Dynamic Asset Allocation Fund

Concept Paper

Giancarlo Marchesi – August 2022

Content

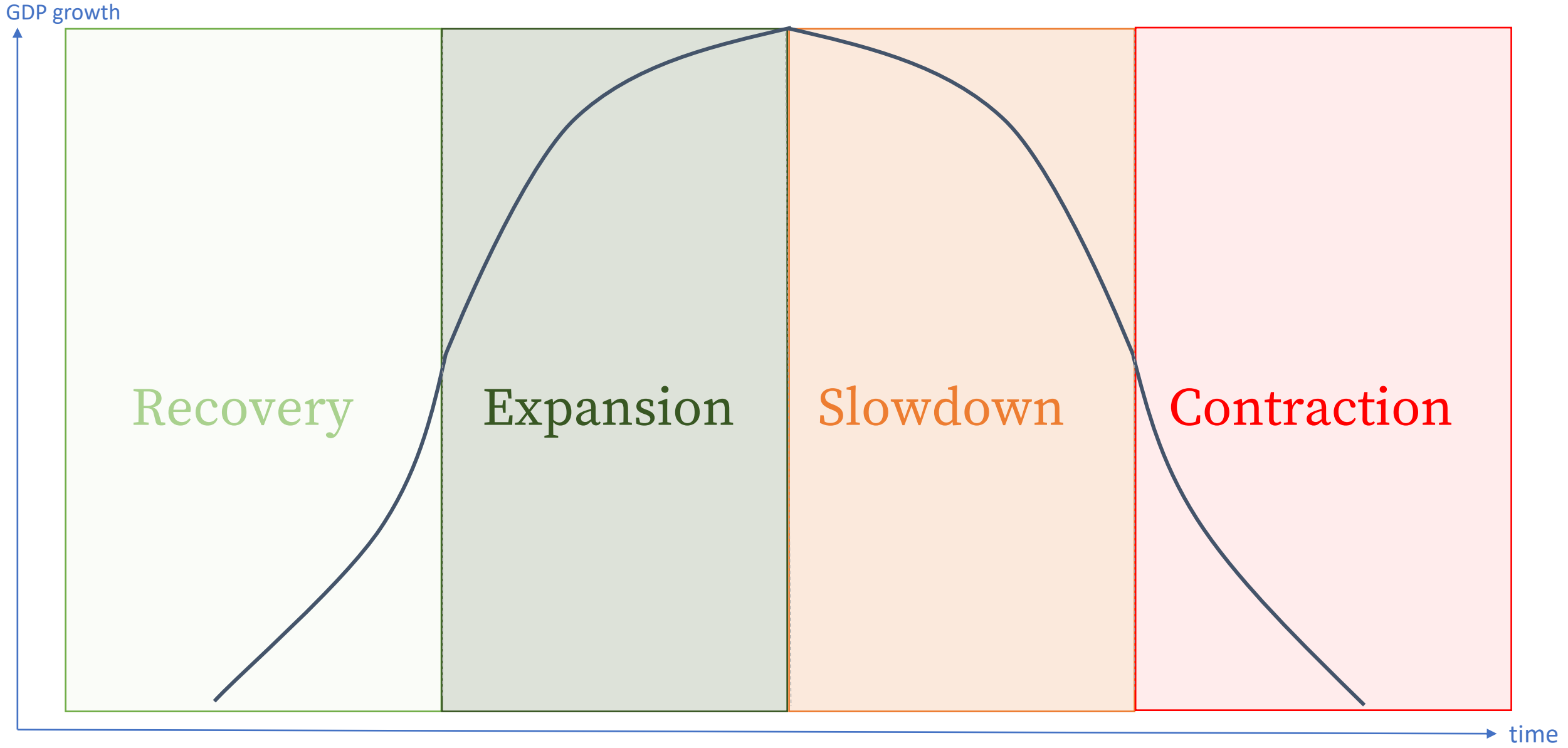
The four phases of the business cycle

- The regularity of the business cycle is a phenomenon associated with developed economies.
- Investment (public and private) in production capacity eventually pushes demand through hiring and higher wages. This drives consumption, which feeds back into investment, and so on until there is excess capacity or a shock that triggers the need for a realignment occurs.
- At this point, companies start layoff cycles, demand contracts, and the economy ends up in a recession.
- An equilibrium is reached after a few months and the cycle begins again. This process typically lasts between 7 and 11 years, although it is not an exact number. The last American cycle lasted from 2009 to 2020.

The four phases of the business cycle

- The National Bureau of Economic Research [NBER] determines the dates of economic cycles in the United States, that is, the dates between periods of expansion and contraction (i.e. recession). They have recorded 35 cycles in just over 170 years.
- A more granular analysis could divide the cycle into four phases.
  - The first phase, recovery, is characterized by a short period of rapid growth (a rebound effect) after a contraction.
  - It is followed by a period of expansion, i.e. robust and stable growth
  - Subsequently, growth slows down until it halts. This is the slowdown phase phase
  - Once the growth is negative, we are in the contraction phase.
- The following graph is a didactic simplification.

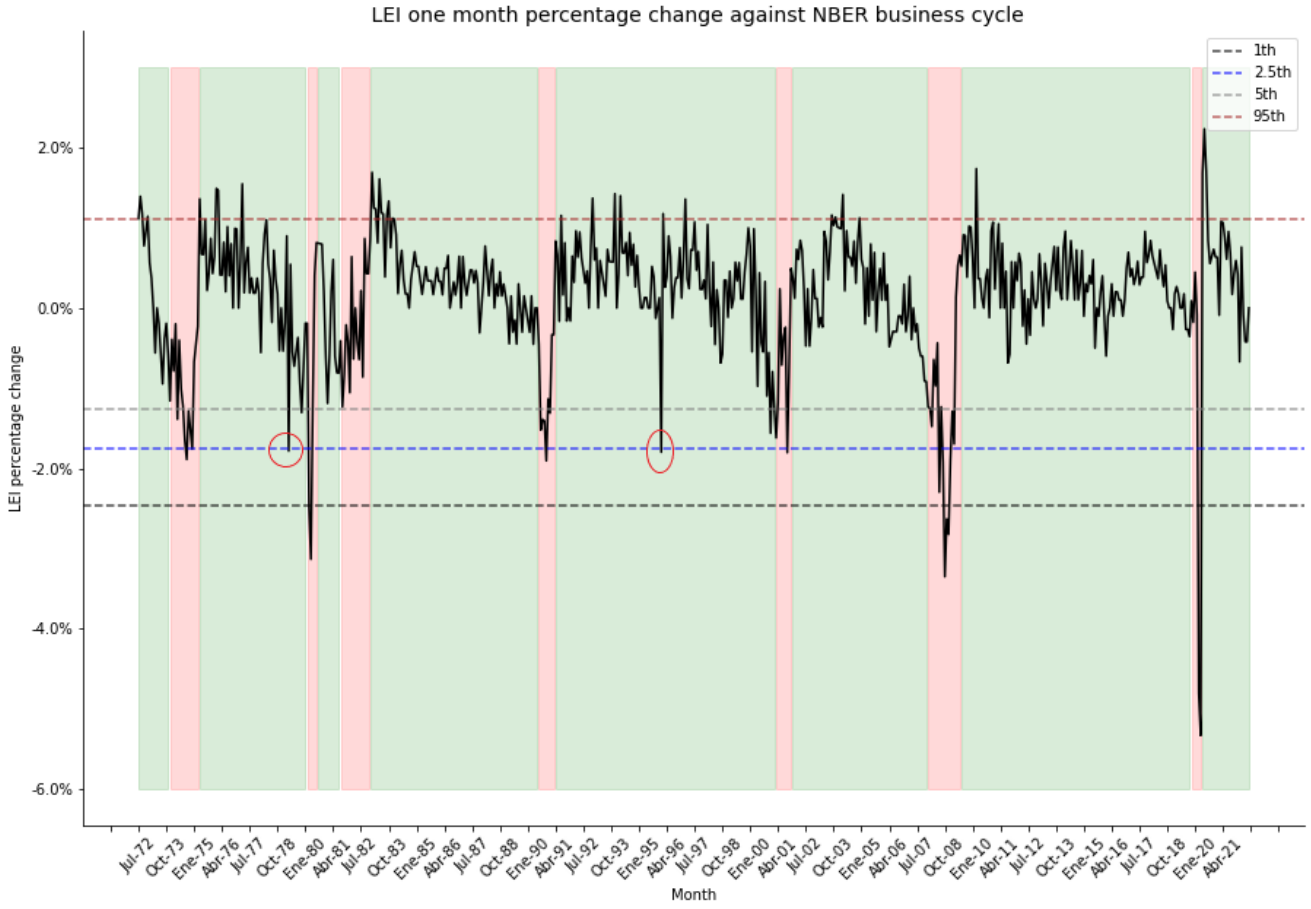
Graphical representation of the four phases



The Leading Economic Index during expansion and contraction

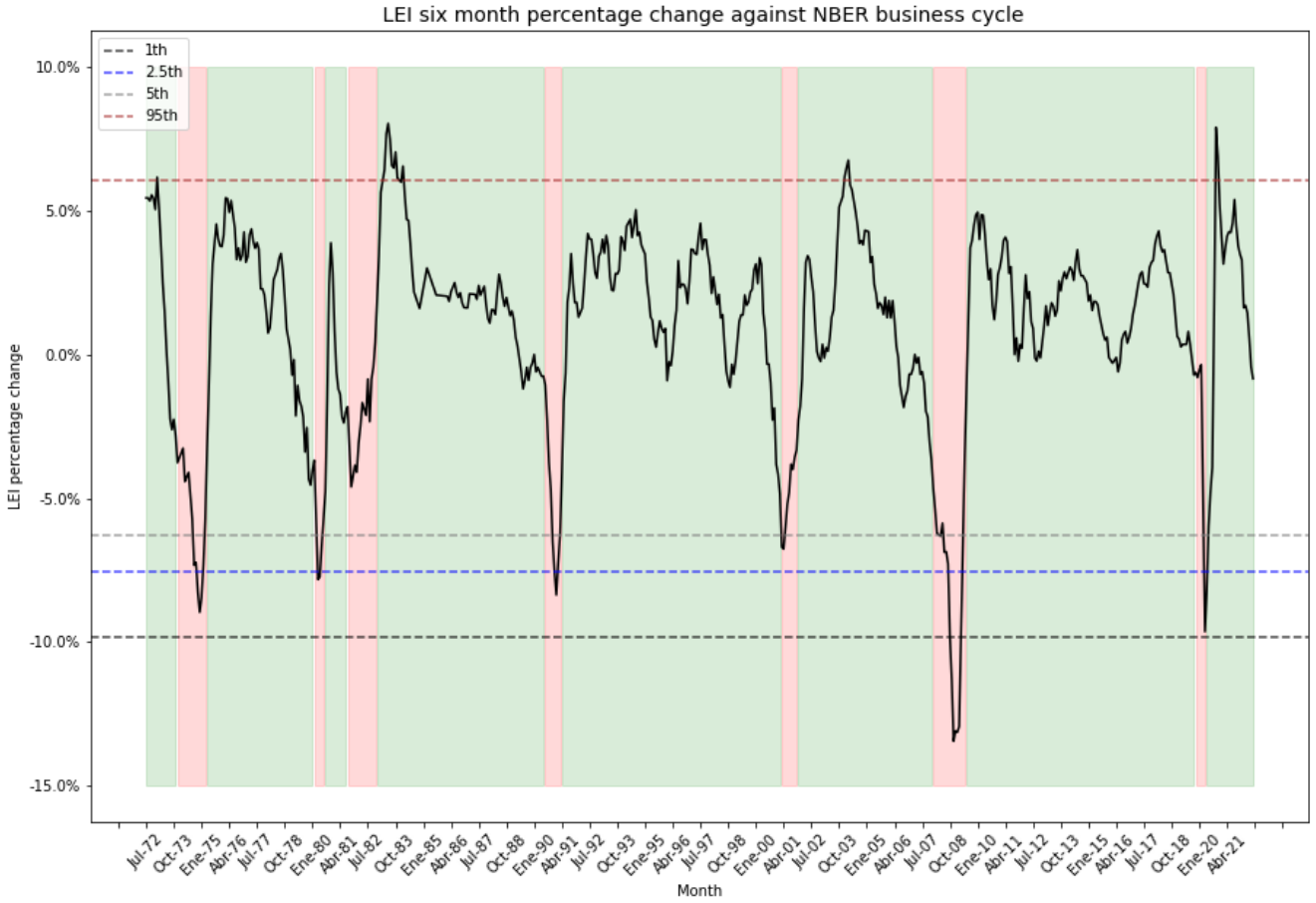
- The Conference Board publishes the leading indicator (LEI) and the coincident indicator (CEI) for the US economy on a monthly basis.
- The former utilizes ten variables and the latter, four. These fourteen variables are all different and enter the index with different weights. They explain the status and expectations of economic agents through various lenses. The last methodological update calibrated both indices to 100 for June 2016.

Monthly percentage change of the LEI against the NBER backdrop



- Expansion (green) and contraction (red), according to NBER since July 1972.
- The horizontal lines correspond to the 1st, 2.5th, 5th, and 95th percentile of the distribution of monthly percentage changes.
- In general, the big negative changes occur in the red stages, although there are two false signals, one in 1979 and one in 1996.

Semi-annual percentage changes of LEI



- This graph matches almost perfectly with recession phases. In other words, six months after the start of a deceleration, if it is worse than 6.26% (the 5th percentile blue line) we are facing a recession.
- However, since the equity market itself is a leading indicator (in fact it is one of the 10 of the LEI, but only with a weight of 3.8%) at this point, it has, most likely, been declining for three or four months.
- This data helps us to confirm a recession but does not prevent the capital losses in a portfolio.

Identifying the four stages using LEI

- The following is the author's proposal for identifying the four stages of the business cycle using monthly, quarterly, and semi-annual percentage changes of LEI:
  - Recovery starts after a contraction, the first time the monthly and quarterly percent changes are both positive
  - Expansion occurs after a recovery phase when the three variables are positive and the difference between the semi-annual percentage change of a month vs. the previous one is negative for the first time (i.e the second derivative turns negative). This signals that the speed of recovery is slowing down.
  - The slowdown phase begins when, in two consecutive months, two of the three variables are negative.
  - Contraction occurs when all three changes are negative, and the semi-annual percentage change exceeds -3%. The order of magnitude indicates that the drop is significant.

Contrasting the four stages against CEI

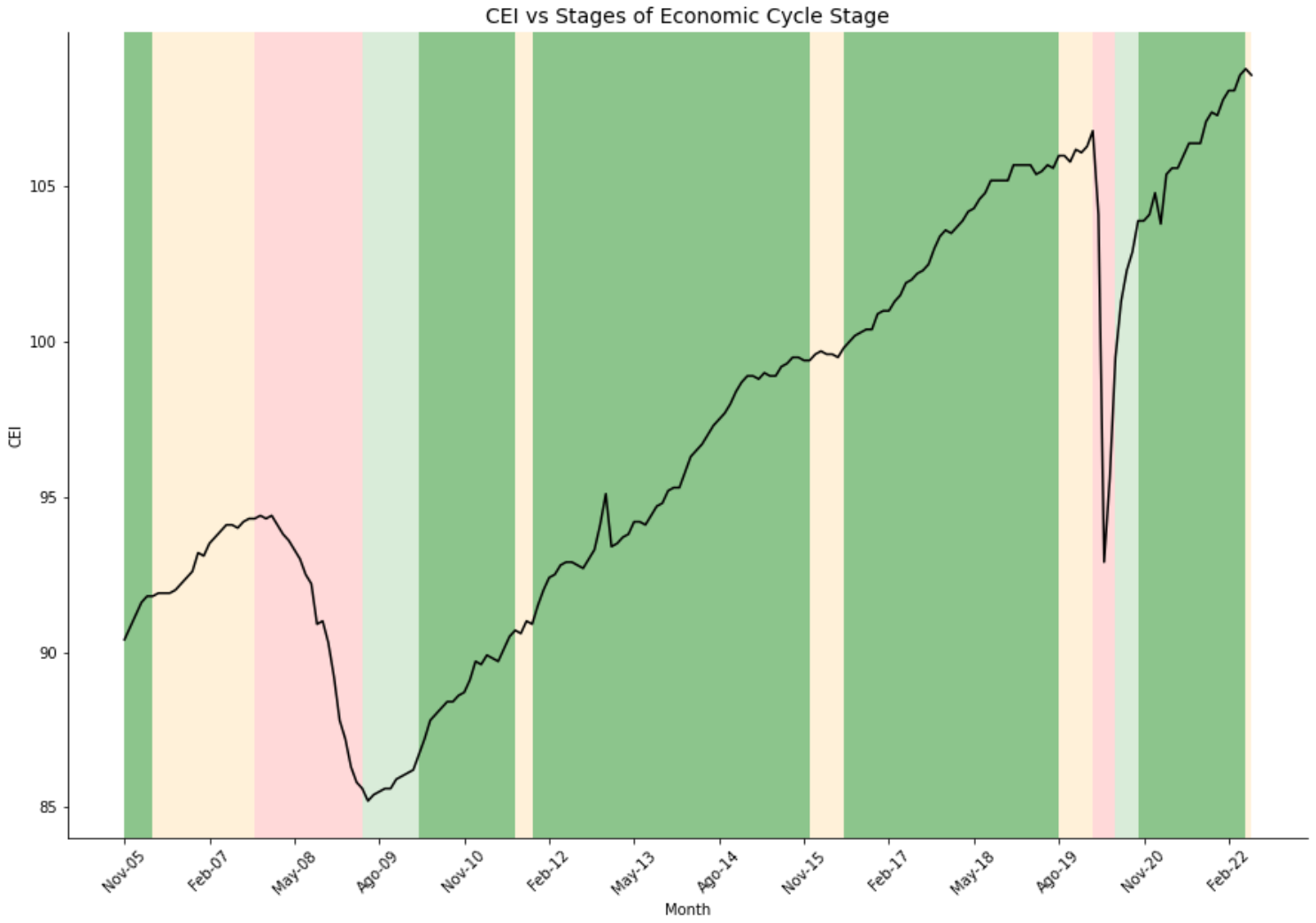
We use the Conference Board's Coincident Index (CEI) to test the hypothesis about cycle stages.

The graph shows the CEI from 2005 to 2022 against the four stages, represented as follows:

- Recovery: light green
- Expansion: dark green
- Deceleration: yellow
- Contraction: red

The colors match with the curve

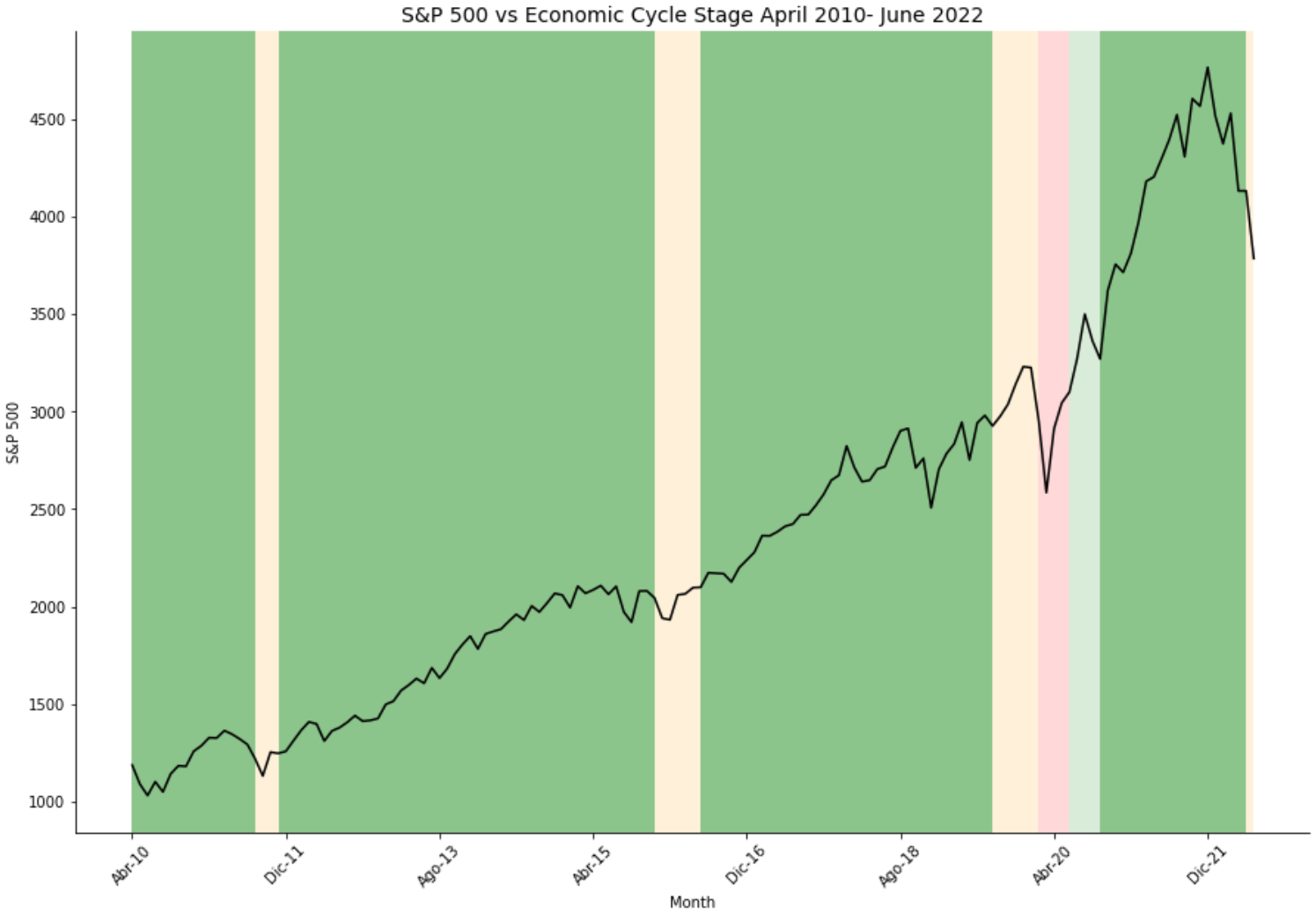
- The slowdown in 2015 is indicated by both the color pattern and CEI
- This happens again towards the end of 2018 and during 2019



Contrasting the four stages against S&P500

During the 2010-2022 period:

- The recovery after the Great Recession stumbled. My analysis indicates a slowdown during 2011, which is also reflected in the S&P 500.
- A second slowdown happens towards the end of 2015.
- Towards the end of 2018, both the economy and the S&P 500 slow down. The Fed had begun a period of interest rate cuts in the second half of 2019 before the COVID arrived.
- The market quickly came out of this supply shock, thanks to the rescue packages of 2020 and 2021. Note that the slope of the post-COVID period, up to its peak, is much steeper than the slope of the total cycle.



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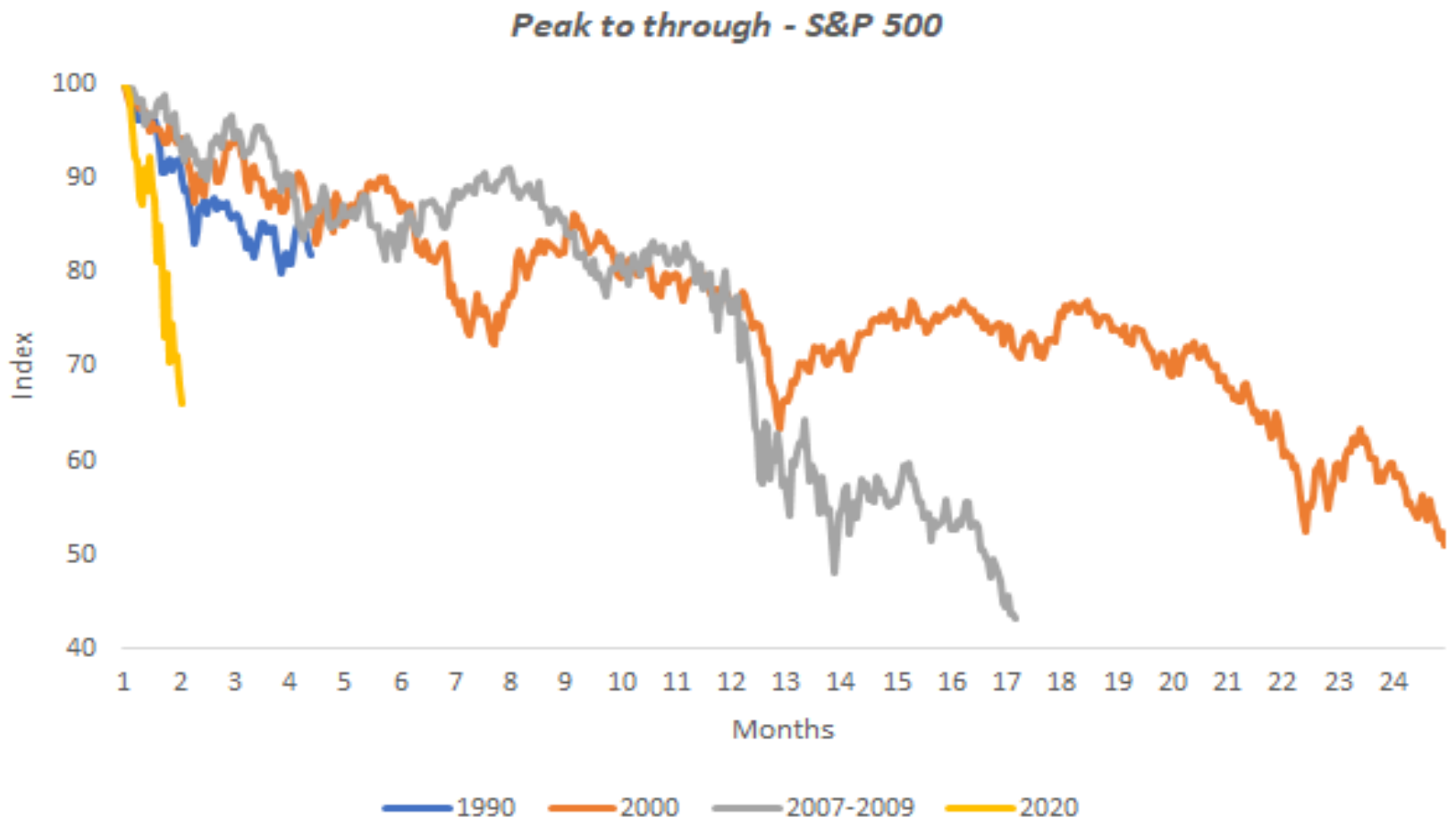
What happens during a contraction phase?

- On average, during the last 7 recessions, the value of the S&P has fallen 25%. The index reaches its peak during the final months of the slowdown stage and reaches the lowest point two or three months before the end of the contraction stage
- However, the composition of the index has undergone important changes during the last 30 years (4 economic cycles) with the arrival of technology giants such as Google (Alphabet), Amazon, Facebook (Meta), and the growth of Microsoft and Apple. For this reason, the last four recessions are probably more relevant to the current context

S&P 500 from peak to through over the past four cycles



- The fall in 2020 was very fast and steep, as it came from the external shock of COVID. It lasted just under two months but still lost 33% of its value
- On the other hand, the crash of the Great Recession lasted seventeen months and lost 57% of its value
- The burst of the .com bubble lasted two years, extending even into the expansion stage while losing almost 50% of its value

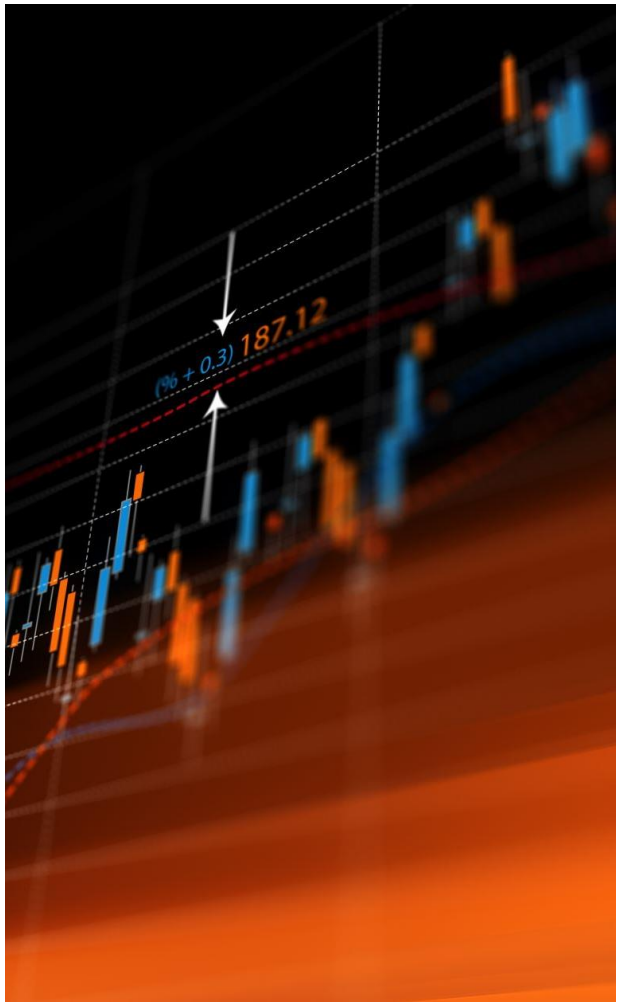
The recovery periods

- The total recovery period, i.e. the number of months it takes to reach the same value as the previous peak, is related to the speed and magnitude of the fall. Longer and deeper declines take more time to recuperate
- In the cases of 2000 and 2007-2009, the recovery took more than 6 years
- Hence, avoiding similar declines is essential for maintaining healthy portfolios in the long term.
- This is where dynamic asset allocation comes in: ***the weight of the assets in the portfolio must vary during the cycle according to the probabilities of performance in that phase***

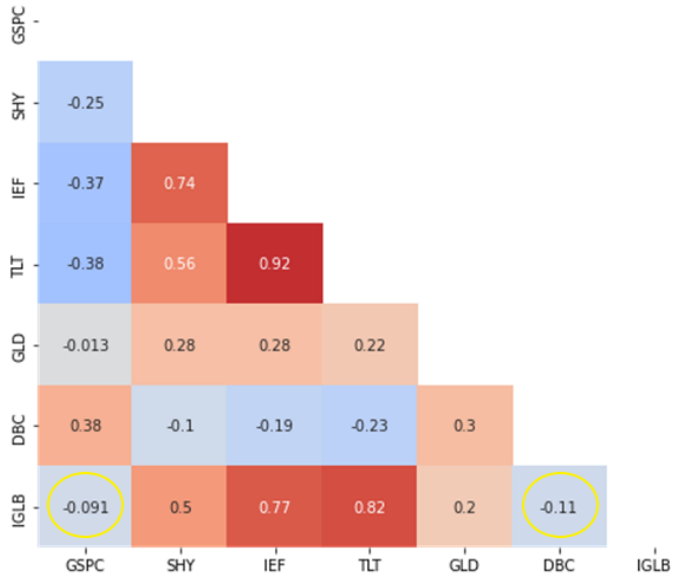
Cycle	*Months to regain peak*
1990	9
2000	81
2007-2009	78
2020	6

Looking for alternatives to equities

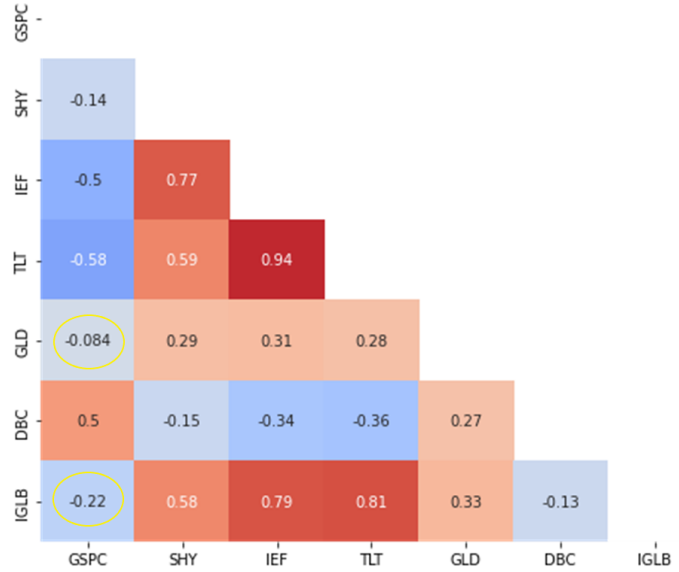
- A downside-mitigating portfolio should have other assets that don't correlate with stock returns. The following slide shows the correlations for these ETFs during the four phases:
- Standard and Poor's 500 equities index [GSPC]
- US treasuries of various maturities [SHY, IEF, TLT]
- Gold [GLD]
- Commodities index [DBC]
- Investment grade 10 year+ corporate bonds [IGLB]



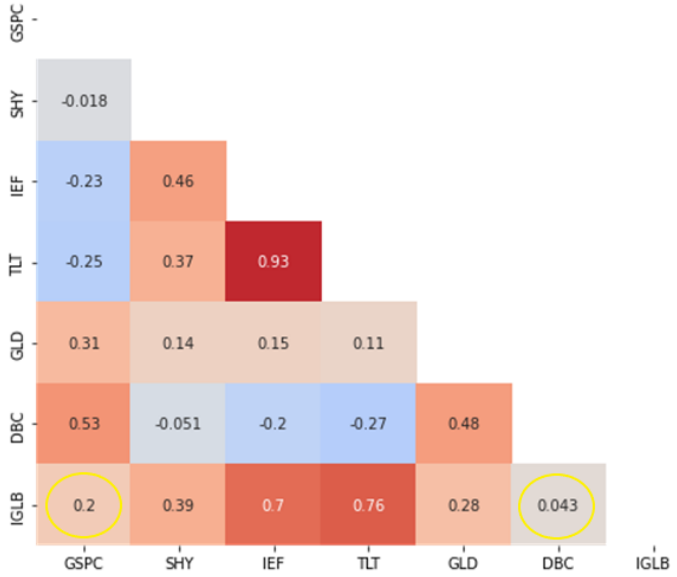
Dark Green



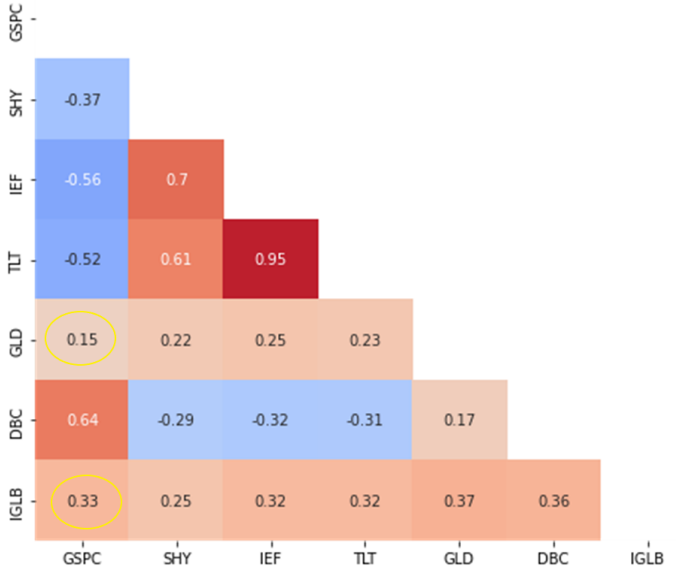
Orange



Light Green



Red



Correlation results

- During the growth stages (dark green and light green) the S&P 500 shows a negative correlation with the three types of treasuries, which is a good indicator that these can act as a counterweight.
- The correlation with corporate bonds depends on the stage of the cycle. It is positive, although relatively small, during the recovery stage and negative, but close to zero during the expansion stage.
- There is also a positive correlation between the GSPC and the commodity index, while the correlation with gold changes signs based on the stage.

ALPHA LYTICS

Betas with S&P 500

- The beta represents the expected percentage change in an asset given a change of 1% in the S&P 500.
- We see that equity indices such as the Russell 2000 and the NASDAQ show betas that are higher than 1. Hence, they can give higher returns during bull runs but, conversely, have steeper decreases in times of contraction.
- Treasuries show negative betas at all stages, confirming that they are a good counterweight to the stock portfolio.

Type	Asset	All_stages	Red	Orange	Light green	Dark green
Equities	Russell 200	1.10	1.07	1.16	1.07	1.10
Equities	DJI	0.93	0.95	0.91	0.89	0.89
Equities	NASDAQ	1.14	0.89	1.13	1.16	1.01
Treasuries	7-10 Year	-0.14	-0.12	-0.17	-0.13	-0.14
Treasuries	1-3 Year	-0.01	-0.03	-0.02	-0.02	-0.02
Treasuries	10-20 Year	-0.36	-0.24	-0.36	-0.26	-0.31
Bonds	IG Corp 10+	0.02	0.24	-0.11	0.10	-0.06
Commodities	Gold	0.01	0.01	0.07	0.47	-0.01
Commodities	DB Index	0.41	0.38	0.39	0.74	0.42

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The model's principles

- This model aims to test the hypothesis that a single, simple, investable product (a dynamic asset allocation fund) can avoid sharp falls and generate consistent returns by capitalizing on market information regarding the economic cycle in real-time
- I create two different funds to test this hypothesis. One contains 8% of crypto assets and the other does not.

ALPHA LYTICS

Principles for the model

- **The business cycle has four phases**: expansion, slowdown, contraction, and recovery. There are economic indicators such as the LEI that provide information to estimate the phases is in real-time
- The **signs of expected returns of the assets** during the phases are reasonably predictable
- **Treasuries perform better than equities during late slowdown and early contraction**. Equity indices and treasury ETFs have negative correlations, so they can be used to counterbalance the losses at different points in the cycle
- **Stocks drop sharply during the last few months of the slowdown** and bottom out a few months before the start of the recovery phase. The VIX volatility measure rises substantially from its average value of 20 to 38 (93rd percentile) during this decline. It is a reasonable sign of turbulence in the equity market
- **During periods of expansion, stocks and commodities are the best-performing assets.** Higher volatility indices like the NASDAQ and Russell 2000 outperform the Standard and Poor's 500 during this stage

Model weights

- The model makes an initial investment on March 1, 2006 (during an expansion phase) worth US$ 1 million. The portfolio is rebalanced on the first day of a new phase. The portfolio only uses ETFs as assets.
- The weights in the model are as follows:

Recovery:

- 100% equities: SPY, QQQ, IWM

Expansion:

- 84% equities: SPY, QQQ, IWM
- 8 % crypto (ETH, BTC)
- 8% DBC

Slowdown:

- 45% equities: SPY, QQQ
- 45 % treasuries (IEF, SHY, TLT)
- 5% Gold (GLD)
- 5% IG Bonds (IGLB)

Contraction:
(1st tranche)

- 90 % treasuries (IEF, SHY, TLT)
- 10% Gold (GLD)

(2nd tranche)

- 50% equities (SPY)
- 40% treasuries
- 10% gold

- If during the contraction phase VIX goes above 38, when VIX returns below 38, to anticipate the recovery phase, the portfolio is rebalanced to 50% equities, 40% treasuries, and 10% gold

Methodology Considerations

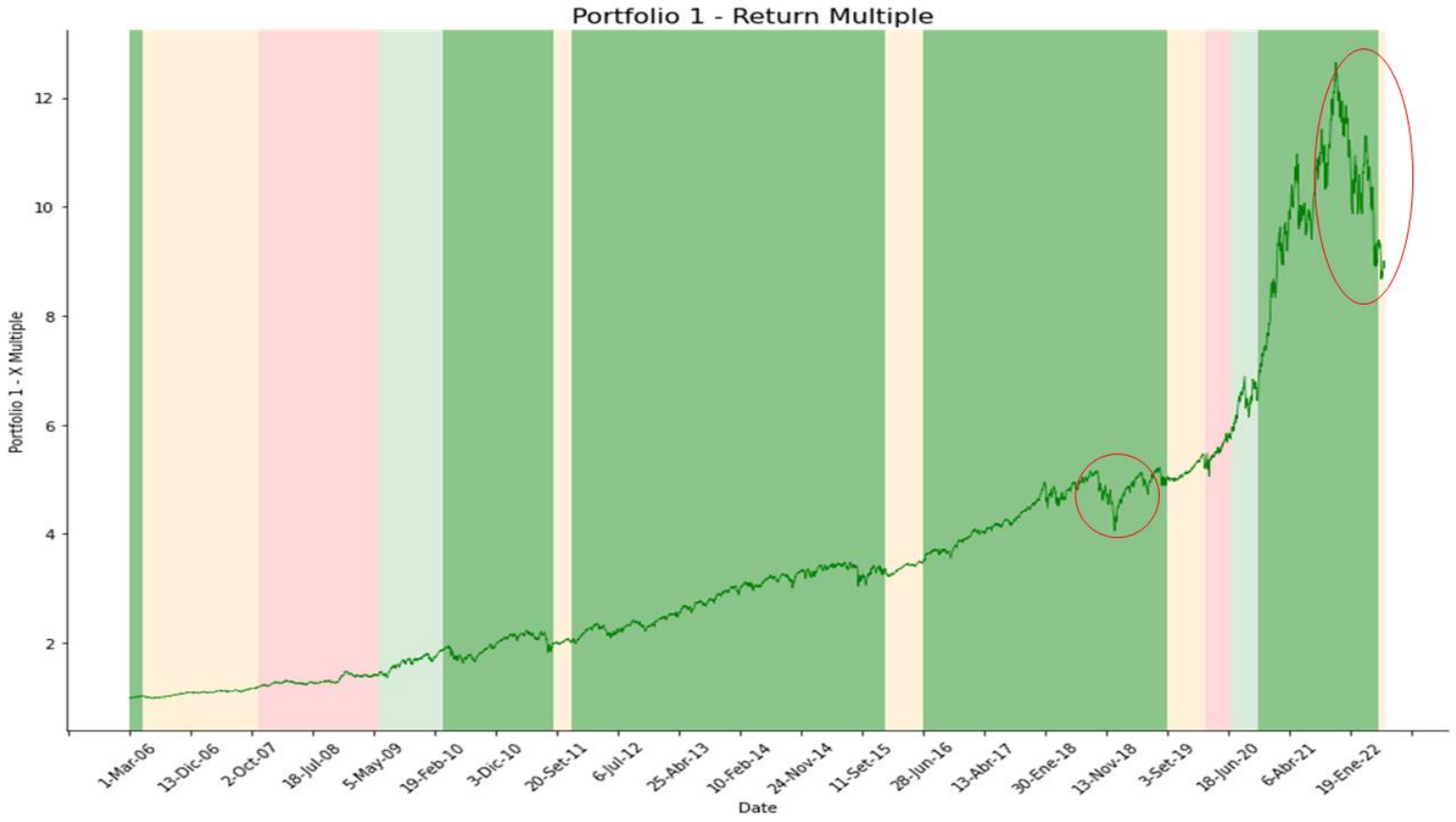
- The model does not consider the cost of trades. Between 4 and 6 trades are made when rebalancing the portfolio at the beginning of each new phase. Since 2006, the portfolio has been rebalanced thirteen times. It also does not consider slippage in the trades (not buying/selling at the exact price of the model). These costs should lower the total return of the portfolio.
- The model rebalances by liquidating the total value of the portfolio at closing and then buying the new assets at opening prices the following day.
- The model does not consider the returns from dividends from ETFs (SPY, QQQ, IWM, IGBL, IEF, SHY, and TLT). These returns should increase the total return of the portfolio.
- The model considers that LEI information is given in real-time on the first day of the month. We know that the LEI is published 45 days after this day. However, it is possible to reconstruct this indicator from data published in real-time to get a reasonable approximation. A second version of the model should be able to replicate the LEI with reasonable accuracy using the index variables and more.
- VIX data is incorporated in real-time. Decisions are made when it crosses the threshold of 38, either rising or falling.

Results: Fund 1 with crypto

Fund 1 - Returns					
Year	Date	US$ Holdings	Annual return	Compound Annual Return	Cummulative Return
Base	1-Mar-06	1,000,000	-	-	-
1	1-Mar-07	1,091,823	9.2%	9.2%	9%
2	3-Mar-08	1,290,649	18.2%	13.6%	29%
3	2-Mar-09	1,391,567	7.8%	11.6%	39%
4	1-Mar-10	1,768,430	27.1%	15.3%	77%
5	1-Mar-11	2,125,371	20.2%	16.3%	113%
6	1-Mar-12	2,285,040	7.5%	14.8%	129%
7	1-Mar-13	2,464,298	7.8%	13.8%	146%
8	3-Mar-14	3,066,733	24.4%	15.0%	207%
9	2-Mar-15	3,429,619	11.8%	14.7%	243%
10	1-Mar-16	3,339,181	-2.6%	12.8%	234%
11	1-Mar-17	4,101,626	22.8%	13.7%	310%
12	1-Mar-18	4,662,408	13.7%	13.7%	366%
13	1-Mar-19	4,877,300	4.6%	13.0%	388%
14	2-Mar-20	5,195,746	6.5%	12.5%	420%
15	1-Mar-21	9,252,071	78.1%	16.0%	825%
16	1-Mar-22	10,444,997	12.9%	15.8%	944%
16.33	30-Jun-22	8,908,599	-14.7%	14.3%	791%

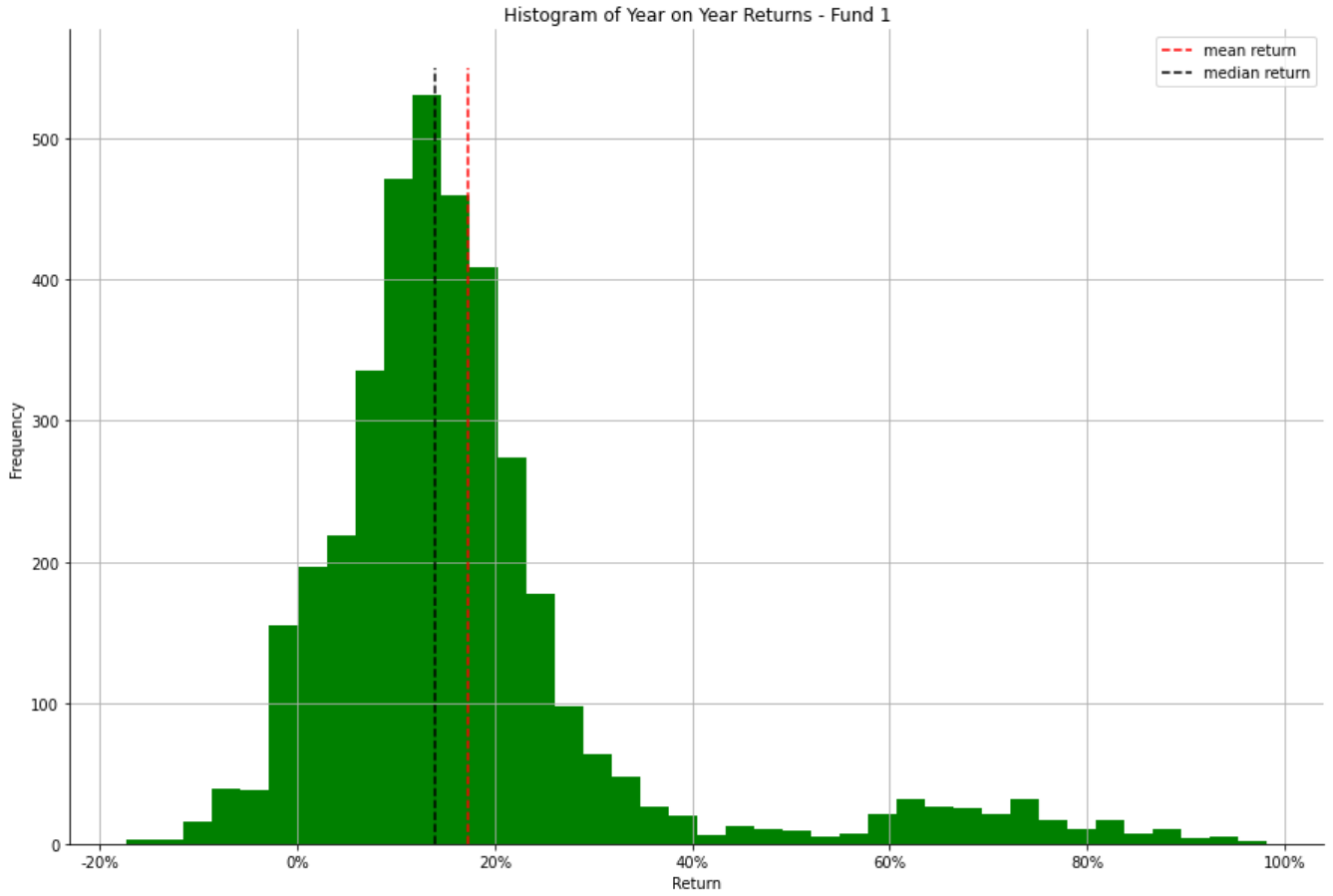
- Until March of 2022, the fund had achieved a compound return of 15.8%.
- However, it has been affected by the drop in stocks and cryptocurrencies in the last three months.
- At its peak, it achieved a 12x return on investment.
- In the 16-year period, it only lost money once, in 2016, although it is losing money in 2022.
- Likewise, we see how it avoided the losses of 2008 and 2020.

Return multiple for Fund 1 over time



- The daily return chart shows an upward trajectory, mostly. However, there is room for improvement. The losses of 2018 and 2022 should be smoothed out.
- Since these happened during times of expansion, it will be necessary to use additional data to achieve this.

Distribution of year-on-year returns Fund 1



- The distribution of daily year-on-year returns (one day vs the same day of the previous year) for Fund 1 is bimodal.
- The average return is 17.3% while the median return is 13.9%. There is a long tail to the right due to the excellent performance of the crypto market between July 2020 and December 2021.

Results: Fund 2 without crypto

Fund 2					
Year	Date	US$ Holdings	Annual return	Compound Annual Return	Cummulative Return
Base	1-Mar-06	1,000,000	-	-	-
1	1-Mar-07	1,091,823	9.2%	9.2%	9%
2	3-Mar-08	1,290,649	18.2%	13.6%	29%
3	2-Mar-09	1,391,567	7.8%	11.6%	39%
4	1-Mar-10	1,768,430	27.1%	15.3%	77%
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10	1-Mar-16	3,339,181	-2.6%	12.8%	234%
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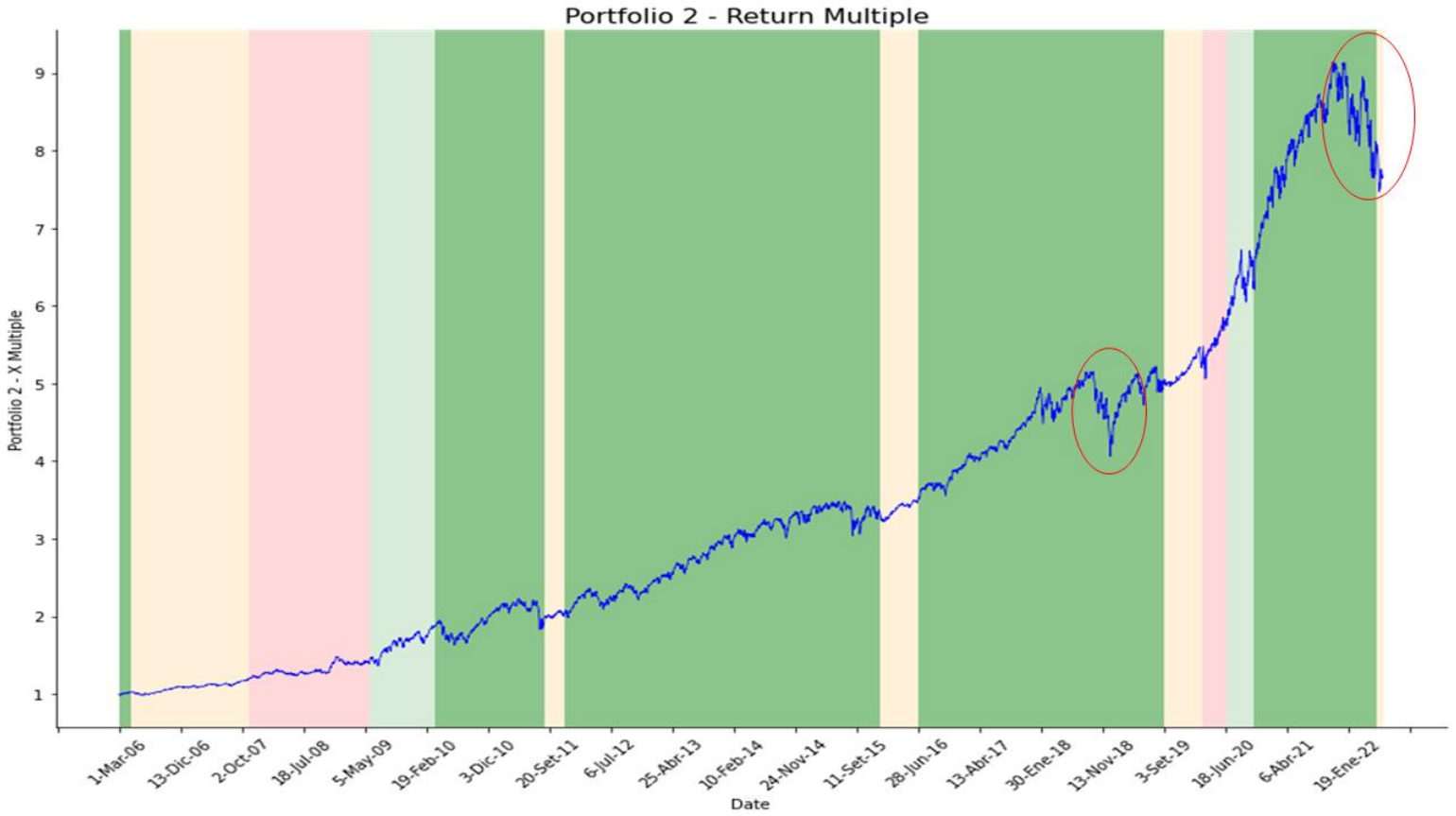
12	1-Mar-18	4,662,408	13.7%	13.7%	366%
13	1-Mar-19	4,877,300	4.6%	13.0%	388%
14	2-Mar-20	5,195,746	6.5%	12.5%	420%
15	1-Mar-21	7,682,723	47.9%	14.6%	668%
16	1-Mar-22	8,350,845	8.7%	14.2%	735%
16.33	30-Jun-22	7,670,277	-8.1%	13.3%	667%

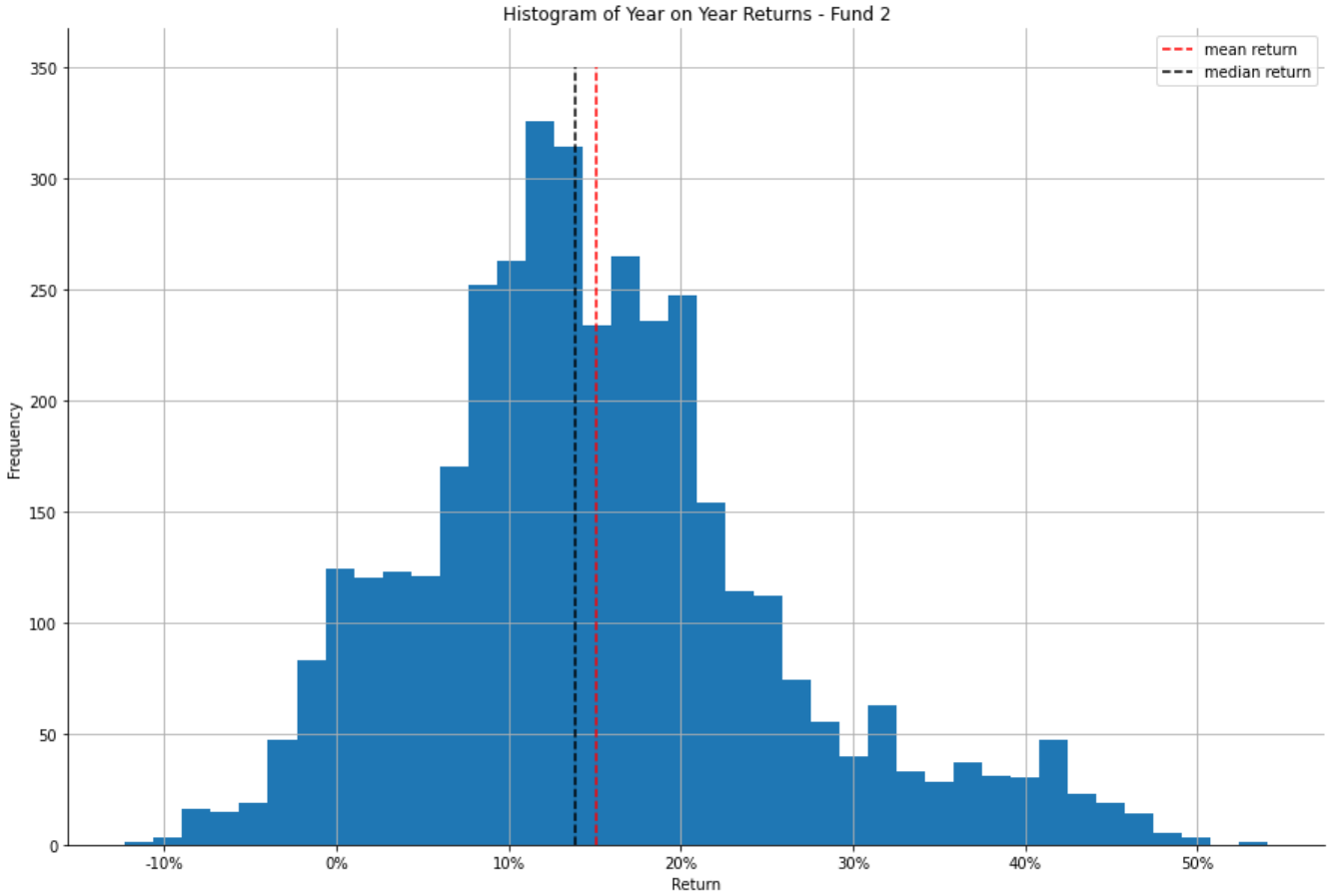
- Fund 2 does not have 8% of cryptocurrencies like Fund 1. It maintains the same weights in the equity indices as in previous phases. For this reason, its profitability is a little lower than Fund 1

Return multiple for Fund 2 over time



- At its highest point, it achieves a return of 9 times the investment. Conversely, the losses during the last quarter were less dramatic than those for Fund 1

Distribution of year-on-year returns Fund 2



- In the case of Fund 2, the mean is 15.8% and the median is also 13.9%.
- The right tail is smaller than that of Fund 1 since it does not hold crypto. The tailed is caused by the high returns of the post-COVID recovery phase, during which the portfolio had 100% equities.

Content

Introducing algorithmic trading

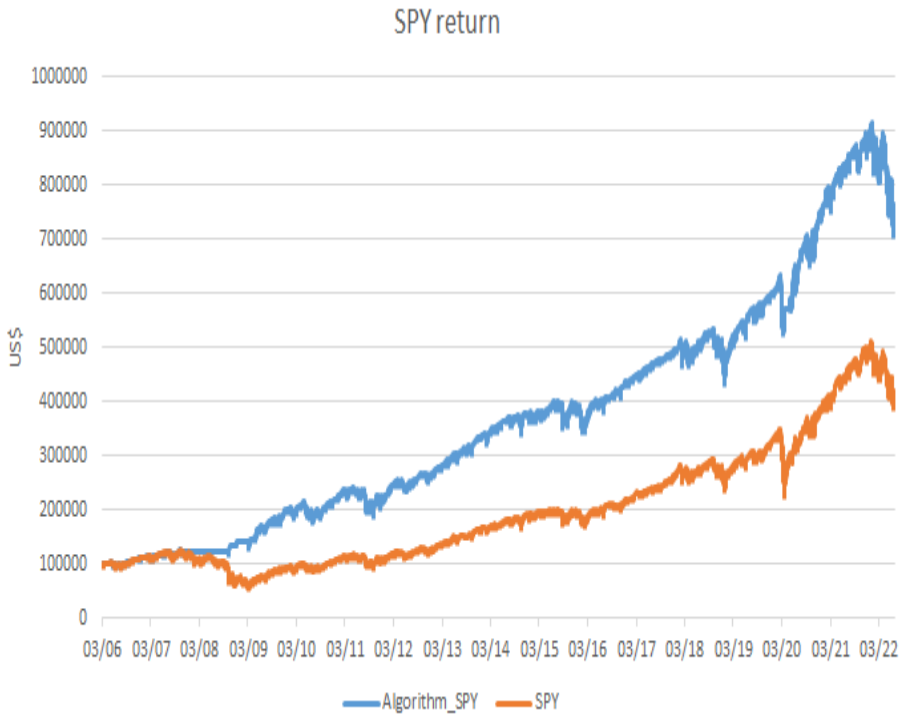
- The simple version of the model has achieved a >14% CAGR, only losing in two of the 17 back-test years (2016 and 2022, so far).
- Introducing trading at the asset level (asset vs cash position), with algorithms based on changes in prices, volume, and market sentiment adds additional costs because of the number of transactions but should be a net positive in terms of returns

Principles of the trading algorithms

I have designed trading algorithms for SPY and ETH based on the same principles:

- **Principle 1: buy low, sell high.** The hourly, 3-hour, and 24-hour returns are normally distributed. A return in the 95th percentile is a sell signal (it is relatively "high") and, conversely, a return in the 5th percentile is a buy signal (it is relatively low).
- **Principle 2: buy lower than you sold. Sell higher than you bought.** Market volatility generates plenty of buy/sell opportunities. Yet to incentivize trading, secondary buy/sell parameters are set at levels close to buy/sell signals based on hourly returns. Hence, if say a 0.5% decrease is a buy signal, but it happened after 8 hours of trading, the algorithm would also consider it as a buying opportunity and execute the trade.
- **Principle 3: buy into the volatility.** In this version of the portfolio, the SPY algorithm embraces the volatility of VIX at 38. After exiting the equity market at the beginning of a contraction phase, once VIX hits 38, the algorithm will make two trades (buy and sell) using the regular rules. The next buy opportunity, however, will happen when the price decreases 7%, then 6%, and successively. The algorithm is trying to ride the bear market and purchase at the bottom while expecting a rebound. For the case of ETH, a similar rule is implemented based on a successive number of negative trading periods and price decreases.
- **Principle 4: accept some losses.** The previous three rules work 80% of the time: i.e. when there is enough volatility. However, sometimes, the market has an upward trajectory that does not allow the algorithm to buy lower than it last sold. Hence, emergency rules are introduced to take a loss in order to avoid misalignment during a bull run.

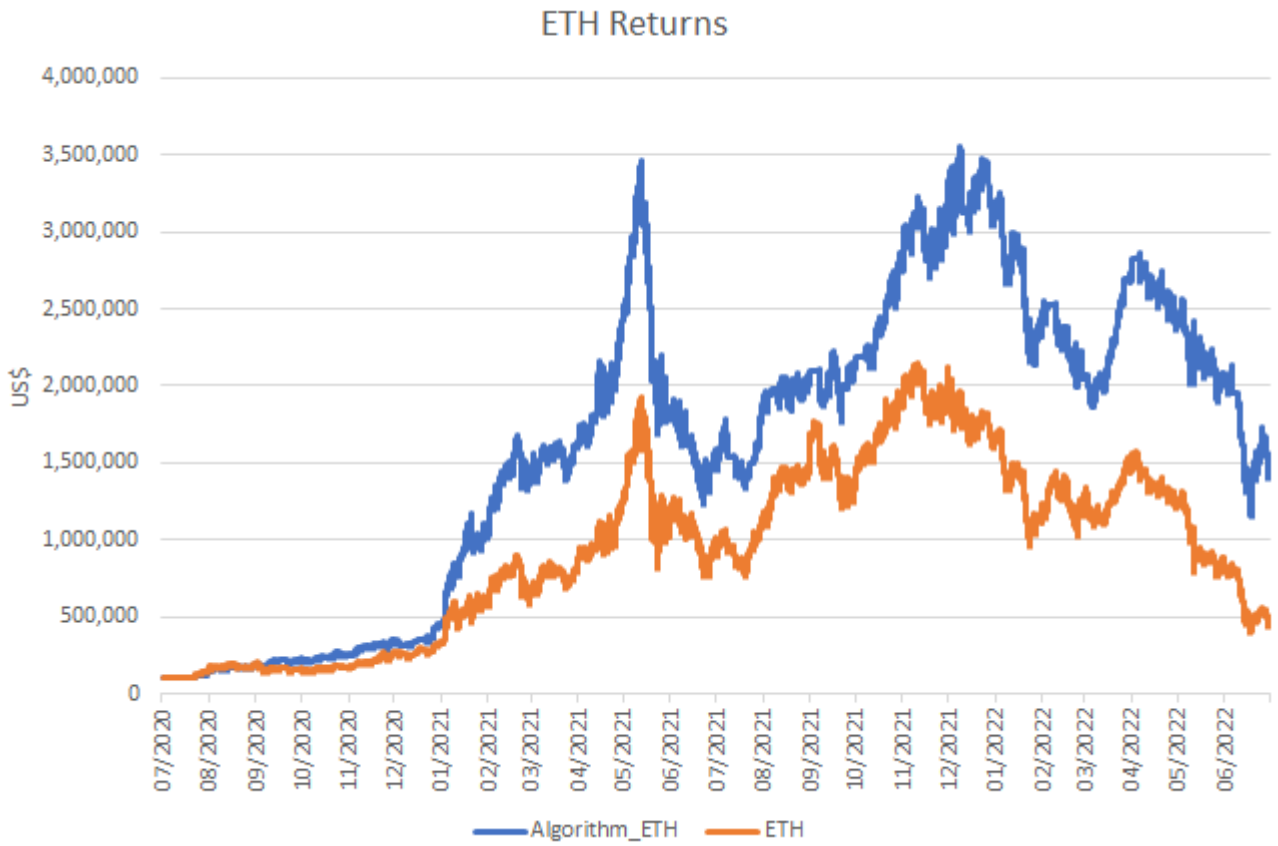
Results for SPY



The compound annual return for the algorithm is 4 points higher than the SPY long position. The algorithm beats this return because it avoided losses during 2008 and 2009 and overperformed the Covid recovery. The reason behind this (and why it is replicable in the future) is that the algorithm exits the market at the beginning of the contraction period. Then it re-enters at peak volatility during the recession. Furthermore, through a series of trades, it was able to take a long position near the bottom of the cycle.

Comparative Returns - SPY							
		Algorithmic Return			Non- Algorithmic Return		
Year	Date	US$ Holdings	Annual return	Compound Annual Return	US$ Holdings	Annual return	Compound Annual Return
Base	1-Mar-06	100,000	-	-	100,000		
1	1-Mar-07	111,071	11.1%	11.1%	109,816	9.8%	9.8%
2	3-Mar-08	122,383	10.2%	10.6%	106,816	-2.7%	3.4%
3	2-Mar-09	140,820	15.1%	12.1%	59,848	-44.0%	-15.7%
4	1-Mar-10	199,657	41.8%	18.9%	93,983	57.0%	-1.5%
5	1-Mar-11	235,859	18.1%	18.7%	114,521	21.9%	2.7%
6	1-Mar-12	250,107	6.0%	16.5%	121,044	5.7%	3.2%
7	1-Mar-13	281,488	12.5%	15.9%	135,529	12.0%	4.4%
8	3-Mar-14	346,036	22.9%	16.8%	169,668	25.2%	6.8%
9	2-Mar-15	381,496	10.2%	16.0%	197,391	16.3%	7.8%
10	1-Mar-16	371,330	-2.7%	14.0%	185,913	-5.8%	6.4%
11	1-Mar-17	448,882	20.9%	14.6%	232,667	25.1%	8.0%
12	1-Mar-18	493,558	10.0%	14.2%	268,427	15.4%	8.6%
13	1-Mar-19	521,681	5.7%	13.5%	284,218	5.9%	8.4%
14	2-Mar-20	557,752	6.9%	13.1%	305,792	7.6%	8.3%
15	1-Mar-21	783,070	40.4%	14.7%	406,533	32.9%	9.8%
16	1-Mar-22	843,139	7.7%	14.3%	462,970	13.9%	10.1%
16.3	30-Jun-22	729,284	-13.5%	12.9%	400,451	-13.5%	8.9%

Results for ETH



- By using the same principles as in SPY, the returns have been very auspicious: US$ 100k invested with the algorithm would have yielded US$ 3.5 million at peak (vs US$ 2.1 million with a long ETH position).
- At the end of June of this year, these holdings would be US$ 1.5 million.

Adding both algorithms to the portfolio

Comparative Returns -Dynamic Asset Allocation Porftolio							
		Algorithmic Return			Non- Algorithmic Return		
Year	Date	US$ Holdings	Annual return	Compound Annual Return	US$ Holdings	Annual return	Compound Annual Return
Base	1-Mar-06	1,000,000	-	-	1,000,000	-	-
1	1-Mar-07	1,106,864	10.7%	10.7%	1,091,823	9.2%	9.2%
2	3-Mar-08	1,308,206	18.2%	14.4%	1,290,649	18.2%	13.6%
3	2-Mar-09	1,322,729	1.1%	9.8%	1,391,567	7.8%	11.6%
4	1-Mar-10	1,801,756	36.2%	15.9%	1,768,430	27.1%	15.3%
5	1-Mar-11	2,141,259	18.8%	16.4%	2,125,371	20.2%	16.3%
6	1-Mar-12	2,336,786	9.1%	15.2%	2,285,040	7.5%	14.8%
7	1-Mar-13	2,557,300	9.4%	14.4%	2,464,298	7.8%	13.8%
8	3-Mar-14	3,185,527	24.6%	15.6%	3,066,733	24.4%	15.0%
9	2-Mar-15	3,495,334	9.7%	14.9%	3,429,619	11.8%	14.7%
10	1-Mar-16	3,515,549	0.6%	13.4%	3,339,181	-2.6%	12.8%
11	1-Mar-17	4,270,222	21.5%	14.1%	4,101,626	22.8%	13.7%
12	1-Mar-18	4,788,437	12.1%	13.9%	4,662,408	13.7%	13.7%
13	1-Mar-19	5,054,155	5.5%	13.3%	4,877,300	4.6%	13.0%
14	2-Mar-20	5,462,920	8.1%	12.9%	5,195,746	6.5%	12.5%
15	1-Mar-21	10,203,398	86.8%	16.7%	9,252,071	78.1%	16.0%
16	1-Mar-22	11,074,026	8.5%	16.2%	10,444,997	12.9%	15.8%
16.3	30-Jun-22	10,017,634	-9.5%	**15.2%**	8,908,599	-14.7%	**14.3%**

- The compound annual rate is now north of 15%. Last year was particularly good because the trading algorithms for SPY and ETH were on. However, that return is probably not going to occur again.
- Nevertheless, the algorithms, in most years added some extra yield, and have avoided negative returns except for, so far, 2022.

Conclusions

- The hypothesis that a dynamic asset allocation portfolio can produce better-than-market returns (i.e. 8.9% for S&P 500 in the last sixteen years) has some validity. By avoiding major losses during the economic cycle (and using the LEI and VIX as guides), the total returns are north of 13%.
- Further yields have been achieved by adding 8% of cryptocurrencies and trading algorithms for ETH and SPY to the portfolio. The following is a short list of additional analyses and tools to improve on this work:
  - Avoid losses in equities during expansion periods: 2011, 2016, 2018, 2022. Use additional variables to detect patterns that could mitigate these situations.
  - Fine-tune the LEI. Produce a similar metric with a shorter time to market.
  - Include trading algorithms for BTC, QQQ, and IWM.
  - Reduce the number of losses on trades during bull runs.