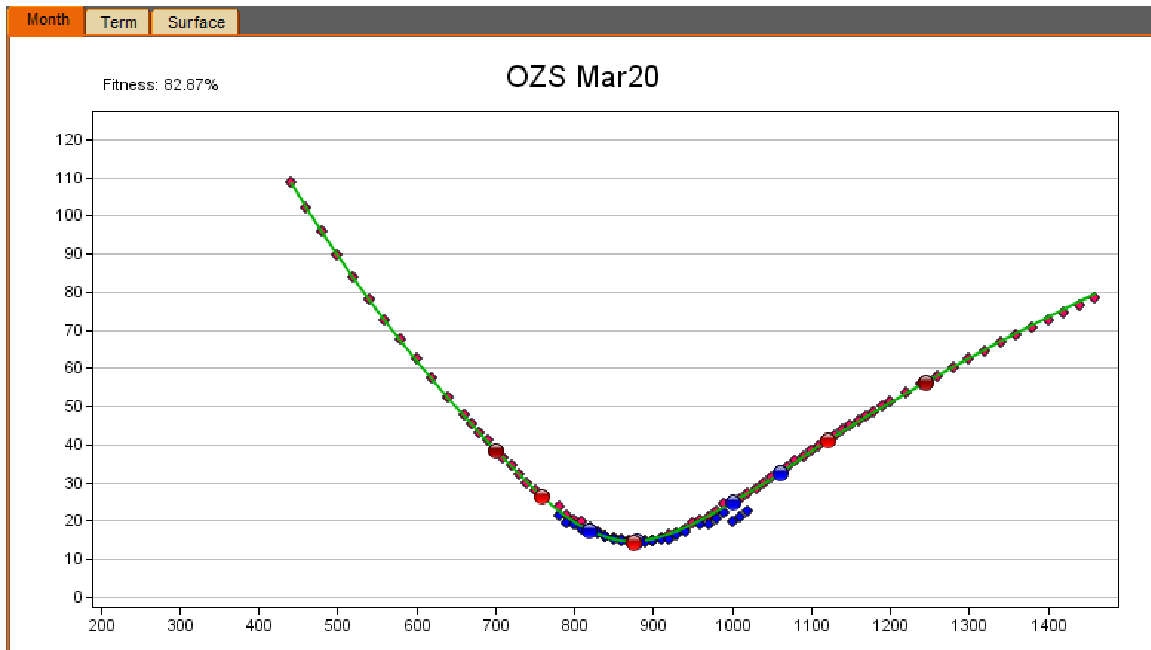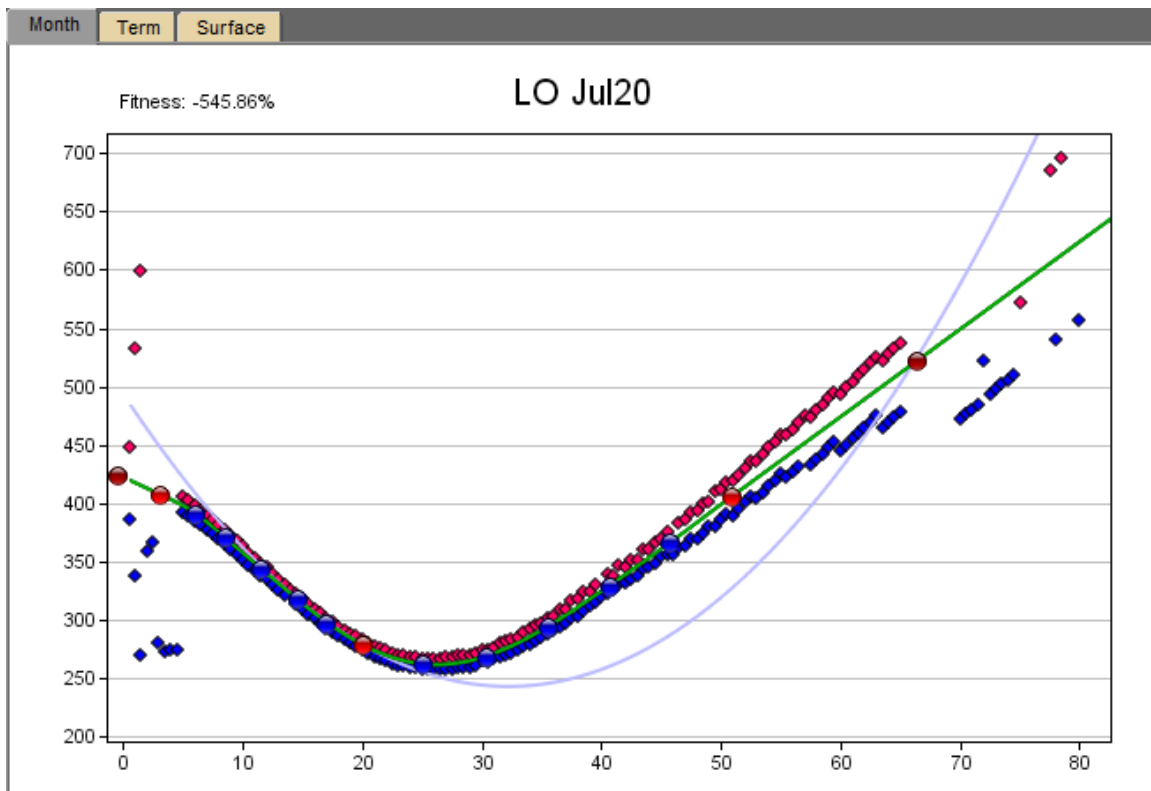
Vol Curve Publication Frequency

The Dynamic Skew algo (DSA) uses a proprietary variable-frequency update strategy that minimizes the error between the currently published vol curve and the current market's implied volatility curve, while also minimizing the total number of vol curve updates. The trade-off between this joint optimization is controlled by the *"curve_update_sensitivity"* setting, which accepts a value between 0.0 and 10.0. Regardless of this setting, the maximum frequency any DSA job can publish a new vol curve is once per second, and the minimum frequency is once every minute (even if the market is completely quiet). While the average update frequencies will vary depending on market conditions, the following table shows some typical values:

curve_update_sensitivity	average time between updates	maximum update frequency
0.0	~1 second	one publish per 1 second
3.0	~3 seconds	one publish per 1 second
5.0	~7 seconds	one publish per 3 seconds
7.0	~20 seconds	one publish per 5 seconds
10.0	~55 seconds	one publish per 8 seconds

In general, the optimal setting depends on the total number of DSA jobs running on the server. With a high job count, users will want higher values for this setting (to reduce the total number of vol curve publishes hitting the server across all jobs). If the DSA job count on the server is low, then users may want lower values for this setting (for faster responses to IV changes). Users with a very high DSA job count on the server may also consider using the following codes in the *"special_flags"* setting to further slow down the vol curve update frequency:

- "SLOW20"
  - This optional flag forces the internal throttle (maximum update frequency) to be no more than one vol curve publish per 20 seconds.
- "SLOW40"
  - This optional flag forces the internal throttle (maximum update frequency) to be no more than one vol curve publish per 40 seconds.

Vol Curve Evolution Over Time

Implied volatility curves generally exhibit both continuity and mean-reversion over various time scales. However, during important events (e.g., an industry report, etc.), abrupt and sudden shocks may occur. The Dynamic Skew algo contains sophisticated proprietary logic to generate an accurate evolution of the published vol curves over time. The setting that controls this is aspect is *"temporal_smoothing"*, which accepts a value between 0.0 (no curve stabilization) and 10.0 (highest curve stabilization).

Note that this setting does not affect the number of vol curve publications, but rather the degree of change produced by each vol curve publication. However, internal logic does contain an interaction with the vol curve publication frequency in the following sense: If a longer time has elapsed since the last vol curve was published, the more degree of change is permitted within the current update (regardless of the *"temporal_smoothing"* value). The default value of *"temporal_smoothing"* is 3.0; traders can experiment if a different value is preferable in their product.

Vol Curve Smoothing

There are two independent smoothing mechanisms that together control the (graphical) vol curve smoothness (i.e., degree of curve complexity). The primary mechanism is a proprietary feature controlled by the *"spline_smoothing"* setting, which accepts a value between 0.0 (none) and 10.0 (most). This feature removes discontinuities from the vol curve, producing smoother and simpler curves that present less noise. The optimal value for a given expiration depends on the curve shape and also usually on the remaining time to expiration. The higher the setting, the more pronounced the smoothing effect is. Too large of a *"spline_smoothing"* value may cause distortions in the curve from over-smoothing. Sharp curvature (e.g. V-shaped curves) will require much smaller values than gentle curvature (e.g. U-shaped curves). This value may require maintenance on a periodic basis.
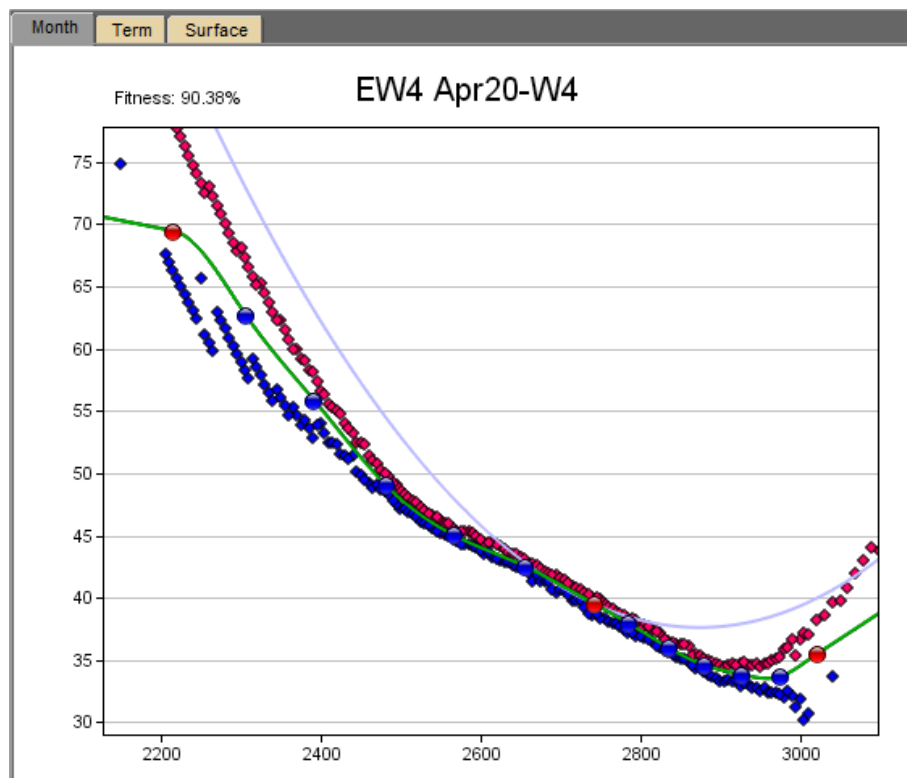
E-mini S&P 500 April 2020 weekly options – Spline smoothing reduces noise

The *"spline_smoothing"* setting works in tandem with the *"model_detail"* setting, which controls the level of detail for the internal smoothing model. This setting has an effect on both the results of the smoothing and the CPU usage for the internal mathematics. The *"model_detail"* setting accepts the following values:

- "Low"
  - This modeling option requires about 4x to 8x less CPU cycles than "Normal". This option works best for non-complex vol curves with gentle U-shaped curvatures.
- "Normal"
  - This modeling option works for most products and expirations. However, for sharp V-shaped vol curves, Normal model detail may be insufficient to prevent an upward bias near the curve vertex (strike with the lowest IV), as shown in the images below.
- "High"
  - This modeling option requires about 4x to 8x more CPU cycles than "Normal". This option may be required for complex vol curves, or those with sharp V-shaped curvatures, such as those near expiration.

LO November 2020 WTI crude near expiration options (zoom-in to curve vertex)
With *model_detail* = Normal
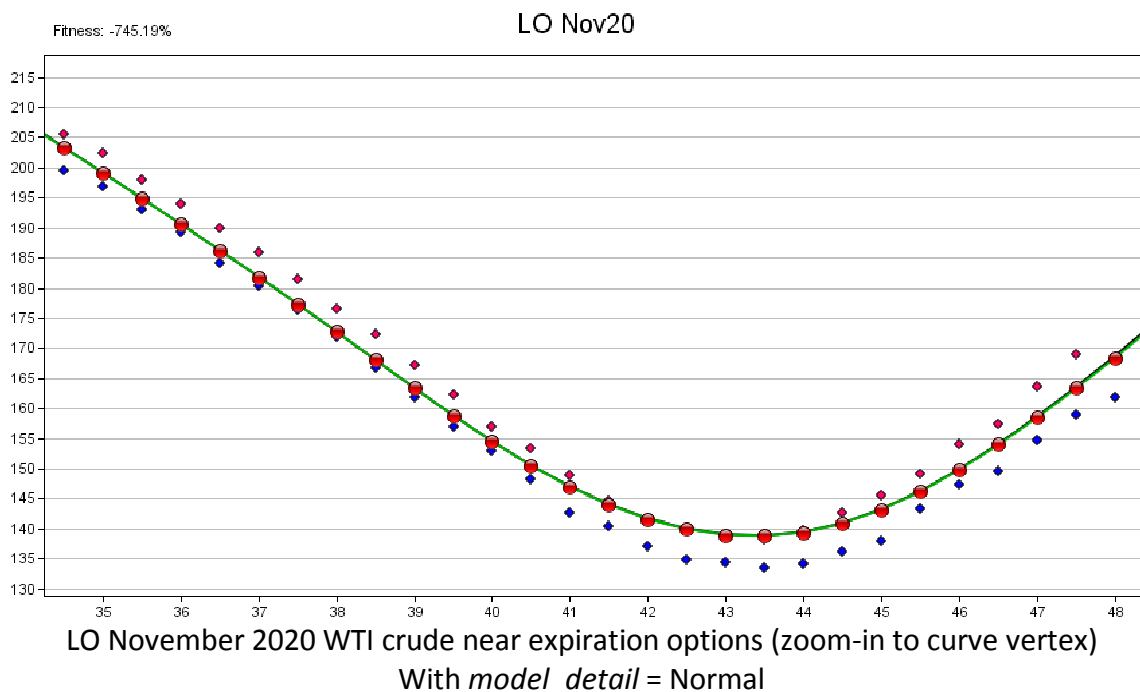
While the V-shape is not very apparent in the above image because of the zoom-in, these near expiration options do have an overall sharp V-shape (as seen if zoomed out). Because of this, Normal model detail cannot perform the spline smoothing without introducing an upward bias near the curve vertex, as shown in the above image. To eliminate this bias, High model detail must be specified here (see below image).
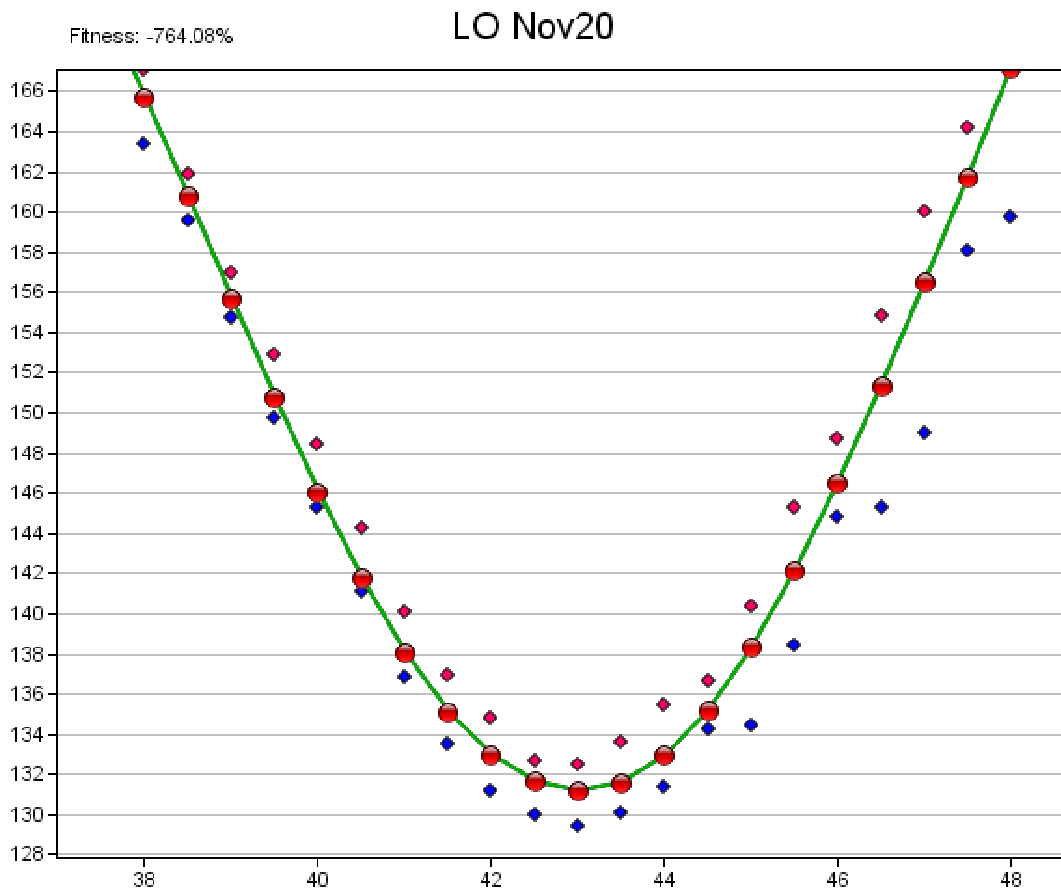
LO November 2020 WTI crude near expiration options (zoom-in to curve vertex)
With *model_detail* = High, the upward bias near the vertex is fixed

 An optional, independent, supplemental smoothing mechanism is controlled with the *"kernel_smoothing"* setting. This kernel-based smoothing feature may increase the quality of the smoothed curve in some cases. However, too high of a value may produce some distortion in U-shaped or V-shaped curves near the vertex (similar to the upward bias previously shown). Recommended values are 0-8 or so, depending on the apparent level of distortion and the density of option strikes. This feature has a fairly stable effect and so usually does not require frequent adjustment.

A technique that usually works well is to first find the optimal *"spline_smoothing"* and *"model_detail"* settings (while *"smoothing_amount"* = 0). This may require some trial and error. Once these optimal values have been established, then the user may choose to increase the supplemental *"kernel_smoothing"* setting value if needed. If not needed, it can be left at zero with no disadvantage. The optimal smoothing settings may change as the days remaining to expiration decrease.
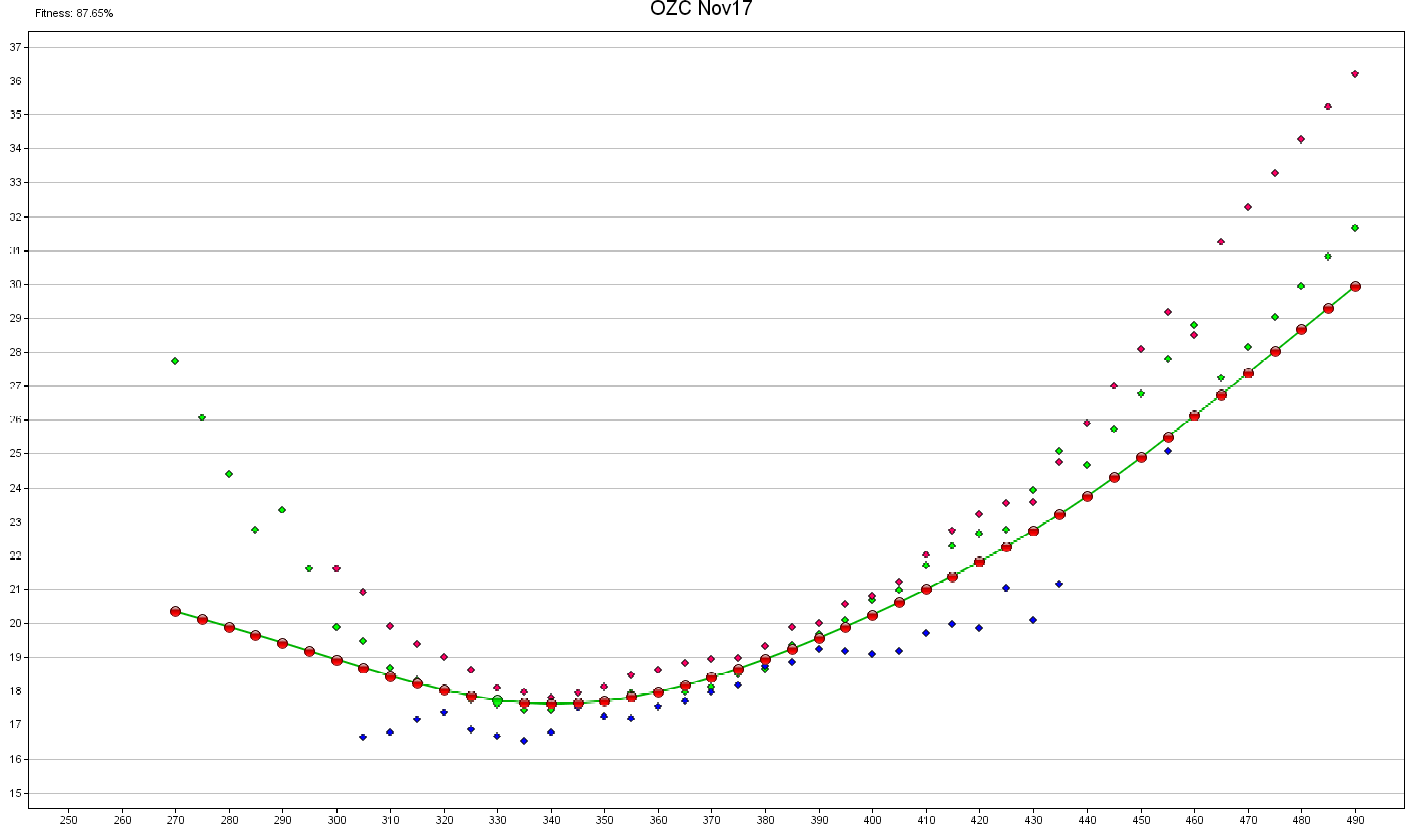
OZC November 2017 Corn Options – Dynamic Skew Fit With High Smoothness Due To Spline Smoothing And Kernel Smoothing Both Applied

Curve Reconstruction Feature

The DSA contains curve reconstruction logic (a.k.a. the "reconstructor") that allows the algo to better deal with temporarily missing markets or bad market data. This feature allows the algo to remember a previous curve (known as a "master pattern" or template), which previously scored highly in certain metrics of quality. The master pattern is remembered even if the algo is stopped or the server is rebooted. The master pattern can be used to recreate missing bids or asks, which is especially useful if there is a sudden liquidity crisis and many markets are pulled.

The following Configuration settings affect various aspects of the reconstructor:
- Special flag "KEOD" will prevent any new master pattern from being selected during the evening session. Assigning this flag will force the algo to use the final master pattern from the day session for the entire evening, which may be beneficial in many products where evening session's markets are less reliable that the day session's markets.

- Special flag "RESET" allows the user to force the algo to delete any previous saved master pattern from the database. This will usually cause the algo to quickly establish a new master pattern once the algo is restarted (assuming the markets are open, which is a prerequisite to establishing a new master pattern). This flag can be useful in the uncommon event the algo has established an invalid or corrupt master pattern.
- Debug flag "XRECON" can force the algo to omit the curve reconstruction logic altogether. This flag was added for development and testing purposes and is not recommended for general use without a specific reason. In most cases, the reconstructor is a highly beneficial feature.
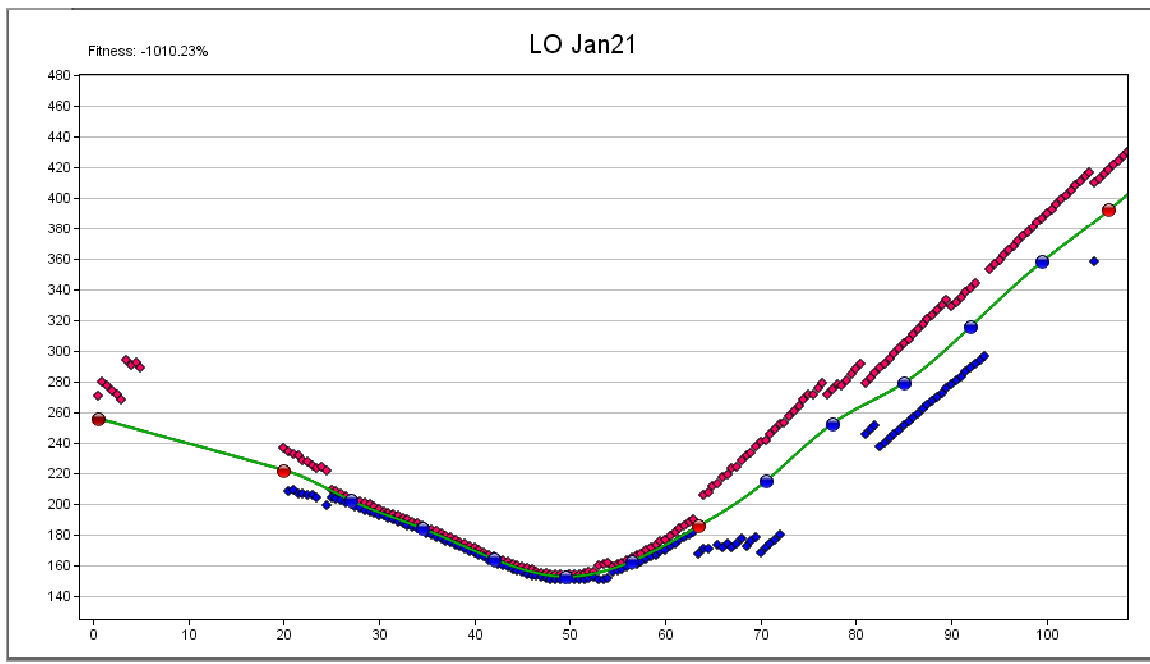
LO January 2021 WTI Crude Options
The reconstructor allows the DSA to handle missing markets & gaps

Wing Treatment

The algo offers two different modes for handling the curve's wings. The primary default mode is "auto-sloping" and this involves a robust and sophisticated algorithm to automatically compute the optimal slope of the put and call wings (independently). This mode usually works quite well. But note that adjusting the market data filtering parameters (see next section) can also affect the results produced by auto-sloping. For Flexible Spline-type curves, the trader can also manually override either/both wing slopes using the *"fs_wing_slopes"* setting (previously discussed).

The other wing treatment mode is called "tabletopping" and this performs a simple horizontal extension of the most outward valid two-sided market that exists on a given wing. Note that the precise strike that becomes the most outward valid two-sided market does depend somewhat on the specified market data filtering settings (see next section). To enable tabletopping mode on either wing (independently), use the checkbox flags *"PUT_TBLTOP"* and/or *"CALL_TBLTOP"* in the algo's configuration. Tabletopping is most useful close to expiration or when the number of quoted strikes with two-sided markets is very small. Tabletopping is always available as a fallback mode if the auto-sloping behavior is not satisfactory.

The setting *"iv_upper_limit"* can also be useful in auto-sloping mode. This setting defines the maximum IV value allowed anywhere on the curve and therefore provides a sort of (auto-sloping + tabletopping) hybrid mode, where the tabletopping behavior at the wings can occur at a user-defined location much higher up the Y-axis (IV) than would occur by using the *"PUT_TBLTOP"* and/or *"CALL_TBLTOP"* checkbox flags. This can be useful, for example, if an expiration has very-far-out calls that actually come down in IV relative to the primary call slope defined by the calls at closer wing strikes (forming a shape more like a bird wing).
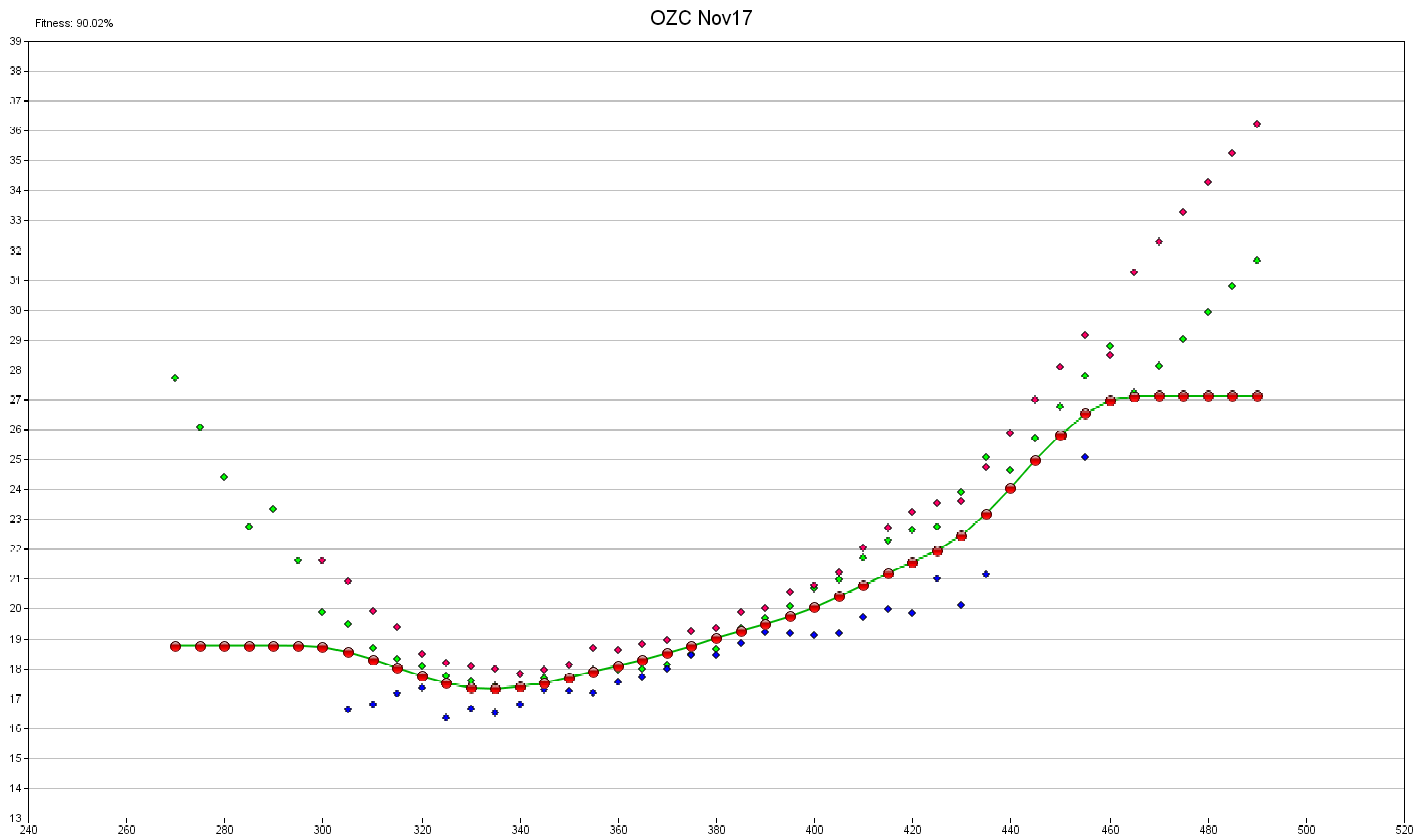
OZC November 2017 Corn Options – With Tabletop Flags Set For Both Wings

Market Data Filtering

These settings detailed in this section are very important as they help the algo determine which outright option markets (and thus, which IVs) are valid and also allow the algo to detect liquidity crises (abnormal widening in options markets). These settings are product-specific and also depend on time to expiration to some degree.

The first setting is *"option_min_size"* and this controls the minimum size required on a bid or ask near ATM in order to accept that price level as valid. As strikes move away from ATM, the algo internally tapers this value down towards 1 at the wing extremities. If a given market side does not have enough size, the algo will progressively examine deeper levels of the book until enough aggregate size has been encountered to meet the criterion. For example, if the user specified 3 here and an outright ATM option had a top-of-book bid showing 1 contract only, then the algo would look at the next price level directly below the bid. Let's say there were 2 contracts showing here. The algo would then accept this 2nd price level as the valid bid because the aggregate size (1 + 2) >= *"option_min_size"* (3 here).

If not enough size is available in the whole book on a given market side, the algo will act as if the price is simply missing on that side. This setting can make the algo more robust by filtering out non-informative small bids and asks. But avoid setting this value too high—excluding too much market information can adversely affect the modeling. In many markets, a setting of 5 to 10 (or less) is sufficient. In the front month of highly liquid options (e.g. Treasury notes or bonds), substantially higher values are reasonable—but always err to the lower side with this setting if unsure.

The second setting is *"option_max_spread_width"* and this constraint is only applied after the effects of *"option_min_size"* have already been applied on both the bid and ask sides. This criterion requires that the size-validated bid and ask price levels of two-sided markets at an outright option strike cannot be further apart than the specified value (in tick units). This value applies to the spread widths near ATM—as strikes move away from ATM, the algo internally tapers this value down to 50% of the setting at the wing extremities.

A good rule of thumb is to set this value to around 2.5 to 3.0 times the typical spread width (in option ticks units) of options near ATM. Setting this value too low is dangerous because it could filter out too many legitimate strikes and thus rely too heavily on model reconstruction instead of actual market data. Setting this value on the higher side is not as big of an issue because the DSA will internally "ratchet down" this spread width criterion value if the markets are sufficiently tight. Thus, it is recommended to err on the higher side with the *"option_max_spread_width"* setting.

If the average spread width over all OTM markets in the 5-55Δ range exceeds the user-specified *"option_max_spread_width"* setting, the algo assumes there is currently a liquidity crisis and all normal curve publications will be skipped. Instead the algo will enter "dual-axis sliding mode" and will remain in this mode until the average market tightness falls back inside the *"option_max_spread_width"* setting. In dual-axis sliding mode, the algo does <u>not</u> create any new curves from market IV info (which is likely unreliable), but instead "slides" the last known good curve around on the X-axis (to match the current underlying price) and (optionally) the Y-axis (to match the best estimate of the current ATM vol, if a reliable estimate is available). In other words, if all markets widen out excessively, then the algo enters dual-axis sliding mode and simply shifts the last known good vol curve up/down and left/right to match the ATM vol point as best as possible.

The third setting is *"future_min_size"* and works identically as *"option_min_size"* except on the futures spread quantities. Because the underlying price is an input to the IV function, this could have a small impact on the resultant IVs. Usually a value around 5 works fine here, but options traders in products with more liquid underlying futures could specify a greater number of futures contracts here. But always err to the lower side with this setting if unsure.

Risk Control Features

Various safety features in Dynamic Skew work together to filter out and minimize the possibility of a bad vol curve publication. In general, the algo will skip any proposed vol curve publication that triggers any of the safety features and will try again after the next update is triggered.

As previously explained, the first safety feature is called <u>liquidity crisis detection</u>. This important feature examines the primary central region of the vol curve prior to each update and computes the average spread width on these outright options. This value is then compared with the user's *"option_max_spread_width"* setting. If the average market spread width is greater than this value, then it is defined as a liquidity crisis event and the normal vol curve update is skipped; instead the algo will temporarily enter "dual-axis sliding mode" (see previous section) until markets tighten down to normal again.

The second safety feature is called <u>vol curve shape detection</u>. This feature is based on the premise that any two consecutive vol curves should not radically differ in shape. Mathematical calculations detect the relative shape of the curve (note that absolute vol values are not incorporated, only the relative shape across the curve) and will skip any update that appears to substantially differ in shape. The algo also remembers the last published curve prior to the algo being stopped, so when the algo is restarted, the first

curve will also be subject to the shape constraint (unless excessive time has elapsed). The special flag "RESET" can be specified in the algo's configuration to force the algo to forget the prior closing curve's shape after any server reboot and/or algo restart (although this setting is not recommended for continual use, as it would also erase the reconstructor's master pattern and other saved data).

The third safety feature is called <u>snap mode</u>. Briefly, this feature prevents the algo from lagging the market excessively if the actual overall vol curve moves vertically in a rapid and sustained (not transient) way. Note, however, that the expected time to the initial detection of such a condition is still dependent on the *"curve_update_sensitivity"* setting.

The fourth safety feature is called the <u>per-strike max vol delta constraint</u>. Large transient vol moves in just one strike (or just a few) may represent an impending liquidity crisis. If any strike has a $|(IV_T - IV_{T-1})| > (\%\ constraint)$, it violates this rule and the entire vol curve update will be skipped. If the violation continues to persist longer than 12 seconds in only "wing" strikes, then this constraint will temporarily be relaxed. However, if the violation continues to persist longer than 10 minutes at any non-wing strike, the algo will turn itself off as a safety mechanism (and also perform job exit signaling as described below).

The fifth safety feature is called <u>theo protection</u>. This feature examines the % of non-wing strikes where the proposed vol curve update would produce a vol value outside the market's current bid-ask IV band. The % threshold is hard-coded and varies between 30% and 50% depending on the number of interior (i.e. non-wing) strikes. Proposed vol curve updates with excessive violations will be skipped. If theo protection violations trigger consecutively and continuously for over 10 minutes, the algo will automatically self-abort.

The sixth safety feature is configurable and is controlled by the *"on_job_exit"* setting. It is obvious that any unanticipated algo stoppage / exit could be dangerous as the vol curve for the affected options expiration will become stagnant at that point. This setting therefore controls the behavior the algo takes directly before exiting (regardless if the algo stoppage was manually requested, or occurred unexpectedly for any other reason). If this safety feature is turned on, then the algo will send out a series of signals notifying Metro and some other important missions / algos of the aborted vol curve handling. The notified components include the following:
- Metro CityCenter: any mass quoting of outrights or options strategies for the affected vol curve expiration will be deactivated automatically.
- Metro RFQ Responder Mission: automatic RFQ responses should be halted for the affected vol curve expiration.
- Axonetric LLC Profiteer Engine Algo: all active missions that involve any instruments with the effected options expiration (or optionally, the whole

symbol) will be automatically deactivated. Profiteer algo version 4.06 or greater is required for compatibility.
- Axonetric LLC Auto-RFQ Algo: all active missions that involve the affected options expiration (or optionally, the whole symbol) will be automatically deactivated. Auto-RFQ algo version 2.25 or greater is required for compatibility.

A seventh optional safety feature is toggled by the *"CONVEXITY"* checkbox flag. If this checkbox is checked, the algo will only publish curves that meet the convexity criterion. This criterion is defined as follows: From the strike with the lowest IV on the curve (the vertex), the curve must be monotonically increasing in both directions outward (toward each wing). Note that some products are fundamentally not convex and therefore this flag should never be set in those products (otherwise no vol curve publications will ever occur).

An eighth optional safety feature is toggled by the *"EXTREME_VOL"* checkbox flag. If activated, this feature enables alternate pathways that prioritize overall curve quality control, instead of the normal priority on optimal curve fit and curvature. Under normal market conditions, this flag should not be used. Only during periods of *extreme market volatility*, when IV spreads are *very wide*, should this flag be used. While there is no guarantee that the DSA will always be able to produce reasonable curves under extreme vol conditions, activating this flag will allow it to do a much better job than it would otherwise (under extreme vol conditions only).
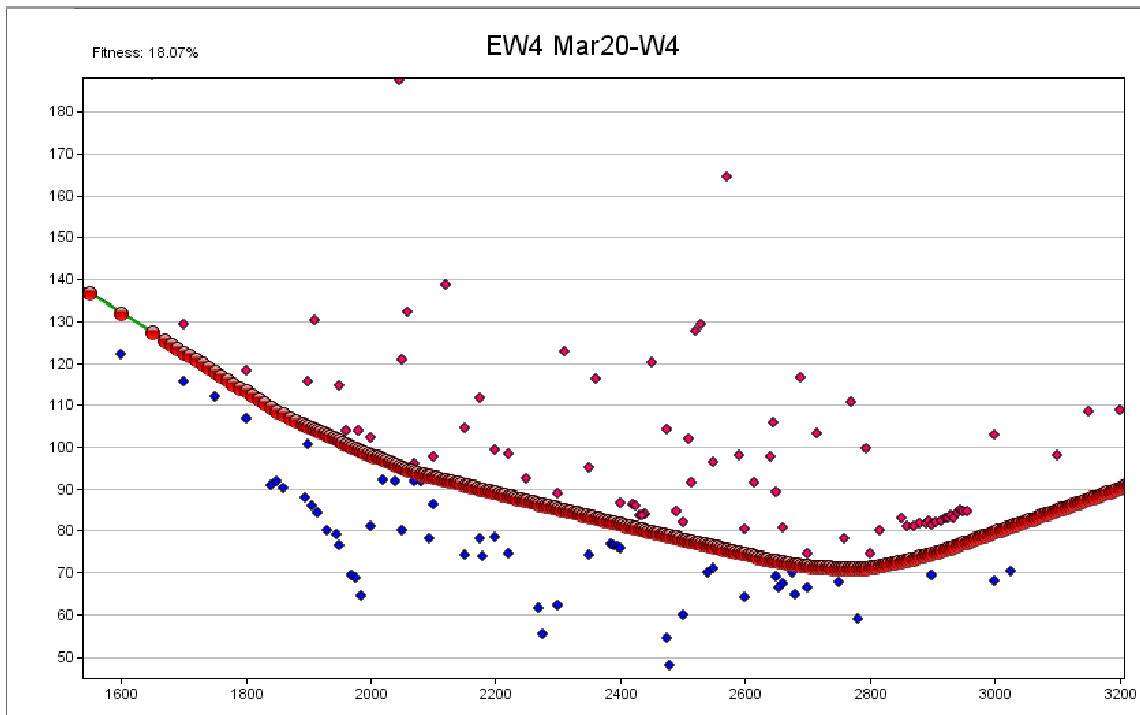
E-mini S&P 500 March 2020 Weekly Options – Usage of the *EXTREME_VOL* flag allows the DSA to generate a reasonable curve during the pandemic crash

"Multi-Skew Risk" Functionality

The Dynamic Skew algo offers an innovative way to have a separate (independent) risk management vol curve and execution vol curve. This capability is realized by using a Metro Artificial Options Symbol in conjunction with a portfolio syncing / trade copying feature available in the algo. Some traders like the idea of executing on realtime Black-Scholes-like greeks (fixed skew), while simultaneously being able to monitor position risk with adjusted greeks derived from a vol path (floating skew). Note that the two vol curves need not be the same curve type (e.g., one curve could be Assigned and driven by the Dynamic Skew algo, while the other could be Flexible Spline, for example, and subject to manual adjustment and publication via the Model Settings page). Please note one limitation is that quoting and RFQ responding are not allowed on the artificial options symbol (although options orders are allowed and will be correctly routed to the real symbol for execution).

To demonstrate some of the various possible configurations, consider the real options symbol "LO" and an artificial options symbol the trader has created named "LOX" (which essentially clones the LO instruments under a new user-specified symbol).

Configuration Example 1
- Execution symbol LO is run with a fixed Assigned curve type, driven by the Dynamic Skew. Quoting and order execution occur normally on LO. Position and trades are synced by the algo over to the LOX artificial symbol, which is running a floating Assigned vol curve type. The algo is also configured to sync the LOX floating curve (to mirror the fixed curve on LO), as well as recalibrate the center point of the LOX vol path (slide). Trader can view accurate risk on his position via the adjusted greeks analyzed on LOX position (which is identical to his LO position). The live risk bar displaying the adjusted greeks of the copied LOX position can be pinned to the LO tradesheets for convenience.

Configuration Example 2
- Execution symbol LO is run with a fixed Assigned curve type, driven by the Dynamic Skew. Quoting and order execution occur normally on LO. Position and trades are synced by the algo over to the LOX artificial symbol, which is running a floating Flexible Spline (or Two-Sided or any other type) vol curve. The algo is not configured to sync the LOX floating curve—instead the trader is responsible for manually adjusting and publishing changes to the LOX curve and/or vol path at whatever frequency deemed fit. Trader can view accurate risk on his position via the adjusted greeks analyzed on LOX position (which is identical to his LO position).

Configuration Example 3

- Execution symbol LO is run with a floating Flexible Spline (or Two-Sided or any other type) vol curve, manually updated and published by the trader. Concomitantly, the Dynamic Skew algo is configured to run only on the LOX floating (or fixed) Assigned curve. No trade or position syncing takes place in this scenario. The trader can now open two different tradesheets, one for LO (under his control) and one for LOX (automatically modeled and updated by the Dynamic Skew algo). Trader can execute like normal on LO while also watching the LOX sheets for confirmation of his decisions. Trader can also run order-based execution algos on LOX (such as Target Finder or Profiteer algo), but he cannot quote or RFQ respond on LOX.

After the artificial options symbol has been properly created in Metro, the algo setting *"copy_trades"* can be specified in the format FromRealSymbol -> ToArtificialSymbol. For example, the setting "LO->LOX" will (unidirectionally) sync any existing position from LO to LOX in the expiration the algo is responsible for, as well as copy all trades in realtime (while the algo is running) from LO to LOX in the expiration the algo is responsible for.

The optional checkbox flag "SYNCCURVE" will determine whether or not the algo also updates the vol curve (and vol path for floating curve types) for the "To" artificial symbol specified in the *"copy_trades"* field (LOX in this example). If specified, the checkbox flag "SYNCCURVE" will ensure that the LOX vol curve is updated to mirror the LO curve approximately once per minute. The "SYNCCURVE" updating of the artificial symbol's vol curve will never happen more frequently than once per minute (regardless of the *"curve_update_sensitivity"* setting); this helps produce stable adjusted greeks on the artificial symbol's copied position by not excessively updating the vol path.
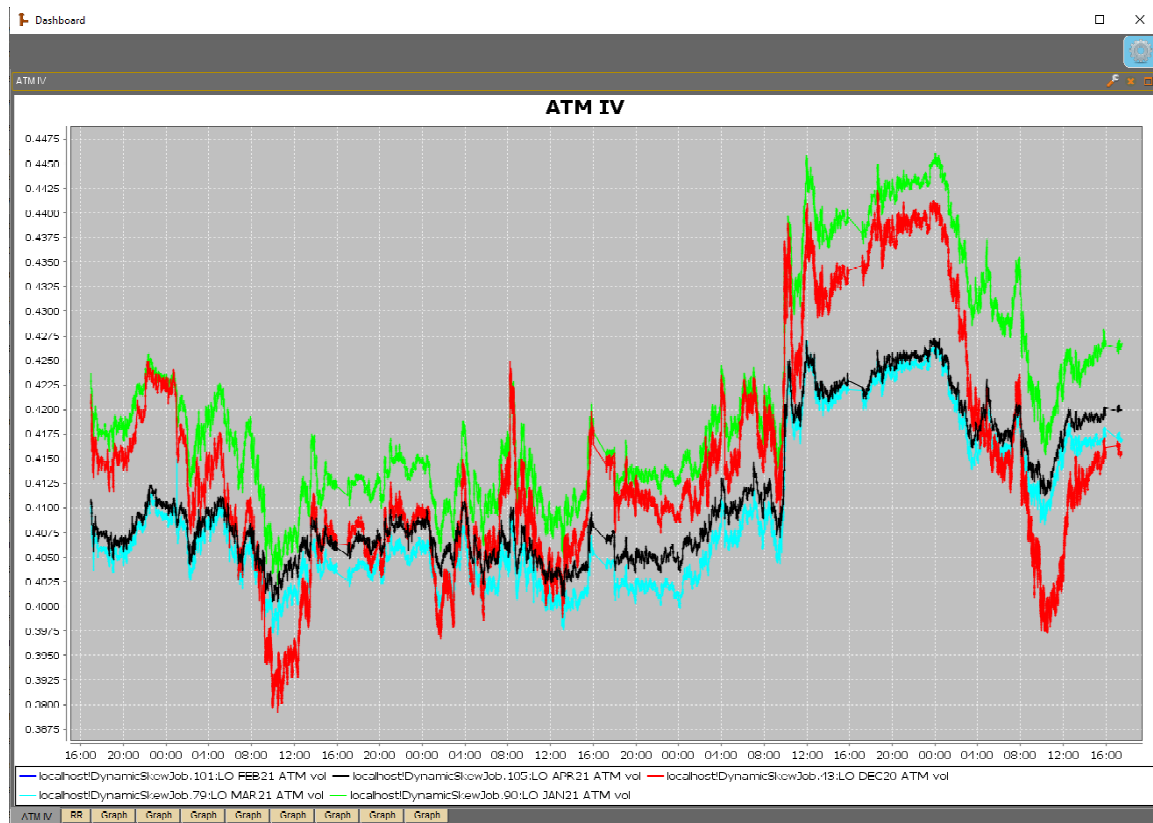
Vol Report Grid & Charting

The algo offers an informative grid report that tracks significant IV data for each expiration driven by the Dynamic Skew algo. This grid exposes vol trading opportunities with objective precision. The dashboard can be obtained via the "Load Dashboard From Server Template" menu item in Metro (after right-clicking on the winding road icon). All active Dynamic Skew job instances will report their vol statistics to the same grid, so information from the whole term structure (and possibly multiple products) is available in just one location.

This valuable market data tool displays industry standard measurements of volatility curve steepness and skew levels. It allows the trader see the "big picture" of a product's volatility, skew dimensions, and cheapest strike. Values accompanied with time-stamped high-low ranges enable the trader to identify mean-reverting trade opportunities as well as relative value plays across the term structure. Live and accurate

data in the matrix format makes it easy to spot relevant items that may be mispriced. Importantly, the report grid will also display "---" dashes in the "Last Publish" column if and when any normal vol curve update is skipped.

Reported stats for each expiration include: 50Δ Vol and its Range (tracked high and low since algo last started), Cheapest Strike and its vol, +25Δ Vol and its Range, -25Δ Vol and its Range, Normalized Skew value and its Range, +5Δ Vol and its Range, -5Δ Vol and its Range, time elapsed since the last normal vol curve publication, the current Underlying price, and a realized volatility metric on the underyling. The realized volatility metric on the underlying is a 1-hour moving window of price range (high-low) as a percentage of the current price. See the next page for an example screenshot.

The DSA also allows real-time charting of the ATM implied volatility and the 25Δ risk reversal. See the Appendix section for instructions on how to configure these charts.

LO WTI Crude Options – Realtime ATM IV of the front term structure

Dynamic Skew Dashboard

Dynamic Skew Report

	Key ▲	Expiry	ATM Vol	ATM Low	ATM High	Cheapest Strike	25d Call
...	LO 2019-07-17	AUG19	31.42	31.23 (-14.0 m)	35.90 (-17.3 h)	60 / 30.21 / 23.37	-1.13
...	LO 2019-08-15	SEP19	31.43	31.25 (-49.8 m)	33.85 (-14.6 h)	63.5 / 29.34 / 17.73	-1.68
...	LO 2019-09-17	OCT19	31.08	30.97 (-17.4 m)	33.11 (-10.9 h)	67 / 28.24 / 13.18	-2.14
...	LO 2019-10-17	NOV19	30.73	30.65 (-48.7 m)	32.61 (-13.5 h)	69 / 27.44 / 12.40	-2.43
...	LO 2019-11-15	DEC19	30.51	30.47 (-12.6 m)	32.19 (-10.9 h)	70.5 / 26.88 / 12.08	-2.58
...	LO 2019-12-16	JAN20	30.61	30.50 (-49.8 m)	32.17 (-19.2 h)	71.5 / 26.66 / 12.48	-2.78
...	LO 2020-01-15	FEB20	30.14	30.10 (-5.5 m)	31.64 (-14.4 h)	74 / 25.89 / 10.09	-2.88
...	LO 2020-02-14	MAR20	29.79	29.75 (-5.6 m)	31.22 (-14.8 h)	75.5 / 25.34 / 9.32	-3.08
...	LO 2020-05-14	JUN20	29.06	28.95 (-1.4 h)	30.04 (-13.1 h)	75.5 / 24.03 / 10.75	-3.29
...	LO 2020-11-17	DEC20	26.90	26.83 (-1.4 h)	27.82 (-4.2 h)	79.5 / 21.97 / 9.54	-3.14

Discard Changes

25d Ca...	25d Call ...	25d Put	25d Pu...	25d Put High	Normalized Skew	NS Low	NS High	5d Call
-1.62	-0.69	2.51	1.58	3.23	-11.60	-13.11	-7.76	2.71
-2.23	-1.62	3.20	3.09	3.74	-15.63	-17.54	-15.00	-0.14
-2.44	-1.99	3.53	3.33	3.86	-18.40	-19.20	-17.06	-1.54
-2.75	-2.30	3.72	3.42	3.91	-20.23	-21.08	-18.71	-1.75
-2.87	-2.47	3.71	3.40	3.87	-20.90	-21.40	-19.25	-2.12
-3.08	-2.70	3.79	3.52	3.95	-21.83	-22.50	-20.20	-2.40
-3.35	-2.74	3.70	3.43	3.86	-22.25	-23.11	-20.86	-3.06
-3.34	-2.92	3.62	3.31	3.87	-22.95	-23.45	-21.32	-3.26
-3.52	-3.07	3.31	3.08	3.60	-23.25	-23.85	-21.84	-3.86
-3.47	-3.06	2.83	2.37	3.07	-22.81	-23.93	-21.09	-3.38

5d Call...	5d Call H...	5d Put	5d Put ...	5d Put H...	Underlying	...
1.30	3.18	10.07	9.40	11.86	57.31 / 0.90%	...
-1.62	0.13	10.23	9.83	11.39	57.42 / 0.88%	...
-4.26	-1.14	10.37	8.34	11.07	57.42 / 0.88%	...
-4.61	-1.46	10.39	10.01	11.17	57.34 / 0.86%	...
-2.62	-1.67	9.87	9.49	10.55	57.24 / 0.93%	...
-4.11	-2.33	9.77	9.40	10.39	57.05 / 0.93%	...
-6.34	-2.84	9.19	8.82	9.95	56.84 / 0.89%	...
-7.05	-2.94	8.59	8.18	9.58	56.62 / 0.87%	...
-4.53	-3.32	8.42	7.30	8.89	55.62 / 0.72%	...
-3.78	-2.18	6.37	5.69	7.22	54.75 / 0.59%	...

Vol Report Grid (screenshot split horizontally in thirds for readability)

Configuration Options

The example screenshot below shows the job-defined Configuration options for one job instance (a single expiration). Each job instance of the algo handles one specific product and expiration. Note that because each options expiration requires its own separate algo instance (a.k.a. "job"), it is advisable to type in the product and expiration in the algo's *"Description"* field (one of the system-defined variables) so that the mapping between any algo job instance and its product+expiration can easily be discerned from other Metro screens, such as the Job Control screen. Note that some of these settings may be hidden from view while the "Simple Mode" checkbox is checked; please uncheck this option in order to view all of the job's settings.

Name	Description	Value
options	the options expiration to model	LO;O;;;FEB21;0;;
curve_update_sensitivity	the sigma threshold (0.0 - 10.0) to trigger a vol curve publish	3.0
temporal_smoothing	curve evolution smoothness: 0.0 (none) - 10.0 (most)	6.0
spline_smoothing	spline smoothing strength: 0.0 (none) - 10.0 (most)	4.0
kernel_smoothing	kernel smoothing strength: 0 (none) - 15 (most)	0
option_min_size	the minimum aggregate size for a valid price level near ATM	2
option_max_spread_width	the max. spread width in ticks for a valid market near ATM	24
underlying_min_size	the minimum aggregate size for a valid price level	1
model_detail	spline model detail affects CPU usage	Normal
PUT_TBLTOP	do put wing tabletopping (instead of auto-sloping)	☐
CALL_TBLTOP	do call wing tabletopping (instead of auto-sloping)	☐
RESET	clear reconstructor and any other saved values in DB	☑
REQTRD	require at least one futures or options trade before first vol curve publish	☐
CONVEXITY	enforce vol curve convexity prerequisite	☐
EXTREME_VOL	enable alternative processing for extreme volatility conditions	☑
copy_trades	sync using format: FromRealSymbol -> ToArtificialSymbol	LO->LOX
SYNCCURVE	also periodically sync the vol curve of the copy trade's artificial symbol	☑
verbosity	log detail level	Basic
curve_publish_cutoff_time	in server time zone (PM); e.g. 3:30	
iv_upper_limit	the maximum allowed IV anywhere on the curve (0=disabled)	0.0
control_pt_vals	optional comma-separated list of control point X-axis values	-3.5, -3, -2.5, -2, -1.5, -1, -0.50, 0.0, 0.50, 1.00, 1.50, 2.00, 2.5, 3.0, 3.5
fs_wing_slopes	put wing slope, call wing slope (optional overrides for Flexible Spline)	-.35,
on_job_exit	action on algo exit or abort	Abort options expiration
special_flags	KEOD=keep EOD pattern through evening, INIT=user-defined pattern, REQ	

Example Configuration For A Dynamic Skew Job Instance (One Expiration)

"options"

Double-click the value cell to pop open the Matcher Editor dialog. Click the "New" button to unlock the filter fields. Select the radio button for the options symbol, set "Type" to "Option", and then type in the expiration code for the expiration to assign to this Dynamic Skew algo instance in the "Expires" field; each options expiration will require its own separate algo instance (a.k.a. "job"). Monthly options expirations can be specified using the 3-character month abbreviation + last 2 digits of the year (e.g. September 2019 expiration would be SEP19). Weekly expirations are specified by the full date of expiration in YYYYMMDD format (e.g. August 23, 2019 would be 20190823). Leave all other fields untouched. Success can be confirmed by viewing a positive number of matches at the bottom field (see image below).

Matcher Editor ×

Symbol	○ BZ ○ BZO ○ CL ○ CLX ● LO ○ LO1 ○ LO2 ○ LO3 ○ LO4 ○ LOX
Type	○ Any ○ Future ● Option ○ Strategy ○ Equity ○ Index ○ Future Strategy
Strikes	
Expires	Sep20
Call/Put	● Either ○ Call ○ Put
Max Legs	
Strategy Type	
Covered	● Either ○ Required ○ Never
# Matches	492

LO;O;;;SEP20;0;;

New
Remove

OK   Cancel

“curve_update_sensitivity”
This 0.0 (highest sensitivity, or most frequent possible) through 10.0 (lowest sensitivity, or most infrequent possible) decimal value controls the frequency of vol curve updates. The optimal setting depends on the total number of DSA jobs running on the server (due to overall CPU burden). With a high job count, users will want higher values for this setting (to reduce the total number of vol curve publishes hitting the server across all jobs). If the DSA job count on the server is low, then users may want lower values for this setting (for faster responses to IV changes). See the “Vol Curve Publication Frequency” section for more detail.

“temporal_smoothing”
This 0.0 (no curve stabilization) through 10.0 (highest curve stabilization) decimal value controls the proprietary curve stabilization logic. Due to internal calculations, this value is independent of the *“curve_update_sensitivity”* setting. Lower values for this setting provide faster response to changes, while higher values provide greater stability and less short-term IV noise. This setting has the most observable effect during fast bursts of updates. See the “Vol Curve Evolution Over Time” section for more detail.

“spline_smoothing”
This decimal value controls the strength of the proprietary spline smoothing logic. Allowed values are 0.0 (deactivated) to 10.0 (strongest effect). The optimal value for a given expiration depends on the curve shape and on the remaining time to expiration. Too large of a *“spline_smoothing”* value may cause distortions in the curve from over-smoothing. Sharp curvature (e.g. V-shaped curves) will require much smaller values than gentle curvature (e.g. U-shaped curves). This value may require maintenance on a periodic basis. The most common range is roughly between 2.0 and 5.0, although various products and expirations may require values outside this range. See the “Vol Curve Smoothing” section for more detail.

"kernel_smoothing"

This integer value controls the strength of the supplemental kernel-based smoothing feature. Allowed values are 0 (deactivated) to 15 (strongest). Too high of a value will distort curvature by pulling upward on the bottom of U-shaped or V-shaped curves; recommended values for these curve shapes are 0-8, depending on how much supplemental smoothing may be required and the apparent level of curve distortion. With high outright option strike density (i.e. many strikes listed by the exchange), higher values can usually be tolerated. This setting is fairly stable over time. See the "Vol Curve Smoothing" section for more detail.

"option_min_size"

This integer value controls the aggregate size required on a bid or ask price level near ATM in order to accept that price level as valid. As strikes move away from ATM, the algo internally tapers this value down towards 1 at the wing extremities. If not enough size is available in the whole book on a given market side, the algo will act as if the price is simply missing on that side. Recommended value depends on the typical depth of the top-of-book market. Avoid setting this value too high otherwise too much information could be filtered out. See the "Market Data Filtering" section for more detail.

"option_max_spread_width"

This integer value controls the maximum allowed distance (spread width) in ticks between the size-validated bid and ask price levels near ATM. As strikes move away from ATM, the algo internally tapers this value down to 50% of the setting at the wing extremities. This criterion only applies to two-sided markets where both sides have ample size (with respect to *"option_min_size"*). Spreads that are too wide will be disregarded and the algo will use mathematical interpolation to reconstruct vol at these strikes. Avoid setting this value too low otherwise too much information will be filtered out. Recommended initial value is about three times (3.0x) the typical spread width (in ticks) of a normal, tight market at the ATM strike. See the "Market Data Filtering" section for more detail.

"underlying_min_size"

This integer value controls the aggregate size required on a bid or ask price level of the underlying futures contract in order to accept that futures price level as valid. Recommended value depends on the typical depth of the top-of-book market in the underlying futures contract. Avoid setting this value too high. See the "Market Data Filtering" section for more detail.

"model_detail"

This setting (Low, Normal, or High) controls the detail of the spline smoothing model (i.e. the *"spline_smoothing"* setting). The *"model_detail"* setting has a large impact on the CPU usage of the job (algo instance). It is recommended to assign this setting to the lowest value that still produces quality curves. In other words, try Low first and see if any reasonable value for *"spline_smoothing"* will produce a quality curve. If not, then

try Normal here, and repeat the process. In general, curves with gentle curvature can tolerate much less model detail without degradation in curve quality. However, sharp curvature (e.g. V-shaped curves) or complex curvature (multiple bends, non-convex curves, etc.) may require higher model detail to avoid persistent smoothing biases. This setting may need to be changed as the option expirations approaches maturity.

"PUT_TBLTOP"
"CALL_TBLTOP"
These two checkbox flags allow the independent activation of tabletopping wing treatment mode for either/both wings. If not checked, the algo will always use the standard auto-sloping wing treatment mode. Auto-sloping may not always behave properly (or may not be desirable) for options close to expiration, deep back months, or expirations with very few strikes quoted. In these cases, tabletop mode may be more appropriate. See the "Wing Treatment" section for more detail.

"RESET"
This checkbox flag forces the algo to reset any persisted state upon the next algo restart. This includes refreshing the grid report reference, erasing any current/saved reconstructor master pattern, as well as deleting any previously saved vol curve shape features from the database (note that a currently violating vol curve shape constraint can also be reset simply by restarting the algo). This flag should only be used temporarily as required. One scenario might be if an old or invalid reconstructor master pattern is causing visible distortions in the curve and needs to be cleared out.

"REQTRD"
This checkbox flag requires the algo to observe at least one market trade in the options (or linked underlying future) before it publishes the very first vol curve. The advantage of this flag is that it prevents any possible bad vol curve fits after server reboot (during market close time, prior to evening market open) due to bogus market data feed info (a known CME issue). The downside is that if the algo is stopped and re-started midday, the very first fit will be delayed until the first trade is seen (which could be a bit in some back months).

"CONVEXITY"
This checkbox flag activates the DSA's optional convexity constraint. This geometric constraint requires any published vol curve to be monotonically increasing in both directions away from the strike with the lowest IV on the vol curve (the curve vertex). This optional risk control cannot be used in products/expirations that are fundamentally not convex, otherwise no vol curve fits will ever be made. See the "Risk Control Features" section for more detail.

"EXTREME_VOL"
This checkbox flag activates an alternate processing pipeline that prioritize overall curve quality control, instead of the normal priority on precise curve fit / curvature. Under

normal market conditions, this flag should not be used. Only during periods of *extreme market volatility*, when IV spreads become *very wide*, should this flag be used. <u>While there is no guarantee that the DSA will always be able to produce reasonable curves under extreme vol conditions</u>, activating this flag will allow it to do a much better job than it would otherwise (under extreme vol conditions only). See the "Risk Control Features" section for more detail.

"copy_trades"

This text value allows for "multi-skew risk" configurations, in conjunction with an artificial options symbol defined in Metro. Leave blank to omit these configurations, otherwise specify the real and artificial options symbol in the following format: FromRealSymbol -> ToArtificialSymbol. For example, the setting "LO->LOX" will (unidirectionally) sync any existing position from LO to LOX *in the expiration the algo is responsible for*, as well as copy all trades in realtime (while the algo is running) from LO to LOX *in the expiration the algo is responsible for*. See the "Multi-Skew Risk Functionality" section for more detail.

"SYNCCURVE"

This checkbox flag is only relevant when the *"copy_trades"* field is defined (non-empty value). This is used in configurations where the trader desires the artificial symbol options' vol curve to also be fit by the Dynamic Skew algo (in addition to fitting the real / primary options' vol curve). If checked, "SYNCCURVE" will ensure that the artificial options' vol curve (and also vol path for floating curves) is updated to mirror the real options' vol curve approximately once per minute (regardless of the *"curve_update_sensitivity"* setting). See the "Multi-Skew Risk Functionality" section for more detail.

"verbosity"

This setting controls the level of detail reported in the algo's log at runtime:
- Minimal
- Basic (recommended)
- Full (may be useful for troubleshooting certain issues)
- Debug (not recommended, as the log will become large very fast)

"curve_publish_cutoff_time"

This optional setting allows the user to specify a cut-off time, that when reached, will prevent the algo from publishing any further vol curve updates. Normally the DSA will continue publishing curve updates up and until the options spread width violates the *"option_max_spread_width"* constraint around market close. However, the final curve published right on, or immediately after, market close may not be as optimal as the curve perhaps one or two minutes prior (when there is better liquidity). This setting allows the user to capture the final vol curve at a time of their choosing. Only PM times 12:00 through 5:00 are allowed, and the time zone is the same as the server's. For example, "3:13" would cause the DSA to stop publishing curves after 3:13 PM time was

reached (assume the server is in the CST time zone). Leave this field blank to skip this behavior.

"iv_upper_limit"

This decimal value defines the maximum IV threshold allowed anywhere on the curve and therefore allows a sort of (auto-sloping + tabletopping) hybrid mode, where the tabletopping behavior at the wings can occur at a user-defined location on the Y-axis (IV). In other words, the user can control how high the IVs on the wings can reach. The default value of 0.0 disables this behavior. Do not set this value too low otherwise no valid vol curve may be published. See the "Wing Treatment" section for more detail.

"control_pt_vals"

This optional text value is only relevant for Flexible Spline-type curve types and allows the user to manually assign the X-axis locations of each Flexible Spline control point. If left blank, the DSA will auto-assign these X-axis locations according to general heuristics. If specified, the format is an ordered list of comma-separated values; the implied units will either be strike price, standard moneyness, or standard deviation (depending on the curve Point Type the user previously chose). Note that the user is only specifying the X-axis locations with this list of points. The DSA will calculate the optimal Y-axis values for each point to create an optimal fit.

- For the "Thirteen Point Flexible Spline", there must be exactly 15 values, in symmetrical order, like so: *put wing slope point, put wing join point, put 5th point, put 4th point, put 3rd point, put 2nd point, put 1st point, center point, call 1st point, call 2nd point, call 3rd point, call 4th point, call 5th point, call wing join point, call wing slope point*. Please see the "Appendix" section for a screenshot where these 15 control points have been explicitly annotated on the chart.
- For the "Flexible Spline", there must be exactly 9 values, in symmetrical order, like so: *put wing slope point, put wing join point, put 2nd point, put 1st point, center point, call 1st point, call 2nd point, call wing join point, call wing slope point*.

It is essential that the comma-separated values are in ascending order and that the put points and call points do not cross over the wrong side of the ATM price boundary. Failure to honor these constraints will cause the spline curve to fail mathematically and no vol curve will be drawn. The standard moneyness and standard deviation units are floating (with respect to the ATM price / center point) by definition, so they will never cross the ATM boundary during algo runtime (assuming they were initially set properly), even if the futures price is moving. In contrast, strike price units are fixed by definition, and thus the DSA internally treats the initial strike price assignments as strike offsets instead. Therefore, the strike offsets will always float with a changing ATM price and will not violate the moving boundary between the put-side and call-side control points.

"fs_wing_slopes"

This optional text value is only relevant for Flexible Spline-type curve types and allows the user to manually assign the put wing slope and/or the call wing slope with a fixed value. The fixed slope value(s) will override the DSA's normal auto-sloping procedure, allowing the user to manually fix the wing slope(s) as desired. The format is: *put wing slope, call wing slope*. The units are the same units as displayed in the Model Settings page in the "Put Wing Slope" and "Call Wing Slope" cells. Either value can be blank to use the algo's automatically determined slope for that wing. For example, ", 0.752" (note the leading comma) would set the call wing slope to 0.752, while auto-sloping the put wing. As another example, "-0.477" would set the put wing slope to -0.477, while continuing to auto-slope the call wing normally.

"on_job_exit"

This setting controls the behavior on algo exit, in both intended and unintended cases:
- Do nothing
  - No protection against a possible stagnant vol curve if the job stops.
- Abort options expiration
  - Abort Metro quoting, missions, and other algo activity in the affected options expiration via various signals. Other options expirations in the same symbol will remain unaffected.
- Abort whole options symbol
  - Abort Metro quoting, missions, and other algo activity in the affected symbol (all options expirations for the symbol) via various signals.

The recommended setting is "Abort options expiration". The "Do nothing" setting should be considered risky due to possible stagnant vol curve situations. See the "Risk Control Features" section for more detail.

"special_flags"

This optional text value allows the user to enable a variety of less commonly used flags. Specify multiple flags by separating their codes with commas; for example, "KEOD,CTMAN" (no double-quotes required). *All flags must be entered in uppercase*. Supported flags include:
- *KEOD*
  - This special flag (Keep End-Of-Day) will prevent any new master pattern from being selected by the reconstructor during the evening session. Setting this flag will force the algo to only use the existing saved master pattern from the database (usually the final master pattern from the day session) for the entire evening, which may be beneficial in products where evening session markets are less reliable.
- *INIT*
  - This special flag is only supported for the Assigned curve type and allows the trader to force the algo to use a manually drawn curve (from the Model Settings page) as the reconstructor's master pattern upon algo restart. Note that the curve is not extracted from the Model Settings

page until the first normal curve publication would normally occur, so there may be some latency between the algo being started and the curve being extracted (if, for example, the markets are currently closed). This feature is not intended for usage in typical cases.

- *REQOTRD*
  - This special flag is nearly identical to the *"REQTRD"* checkbox flag. The only difference is that this flag explicitly requires an options trade to be observed before it publishes the very first vol curve (observed underlying trades do not count). This flag can be useful if the underlying market is open when the options market is still closed. Options market IV info is generally not dependable while the options market is closed.
- *UVPCPO*
  - This special flag stands for "Update Vol Path's Center Point Only", and can optionally be assigned when the algo is fitting a floating vol curve. If specified, only the center (middle) point of the vol path will be updated to match the ATM price and vol. In contrast, normally all three points of the vol slide are shifted (translated) to account for the X- and Y-axis changes in the center point. The advantage to *"UVPCPO"* is that the adjusted greeks for the portfolio are more stable (from update to update) than under the normal mode; the disadvantage is that the relative shape of the vol slide can and will change with large moves in ATM vol. If the trader is not watching, the concavity could even potentially reverse on very large moves.
- *CTMAN*
  - This special flag will force the algo to also copy trades for manual trades (normally manual trades are not copied). This flag is only relevant if the *"copy_trades"* setting is specified.
- *SLOW20*
  - This special flag forces the DSA's internal throttle (maximum vol curve update frequency) to be no more than one vol curve publish per 20 seconds. This is a slower throttle than the *"curve_update_sensitivity"* setting normally allows.
- *SLOW40*
  - This special flag forces the DSA's internal throttle (maximum vol curve update frequency) to be no more than one vol curve publish per 40 seconds. This is a substantially slower throttle than the *"curve_update_sensitivity"* setting normally allows.
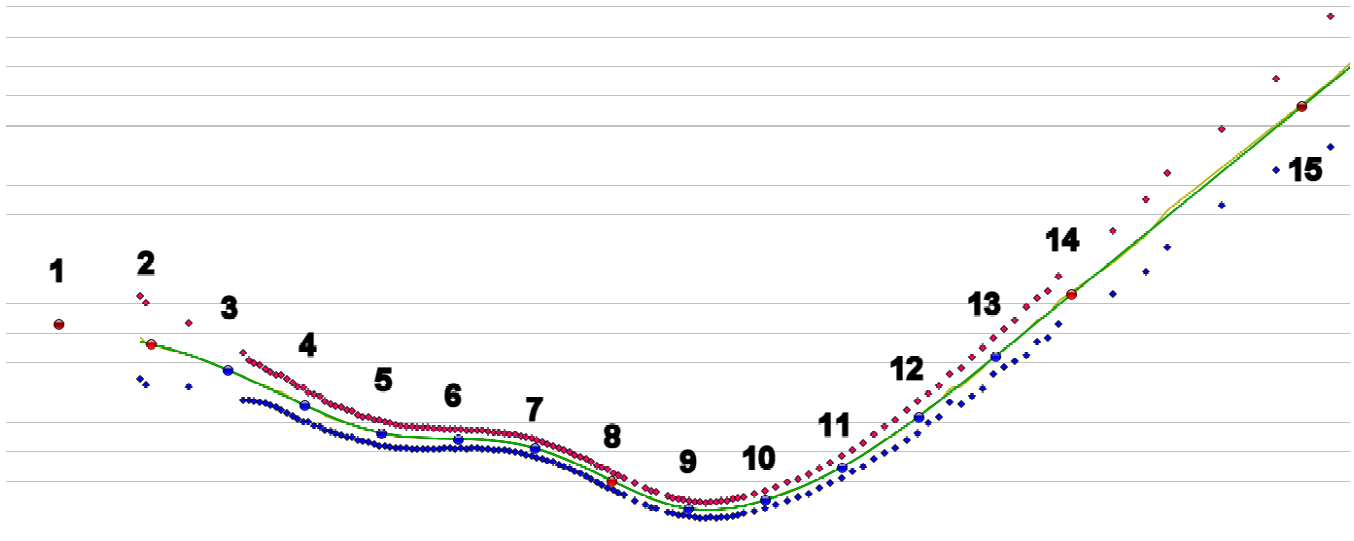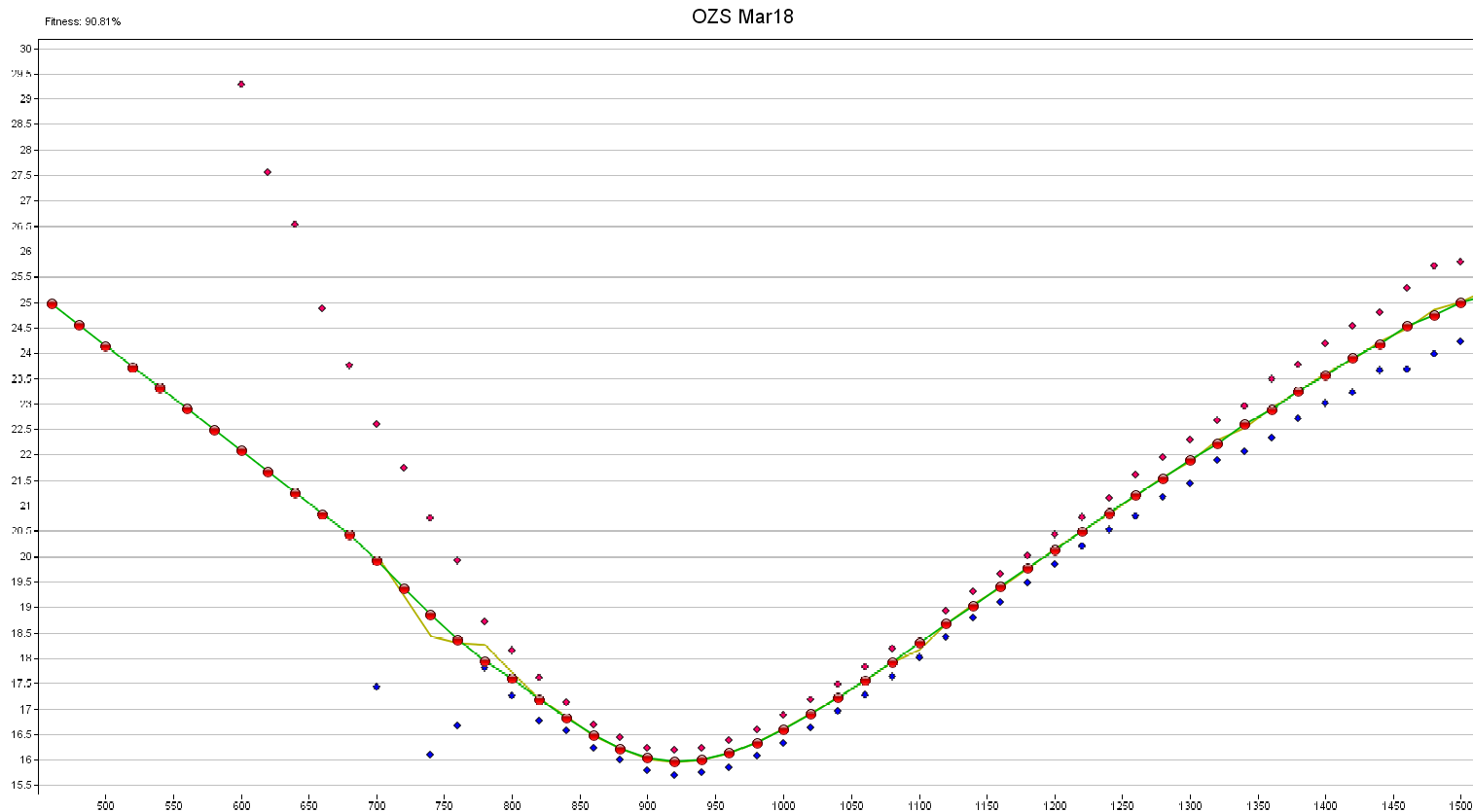
Thirteen Point Flexible Spline Curve (with the 15 ordered control points labeled)
The center / ATM point is control point #8, which divides the put & call sides.
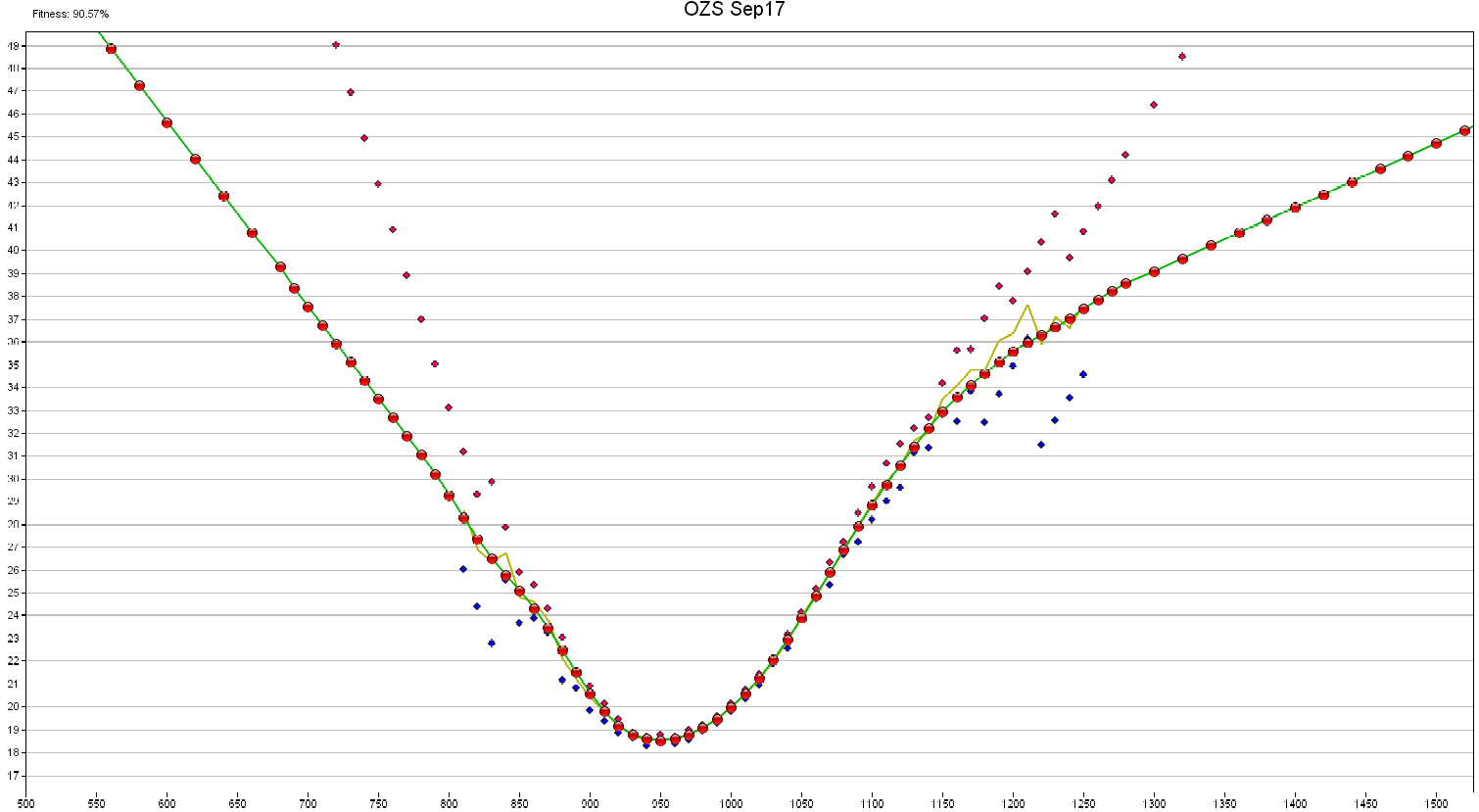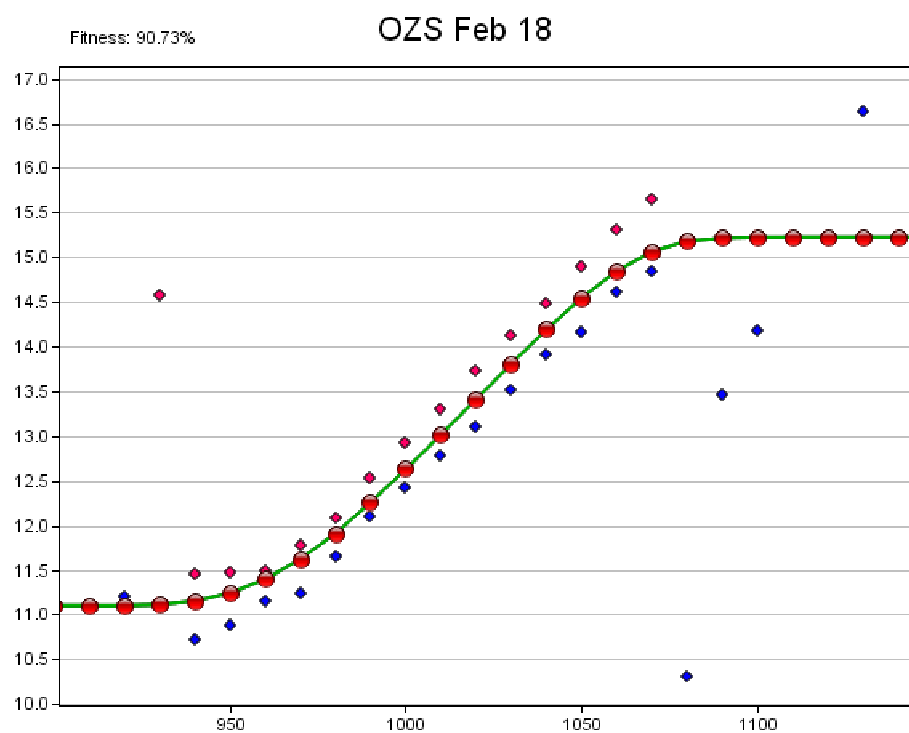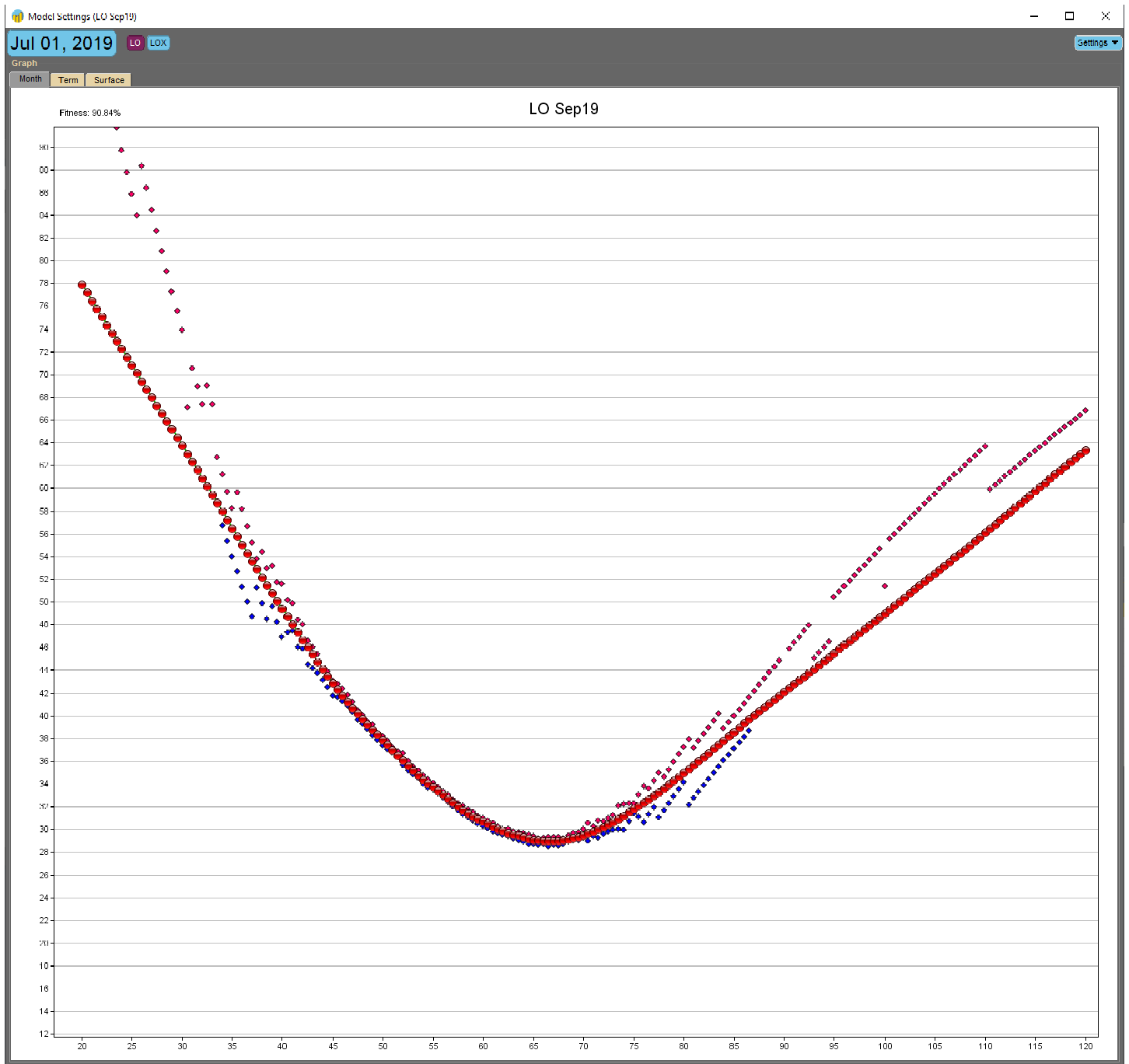

OZS Sep. 2017 Soybeans Options – Assigned Vol Curve With Wing Auto-Sloping

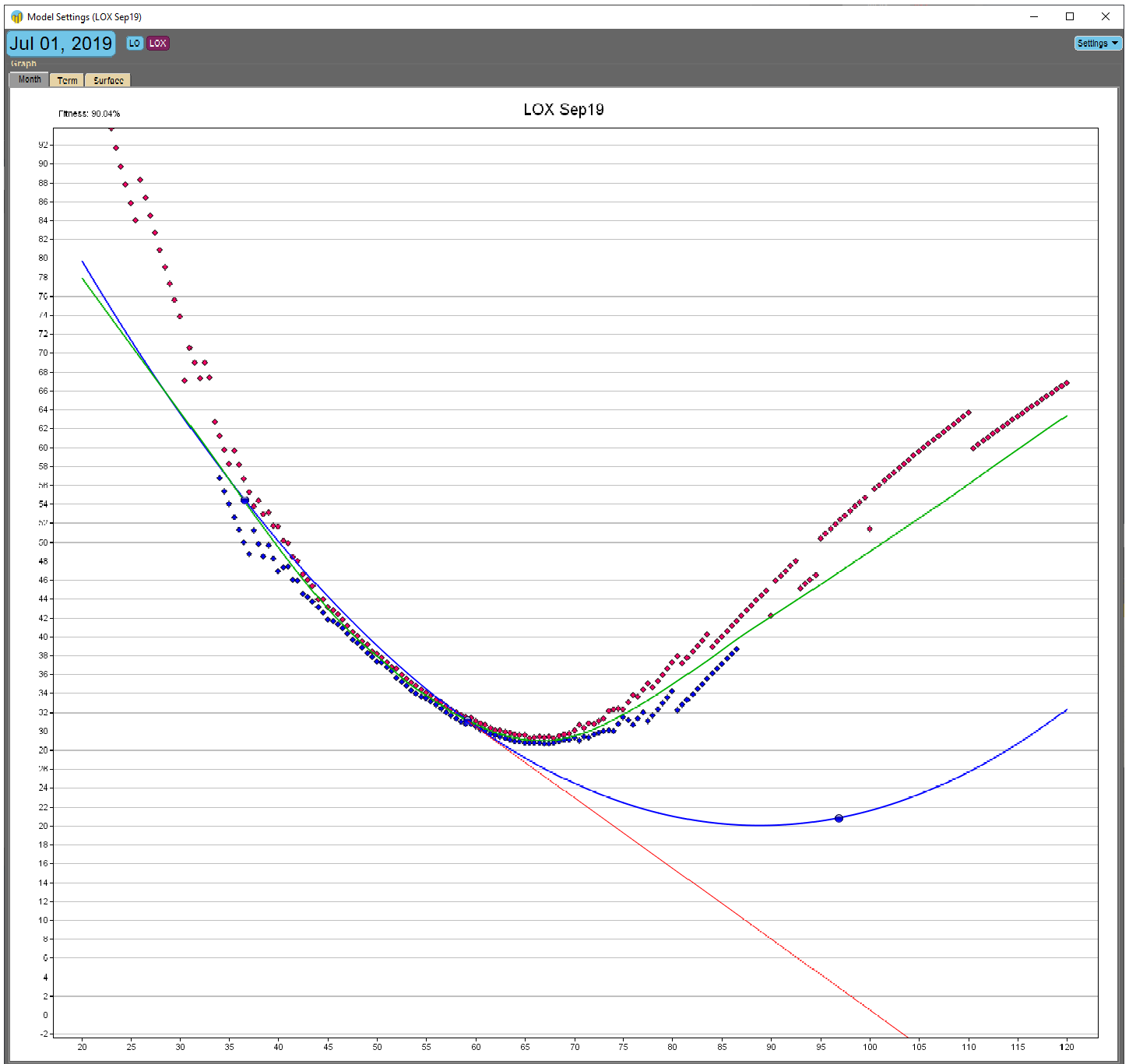Fitness: 90.81%

OZS Mar18

OZS March 2018 Soybeans Options – Assigned Vol Curve With Wing Auto-Sloping

Fitness: 90.73%

OZS Feb 18

OZS Feb. 2018 Soybeans Options – Overnight Session With Wing Tabletopping
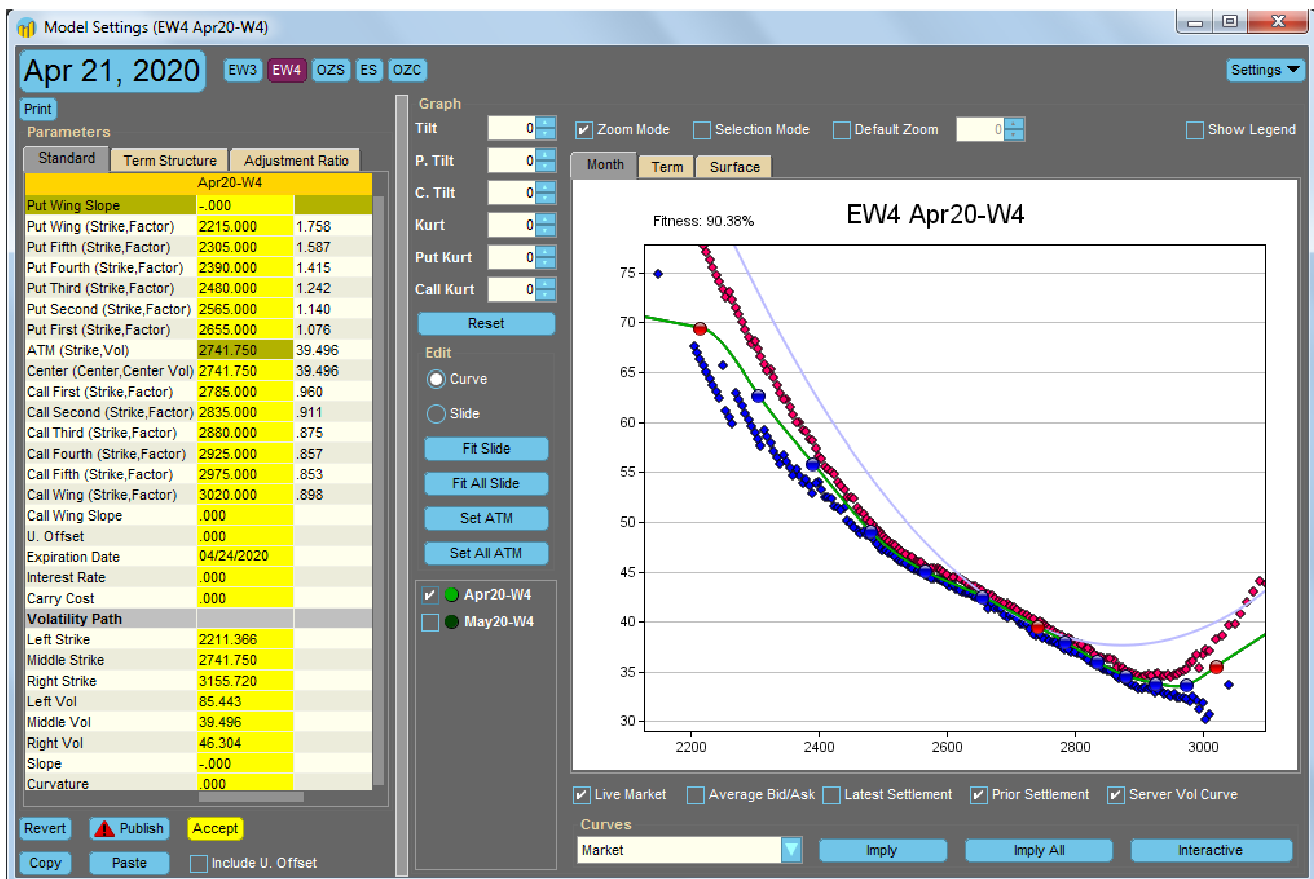
LO Sep. 2019 Crude Oil Options – Fixed Skew – Assigned Vol Curve

LOX Artificial Symbol Sep. 2019 Crude Oil Options – Floating Skew
(vol path in blue, vol curve in green)
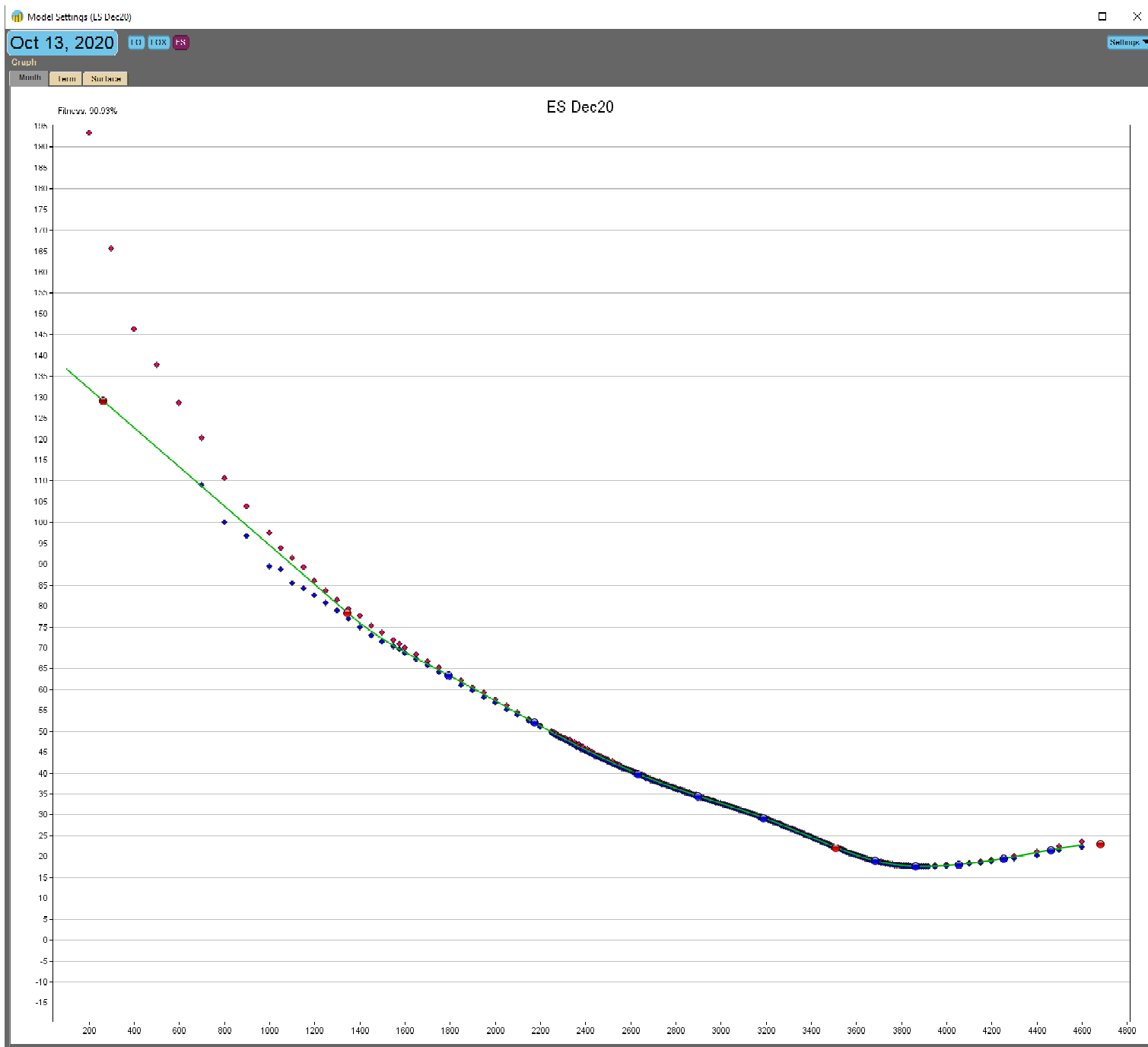
ES E-mini S&P 500 December 2020 Options – Thirteen Point Flexible Spline

Thirteen Point Flexible Spline With Point Type = Strike Price (control points' X-axis units)
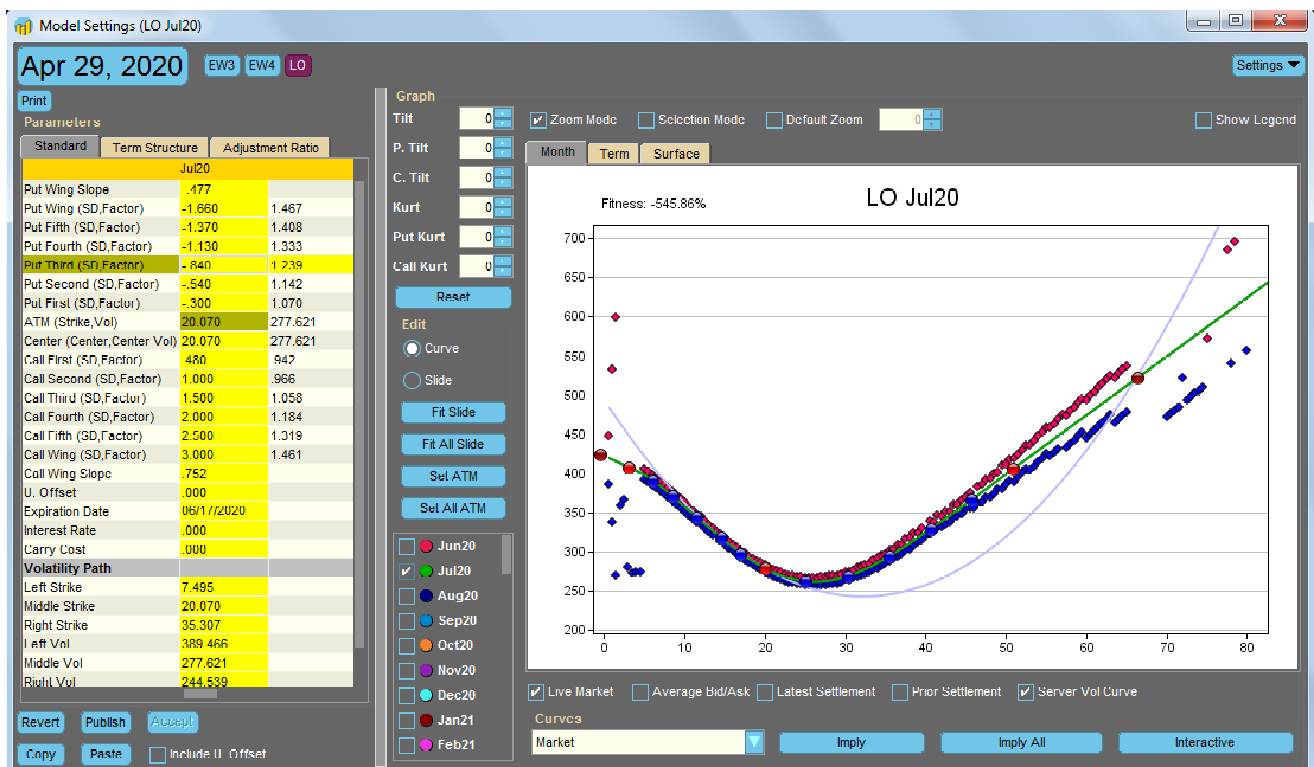
Thirteen Point Flexible Spline With Point Type = Standard Deviation

The four Excel charts below were created from vol curves generated by the Dynamic Skew algo across the CME WTI crude oil options (LO) term structure. The term structure correlations are apparent from multiple perspectives. These important ratios and metrics can be tracked and monitored in the **"Vol Levels"** algo, making it an ideal analytical tool to pair with the Dynamic Skew algo. The combined use of these two complementary algos allows traders to quickly identify and pinpoint intraday and "big picture" vol trading opportunities.

IV vs BSM Delta

IV vs Standardized Moneyness

BSM Deltas: Scaled IVs

Y-axis: *Ratio to 50 Delta* (0.700 to 1.500)

X-axis: *Call Delta* (95, 90, 85, 80, 75, 65, 50, 35, 25, 20, 15, 10, 5)

Legend: 1st Month, 2nd Month, 3rd Month, 4th Month, 5th month, 6th Month, 7th Month

Standardized Moneyness: Scaled IVs
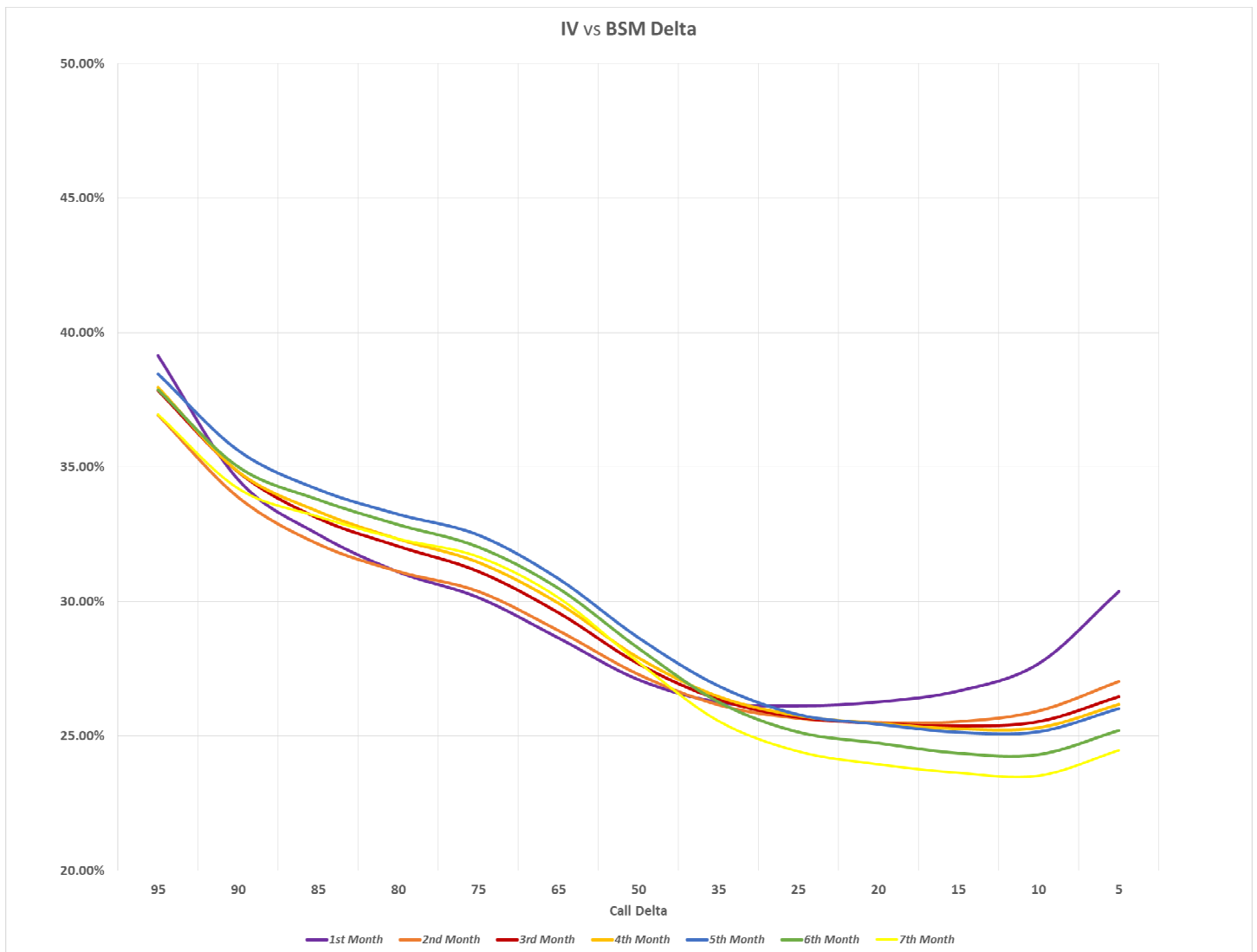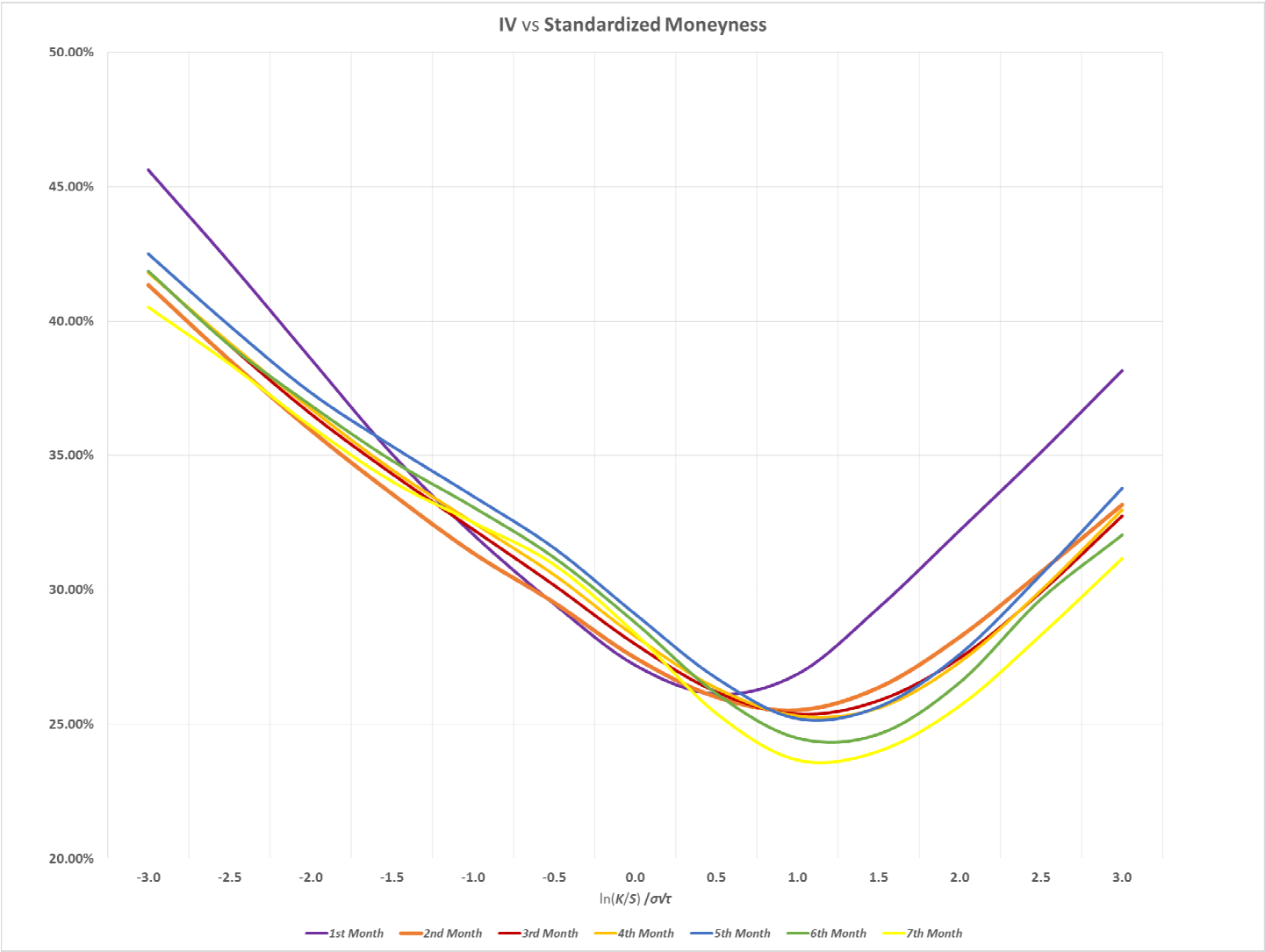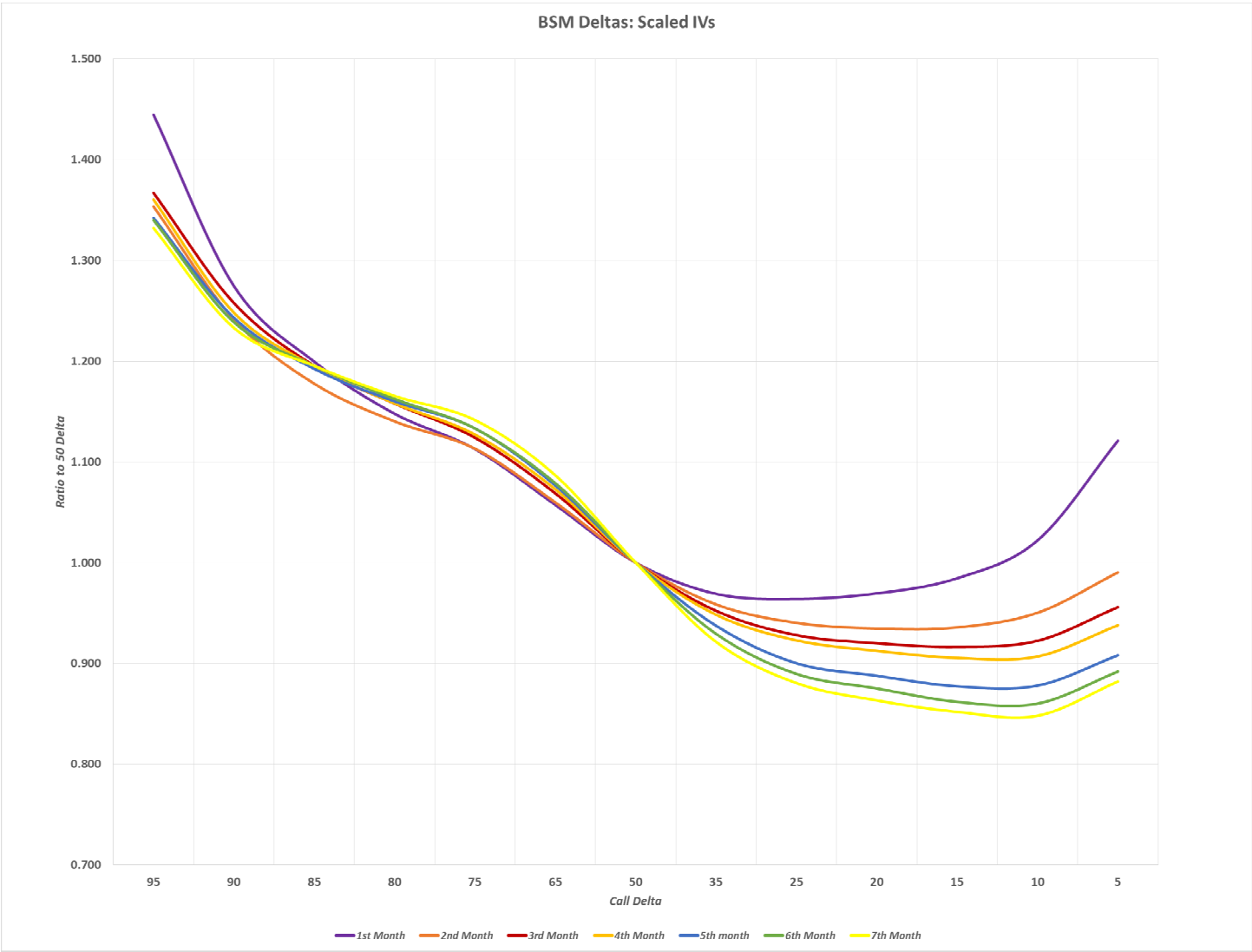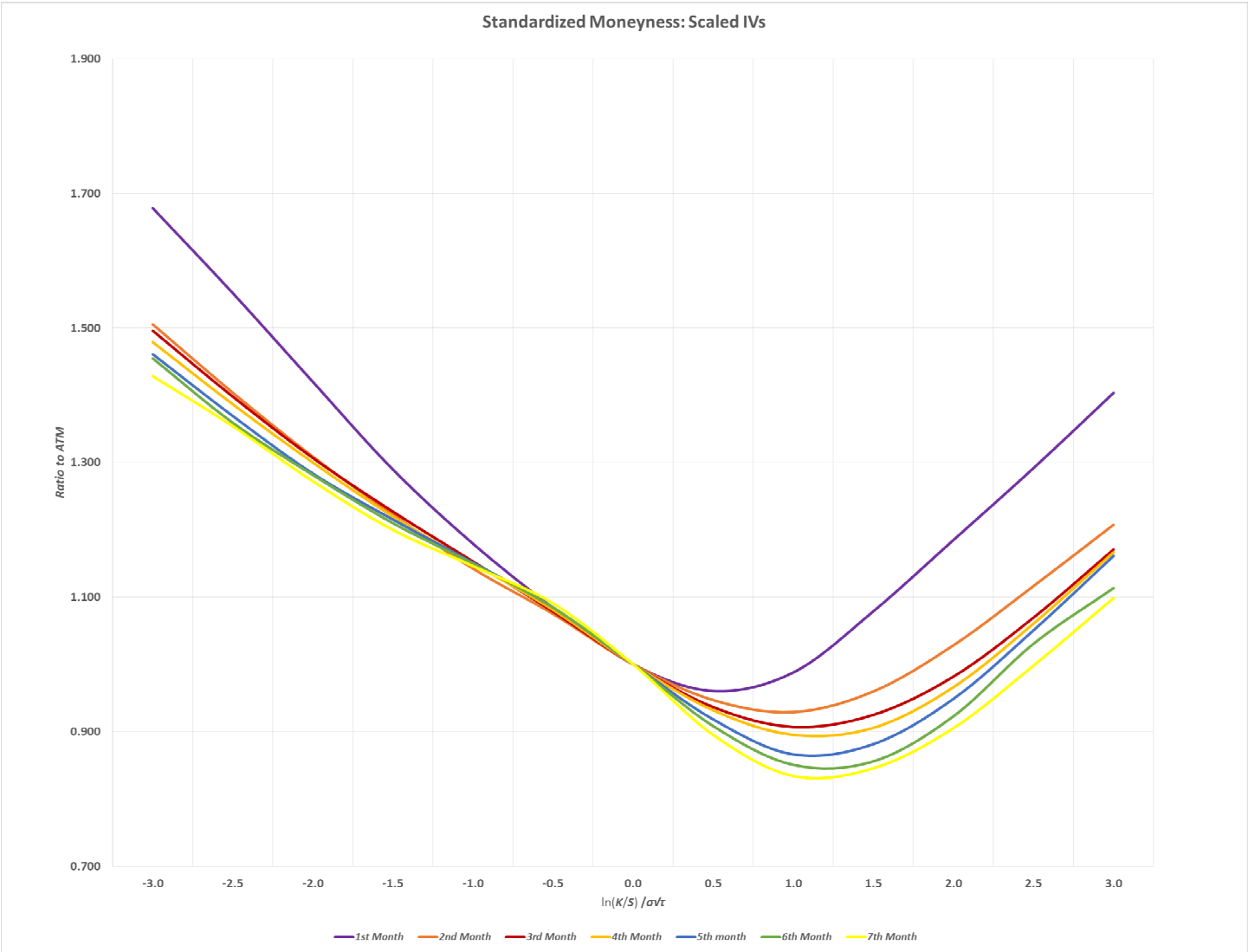
Follow these instructions to create and configure charting dashboards to display realtime DSA charting info:

1. After right-clicking the winding road icon in the Metro toolbar, select "Load Dashboard from server template" from the pop-up context menu. This will open up a blank charting dashboard.
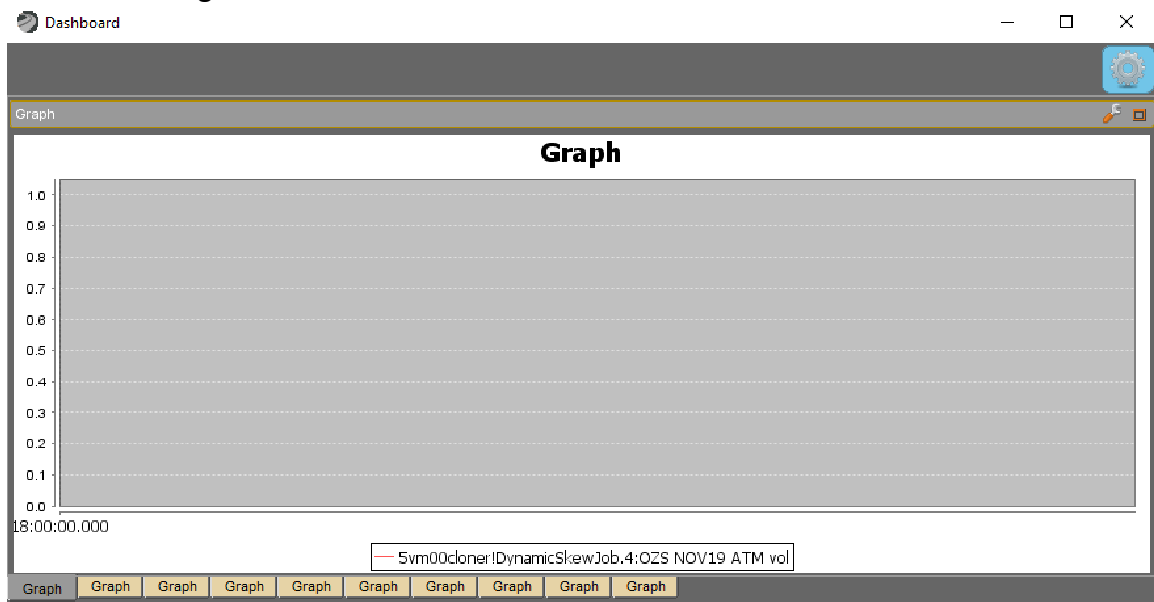

2. Click the wrench icon in the upper right corner and the "Configure Dashboard Graph" dialog will open. Here you can change the title of the chart and also click the "Add" button to add various data series to the chart (data series are exposed as "probes" on the server associated with the respective DSA jobs).
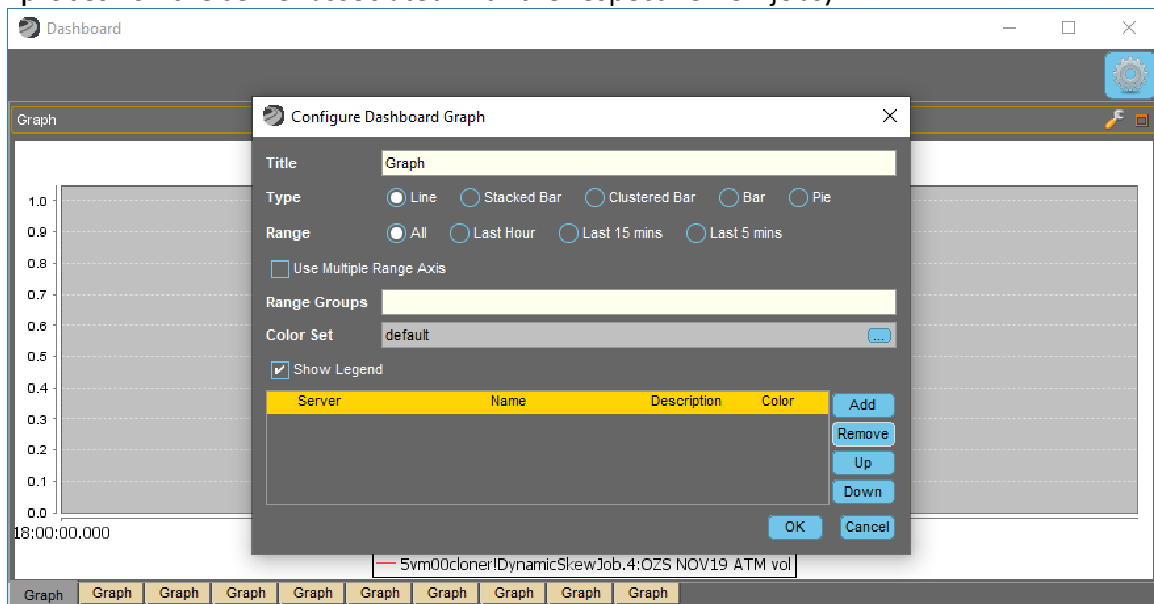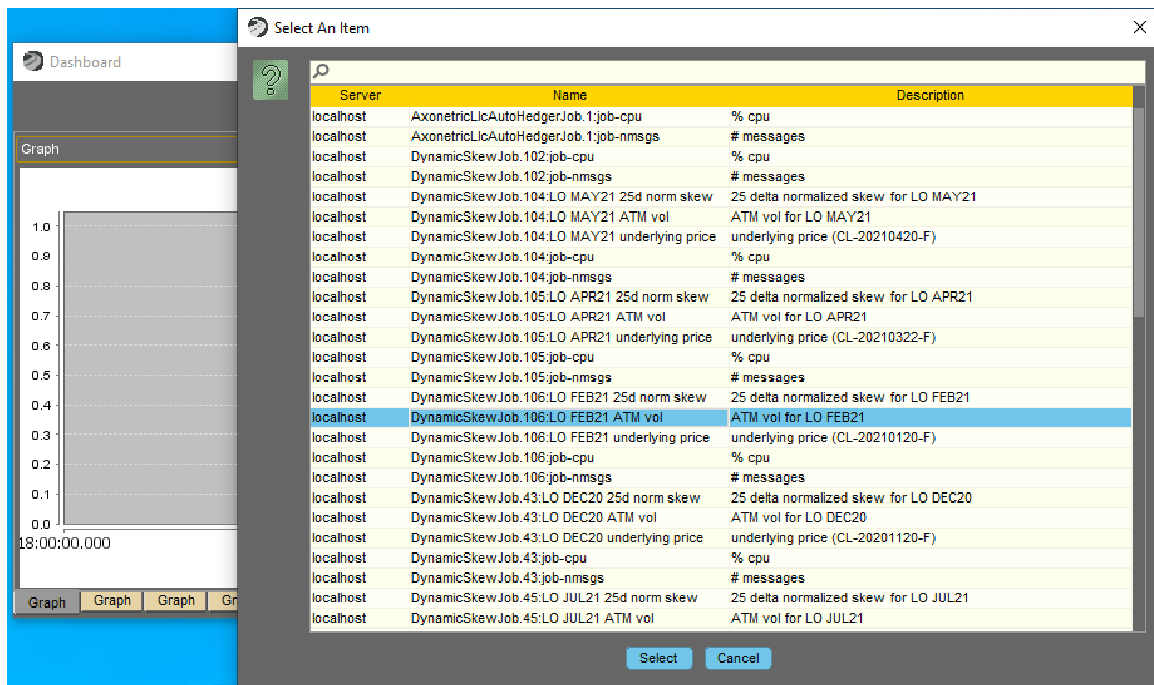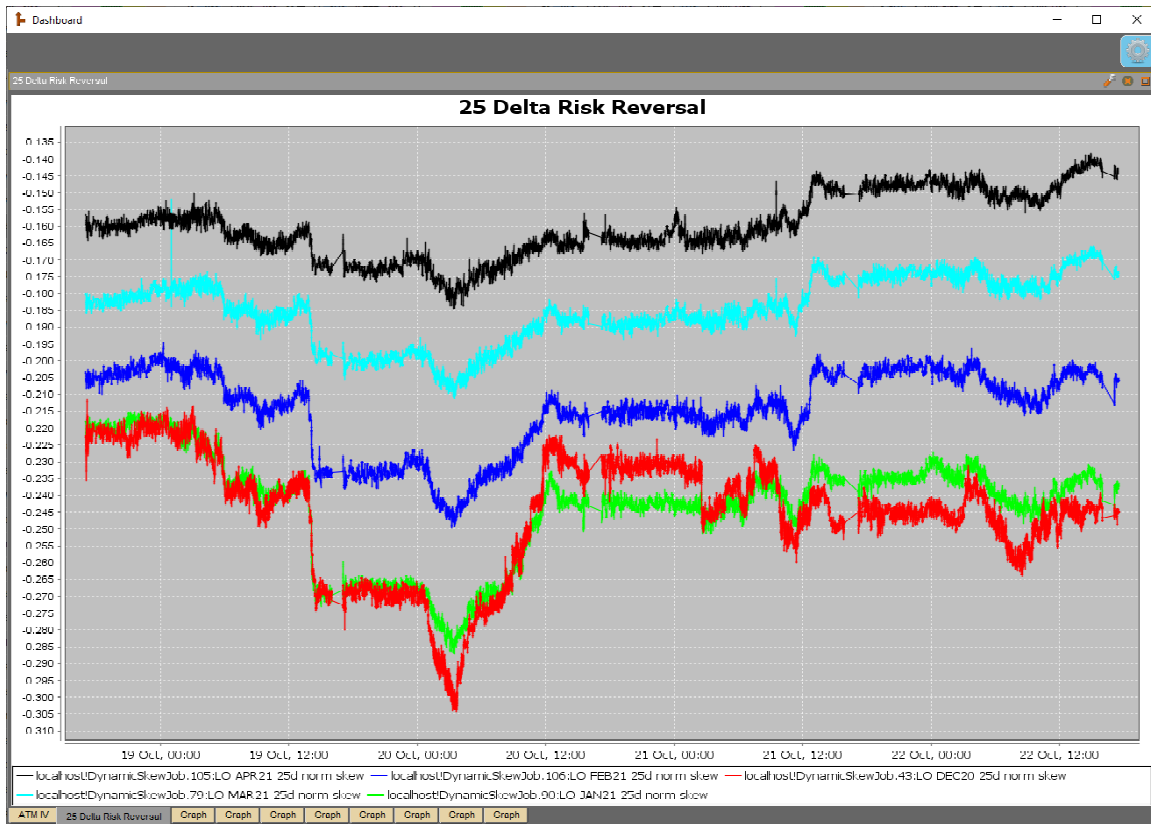
3. If you add multiple data series, you can select the unique colors for each. You may also check the "Use Multiple Range Axis" checkbox if the series are better charted with multiple (independent) Y-axes.
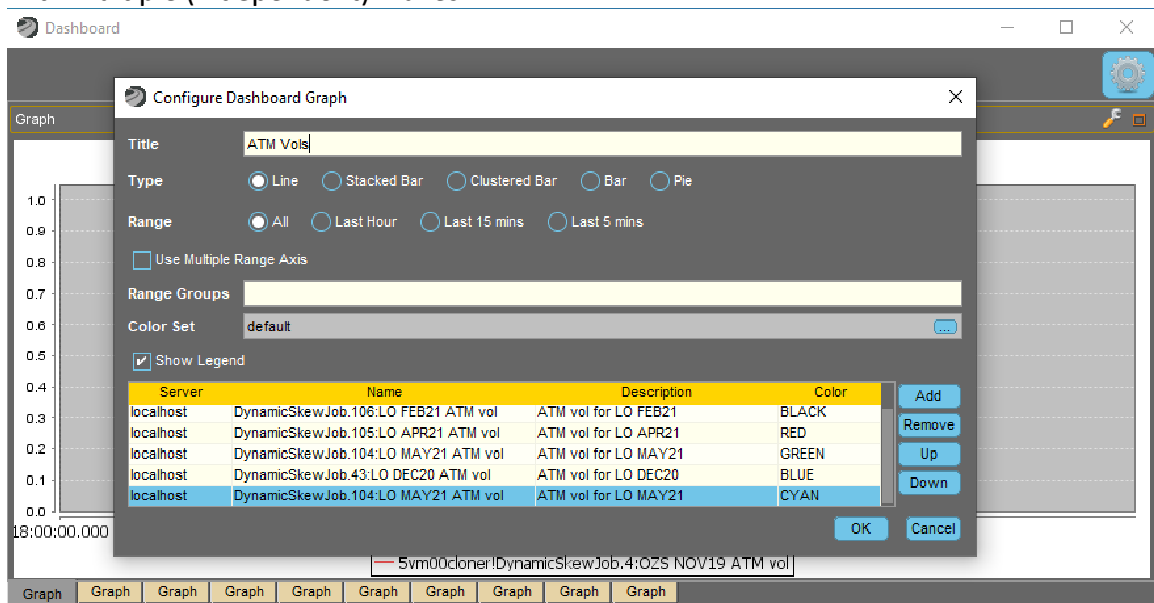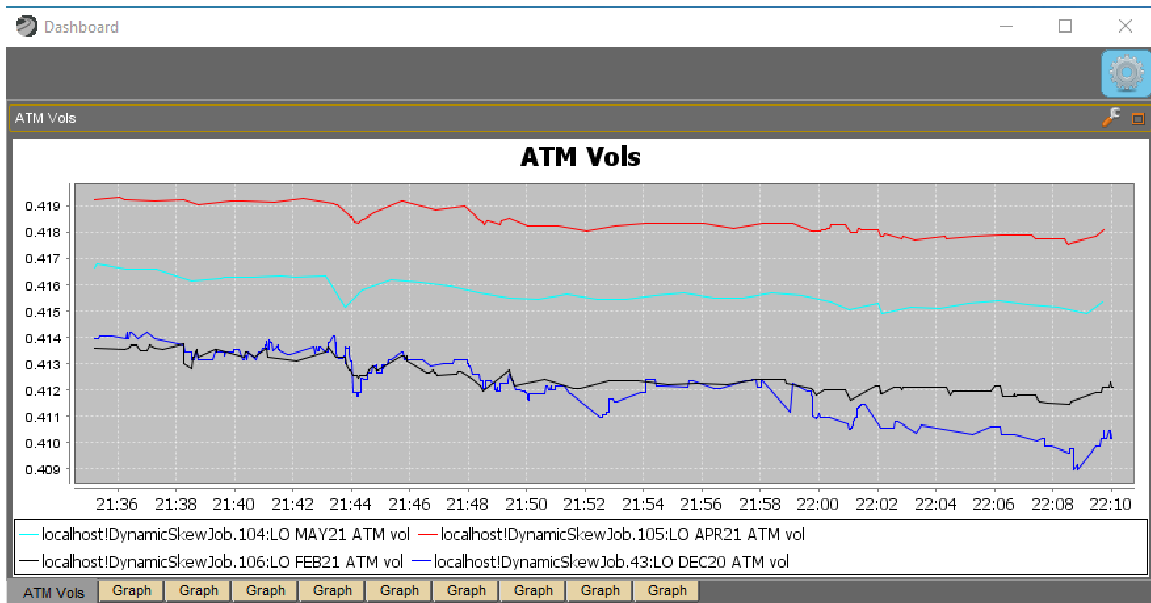

4. Click OK to complete the chart configuration.

LO WTI Crude Options – Realtime 25Δ risk reversals of the front term structure

LO WTI Crude Options – Realtime ATM IV of the front term structure