

# Tail risk hedging with VIX calls

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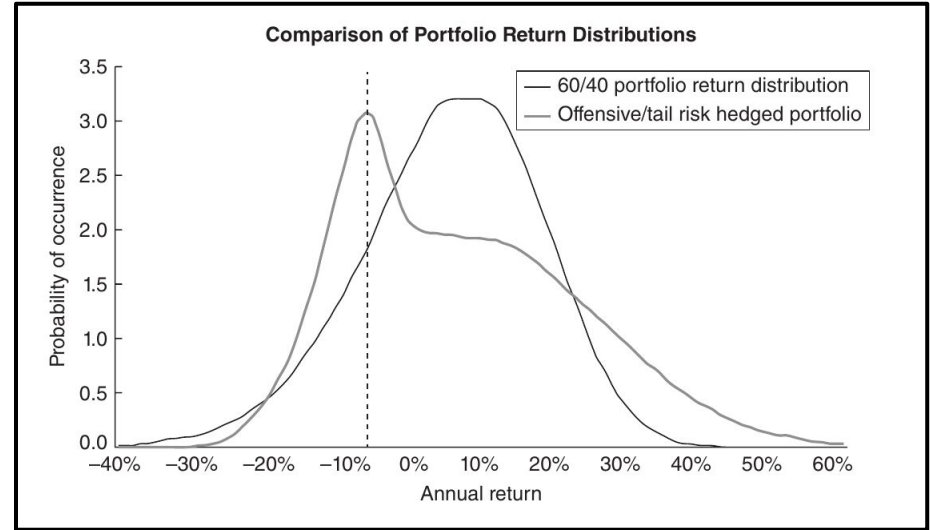
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# Why hedge?

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- Protect from market downturns
- Tune remainder of portfolio more aggressively
- Allow for more leverage



Return distribution of 60/40 portfolio of stocks/bonds vs. actively hedged portfolio. The median return of the hedged portfolio is lower, but its expected return is higher

# Hedging with VIX calls

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- VIX (CBOE Volatility Index) calls were selected as the hedging instrument of choice
  - Bet on increased volatility in response to lower equity prices / crisis
  - Convexity
  - Liquidity when other instruments are illiquid
  - Small contracts = easy to scale
  - European options, cash settled on expiration

Out of the money calls = high convexity

# Inspiration: VXTH

- Index developed by CBOE
- Portfolio holds S&P500
- Variable allocation to 1-month 30-delta VIX calls
- Hedge pays off with market downturn and volatility spike
  - Convexity of VIX calls is key!

VIX	Portfolio hedge allocation
$X \leq 15$	0%
$15 > X \leq 30$	1%
$30 > X \leq 50$	0.5%
$X > 50$	0%



**Green: Hedged portfolio**  
**Black: SPX benchmark**

# Inspiration: VXTH

March 2020: hedge pays off. Sold the VIX calls and “bought the dip” at exactly the right time



No significant outperformance in 2008

Slow bleed 2010-2020

**Green: Hedged portfolio**

**Black: SPX benchmark**

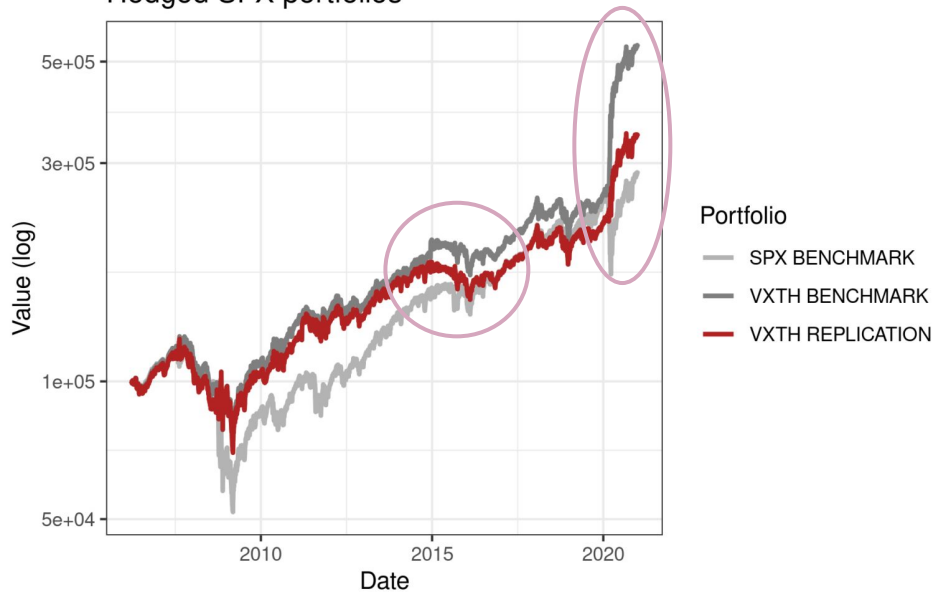
# At the midterm...

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- Backtested/replicated VXTH from 2006-2020
  - Daily VIX option price data
  - Not perfect replication, but mirrors the main trends
  - Improvement on absolute and risk adjusted returns compared to 100% SPX
  - Less drawdown than 100% SPX

# VXTH replication

Hedged SPX portfolios



	SPX	VXTH (benchmark)	VXTH (replicated)
CAGR	7.49	12.2	8.8
Sharpe ratio (Annualized)	0.49	0.67	0.66
StdDev (Annualized)	15.2	18.3	13.5
Worst drawdown	52.5%	37.4%	35.1%

# New areas to backtest

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- Trade signals
  - Portfolio holding a ladder of calls (30, 60, 90 days to expiration)
  - Optimal option delta
  - Monetization after a specific return on the hedge
  - Hedge amount
- 
- Backtesting is limiting: **you don't want to overfit** to the few crashes in history where this hedge will protect you



VIX prices



No hedge  
VIX > 50

0.5% hedge  
30 < VIX < 50

1% hedge  
15 < VIX < 30

No hedge  
VIX < 15

Transition matrix of  
closing prices

	0	1	2	3
0	1339	106	0	0
1	105	1756	35	0
2	0	35	262	9
3	0	0	9	65

	0	1	2	3
0	35.98%	2.85%	0.00%	0.00%
1	2.82%	47.19%	0.94%	0.00%
2	0.00%	0.94%	7.04%	0.24%
3	0.00%	0.00%	0.24%	1.75%

# Portfolio holding a ladder of calls

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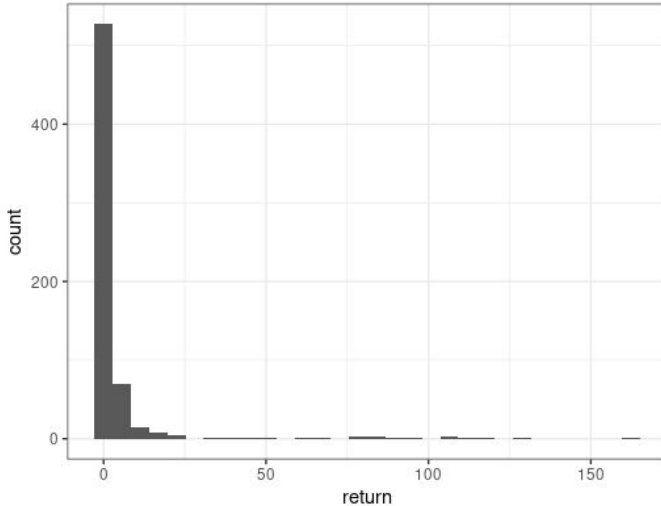
- This was tested to reduce “timing luck” of only holding a single option
- Buy 30, 60, 90 day options
  - Replace expiring option with new 90-day option
  - Allocate hedge equally among all 3

	CAGR	Sharpe
SPX	7.49	0.49
SPX + hedge	8.27	0.62
SPX + hedge (ladder)	<b>9.89</b>	<b>0.64</b>

# Optimal option delta

- Lower option delta = more convexity = less frequent, higher payoff
- 10 delta appears to be a sweet spot

Returns of 90 dte, 0.1 delta VIX calls



multiple	%
<b>Expire worthless</b>	97.4
<b>2</b>	30
<b>5</b>	11.4
<b>10</b>	7.4
<b>20</b>	4.3
<b>50</b>	<b>2.9</b>

event	Purchase date	Highest multiple
2008	2008-08-08	163
2020 COVID	2020-01-02	127
2007	2007-05-10	22
Feb 2018 crash	2017-11-27	21
Black monday Aug 2011	2011-07-08	16
Flash crash May 2010	2010-04-05	13

# Optimal option delta

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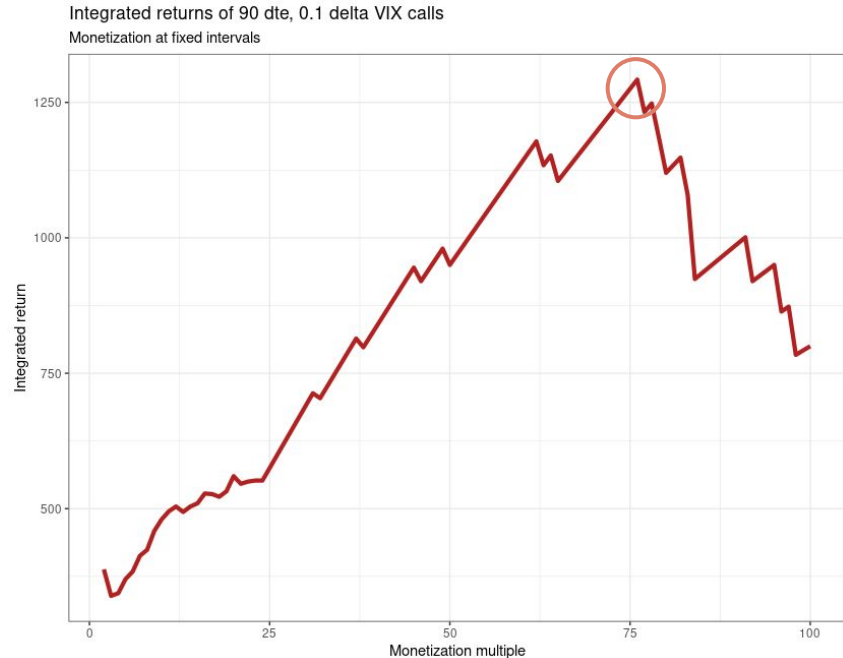
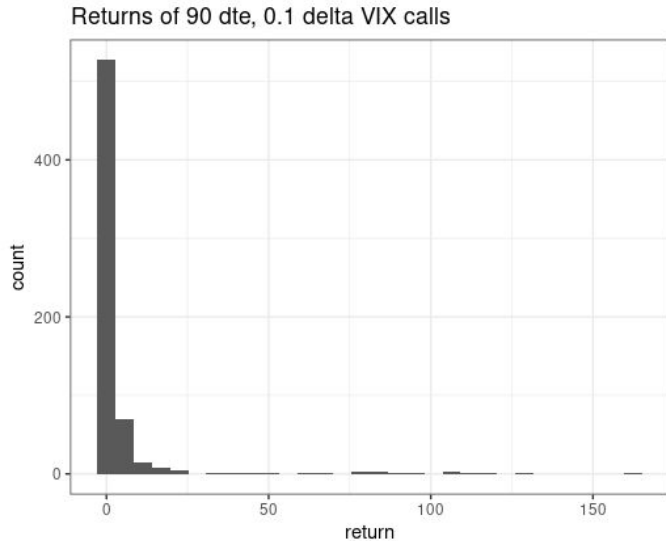
- Lower option delta = more convexity = less frequent, higher payoff
- 10 delta appears to be a sweet spot

	CAGR	Sharpe
SPX	7.49	0.49
SPX + hedge (30 delta)	8.27	0.62
SPX + hedge (10 delta)	<b>8.90</b>	<b>0.58</b>

# Monetization threshold

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- Rather than waiting for options to expire, we should sell the hedge when it hits a high enough value
- Based on max returns of 90-day, 10 delta calls, 75x monetization is optimal



# Monetization threshold

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- In backtests, 100x monetization appears to be the best
  - Somewhere 75-100x is probably sufficient

	CAGR	Sharpe
SPX	7.49	0.49
SPX + hedge	8.27	0.62
SPX + hedge (100x monetization)	<b>8.14</b>	<b>0.75</b>

# Hedge amount

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Original idea was to hedge 1% and 0.5%, depending on VIX conditions

- Less hedge is actually better in lower volatility!
- More hedge is better in high volatility - risky but high payoff

VIX	Old hedge allocation	New hedge allocation
$X \leq 15$	0%	0%
$15 > X \leq 30$	1%	0.5%
$30 > X \leq 50$	0.5%	1.0%
$X > 50$	0%	0%

	CAGR	Sharpe
SPX	7.49	0.49
SPX + hedge	8.27	0.62
SPX + hedge (new percentages)	<b>9.81</b>	<b>0.58</b>

# Putting it all together

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30, 60, 90 day hedges

Option delta: 10

Monetization threshold: 100x

Hedge amount: 0.5%, 1.0%

*How do all these changes combine for a synergistic effect? Still wary of timing luck.*

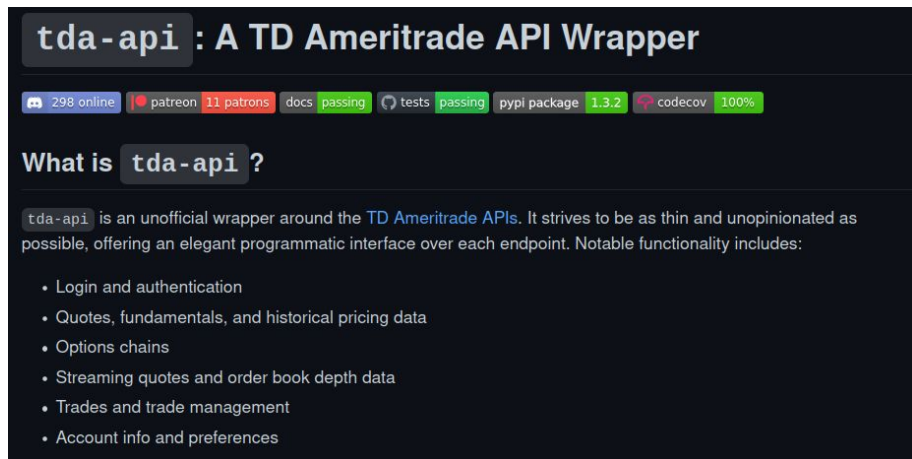
	CAGR	Sharpe
SPX	7.49	0.49
SPX + hedge	8.27	0.62
SPX + hedge (all together)	<b>11.41</b>	<b>0.65</b>



# Automated trading with `tda-api` (sort of)

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- Helpful python wrapper for automatic trading
- Accessible for any retail trader



The screenshot shows the GitHub repository page for `tda-api`. At the top, the repository name is displayed as `tda-api` : A TD Ameritrade API Wrapper. Below the name, there are several status indicators: 298 online users, 11 patrons on Patreon, docs passing, tests passing, pypi package 1.3.2, and codecov 100%. The main heading is "What is `tda-api` ?". The description states that `tda-api` is an unofficial wrapper around the TD Ameritrade APIs, designed to be thin and unopinionated, offering an elegant programmatic interface over each endpoint. The notable functionality includes:

- Login and authentication
- Quotes, fundamentals, and historical pricing data
- Options chains
- Streaming quotes and order book depth data
- Trades and trade management
- Account info and preferences

# Automated trading with `tda-api` (sort of)

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- This strategy trades very infrequently (~1x /month)
- Rather than automate the whole process, simply analyze market signals and print what trades to make
- Don't have to code risk management, execution, etc....

```
Portfolio value: 9995.18  
VIX price today: 17.9  
VIX regime today: 1  
Hedge today: True
```

```
Buy this call:  
Expiration: 2021-08-18  
DTE: 78  
Strike: 70.0  
Delta: 0.1  
Bid: 0.4 Ask: 0.45  
Contracts: 1  
Hedge percentage: 0.45%
```

**Thank you!**

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# Transaction costs

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Today, April 27, 2021

- VIX at 17.5
- Option transactions are \$0.65 to open, \$0.65 to close, free to close if they expire worthless!

Expiration	Delta	Strike	Bid	Ask	Spread	Spread %	Open cost %
5/19	30	24	1.00	1.05	0.05	4.88%	0.63%
5/19	20	28	0.65	0.70	0.05	7.41%	0.96%
5/19	10	37.5	0.30	0.35	0.05	15.38%	2.00%
6/16	30	29	1.50	1.60	0.10	6.45%	0.42%
6/16	20	37.5	0.85	0.90	0.05	5.71%	0.74%
6/16	10	50	0.45	0.50	0.05	10.53%	1.37%
7/21	30	35	1.60	1.70	0.10	6.06%	0.39%
7/21	20	42.5	1.05	1.15	0.10	9.09%	0.59%
7/21	10	60	0.45	0.55	0.10	20.00%	1.30%

I got filled for one contract at 1.55 here

# Transaction costs included in the model

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- Option transactions cost \$0.65 to open, \$0.65 to close
- Assume worst case where we buy at ask, sell at bid

<b>Portfolio</b>	<b>Sharpe ratio Previously</b>	<b>Sharpe ratio Worst case</b>	<b>CAGR Previously</b>	<b>CAGR Worst case</b>
SPX + hedge	0.66	0.56	8.8	7.53
UPRO/TMF + hedge	0.87	0.80	19.2	17.8
SPX alone	0.49		7.49	
UPRO/TMF alone	0.70		17.1	

