ANTIFRAGILE ASSET ALLOCATION MODEL

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ABSTRACT

Most of the active investment strategies focus on the constant excess returns generation over time, through a dynamic management of positions on the market. These positions are subject to possible Black Swans, events that are by definition unpredictable, destructive and only explainable afterwards. The conventional approach to risk management is to diversify investments across asset classes, however the crashes of 2001 (Dotcom bubble) and 2008 (Great Financial Crisis) questioned those portfolios so far considered well diversified. The risk of such events occurring is called tail risk. Over the last few years, many tail risk protection strategies have spread, often producing unsatisfactory results. This paper aims to demonstrate how the combination of an active quantitative investment model and an effective tail risk hedging strategy leads to the creation of an antifragile portfolio, immune to the black swans and able to exploit them to their advantage.

I. INTRODUCTION

In the financial world the Black Swan concept has found a considerable diffusion thanks to Taleb's (2007) literary book, the New York Times bestseller "The Black Swan", in combination with the turbulences in financial markets.

There are three main factors that describe a Black Swan event:

- Rational explanations are given after a black swan event occurs. This is based on the fact that humans are able to explain and justify unexpected phenomena after it occurred.
- A black swan event always has an extreme impact: the Great Financial Crisis had an extreme and destructive impact on the financial markets.
- A black swan event is unexpected and is deemed "improbable". It is impossible to predict a black swan event ahead of time because it is unthinkable for most of the people until it happens.

The main issue of Black Swans is the inability for investors to predict such extremes events (tail risk events) and correctly incorporate their impact into portfolios; they try to apply financial models based on known probabilities instead of actually taking into account their unpredictability.

Financial disasters are therefore very similar to natural disasters. Earthquakes, for example, are considered to be random events, accidental and unpredictable. The occurrence of seismic events on the earth's surface is a certainty, the uncertainty concerns where they will occur, when and to what extent.

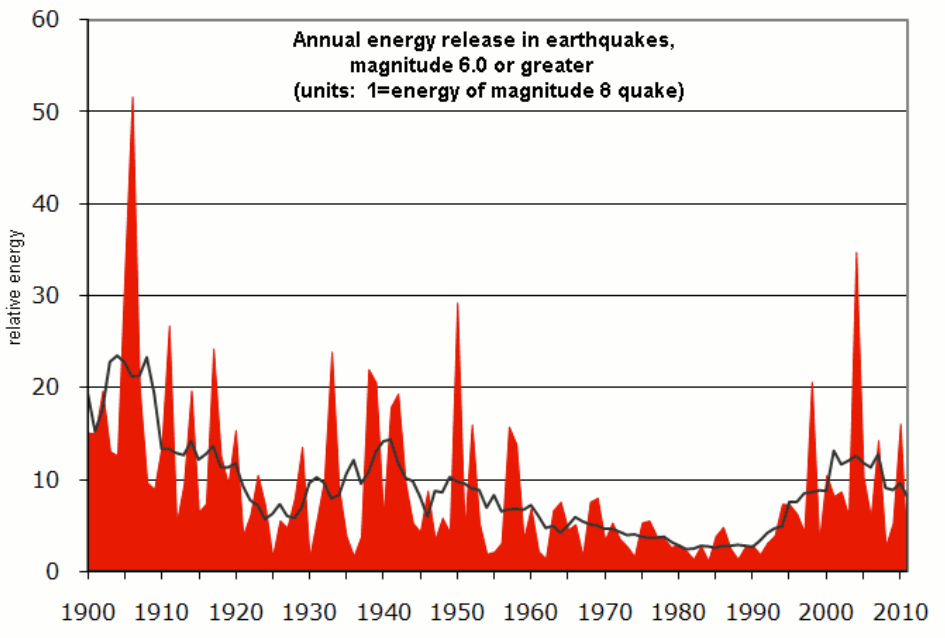

***Figure 1**. Relative annual energy release from earthquakes, magnitude 6 or greater, from 1900 to 2010. Source: U.S Geological Survey, http://www.johnstonsarchive.net/*

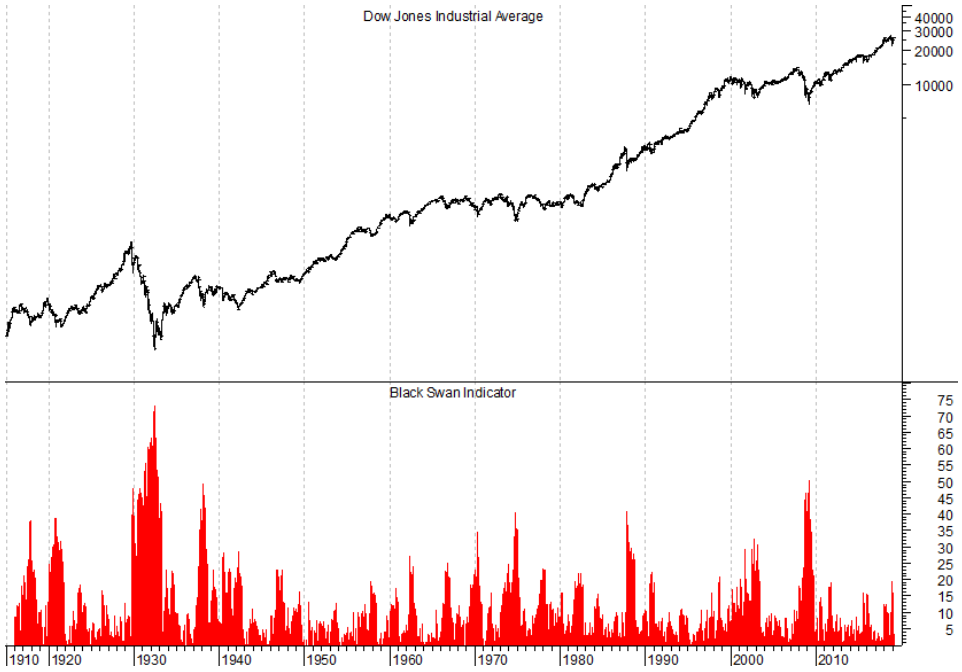

***Figure 2.** Dow Jones Industrial Average (black). Black Swan Indicator (red) shows the market corrections. Monthly data, from February 1915 to February 2019.*

Through the use of historical data and statistical models it is possible to identify areas of higher seismic risk, the same way as in the financial markets it is possible to identify the riskiest asset classes based on volatility.

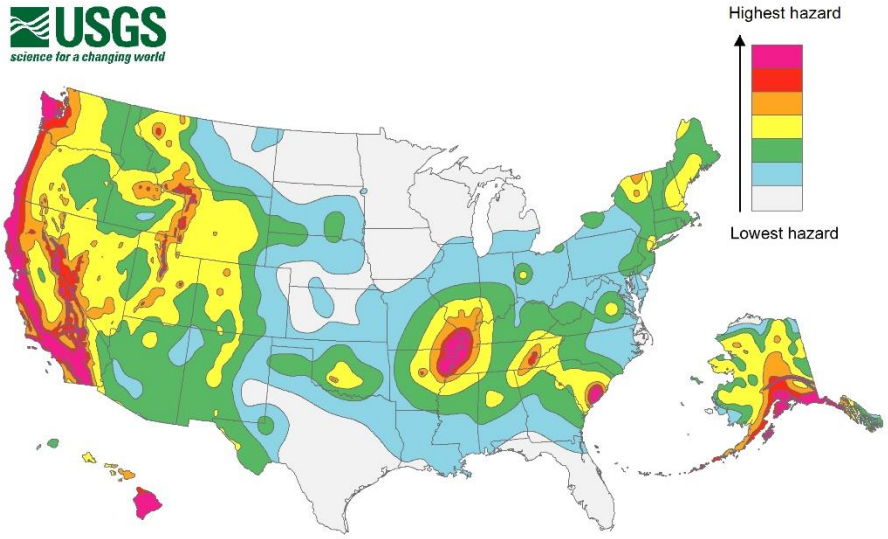

Figure 3. *Areas across United States that are most likely to experience a significant earthquake in the next 50 years. Source: U.S Geological Survey.*

Asset Class	Avg. Annual Return (1926-2011)	Standard Deviation
Large Stocks	11.80%	20.30%
Small Stocks	16.50%	32.50%
Corporate Bonds	6.40%	8.40%
Long-Term Government Bonds	6.10%	9.80%
Intermediate Government Bonds	5.50%	5.70%
U.S T-Bills	3.60%	3.10%

Table 1. *Asset Classes' average annual return and standard deviation, from 1926 to 2011. Source: BofA Merrill Lunch, Ibbotson.*

The unpredictability of earthquakes, however, has not prevented humanity from building houses, selecting the most suitable land and the best technologies to make the building as resistant and flexible as possible to seismic events. The rarity, inexplicability and uncertainty of Black Swans makes our investment management models and, consequently, our portfolios fragile. The best antidote against fragility is Antifragility, a system that can take advantage of randomness, chaos. This paper aims to demonstrate how merging the Sector Rotation Model, a sector rotation quantitative strategy, and the Black Swan Hedging Model, a tail risk hedging strategy, leads to a model capable of producing excess returns and outperformance both during positive market phases as well as during extremely negative events. I named such model Antifragile Asset Allocation Model.

II. BACKGROUND AND METHODOLOGY

This paper originates from considerations about the studies of different authors, providing a link between different concepts and methods through personal implementations. It is worth mentioning the most influential authors, with reference to their contribution:

- Nassim Nicholas Taleb, for his contribution in defining the concept of Black Swans, indicating how to manage them through Antifragitility;
- Wouter J. Keller and Hugo S. van Putten, for their contribution in the definition of a new quantitative strategy, the Flexible Asset Allocation;
- Meb Faber, for his research on quantitative analysis and non-discretionary strategies;
- Welles Wilder, for technical studies on breakout, range and trend concept models;
- Robert Engle and Tim Bollerslev, for the development of analytical methods of economic historical series with dynamic volatility over time;
- Martin J.Pring, for the works on the stages of the economic cycle and their definition.

The paper consists of four parts. The first part covers the illustration of the Sector Rotation Model, managed by a ranking algorithm that selects the best sectors. The main quantitative factors of the ranking system are explained and the calculations details are shown. The second part explains how some tail risk hedging strategies work and how they can be improved through a more adaptive strategy such as the Black Swan Hedging Model. The third part shows the Antifragile Asset Allocation Model, obtained by merging the models mentioned above. The final part illustrates the results of a model backtesting, represented through monthly performances from June 2004 to February 2019.

III. SECTOR ROTATION MODEL

Sector Rotation consists of shifting investment assets from one sector of the economy to another, in order to capture returns from different market cycles. Sector Rotation strategies are popular because they provide diversification and risk-adjusted returns over time.

The Sector Rotation Model consists of 11 sectors of the S&P500, represented by their respective ETFs.

1	SPDR Consumer Discretionary ETF	XLY
2	SPDR Health Care ETF	XLV
3	SPDR Utilities ETF	XLU
4	SPDR Consumer Staples ETF	XLP
5	SPDR Technology ETF	XLK
6	SPDR Industrial ETF	XLI
7	SPDR Financial ETF	XLF
8	SPDR Energy ETF	XLE
9	SPDR Materials ETF	XLB
10	Vanguard Communication Services ETF	VOX
11	SPDR Dow Jones REIT ETF	RWR

***Table 2**. Sector Rotation Model: list of ETFs.*

The Sector Rotation Model is the main pillar of the Antifragile Asset Allocation Model, because of its ability to adapt to market cycles (Recession, Early Recover, Late Recovery, Early Recession) providing the portfolio flexibility and robustness.

Each month the Sector Rotation Model ranks the 11 ETFs based on the following factors:

- (M) Absolute Momentum: to determine assets' profitability. Calculation: 4 months momentum (ROC – Rate of Change)
- (V) Volatility Model: to determine assets' risk. Calculation: edited version of GARCH Model.
- (C) Average Relative Correlations: to achieve diversification. Calculation: 4 months average correlation across the ETFs
- (T) ATR Trend/Breakout System: to determine assets' directionality. Calculation: ATR Bands on daily timeframe. Upper Band = 42 periods ATR + Highest Close of 63 periods. Lower Band = 42 periods ATR + Highest Low of 105 periods.

$$TRANK = (wM * Rank(M) + wV * Rank(V) + wC * Rank(C) - wT * T) + M/n \quad (1)$$

Where:

$Rank(M)$ = ranking from 1 to 11 of the asset based on the Absolute Momentum.

$Rank(V)$ = ranking from 1 to 11 of the asset based on the Volatility Model

$Rank(C)$ = ranking from 1 to 11 of the asset based on the Average Relative Correlation

T = ATR Trend/Breakout System.

wM = % weight assigned to $Rank(M)$ for TRank evaluation

wV = % weight assigned to $Rank(V)$ for TRank evaluation

wC = % weight assigned to $Rank(C)$ for TRank evaluation

wT = % weight assigned to $Rank(T)$ for TRank evaluation

n = number of assets

The best 5 ETFs are selected based on each TRank and are equally weighted in the portfolio.

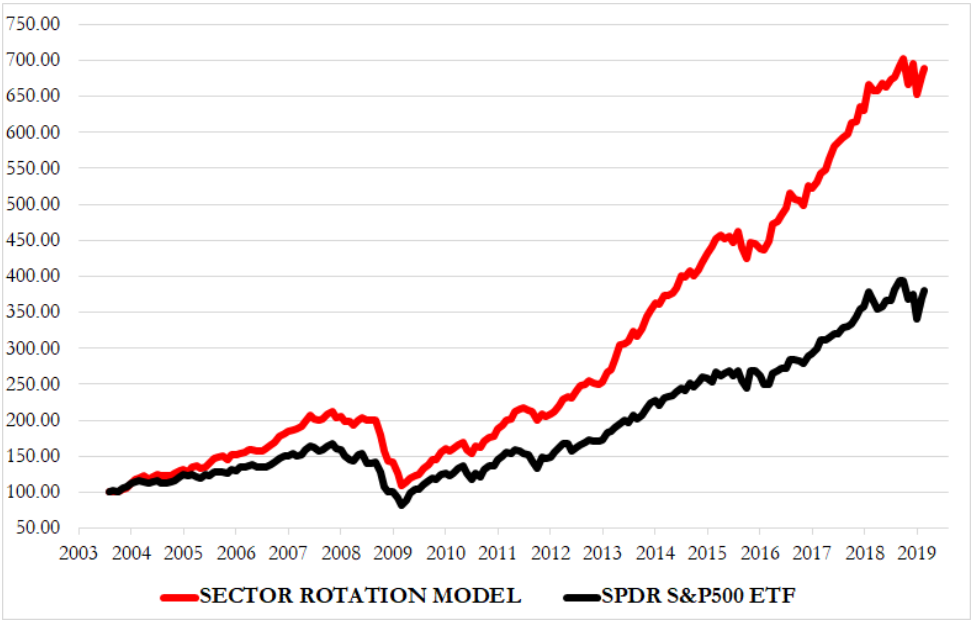

Figure 5. *Sector Rotation Mode (red) and SPDR S&P500 (black), performances comparison. Monthly Data, from August 2003 to February 2019.*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2003								1.61%	-0.31%	2.68%	1.82%	7.12%	**13.44%**
2004	3.33%	2.65%	1.87%	-3.49%	2.43%	3.44%	-1.61%	0.03%	0.40%	1.81%	2.85%	1.65%	**16.22%**
2005	-2.86%	5.81%	0.33%	-1.49%	1.27%	3.49%	4.50%	1.13%	0.95%	-2.58%	4.35%	-0.54%	**14.87%**
2006	1.35%	1.92%	1.49%	0.66%	-1.85%	0.69%	1.91%	2.90%	2.69%	4.27%	2.37%	1.42%	**21.59%**
2007	1.63%	0.65%	1.30%	4.24%	3.96%	-2.48%	-0.65%	1.15%	3.17%	1.84%	-4.22%	1.01%	**11.87%**
2008	-3.44%	-0.41%	-2.54%	4.11%	1.13%	-1.32%	0.19%	-0.63%	-10.17%	-12.53%	-8.20%	-1.86%	**-31.37%**
2009	-9.95%	-13.55%	4.19%	4.45%	2.16%	2.24%	6.51%	4.13%	5.05%	-0.58%	7.18%	3.58%	**13.80%**
2010	-2.48%	2.15%	3.73%	1.99%	-5.89%	-4.00%	7.15%	-1.18%	5.16%	3.15%	0.87%	5.73%	**16.63%**
2011	3.42%	3.59%	0.77%	4.84%	1.84%	0.80%	-1.60%	-1.11%	-5.27%	3.53%	-1.14%	1.14%	**10.88%**
2012	1.99%	4.04%	3.63%	1.87%	-0.67%	4.26%	2.63%	0.86%	1.95%	-1.12%	-0.65%	0.92%	**21.38%**
2013	5.51%	1.63%	4.75%	7.26%	0.77%	1.01%	4.68%	-2.13%	3.10%	5.04%	2.49%	2.87%	**43.46%**
2014	-0.22%	3.05%	0.11%	1.16%	1.84%	4.17%	-0.32%	2.00%	-1.71%	2.45%	2.25%	3.03%	**19.13%**
2015	2.28%	2.31%	1.43%	-1.37%	0.81%	-1.88%	3.34%	-4.88%	-3.17%	5.20%	-0.66%	-1.50%	**1.46%**
2016	-0.32%	2.65%	5.63%	0.72%	1.53%	2.41%	4.09%	-1.60%	-0.62%	-1.24%	5.59%	-0.65%	**19.38%**
2017	1.47%	2.49%	0.93%	2.58%	3.19%	0.82%	1.06%	0.88%	2.75%	0.26%	3.36%	-0.96%	**20.44%**
2018	5.84%	-1.26%	0.06%	1.46%	-0.72%	1.58%	0.39%	2.32%	1.42%	-5.07%	4.42%	-6.14%	**3.70%**
2019	3.88%	1.63%											**5.57%**

Table 3. *Sector Rotation Model, historical returns. Monthly Data, from August 2003 to February 2019.*

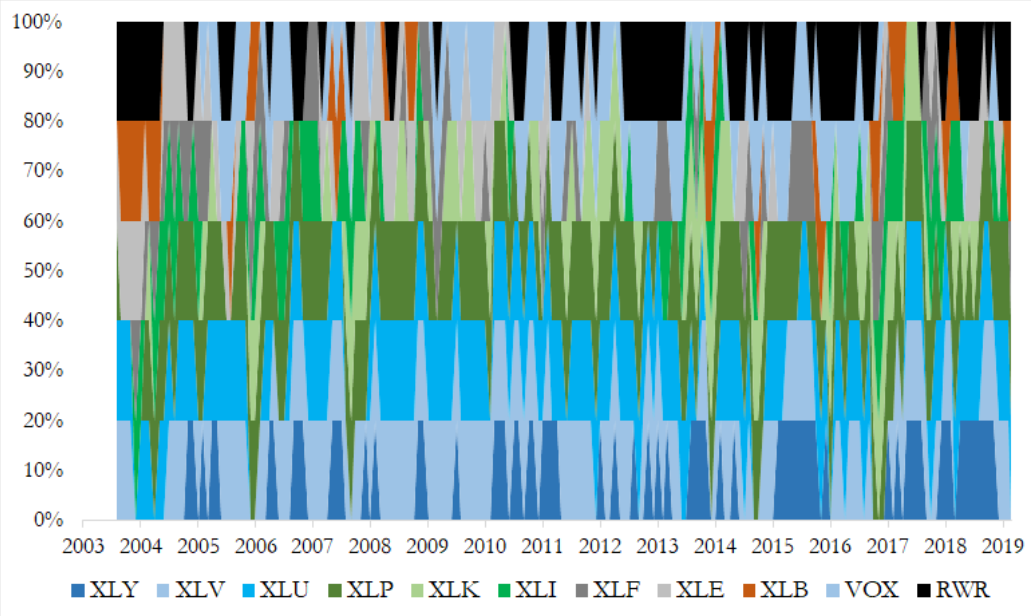

Figure 6. *Sector Rotation Model, allocation across time. Monthly data, from August 2003 to February 2019.*

The Rotation Sector Model beats the S&P500 index over time, constantly outperforming it. The model demonstrates flexibility, adapting to different market cycles, and robustness, showing resilience to medium market corrections. However, the model is not immune to crashes and black swans, so it needs a dedicated protection against such events.

IV. BLACK SWAN HEDGING STRATEGY

In statistics "tails" are defined as the extremes of a distribution, the outcomes that have a small probability of occurring. In finance tail risk represents the loss at the most negative part of an asset or portfolio's return distribution caused by infrequent and outsized downside market moves. Many studies show that equity market returns do not follow a normal distribution, with tails fatter than predicted. The traditional approach to managing portfolio risk involves investments diversification amongst not correlated assets classes: if the correlation amongst assets is low, this will mitigate the impact of big market corrections on the portfolio. However extreme losses occur during times of crisis or financial market distress, characterized by a contagion effect and a pronounced rise in many asset classes correlations to equities.

Recent market turmoils have highlighted that extreme market moves occur more frequently than most statistical models predict and diversification strategies typically break down in these circumstances. The infamous black swans of the first two decades of the 21st century generated attention and investment flows aimed to hedge against tail risk. Theoretically, a tail risk strategy acts as a sort of insurance, since it has a low or negative required rate of return but it pays off at times of market distress. There are several Tail Risk Hedging strategies (Puts, Delta-hedged options, volatility products) but there is a significant disagreement regarding the efficacy of such strategies and their cost/benefit tradeoffs.

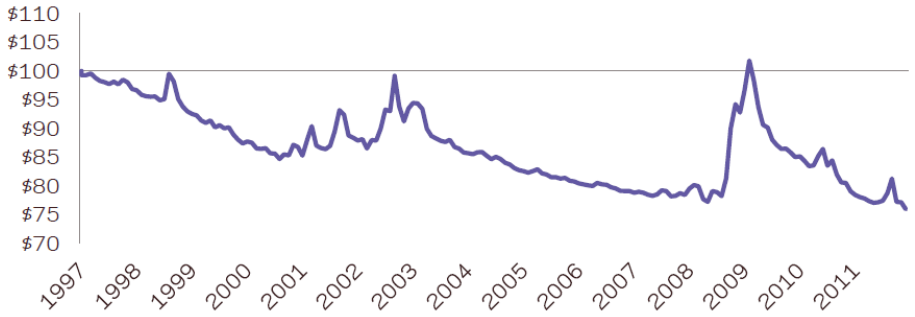

Figure 7. *Hypothetical Cumulative Growth of $100 into 1-Year OTM Puts on the S&P. Monthly Data, from 1996 to 2012. Source: AQR.*

The following chart represents how adding a permanent Tail Risk strategy that buys monthly 5% out of the money options on the S&P500 with 90% of allocation invested in 10-year U.S. Government Bonds affects portfolio returns.

	S&P 500	80% S&P 20% TAIL RISK	60% S&P 40% TAIL RISK	40% S&P 60% TAIL RISK	20% S&P 80% TAIL RISK	TAIL RISK
Return	9.89%	8.74%	7.39%	5.86%	4.16%	2.31%
Volatility	15.11%	11.36%	8.18%	6.49%	7.38%	10.19%
Sharpe Ratio	0.44	0.48	0.50	0.39	0.12	(0.10)
MaxDD	(50.95%)	(38.20%)	(22.96%)	(10.28%)	(14.40%)	(26.64%)

Table 4. *Tail Risk strategy and S&P500 performance comparison. From June 1986 to December 2012. Source: Meb Faber/GFD*

In all cases the Tail Risk Strategy brings a decrease in drawdowns but the reduction in volatility does not compensate for the reduction in returns, so Sharpe Ratio worsens. According to the writer's opinion, the current tail risk strategies are too static and unable to adapt to different types of market corrections.

The Black Swan Hedging Model, hereby explained, consists of 7 ETFs representing different types of asset classes that can benefit from market corrections of different nature.

1	Invesco CurrencyShares Swiss Franc ETF	FXY
2	Invesco CurrencyShares Japanese Yen ETF	FXF
3	SPDR Gold Shares ETF	GLD
4	iShares 7-10 Year Treasury Bond ETF	IEF
5	ProShares Short S&P500 ETF	SH
6	iShares 20+ Year Treasury Bond ETF	TLT
7	iShares 1-3 Year Treasury Bond ETF	SHY

Table 5. *Black Swan Hedging Model: list of ETFs.*

The best 3 ETFs will be taken in consideration for the upcoming allocation, based on the ranking system described in the prior paragraph. For each of the 3 ETFs, if it has a positive Absolute Momentum (M), then it will be included in the portfolio, otherwise its weighting will be replaced with Cash, represented by iShares 1-3 Year Treasury Bond ETF.

In an extreme case where all the top 3 ETFs have a negative Absolute Momentum (M), Cash will assume a 100% weighting.

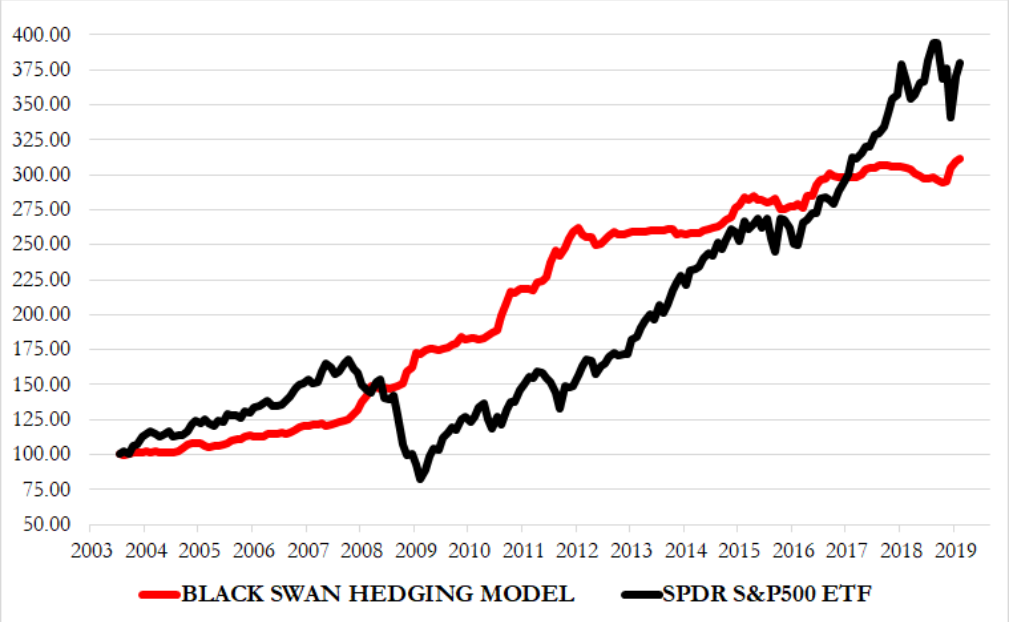

Figure 8. *Black Swan Hedging Model (red) and SPDR S&P500 (black), performances comparison. Monthly Data, from August 2003 to February 2019*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2003								-0.05%	0.95%	0.13%	-0.01%	0.72%	**1.74%**
2004	0.99%	-1.14%	0.57%	-1.16%	0.00%	-0.03%	0.25%	1.06%	2.17%	2.87%	0.54%	-0.28%	**5.93%**
2005	-0.13%	-1.34%	-0.80%	0.49%	0.48%	0.60%	0.82%	1.59%	1.22%	-0.09%	2.20%	0.04%	**5.15%**
2006	-0.31%	-0.27%	0.28%	1.86%	-0.03%	-0.04%	0.23%	-0.56%	0.97%	1.40%	1.54%	0.95%	**6.15%**
2007	-0.10%	0.92%	0.31%	0.28%	-0.93%	0.45%	0.89%	0.49%	0.79%	0.81%	3.44%	1.91%	**9.60%**
2008	4.35%	3.43%	4.61%	-0.72%	-0.24%	0.47%	-0.53%	0.41%	0.62%	1.33%	5.45%	1.99%	**23.06%**
2009	6.26%	-0.62%	1.90%	0.64%	0.02%	-0.62%	0.63%	0.58%	0.88%	0.55%	2.56%	-0.80%	**12.43%**
2010	0.26%	0.06%	-0.26%	0.29%	1.10%	1.17%	0.88%	5.37%	4.94%	3.42%	-0.28%	1.40%	**19.73%**
2011	-0.17%	-0.05%	-0.12%	2.41%	0.47%	1.39%	4.70%	3.43%	-1.73%	2.48%	2.93%	1.78%	**18.79%**
2012	0.95%	-1.70%	-0.92%	-0.06%	-2.14%	0.58%	1.04%	1.05%	1.15%	-0.80%	0.18%	0.39%	**-0.35%**
2013	0.23%	0.04%	0.04%	0.07%	0.33%	-0.10%	0.16%	-0.10%	0.22%	0.02%	-1.24%	0.40%	**0.05%**
2014	-0.39%	0.06%	0.03%	0.19%	0.51%	0.44%	0.31%	0.59%	0.79%	1.10%	0.53%	2.42%	**6.77%**
2015	0.66%	2.15%	-0.70%	0.92%	-0.81%	-0.06%	-0.75%	0.23%	0.81%	-2.62%	-0.12%	0.67%	**0.30%**
2016	0.25%	0.42%	-1.04%	3.15%	0.13%	2.76%	1.10%	0.27%	1.24%	-0.48%	-0.47%	0.00%	**7.50%**
2017	0.24%	-0.02%	0.06%	0.34%	1.47%	0.17%	0.05%	0.71%	0.10%	-0.09%	-0.22%	-0.13%	**2.68%**
2018	-0.08%	-0.20%	-0.28%	-1.07%	-0.47%	-0.82%	0.07%	0.34%	-0.52%	-0.83%	0.37%	3.41%	**-0.17%**
2019	1.36%	0.68%											**2.04%**

Table 6. *Black Swan Hedging Model, historical returns. Monthly Data, from August 2003 to February 2019*

BLACK SWAN HEDGING MODEL			
Absolute Performance	211.53%	Annualized STD	4.75%
Performance YTD	2.04%	Sharpe Ratio	1.33
Worst Year	-0.35%	Max DrawDown 3m	-3.11%
Best Year	23.06%	Max Drawup 3m	13.73%
Worst Month	-2.62%	Positive Months	127
Best Month	6.26%	Negative Months	61

Table 7. *Black Swan Hedging Model, , statistics summary*

The Black Swan Hedging Model provides effective protection against market corrections, demonstrating the ability to take advantage of the most extreme events.

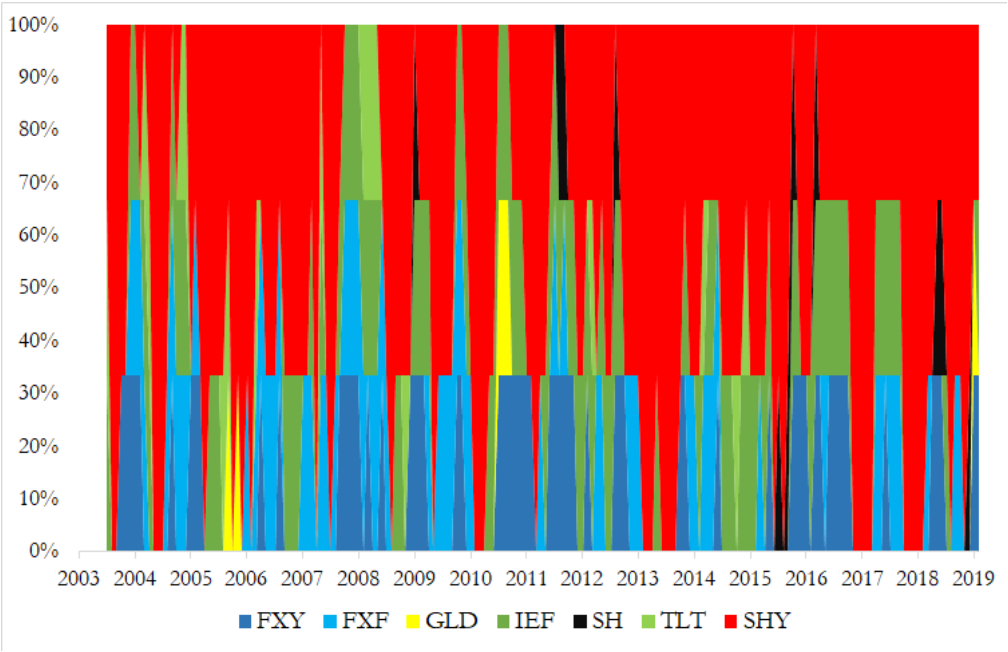

***Figure 9**. Black Swan Hedging Model, allocation across time. Monthly data, from August 2003 to February 2019*

V. ANTIFRAGILITY

The Antifragile Asset Allocation Model represents the union between the Sector Rotation Model and the Black Swan Hedging Model. The Sector Rotation Model selects the best 5 sector ETFs.

For each of the 5 ETFs, if it has a positive Absolute Momentum (M), then it will be included in the Antifragile Portfolio with a 20% weighting. If all the top 5 sector ETFs have a negative Absolute Momentum (M), the Black Swan Hedging Model allocation will assume a 100% weighting.

The unassigned weighting will be replaced with the Black Swan Hedging Model allocation.

ANTIFRAGILE ASSET ALLOCATION MODEL - 02/19/2019			
1	SPDR Consumer Discretionary ETF	XLY	0.00%
2	SPDR Health Care ETF	XLV	0.00%
3	SPDR Utilities ETF	XLU	20.00%
4	SPDR Consumer Staples ETF	XLP	0.00%
5	SPDR Technology ETF	XLK	0.00%
6	SPDR Industrial ETF	XLI	0.00%
7	SPDR Financial ETF	XLF	0.00%
8	SPDR Energy ETF	XLE	0.00%
9	SPDR Materials ETF	XLB	0.00%
10	Vanguard Communication Services ETF	VOX	0.00%
11	SPDR Dow Jones REIT ETF	RWR	20.00%
12	Invesco CurrencyShares Swiss Franc ETF	FXY	20.00%
13	Invesco CurrencyShares Japanese Yen ETF	FXF	0.00%
14	SPDR Gold Shares ETF	GLD	0.00%
15	iShares 7-10 Year Treasury Bond ETF	IEF	20.00%
16	ProShares Short S&P500 ETF	SH	0.00%
17	iShares 20+ Year Treasury Bond ETF	TLT	0.00%
18	iShares 1-3 Year Treasury Bond ETF	SHY	20.00%
			100.00%

Table 8. *Antifragile Asset Allocation Model, list of ETFs and respective weighting, updated to 02/19/2019.*

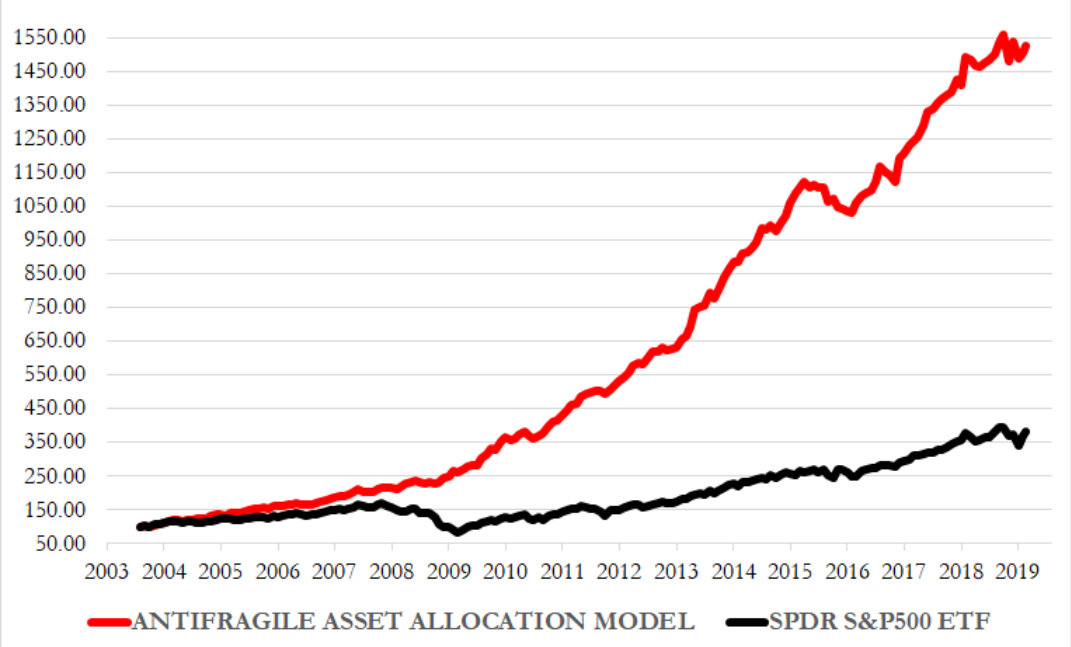

Figure 10*. Antifragile Asset Allocation Model (red) and SPDR S&P500 (black), performances comparison. Monthly Data, from August 2003 to February 2019.*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2003								1.61%	-0.31%	2.29%	1.82%	7.12%	**13.01%**
2004	3.33%	2.65%	1.87%	-3.49%	1.35%	2.20%	0.21%	0.34%	2.40%	3.82%	3.89%	0.55%	**20.63%**
2005	-1.78%	5.81%	0.33%	0.18%	0.53%	3.49%	3.56%	1.13%	0.95%	-1.52%	4.35%	-0.48%	**17.53%**
2006	1.35%	1.60%	1.49%	0.66%	-1.43%	0.75%	-0.05%	1.71%	1.65%	3.99%	2.37%	1.42%	**16.55%**
2007	1.63%	0.65%	1.30%	4.24%	3.96%	-2.48%	-0.65%	0.50%	3.30%	1.62%	-0.13%	1.73%	**16.61%**
2008	-2.50%	3.43%	4.61%	1.50%	0.84%	-0.29%	-2.09%	0.74%	-1.07%	1.33%	5.45%	1.99%	**14.49%**
2009	6.26%	-0.62%	2.97%	2.60%	1.19%	0.79%	6.51%	4.13%	5.05%	-0.58%	7.18%	3.58%	**46.31%**
2010	-2.48%	2.15%	3.19%	1.99%	-3.04%	-2.72%	2.69%	1.98%	5.85%	3.15%	0.87%	3.85%	**18.42%**
2011	3.14%	3.59%	0.77%	4.84%	1.84%	0.80%	0.06%	0.18%	-1.54%	2.71%	2.55%	1.85%	**22.71%**
2012	2.39%	2.79%	3.36%	1.87%	-1.21%	3.80%	2.63%	0.23%	1.95%	-1.12%	0.37%	0.74%	**19.15%**
2013	3.97%	1.63%	4.07%	7.26%	0.77%	1.01%	4.68%	-2.13%	3.11%	5.04%	2.49%	2.87%	**40.45%**
2014	-0.22%	3.05%	0.22%	1.47%	1.84%	4.17%	-0.32%	1.27%	-1.71%	2.45%	2.25%	3.68%	**19.53%**
2015	2.79%	1.42%	1.43%	-1.20%	0.47%	-0.52%	-0.02%	-3.65%	0.81%	-2.62%	-0.48%	-0.65%	**-2.36%**
2016	-0.32%	2.65%	2.10%	0.76%	0.74%	2.41%	4.09%	-1.60%	-0.62%	-1.79%	6.26%	0.85%	**16.34%**
2017	2.09%	1.25%	0.93%	2.58%	3.19%	0.82%	1.05%	0.88%	1.02%	0.53%	2.69%	-0.96%	**17.24%**
2018	5.84%	-0.53%	-1.32%	-0.16%	0.71%	0.75%	1.07%	2.32%	1.42%	-5.07%	3.90%	-3.22%	**5.37%**
2019	1.36%	1.27%											**2.65%**

Table 9. *Antifragile Asset Allocation Model, historical returns. Monthly data, from August 2003 to February 2019*

The Antifragile Asset Allocation Model maintains the qualities of the strategies which it derives from, showing adaptability to different market cycles, resilience against market corrections and antifragility against extreme events.

VI. APPLICATION AND EMPIRICAL TESTS

The Antifragile Asset Allocation Model works by applying the algorithms discussed in the previous paragraphs. The database is end-of-day and it is downloaded from Yahoo! Finance. Where necessary, interpolations have been made with consistent historical series in order to achieve temporal homogeneity.

Data interpolation was performed on RStudio; Absolute Momentum, Volatility Model, Average Relative Correlation and ATR Trend/Breakout System indicators were programmed on Metastock; classification and the rankings were programmed on Excel. The test was performed on a USD Portfolio, consisting mainly of ETFs, to ensure maximum plausibility.

Daily and monthly returns are used. Simulation results are from August 2003 through February 2019. No transaction costs are included, all results are gross of any transaction fees, management fees, or any other fees that might be associated with executing the models in real-time.

The current allocation of the Portfolio is determined by the Ranking Model of the previous month. The Ranking Model in the last session of the current month determines the allocation of the following month.

To assess the effectiveness of the proposed strategy, the performance of the Antifragile Asset Allocation Model was compared to the Salient Risk Parity Index[1], managed by a Risk Parity portfolio with 10% Volatility Targeting.

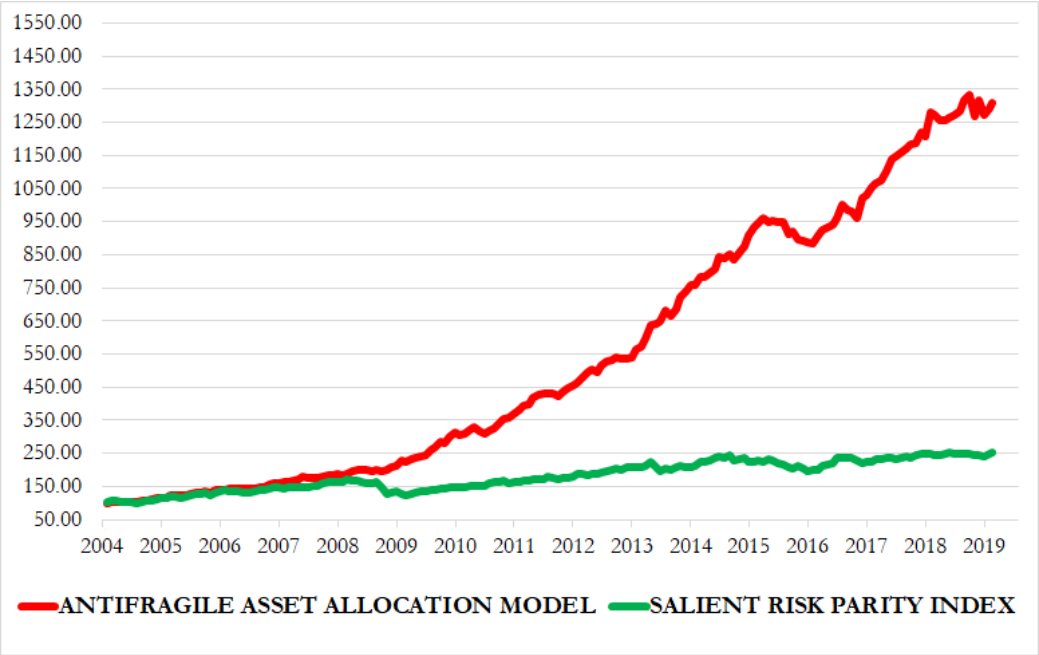

Figure 11. *Ranked Asset Allocation Model (red), Salient Risk Parity Index (green), performance comparison. Monthly data, from January 2004 to February 2019.*

	PORT AAAM	Salient RP Index		PORT AAAM	Salient RP Index
Absolute Performanc	1427.25%	153.70%	Annualized STD	7.70%	9.54%
Performance YTD	2.65%	6.08%	Sharpe Ratio	2.53	0.53
Worst Year	-2.36%	-16.87%	Max DrawDown 3m	-5.45%	-22.82%
Best Year	46.31%	18.57%	Max Drawup 3m	15.69%	10.82%

Table 10. *Antifragile Asset Allocation Model (AAAM) and Salient Risk Parity Index, statistics summar.*

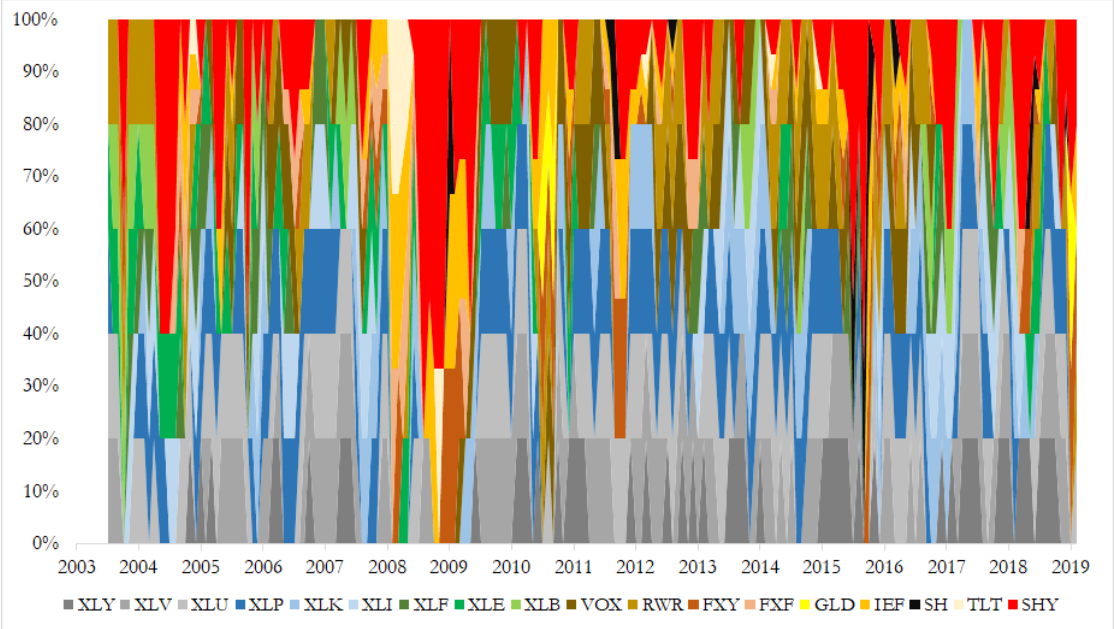

Figure 12. *Antifragile Asset Allocation Model: allocation across time. Monthly data, from August 2003 to February 2019.*

VII. CONCLUSION

In this paper I focused on the creation of an asset allocation model inspired by the concept of antifragility proposed by N.N. Taleb: capable of gaining from disorder and unpredictable events. To achieve this goal I've created a ranking algorithm that selects the best assets over time. The algorithm consists of quantitative factors such as Momentum, Correlations, Volatility and Trend to determine respectively profitability, diversification, risk and directionality of the assets. In order to achieve antifragility, the ranking system has been applied to two models with different characteristics: Sector Rotation Model and the Black Swan Hedging Strategy. The first model beats the benchmark, represented by the SPDR S&P500 ETF, and constantly outperforms it over time, showing adaptability to different economic cycles and robustness during medium-sized market corrections. The second one proves to be a valid alternative to the most popular tail risk hedging strategies, gaining during black swans while maintaining low volatility. The antifragility is achieved by merging the peculiarities of both models. The Antifragile Asset Allocation Model proves to be dynamic and flexible during the positive phases of the market, resilient and able to exploit negative events of various nature to its advantage.

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ENDNOTES

[1] Source: http://www.salientindices.com/risk-parity.html

FIGURES

TABLES