

MIMS – Multi Asset Global Opportunities Fund

Portfolio Management Team

Report – December 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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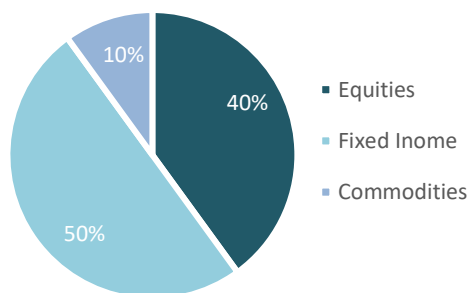
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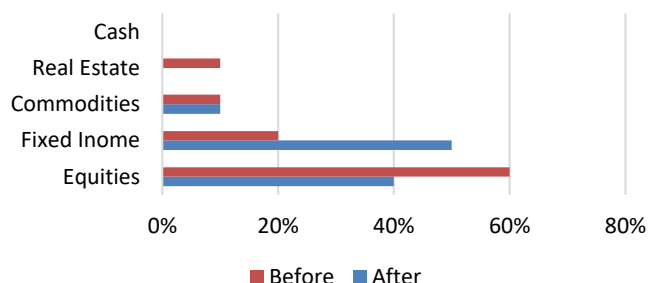
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Asset Allocation



Results of the rebalancing



Investment Approaches

Top-down approach

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.

Bottom-up approach

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.

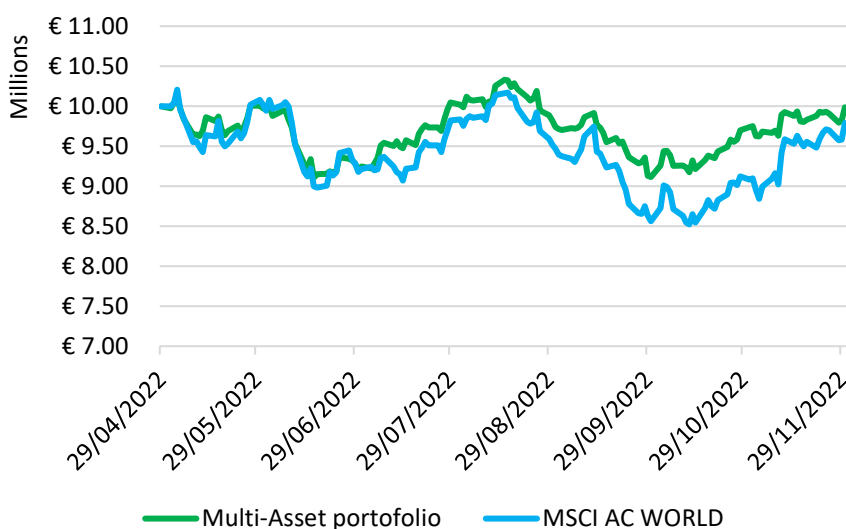
Research contribution

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

29.04.2022 – 30.11.2022



The fund this year has been restarted to € 10M due to the addition of bonds which have minimum lots of 100k and 150k that wouldn't have been possible to be added in a fund with lower AuM.

The analysis considered the cumulative gain over the entire period since inception. 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.

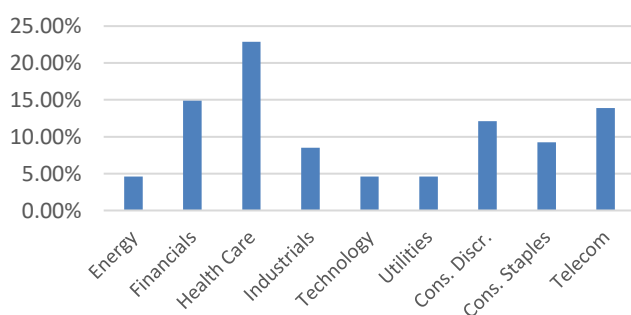
Considering an initial value of € 10M at the market close of 29.04.2022, the portfolio reached a final cumulative value of € 9,988.85M at the market close of 30/11/2022.

Top 10 Holdings

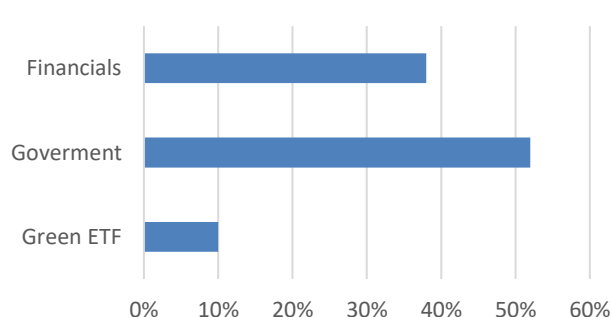
Security	Weight	Security	Weight
ILGV 2.875 29-JAN-2024	5.5%	Btp Tf 0% Nv23	5.0%
UST 2.250 31-JAN-2024	5.5%	ERST 6.693 14-NOV-2025 '24 MTN	5.0%
GBGV 1.000 22-APR-2024	5.0%	HSBA 6.364 16-NOV-2032 FRN	5.0%
NORWAY, KINGDOM OF (GOVERNMENT)	5.0%	RBIV 8.750 22-NOV-2025 '24 MTN	5.0%
iShares € Corp Bond 0-3yr ESG UCITS ETF	5.0%	CRDI 5.850 15-NOV-2027 '26	4.0%

Sector breakdown

Equity



Bond



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Considering the macro situation which has radically changed since the last report, the team has decided to increase drastically the allocation to bonds. In fact, in contrast with the last semester when nominal interest rates were negative or approximately around zero, the normalization of monetary policy carried out by central banks drove yields back into positive territory making them more appealing. As a result of more hawkish central bank policies, we have the ECB deposit rate at 1,5% and the Federal Reserve key rate around 3,75%. In addition to this, bond prices incorporate the expectations of further rates increases giving investors attractive positive nominal interest rates, with a much lower risk compared to equity. For the aforementioned reasons, we decided to bring the bond holdings of the portfolio to a weight 50% of the total portfolio.

CRDI 5.850 15-NOV-2027 '26 MTN XS2555420103

The first bond we opted for is a 5.85, 2027 senior non-preferred callable bond, issued by Unicredit, which is the second largest bank in Italy by total assets (916.67 billion €). Today the bond opened at B/A: 102.883/103.188 and it is yielding BYld/AYld: 5.041/4.956 with a duration of 3,63 years.

The issue rating is a BBB- since the issuer's is BBB, however, we believe that the bank suffers from the home country's bad financial reputation and rating of BBB. As a matter of fact, the Refinitiv model, which scores ratings of governments and firms based on macroeconomics factors, assigned to Unicredit the maximum score across its peers and a rating of BBB+. For this reason, we are confident that the credit spread between Unicredits' and Italy's government bonds overestimates the extra risk of the bond, thus, making this bond a great investment opportunity.

ERST 6.693 14-NOV-2025 '24 MTN XS2555412001

We opted for a 6.693, 2025 senior non-preferred callable bond, issued by Ceska Sporitelna, which is the second largest bank in Czech Republic for total assets (67.5 billion €) and part of Erste Group. Today the bond opened at B/A: 102.988/103.614 and it is yielding BYld/AYld: 5.045/4.71 with a duration of 1,89 years.

The issue rating is A/A- while the issuer's is A. Czech Republic rating is at AA- thanks to its record of credible macroeconomic and monetary policies, a robust institutional framework, and strong external finances. However, it got a negative outlook due to the risks posed by the European energy crisis on Czech Republic's economic and fiscal performance. We believe that this would be an attractive yield considering the rating of the bond and the limited risk it is exposed to. The investment would offer a steady 5% during the next two years.

RBIV 8.750 22-NOV-2025 '24 MTN XS2559379529

This bond was issued by Raiffeisen Bank Zrt, the Hungarian branch of Raiffeisen Bank, on November 22. It matures on November 22, 2025 and has a coupon rate of 8.75%, while the yield is currently at 7.66%.

We believe that including this bond in our portfolio is a worthwhile investment for a number of reasons. First of all, it has a short duration: indeed, its modified duration to maturity is equal to 1.824, which implies a limited price sensibility to interest rate changes. Then, its coupon rate of 8.75% is quite high for being a Baa3 issue. Finally, despite being an emerging country, Hungary's public debt-to-GDP (76.8% in 2021) is lower than the euro area average (87.8% in the second quarter of 2022). Moreover, its GDP is expected to grow 5.5% year-on-year, compared to an expected growth 3.3% for the euro area. Although confidence indicators have deteriorated and macroeconomic data point to weakening consumption, housing transactions, construction activity and lending, investing in a bond issued by a bank operating in this country does not seem to present relevant economic risks that are not compensated by the attractive YTM.

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Bond Approach

HSBA 6.364 16-NOV-2032 FRN XS2553547444

This bond was issued by HSBC on November 16. It matures on November 16, 2032 and it is a resettable note, paying an initial interest rate of 6.364% per annum until November 16 2027. After this date, the coupon rate is reset, using the 6-months EURIBOR as benchmark rate, to which a margin of 3.3% is added. Furthermore, its yield is currently at 5.65%.

Despite being a Tier 2 bond, thus implying a higher level of risk than other bonds, we chose to include this bond in our portfolio because its coupon rates look particularly attractive for being an A- issue. Furthermore, HSBC is a sound institution and investing in this specific bond allows us to take advantage of interesting yields.

IBM

Company overview

IBM is based in New York and operates in the Software, Artificial Intelligence, and Consulting industries. Even though it is a historical company, it does not lack dynamism. In the last years, IBM has been going through some changes, selling the division with less growth potential and giving more space to the more promising ones. For instance, the IT Service division was sold in 2021 and is now listed under the name of Kyndryl. These changes show the commitment of the company to leave behind the past years of sluggish revenues and margins.

The business model focuses on helping its clients from all over the world with digital transformation. Revenues are geographically diversified, with 49% coming from America, 31% from Europe and Middle East, and 20% from Asia.

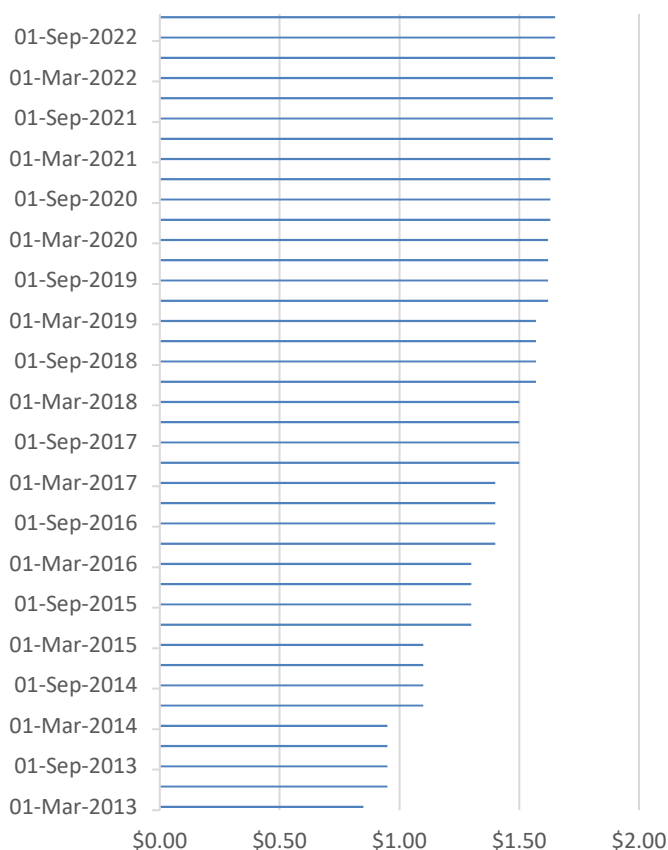
IBM shouldn't suffer from the possible recession thanks to its business model: 83% of the revenues come from long-term contracts. Moreover, during an economic crisis, businesses could try to lower operating costs by implementing software and artificial intelligence in the production processes, increasing the demand for IBM's products and services.

Being one of their main focuses, Cloud computing only covers 4% of the market, but the industry has an expected CAGR of 21% for the next ten years. The company is also a leader in AI and consulting, but those markets are more competitive and fragmented.

IBM operates in an industry with high barriers to entrance, thanks to its patents and R&D investments (11% of revenues) that protect the company from competitors.

The price is at par with our target, but the company distributes a generous dividend of 4.47%, and the valuation could benefit from a pivot in monetary policy.

IBM Historical dividends



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Brookfield Infrastructure Partners

Company overview

Brookfield Infrastructure Partners is a Canadian Limited Partnership created by Brookfield Asset Management (\$650bn AUM) to invest in infrastructure projects, with \$75bn of total asset value. The partnership aims to find investment opportunities with an annual return between 12% and 15%, mainly in transport, utilities, midstream, and data.

Infrastructure projects are an alternative investment with a long-time horizon in usually natural monopolies with high barriers to entry within highly regulated sectors with low elasticity of demand. Those characteristics make infrastructure a stable investment, with predictable cash flows and low correlation to traditional asset classes. For this reason, combined with the business model based on long-term contracts that fix ex ante most revenues and costs which are contractually linked to inflation, Brookfield Infrastructure Partners is allowed to use higher levels of leverage that amplify its returns while its investments remain reasonably safe. Considering the stable cashflows, of which more than 90% recur annually, the limited partnership can be seen as a high-performing fixed income product (13% average return in the last ten years).

The investments are spread mainly in developed markets, 52% in NA, 13% in the UK, 12% in the EU, but also in emerging markets, with 16% in India.

The average target price is \$44, representing a 25% upside from its current price, and the valuations could increase further in case of convergence of risk-free rate and market risk premium to lower historical values. Furthermore, the partnership constantly distributes quarterly dividends, with a 4.11% yield.

Pepsi

Company overview

PepsiCo, Inc. (PEP) is an American multinational company selling various beverages and convenient food and snacks. PepsiCo's product portfolio includes a wide range of iconic brands such as Lay's, Doritos, Cheetos, Gatorade, Pepsi-Cola, Mountain Dew and Quaker. Management is divesting away from non-core brands and is investing in growth, especially in emerging markets. Its valuable brands and steady growth business enable the company to carry a relatively low beta, and thus to be characterized by a lower volatility than the market. This, coupled with a strong balance sheet and dominant industry position, set PepsiCo in a favorable spot to deal with the turbulent macroeconomic environment. Moreover, PepsiCo is able to maintain a strong profit margin, reaching a value of 12.30% in September 2022.

Sanofi

Company overview

Sanofi S.A. is a French multinational company specialized in R&D, manufacturing and marketing of pharmaceutical products and healthcare solutions. It operates through the following business segments: Pharmaceuticals, Consumer Healthcare, and Vaccines. Sanofi's R&D efforts focus on advancing a combination of drugs to increase the effectiveness of treatments and on advancing the formulation of new biologics to produce precision medicines. Sanofi started working on its COVID-19 vaccine but not yielding timely results, it started supporting the manufacturing and distribution of already approved vaccines.

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FOCUS: Commodity strategy

We decided to rebalance our allocation in commodities considering the current macroeconomic trends. We decided to keep the same percentage of commodities in our portfolio, and we decided to cut Lithium and Nickel while introducing Silver into our holdings. The detailed reasons for our choices can be found in a specific analysis later in the report.

Up to now, Minerva held 4 commodities in its Multi Asset Global Opportunities Fund, namely Copper, Gold, Nickel and Lithium. The current macroeconomic scenario, characterized by high volatility, high inflation and rising interest rates, suggests a reconsideration of our holdings.

Our strategy is based on the current and future decisions of Central Banks and the growth prospects for the industrial sector.

Crude Oil

We suggest a rebalancing of 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 leading to a improvement of the supply-side constraints and shortages. Moreover, Oil is increasingly being condemned as a dirty asset on which the West depends too much. Thus, the decarbonization commitment has sped up its pace.

Gold

We decided to allocate 3,5% of our portfolio to Gold. While raising interest rates and a strong dollar disincentivize investors from buying it, the high inflation we are experiencing and the likely scenario of a recession could convince investors to secure their money by investing in Gold, being a hedge against negative real rates. We also believe that if the USD were to test again its recent high, gold would likely suffer as a result but that it would quickly pick back up when CBs pivot their policy. Finally, the global supply shortages of the precious metal could cause the prices to rise, especially given the fact that Central Banks are accumulating it and that both Russia and China could be preparing a Gold-backed currency.

Nickel and Lithium

We believe that the hawkish increases of interest rates by the FED and the other Central Banks and the prospect of a recession will impact negatively the industrial activity towards the green transition. We forecast decreasing demand from consumers and a consequently decreasing demand for industrial materials by manufacturers. Moreover, Lithium is now trading at all-time highs, which makes the possibility of a decrease in price in the next future likely. Thus, we decide to cut these metals out of our holdings.

Silver

We decided to introduce Silver in our portfolio, allocating 2,5% to it. Silver is a material strictly correlated to the green transition, as it is used in many technologies, especially in photovoltaic industries. Moreover, its value is strictly correlated with Gold, being considered a hedge against inflation as well. Taking into account the same considerations made for Gold, and noticing that Gold is now relatively more expensive than Silver, we believe that the price of Silver will rise, reducing the spread between the two precious metals.

Copper

We allocate 1% to Copper. This metal is largely used by industries. It is interesting to notice that LME (London Metal Exchange) used to have daily inventories of 250-350k tons of Copper a couple of years ago, against today's inventories of about 100k tons. As its price has dropped significantly from the all-time highs reached at the beginning of 2022 and considering that the demand for it has risen steadily over the past years and is likely to continue doing so, we believe that growing demand and scarcity will drive Copper's prices up.

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APPENDIX

Asset Class	Security	Weight
Bond	RBIV 8.750 22-NOV-2025 '24 MTN	4.85%
Bond	HSBA 6.364 16-NOV-2032 FRN	4.85%
Bond	CRDI 5.850 15-NOV-2027 '26 MTN	3.88%
Bond	ERST 6.693 14-NOV-2025 '24 MTN	4.85%
Bond	ILGV 2.875 29-JAN-2024 MTN	5.34%
Bond	UST 2.250 31-JAN-2024	5.34%
Bond	GBGV 1.000 22-APR-2024	4.85%
Bond	NORWAY, KINGDOM OF (GOVERNMENT)	4.85%
Bond	iShares € Corp Bond 0-3yr ESG UCITS ETF	4.85%
Bond	Btp Tf 0% Nv23	4.85%
Equity	IBM	1.79%
Equity	Brookfield Infrastructure Partners	1.79%
Equity	Merck	1.70%
Equity	Target	1.79%
Equity	Pepsi	1.79%
Equity	Unilever	1.79%
Equity	GSK	1.79%
Equity	Sanofi	1.79%
Equity	Nexi	1.65%
Equity	Roche	1.79%
Equity	Eni	1.79%
Equity	Novartis	1.79%
Equity	Vodafone	1.79%
Equity	Airbus	1.65%
Equity	ASML	1.79%
Equity	Intesa	1.79%
Equity	AT&T	1.79%
Equity	Verizon	1.79%
Equity	Southwest airlines	0.97%
Equity	United airlines	0.97%
Equity	Ryanair	0.97%
Equity	Bank of China	1.94%
Equity	ICBC	2.04%
Commodities	Copper	0.97%
Commodities	Crude Oil	0.97%
Commodities	Gold	3.40%
Commodities	Nickel	0.97%
Commodities	Lithium	0.97%
Commodities	Silver	2.43%
Hedge	SPXW 5/31/23 P3200	3.00%

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Quantitative Research Team

Risk Report – December 2022

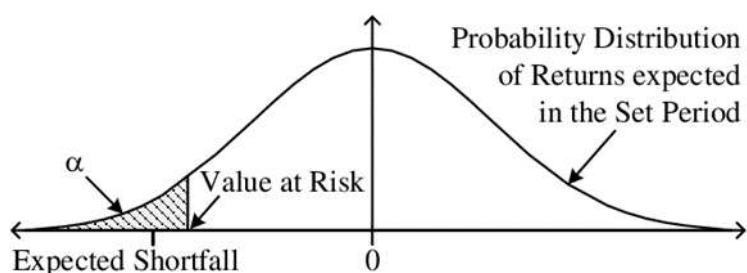
Introduction

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 $\alpha\%$ of probability over a time horizon of 1 day. For instance, if the VaR ($\alpha=5\%$) = -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 $\alpha\%$ 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.

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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 its 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 F_n , is:

$$D_n = \sup x |(F_n - F)|$$

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.

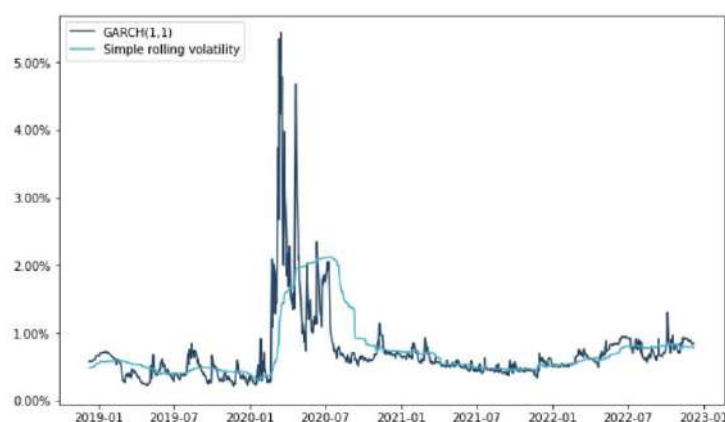
Time-series modelling approach

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.



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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:

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

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.

TOP & BOTTOM 5 stocks (simple approach)

	VaR 95	VaR 99	ES 95	ES 99
RBIV 8.750 22-NOV-2025 '24 MTN	-0.08%	-0.12%	-0.11%	-0.14%
CRDI 5.850 15-NOV-2027 '26 MTN	-0.10%	-0.15%	-0.13%	-0.18%
ERST 6.693 14-NOV-2025 '24 MTN	-0.13%	-0.22%	-0.18%	-0.29%
HSBA 6.364 16-NOV-2032 FRN	-0.16%	-0.22%	-0.19%	-0.25%
Norway Tf 3% Mz24 Nok	-0.18%	-0.25%	-0.22%	-0.29%

	VaR 95	VaR 99	ES 95	ES 99
Crude Oil	-4.97%	-7.12%	-8.29%	-8.22%
target	-5.01%	-7.11%	-8.30%	-8.20%
ASML	-5.47%	-7.78%	-8.86%	-8.96%
United airlines	-5.62%	-8.03%	-7.10%	-8.26%
Nickel	-8.85%	-12.01%	-11.35%	-15.05%

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%}	-0.79%	-0.95%
VaR_{99%}	-1.14%	-1.57%
ES_{95%}	-1.01%	-1.36%
ES_{99%}	-1.32%	-2.09%

TOP & BOTTOM 5 stocks (GARCH)

	VaR 95 (GARCH)	VaR 99 (GARCH)	ES 95 (GARCH)	ES 99 (GARCH)
Norway Tf 3% Mz24 Nok	-0.18%	-0.26%	-0.23%	-0.30%
Btp Tf 0% Nv23	-0.16%	-0.29%	-0.25%	-0.41%
UST 2.250 31-JAN-2024	-0.23%	-0.37%	-0.32%	-0.48%
GBOV 1.000 22-APR-2024	-0.26%	-0.40%	-0.35%	-0.52%
ILGV 2.875 29-JAN-2024 MTN	-0.24%	-0.42%	-0.36%	-0.60%

	VaR 95 (GARCH)	VaR 99 (GARCH)	ES 95 (GARCH)	ES 99 (GARCH)
ASML	-6.17%	-9.11%	-7.99%	-10.82%
Sanofi	-5.79%	-9.73%	-8.35%	-12.91%
target	-6.55%	-11.70%	-10.00%	-16.63%
Nickel	-6.59%	-12.49%	-10.63%	-18.71%
GSK	-8.39%	-14.05%	-12.10%	-18.77%

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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:

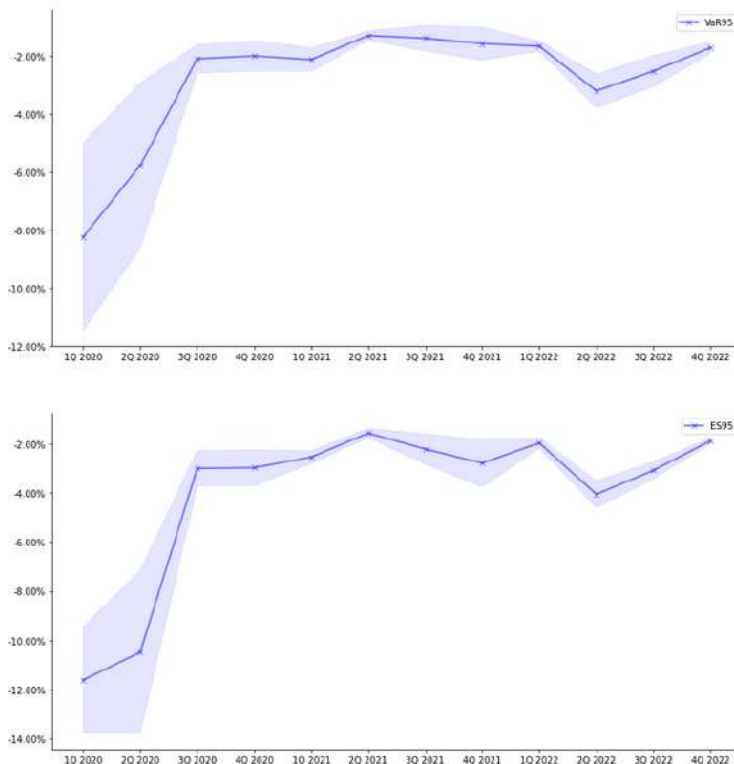
- Sample with replacement n times from the original sample (note that one observation could be selected more than once);
- Compute the metric of interest (in our case the VaR or ES) on this newly created sample and save it;
- Repeat the previous steps M times with $M \rightarrow +\infty$ (we have selected $M=100.000$ 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%}	-0.75%	0.08%
VaR_{99%}	-1.19%	0.2%
ES_{95%}	-0.99%	0.1%
ES_{99%}	-1.33%	0.17%

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

Stock	Weight	Stock	Weight
IBM	1,85%	Vodafone	1,85%
Brookfield Infrastructure Partners	1,85%	Airbus	1,70%
Merck	1,75%	ASML	1,85%
target	1,85%	Intesa	1,85%
Pepsi	1,85%	AT&T	1,85%
Unilever	1,85%	Verizon	1,85%
GSK	1,85%	Southwest airlines	1,00%
Sanofi	1,85%	United airlines	1,00%
Nexi	1,70%	Ryanair	1,00%
Roche	1,85%	Bank of China	2,00%
Eni	1,85%	ICBC	2,10%
Novartis	1,85%		

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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:

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

Where:

Π is the Implied Excess Equilibrium Return Vector ($N \times 1$ column vector),

Σ represents the covariance matrix of excess returns ($N \times N$ 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 a matrix that identifies the assets involved in the views ($K \times N$ matrix),

Ω is a diagonal covariance matrix of error terms from the expressed views representing the uncertainty in each view ($K \times K$ matrix),

Q is the View Vector ($K \times 1$ 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.

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