Minerva Investment Management Society
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For investment professionals only

MIMS – Multi Asset Global Opportunities Fund

Portfolio Management Team

Report – May 2022

Fund description

MIMS – Multi Asset Global Opportunities Fund is an actively-managed fund by Minerva Investment Management Society, based on environmental, social, and governance (ESG) criteria.

The ultimate goal of this portfolio is to achieve long-term growth whilst controlling volatility. To that end, this fund will be comprised of a multitude of securities with the possibility, in exceptional cases, to take short term speculative positions. Hedging positions might be implemented through financial derivative instruments. To ensure diversification, this virtual portfolio is spread across geographies, sectors and asset classes, and is built through fundamental analysis, ESG integration and macroeconomic views.

In total, the asset allocation will aim to include around 30 different securities with a changing risky component to take advantage of contingent market conditions. The dynamic asset allocation prevents us from using a reference benchmark. The portfolio will be rebalanced every six months, with exceptional reviews to position for market shocks. The holdings only include instruments from the public markets, spread across equity, fixed income, real estate and commodities. ETPs might be considered to take additional exposures to niche markets.

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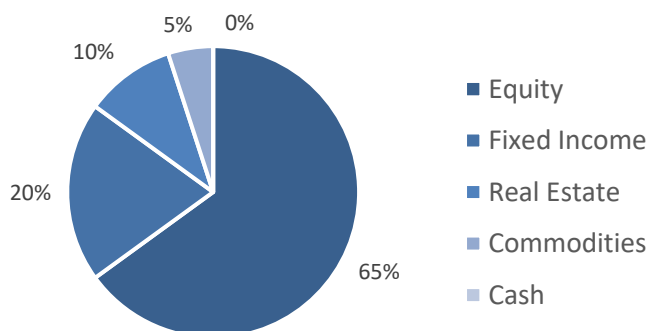
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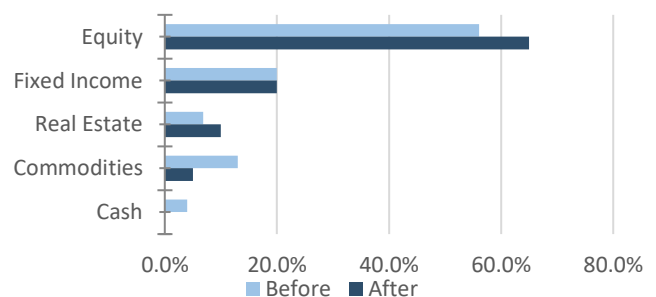Martina Perrone: +39 3334759395
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Asset class

- Equity
- Fixed Income
- Real Estate
- Commodities
- Cash

Results of the current rebalancing

Investment Approaches

| Top-down approach	Bottom-up approach	Research contribution
Starting from the macroeconomic outlook provided by the Macro Research Team, the Investment Team identifies appealing industries, geographies and asset classes for which the best-performing securities will be analyzed thoroughly. The Team applies a shared approach to the different asset classes by considering the main return drivers for any holding.	If a security stands out to one of the Investment Analysts, the suggestion is discussed with the Team and further analysis follows. Long-term growth potential combined with high ESG standards and limited risk downsides both on a micro and macro level are required to consider the investment.	The investment process uses internal research produced by the Research division of Minerva IMS. The Macro Team provides the outlook underlying the top-down approach. The Equity Team provides recommendations on potential stock holdings. Findings by the Markets and Alternatives Team are used for particular asset classes.

Performance since inception
30.11.2021 – 26.04.2022

€141,361.32
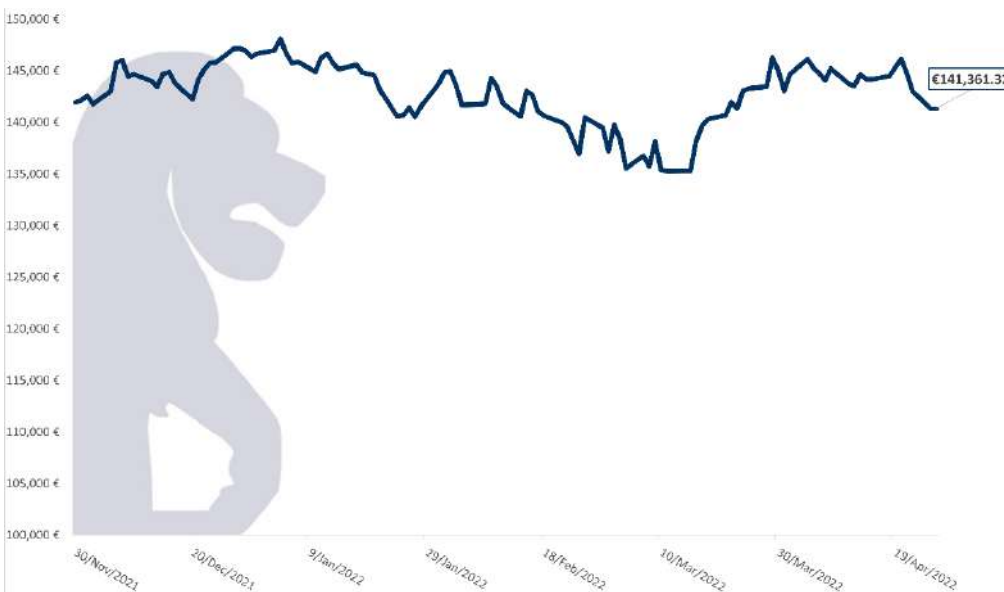
Initial holdings have been monitored since 05.12.2019 and additional ones have been introduced on 24.03.2020. The official starting date for the portfolio is 07.04.2020, a second rebalancing took place on 23.11.2020, a third on 10.05.2021 fourth on 30.11.2021 and the last on 26/04/2022. The analysis considered the cumulative gain over the entire period since inceptions. Any security is held only in a discrete number, stock dividends and bond coupons are reinvested at the end of the day in which payments are received.

The fund value is measured at the close of each trading day. Corporate events, dividend reinvestment and fund rebalancing are carried out at the market close.

Considering an initial value of € 100 000 at the market open of 07.04.2020, the portfolio reached a final cumulative value of € 146,361.32 at the close of 26/04/2022.
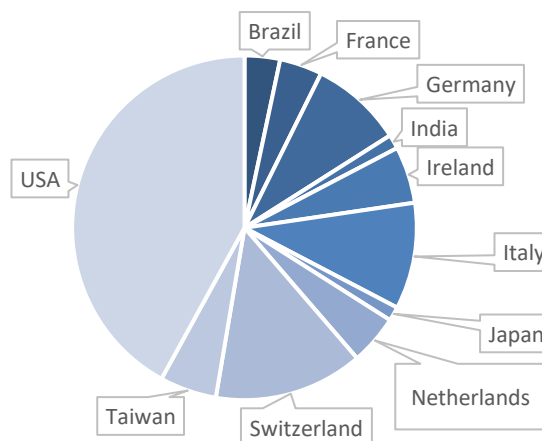
	1 month	2 months	3 months	Since inception	Daily Volatility	Sharpe Ratio
Multi Asset Fund	3.42%	1.12%	-3.46%	41.36%	0.94%	0.005

Top 5 Holdings

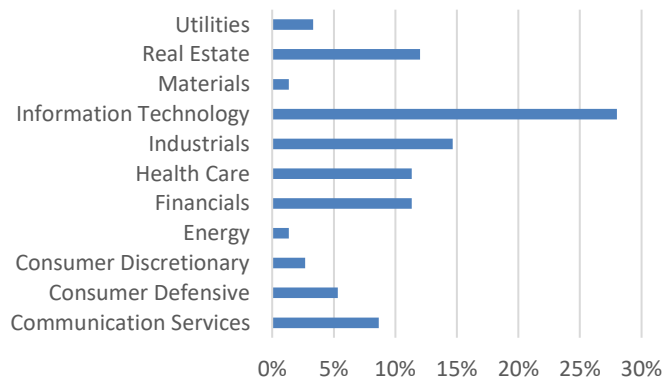| Security	Weight
RYANAIR	4.0%
TSMC	4.0%
SAP	4.0%
UBS	4.0%
NOVARTIS	4.0%

Note: the weights are a product of a mean-variance optimization where stock allocations are capped at 10% of the Equity portion.
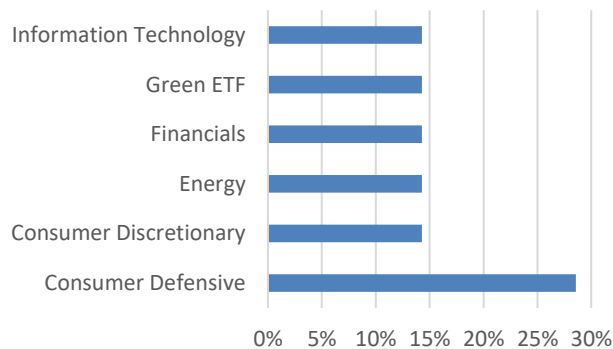
Geographical Asset Allocation

Sector breakdown

Equity

Bond

Chubb Limited (CB)

This semester the multi-asset fund has adopted a value Investing strategy coupled with geo-political risk reduction. The aim of the new allocation is to benefit from undervalued companies while further diversifying the industry exposure of the fund. The strategy was chosen to navigate the current period of high volatility and geo-political risk many countries and companies are experiencing.

In the equity space we focused on selecting financially strong companies with a proven track record of excellent financial and supply chain management. Six new companies are introduced each belonging to a different sector. **Ryanair Holdings plc (RYA.IR)** is the only European carrier who has hedged 80% of its exposure at approximately $65 per barrel, making it the most hedged airline in Europe. **Taiwan Semiconductor Manufacturing Company Limited (TSM)** holds 65% of the global production of semiconductors. **Costco Wholesale Corporation (COST)** offering its members low prices on a limited selection of nationally branded and private-label products in a wide range of categories allows them to produce high sales volumes and rapid inventory turnover. **Chubb Limited (CB)** is a leading global insurer serving customers from the largest multinational companies to individuals and families around the world. Finally, **InMode Ltd. (INMD)** designs, develops, manufactures and markets minimally invasive aesthetic medical products and boosts 46% of profit margin. All six companies have been screened to ensure compliance of ESG criteria in line with the spirit of the fund.

In the **fixed income** part of the portfolio no additions were made. The reason for this choice is double, first the allocation was studied in detail during the previous rebalancing to reflect a long-term view, second, we expect imminent interest rate hikes which could negatively impact existing bonds. We plan to change our allocation when policies from the ECB and FED have been clearly defined.

Disinvestment Cases & Asset Classes Overview

Equity

To finance our current rebalancing strategy, we disinvest in stocks which eroded their growth opportunities in years or did not confirm their disruptive potential in the last months.

We currently consider **Matterport (MTTR)** a risk for our cumulative return as the expected growth of the digital space industry has not yet materialized and the market has been extremely unfavorable to the stock

We then disinvest from **Anhui (600585.SS)** given the continuous increase in the company debt. We aim with the choice to reduce our exposure to the Chinese property market.

Finally, we disinvest from **Italgas (IG.MI)** for two main reasons. The first is due to the previous excessive exposure to the Italian market. The second because we aim to reduce exposure to the utility sector.

Commodities

We maintain our allocation in commodities, except for **Crude Oil** which we now decide to cut from our portfolio (from a relative weight of only 1%). The reason why we decide to cut this investment is strictly connected with our idea of green transition and dynamic world change to renewable energies and in particular hydrogen but also **Lithium** and **Nickel** where you can find a specific analysis at the end of the report.

Bond & Real Estate

In the bond space we highlight the expiration of the China Rail bond which matured on 30/12/2021. No changes were made to the REITs composition.

Chubb Limited (CB)

Company overview

Chubb is a leading global insurer serving customers from the largest multinational companies to individuals and families around the world. Chubb maintains executive offices in Zurich, New York, London, Paris and other locations, and employs approximately 31,000 people worldwide.

The company took its present form in 2016 when ACE Limited acquired the Chubb Corporation, creating the world's largest publicly traded property and casualty insurance company.

Chubb Ltd. is a holding company, which engages in the provision of commercial and personal property and casualty insurance, personal accident and accident and health (A&H), reinsurance, life insurance, fire and marine insurance.

Chubb's core operating insurance companies maintain financial strength ratings of AA from Standard & Poor's and A++ from A.M. Best.

Financials

By analyzing the company's financial statements, it is possible to identify a continuous earnings growth trend, a high ROE and a strong balance sheet. Last year the company showcased an earnings growth of 147.3% and over the span of 5 years it has shown an overall 16.77% earnings growth.

CB's Dividend Payout Ratio is ranked higher than 85% of the Companies in the Insurance industry with a current level of 0.16.

Chubb has more than $190 billion in assets and reported $41 billion of gross premiums written in 2020.

A closer look at the balance sheet allows us to observe the conservative capitalization of the company and the low leverage.

Dividend Payout Ratio Industry Distribution
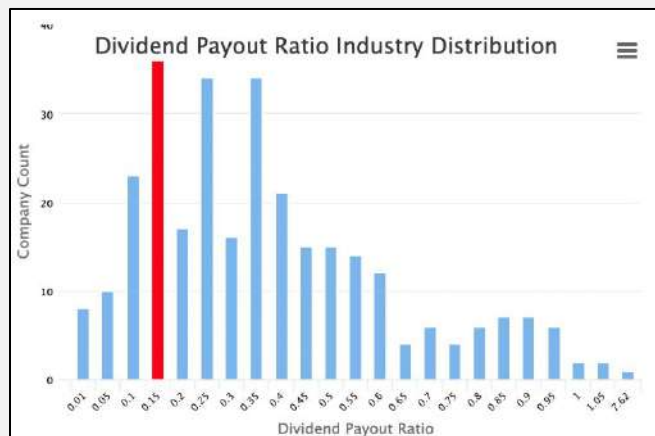
InMode Ltd. (INMD)

Company overview

InMode Ltd. designs, develops, manufactures and markets minimally-invasive aesthetic medical products. It also designs, develops, manufactures and markets non-invasive medical aesthetic products that target an array of procedures including permanent hair reduction, facial skin rejuvenation, wrinkle reduction, cellulite treatment, skin appearance and texture and superficial benign vascular and pigmented lesions.

As we well know the beauty market is heavy influenced by celebrities. Companies pay millions for a familiar face to endorse their product and drive sales. But what if celebrities use a company's product without endorsement, as it happens with InMode? There is only one way for this to happen: that product or service is the best available.

InMode's services have been used by multiple celebrities. The list includes Chrissy Teigen, Emma Roberts, and Britney Spears.

It's great that the research team is continuously developing new products and that demand for these products is constantly increasing. InMode's products are immune to crises; even during the pandemic, despite fears that it would impact the business, InMode achieved record results quarter after quarter.

Financials

InMode is a company with positive revenues and profits that have been growing steadily since 2018. In 2021 its revenue increased by 73.5% compared to last year. While its profits increased by 120%. Thanks to its technologies with sustainable cost advantages, its gross margins are at 85%. EBITDA and profit margins are respectably 46.8% and 46.1% which are considered very high!

Revenues is expected to grow by around 20% and profits by around 5%. We have reason to believe that these expectations will be beaten. If we see the outlook made in the investor relation of 2020, the expected revenues for the end of the year 2021 was of about 250/260 mln. and in the end, they recorded revenues of 360 mln. InMode has recently released its expected first quarter results, which are revenue of 85 to 85.5 million and has already beaten the previous expectations of 80 million revenue.

InMode's target price is 82 USD and recently its price fell to 27.5 USD which is below the 52W Range (33.11- 99.27).

Because of the big decline in the share price, its p/e is now 15 and the forward p/e is 13. Furthermore, InMode has very high ROA (40%), ROE(46%) and ROI(39,5%) which is great and shows that it's a well-run company. Finally, its P/B is 7.5x which indicates the company is conservatively priced vis-à-vis the fundamentals especially considering the fast growth it is experiencing.

InMode's has a solid balance sheet. It has constantly increased cash and right now, it has 457 Mln. of cash which is more than 10% of its market capitalization. In addition, InMode's short term assets (470 Mln.) exceed its short (52 Mln.)- and its long-term liabilities (10.9 Mln.).

Management

The management has a solid track record. In fact, the average management tenure is 9.8 year and Mosche Mizrahy, who is the the CEO (68yo), has a tenure of 14.25 yrs. and owns 2.4% of InMode. Total insider ownership is 17.5%.

In the past, InMode has done share buybacks and recently announced a share repurchase programme of up to 1M shares.

Ryanair Holdings Plc (RYA.IR)

Company overview

Ryanair is an airline operating in the European region and is headquartered in Ireland, where it was also originally listed on the ISE. The company operates in the short-haul business and employs an aggressive low-cost strategy that allows it to obtain higher margins than the average players in the industry, while also capturing the attention of consumers, which tend to sacrifice loyalty for a discount on tickets.

While the main company revenue source consists in ticket revenue, up to half of total revenue can be made up of ancillary service revenue.

Ryanair has been consistently the most profitable airline in the region for the past years and now we believe that it could be a good moment to take advantage of an investment opportunity. At the moment, the geopolitical conflict in eastern Europe heavily hit travel and passenger flows. At the same time, fears over supply chain disruptions over heavy metals and energy sources have boosted market prices. This has incredibly fed into the already existing inflationary pressure, but it has also complicated the operations of airlines. Indeed, the major component in their cost structure turns out to be jet fuel, which follows the behavior of oil. As a consequence, airlines find themselves in a situation with less clients and higher costs. It does not seem particularly bright. However, this is exactly why we shall focus on them as the causes of turmoil all strictly depend on a single geopolitical event unlikely to prolong in the long-term. In particular, we shall focus on Ryanair, which is a structurally strong player and has shown steady recovery from the beginning of the pandemic up until the beginning of the war. According to the company, in March 2022 the registered number of passengers was 11.2Mln, well above FY2019 and FY2018 data. The loading factor also recovered up to 87%, still below 2019 counterparts but gradually catching up.

With respect to the cost component, Ryanair has been hedging its oil exposure. For the year 2022, Ryanair has hedged 80% of its exposure at approximately $65 per barrel, making it the most hedged airline in Europe.

Financials

Solvency

The interest coverage has been solid throughout the years with FY2020 EBIT/Interest Expense of 15.47.

D/E ratio for FY2021 stood at approximately 1.65 and its most recent credit rating is BBB by S&P.

It's important to point out that some of its key competitors show D/E ratios of 4 (Wizz Air), 2.7 (EasyJet), ~40 (IAG), 9 (Lufthansa) and Air France KLM has been showing negative shareholder's equity for the past 2 fiscal years. The highest comparable interest coverage ratio for a suitable time frame is 7.77 (EasyJet).

Profitability

Ryanair's ROE for FY2020 was 12.81% but climbed up to as high as 32.62% in FY2018.

Its Net Income Margin for the most comparable time frame is the highest among the aforementioned comparable companies.

Liquidity

The overall cash flow was actually positive at the aggregate level including financing and investing activities.

The standard cash ratio for FY2021 corresponds to about 0.75, higher than its standard competitors but lower than its low-cost counterparts. Current and Quick ratios are also in line with the industry.

The conflict may have presented an interesting opportunity, with potential upsides of up to 30% from the announcement of the conflict with respect to current market valuation.
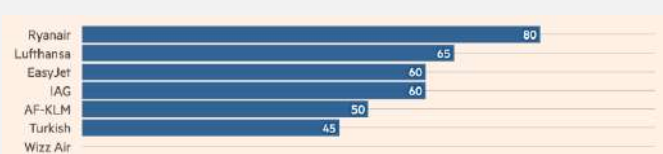
Oil Hedging by company – Source FT.com

TSMC Ltd (TSM)

Company Profile

TSMC is the global leader in the production of the most advanced semiconductor components.

The product range is quite extensive, and it includes chips for smartphones, high performance computing (graphics cards and microprocessors), Internet of Things (high connectivity products with AI enhancing capability), automotive electronics, digital consumer electronics (TVs, digital cameras...) and others. Its clients are based in multiple geographies around the world and include the likes of Nvidia, AMD, Intel, Broadcom and Qualcomm.

The company is estimated to hold around 60-65% of the global production of semiconductors and it competes with other players with fully operating foundries like Samsung, UMC, SMIC, GlobalFoundries and integrated device manufacturers (IDMs) like Intel.

Due to the infamous supply chain disruption, the company has been at the center of the matter and with the evolution and huge capital investments in the sector, semiconductor manufacturing is likely to increase.

TSMC trades both on the TWSE and NASDAQ. Its last price was $104.79 (NSDQ:TSM), down 26% from the highs of January 14 2022.

Valuation (Data still sourced from Capital IQ Pro)

TSMC has an Enterprise value of $516.7Bln, the current EV/EBITDA over the last twelve months was 13.79, its P/B stands at 7.04 and its P/E for the last 12 months was 25.6.

Its next twelve months EV/EBITDA is forecasted to be 10.83, its PE to be 19.34 and its P/B to 5.66. All multiples, clearly assuming a rather constant valuation metric, are forecasted to decrease in the years to come. In almost all categories, TSMC seems to be relevantly more expensive than the comparable companies, with the exception of GlobalFoundries, which is in line with TSMC. The abnormally high PE ratio of TSMC is due to the huge number of outstanding shares (25Bln) against, for example, Intel's 4Bln shares. Their Net income was approximately the same for FY2021.

Outlook

The future of the semiconductor sector from the manufacturing perspective is nothing but bright.

Fintechs, NFTs, AI driven vehicles, Smart-homes and even ESG advancements to reduce carbon footprint may all consistently maintain or increase demand. The quantity of funds being channeled into the industry is also massive with players like Intel and TSMC investing a total amount of ~$180Bln in expansion, R&D and similar areas. National authorities are also stepping up their capital as both the European and U.S. Chips acts will bring an additional ~$100Bln to be split in the two regions for the internalization of production. This all indicates a strong interest and future growth into the sector.

TSMC is also planning to launch new state-of-the-art 3nm chips in 2022 and is already working on the development of 2nm technology. Its sheer size and deep pockets make its position similar to a monopolist.

Risks

The main risks to be identified are the sudden decline in demand for semiconductors which seems rather unlikely and the rise of strong competitors that could disrupt the market share of the company. As previously stated, Intel and Samsung are both planning to launch or spin-off their foundry divisions in order to scale up proper production. However, Intel's foundries will not be fully operational in the short term, as the average state-of-the-art foundry needs 3-4 years to become fully operational. Moreover, Intel needs to radically change its business model as well from an IDM to a foundry, thus many uncertainties are related to the project.

Samsung on the other hand already has a foundry and even if it's considering spinning it off, it has been around for a while but production is nowhere near TSMC, who is constantly investing in new technologies, machines and never lagging behind technological change.

Other two external factors that could cause issues to the company may be the lack of talent, which is actually essential in the production cycle and eventual political tensions with China and the eventual fear of a conflict.

Nevertheless, in an average scenario, TSMC has nothing to fear.

Costco Wholesale Corporation (COST)

Company overview

Costco is a membership warehouse club, dedicated to bringing its members the best possible prices on quality brand-name merchandise. With hundreds of locations worldwide, Costco provides a wide selection of merchandise, plus the convenience of specialty departments and exclusive member services.

Today the corporation reports 828 locations, located worldwide, that generated more than $192 billion in sales for FY2021.

The concept of offering their members low prices on a limited selection of nationally branded and private-label products in a wide range of categories allows them to produce high sales volumes and rapid inventory turnover. This, when combined with the operating efficiencies achieved by volume purchasing, efficient distribution and reduced handling of merchandise in self-service warehouse facilities, enables them to operate profitably at significantly lower gross margins (net sales less merchandise costs) than most other retailers and, as a consequence, to constantly increase its market share and consumer loyalty. The latter has allowed Costco to become a household name within the communities in which it operates. This "share of mind" enables the company to be one of the main sources through which manufacturers prefer to sell their products to the public, hence allowing Costco to leverage them by stipulating contracts whose terms allow the retailer to pay for the products even after months from the effective sale.

In addition, because its consumers are primarily attracted by the quality of merchandise and low prices, their warehouses are cheap and not elaborate. Moreover, their warehouses on average operate on a seven-day, 70-hour week. Because the hours of operation are shorter than other retailers, and due to the additional cost efficiencies mentioned above, labor costs are lower relative to the volume of sales.

Costco also differentiates itself in its inventory policy; indeed, it sells under 4000 different products per-warehouse (the industry average is well above 12000). Thus, seeking to limit most items to fast-selling models, sizes and/or colors.

What truly makes Costco's business model work is its membership program. Indeed, it is not allowed to shop inside its warehouses without one (unless by paying a "nonmember tax" each time). There are 3 types of memberships, each differs by the nature of the costumer. These fees are $60 on average per year and are essential for Costco. In fact, they make more than 50% of its yearly profits. Basically, that is how the company is able to successfully profit while selling high quality items at low prices. It has also proved to be highly appreciated by customers (the last yearly data shows a renewal rate of 89%). It also allows Costco to retain talent by avoiding to pass the burden of low-priced items to its employees' salaries (highest expense after the cost of goods sold).

Financial Analysis

Considering that Costco is a warehouse retailer its profit margin is not satisfactory from a nominal point of view. Nevertheless, it is 2.60% that, if compared with the average 2.27% of its main competitors (Walmart, Target and Kroger), is certainly satisfactory.

The really attractive metric is the return on invested capital which is 27.93%. It is even more attractive if we notice that this is a business which keeps growing at an average rate of 8% per year. Conversely, its competitors stand at an average return on equity of 15%.

Additionally, Costco uses very little debt. Indeed, its Debt-to-Equity Ratio is a mere 34.29%. Its competitors are not very indebted either, but still show worse figures than Costco. They average a D/E Ratio of 55%.

Verizon Communications Inc (VZ)

Company Profile

Verizon Communications Inc. is a holding company. The Company, through its subsidiaries, provides communications, information and entertainment products and services to consumers, businesses and governmental agencies. Its reportable segments are Verizon Consumer Group and Verizon Business Group.

In 2015, Verizon expanded into content ownership by acquiring AOL, and two years later, it acquired Yahoo! Inc. AOL and Yahoo were amalgamated into a new division named Oath Inc., which was rebranded as Verizon Media in January 2019, and was spun off and rebranded to Yahoo after its sale to Apollo Global Management.

For more than 20 years, Verizon has been in the top 20 in the Fortune 500 listings of corporations in the United States by total revenue.

Financial Analysis

By analyzing the companies' financial statement, it is possible to identify particularly high margins (both operating and net) compared to its main competitors such as AT&T (respectively c.a. 23% and 15% vs 11% and 5.5% in the last 3 years).

Moreover, the company's attractive earnings multiples are brought to light by a P/E ratio at 10.13 for the current year.

In addition, the company is a great yield company with consistent high dividend expectations.

Finally, Verizon's 29.9% ROE (compared to AT&T's 15%) also demonstrates a profitable usage of the shareholders' money. This may due also to the high leverage (and consequent debt position) that the company holds, which rises some questions on the financial soundness of the company. However, in the following years, the company expects a reduction in debt and a higher EBITDA that would guarantee a more sustainable growth.

Justification of the recommendation

Given the current environment with a very volatile and uncertain market, a low-beta stock may be a wise choice. Moreover, the company has a low PTB ratio, suggesting that the stock has a potential upside to be exploited. In addition, the ESG risk is considered to be also well managed by the company. For this reason, Sustainalytics attributes an 18.3 (or Low Risk) score.

On the other hand, the poor financial situation in the past years combined with a low revenue growth suggest being cautious and to consider potential risks too in the overall evaluation.

FOCUS: Commodity strategy

At the moment Minerva holds 5 commodities in its Multi Asset Global Opportunities Fund, namely Copper, Crude Oil, Gold, Nickel and Lithium.

The current geopolitical scenario jointed with the economic recovery from the pandemic and the essential accelerated ESG transition have all contributed to the current market volatility on the aforementioned asset class.
Our strategy focuses on strong ESG rationale and especially common sense.

Crude Oil

We suggest a rebalancing on the portfolio cutting Crude Oil and underweighting Gold for contrasting reasons. Crude oil (Brent and WTI) has recently met all-time highs due to the Ukrainian conflict. Consequently, it would be wise to exit the position at a surplus before the geopolitical situation stabilizes and trading resumes. Moreover, Oil is increasingly being condemned as a dirty asset on which the West depends to much. Thus, the decarbonization has sped up its pace.

Gold

With respect to gold, we take a long-term perspective in the interest rate environment. Being considered as a safe haven when inflationary pressures are tight, it could turn out to be useful in the short-term, but with normalization and incoming QT and interest rate hikes, investors may look for more appealing investment opportunities. We allocate 1% to Gold.

Green transition metals: Introduction and Nickel

Finally, with regards to Copper, Nickel and especially Lithium, the situation is more complicated. These three commodities are very useful for the green transition. With the bullish rally and inflationary pressures their price has experienced a gargantuan increase over the short term. According to Trading Economics, while Copper and Lithium have been experiencing a bullish trend since mid-2020/early-2021, Nickel has experienced a tremendous jump due to the announcement of the war, leading to its trading suspension on the LME. As a consequence, we would underweight Nickel given the correlation of its volatility and the current geopolitical scenario. We allocate 1% to nickel.

Lithium

With regards to Lithium, the material is definitely necessary for digitalization and batteries, which in turn are fundamental for the EV industry. However, the price rally has begun to show some weakness starting in March, moving in a flattened pattern. Supposedly, this is due to the fear of prohibitively high prices for EV producers and in turn for consumers. Even if the rise of green alternatives and reduced supply in the industry make lithium very appealing, the aforementioned topic could suggest an underweight of the current holding. We allocate 1% to Lithium.

Copper

On the other hand, Copper seems to be holding relatively well even if it finds itself at all time highs. The conflict seems to have sparked only a 10% increase which was later corrected and stands at 5% since the declaration of the war. As a consequence, if an exposure into transitory metals is requested, an EW could be suitable for the commodity at hand. We allocate 2% to Copper

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Quantitative Research Team

Risk Report – May 2022

Introduction

The main objective of this section is to assess and quantify the risk embedded in the Minerva IMS Multi Asset Global Opportunities Fund built by the portfolio team. We use a daily perspective on the potential extreme behavior of a basket of assets selected by the portfolio analysts. The analysis will include three VaR and ES models (two parametric and one non-parametric) and a Black-Litterman model for optimal allocation.

Our focus is the estimation of the two main risk indicators:

- The daily Value at Risk (VaR): the maximum portfolio loss that occurs with α% of probability over a time horizon of 1 day. For instance, if the VaR (α=5%) = -3.00%, it means that tomorrow there is a 5% probability of encountering a loss in the interval [-100%, -3.00%] potentially;

- The daily Expected Shortfall (ES): the expected return on the portfolio in the worst α% of cases. So, it is just a mean of the returns lower than the VaR.

A simple technique to estimate these two measure is based on a historical approach: given a time series of returns of a financial security, we can easily compute the desired quantile of the historical distribution to estimate the VaR, and, after that, estimate the ES just by averaging the values below this threshold.
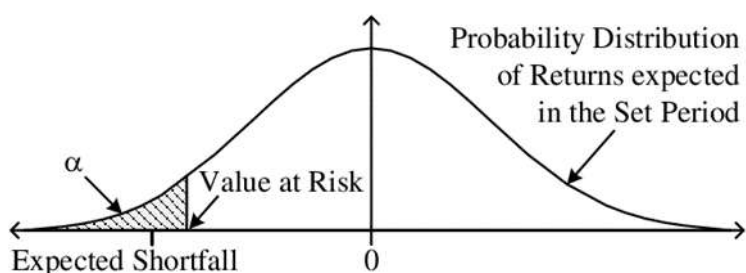
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However, this naive approach is not well suited for our purpose: in fact, by considering our portfolio as a single financial asset, we are losing all the information that comes from all the components; moreover, with this approach we are simply focusing on the past behavior of the fund, while our main goal is to retrieve a risk metric for the future possible trends.

In order to overcome these issues, we propose two alternative techniques that provides better risk estimates:

• Parametric approach (simple approach and time-series modelling approach)
• Bootstrapping

The first method is very well suited for understanding the main vulnerabilities in the portfolio composition, while with the second one it is possible to observe how the metrics varied in the past quarters.

For both pieces of analysis, we used daily market prices of portfolio constituents for the past six months. All the analysis has been conducted with Python.

Parametric approach

In this section we propose to analyze VaR and ES separately for each asset included in the portfolio and then, to estimate the VaR and ES for the whole fund by taking into account the correlation between portfolio constituents.

Parametric approach is based on the assumption that returns of a financial security follow some theoretical distribution. Thus, VaR and ES can be expressed as an α-percentile of the distribution. The crucial step to accurately estimate VaR and ES is to select the appropriate distribution of returns and estimate it's parameters.

It is possible to state that stock returns do not follow Gaussian distribution due to the presence of "fat tails": unexpected events might have a huge impact on the stock prices, so it is possible to observe extreme values more frequently than a Normal distribution would predict. For this reason, we assume that stock returns follow a Student-t distribution, thus, the parameters to be estimated are the mean μ, volatility σ and number of degrees of freedom ν.

To obtain more valid and robust results, we proceed with two alternative parameter estimation approaches – (a) simple approach, and (b) time-series modelling approach. For all parts of analysis, we use the last 100 return observations, which correspond almost to 4-months window.

Simple approach

Under the simple approach, we estimate the above-mentioned parameters in the following way:

1. We assume that the mean historical daily return of each security are a good estimate for the expected future return. Thus, μ is estimated as a simple average of daily returns.

2. Volatility of returns σ is calculated as a simple standard deviation of returns.

3. Number of degrees of freedom ν is selected in a way that it best approximates the empirical distribution of returns. In order to do that, we used the Kolmogorov-Smirnov statistic that, for a given empirical cumulative distribution function F and a proposal Fn, is:

$$Dn = \sup x |(Fn - F)|$$

Ideally it should be equal to 0 for a perfect fit, so our goal is to minimize it by proposing different ν for Student-t distribution.
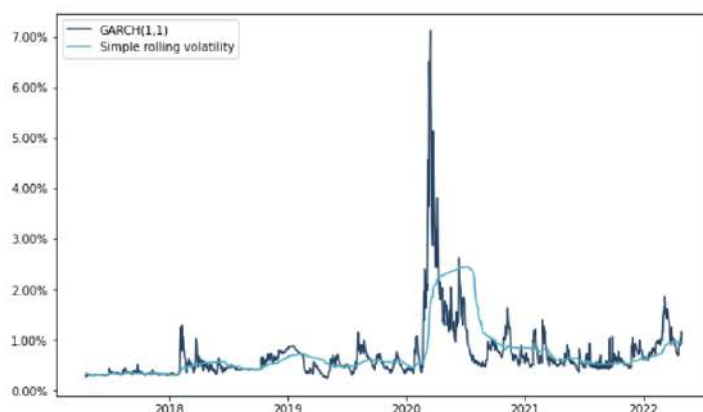
Time-series modelling approach

Because the volatility of returns is not constant over time, it is often modelled by conditional heteroscedasticity processes. The most common way to model volatility is through a Generalized Autoregressive Conditional Heteroscedasticity model GARCH(p,q), where the forecast of the next-period volatility depends on the previous p shocks to stock returns (derived from some mean model) and previous q forecasts of volatility:

$$\sigma_{t+1|t}^2 = \omega + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j+1|t-j}^2$$

The advantage of GARCH model is that it allows to better estimate the current forecast of return volatility by putting more weight on more recent information. Thus, in the periods of market turbulence GARCH model will produce higher volatility forecasts than the simple average of squared deviations from the mean (see the graph at the bottom).

Because the portfolio is composed exclusively of equity instruments traded on liquid markets, we can assume that prices are efficient, and thus returns can be described by a constant mean model for GARCH(p,q) process, which implies that current mean estimates do not depend on previous returns or shocks. GARCH(p,q) then is estimated by Maximum Likelihood (MLE), which optimizes the distribution parameters. We subsequently use MLE estimates of distribution to derive VaR and ES.

Parametric approach (continued)

Value-at-risk

Once the parameters of stock returns are known, it is possible to calculate VaR. We estimate the VaR for 95% and 99% confidence level by applying the following formula:

$$VaR_\alpha = \sigma * T_\nu^{-1}(\alpha) + \mu$$

where σ is the estimated volatility of a security, $T_\nu^{-1}(\alpha)$ is the α-percentile of a Student-t distribution with ν degrees of freedom, and μ is the expected return of a stock.

Expected shortfall

Expected shortfall is defined as a conditional expectation of loss, given that the loss occurred. If we introduce the assumption of a continuous distribution of returns of a security, then parametric expected shortfall is simply defined as a tail conditional expectation, and thus can in general be defined by the following formula for any security X :

$$ES_\alpha(X) = -\frac{1}{\alpha}\int_0^\alpha VaR_\gamma(X)\,d\gamma$$

Under the assumption of Student-t distribution with ν degrees of freedom it can be proven that the expected shortfall would be given as:

$$ES_\alpha(X) = \sigma * \frac{\nu + \left(T_\nu^{-1}(\alpha)\right)^2}{\nu - 1}\frac{\tau_\nu\left(T_\nu^{-1}(\alpha)\right)}{\alpha} + \mu$$

where σ is the estimated volatility of a security, $T_\nu^{-1}(\alpha)$ is the α-percentile of a Student-t distribution with ν degrees of freedom, $\tau_\nu(\cdot)$ is the probability density function of Student-t distribution with ν degrees of freedom and μ is the expected return of a stock.

We estimate the ES for 95% and 99% confidence level.

Portfolio VaR and ES

Considering the correlation between the stocks, we estimate the VaR and ES of the whole portfolio for 95% and 99% confidence level by applying the following formulas:

$$VaR_{\alpha,ptf} \approx \sqrt{VaR_\alpha * \rho * VaR_\alpha{'}}$$
$$ES_{\alpha,ptf} \approx \sqrt{ES_\alpha * \rho * ES_\alpha{'}}$$

where VaR_α and ES_α are column vectors of individual stock VaR and ES, respectively and ρ is the correlation matrix between securities

The approximation arises because of the assumption of Student-t distribution of returns – the formulas above become an equality the closer the distribution of returns is to the Gaussian.

Results

GARCH results appear to be more conservative than the simple approach ones. Indeed, while simple approach equally weights all observations, GARCH puts more weight on the most recent observations, thus, it better estimates the future volatility and allows to produce more reliable risk metrics.

	Simple approach	GARCH
VaR$_{95\%}$	-1.27%	-1.84%
VaR$_{99\%}$	-1.83%	-3.01%
ES$_{95\%}$	-1.62%	-2.60%
ES$_{99\%}$	-2.13%	-3.94%

TOP & BOTTOM 5 stocks (GARCH)

	VaR 95 (GARCH)	VaR 99 (GARCH)	ES 95 (GARCH)	ES 99 (GARCH)
Volkswagen bond	-0.08%	-0.13%	-0.11%	-0.16%
Intesa SP bond	-0.57%	-1.02%	-0.87%	-1.44%
Apple bond	-0.77%	-1.15%	-1.01%	-1.38%
Total bond	-0.95%	-1.37%	-1.21%	-1.61%
Target Corp bond	-0.97%	-1.41%	-1.24%	-1.67%

	VaR 95 (GARCH)	VaR 99 (GARCH)	ES 95 (GARCH)	ES 99 (GARCH)
ASML Holding NV	-5.95%	-9.15%	-7.96%	-11.17%
Micron Technology Inc	-5.67%	-9.28%	-7.99%	-12.04%
Ryanair Holdings plc	-6.54%	-10.91%	-9.37%	-14.44%
PLD	-8.21%	-12.91%	-11.18%	-16.08%
InMode Ltd.	-9.36%	-14.98%	-12.93%	-18.97%

TOP & BOTTOM 5 stocks (simple approach)

	VaR 95	VaR 99	ES 95	ES 99
Volkswagen bond	-0.05%	-0.07%	-0.07%	-0.09%
Intesa SP bond	-0.30%	-0.43%	-0.38%	-0.49%
Apple bond	-0.54%	-0.75%	-0.67%	-0.86%
Lyxor Green Bond ETF	-0.66%	-0.94%	-0.83%	-1.08%
Target Corp bond	-0.68%	-0.96%	-0.85%	-1.09%

	VaR 95	VaR 99	ES 95	ES 99
ASML Holding NV	-4.29%	-6.40%	-5.60%	-7.64%
Micron Technology Inc.	-4.38%	-6.38%	-5.61%	-7.47%
Ryanair Holdings plc	-4.51%	-6.51%	-5.74%	-7.58%
Taiwan Semiconductor Manufacturing Company Limited	-5.87%	-8.21%	-7.23%	-9.51%
InMode Ltd.	-6.89%	-9.54%	-8.44%	-11.02%

Bootstrapping

When estimating a certain metric, one of the main problems in Statistics is the lack of the whole population data and the consequent use of only a sample. In our case the population data is the complete historical price data of the securities that are part of our portfolio, in which we only have the data of recent years.

Bootstrapping is a statistical technique that by having only a sample of the population data, provides estimates of statistical metrics that are closer to the ones obtained from the population data.

Given a sample of size n, implementing bootstrap is very simple:
• Sample with replacement n times from the original sample (note that one observation could be selected more than once);
• Compute the metric of interest (in our case the VaR or ES) on this newly created sample and save it;
• Repeat the previous steps M times with M→+∞ (we have selected M=100.000 for instance);
• Average and compute the standard error of the metrics estimated in each step.

With this method, by estimating the expected shortfall and the standard errors, we can retrieve a more insightful view of our portfolio, but in this case, we are losing the risk contribution of each stock that we had in the previous case.

	Estimate	Standard error
VaR$_{95\%}$	-1.26%	0.14%
VaR$_{99\%}$	-2.13%	0.37%
ES$_{95\%}$	-1.72%	0.18%
ES$_{99\%}$	-2.36%	0. 28%

Quarter analysis

Thanks to this method, we can take a look at the evolution of our metrics of interest (Expected Shortfall and VaR) in the past three years:
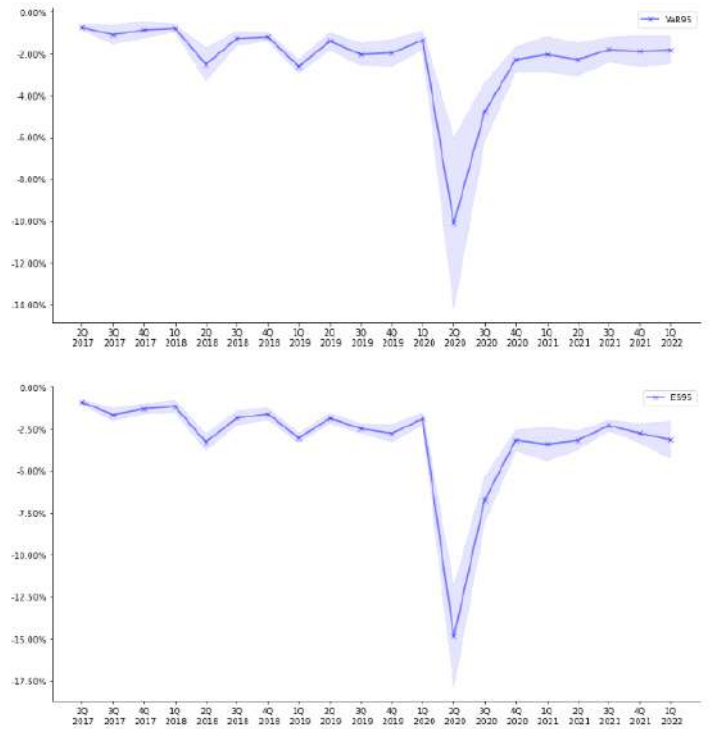
Black-Litterman weights

AIR.PA	3.00%	UBSG.SW	4.00%
GOOGL	3.00%	NEXI.MI	3.50%
AAPL	3.00%	CMI	4.00%
ASML.AS	3.50%	BIP	1.00%
BAYN.DE	2.50%	NVS	4.00%
DIS	1.50%	VZ	2.00%
ENI.MI	1.00%	RYA.IR	4.00%
ISP.MI	2.00%	TSM	4.00%
MU	3.00%	CB	2.50%
MONC.MI	1.00%	INMD	2.00%
NEOE3.SA	2.50%	COST	3.00%
NESTLEIND	1.00%	EQUIX	2.50%
SAP.DE	4.00%	EQR	2.00%
TM	1.00%	PLD	1.50%
CTRE	2.00%	SAFE	1.00%

Black –Litterman model

Introduction

The Black-Litterman asset allocation model, created by Fischer Black and Robert Litterman, is a sophisticated portfolio construction method. The main trait that distinguishes the model is the Bayesian approach that is embodied in the inclusion of investors' expectations on future returns in building an optimal portfolio. Unlike the Markowitz optimization, in which return is maximized for a given level of risk, the Black-Litterman model combines the subjective views of an investor regarding the expected returns of one or more assets with the market equilibrium vector of expected returns to form a new estimate of expected returns. The resulting new vector of returns leads to intuitive portfolios with sensible portfolio weights.

Inputs

To compute the portfolio composition, the model requires specific inputs. Some of them are common to other optimization models, like the expected excess returns and the variance-covariance matrix. In addition, we have:

- **VIEWS**: each investor has its own expectations about excess returns, which may deviate from the implied market ones. Views can be expressed in either absolute terms (Disney will have an absolute excess return of 5.25%) or in relative terms (Microsoft will outperform Apple by 2%). On the mathematic perspective, views are represented by a column vector with each element corresponds to a absolute/relative returns.

- **PICKING MATRIX**: this crucial element allows us to link each view to its corresponding asset. Mathematically, we have a matrix whose rows express the different views: absolute views have a single 1 in the column corresponding to the ticker's position, whereas relative views have positive numbers in the nominally outperforming asset columns and negative numbers in the nominally underperforming asset columns. All the other values are set to 0.

Procedure

The Black-Litterman optimization process can be summarized in four parts:

- Estimate the (prior) implied expected returns using relative market capitalization weights and implied risk-aversion;
- Based on the investor views, build the view vector, the picking matrix and the (diagonal) matrix with the variance of each scenario;
- Use all of the previous inputs to compute the (posterior) "Black-Litterman" vector of expected excess returns;
- Use the vector of Black-Litterman posterior returns to compute the new weights for the portfolio.

Key formulas and equations

The starting point is the computation of the implied excess returns via a reverse optimization method:

$$\Pi = \lambda\Sigma w_{market}$$

Where:
Π is the Implied Excess Equilibrium Return Vector (N x 1 column vector),
Σ represents the covariance matrix of excess returns (N x N matrix),
λ is the risk aversion coefficient,
w_{market} is the market capitalization weight.

The conversion from the prior return vector to the posterior Combined Return Vector ($E[R]$) is done according to:

$$E[R] = [(\tau\Sigma)^{-1} + P'\Omega^{-1}P]^{-1}[(\tau\Sigma)^{-1}\Pi + P'\Omega^{-1}Q]$$

Where:
τ is a scalar,
P is is a matrix that identifies the assets involved in the views (K x N matrix),
Ω is a diagonal covariance matrix of error terms from the expressed views representing the uncertainty in each view (K x K matrix),
Q is the View Vector (K x 1 column vector).
This formula can be intuitively interpreted as a weighted average between the (prior) implied returns and our views, with weights that depend on how much we are uncertain regarding every single view.