

MIMS – Multi Asset Global Opportunities Fund

Portfolio Management Team

Report – December 2023

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.



Head of Asset Management

Jacopo Prevedello: jacopo.prevedello@studbocconi.it

Head of Portfolio Management

Matteo Consalvo: matteo.consalvo@studbocconi.it

Portfolio Manager

Francesco Sorbone: francesco.sorbone@studbocconi.it

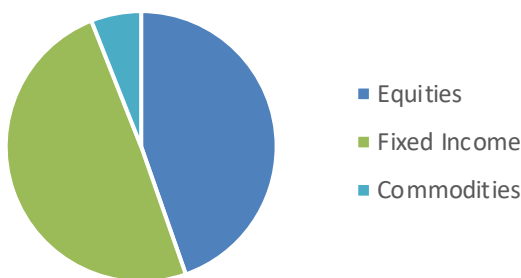
Portfolio Analysts

Giuseppe Palermo: giuseppe.palermo@studbocconi.it

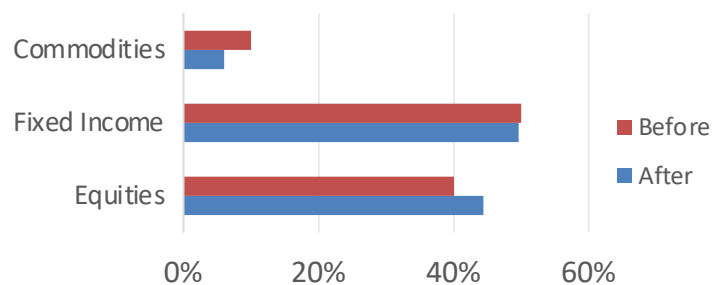
Federico Tita: federico.tita@studbocconi.it

Luca Delorenzi: luca.delorenzi@studbocconi.it

Asset Allocation



Asset Classes 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

28.04.2023 – 22.12.2023

Performance



Update on performance

During the current semester, the fund has reported a profit of **3.42%**, beginning at € 9,321,577 and ending at € 9,639,720, with an annualized performance of **5.3%**.

The return of the fund was mainly driven by the **bond allocation of the portfolio**, thanks to the reduction of the yields on the longer end of the curve and to the compression of spreads. However, the **equity allocation of the portfolio** did not perform as expected. Indeed we exposed ourselves towards value sectors, which underperformed during the period.

Methodological note

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.

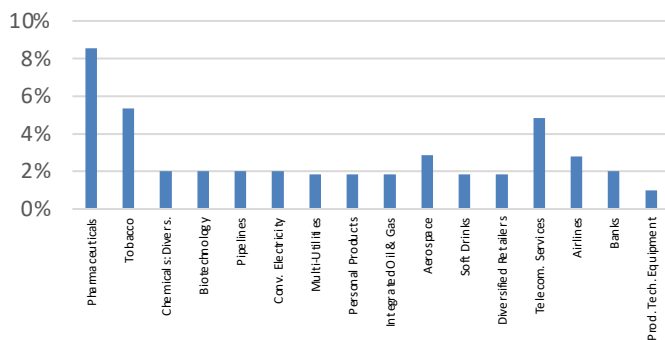
New positioning - Top 10 Holdings

Security	Weight
FRGV 0.100 01-MAR-2025	13%
UST 3.875 30-NOV-2027	10.0%
ITGV 15-DEC-2024	10.0%
DEGV 2.200 12-DEC-2024	6,35%
EUUNI 0.700 06-JUL-2051	5.0%

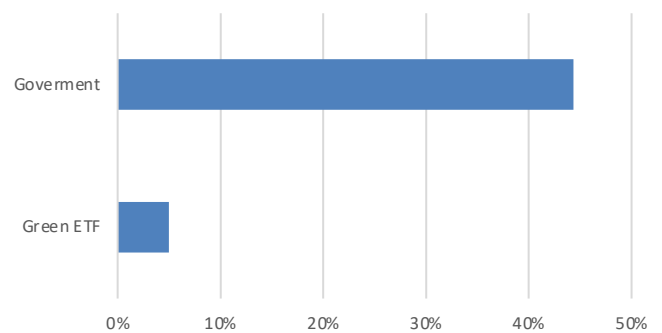
Security	Weight
iShares € Corp Bond 0-3yr ESG UCITS ETF	5.0%
Bayer	2.0%
Imperial Brands	2.0%
Pfizer	2.0%
Gold	2.0%

Sector breakdown

Equity



Bond



DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only with regards to the specific objectives of Minerva Investment Management Society virtual portfolios.

© Minerva Investment Management 2020. All rights are reserved.



New entries

- ↗ ALBEMARLE CORP
- ↗ GENMAB A/S
- ↗ SNAM
- ↗ TERNA
- ↗ UST 3.875 30-NOV-2027
- ↗ ITGV 15-DEC-2024
- ↗ DEGV 2.200 12-DEC-2024
- ↗ FRGV 0.100 01-MAR-2025

Outs

- ↘ UST PO STR 15-FEB-2053
- ↘ HSBA 6.364 16-NOV-2032 FRN
- ↘ ERST 6.693 14-NOV-2025 '24 MTN
- ↘ CRDI 5.850 15-NOV-2027 '26 MTN
- ↘ RBIV 8.750 22-NOV-2025 '24 MTN
- ↘ NOGV 3.000 14-MAR-2024
- ↘ BLGG 2.375 30-APR-2026
- ↘ BEGV 0.650 22-JUN-2071
- ↘ IBM
- ↘ UNITEDHEALTH GROUP

RATIONALE OF THE REBALANCING

As per fund approach, every 6 months there is a rebalancing of the portfolio. We monitor in depth the evolution of the prices of the securities in our portfolio, when we believe the securities have reached their maximum potential, with the market price converging to our target price, we substitute them with other securities with higher potential.

↘ OUTS

Beginning with the securities we removed, there are all the **bonds issued by financial institutions** which were interesting when spreads were wider, but now we consider them too tight, so we prefer to reduce the risk by investing in government bonds. Secondly, we also removed part of the longer dated bonds, as we believe the yields on that part of the curve have dropped too much. Lastly, we removed the government bond in NOK expiring next year due to the currency appreciating to what we consider an appropriate level.

Regarding equities, we have removed **IBM, UNITEDHEALTH GROUP** as we think that they have reached their potential.

↗ NEW ENTRIES

The main decision this semester was to reduce the duration of the bond portfolio, as we believe that the yields of the longer part of the **curve dopped too much, making it unattractive**. Therefore, we decided to remove most of the ultra-long bonds. Furthermore, we decided to switch the allocation more towards government bonds, removing the bonds issued by financials. We believe **that credit spreads have tightened too much**, considering the current macroeconomic conditions, and that they will widen again in the near future, vanishing the possible positive carry from higher yield bonds. We also decided to insert an Inflation-linked bond as the breakeven inflation for this kind of instruments has decreased excessively.

= UNCHANGED

The equity portion of the fund was mainly unchanged. We still believe that **value equities are undervalued** compared to growth ones, even if they underperformed during the last months. Furthermore, the commodity allocation remained roughly the same.

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only with regards to the specific objectives of Minerva Investment Management Society virtual portfolios.

© Minerva Investment Management 2020. All rights are reserved.



This bond is an inflation-linked bond which basically pays a fixed sum + the increase in inflation (in this case the European one). We decided to add this bond as the expectations of inflation, according to us, have reduced too much, for example the breakeven inflation of this bond against a plain one is 1.76%, even lower than the central bank target.

Terna

Terna (Market Cap: 14.8B) is the legal monopolist in Italy's electricity transmission sector, managing 99.6% of the Italian National Transmission Grid at high voltage. The evolving international energy landscape, coupled with the gas crisis triggered by the conflict in Ukraine, necessitates an accelerated focus on investments in renewables and electricity grids at the European level. Consequently, we believe that Terna's long-term growth potential has improved. Terna is positioned to spearhead the transition of the electricity system towards renewables, with €18.1 billion earmarked for capital expenditure in the 10-year National Development Plan for the network. Trading at a favorable P/E ratio (16x), Terna's consistent revenue growth (6.5% CAGR) and income growth (3.6% CAGR) over the last five years, along with a projected 7% average annual growth in Regulatory Asset Base (RAB) until 2025, make it an attractive investment. Additionally, Terna offers a 4.3% dividend yield, and its stock price has historically delivered positive capital gains. While Terna shares similar risks with Snam, given their central role in the Energy Transition, we anticipate a supportive approach from the government and regulatory bodies.

Albemarle Corp.

Albemarle Corp. is a US-based company engaging in the production of chemicals including lithium and bromine. It is one of the world's largest producers of lithium and most of its revenues derive from China (32%), South Korea (22%), Japan (15%), and the US (12%).

The company's strong positioning in the market can in part be explained by a significant cost advantage over its competitors. Its salt flats in Chile and its bromine-bearing brines in the Dead Sea and Arkansas are unique assets that, thanks to the specific atmospheric and geological conditions, make the extraction of lithium and bromine particularly cheap.

The fall in lithium prices since November 2022 dragged down Albemarle's stock, which is currently trading at a P/E ratio of 4.6x, far below the 5-year average of 59.7x. We see this as an interesting opportunity since the demand for this commodity (closely related to the Electric Vehicles sector) is still strong and is expected to outpace supply in the coming years. In fact, in a scenario in which lithium prices stabilize and start growing moderately, the company's solid financials and its particular cost structure would make Albemarle one of the best-positioned players in the industry.

A potential risk to consider for the long term is Chile's plan to nationalize lithium production. If this occurs, Albemarle could be forced to sell a majority stake in one of its most valuable assets to the Chilean government at a price as low as asset book value to extend its lease. However, since the contract expires only in 2043, we do not consider this risk relevant in the medium run.

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only with regards to the specific objectives of Minerva Investment Management Society virtual portfolios.

© Minerva Investment Management 2020. All rights are reserved.



Snam

Snam S.p.A. (Market Cap: 15.3B) – Originally a subsidiary of the Italian energy company Eni, it transitioned to an independent entity in 2001. Snam holds a pivotal role as the Italian gas transport and dispatching operator (TSO) and is the primary player in natural gas storage in Italy. The company effectively manages the most extensive gas transport network in Europe. Its operations are primarily focused on gas transportation tariffs (constituting 80% of EBITDA) and storage services (comprising 20% of EBITDA), both operating in regulated environments based on the RAB system.

Looking ahead, Snam envisions a prolonged cycle of investments in green gas and hydrogen development, covering production, transport, and storage. The strategic plan for the period 2021-25 outlines a capital expenditure of €8.1 billion, with a notable 47% of investments aligning with sustainability criteria under the EU Taxonomy. The company identifies appealing growth opportunities in the 2026-30 timeframe, aiming to secure a robust EBITDA CAGR of 8-10%. Furthermore, over the past five years, revenue has shown consistent growth at a CAGR of 5.6%. This performance is complemented by a consistently high dividend yield, currently at 6.2%, and a relatively stable stock price. These factors contribute to making SNAM a solid defensive stock to consider adding to our portfolio.

Despite these positive indicators, Snam faces strategic risks that warrant attention, including regulatory uncertainties, geopolitical instability, and the evolving landscape of climate change. These factors pose potential challenges that could impact the company's financial performance.

Genmab

Genmab is a Copenhagen-based biotechnology company specializing in antibody therapeutics for the treatment of cancer. Its leading product is Darzalex, developed in cooperation with Johnson & Johnson and now considered the standard of care for multiple myeloma.

This medicine, particularly successful due to its strong efficacy, its limited side effects, and its safety, is considered hardly replaceable. The only realistic alternative could be Bristol Myers Squibb's CAR-T therapy, which, however, presents a series of problems related to its specificity to each patient.

Therefore, Genmab seems to have, at least until the expiration of the patent in 2031, a very stable stream of revenue. Moreover, since the medicine is distributed by Johnson & Johnson, Genmab's costs associated with Darzalex are null, and the 20% of sales which are collected by the Dutch company can be entirely reinvested in R&D.

As a result, thanks to its solid revenues, its particularly high margins (5-year average Net Income margin of 41.9%), and its low level of debt (Total Debt/EBITDA in 2022 was 0.089x), Genmab seems perfectly positioned to innovate and grow further.

In fact, the company is developing its proprietary antibody technology platforms, DuoBody and HexaBody, which are expected to accelerate its research processes and can represent a strong competitive advantage.

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only with regards to the specific objectives of Minerva Investment Management Society virtual portfolios.

© Minerva Investment Management 2020. All rights are reserved.



According to the CME Fed Watchtool, the market implies probabilities of 14.3% and 55.1% for rate easing at the January and March meetings, respectively. However, we hold the view that these estimates are excessively optimistic, given the robust resilience observed in the job market and the persistent stickiness of inflation in the United States.

The USD is currently trading around 1.08, with forward rates indicating a potential appreciation of the EUR. Despite the continued inversion on the 2-year to 10-year segment of the curve, the 5-year to 10-year curve is notably flat. In light of these dynamics, we identify a compelling buying opportunity in the 4-year maturity. The flattening observed in the 5-10-year curve leads us to anticipate that even in the event of a curve steepening, the market would predominantly impact the 2-year and 10-year maturities, with minimal upward shifts on the 4-5-year maturity. Recognizing the current mispricing in rate-easing probabilities, we acknowledge the potential negative impact on bond prices, but we contend that this effect would be more pronounced in longer-duration bonds.

To summarize, we recommend a buy position on bonds with maturities ranging from 4 to 6 years, emphasizing low duration to mitigate interest rate risk while still allowing participation in the potential upside associated with any eventual interest rate easing.

The yield curve in Italy distinguishes itself as one of the few within the Eurozone maintaining a normal slope, presenting an attractive yield proposition for the 10-year maturity segment. A strategic perspective suggests an efficient risk-return tradeoff by capitalizing on the eventual anticipated rate easing from the ECB and through a parallel shift in the curve.

The current shape of the yield curve allows to contain the risk of its steepening or curvature. This allocation is uniquely viable due to the absence of an inverted curve, where any inversion typically results from retracement in shorter maturities. It is noteworthy that the Italian CDS hovers around its long-term average, indicating a potential vulnerability to an escalation in credit risk over time. Despite the recent rally in Italian 10-year BTPs, their current yield remains higher than observed six months ago.

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only with regards to the specific objectives of Minerva Investment Management Society virtual portfolios.

© Minerva Investment Management 2020. All rights are reserved.

Detailed Holdings

FRGV 0.100 01-MAR-2025	FR0012558310	13.00%
UST 3.875 30-NOV-2027	US91282CFZ95	10.00%
ITGV 15-DEC-2024	IT0005474330	10.00%
DEGV 2.200 12-DEC-2024	DE0001104909	6.35%
EUUNI 0.700 06-JUL-2051	EU000A3KTGW6	5.00%
iShares € Corp Bond 0-3yr ESG UCITS ETF	IE00BYZTVV78	5.00%
Bayer	DE000BAY0017	2.00%
Imperial brands	GB0004544929	2.00%
Pfizer	US7170811035	2.00%
Crude Oil	CRUDOIL	2.00%
Gold	GOLDBLN	2.00%
Albemarle Corp	US0126531013	2.00%
Genmab A/S	DK0010272202	2.00%
Snam	IT0003153415	2.00%
Terna	IT0003242622	2.00%
Brookfield Infrastructure Partners	BMG162521014	1.85%
Unilever	GB00B10RZP78	1.85%
GSK	GB00BN7SWP63	1.85%

Eni	IT0003132476	1.85%
Airbus	NL0000235190	1.85%
Coca-Cola	US1912161007	1.85%
Philip Morris	US7181721090	1.85%
target	US87612E1064	1.85%
Verizon	US92343V1044	1.85%
Roche	CH0012032048	1.70%
Southwest airlines	US8447411088	1.60%
British American Tobacco	GB0002875804	1.50%
Vodafone	GB00BH4HKS39	1.50%
AT&T	US00206R1023	1.50%
United airlines	US9100471096	1.20%
Bank of China	CNE1000001Z5	1.00%
ICBC	CNE1000003G1	1.00%
Sanofi	FR0000120578	1.00%
Avio S.p.A.	IT0005119810	1.00%
ASML	NL0010273215	1.00%
Copper	LCPCASH	1.00%
Silver	SILVERH	1.00%

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only with regards to the specific objectives of Minerva Investment Management Society virtual portfolios.

© Minerva Investment Management 2020. All rights are reserved.



Quantitative Research Team

Risk Report – December 2023

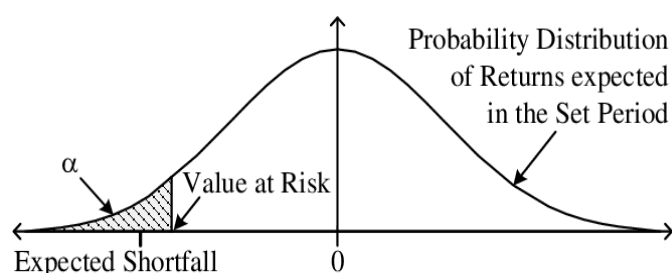
Introduction

The main objective of this section is to assess and quantify the risk embedded in the allocation 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 an overview of how sentiment analysis can be considered a factor for short term investments.

As the Investment Risk division, 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.



Head of Quantitative Research

Umberto Barbieri: barbieri.umberto@studbocconi.it

Analysts

Erik Bergqvist: kjell.bergqvist@master.unibocconi.it

Francesco Braicovich: francesco.braicovich@studbocconi.it

Giacomo Gregori: giacomo.gregori@studbocconi.it

Antonio Petrai: antonio.petrai@studbocconi.it

Enrico Sammarco: enrico.sammarco@studbocconi.it

Vasileios Stavropoulos: vasileios.stavropoulos@studbocconi.it

Nathan Van Es: nathan.vanes@studbocconi.it

Erik Vik: erik.vik@studbocconi.it

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 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 6 months,. All the analysis has been conducted with Python.

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only in regard to the specific objectives of Minerva Investment Management Society virtual Funds. © Minerva Investment Management 2023. All rights are reserved.

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 252 return observations, which correspond to 1-year 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.

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only in regard to the specific objectives of Minerva Investment Management Society virtual Funds. © Minerva Investment Management 2023. All rights are reserved.

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.

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 are slightly higher in magnitude than the simple approach ones, potentially due to the higher volatility in the markets recently. Indeed, 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%}	-0.55%	-0.62%
VaR_{99%}	-0.78%	-1.02%
ES_{95%}	-0.69%	-0.88%
ES_{99%}	-0.91%	-1.36%

TOP & BOTTOM 5 assets (simple approach)

	VaR 95	VaR 99	ES 95	ES 99
ITGV 15-DEC-2024	-0.17%	-0.25%	-0.22%	-0.29%
DEGV 2.200 12-DEC-2024	-0.18%	-0.27%	-0.24%	-0.31%
FRG0 0.100 01-MAR-2025	-0.21%	-0.31%	-0.27%	-0.35%
iShares € Corp Bond 0-3yr ESG UCITS ETF	-0.25%	-0.37%	-0.32%	-0.43%
UST 3.875 30-NOV-2027	-0.86%	-1.23%	-1.09%	-1.42%

	VaR 95	VaR 99	ES 95	ES 99
Bayer	-3.29%	-4.64%	-4.12%	-5.33%
Southwest Airlines	-3.23%	-4.69%	-4.13%	-5.48%
Brookfield Infrastructure Partners	-3.33%	-4.77%	-4.21%	-5.51%
United Airlines	-3.65%	-5.27%	-4.65%	-6.13%
Crude Oil	-3.74%	-5.38%	-4.75%	-6.24%

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only in regard to the specific objectives of Minerva Investment Management Securities Virtual Funds. © Minerva Investment Management 2023. All rights are reserved.

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.

	Estimate	Standard error
VaR_{95%}	-0.57%	0.13%
VaR_{99%}	-0.83%	0.17%
ES_{95%}	-0.71%	0.12%
ES_{99%}	-0.90%	0.19%

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.

TOP & BOTTOM 5 assets (GARCH)

	VaR 95 (GARCH)	VaR 99 (GARCH)	ES 95 (GARCH)	ES 99 (GARCH)
DEGV 2.200 12-DEC-2024	-0.09%	-0.14%	-0.12%	-0.18%
iShares € Corp Bond 0-3yr ESG UCITS ETF	-0.14%	-0.21%	-0.18%	-0.24%
FRGV 0.100 01-MAR-2025	-0.15%	-0.25%	-0.21%	-0.32%
UST 3.875 30-NOV-2027	-0.91%	-1.40%	-1.22%	-1.72%
Copper	-1.38%	-1.96%	-1.74%	-2.25%

	VaR 95 (GARCH)	VaR 99 (GARCH)	ES 95 (GARCH)	ES 99 (GARCH)
United Airlines	-3.97%	-6.47%	-5.57%	-8.32%
Bayer	-3.62%	-6.85%	-5.85%	-10.36%
Brookfield Infrastructure Partners	-4.59%	-7.50%	-6.46%	-9.70%
Genmab A/S	-5.33%	-9.85%	-8.42%	-14.57%
Albemarle Corp	-7.43%	-11.96%	-10.33%	-15.34%

DISCLAIMER

This is an academic paper related to an academic project that doesn't pretend to represent any investment recommendation nor offer any solicitation to buy or sell securities or to adopt an investment strategy. The opinions expressed are subject to change. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Reliance upon information in this material is at the sole risk and discretion of the reader. The material was prepared only in regard to the specific objectives of Minerva Investment Management Securities virtual Funds. © Minerva Investment Management 2023. All rights are reserved.