

A Mean Reversion Strategy with 2.11 Sharpe

Trading rules to trade QQQ with 5x better risk-adjusted return without the large drawdowns



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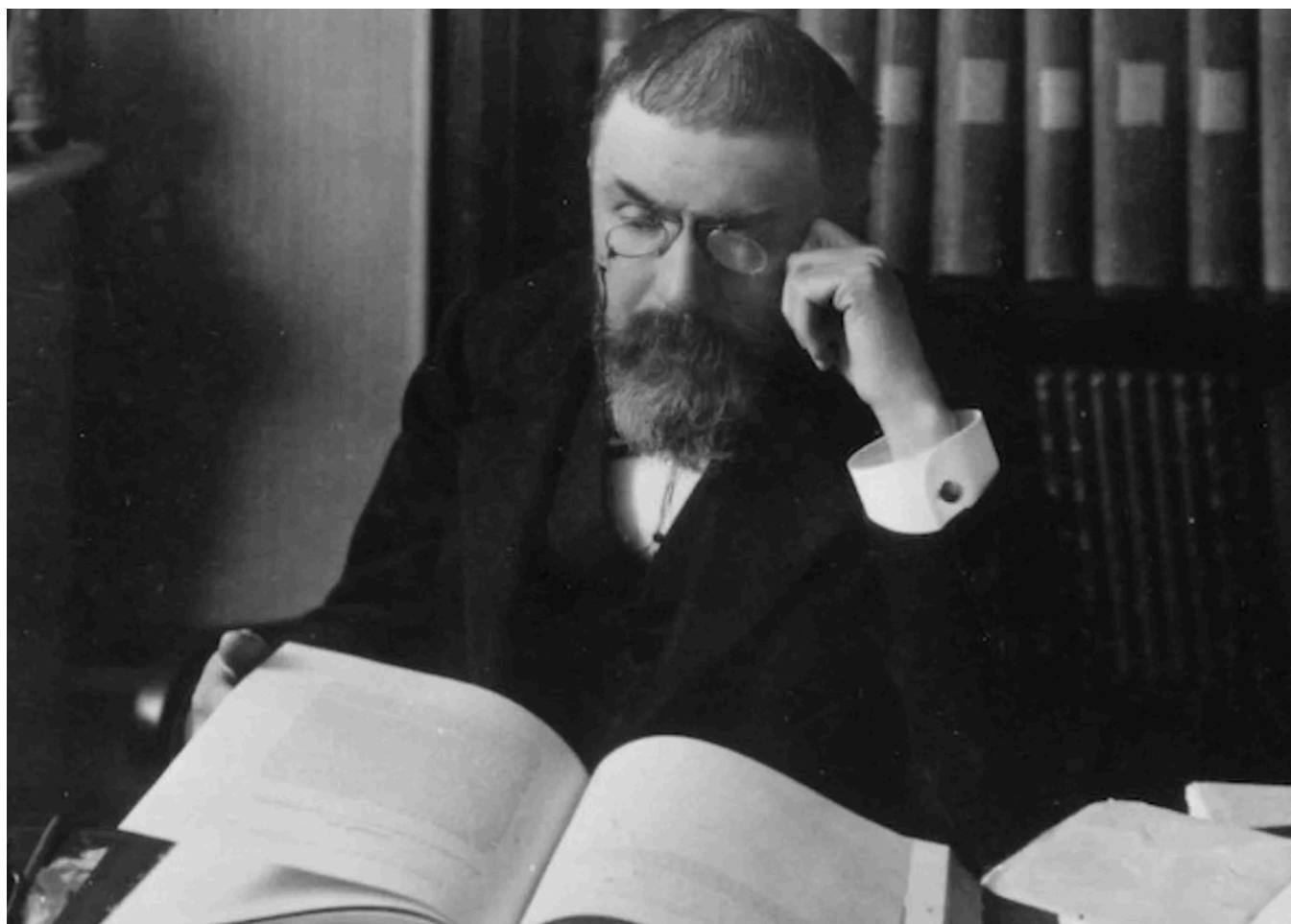


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Henri Poincaré: renowned French mathematician, physicist, and philosopher

The idea

“Never disdain to make a verification when opportunity offers.” Henri Poincaré

I always loved this quote from Poincaré. It's a classical version of the "trust but verify" famous Russian proverb. If there is an area where it is imperative to apply this

principle, it is in quantitative trading.

With that in mind, I decided to test a mean reversion strategy I read in a blog. The original rules were clear:

- Compute the **rolling mean of High minus Low** over the last 25 days;
- Compute the **IBS indicator**: $(\text{Close} - \text{Low}) / (\text{High} - \text{Low})$;
- Compute a **lower band** as the **rolling High** over the last 10 days minus $2.5 \times$ the rolling mean of High minus Low (first bullet);
- **Go long** whenever **SPY closes under the lower band** (3rd bullet), and **IBS is lower than 0.3**;
- **Close the trade** whenever the **SPY close is higher than yesterday's high**.

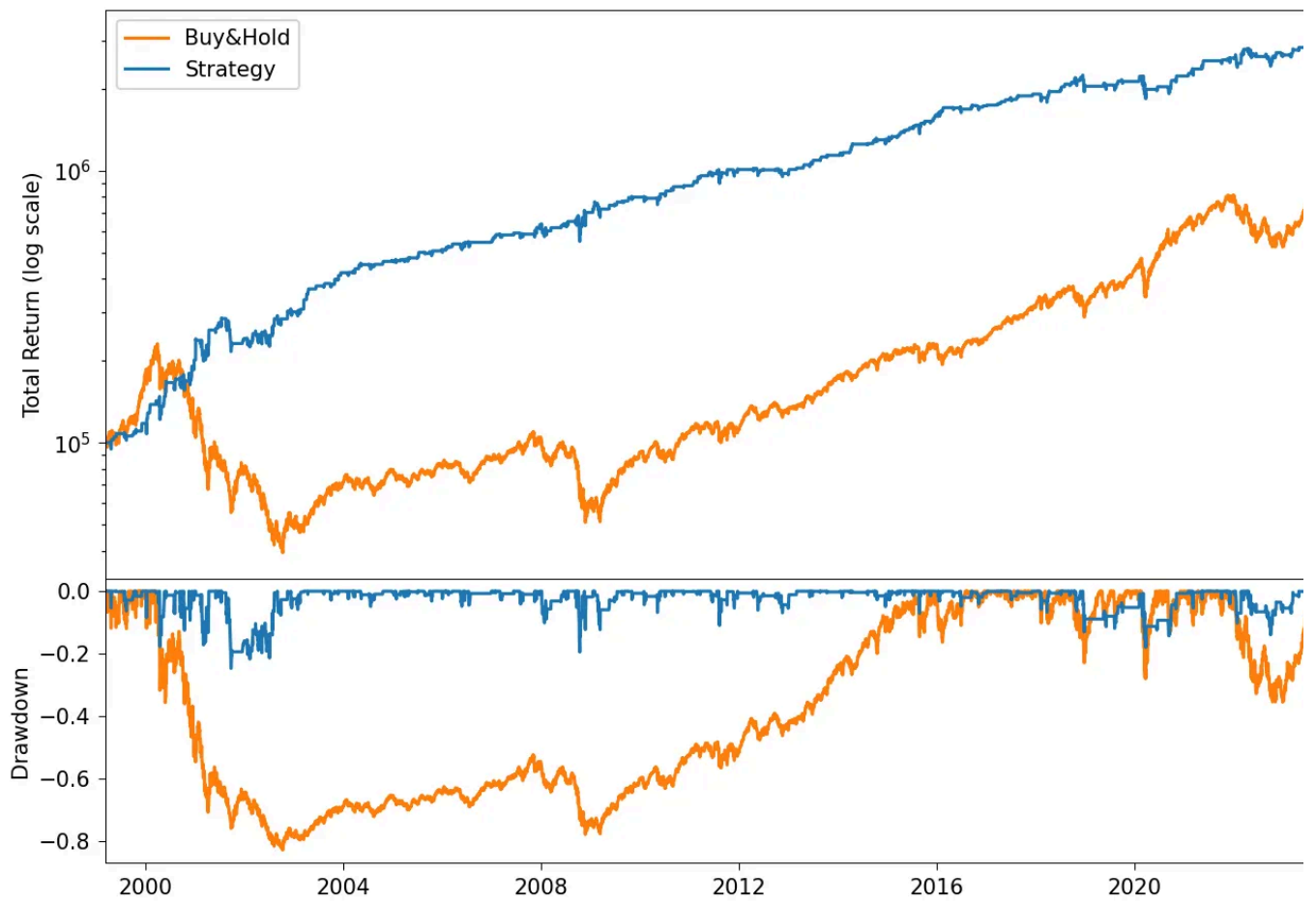
The logic behind this trading strategy is that the market tends to bounce back once it drops too low from its recent highs.

The blog showed an impressive equity curve. My first thought was about Poincaré's hypothesis: it is an opportunity to make a verification that I won't disdain.

First experiments

Running the original rules precisely as described in the blog led to slightly worse results: 1.39 Sharpe, 7.1% annual return from 1993–2024 (vs. 8.3% Buy&Hold), despite being invested only 18% of the time. That can be explained by my backtest being almost four years longer (the original run was only until 2020).

Then, after trying some instruments, I experimented with **QQQ** and got much better results:



Equity and drawdown curves for the strategy with original rules applied to QQQ

The summary of backtest statistics showed promising results:

	Strategy	Buy&Hold	S&P 500
Start	1999-03-10		
End	2024-05-17		
Duration [days]	9,200		
Exposure Time [%]	20.0	100.0	100.0
Start [\$]	100,000	100,000	100,000
Final [\$]	3,092,578	909,793	412,000
Peak [\$]	3,142,513	912,267	412,000
Return [%]	2992.6	809.8	300.0
Return (Ann.) [%]	14.6	9.2	9.2
Volatility (Ann.) [%]	16.4	27.8	27.8
Sharpe Ratio	1.83	0.45	0.45
Exposure-Adjusted Return (Ann.) [%]	73.1	9.2	9.2
Correlation	1.00	0.59	0.59
Max. Drawdown [%]	-24.7	-82.9	-82.9
Avg. Drawdown [%]	-2.8	-3.4	-3.4
Max. Drawdown Duration [days]	535	3,925	1,000
Avg. Drawdown Duration [days]	26	38	38
# Drawdowns	177	159	159
# Drawdowns / year	7	6	6

Summary of the backtest statistics

	All Trades	Winning Trades	Losing Trades
# Trades	323	239	
# Trades / year	12	9	
Avg. return / trade [%]	1.12	2.32	-1.12
Best / worst trade [%]		18.07	-18.07
Max. Trade Duration [days]	25	18	
Avg. Trade Duration [days]	6	5	
Win Rate [%]	74.0		
Profit Factor	2.36		
Win/Loss Ratio	2.85		
Payoff Ratio	1.00		
CPC Index	4.98		
Expectancy [\$]	9,265		

Summary of the backtest trades

Although those were good results, the maximum drawdown was too long and too deep for my taste. Holding to a strategy through a **~25% drawdown** and having a drawdown of **one and a half years** is **too much** for most people's risk tolerance.

What could we do to try to minimize this drawdown?

Improvement 1: Market Regime Filter

At first, I tried to apply **stop-losses**. But they never quite worked. Whenever I used them, they would not only **cut losers** but also **cut winners**, making things worse.

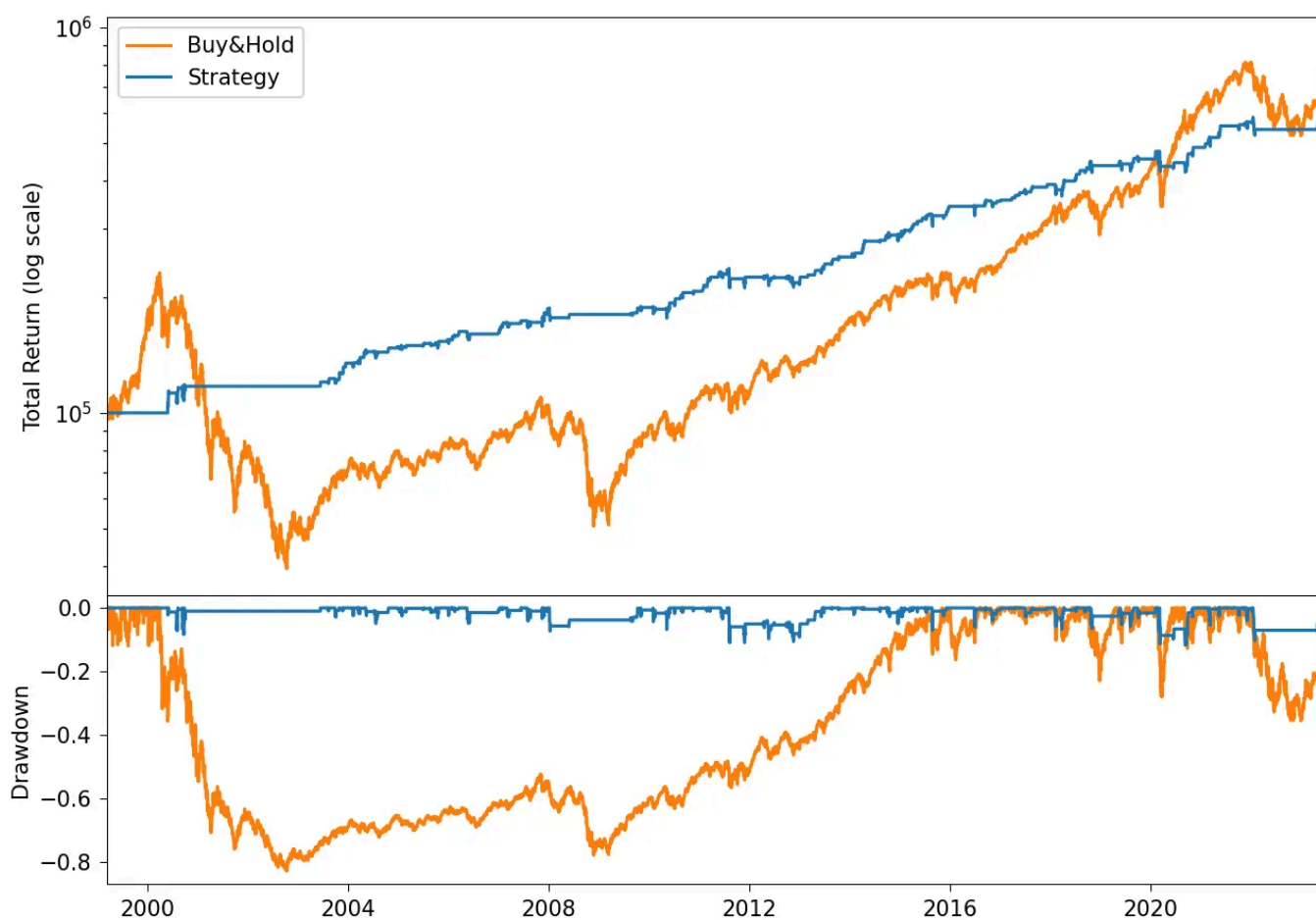
Then, I tried **Market Regime Filters**, which are great tools for **reducing drawdown**. Implementing a market regime filter is quite simple. I just needed to add a trading rule that would only allow trades in bull markets and get to **100% cash** in bear markets.

There are several ways to define a bull/bear market quantitatively. I decided to use simplest one:

- Whenever the **prices are above the 200-SMA**, we are in a bull market: we can **trade**;
- Whenever the **prices fall below the 200-SMA**, we are in a bear market: we **move 100% cash**.

I experimented a bit with the number of days in the SMA — 150, 200, 300 — to find what works best. After tweaking a bit, I found that **300** was the best option. But I tested 4-5 options only (I'm not a fan of optimization; I believe they can quickly lead to overfitting).

The results are shown below:



Equity and drawdown curves for the strategy with market regime filter

	Strategy	Buy&Hold	S&P 500
Start	1999-03-10		
End	2024-05-17		
Duration [days]	9,200		
Exposure Time [%]	11.7	100.0	100.0
Start [\$]	100,000	100,000	100,000
Final [\$]	605,297	909,793	412,000
Peak [\$]	615,070	912,267	412,000
Return [%]	505.3	809.8	300.0
Return (Ann.) [%]	7.4	9.2	9.2
Volatility (Ann.) [%]	8.8	27.8	27.8
Sharpe Ratio	2.25	0.45	0.45
Exposure-Adjusted Return (Ann.) [%]	63.7	9.2	9.2
Correlation	1.00	0.31	0.31
Max. Drawdown [%]	-11.7	-82.9	-50.0
Avg. Drawdown [%]	-2.1	-3.4	-3.4
Max. Drawdown Duration [days]	677	3,925	1,000
Avg. Drawdown Duration [days]	43	38	38
# Drawdowns	110	159	159
# Drawdowns / year	4	6	6

Summary of the backtest statistics

	All Trades	Winning Trades	Losing Tra
# Trades	192	149	
# Trades / year	7	5	
Avg. return / trade [%]	0.96	1.74	-
Best / worst trade [%]		12.61	-6
Max. Trade Duration [days]	21	15	
Avg. Trade Duration [days]	6	5	
Win Rate [%]	77.6		
Profit Factor	3.13		
Win/Loss Ratio	3.47		
Payoff Ratio	1.00		
CPC Index	8.42		
Expectancy [\$]	2,632		

Summary of the backtest trades

It worked! This was a significant improvement over the original rules but with some drawbacks:

- The **Sharpe Ratio** went from 1.83 to 2.25, driven by a significant **reduction in exposure time**: the strategy spent 11.7% of the time invested vs. 20.0% in the previous experiment;
- The drawdown improved drastically: the **maximum drawdown** went from -24 to -11.7%, the **average drawdown** went from -2.8% to -2.1%, and the **# of drawdowns** went from 7/year to 4/year;
- However, the **total return was almost cut by half**: the annualized returns went from 14.6% to 7.4%.

Could we improve even further? Could we change it to re-introduce more returns without compromising on more drawdowns?

Improvement 2: A better exit strategy with dynamic stop losses

My first idea was to use leverage. So, I tested the exact same strategy with the following adjustments:

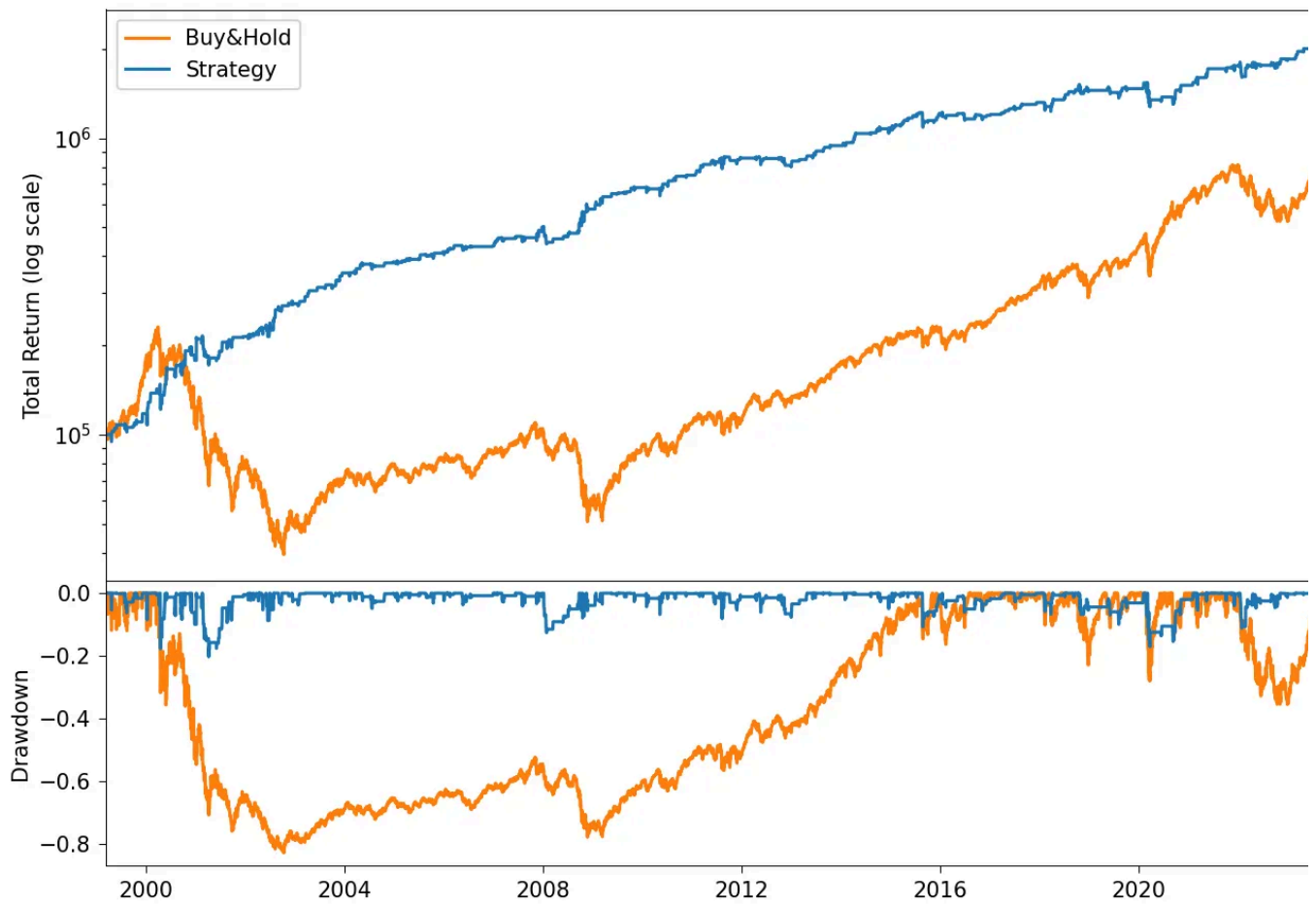
- Whenever the strategy signaled to go long, it would go long on QLD instead of QQQ (2x leverage);
- Then, the strategy would observe QLD prices to exit instead of QQQ.

This idea **did not work**. Although the strategy achieved **11.7% in annualized return** with a **2.1 Sharpe**, it failed to keep the maximum drawdown in check: the **maximum drawdown reached -29%**, worse even than our very first experiment. So, I gave up using leverage.

Then, I decided to **abandon the market regime filter** but **improve the exit strategy**. Curiously, the market regime filter was what inspired me to try a new exit strategy. Now, the strategy would exit trades whenever one of the two conditions below were met:

- **Close the trade** whenever the **price is higher than yesterday's high** (same as before);
- **Close the trade** whenever the **price is lower than the 300-SMA** (new condition).

We could see this new condition as a **dynamic stop loss**. Anyway, here are the results:



Equity and drawdown curves for the strategy with original rules applied to QQQ
with a dynamic stop

	Strategy	Buy&Hold	S&P
Start	1999-03-10		
End	2024-05-17		
Duration [days]	9,200		
Exposure Time [%]	15.1	100.0	1
Start [\$]	100,000	100,000	100,
Final [\$]	2,184,914	909,793	412,
Peak [\$]	2,220,195	912,267	412,
Return [%]	2084.9	809.8	3
Return (Ann.) [%]	13.0	9.2	
Volatility (Ann.) [%]	13.5	27.8	
Sharpe Ratio	2.11	0.45	
Exposure-Adjusted Return (Ann.) [%]	86.6	9.2	
Correlation	1.00	0.49	
Max. Drawdown [%]	-20.3	-82.9	-
Avg. Drawdown [%]	-2.7	-3.4	
Max. Drawdown Duration [days]	323	3,925	1,
Avg. Drawdown Duration [days]	30	38	
# Drawdowns	155	159	
# Drawdowns / year	6	6	

Summary of the backtest statistics

	All Trades	Winning Trades	Losing Trades
# Trades	414	284	
# Trades / year	16	11	
Avg. return / trade [%]	0.79	2.13	-
Best / worst trade [%]		18.07	-1
Max. Trade Duration [days]	15	15	
Avg. Trade Duration [days]	4	4	
Win Rate [%]	68.6		
Profit Factor	1.98		
Win/Loss Ratio	2.18		
Payoff Ratio	0.99		
CPC Index	2.97		
Expectancy [\$]	5,036		

Summary of the backtest trades

There we go! In this experiment, we improved our first run, reintroducing a higher return while reducing the drawdown. Specifically:

- The Sharpe Ratio went from the original 1.83 to 2.11, while the annualized returns from 14.6% to 13.0%, still well above Buy&Hold (9.2%);
- The maximum drawdown went from -24.7% to -20.3%;
- Most importantly, the maximum drawdown duration went from 535 days to less than a year, and the # of drawdowns from 177 to 155.

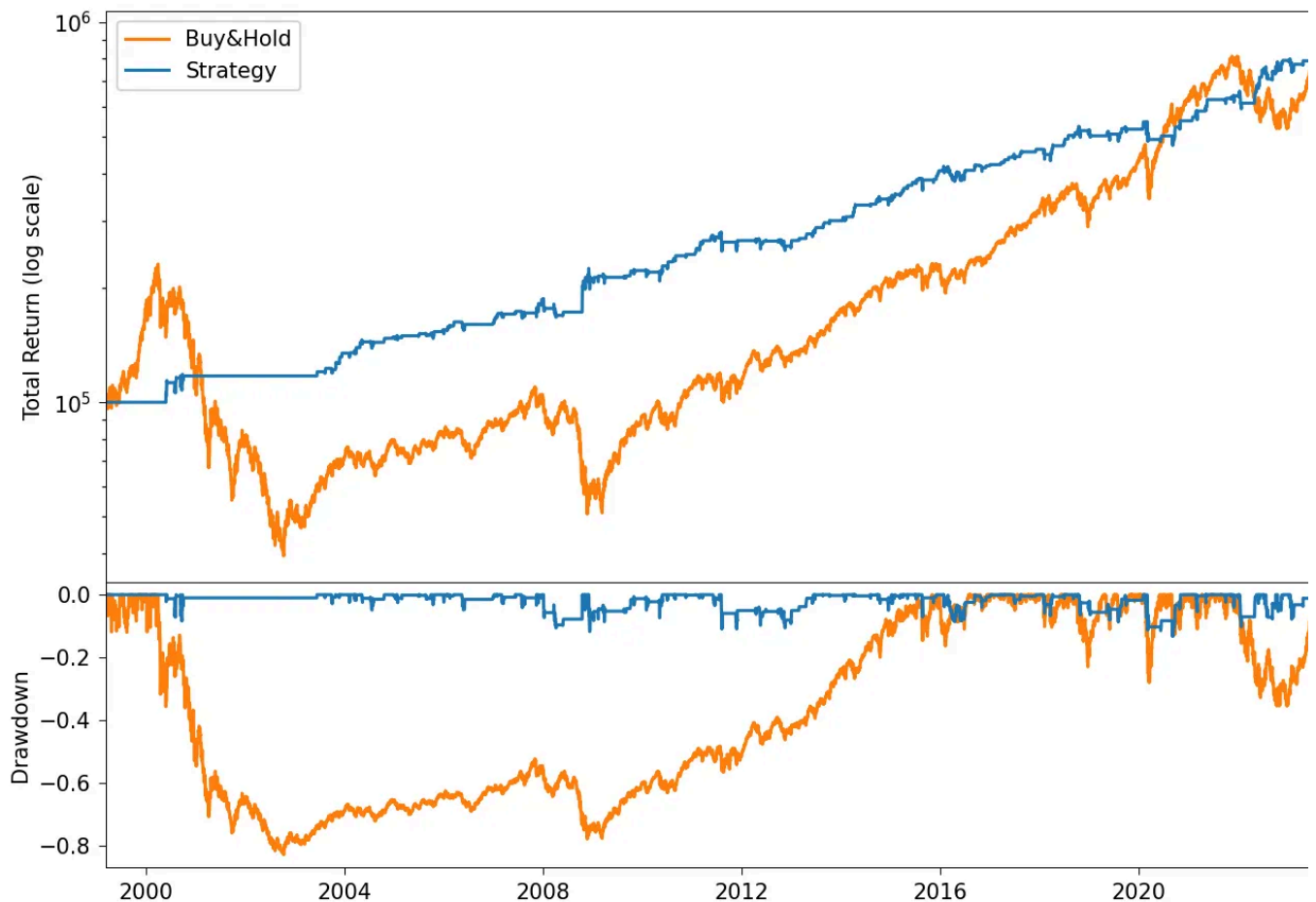
While this maximum drawdown is still a bit high for my taste, this is a strategy I would be willing to forward-test and trade.

However, I still thought I could do better.

Improvement 3: Long & Short

Yesterday, I went for a morning run. Somehow, getting in a workout sparks my creativity. By the end of 10K, I got the idea: what if the strategy **simultaneously trades** **QQQ in bull markets** and **PSQ (the inverse ETF) in bear markets**?

This is the answer:



Equity and drawdown curves for the strategy applied to QQQ in bull markets and PSQ in bear markets

	Strategy	Buy&Hold	S&P
Start	1999-03-10		
End	2024-05-17		
Duration [days]	9,200		
Exposure Time [%]	13.7	100.0	100.0
Start [\$]	100,000	100,000	100,000
Final [\$]	861,887	909,793	412,000
Peak [\$]	875,801	912,267	412,000
Return [%]	761.9	809.8	300.0
Return (Ann.) [%]	8.9	9.2	
Volatility (Ann.) [%]	10.4	27.8	
Sharpe Ratio	2.02	0.45	0.0
Exposure-Adjusted Return (Ann.) [%]	65.1	9.2	
Correlation	1.00	0.14	
Max. Drawdown [%]	-13.3	-82.9	-90.0
Avg. Drawdown [%]	-2.3	-3.4	
Max. Drawdown Duration [days]	677	3,925	1,000
Avg. Drawdown Duration [days]	38	38	
# Drawdowns	124	159	
# Drawdowns / year	4	6	

Summary of the backtest statistics

	All Trades	Winning Trades	Losing Trades
# Trades	227	171	
# Trades / year	9	6	
Avg. return / trade [%]	0.99	1.91	-
Best / worst trade [%]		16.37	-16.37
Max. Trade Duration [days]	21	15	
Avg. Trade Duration [days]	6	5	
Win Rate [%]	75.3		
Profit Factor	2.94		
Win/Loss Ratio	3.05		
Payoff Ratio	1.05		
CPC Index	6.76		
Expectancy [\$]	3,394		

Summary of the backtest trades

We were able to achieve a good compromise with this last improvement:

- While the **2.02 Sharpe** was lower than the 2.25 from the Market Regime Filter experiment, the Long&Short experiment improved the **annualized return from 7.4% to 8.9%**, almost the same as the Buy&Hold (9.2%): the additional trades in bear markets paid off;
- Comparing the **maximum drawdown** to the Market Regime Filter experiment went **from -11.7% to -13.3%**, a slight increase; however, compared to the Dynamic Stop Losses experiment (-20.3%), it was a **drastic reduction**.

Final Thoughts

Which experiment should we choose to trade? The one with Dynamic Stop Losses with a higher Sharpe (2.11), higher annualized returns (13.0%), and lower maximum drawdown (-20.3%)? Or should we choose the Long&Short variation, with a lower Sharpe (2.02), lower annualized returns (8.9%), but a much better maximum drawdown (-13.3%)?

Also, taking into consideration the **low exposure time from 12-15% in all experin improvements**, should we even consider the Market Regime Filter long-only experiment with the highest Sharpe (2.25) and lowest maximum drawdown (-11.7% **complement it with different strategies to increase its low annualized returns (7.4**

Those are good questions. If I had to **pick one**, I would choose the **Long&Short** variation. But the experiment with Dynamic Stop Losses also has its merits.

However, I believe the best way forward would be to **develop new complementary strategies and run them simultaneously to increase the exposure time**, thus increasing the total return. Think about the Market Regime Filter long-only experiment:

- It achieved a **2.25 Sharpe**, annualized returns of 7.4%, and -11.7% maximum drawdown with **only 11.7% of exposure time**;
- If we could be invested in this strategy 100% of the time, theoretically, we could achieve 63.7% of annual returns;
- So, let's say we could develop additional strategies with the same stats and combine them such that we could increase the time invested to 50% (more realistically): we could reach close to 32% annual returns with a 2.25 Sharpe and drawdowns lower than -12%!

I will do this (while all three variations get a good forward test in real market conditions).

I'd love to hear your thoughts about this approach. If you have any questions or comments, **just reach out via [Twitter](#) or [email](#)**.

Also, if you want to **implement this strategy and need help**, just let me know.

Cheers!

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Trevor Canty 2024年7月14日

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I may have missed it but does the model require you to hold a losing trade until this trigger
"Close the trade whenever the SPY close is higher than yesterday's high." I.e. there is no se
stop loss mechanism?

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Michael Berman 2024年7月1日

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