Arbitrage and Statistical Arbitrage

Everestia LLC, October 2022

Disclaimer

This short note is for informational and educational purposes only. It should not be considered as investment advice. For investment advice, please contact Everestia LLC. Some conceptual components of Everestia's strategy are rooted in statistical arbitrage. However, strictly speaking, Everestia's strategy is not statistical arbitrage.

Introduction

This short note is to introduce the concept of arbitrage and statistical arbitrage.

In many cases, the same financial instrument, say SPY, the ETF tracking SP500, is traded at many different exchanges / markets. Most of the people trades only in one of those markets. For people trades in more than one markets, like large banks, when the prices are different at different market, there is an arbitrage opportunity. The trader would buy low at one market and sell high at a different market simultaneously. This is what is often referred as arbitrage, making a return without taking any risks. Of course, there are other factors, such as bid-offer, transaction cost, IT requirements. So, it might not be risk-free and cost-free profit. Arbitrage opportunities are rare and profits are small. In fact, the efficient market theory in any standard textbook on capital market says there is no arbitrage. It is likely that the large institutions, making arbitrage trades, removed all meaningful arbitrage opportunities.

Statistical Arbitrage

What if they are not the same exact financial instrument, but closely linked? For example, referencing to SP500, there are ETFs (SPY) and futures. The movement of both ETF and futures should go with the SP500 index. Further, as SP500 consists of 500 underlying stocks, the movements of the index should go with the movements of the underlying stocks. Now we start to get to the boundary of the statistical arbitrage.

When the ETF and future linked to SP500 index are traded at the market price different from the implied / derived price from the index, there is an opportunity, as statistically and ultimately, the ETF and the Future should "converge"" or mean-reverting to the implied / derived price. We might not know

when the converge will happen. Many times, before the converge, It might be possible there will be extended period of divergence. But history told us, that the converge will eventually happen in some time horizon. This is what I call statistical arbitrage. Such statistical arbitrage does exist in the market. There are traders making a living using this strategy.

Some people refer similar strategy using two highly correlated stocks, like GM and Ford, as statistical arbitrage as well. In my view, movements of individual stocks, no matter how strong the correlation are, are influenced by so many factors which are specific to the firm. The converge might not happen. To me, statistical arbitrage should be linked to construction of the instruments. The relationship between the instruments should be mathematical.

VXX and TVIX

The rest of the note, we will illustrate the statical arbitrage using a pair of volatility ETFs, TVIX and VXX. TVIX and VXX once were traded actively in the market, and both ETF are linked to the short-term volatility index (Bloomberg Ticker SPVXSP). (Note that, due to various reasons, the ETFs are not longer trading "normally" in the market.)

ETF premium is a term people use to measure the market dislocation of ETFs.

ETF premium = (Market price of the ETF) / (Implied price (or net asset value NAV)) – 1

Some people refer Implied price as net asset value (NAV). The ETF premium often moves around zero, meaning the market price is close to the implied price most of the cases.

When the market price of ETF is higher than the NAV, it is called trading at premium. If the market price is lower than the NAV. It is called trading at a discount.

Model Assumptions

The model uses process interval of 30 minutes. The 30 minutes price bar are used to make the decision to enter or exit the trade.

As the TVIX is reserve 2X ETF of VIX short term index and VXX is reserve 1X ETF. If we short $100k of TVIX, we will short $200k VXX.

The Portfolio ETF Premium = TVIX ETF Premium – 2*(VXX ETF Premium)

The portfolio is rebalanced every 30 minutes to have the same market value. So, there is no compounding necessary. Return over the holding period will be the simple of the return over all the 30-minute periods.

There are many other assumptions of the model which simplifies the real trading environment, such as, no borrowing cost of short shares, no bid/offer.

Below Table 1 has the distribution of the portfolio ETF premiums. The distribution provides a roughly idea of the range of the portfolio ETF premium, and give us some basic idea when to enter and when to exit the trade.

Table 1 Distribution of Portfolio ETF Premium

		Percentile							
max	min	1%	2.50%	5%	25%	50%	75%	98%	99%
3.89%	3.00%	-0.30%	0.06%	0.12%	0.72%	1.41%	2.39%	3.07%	3.21%

Model Inputs / Output

Back testing Data:

7/24/2019 10AM to 12/30/2019 15PM, every 30 minutes.

Portfolio:

short TVIX of market value of $100k and hedged with a short of VXX of $200k, rebalance every 30 minutes to keep the market value at $100k of short TVIX and $200k of VXX.

Parameters to enter and exit the trade:

- ETF Premium to Enter the trade: 3%
- ETF premium level to exit the trade: 0 %

Return of each trade is the sum of the return of all 30-minute periods in the trade.

Table 2 Return Summary of (3%, 0%)

Total Portfolio return	5.11%
Trade count	2
Estimated Sharpe	1.89
Trade 1 return	3.32%
Trade 2 return	1.79%

Portfolio return during a 30 minutes period = –(TVIX(t+1)/TVIX(t)-1) + 2*(VXX(t+1)/VXX(t) – 1)

Estimated Sharpe = (Average Daily Return) / (Daily Return STDEV) * 252^ 0.5

Model Sensitivity

What if we choose different level to enter the trade and exit the trade? We compare four following sensitivity cases. Case #1 is discussed above.

(Premium to Enter, Premium to Exit) = #1 (3%,0%) or #2 (2%,0%) or #3 (3%, 1%) #4 (2%, 1%)

The results of each sensitivity runs are summarized in the table below.

As the Premium to Enter and Premium to Exit move closer to the center of the distribution, there will be more trades and less profit for each trade.

Table 3 Sensitivity of Trade Parameters

Inputs / Assumptions					
	Cases	#1	#2	#3	#4
ETF Premium to Enter		3%	3%	2%	2%
ETF Premium to Exit		0%	1%	0%	1%
Outputs					
Total Portfolio Return		5.11%	3.89%	8.70%	6.76%
Trade Count		2	2	5	6
Estimated Sharpe		1.89	1.38	2.54	1.98
Trade 1 Return		3.32%	2.69%	2.33%	1.25%
Trade 2 Return		1.79%	1.20%	-0.07%	0.26%
Trade 3 Return				2.02%	1.39%
Trade 4 Return				2.19%	0.91%
Trade 5 Return				2.24%	1.31%
Trade 6 Return					1.65%

It appears case #3 or #4 are good parameters to trade. They have higher total return and Sharpe ratio.