

WallStreetCourier.com – Research Paper

***The Most Rewarding Portfolio Construction Techniques:  
An Unbiased Evaluation!***

This article was awarded as Editor's Pick on Seeking Alpha!

## The Most Rewarding Portfolio Construction Techniques: An Unbiased Evaluation!

Portfolio construction techniques based on predicted risk, without expected returns, have become quite popular within the last couple of years. Especially on Seeking Alpha, great articles have been published by fellow contributors, covering the full range of modern portfolio theory and other different kind of tactical asset allocation concepts.

However, most of those published articles are based on back testing, whereas limited historical data as well as highly unlikely similar future performances of certain asset classes (e.g. the 30 year bull market in bonds or the very nice trend structure of equities between 2000 and 2010) are making an evaluation or comparisons of different kind of portfolio construction techniques quite difficult. Of course, this issue has led to many questions by fellow readers, how a certain portfolio would have performed, if there had been a huge decline in the bond market or if other tail-events would have happened. Since many of these questions have not been answered yet, we would like to analyze and compare ten popular portfolio construction techniques by applying an advanced Monte Carlo simulation to avoid using historical data. Therefore we will be able to get an unbiased view of the pros and cons of each single portfolio construction technique.

### I: Analyzed Portfolios

In terms of asset selection, we are reviewing following concepts:

#### 1. **Global Minimum Variance Portfolio (GMV):**

This portfolio construction technique has only the objective of lowering risk, rather than aiming to optimize the risk/reward ratio. It creates a portfolio with the lowest possible risk (volatility), which mostly leads to pronounced concentration in low volatility asset classes.

#### 2. **Minimum Correlation Portfolio (MCP):**

Asset classes with low correlations and volatility relative to other asset classes within the portfolio receive higher weighting. So in the end, the weightings will lead to the effect that all underlying asset classes have the lowest volatility weighted average correlation coefficient to each other. We have used the simple version of the construction technique since the advanced one involves also parts from the Inverse Volatility concept, which is being evaluated separately.

#### 3. **Most Diversified Portfolio (MDP):**

In contrast to the MCP, the MDP is focused on maximizing the diversification benefits within the portfolio (instead on minimizing the average correlation), by maximizing the diversification ratio, which is defined as the ratio of the portfolio's weighted average volatility to its overall volatility. Therefore the MDP will utilize the highest degree of diversification benefits. (A broad based MDP is being updated on a regular basis on our website – [www.WallStreetCourier.com](http://www.WallStreetCourier.com)).

#### 4. **Risk Parity Portfolio (RPP):**

The concept is quite straightforward: each asset class should contribute the same amount of risk (volatility) to the overall portfolio. Therefore assets with lower risk, such as bonds, will get a larger part of the portfolio than risky ones.

#### 5. **Inverse Volatility Portfolio (IVP):**

Each asset is weighted in inverse proportion to its volatility and then all assets are rescaled

to sum up to 1. Therefore lower weights are given to high volatility assets and higher weights to low volatility securities. Misleadingly, this concept is often being mixed-up with the risk parity approach, since they are quite similar. Nevertheless, since the overall portfolio volatility is not an additive function of the underlying volatilities, each asset class is not contributing exactly the same amount of risk to the overall portfolio!

**6. Minimum Tail Dependent Portfolio (MTP):**

Quite unknown so far, this concept is weighting asset classes according to their tail-dependencies. In the first step, it measures the correlation of each asset class during tail events (by using copulas) and then the weights are set to get a minimum tail dependent portfolio.

**7. Classic Balanced Portfolio (CBP):**

A standard portfolio where 60 percent is being invested in equities and 40 percent in bonds.

**8. Momentum Based Portfolio (MBP):**

This strategy owns the best two out of four asset classes (equally weighted), which performed the best in the trailing one-month and holds that asset class forward for one additional month.

**9. IVY Portfolio (IVP):**

The strategy calculates a 10-month moving average for each underlying asset class. If the current price is above its long-term average, the specific asset class will be added within the portfolio otherwise its whole exposure is moved to cash.

**10. Permanent Portfolio (PEP):**

Harry Browne's "Permanent Portfolio" is investing 25% in stocks, 25% in cash, 25% in gold, and 25% in long-term treasury bonds as a way to cover each of the four economic stages (prosperity, recession, inflation, and deflation).

## II: Methodology

As already mentioned above, we are using a Monte Carlo simulation, to generate 300 years of daily data. In general, a Monte Carlo simulation performs any kind of analysis by building samples of possible results by substituting a range of values (a probability distribution) for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability function. In other words, it is possible to simulate umpteen years of data, which have more or less the same risk characteristics as the desired underlying asset classes.

In our example, we will use a multivariate normal distribution ([http://en.wikipedia.org/wiki/Multivariate\\_normal\\_distribution](http://en.wikipedia.org/wiki/Multivariate_normal_distribution)), which is fitted with certain parameters (return- and correlation estimates) in order to describe the random behavior (market riskiness) of asset returns. Worth mentioning is the fact that the input parameters are just a point of reference since the multivariate normal distribution will randomly generate values within the normal standard distribution. However, when it comes to simulations, the results should be seen as additional source of information rather than an all explaining framework. For that reason, all the results should be treated with caution and should just be seen as another mosaic stone in quantitative finance.

According to a Bridgewater research paper, betas (asset classes) have had, and are expected to have, ratios of excess returns to excess risks (Sharpe Ratios) of about 0.2 to 0.3 (www.bwater.com). That is because:

- "there needs to be some extra return to compensate investors for excess risk (so this ratio should be positive),
- but this ratio cannot be very extremely positive because that would make these investments attract substantial amounts of capital that would bid up their prices and lower their expected return."

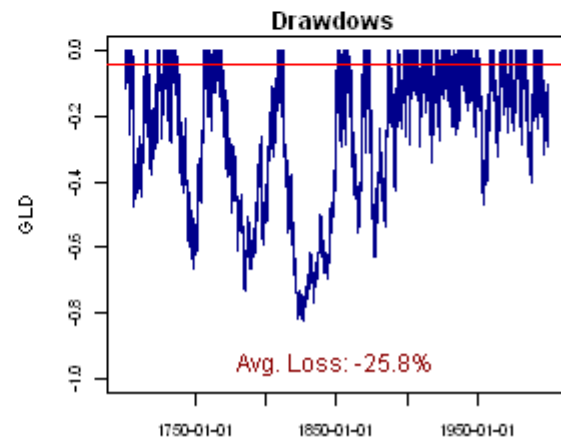
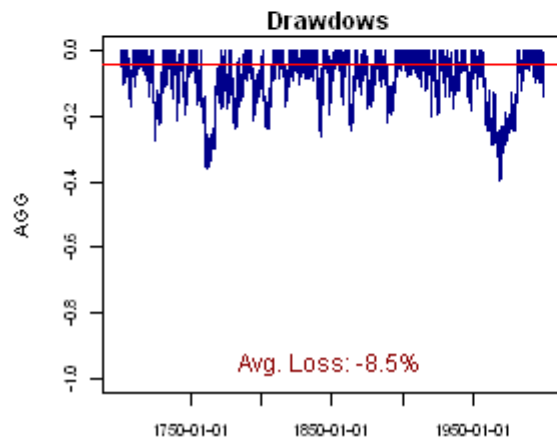
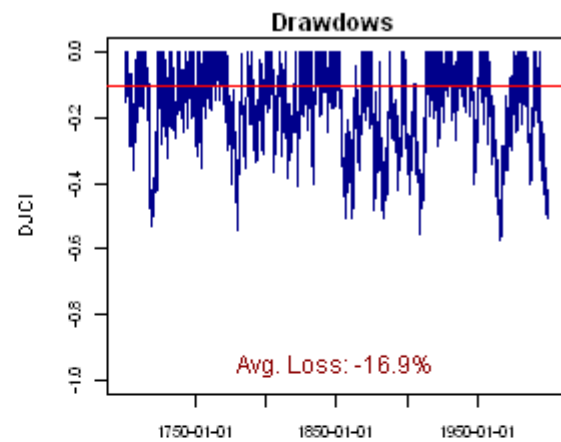
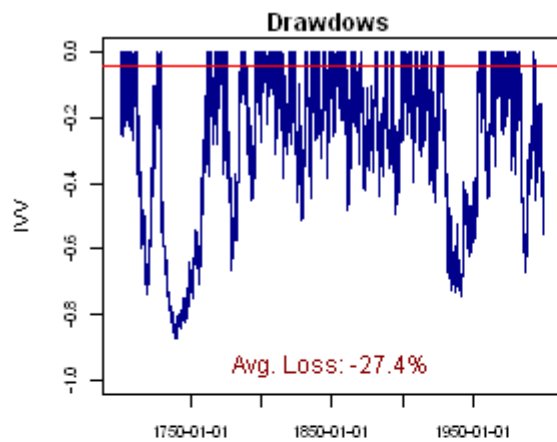
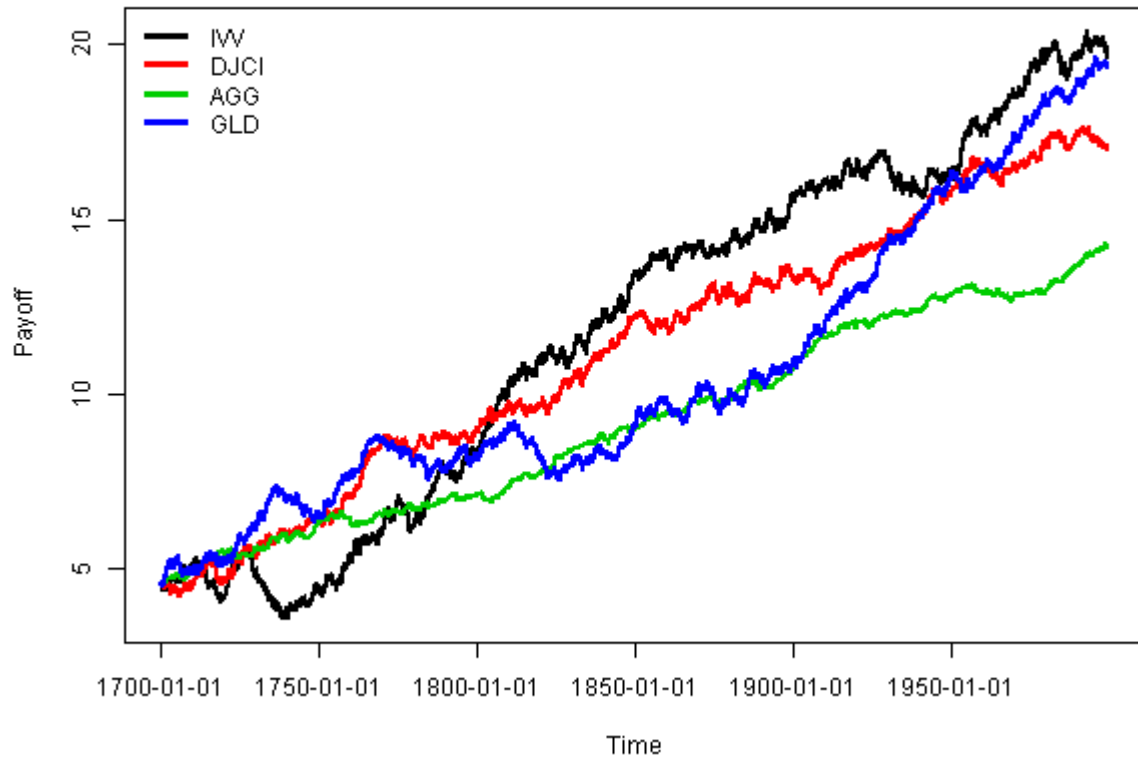
Therefore we have used an average return estimation for each asset class which produces Sharpe Ratios of 0.2 to 0.3, whereas the risk free rate is 1.5 percent. Furthermore, we have used the historical variance-/covariance matrix from 1980 until 2013 for the iShares Core S&P 500 ETF (IVV), the iShares Core Total U.S. Bond Market ETF (AGG), the UBS ETRACS DJ-UBS Commodity Index Total Return ETN (DJCI) and the SPDR Gold Shares (GLD), as reference point for the underlying correlations assumptions.

Summary statistics, drawdowns as well as a performance chart (logarithmic scale) for the four simulated asset classes are given below. As you can see, the Sharpe Ratios for the underlying securities are almost equal, since they are ranging between 0.2 and 0.3. More importantly, with a maximum loss of 87 percent, equities (IVV) have faced the highest decline in the past, followed by gold (GLD), commodities (DJCI) and bonds (AGG). Another interesting fact is the decline of bonds (AGG) by almost 40 percent, a situation which we have not seen in the last couple of decades. Therefore, it will be quite interesting to see, how bond-heavy portfolio construction techniques will perform under such conditions. However, the overall key statistics are looking quite reasonable and therefore the simulated time series can be seen as a quite good proxy for evaluating the above mentioned portfolio concepts.

Performance Ratios [1700-2000]					
Portfolio	CAGR	Volatility	Sharpe Ratio [Rf=1.5%]	Maximum Loss	Avg. Loss
IVV	5.00%	19.1%	0.183	-87.2%	-27.4%
GLD	4.13%	15.5%	0.170	-57.1%	-16.9%
AGG	3.19%	7.5%	0.226	-39.6%	-8.4%
DJCI	4.92%	16.7%	0.204	-82.3%	-25.8%

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### Overview Performance (Log-Scale)



In our example, there is no allowance for transaction costs or brokerage fees. In order to minimize transaction costs, we rebalance the portfolio on a monthly basis, whereas 1-day slippage is included. In addition, we have determined the weights for all portfolio concepts on a monthly basis. Worth mentioning is the fact that we are using a rolling variance/co-variance matrix to determine the weights for all risk-based concepts, as correlations among asset classes are not stable over time.

### III: Results

#### a) CAGR

The simulation results are summarized in the table below. The most favorable portfolio in terms of performance is the Minimum Correlation Portfolio (MCP), with an annualized return of 5.87 percent, followed by the Momentum Based Portfolio (MBP) with 5.55 percent and the Most Diversified Portfolio with 5.3 percent. With slightly more than 4 percent, the IVY Portfolio (IVY) is delivering the lowest compound annual growth rate, followed by the Classical Balanced Portfolio (CBP), with an average return of 4.07 percent a year.

Performance Ratios						
Portfolio	CAGR	Volatility	Sharpe Ratio [Rf=1.5%]	Maximum Loss	Avg. Loss	# Neg. Calendar Years
GMV	4.5%	6.3%	0.467	-19.9%	-4.4%	27
MCP	5.9%	11.2%	0.390	-43.3%	-10.4%	32
MDP	5.3%	6.9%	0.551	-21.5%	-4.1%	24
RPP	5.3%	7.1%	0.538	-20.6%	-4.2%	25
MTP	5.1%	7.1%	0.502	-23.3%	-4.5%	24
IVP	5.2%	7.3%	0.505	-21.5%	-4.4%	26
CBP	4.1%	8.7%	0.296	-35.5%	-8.7%	33
MBP	5.6%	11.6%	0.351	-37.3%	-8.2%	30
IVY	4.0%	6.6%	0.380	-18.3%	-4.5%	31
PEP	5.0%	6.6%	0.534	-24.3%	-4.1%	25

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#### b) Sharpe Ratios

However, return is just telling one side of the story. For that reason, the Sharpe Ratio is a better measure to examine the risk/reward ratio. The Most Diversified Portfolio (MDP) has the highest Sharpe Ratio, followed by the Permanent Portfolio (PEP) and the Risk Parity Portfolio (RPP). This result is strongly in-line with the theoretical background (<https://www.putnam.com/literature/pdf/SU830.pdf>), as there should be no other portfolio combination, which can achieve a higher risk-/return ratio than the Most Diversified Portfolio (MDP). In general, 5 out of 10 portfolio concepts had Sharpe Ratios above 0.5. Moreover, the Classic Balanced Portfolio (CBP), as well as all timing based portfolio concepts (MBP, IVY) are delivering the lowest Sharpe Ratios. A quite good reason for that outcome is the fact that those portfolios are not as good diversified as their peers and therefore their overall portfolio volatility is either too high (CBP and the MBP) or their average return is too low (IVY).

#### c) Volatility/Risk

In terms of risk, the Global Minimum Variance Portfolio (GMP) has of course the lowest portfolio volatility, whereas the Momentum Based Portfolio (MBP) and the Minimum Correlation Portfolio (MCP) are having by far the highest ones.

#### d) Drawdowns

To evaluate the absolute return character of each portfolio construction technique, we will have a closer look on the ability of each concept to generate absolute returns on a yearly basis as well as on the maximal- and average drawdown statistics of those portfolios.

Within almost 300 years of data, the Most Diversified Portfolio (MDP) as well as the Minimum Tail Depended Portfolio (MTP) had only 24 negative years, followed by the Permanent Portfolio (PEP) and the Risk Parity Portfolio (RPR) with 25 years of negative returns. The Global Minimum Variance Portfolio (GMV) failed to deliver positive returns in 27 years, whereas all other portfolio concepts had negative returns in 30 (MBP) years or above (IVY, MCP and the CBP).

The IVY Portfolio (IVY) as well as the Global Minimum Variance (GMV) had the lowest maximal drawdown, whereas the Minimum Correlation Portfolio (MCP) as well as the Momentum Based Portfolio (MBP) had by far the highest ones. Another highly interesting fact is that the largest drawdown of most portfolios did not occur within the same time period in which their underlying asset classes suffered the most (see table below).

Largest Drawdowns [Daily Data]							
	From	Trough	To	Depth	Length	To Trough	Recovery
IVV	02/13/1728	07/25/1738	04/06/1761	-87.2%	8647	2726	5921
GLD	12/19/1811	04/14/1826	08/07/1850	-82.3%	10080	3737	6343
AGG	07/19/1956	01/23/1969	10/15/1981	-39.6%	6586	3266	3320
DJCI	01/16/1957	04/15/1966	05/13/1975	-57.1%	4780	2413	2367
MCP	11/16/1927	06/27/1932	12/18/1936	-43.3%	2373	1204	1169
CBP	01/26/1928	09/18/1935	12/04/1942	-35.5%	3877	1995	1882
GMV	12/04/1957	01/24/1969	05/19/1970	-19.9%	3250	2908	342
MBP	10/26/1981	04/28/1987	04/27/1990	-37.3%	2220	1437	783
MDP	05/12/1983	06/20/1985	08/11/1988	-21.5%	1371	551	820
RPP	05/12/1983	06/20/1985	08/26/1988	-20.6%	1382	551	831
MTP	05/12/1983	06/20/1985	10/10/1988	-23.3%	1413	551	862
IVP	05/12/1983	02/27/1987	10/11/1988	-21.5%	1414	992	422
PEP	08/18/1983	03/03/1987	01/16/1989	-24.3%	1413	924	489
IVY	08/25/1983	04/21/1986	08/26/1988	-18.3%	1307	693	614

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Especially, the Risk Parity Portfolio (RPP) and the Most Diversified Portfolio (MDP) were holding up quite well, during that time the bond market crashed, while the Global Minimum Variance Portfolio (GMV) was hurt the most! This outcome is not surprisingly at all, since the Global Minimum Variance Portfolio is heavily weighted in bonds and in addition, this concept does not utilize all benefits from diversification. As already mentioned in other **articles**, as long as the correlations within the underlying asset classes remain low, the Risk Parity Portfolio (RPP) as well as the Most Diversified Portfolio (MDP) won't be hurt too much, in times of rising interest rates, although they are also heavily weighted in bonds. This is mainly due to the effect, that other asset classes are offsetting the negative performance of bonds. In general, prices do not go down to zero over night and therefore it still makes sense to keep a declining asset class within the portfolio, due to their diversification benefits. For example, if there is a normal correction within an ongoing equity bull market, bonds still tend to rise although they might be in a longer lasting down-trend. This will lead to smoother returns and less drawdowns, which is one of the main strengths of those new portfolio construction concepts. Furthermore, we can see that apart from the Minimum Correlation Portfolio (MCP), the Classic Balanced Portfolio (CBP) and the Global Minimum Variance

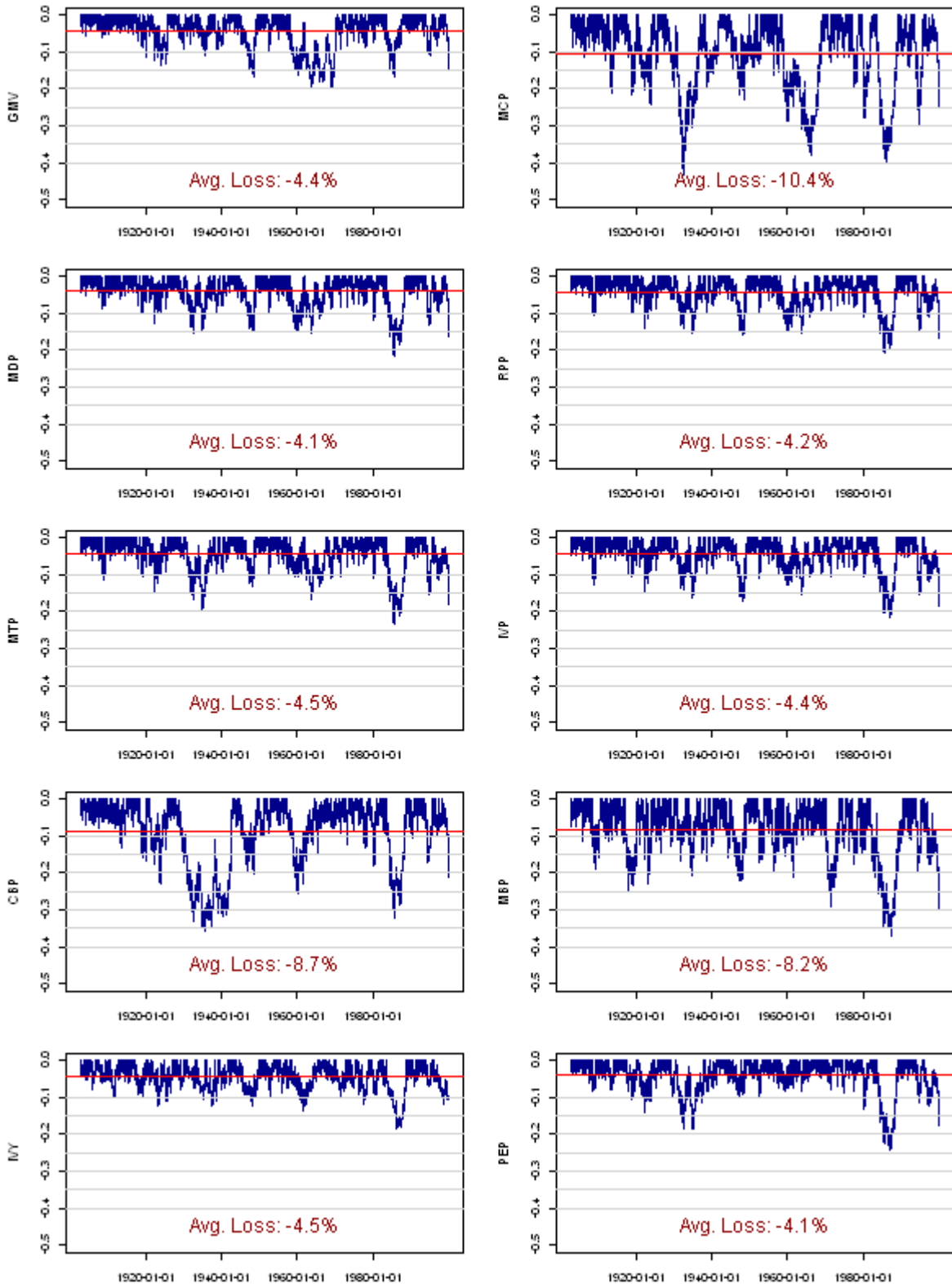


(GMV), all other concepts had their worst performance more or less during the same time period.

#### **e) Average Losses**

Since the historical maximum drawdown is just representing a single tail event in the past, the average drawdowns are much more accurate to evaluate the absolute return character of each construction technique. Below, we have charted all drawdowns as well as the average loss of each portfolio. There we can see that the Permanent Portfolio (PEP) as well as the Most Diversified Portfolio (MDP) had the lowest drawdowns on average, whereas the Minimum Correlation Portfolio (MCP), the Classic Balanced Portfolio (CBP) as well as the Momentum Based Portfolio (MBP) had the highest ones.





**f) Overall Scoring**

To make things more clearly, we have ranked the portfolios with numbers ranging from 10 to 1, whereas 10 represents the most favorable result. Furthermore, we have averaged all scores, to get a total score for each portfolio. There we can see that the Most Diversified Portfolio (MDP) has got the highest average score and is therefore representing a good mixture between performance and risk. The Risk Parity Portfolio (RPP) is on the second place, with a

score of 7.5, followed by the Permanent Portfolio (PEP) and Global Minimum Variance Portfolio (GMV). However, with 2 points, the Classic Balanced Portfolio (CBP) has received the lowest score among all evaluated portfolio construction concepts, followed by the Minimum Correlation Portfolio (MCP) and the Momentum Based Portfolio (MBP)!

Scores (10 = Best)								
Portfolio	CAGR	Volatility	Sharpe Ratio [Rf=1.5%]	Maximum Loss	Avg. Loss	# Neg. Calendar Years	Avg. Score	
GMV	3.00	10.00	5.00	9.00	7.00	5.00	6.50	
MCP	10.00	2.00	4.00	1.00	1.00	2.00	3.33	
MDP	8.00	7.00	10.00	7.00	9.00	9.00	8.33	
RPP	7.00	6.00	9.00	8.00	8.00	7.00	7.50	
MTP	5.00	5.00	6.00	5.00	5.00	9.00	5.83	
IVP	6.00	4.00	7.00	6.00	6.00	6.00	5.83	
CBP	2.00	3.00	1.00	3.00	2.00	1.00	2.00	
MBP	9.00	1.00	2.00	2.00	3.00	4.00	3.50	
IVY	1.00	8.00	3.00	10.00	4.00	3.00	4.83	
PEP	4.00	9.00	8.00	4.00	10.00	7.00	7.00	

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#### IV: Summary

Basically, all portfolio construction techniques are delivering higher Sharpe Ratios than their underlying asset classes, which is just another proof of the overall diversification concept. The Global Minimum Variance Portfolio (GMV) is still doing a good job although it will definitely get hurt the most if we see rising interest rates in the future. As already mentioned in our previous articles, a huge decline in the bond market will not automatically lead to such catastrophic scenarios for the Risk Parity Portfolio (RPP) or the Most Diversified Portfolio (MDP), as some fellow readers might have thought. In contrast, the Inverse Volatility Portfolio (IVP), which is often mixed-up with the risk parity approach, is underperforming its bigger brother (RPP) in terms of its overall score. If we focus on portfolios that are based on timing rather than portfolio construction, we can see that the typical late-in, late-out effect of those concepts will mostly lead to increased volatility or low returns, which is of course affecting their Sharpe Ratios as well as other risk/performance based ratios. The Minimum Correlation Portfolio (MCP) does not utilize all the benefits which can be achieved by diversification and if we have a look at this specific weighting algorithm, we do not really see any big advantage over other concepts. The Minimum Tail Dependent Portfolio (MTP) has shown quite robust results and given a Sharpe Ratio above 0.5, it is definitive worth an investment. However, as this optimization concept needs a lot of estimates (via copula), we think it might be a bit challenging for common investors to understand the rationale behind it. In contrast, the Permanent Portfolio defended its reputation, to be a good and simple investment concept as it has delivered the third highest Sharpe Ratio and the third highest overall score. Furthermore, we can say that the Classic Balanced Portfolio (CBP) is by far the worst concept, followed by the Momentum Based Portfolio (MBP), whereas the Most Diversified Portfolio (MDP) has shown once again that diversification pays off the most, as it is the only free lunch an investor has.

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Diversified Market Timing & Investment Advisory!

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