

ASSET ALLOCATION PROPOSITION IN SCIENTIFIC DIVERSIFICATION

Portfolio Management Group Assignment

MSc. Finance May 2020

Abstract: As a value-driven Asset Management Company, SAC associates is committed to provide its clients with tailored investment strategy planning, exceptional customer service and outstanding financial performance. Based on the recommendations put forward by AM International Ltd., the purpose of this proposal report is to address the benefits of scientific diversification, consistent with the latest insights from Modern Portfolio Theory.



Asset Management Company

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1.0 Strategy Description

The Eurostoxx_50 index has been selected to constitute the asset universe used as the benchmark. The goal here is to build a well-diversified global portfolio, therefore, such selection is due to the following arguments: 1) Pension fund usually has a relatively long investment horizon, so stable income stream such as dividends is required to pay for its liabilities; 2) Pension fund has smaller risk tolerance, so index with high underlying volatility is not given the preference as opposed to “blue chip” focused index; 3) Country exposure and sector exposure are preferred to be diversified for pension funds, so single country limited index such as IBEX_35 and OMXS_30 are not ideal; 4) It is beneficial for pension fund to invest in large-cap focused indices with less fluctuation. As a conclusion, Eurostoxx_50 meets all the criteria listed.

The initial period coverage incorporated is from Jul 7, 2005 to Dec 31, 2019, for a more comprehensive analysis. We have implemented the GMV Strategy by implementing 3 variations of GMV – **GMV with Sample Covariance methodology**, **GMV Shrinkage methodology** and **Optimized GMV methodology** in order to obtain the best solution.

Our recommended strategy is **Optimized Global Minimum Variance (GMV)**, which is a modification from the basic GMV strategy.

Key Performance Indicators:

Based on the methodology of Optimized GMV, the following key financial indicators are produced on the full period historical index data (Jul 7, 2005 to Dec 31, 2019): (**Exhibit 1**)

- 1) **Benchmark Information:** The Optimized GMV strategy delivers an annualized return of 7.63%, as opposed to 5.64% for Market-cap weighted (CW) and 3.14% for Equally weighted (EW) benchmarks. The annualized volatility for Optimized GMV is 16.55%, as opposed to 21.35% and 21.47% for CW and EW respectively.
- 2) **Top 10 Weight Allocations:** Iberdrola-10.71%, Fresenius-9.93%, Unilever-9.67%, Deutsche-6.71%, Sap-6.35%, Danone-5.13%, Enel-4.46%, Orange-4.16%, Anheuser-4.09%, Telefonica-3.83%. Total of 65.04%.
- 3) **Weighting Scheme:** Larger weights are allocated to effective assets with low volatility, as opposed to free-float market cap of Eurostoxx_50 index itself.

2005-2019 Historic Data Backtest Analysis - EUROSTOXX50									
	Annualized Ret	Annualized	Skewness	Kurtosis	Cornish-Fisher VaR	Historic CVaR	Sharpe Ratio	Max Drawdown	
EW	0.056394	0.214715	0.190678	10.313953	0.019197	0.03183	0.262647	-0.564918	
CW	0.031418	0.213505	0.316045	12.147958	0.018191	0.031585	0.147155	-0.571563	
gmV	0.045389	0.156832	-0.859507	11.262174	0.016652	0.023776	0.289414	-0.587285	
Shrinkage gmV	0.04546	0.155905	-0.837123	11.957586	0.016359	0.023749	0.291586	-0.603417	
Optimized gmV	0.076336	0.165515	-0.787587	16.366667	0.016201	0.024413	0.4612	-0.53492	

Exhibit 1 : 2005-2019 Historic Data – BackTest Analysis

- 5) **Sector Exposure and Country Exposure:** 12.6% Technology, 12.4% Personal & Household Goods, 11.0% Health Care, 9.6% Industrial Goods & Services, 9.2% Chemicals, 7.2% Banks, 6.2% Insurance, 6.0% Utilities, 5.8% Oil & Gas, 4.3% Retail. 38.7% France, 32.2% Germany, 12.0% Netherlands, 8.7% Spain, 4.9% Italy, 1.7% Belgium, 1.0% Ireland, 0.8% Finland.
- 6) **Tracking Error:** **0.49** between Optimized GMV and CW; **0.51** between Optimized GMV and EW.
- 7) **Information Ratio:** **0.0916** between Optimized GMV and CW; **0.0389** between Optimized GMV and EW.
- 8) **Risk Measures:** Skewness = **-0.79**; Kurtosis = **16.37**; VaR = **0.0162**; Conditional VaR=**0.0244**.
- 9) **Back-testing of Performance:** Refer to the results in **Exhibit 1**.
- 10) **Sharpe Ratio:** **0.4612** for Optimized GMV, as opposed to **0.1472** for CW and **0.2626** for EW.
- 11) **Maximum Drawdown:** **-0.5349** for Optimized GMV, as opposed to **-0.5716** for CW and **-0.5649** for EW.

2.0 Value Proposition

Following this particular attraction emphasizing the benefits of scientific diversification process, the added value of our recommended Optimal GMV benchmark can therefore be demonstrated based on the statistics output provided in the 1.0 section:

1. The Optimized GMV demonstrates a much higher **annualized return** and lower **annualized volatility** than CW and EW versions of benchmarks. These two elements collectively contribute to a better performance as required by the pension fund investment mandate. (**Exhibit 1 and 2**)

¹ Based on composition as of Mar 31, 2020. Stoxx.com.

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2. It is observed that the **top 10 weight allocations** under Optimized GMV differ significantly than those under CW and EW(Exhibit). For example, under Optimized GMV, the top allocation is assigned to asset “Iberdrola” based on the least volatility, but in the case of CW and EW its fairly underweighted. (Exhibit 3)

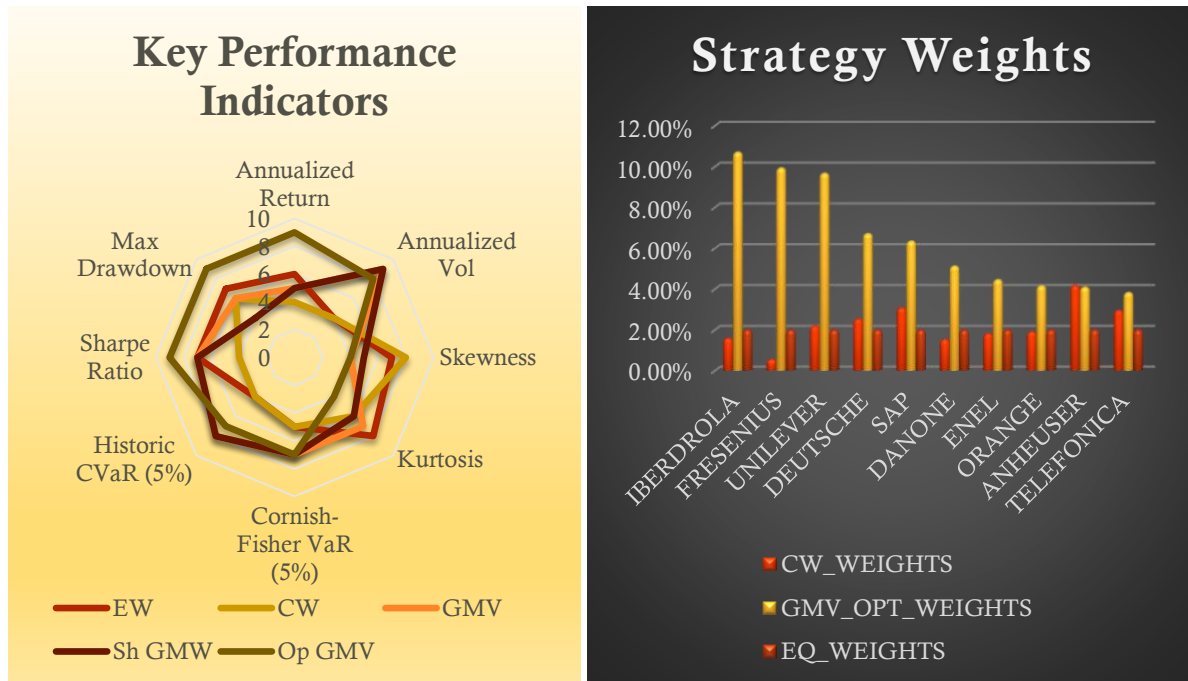


Exhibit 2 : Key Performance Indicators.

Exhibit 3 : Weights of different Strategies

3. In terms of **weighting scheme**, the added value of Optimized GMV is demonstrated by its weight assignment to effective assets with low volatility, which is associated with target portfolio efficiency. It can be observed that “SANOFI” for example, which has a larger weight allocation under CW benchmark, is not listed on the top 10 allocation of Optimized GMV. This implies that asset in fashion business has lower resilience to market shocks. (Exhibit 3)

4. **Sector exposure** changes from period to period, but the example of industry sector weightings provides an overall sense of “blue-chip” characteristic of Eurostoxx_50 based asset universe. More emphasis is placed on low risk and relatively stable sectors such as Health Care and Personal & Household Goods compared to high risk sectors such as Oil & Gas. Under Optimized GMV, the largest allocation is assigned to Iberdrola of 10.71%. Iberdrola is a global energy leader in the relatively stable and sustainable utility industry sector.

5. **Tracking error** represents the risk taken by portfolio managers compared to the benchmarks. The ratios of 0.49% of Optimized GMV over CW and 0.51% of Optimized GMV over EW are both lower than 1%, which indicates the active risk sustained is greatly reduced after implementing the strategy.

6. **Information ratio** incorporates the risk component into active returns to provide a more complete measurement of performance. The higher the ratio, the higher the active return given the amount of risk taken. We observe that we obtain the information between opt-gmv and ew to be 0.0388 and for opt-gmv and cw to be 0.091 which indicates that this strategy with its views is performing better than the EW and CW.

7. Risk Measures include **Skewness, Kurtosis, VaR** and **Conditional VaR**. Volatility is considered a sufficient measurement of risk only when asset returns are normally distributed, which is not the case in reality. Skewness of Optimized GMV is -0.79 which means more values are concentrated on the right side (tail) of the distribution graph while the left tail of the distribution graph is longer which suggests that the portfolio can be used but with caution. Kurtosis measures the frequency of extreme positive or negative returns, 16.37 under Optimized GMV indicates fatter tails than normal distribution, which is a fairly due to large outlier effect. VaR serves as a max potential loss threshold. Our computation is conducted at 5% level excluding the 5% extreme losses. Under Optimized GMV, this worst-case scenario threshold of 0.0162 is higher than CW

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of 0.0182 and EW of 0.0192, which reinforces the that the strategy performs better than EW and CW. Conditional VaR is the average of the expected losses that goes below VaR threshold as an extended conservatism risk measure. Under Optimized GMV, it has a value of 0.0244 which is lower than that of CW and EW. VaR and Conditional VaR are robust measures of extreme risk. **(Exhibit 1 and 2)**

8. Sharpe Ratio: the ratio under Optimized GMV is $0.4612 > EW > CW$. The higher the Sharpe Ratio, the higher the portfolio efficiency. **(Exhibit 1 and 2)**

9. Maximum Drawdown: this indicator provides the max loss from previous high to subsequent low, in terms of worst possible return that the fund could get if buy peak and sell bottom. The value under Optimized GMV is the least negative, which again evidenced the leading benefit of our strategy in managing the downside. EW is next preferred, and CW is the least preferred under this measure. **(Exhibit 1 and 2)**

Macro-Economic Viewpoints:

However, certain strategies have fared relatively well than optimized GMV strategies in different spells, owing to changing macro-economic conditions. During the time frame covered in our data analysis, one of the key macro-economic events that affected the global financial markets was the subprime mortgage crisis in 2008. Excessive risk-taking by the banks spiraled into an international banking crisis, which eroded billions of dollars in shareholders wealth, particularly in the banking industry. The European Sovereign Debt crisis in 2011 also witnessed fall of several financial institutions and a loss of confidence in the European businesses and economies.

Between 2007 and 2012, the major constituents of the Euro Stoxx 50 index included Santander, BNP Paribas and Deutsche Bank AG, which were among the hardest hit by the global financial crisis. In May 2008, European car sales fell by 7.8%. Accordingly, Volkswagen AG, Europe's biggest carmaker and a major constituent of the index, saw its value depreciate whilst energy stocks such as Total also witnessed a steep decline on account of falling energy demand. The recession also coincided with certain companies losing market value on account of risk idiosyncratic to an industry. Nokia, for example, the 4th largest constituent in the index, saw its market cap decline from \$151 billion in October 2007 to \$ 26 billion in the next 15 months, eventually falling to \$6 billion by the end of 2012.

Consequently, cap weighted strategy did not fare well in these market conditions as their composition was skewed towards industries and sectors most adversely affected by the macro-economic events. Equally weighted portfolios divided the risk better among sectors and were therefore better rewarded in their returns during 2008-2012. Sample GMV strategy delivered the highest returns as these portfolios allocated capital towards low volatility stocks which were least affected by extreme fluctuations in the market due to heightened uncertainty. Although optimizing the GMV strategy to remove stocks with inefficient risk-reward ratios did not yield the desired results and had the worst sharpe ratio at -0.386. For instance, under the optimized GMV strategy Airbus, Schnieder Electric, Safran and ASML holdings were not accounted, all of which delivered returns from 50%-200% in the corresponding period.

All three variants of GMV strategy performed identically well in the post financial crisis era which has been marked by the longest bull run in the history of financial markets. The Sharpe ratio of optimized GMV strategy (1.27) marginally trailed that of GMV (1.386) but significantly outperformed both equally weighted and capital weighted strategies, on the back of better returns and lesser volatility. Stocks such as Muenchener, Unilever, Iberdrola and Vivendi, collectively held more than half of the weight under GMV during the given period and delivered cumulative returns of more than 40%, while they represented only 6% in the market capitalization-based portfolio.

The COVID-19 pandemic has had an unprecedented effect on the financial markets worldwide. After falling about 39% since the pandemic outbreak, The Euro Stoxx 50 Index has recovered 26%, on the back of stimulus programs and capital injections from the European Central Bank. Markets globally have followed the suit, pointing towards a quick recovery and return to the boom times. However, data from recent earnings of corporates has been far from promising and any new shocks such as a second wave of COVID-19 could turn the tide. The path to return to all-time market highs seems long and harrowing and could follow a long spell

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of choppy trading conditions going forward. In light of the present market conditions, we present the following view on the markets which encompasses the performance of our strategy under the most likely market scenarios.

Exhibit 5: Investment Strategy Returns

During the Financial Crisis 2007-2011 - EUROSTOXX50								
	Annualized Return	Annualized Vol	Skewness	Kurtosis	Cornish-Fisher VaR (5%)	Historic CVaR (5%)	Sharpe Ratio	Max Drawdown
EW	-0.2506	0.281981	0.37519	8.380047	0.025386	0.041787	-0.173445	-0.564919
CW	-0.063562	0.283977	0.52882	10.037442	0.024276	0.04209	-0.284255	-0.571563
gmV	-0.03072	0.184482	-0.969035	10.719422	0.021441	0.03051	-0.157959	-0.587285
Shrinkage_gmv	-0.050515	0.182344	-0.828831	11.172226	0.020753	0.030364	-0.262829	-0.603417
Optimized_gmv	-0.077903	0.201591	-0.559796	11.19775	0.020966	0.031307	-0.386443	-0.593754
Post the Financial Crisis - Recovery phase 2012-2015 - EUROSTOXX50								
	Annualized Return	Annualized Vol	Skewness	Kurtosis	Cornish-Fisher VaR (5%)	Historic CVaR (5%)	Sharpe Ratio	Max Drawdown
EW	0.115172	0.193527	-0.001463	4.576084	0.019153	0.027629	0.595119	-0.193478
CW	0.09536	0.191411	0.000438	4.580987	0.019003	0.027187	0.498193	-0.198781
gmV	0.199533	0.143869	-0.041818	4.184799	0.014027	0.01996	1.38691	-0.107728
Shrinkage_gmv	0.189659	0.141841	-0.034504	4.284744	0.013816	0.019693	1.337121	-0.110394
Optimized_gmv	0.191809	0.150988	0.081614	4.327177	0.014419	0.02042	1.270362	-0.128739
Past 5 years Performance 2016-2020 - EUROSTOXX50								
	Annualized Return	Annualized Vol	Skewness	Kurtosis	Cornish-Fisher VaR (5%)	Historic CVaR (5%)	Sharpe Ratio	Max Drawdown
EW	0.070171	0.145911	-0.894422	13.827136	0.01499	0.020924	0.480917	-0.207526
CW	0.069939	0.140599	-0.793854	11.463907	0.014634	0.02038	0.497435	-0.212641
gmV	-0.007325	0.120558	-0.706211	10.105131	0.01285	0.017387	-0.060763	-0.186136
mv_sh_r	0.026505	0.118057	-0.686586	9.813633	0.012458	0.017036	0.224507	-0.136702
gmV_optimized	0.039339	0.120093	-0.738845	9.890275	0.012715	0.017172	0.32757	-0.125349



Exhibit 4 : Performance for weighting schemes in different phases over the last 15 years

We break down the scenario analysis into the Good, the bad and the ugly.

The Good Scenario: markets witness a quick V/ U shaped recovery on the back of US FED and ECB's continued support and stronger supply demand with easing lockdowns. We recommend a portfolio mirroring the **GMV variants** as seen between 2012-2015 (**Exhibit 4**) where rising employment and consumer disposable income contributed to the growth of low volatility high profitability stocks such as LVMH. Retail tourism and aviation sectors are among the worst affected and a quick rebound would allow stocks such as Airbus, LVMH and L'Oréal to replicate their past success post a recession.

The Bad Scenario: There is a permanent loss of both demand and supply and corporates take 2-3 years to resurrect their operations and supply chains. Unemployment in USA and Europe has touched record highs and irrespective of the recovery, it will be a challenging task for economies to bring back 40 million jobs in 12 months. A W-shaped recovery would be more likely, with choppy markets dominated by macro-economic events and success of the tools adopted by government and central banks, not to mention the outcome of global trade deals, especially involving China. The air of animosity regarding the US-China trade deal has dominated global financial markets in recent years (2016-2019). As illustrated from (**Exhibit 4**), a portfolio dominated by **market capitalization** of companies has proven to be the ideal strategy in such scenarios, since the size of operations and global supply chains of blue chips has traditionally allowed them to ride the uncertainty and downturn in any specific market, while small-mid size firms usually find it difficult in the event of disruptions of their operations in a key market.

The Ugly Scenario: Q1 turns out to be a glimpse of the impending crisis and markets witness a downturn similar to 2001, where US markets recovered 33% after initially falling 37% and then losing close to 50% of market cap. A fall in market returns would be almost inevitable in any of the strategies, however as illustrated by (**Exhibit 4**), the **sample GMV variant** had the highest Sharpe ratio in similar economic conditions as witnessed during the 2008 global financial crisis, which limited the downside along with the least amount of volatility.

Timing the markets is a tough ask. The probabilities are low, and the downsides are high. Financial laurels such as Nouriel Roubini have been pointing towards asset frothiness and weak fundamentals in the market for well over 5 years, crediting the success of the markets majorly to extended support by central banks and lower interest rates. We maintain a long-term view on the markets which should encompass at least one more complete cycle of all the recession and recovery. Based on the short-term scenarios the GMV model of portfolio management has delivered the best returns coupled with the lowest deviations and limited downsides. Optimizing the GMV sample to eliminate least efficient return-risk securities has amplified returns in the long run and we recommend this strategy with a time horizon of 10-12 years to maximize investor wealth and risk-return trade off in the current market.

3.0 Strategy, Computations and Assumptions

GMV with Sample Covariance Methodology

The basic GMV strategy possesses a remarkable practical implication without requirement for estimates on expected returns due to the sole objective of minimizing the risk.

Computations and Assumptions:

It can be expressed as: **Min (portfolio variance) = Sum of ($w_i * w_j * \sigma_{ij}$)**, where i and j denote the individual assets within the portfolio, and σ_{ij} is the covariance between the two assets. So in our computations we use the sample covariance matrix and assume that the returns are equal, we generate the ideal weights by finding the weights which generate the maximum Sharpe ratio by having constraints such as Sum of weights should be equal to 1 and weights should be in range of 0 to 1. The fact that this strategy does not require estimates on expected returns gives rise to the embedded assumption while conducting our subsequent computation that all assets have the same expected returns. Thus, by optimizing the risk-return trade off, the focus can be placed on minimizing the risk only.

As a result of basic GMV, the portfolio is heavily weighted on the constituents with low volatility. The essential benefit of this attribute is that it tends to be consistent with pension fund's preference on low risk tolerance as expected. However, the delivery of low risk portfolio might come with a relatively low performance related to its concentrated constituents.

GMV Shrinkage Methodology

The Shrinkage GMV strategy also possesses a remarkable practical implication without requirement for estimates on expected returns but considers a weighted average of Sample based covariance matrix & Constant Correlation Covariance Matrix, in order to reduce the number of computations and increase efficiency.

Computations and Assumptions:

So, we use the sample covariance and a constant correlation matrix, a trade-off between sample risk and model risk. The idea behind the shrinkage method is that, you're not going to have to choose either to go for higher sample risk or higher model risk, you are going to take two methodologies and you're going to mix them. Here we choose the delta optimally, in our case we assume it to be **0.5**, then we find the optimal trade-off. With this combination diversify away some of the sample risk and model risk.

Assumptions we make in this strategy are Sum of weights should be equal to 1 and the weight of each constituent should be in the range of 0 to 1.

$$\hat{S}_{shrink} = \delta^* \hat{F} + (1 - \delta^*) \hat{S}$$

Optimized GMV Methodology

The basic GMV strategy has been improved to Optimized GMV. Under the Optimized GMV, the objective remains to be a minimum portfolio variance, but a constraint is imposed on the minimum effective number of constituents (ENC). In this way, the assets with low volatility but not contributing to the actual portfolio returns are determined to be “ineffective” and are removed from the list of constituents.

Computations and Assumptions:

$$ENC \equiv \left(\sum_{i=1}^N w_i^2 \right)^{-1}$$

In an optimized GMV we calculate the ENC by taking an inverse of sum of squares of the weights of all the constituents in the Index portfolio. We then obtain a number which constitutes the exact number of companies which significantly contribute towards the returns in a portfolio.

Market-cap weighted (CW)

Market-cap weighted (CW) version of the benchmark is a buy-it-all strategy. Its main objective is to represent the stock market, not the ultimate efficiency in risk-return trade off. So, the cap weighting scheme leads to inefficiency. Since they are weighted in proportion to their market capitalization, larger cap stocks receive a higher weight allocation. The cap weighted benchmark appears to be a concentrated portfolio as a result of disproportionately large allocation to the largest cap stocks.

Equally weighted (EW)

Equally weighted (EW) version of the benchmark is naïve diversification, and under the equally weighted portfolio, also referred to as Maximum ENC portfolio. In this case, weights are equally balanced across portfolio constituents. However, a well-balanced portfolio is not equivalent to a well-rewarded portfolio, where being well-balanced simply suggests a spread of capital values across securities, not entirely the true objective of diversification as mentioned at the beginning of this section.