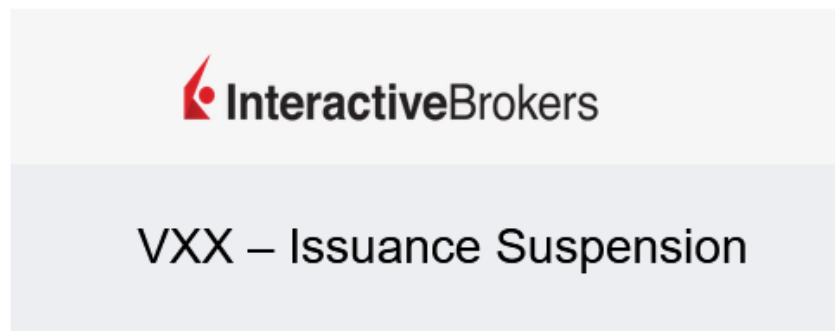


Motivation:

In early 2022 I added and started trading a complementary strategy to my day trading that involved always being long or short the VXX based on the closing prices of the VIX and the VIX3M future. Said strategy is not particularly good on its own; it is highly volatile, does not beat the market average, and draws down about twice what it returns in a given year. However, the historical returns are uncorrelated with my current strategies' historical returns, so adding it provides additional expected future value to the portfolio.

Shortly after my first trade (short), I received this notice from my broker:



Dear Trader,

We are contacting you because an account you manage holds a short position in IPATH SERIES B S&P 500 VIX (VXX). The issuer (Barclays Bank PLC) has suspended, until further notice, any further sales from inventory and any further issuances as of March 14th, 2022.

This action may lead to increases in the borrow fee rate, decreased securities lending market supply and a greater risk of buy-in.

So... **options!**

Instrument:

According to Barclays' SEC Filing, the VXX: "is calculated based on the strategy of continuously owning a rolling portfolio of one-month and two-month VIX futures to target a constant weighted average futures maturity of 1 month." [1]

The VXX is an instrument for individuals that "seek an investment with a return linked to the forward implied volatility of the S&P 500® Index." [1]

Rolling:

As time passes, contracts that used to be two-month VIX futures will become less than two-month VIX futures. In order to achieve the desired maturity, these contracts must be “rolled” forward.

If the market for these contracts is in **contango**, such that the prices in the distant delivery months are higher than nearer delivery months, the roll (sale) of the held contract would occur at a price **lower** than the price of buying the more distant contract. This would be referred to as a negative “**roll yield**”.

Note that **contango** is typically the observed historical state of VIX futures, and Barclays states “The contracts included in the Indices [VXX and VXZ] have not historically exhibited consistent periods of **backwardation**, and **backwardation** will most likely not exist at many, if not most times.” Emphasis mine. [1]

Example:

- A futures contract is purchased and held in January for \$10. It has a March expiration.
- In February, this contract needs to be replaced for a contract that expires in April.
 - This is done in order to retain the desired futures maturity of 1 month.
- The January contract still costs \$10.
- The February contract costs \$9.
 - This scenario is **backwardation**.
- Selling the January contract results in + \$10
- Buying the February contract results in - \$9.
 - This scenario has positive **roll yield**.

Because VIX futures have fixed expiration dates, volatility indexes such as the VXX *must* undergo a rolling process to rotate their inventory of futures in order to keep their stated exposure to volatility.

Regardless of rolling, the daily price action of VXX is dominated by market volatility. In periods of high volatility, the negative roll yield puts far less downward pressure on the price than upward pressure due to the VIX increasing. We do occasionally observe periods of long term VXX increases.

Split Adjustment:

Due to the nature of the roll yield and how the VIX Index has typically mean reverted over the longer term to a historical mean, a tracking ETN such as the VXX should in theory perpetually decay in price. Barclays has addressed this by periodically splitting with a 0.25 adjustment, or a 1-to-4 “reverse split”.

VXX Split History Table	
<i>Date</i>	<i>Ratio</i>
11/09/2010	1 for 4
10/05/2012	1 for 4
11/08/2013	1 for 4
08/09/2016	1 for 4
08/23/2017	1 for 4
04/23/2021	1 for 4

[6]

I suspect that Barclays does this for multiple reasons, but one is likely that fund managers have a mandate to only trade or own products in their portfolios that have a minimum price, much like how insurance companies are not allowed to buy BBB bonds.

Note - VXX valuation date of 29 Jan 2019 and subsequent recreation:

Someone clever will wonder how I have handled this; as is typical, someone smarter, see refrence, has already found the solution and I simply learned from it.

IsVXX: (Symbol=\$VXX-201901 and Year < 2019) or (Symbol=\$VXX and Year >= 2019)

// because VXX was retired and re-created, there are two symbols

Contango: (\$\$VIX, C) < Extern(\$\$VIX3M, C)

// true if VIX in Contango, false otherwise

LongEntrySetup: IsVXX and not Contango

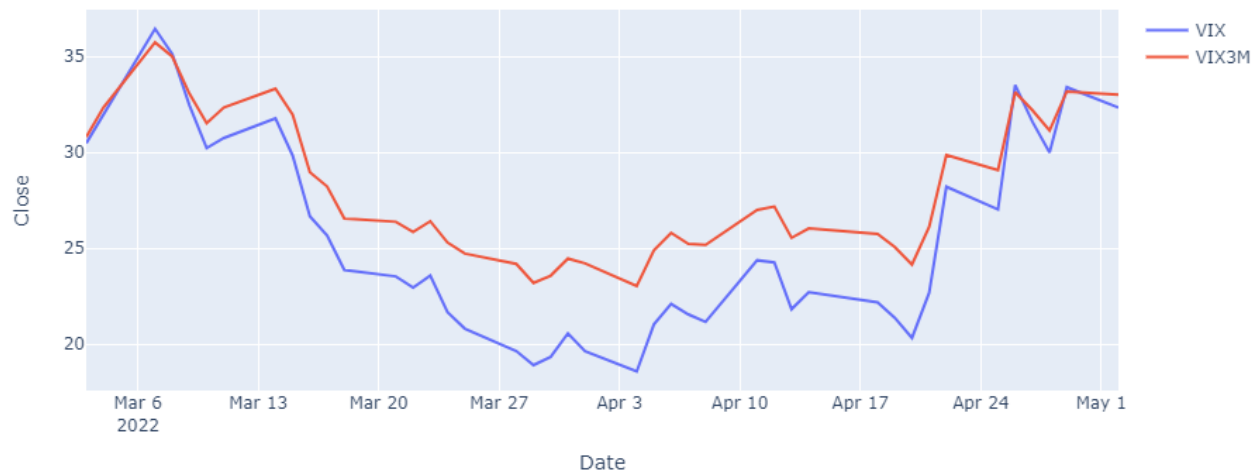
// long when in backwardation, use the correct VXX symbol for this date

// Credit **Marsten Parker** at <https://mhptrading.com/>

Options Data Analysis:

Taking a look at the recent VIX and VIX3M data, we see what has been assumed by Barclays. The VIX has mostly been in contango with its three month future.

VIX and VIX3M



I wanted to compare a few days of data on VXX options and have used data from WRDS thanks to my department.

Using three weeks of expirations and calls and puts, we can verify our assumption that options with a smaller TTM will “smile” more so than those with further expirations.

Implied Volatility vs Strike Price



3D Modeling:

Let's model the IV of all of the calls and puts on:

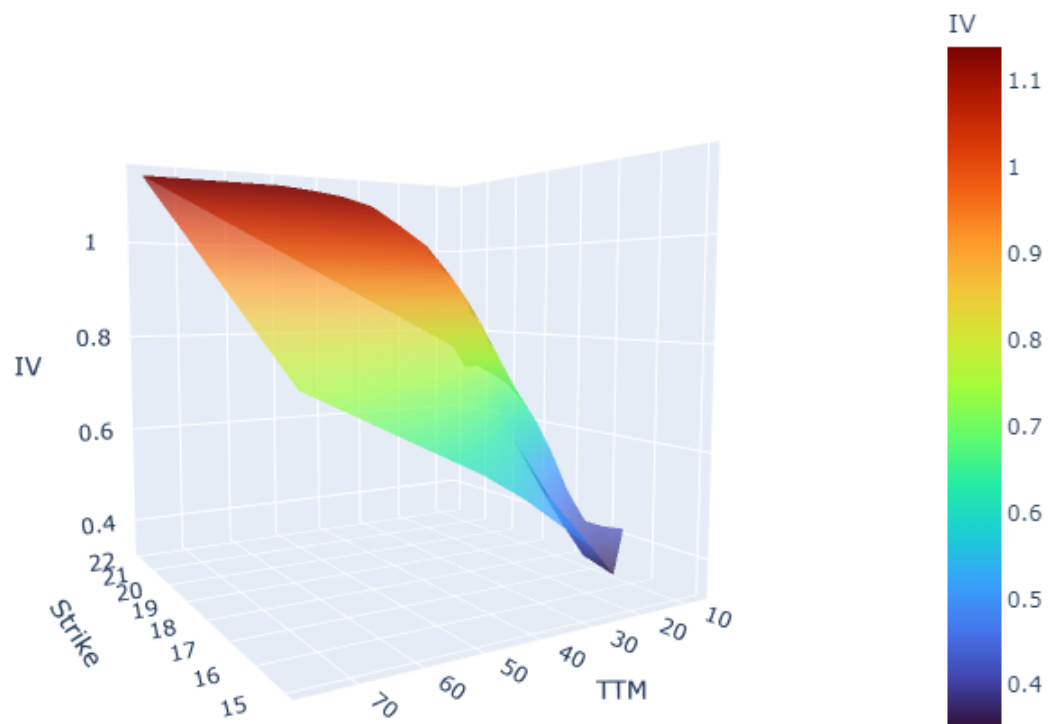
1. A calm day, such as the last day of the year.
2. A day where we see a flip in the VIX and VIX3M.
3. A day where we see a reverse split.
4. A day with a lot of data

Some initial housekeeping is needed: namely, merging the datasets used for graphing the VXX closing price to the options data in order to have a spot price, and filtering puts and calls to those within 20% of the spot price.

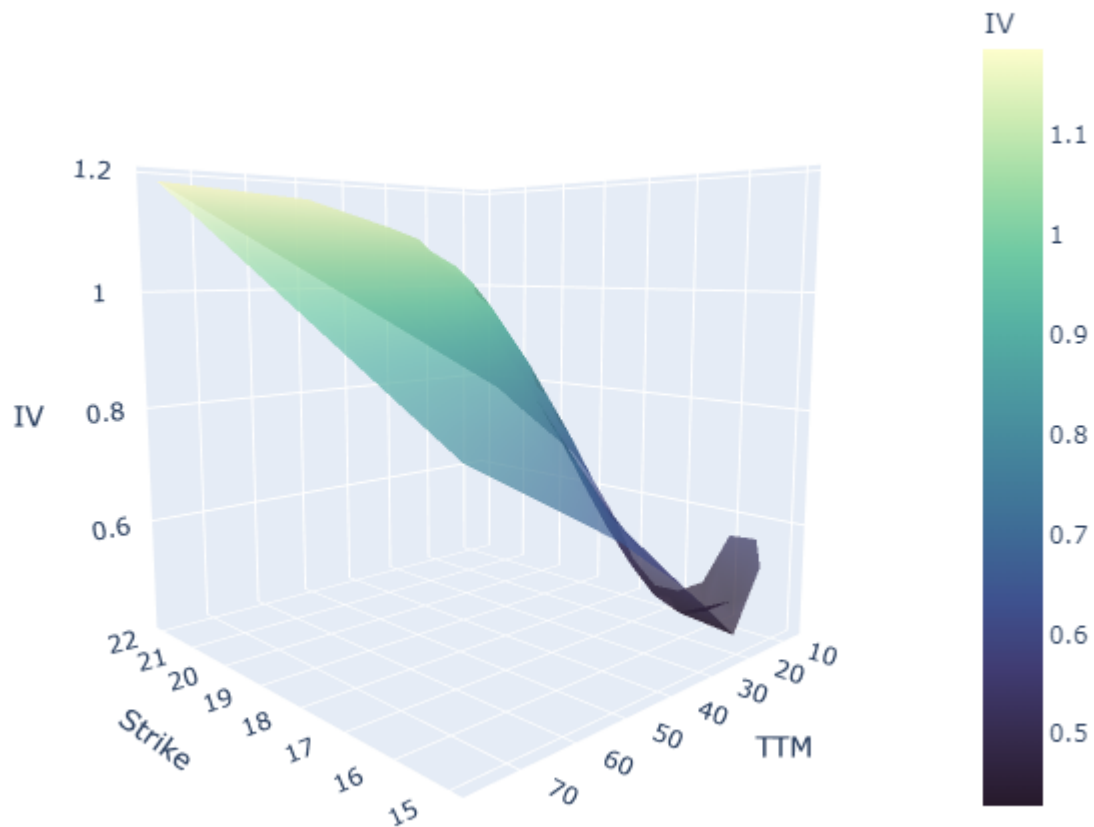
1: A calm day.

There are 84 calls and 91 puts on 2021-12-31 with the original filter.

Calm Day: Call Vol Surface



Calm Day: Put Vol Surface



Conclusion:

The puts have a much "cleaner" looking volatility smile.

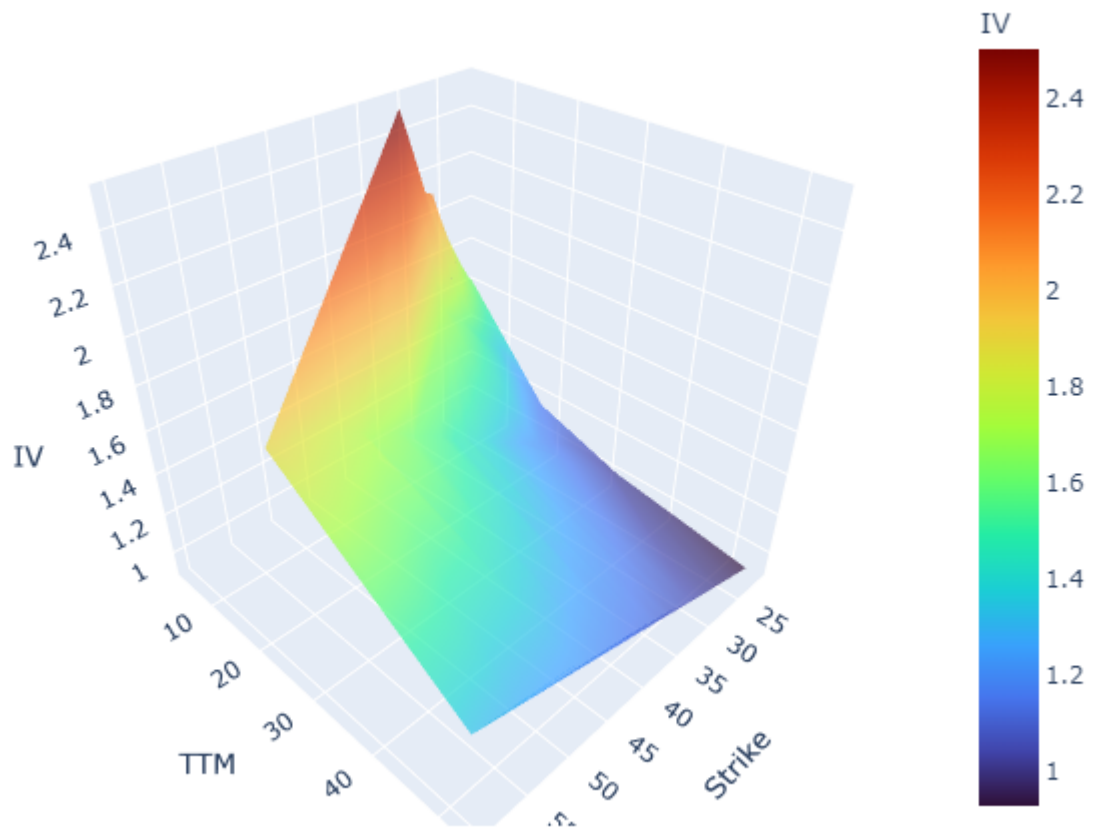
The calls seem to have the "smirk".

This could be because of the extra 7 puts that we have, but I don't think that's necessarily the reason.

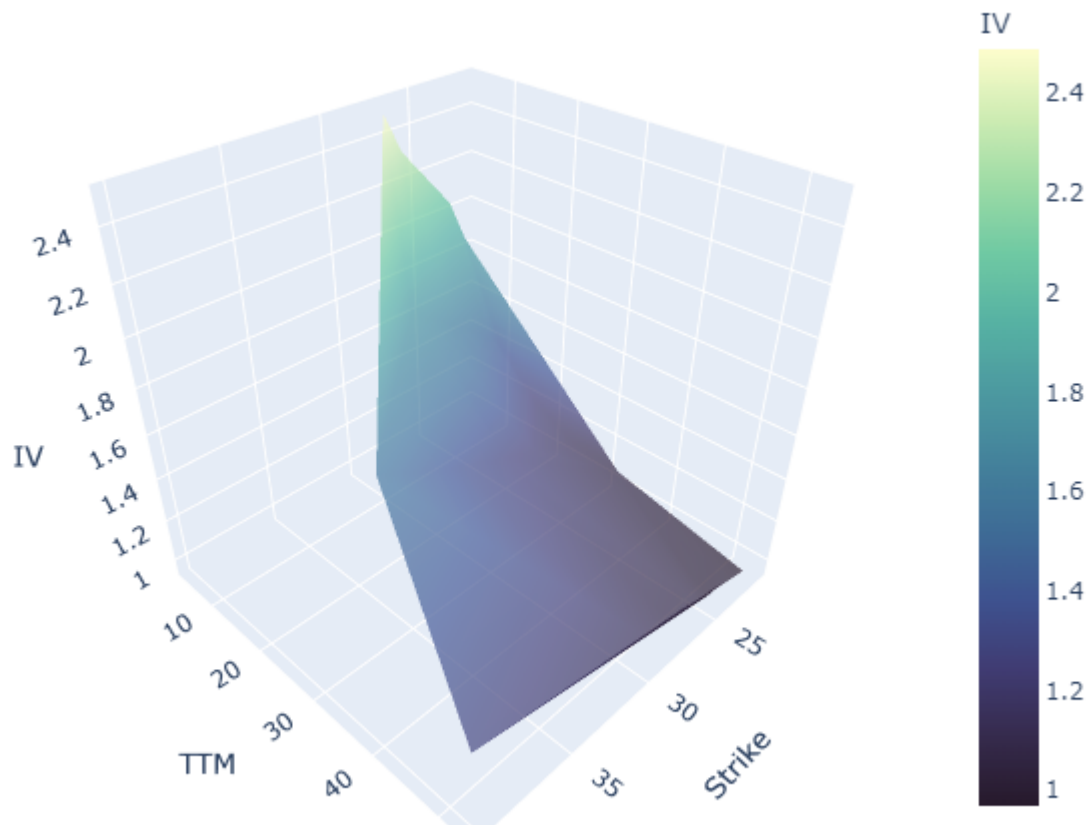
2: A day where we see a flip in the VIX and VIX3M.

There are 78 calls and 26 puts on 2020-02-24 *with a modified filter*.

Flip Day: Call Vol Surface



Flip Day: Put Vol Surface



Conclusion:

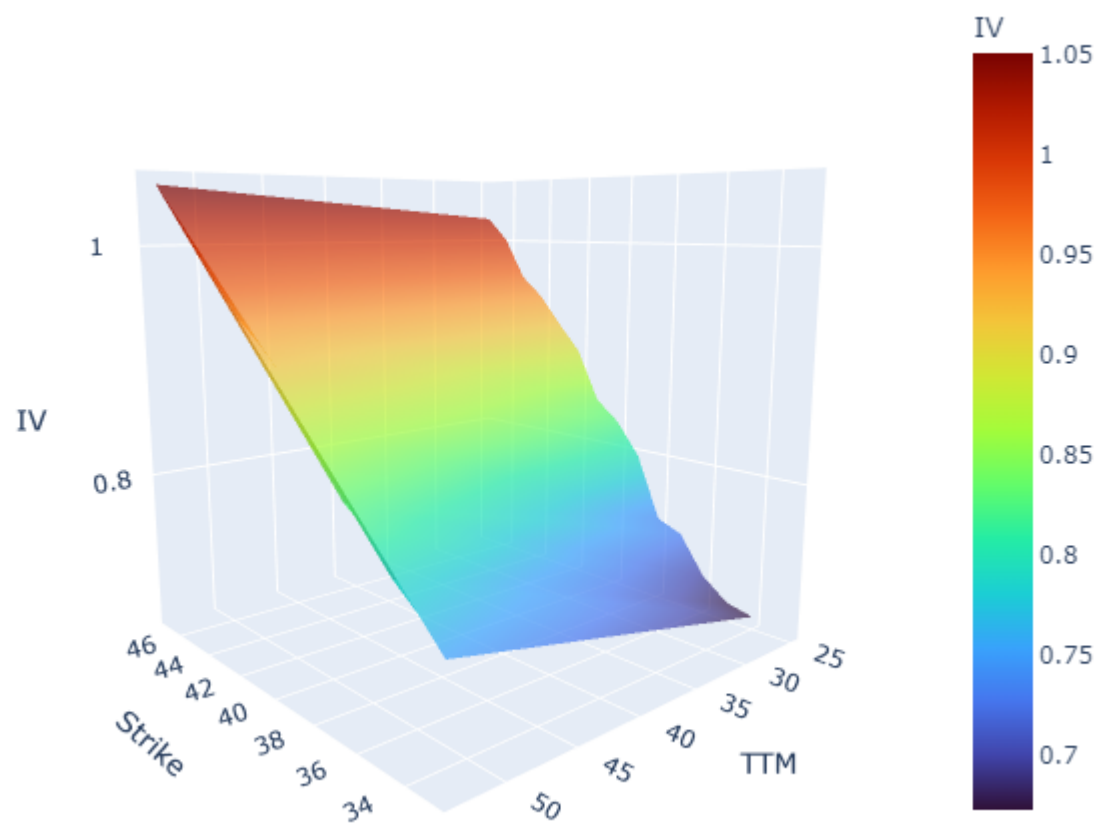
Because the VXX price is low, and the instrument that it tracks is a **volatility based product**, a simple 20% above and below underlying price filter for strike was simply not enough.

I had to modify my data for this date to + and – 70% of spot price.

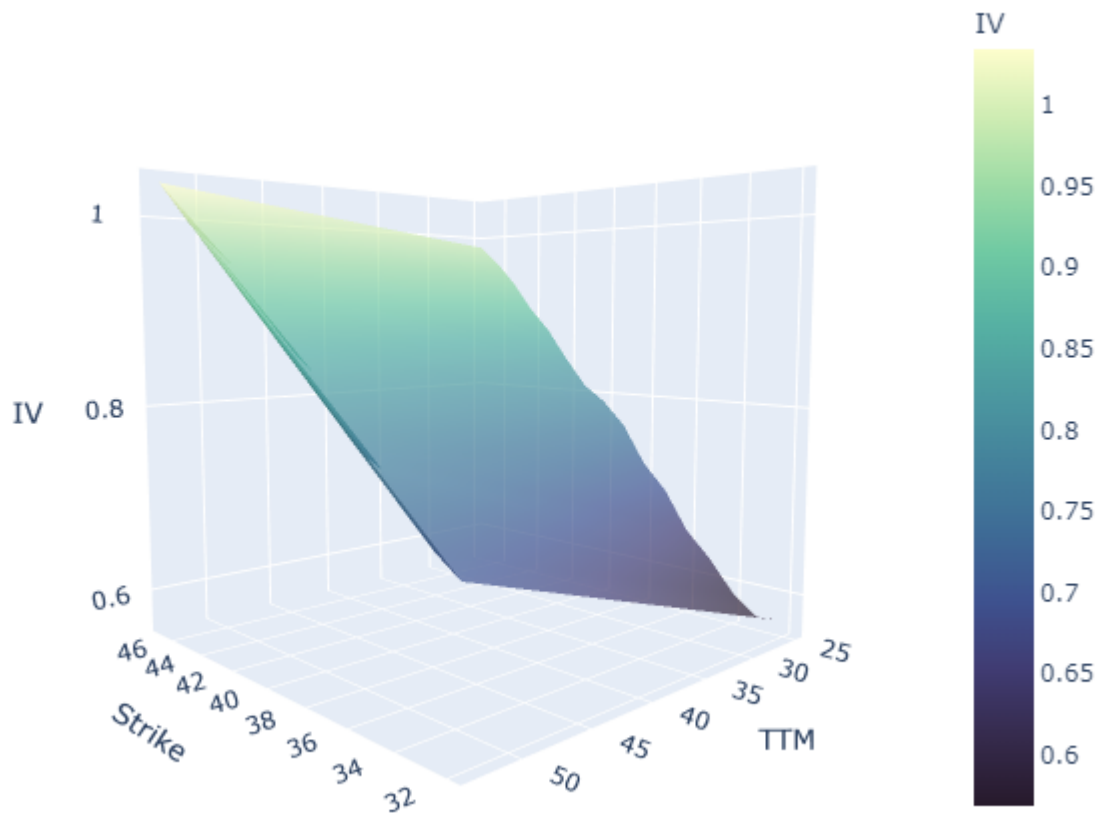
3: A day where we see a reverse split.

There are 28 calls and 30 puts on 2021-04-26 with the original filter.

Split Day : Call Vol Surface



Split Day: Put Vol Surface



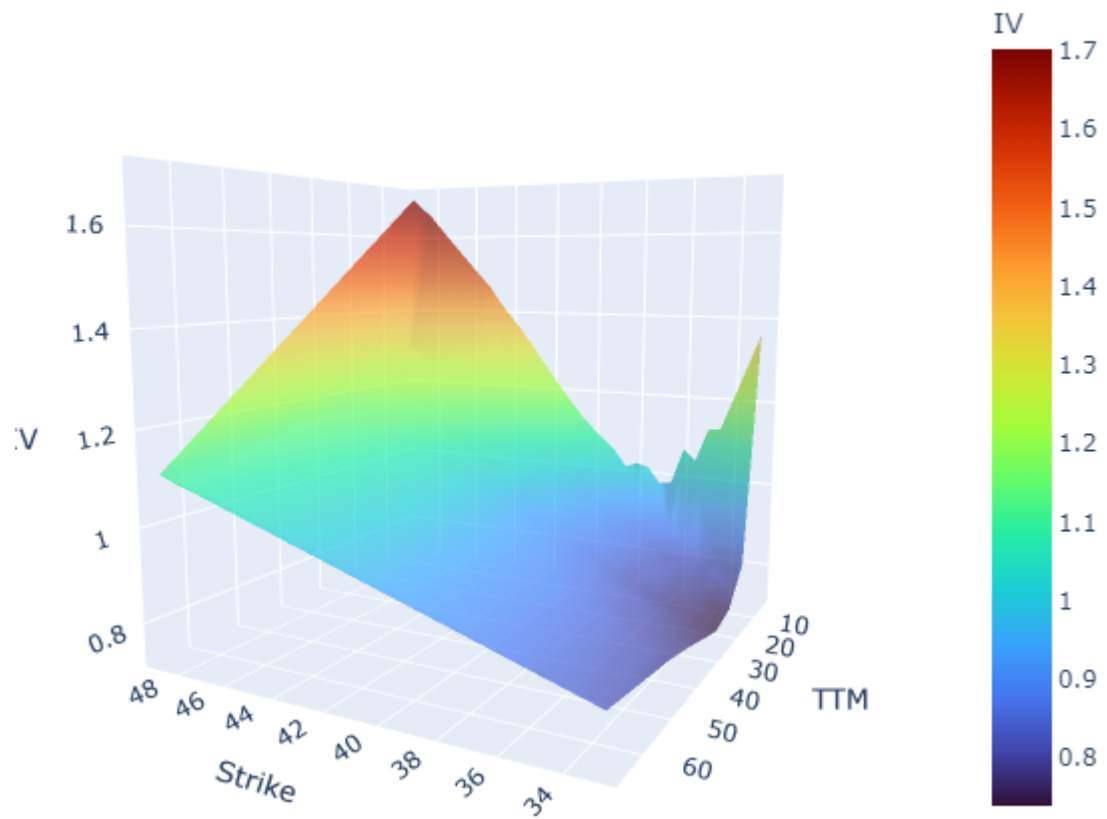
Conclusion:

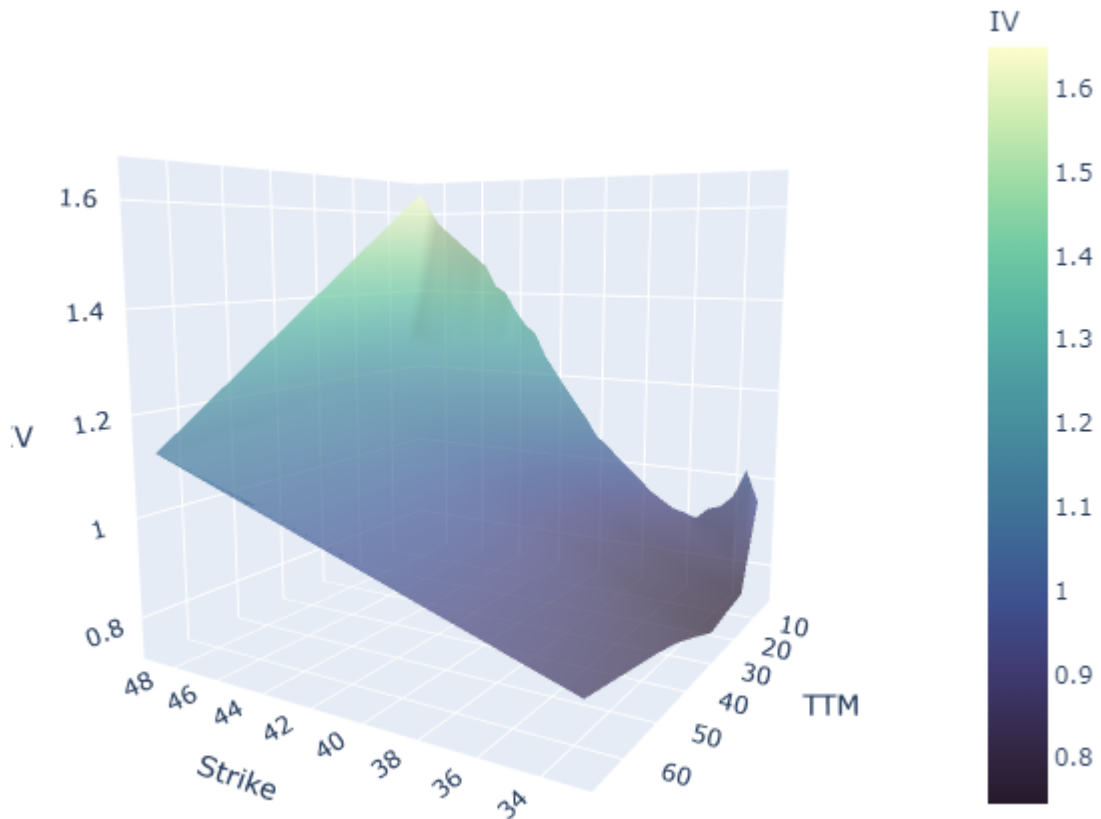
It looks like a bona-fide forward slash. There is absolutely no hint of a smile to this day!

4: A day with a lot of data.

There are 191 calls and 195 puts on 2021-05-11 with the original filter.

High Data Day: Call Vol Surface





Conclusion:

Now THAT is a pretty clean looking IV surface!

Final Thoughts

It seems to me that further investigation is warranted with a product like the VXX or the VIX.

A simple "Filter strikes within 20% of daily close" is not sufficient.

There should be a far superior way that is not complicated, i.e. robust: keeping all strikes within a certain *rolling range* of the daily close.

There are multiple avenues for this. Some ideas:

- Standard Deviation
- Average True Range
- HH and LL channel

I also imagine that the further you went back in time, due to the nature of the constant reverse splits, this issue will NOT be a problem!

Plenty of people do research on large swaths of historical data, and I can see this error being made accidentally on other similar products.

I think this bias needs a name. I propose the SAVOR.

Split

Aadjusted

Volatile

Option

Rule

SAVOR your data! I'm glad I did not give up on modeling the flip day, even if it did take a month to figure out. Further information can be found in the discovery.ipynb file at <https://github.com/algo-dude/AdvancedFinancialDerivatives/tree/master/Final>

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