



V E L A

VOLATILITY FITTING APP

User Guide

December 2016

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Change History

Date	Changes
12/23/2016	Version 1.0



Introduction

The Volatility Fitting App is a Metro Widget that allows for the automated management of Volatility Curves. The functionality fits the market by creating and updating Assigned Volatility Curves based on the implied volatilities of the Live Options markets.

The Volatility Fitting App leverages the powerful, yet simple to use Metro APIs, the Freeway API and Widget API, in providing new functionality that complements the rich out-of-the-box functionality inherent in Vela's flagship Metro platform.

This document outlines the usages of the app and covers several topics. It captures the typical user's workflow along with everything that user needs to leverage the functionality: configuration settings, job interactions, a walkthrough of the different GUIs and their purpose.

Implementation Approach

The Volatility Fitting App uses the Assigned Volatility Curve type offered by the Metro platform. The Assigned Volatility Curve allows for volatility values to be specified on a strike-by-strike basis.

The functionality is currently implemented via back-end components only, as Freeway Jobs (VolatilityFitterJob). The configuration of the functionality is done via the standard Freeway Job Configuration screen, and the functionality does not present any additional front-end components.

Functionality Highlights

- The Volatility Fitting App provides the user with the ability to automatically fit volatility curves to the market for one or more expirations on one or more products. This fit can be employed manually (with enhancements over the out-of-the-box fitting), or on a configurable schedule.
- The volatility fitting functionality fits the market by calculating the implied volatilities of the bid and offer prices for all the strikes within an option expiration and setting the volatility value for a strike to be the average between the bid implied volatility and offer implied volatility.
- The volatility fitting app breaks up an option expiration's strike range into segments to capture market behavior local to certain parts of the curve. The average implied bid-offer vol spread (difference) of strikes within the segment is calculated and used to determine vols at strikes where only one side of data (bid or offer) is available. Outlier vols within the segment are removed from the average computation.
 - The skew is segmented by the wing cutoffs, and 1, 2, 3 standard deviation points by default.
 - An alternative segmentation method is configurable (BYMONOTONICVOLS), which segments the skew at points where the bid or offer skew slope changes signs.
- In the case of strikes for which there is no price, or for strikes whose prices were determined to be outliers, the functionality employs a linear interpolation between the adjacent strike prices in order to determine the volatility.
- Wing segments are determined to start at a user-provided cutoff point, specified in delta terms. These deltas leverage the current vol skew and model being used at each fit. The first fit will use flat atm vol Black-Scholes deltas to determine equivalent strikes.
- The Volatility Fitter App can also automatically determine the wing segment cutoff points as being the lowest strike, for the put side, and highest Strike, for the call side, having with a bid price.
- Users can also specify a wing slope for each side (in vol/strike) or choose to have both wings automatically determine their slope. The Volatility Fitter automatically determines wing slopes by examining the slope between the atm strike, respective wing cutoff strike, and the available data.
- For option expirations for which there is only sparse market data (sparsity determined by user-specified threshold), an alternative method applying an offset to the volatility curve of a liquid front-month will be leveraged, shifting the entire curve by the offset (the offset will be the difference of the atm implied vol of the two strikes).
- The Volatility Fitter Job only publishes a new fitted skew if the skew is sufficiently different from the existing skew for the instrument month being fitted, or if the existing skew is off the market. This throttling behavior is intended to reduce unnecessary stress on the Metro NOW theoretical center.

Purchasing and Installing

The Volatility Fitting App will be available on the Metro App Store via this [link](#). During the checkout process, the users will have the opportunity to choose the Metro installation (instance) against which to deploy the functionality.

Upon restarting the Metro front-end, the widget will be installed.

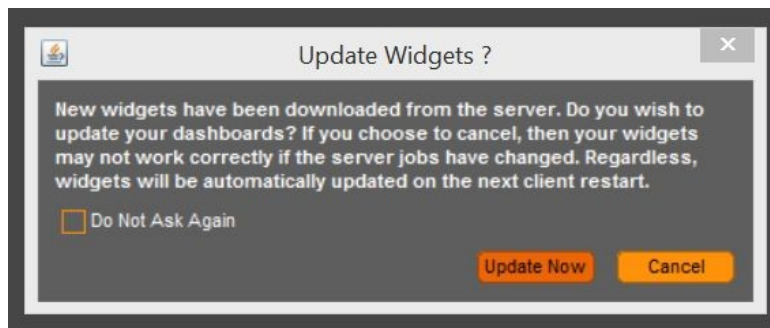


Figure: Install dialog upon a new app purchase or app version update

Configuring and Setting Up

At least 1 (one) instance of the Volatility Fitting Job needs to be created, as an execution unit before being able to use the fitting functionality. This is accomplished via the Freeway Jobs Window, with the “New” button.

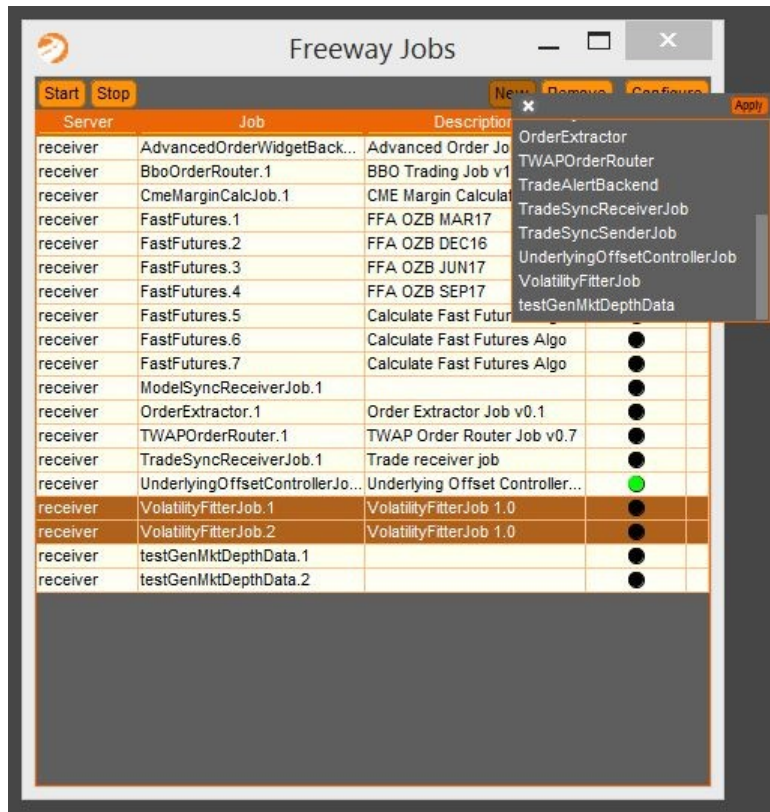
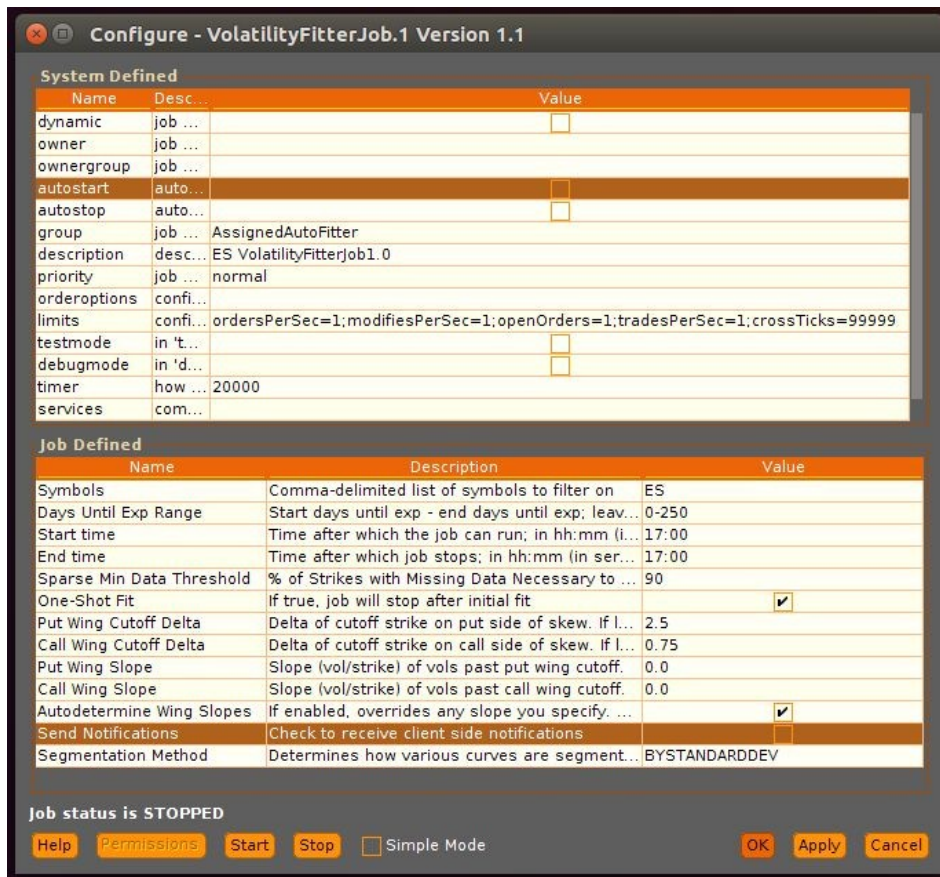


Figure: Job Instantiation

Configuring the Volatility Fitting App is accomplished via the Job Configuration Screen.



Configure - VolatilityFitterJob.1 Version 1.1

System Defined

Name	Desc...	Value
dynamic	job ...	<input type="checkbox"/>
owner	job ...	
ownergroup	job ...	
autostart	auto...	<input type="checkbox"/>
autostop	auto...	<input type="checkbox"/>
group	job ... AssignedAutoFitter	
description	desc... ES VolatilityFitterJob1.0	
priority	job ... normal	
orderoptions	confi...	
limits	confi... ordersPerSec=1;modifiesPerSec=1;openOrders=1;tradesPerSec=1;crossTicks=99999	
testmode	in 't...	<input type="checkbox"/>
debugmode	in 'd...	<input type="checkbox"/>
timer	how ... 20000	
services	com...	

Job Defined

Name	Description	Value
Symbols	Comma-delimited list of symbols to filter on	ES
Days Until Exp Range	Start days until exp - end days until exp; leav...	0-250
Start time	Time after which the job can run; in hh:mm (i...	17:00
End time	Time after which job stops; in hh:mm (in ser...	17:00
Sparse Min Data Threshold	% of Strikes with Missing Data Necessary to ...	90
One-Shot Fit	If true, job will stop after initial fit	<input checked="" type="checkbox"/>
Put Wing Cutoff Delta	Delta of cutoff strike on put side of skew. If l...	2.5
Call Wing Cutoff Delta	Delta of cutoff strike on call side of skew. If l...	0.75
Put Wing Slope	Slope (vol/strike) of vols past put wing cutoff.	0.0
Call Wing Slope	Slope (vol/strike) of vols past call wing cutoff.	0.0
Autodetermine Wing Slopes	If enabled, overrides any slope you specify. ...	<input checked="" type="checkbox"/>
Send Notifications	Check to receive client side notifications	<input type="checkbox"/>
Segmentation Method	Determines how various curves are segment...	BYSTANDARDDEV

Job status is STOPPED

Help Permissions Start Stop ☐ Simple Mode OK Apply Cancel

Figure: Volatility Fitting App Job Configuration Screen

The Job Configuration Screen can be brought up by accessing the “Job Control” under the Freeway icon within the Metro toolbar.

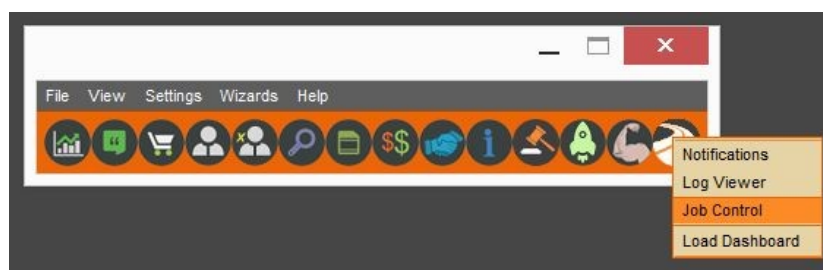


Figure: Freeway Icon and Job Control menu



Server	Job	Description	Status
receiver	AdvancedOrderWidgetBack...	Advanced Order Job 1.5	●
receiver	BboOrderRouter.1	BBO Trading Job v1.2	●
receiver	CmeMarginCalcJob.1	CME Margin Calculator Job ...	●
receiver	FastFutures.1	FFA OZB MAR17	●
receiver	FastFutures.2	FFA OZB DEC16	●
receiver	FastFutures.3	FFA OZB JUN17	●
receiver	FastFutures.4	FFA OZB SEP17	●
receiver	FastFutures.5	Calculate Fast Futures Algo	●
receiver	FastFutures.6	Calculate Fast Futures Algo	●
receiver	FastFutures.7	Calculate Fast Futures Algo	●
receiver	ModelSyncReceiverJob.1		●
receiver	OrderExtractor.1	Order Extractor Job v0.1	●
receiver	TWAPOrderRouter.1	TWAP Order Router Job v0.7	●
receiver	TradeSyncReceiverJob.1	Trade receiver job	●
receiver	UnderlyingOffsetControllerJo...	Underlying Offset Controller...	●
receiver	VolatilityFitterJob.1	VolatilityFitterJob 1.0	●
receiver	VolatilityFitterJob.2	VolatilityFitterJob 1.0	●
receiver	testGenMktDepthData.1		●
receiver	testGenMktDepthData.2		●

Figure: (Instantiated) Freeway Jobs Window

The Job configurations available are:

Configuration	Description
Timer	Interval, in milliseconds, at which the job should generate volatility curves (fit the market).
AutoStart	If checked, the job will start up when your server starts up.
test mode	If checked, the job will determine fitted skews, but not publish them. This is largely a debugging tool.
debug mode	If checked, the job will produce extra, detailed logging. This is largely a debugging tool.
Symbols	Symbols (products), as comma-delimited list, for which the job should generate Volatility Curves.
Days Until Exp Range	An expression of the form min days until exp - max days until exp , specifying all option expirations for which the job shall generate volatility curves. If left blank all expirations will be fit. Example: 0-100, where any option expirations with days to expiration between 0 and 100, would be included.
Start Time and End Time	Start and end times defining the session during which the job shall generate volatility curves.



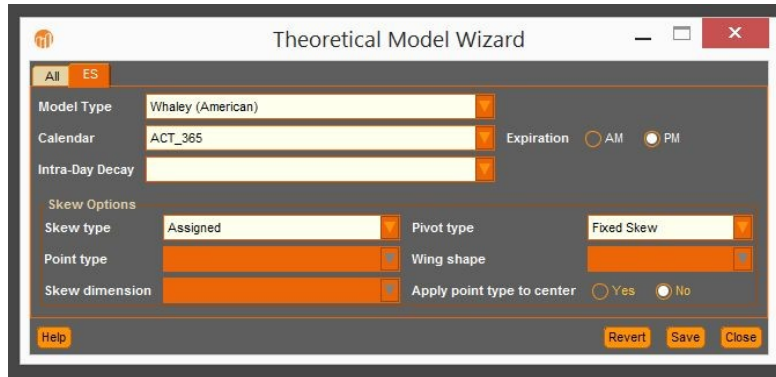
Configuration	Description
	Example: Start Time: 17:00, End Time: 16:00 would cover the typical CME trading session.
Sparse Min Data Threshold	The percentage of strikes within an option expiration lacking market data, which would categorize the expiration as an illiquid expiration and therefore use an alternate algorithm for generating a volatility curve. The threshold does not include outliers and one-sided markets.
One-Shot Fit	If enabled, the Job shall generate only one set of Volatility Curves and cease execution.
Put/Call Wing Cut-off Delta	<p>The cutoff point, defined in delta terms, where the wing segments of the volatility curve shall start; the wing has a curvature of 0 and a consistent slope. Deltas specified will always be positive and typically be between 0 and 100.</p> <p>If the cutoff point is specified as 0 (zero), the job automatically determines the cutoff point to be the last strike (lowest for the put side, highest for the call side of the curve) with a bid price.</p>
Put/Call Wing Slope	<p>The slope for the wing segment of the Volatility Curve.</p> <p>The slope is specified in terms of increase in volatility (as a percentage) for 1-point increase in the Strike price. For example, if the current volatility at Strike 2000 is 19% (or 19 vol), if the desired volatility at Strike 2100 is 20% (or 20 vol), the slope shall be specified as 0.01 $((20-19)/(2100-2000))$.</p>
Auto determine Wing Slope	The slope of the wing segments would be automatically determined by the job by being the slope determined by the ATM strike and the last strike with a bid price. Note that this will override any slopes set in the configuration.
Send Notifications	Check to receive client-side notifications when skews publish.
Segmentation Method	<p>BYSTANDARDDEV (default): The skew is segmented at the 1, 2 and 3 standard deviation points and at the specified wing cutoff points.</p> <p>BYMONOTONICVOLS: The skew is segmented at points where the bid or offer boll is not monotonic (switches from nondecreasing to decreasing on the call side, or nonincreasing to increasing on the put side).</p>

Note: The ability to fit the market for several distinct Symbols or Expirations, which may require distinct sets of configuration values, can be accomplished by creating multiple instances of the Volatility Fitting Job and having each instance generate Volatility Curves for a subset of Expirations.

For example, a Job instance with a certain set of configuration values can be used for the front Expirations for a product, while a different Job with a distinct set of configuration values can be used for the back Expirations of the same product.

Similarly, if increased performance is desired, multiple Job instances may be created, each generating Volatility Curves for a smaller subset of Expirations.

The only Volatility Curve type applicable for the Volatility Fitting logic is the Assigned Volatility Curve, which allows for the setting of volatility on a per Strike basis. The selection of a Volatility Curve Type is made via the Theoretical Model Wizard.



Theoretical Model Wizard

All ES

Model Type: Whaley (American)

Calendar: ACT_365

Intra-Day Decay:

Expiration: ☐ AM ☒ PM

Skew Options

Skew type: Assigned

Pivot type: Fixed Skew

Point type:

Wing shape:

Skew dimension:

Apply point type to center: ☐ Yes ☒ No

Help Revert Save Close

Figure: Theoretical Model Wizard

Generating Volatility Curves (Fitting the Market)

Upon successful configuration of a Job instance, the volatility fitting logic is activated by starting the Job. This is accomplished by the Freeway Job window, via the “Start” button. The Job will proceed to generate an Assigned Volatility Curve that best fits the market, based on the implemented logic. Some of the relevant highlights of the implementation details can be found in the “Functionality Highlights” section.

The generated Volatility Curve can be viewed within the Metro Model Controller, which can be brought up via the Trade Sheet. It is recommended that the Trade Sheet is Configured to “Auto-Accept” in order to allow for the Volatility Curve changes made by the volatility fitting logic to be automatically accepted within the Trade Sheet widgets without user intervention.

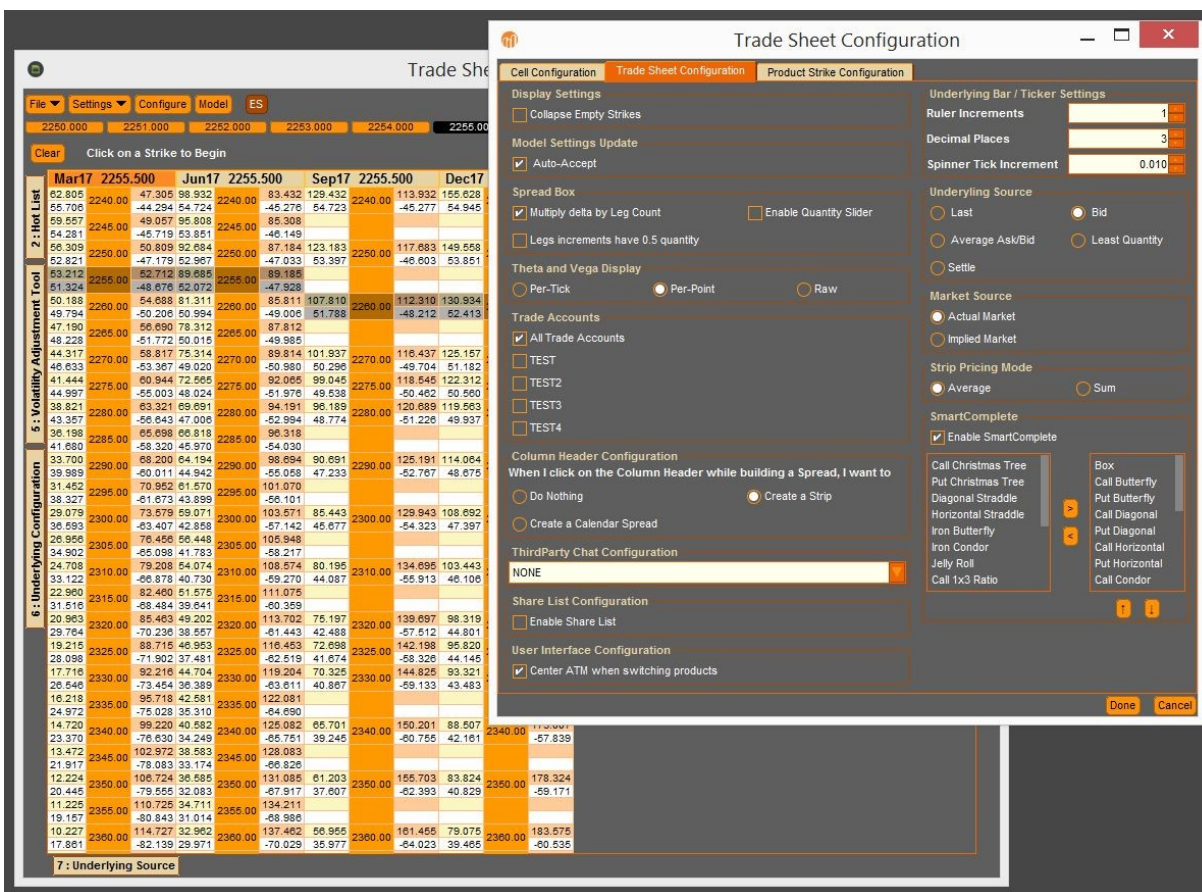


Figure: Trade Sheet with Configuration Dialog

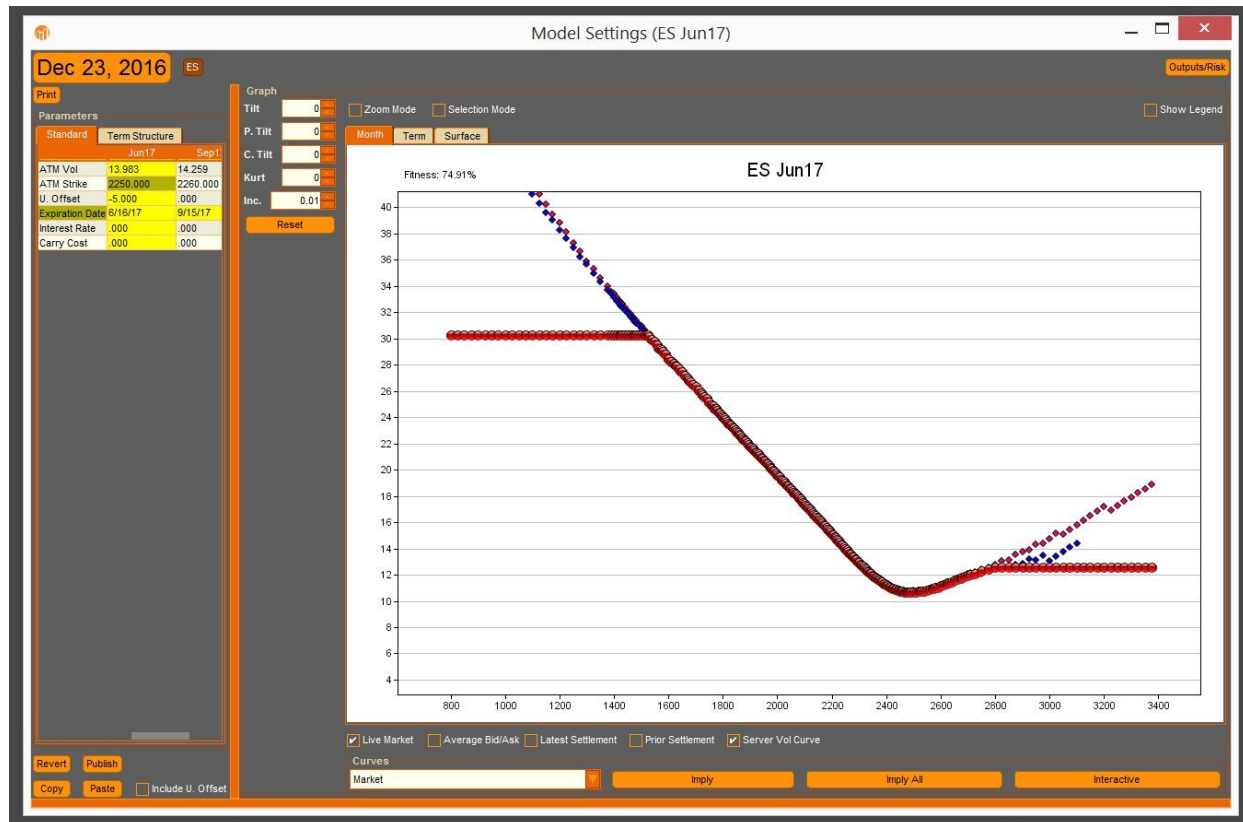


Figure: Viewing Generated Volatility Curve in Trade Sheet Model Controller

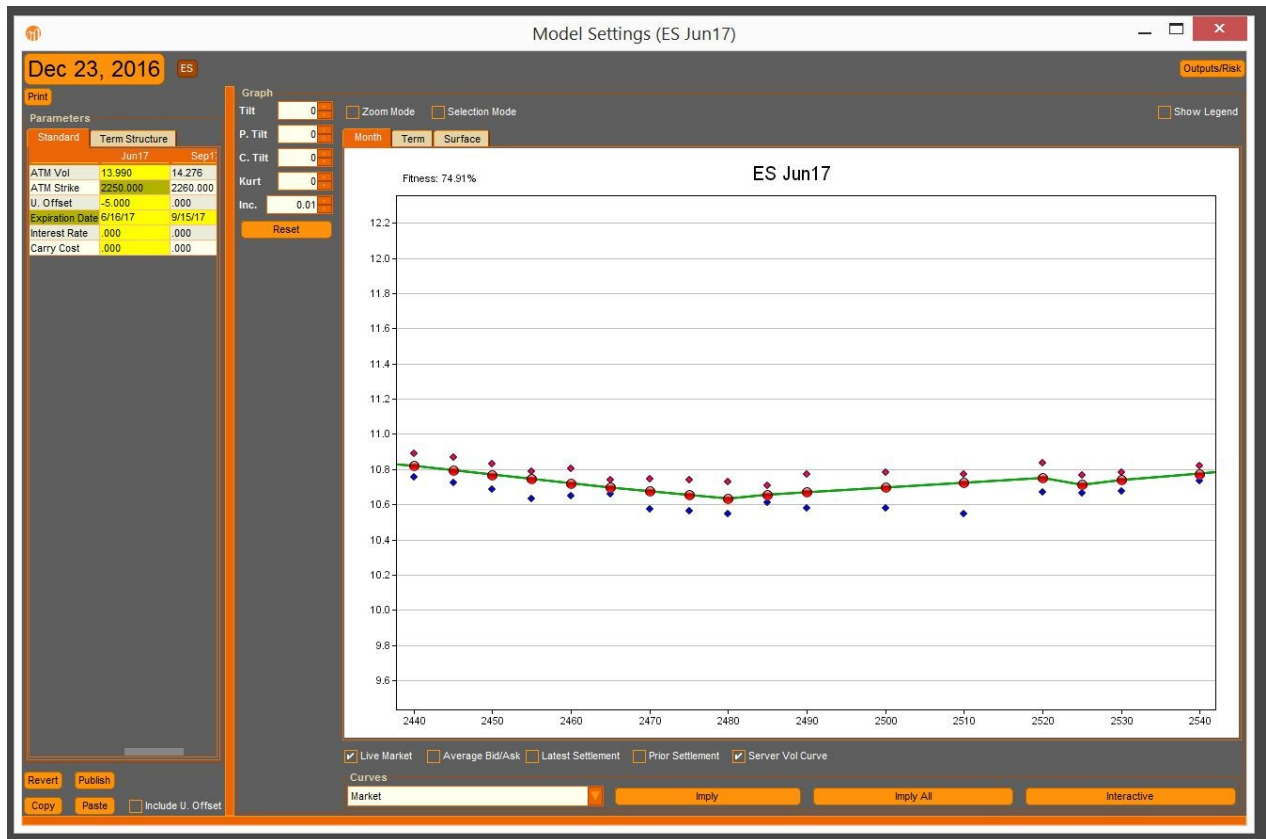


Figure: Detail of Generated Volatility Curve in Trade Sheet Model Controller

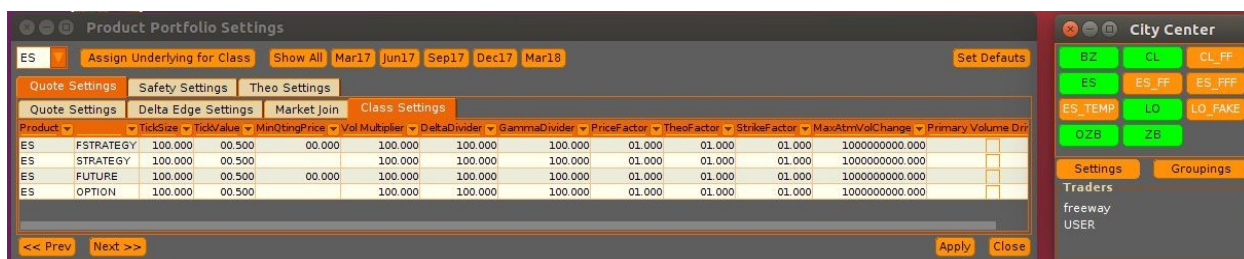
Additional Considerations

Due to the wide-variety of use-cases of the Metro platform, users may have different expectations, requirements, and experiences of/with the Volatility Fitter. This section aims to highlight and address those concerns and expectations.

Max ATM Vol Change

MaxAtmVolChange is a Vela Metro App Store safety setting that can be applied to a product, preventing any server-side volatility change in any of the product's expirations if the atm strike volatility changes by more than the specified percentage. To ensure that the Atm Vol Change solution can make publishes, set this number to a very high value.

The MaxAtmVolChange safety can be found in Metro **City Center** → click the **Settings** button → select the Product you are Fitting from the drop-down → click on the **Quote Settings** tab → click on the **Class Settings** tab underneath.



Publishes Via the Model Control

While the Volatility Fitter job is running, users will still can fit and publish the model via the OC Metro mode control. Doing so will not prevent the Volatility Fitter job from fitting per its configured schedule. Note that in some versions of Metro, fitting an Assigned-type skew via the model control may be difficult as strikes with missing data are fit to 0 vol. To get some level of manual intervention without using the model control, you may consider having one Volatility Fitter job instance configured to run in One-Shot-Fit mode. In such a case, starting the job will be the equivalent of fitting to implied and publishing via the model control, but will gain the logic of the Volatility Fitter job.

Using the Auto determine Wing Slopes Functionality

The Volatility Fitter App only supports linear wings currently, meaning that it may be impossible to find such a linear wing that can fit all the implied bids and offers, especially if there is concavity in the market data. For this reason, the **Auto determine Wing Slopes** configuration was intended to be used with the automatically-determined wing cutoff points (setting wing cutoff deltas to 0) as it is easiest to determine the wing slope when there is only one set of volatilities (offers) to worry about. Users may set the wing cutoff points to any delta and use the **Auto determine Wing Slopes** configuration, but the user should note that this can result in wing vols being off the market.



Theos and Theoretical Cache

The Theo Cache is an internal structure to the Vela Metro platform that stores pre-calculated theo values at different potential underlying prices with the purpose of avoiding costly real-time calculations. Any model publish purges the cache and prompts a recalculation of the theos, which can be costly. The Volatility Fitter Job is designed to minimize stress on the theoretical cache, but certain usages of the job may require additional server-side/job configuration to ensure this. If you plan on running the Volatility Fitter job with a frequency higher than 5000 Millis or plan on fitting more than 30 instrument months, please consult with the Metro App Store support on your use-case.