Lisbon School of Economics & Management
Universidade de Lisboa

MASTER OF SCIENCE IN
FINANCE

MASTERS FINAL WORK
PROJECT

INVESTMENT POLICY STATEMENT:
INTESA SANPAOLO VITA LONG-TERM LINE

SIMONE AVANZINI

JUNE 2024

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Abstract

The Investment Policy Statement (IPS) presented is crafted to align with the characteristics of the Italian defined-contribution pension fund, Intesa Sanpaolo Vita Long-Term Line. The client's objectives encapsulate considerations of security, quality, returns, and liquidity, with a particular emphasis on the integration of environmental, social, and governance (ESG) principles within the investment framework.

Mean-Variance Theory optimization is applied to determine the proposed portfolio. The portfolio is anticipated to yield a return of 5.32 percent with an expected volatility of 7.12 percent, satisfying all the client's restrictions.

Key constraints governing the portfolio include a minimum return threshold of 4.5 percent, a maximum volatility limit of 7.8 percent, duration constraints ranging between 6 and 10 years, the prohibition of short selling activities is also enforced, and additional constraints dictate the minimum and maximum weightings for various asset classes, countries, and credit quality exposures.

The IPS concludes with a comprehensive analysis encompassing expected returns, volatilities, Value-at-Risk (VaR), and Conditional Expected Shortfall (CES). This analysis is performed utilizing both historical data and Monte Carlo simulations at specific confidence intervals, enhancing the robustness of the assessment.

JEL classification:C6; G11
Keywords: Asset Management; Portfolio Theory; IPS; Institutional Investors; Defined Contribution, Pension Funds

Resumo

A Declaração de Política de Investimento/Investment Policy Statement (DPI/IPS) aqui apresentada foi elaborada para alinhar uma carteira de investimentos com as características da linha de longo-prazo do fundo de pensão de contribuição definida Italiano, Intesa Sanpaolo Vita.

Os objetivos do cliente abrangem considerações de segurança, qualidade, retornos e liquidez, com ênfase na integração dos princípios ambientais, sociais e de governança (ESG) no quadro de investimento.

A Teoria da Variância-Média foi utilizada e optimizada de modo a determinar a carteira proposta.

É previsto que a carteira proposta produza um retorno de 5,32 % com uma volatilidade esperada de 7,12%, satisfazendo muitas outras restrições impostas pelo cliente.

As restrições que regem a carteira incluem uma amplitude de potenciais retornos com limite mínimo de 4,5%, um limite máximo de volatilidade de 7,8% e restrições de duração entre 6 a 10 anos, bem como a publicação de venda a descoberto (short-selling). O IPS termina com uma análise dos retornos, volatilidades, Valor em Risco (Value at risk, VaR) e Expectativa Condicional de Perda (CES). Esta análise foi realizada utilizando tanto dados históricos como simulações de “Monte Carlo” em intervalos de confiança específicos, aumentando a robustez da avaliação.

Classificação JEL: C6; G11
Palavras-Chave: Gestão de Activos; Teoria da Carteira; IPS; Investidores Institucionais

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In this section of my thesis, I would like to express my deepest gratitude to all my friends, both from the Valley and those I met during the last two years in Lisbon. Thank you for understanding and helping me in every situation. This journey has been a gift, and I sincerely hope to see all of you again in the future.

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Additionally, I would like to extend my heartfelt thanks to my supervisor, Professor Raquel Gaspar, who guided me through this challenge and was always available when needed. Thank you for your precious time and knowledge.

Last but not least, I want to thank me
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And trying to give more than I receive
I want to thank me for trying to do more right than wrong
I want to thank me for just being me at all times.

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1 Executive Summary

The Investment Policy Statement (IPS) delineates the investment objectives, constraints, and risk tolerance for the portfolio proposed to Intesa Sanpaolo Vita Long-Term Line, an Italian defined-contribution pension fund. The IPS aims to ensure that investment decisions align with the fund's mission and target performance.

For portfolio optimization, the Mean-Variance Theory (MVT), rooted in the work of Markowitz in 1952, is employed. This theory serves as a framework for optimizing portfolio returns while managing risk.

Subject to predefined constraints, the portfolio is projected to achieve an annual expected return of 5.32 percent and an annual expected volatility of 7.12 percent over the medium/long-term. These projections are based on rigorous analysis and modelling techniques.

The Investment Policy Statement exclusively pertains to assets held within the Intesa Sanpaolo Vita Long-Term Line's general account, dedicated to funding contributors' pensions. The fund adopts a predominantly conservative investment approach, aiming to generate stable and sustainable returns consistent with its long-term pension obligations to clients.

2 Investment Policy Statement

2.1 Scope and Purpose

2.1.1 Investor

The Italian banking institution Intesa Sanpaolo was established in 2007 with the union of Banca Intesa S.p.A. and Sanpaolo IMI S.p.A. Intesa Sanpaolo's goal is to meet the demands of its clients by encouraging the wise and economical use of resources, avoiding waste of any kind, and gradually favouring sustainable decisions. The pension fund line that is being examined in this research is the long-term line, which focuses on sustainability and ESG issues.

2.1.2 Structure

The oversight and strategic direction for investment activities within Intesa Sanpaolo Long-Term Line are the responsibility of the Board of Directors. Their primary duty is to ensure that the company's investment portfolio serves the best interests of its clients and stakeholders.

Supporting the Board of Directors in developing and executing investment policies and strategies is the role of the Investment Committee. Comprised of individuals with relevant expertise in finance, investments, and risk management, the committee ensures comprehensive decision-making.

Assuming responsibility for implementing the Investment Policy Statement (IPS) and managing day-to-day investment operations is the Chief Investment Officer (CIO). Endowed with the authority to lead the investment team, oversee investment managers, and provide regular reports on portfolio performance and strategy, the CIO plays a pivotal role in decision-making processes.

The investment team, under the guidance of the CIO, is composed of experts spanning various asset classes and investment strategies. Their responsibilities encompass thorough research, due diligence, portfolio construction, and continuous monitoring of investment managers and strategies. External investment managers may be engaged to oversee specific portions of the investment portfolio, provided their capabilities align with the requirements of Intesa Sanpaolo Long-Term Line.

Collaborating with the Risk Management Committee, the Investment Committee tracks investment-related risks and ensures compliance with the risk management framework outlined in the IPS. Regular risk reports, detailing key risk indicators and mitigation measures, are provided by the CIO to both committees and the Board of Directors.

Addressing risk management, the Risk Management Department within Intesa Sanpaolo Long-Term Line identifies, assesses, and manages investment-related risks. Staffed with experts in risk management, compliance, and investment operations, the department collaborates closely with the Investment Committee and the CIO to establish risk management policies, monitor portfolio risk exposures, and implement mitigation strategies.

Finally, the Chief Financial Officer is tasked with mandating asset management requirements for all firms engaged to provide investment services. Additionally, each firm must provide written confirmation of receipt and acceptance of the mandate document.

2.2 Governance

The investment approach should emphasize appropriate diversification and risk management, ensuring that risks associated with the assets are measurable and subject to ongoing monitoring. Both intrinsic and market risks need to be evaluated. The risk level must align with the client’s overall risk profile.

Various departments within the company play distinct roles during the investment process. These roles encompass data collection, analysis, and strategic decision-

making for the Investment Policy Statement (IPS). The IPS and investment strategy require approval from the Board of Directors, who oversee the company's investments, keeping in mind the acceptable risk tolerance and constraints. They also decide on any deviations from risk tolerance standards and approve corrective actions.

The Investment Committee is tasked with supervising the investment policy, strategy, and execution. It evaluates investment performance against benchmarks and asset allocation, considering predefined constraints and risk tolerance. The committee analyzes investment returns and recommends actions to address potential deviations from tolerance levels. The Chief Investment Officer (CIO) is responsible for selecting, monitoring, and, in case of need, terminating the services of investment management firms managing the selected assets.

The Investments Department is in charge of developing and implementing procedures to suggest IPS revisions through regular review and monitoring. It executes the investment strategy, optimizes the investment profile, and determines fund and asset allocation within established tolerance limits. The department manages investment risk, proposes new methods and procedures to measure risk and return, and reports to the Investment Committee and Board of Directors on market performance, investment allocation, and expected returns. In addition, it ensures adequate liquidity of investments and suggests ways to minimize management costs.

The responsible for developing and implementing procedures to evaluate investment risks is the Risk Management Department. This department proposes risk measurement and capital requirement methods and procedures, monitors them, and reports findings to the Board. It collaborates on analyzing and identifying mitigation measures for potential tolerance level breaches.

The Financial Department ensures accurate valuation of financial assets and proper accounting for financial transactions. It also oversees the preparation of external reports related to the investments.

2.3 Investment, Return and Risk Objectives

2.3.1 Investment Objective

The primary objective of this investment policy is to create an optimized portfolio tailored to the client's preferences and long-term goals. This involves constructing a diversified and balanced portfolio that aligns with the core values and ethical standards of the institution, integrating environmental, social, and governance (ESG) criteria into the investment process. The strategy aims to preserve capital, generate reliable income, and maintain sufficient liquidity to meet long-term obligations of the fund’s contributors, ensuring financial stability and sustainability. A robust governance framework is established, with clear roles, transparent decision-making processes, and regular performance reviews to monitor and adjust the portfolio as necessary.

To achieve these objectives, the investment policy emphasizes the importance of adhering to all relevant laws, regulations, and industry standards. The strategy includes effective stakeholder communication, providing transparency and fostering trust among all parties involved. By focusing on the client's specific requirements and preferences, the policy seeks to optimize the risk-return profile of the portfolio, ensuring that it meets the client's financial needs and objectives.

Innovation and adaptability are key components of the investment strategy, allowing the portfolio to stay responsive to changing market conditions and emerging opportunities. This includes constantly staying informed about new investment opportunities, technologies, and trends that can enhance portfolio performance. Overall, the policy aims to ensure prudent management of the pension fund, securing the financial future of beneficiaries and fulfilling fiduciary duties effectively. The comprehensive approach combines rigorous analysis, strategic planning, and continuous monitoring to achieve the desired outcomes for the client.

2.3.2 Return and Risk Requirements

The target for the final portfolio proposed to the client is a minimum annual return of 4.5 percent, together with a maximum annual volatility of 7.8 percent. This enables us to construct a portfolio that delivers attractive returns while effectively mitigating risks.

2.3.3 Risk Tolerance

The Investment Policy Statement (IPS) establishes a portfolio designed to optimize returns while managing risk in the most possible effective way. This strategy results to be essential in order to align with the client's preferences and long-term liabilities of its contributors. Recognizing that investment returns can vary, the IPS aims to balance the need for favorable returns with the necessity of mitigating risk. Given the client's relatively low-risk tolerance and the objective of matching liabilities, the IPS adopts a conservative approach.

The client's investment horizon extends over 15 years, indicating the potential for higher returns. However, the low-risk tolerance requires a cautious investment strategy. Diversification across different asset classes and sectors becomes pivotal in managing the associated risks, enhancing risk-adjusted returns, and ensuring the stability of the portfolio.

Being a pension fund, the client demonstrates a sophisticated understanding of the financial environment and the uncertainties associated to it. The IPS emphasizes the importance of selecting appropriate assets and adjusting the portfolio's duration and cash flow characteristics to match the timing and size of future liabilities.

Ensuring the immunization of the portfolio depends on various factors, including market returns on investments and the client's desired level of certainty or risk tolerance. If greater certainty in meeting liabilities is desired, a larger portion of the portfolio may be allocated to low-risk assets, which could lead to lower returns. By incorporating these considerations, the IPS prudently manages risk while pursuing the investment objectives of Intesa Sanpaolo Long-Term Line.

2.3.4 Relevant Constraints

In establishing the optimized portfolio, several constraints are meticulously considered. Firstly, a duration range between 6 and 10 years is established to match the client's long-term liabilities. Given the client's need for a low-risk portfolio, a significant allocation to fixed-income assets is required. Fixed-income securities offer stable returns and are generally considered low-risk investments. Consequently, a minimum allocation of 40 percent to this asset class is mandated by the client, who also specifies a preference for investments in both sovereign and corporate bonds, in the investment-grade category. Additionally, short selling is strongly disliked and thus prohibited for all investments (see *Table 1*).

Table 1: Exposure Constraints *Source: Made by Author*

ASSET CLASSES WEIGHTS

ASSET CLASS	MINIMUM WEIGHT	MAXIMUM WEIGHT
FIXED-INCOME	40%	100%
EQUITY	0%	60%
ALTERNATIVES	0%	15%

For the equity side, the portfolio is restricted to a maximum of 60 percent. Preference should be given to European assets or those denominated in EUR to mitigate currency risk. Investments in non-European countries are limited to a maximum of 10 percent. Due to their uncertainty and higher risk, emerging markets are not prioritized.

This strategy approach ensures effective management of currency risk and maintains the stability and integrity of the portfolio, aligning with the client's risk tolerance and investment preferences by adhering to these constraints. The portfolio aims to achieve an optimal balance between risk and return, ensuring long-term financial stability for the client.

2.3.5 Other Considerations relevant to Investment Strategy

In addition to the primary constraints, several other factors are considered to ensure the portfolio aligns with the client's overall strategy and requirements. Ethical and social responsibility considerations play a significant role in the investment strategy. Investments are screened emphasizing Environmental, Social, and Governance (ESG) criteria. The portfolio prioritizes companies demonstrating strong sustainability practices, good corporate governance, and positive social impact. Sector restrictions may also be imposed to avoid overexposure to particular industries, thereby enhancing diversification and reducing sector-specific risks.

Figure 1: ESG Score Composition *Source: www.lseg.com*

Regulatory compliance is another critical constraint, ensuring that all investments adhere to relevant legal and regulatory frameworks, both domestic and international. This includes adhering to specific mandates related to the pension fund's fiduciary responsibilities. Finally, tax efficiency is considered to optimize after-tax returns, taking into account the client's tax status and relevant tax regulations. By incorporating these additional constraints, the investment strategy is robustly tailored to meet the client's comprehensive financial goals and ethical standards (*Figure 1*).

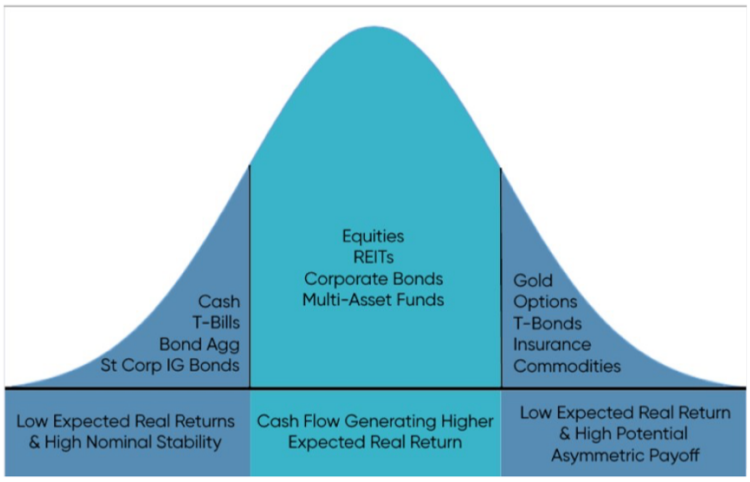
2.4 Risk Management

In constructing the optimized portfolio, a primary concern is the management of risk, particularly through the meticulous matching of asset duration to the client's specific needs. By aligning the duration of the portfolio's assets with the anticipated timeline of the client's liabilities, we aim to minimize interest rate risk and ensure the portfolio can meet future obligations. This alignment is crucial for a low-risk tolerance client, ensuring a stable investment approach. A substantial allocation to fixed-income securities, known for their lower risk and stable returns, forms the core of this strategy. The preference for investment-grade sovereign and corporate bonds further enhances stability and aligns with the client's conservative risk profile.

The selection of bonds involves carefully matching their maturities with the expected payout schedule of the client's liabilities. This duration matching or immunization strategy is designed to provide the necessary funds as liabilities come due, thereby minimizing reinvestment risk and interest rate volatility.

According to Roche et. al. (2023) it is possible to understand the appropriate time horizons for certain asset classes by quantifying their specific duration. They propose *Figure 2* that enlightens our choice of focusing on equity, corporate bonds and government bonds.

Figure 2: Investments according to Return Goal *Source: www.disciplinefunds.com*



Beyond duration matching, the investment strategy incorporates a continuous macroeconomic overview. This involves regular analysis of interest rate trends,

inflation expectations, economic cycles, and geopolitical developments, all of which can significantly impact portfolio performance and stability. Incorporating these macroeconomic insights allows for informed adjustments to the portfolio, maintaining its resilience and alignment with the client's long-term objectives. This approach involves periodic portfolio reviews and rebalancing to ensure adherence to the target duration and asset allocation. Given the dynamic nature of the market, this ongoing vigilance and flexibility are essential for adapting the investment strategy to evolving conditions.

To support these strategies, advanced risk management tools are employed, including Monte Carlo simulations and historical data analysis using a geometric Brownian motion model. These tools compute Value at Risk (VaR) and Conditional Expected Shortfall (CES), providing a quantitative assessment of potential losses under various market scenarios. Such metrics enable a robust evaluation of the portfolio's risk profile, facilitating informed decision-making.

The process for rebalancing portfolios to target allocations is well-defined. Periodic reviews are conducted to assess the portfolio's alignment with the client's objectives and risk tolerance. This structured approach to rebalancing helps manage risk and optimize returns, adapting to market changes while preserving the integrity of the investment strategy.

By integrating these risk management practices, performance measurement, and rebalancing processes, the investment strategy is designed to prudently manage risk while pursuing the investment objectives of the client. This comprehensive approach ensures that the portfolio remains resilient, aligned with the client's needs, and capable of achieving long-term financial goals.

3 Investment Design

3.1 Investment Philosophy

The investment philosophy adopted in this portfolio is grounded in a combination of active and passive management strategies, drawing from the framework proposed by Natter et al. (2021). They identify three primary drivers of fund returns: active security selection, passive style returns, and active market-timing performance.

- **Active Security Selection**: This involves making informed decisions to predict securities' idiosyncratic deviations from expected returns. Our approach focuses on the quality, risk exposure, and duration of bonds. For equities and corporate bonds, we analyze past performance, expected future performance, risk exposure, and the financial stability of the issuing companies. By rigorously evaluating these factors, we aim to identify securities that are likely to outperform their expected returns.
- **Passive Style Returns**: These are achieved by harvesting systematic risk premiums through long-term risk exposures. We ensure that the portfolio captures these premiums by maintaining a diversified allocation across asset classes, including equities, fixed income, and alternative investments. This diversification helps in stabilizing returns and reducing unsystematic risk.
- **Active Market-Timing Performance**: This involves making strategic decisions to temporarily deviate from long-term risk exposures based on market conditions. Although market timing can be challenging, we incorporate a dynamic approach to adjust the portfolio in response to macroeconomic trends, interest rate changes, and other relevant market indicators.

To implement this philosophy, we start with a comprehensive screening process to create an initial list of potential investments. For bonds, we prioritize quality, risk exposure, and duration to ensure alignment with the client's risk tolerance and investment horizon. For equities and corporate bonds, we focus on companies with strong past performance, solid fundamentals, and robust risk management practices. Using this refined list, we utilize advanced tools such as the Excel Solver to optimize the selection of assets. This optimization process takes into account the client's specific constraints and preferences, such as risk tolerance, investment horizon, and

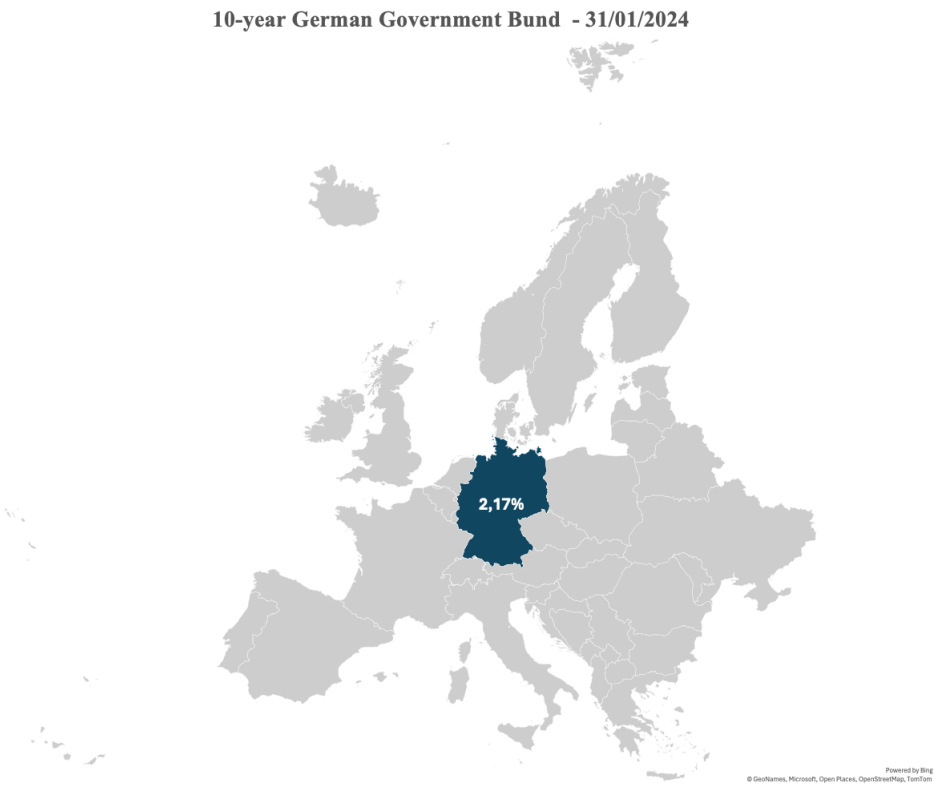
any ethical or ESG considerations. The result is a tailored portfolio designed to achieve Intesa Sanpaolo Long-Term Line desired balance of risk and return.

In conclusion, our investment philosophy is a combination of rigorous security selection, strategic risk exposure, and dynamic market-timing adjustments. By integrating these elements, we aim to construct a portfolio that not only meets the client's objectives but also adapts to changing market conditions, ensuring long-term stability and growth.

3.1.1 Macroeconomic Analysis

In constructing our investment portfolio, we use the 10-year German government bond (Bund) as the risk-free rate. As of January 31, 2024, the yield on this bond is 2.17 percent. This choice is justified by the fact that our investments are predominantly within the Eurozone, making the German Bund a suitable benchmark for risk-free returns (*Figure 3*).

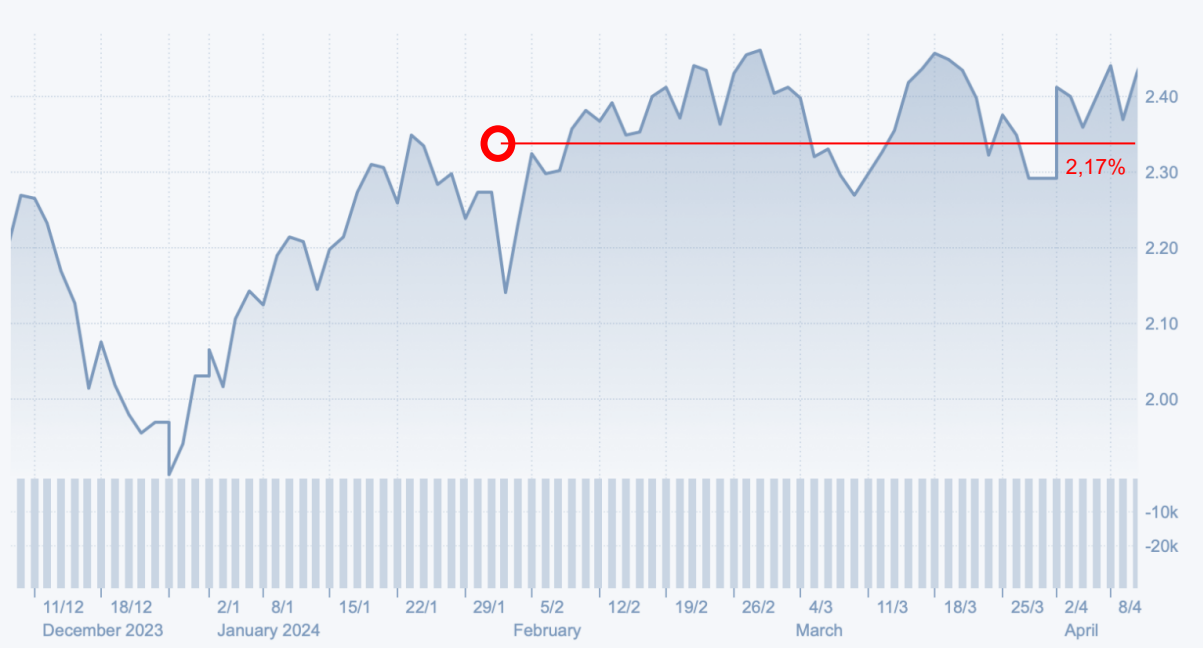
Figure 3: 10-year German Govt. Bund *Source: Made by Author*



The German government bond is considered one of the safest investments in the Eurozone due to Germany's strong credit rating and stable economic environment. By using the yield on the 10-year Bund as our risk-free rate, we align our portfolio's foundational assumptions with a reliable and relevant financial instrument.

In *Figure 4*, we present the evolution of the rate over the past six months, which demonstrates a discernible upward trend. Despite this increase, the rate remains comparatively lower than those observed in other European countries. This trend highlights the relative stability and attractiveness of the rate within the Eurozone, making it a pertinent choice for risk-free rate calculations in our investment strategy. Additionally, when compared to the US yield, which generally exhibits higher rates due to differing economic conditions and monetary policies, the Eurozone rate offers a more conservative benchmark, further reinforcing its suitability for our purposes.

Figure 4: 10-yr German Govt. Bund *Source: www.markets.ft.com*



3.2 Optimisation Portfolio

3.2.1 Mean Variance optimization and restrictions

Expected returns and volatilities for the initial calculations are derived from the 2024 Long-Term Capital Market Assumptions (LTCMAs) provided by JP Morgan. Despite the fact that we cannot use short selling we determine the envelop hyperbola to take a reference in terms of efficiency. Using the mean-variance framework we compute several portfolios, such as the minimum variance and the tangent portfolio.

The process involves utilizing the Solver function in Excel to optimize the portfolio while adhering to specific constraints. These constraints include a minimum allocation of 60 percent to the three fixed-income benchmarks, ensuring a substantial portion of the portfolio is invested in relatively stable assets. Additionally, each benchmark must receive a minimum investment of 2.5 percent, precluding short selling and promoting diversification across the selected benchmarks.

Moreover, to mitigate risk, a maximum volatility threshold of 7.8 percent is imposed, ensuring that the portfolio maintains an acceptable level of risk exposure. Simultaneously, a minimum annual expected return of 4.5 percent is set to ensure that the portfolio meets the client's performance objectives while balancing risk considerations.

The individual assets chosen for the portfolio are sourced from these benchmarks and are selected to mirror their performance characteristics. This approach ensures that the portfolio not only meets the client’s constraints but also adheres to the desired risk-return profile.

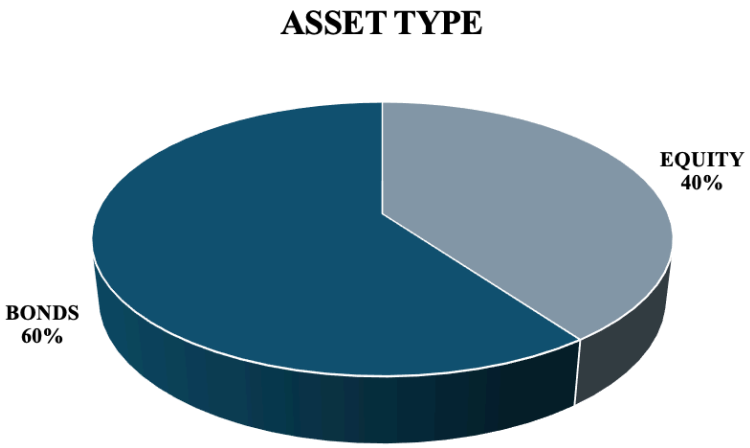
The return and volatility computations are conducted with a focus on historical performance and future expectations, aligning with the benchmarks' asset characteristics. This methodical approach facilitates the identification of optimal assets, ensuring a well-diversified portfolio that meets the client's investment objectives while adhering to established risk parameters.

3.2.2 Strategic Asset Allocation

Benchmark Allocation

At this stage, the focus is on determining the optimal asset allocation for the portfolio, specifically the distribution between equity and fixed-income securities. Given the client's conservative risk tolerance and a long-term investment horizon of 15 years, it is crucial to find a balance that ensures growth while minimizing volatility (*Figure 5*).

Figure 5: Asset Type Distribution *Source: Made by Author*



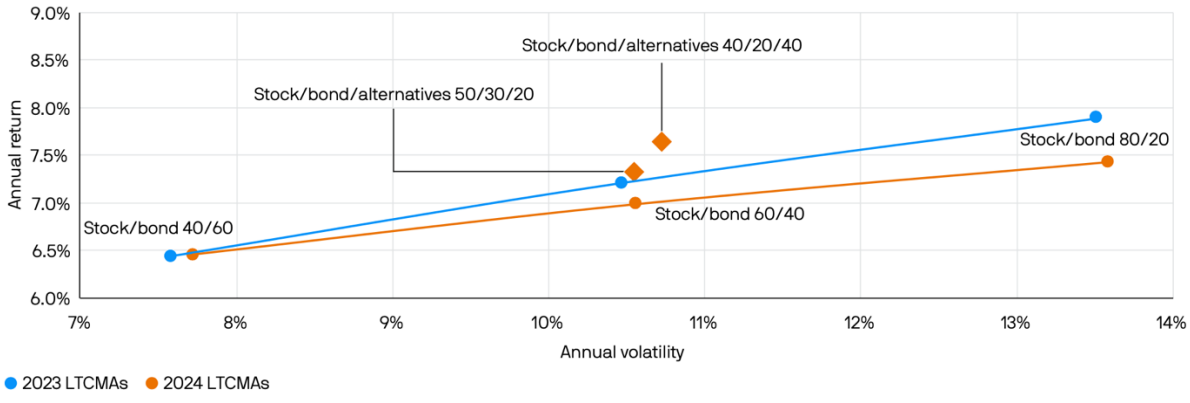
To determine the appropriate asset allocation, we utilize again the 2024 Long-Term Capital Market Assumptions (LTCMAs) provided by J.P. Morgan, which offer valuable insights into the expected annual returns and volatilities associated with various asset class combinations. These assumptions enable us to model different portfolio scenarios and evaluate their potential outcomes.

After thorough analysis, a 40/60 allocation between equities and fixed-income securities emerges as the most suitable for meeting the fund's objectives. This distribution balances the growth potential of equities with the stability of fixed-income investments, aligning with the client's risk tolerance and investment horizon (see *Figure 6*).

The chosen 40/60 equity-to-fixed-income ratio is supported by historical performance data and current market conditions, indicating that this mix provides a favorable trade-off between risk and return. This allocation is further justified by constraints and

objectives proposed by the client, ensuring that the annual expected return and volatility are consistent with their goals.

Figure 6: 2023 LTCMAs vs 2024 LTCMAs *Source: www.am.jpmorgan.com*



Source: J.P. Morgan Asset Management; data as of September 30, 2023.

In *Table 2* below, the annualized expected returns and volatilities from JP Morgan – 2024 LTCMAs are reported, providing further insights into the expected performance metrics of the selected benchmarks.

Table 2: Final Benchmark Returns and Volatilities *Source: Made by Author*

Indices	Exp. Return	Volatility
Bloomberg Eurozone Developed Markets Small Cap Net Return Index	8,30%	18,25%
MSCI Europe ESG Leaders Index	7,30%	15,06%
iBoxx® EUR Sovereigns Eurozone AAA Index	3,50%	5,07%
Bloomberg EuroAgg Total Return Index	3,50%	5,07%
Markit iBoxx Corporates EUR Index	4,00%	5,03%

All five indices chosen are Euro-denominated. The first two indices in *Table 2* are equity indices: one focuses on companies with smaller capitalization, and the other on companies with larger capitalizations, both consisting solely of European stocks. As expected, these two indices exhibit higher volatility compared to the ones following.

The subsequent three indices are fixed-income indices, emphasizing investment-grade bonds, the safest category, to ensure a high level of security for the client. The last two of these indices are composed entirely of sovereign bonds, which accounts for its slightly higher expected return. The last one in the list also incorporates some

extra-European bonds but remains Euro-denominated. This combination of benchmarks, along with their allocation in the final portfolio, ensures adequate diversification while adhering to all the constraints set by Intesa Sanpaolo Vita.

Alliance Bernstein (2023) supports our approach of prioritizing fixed-income investments in European markets, particularly high-quality (investment grade) bonds. The article highlights that the policy easing of the past months should benefit Euro and UK sovereign bonds. Additionally, fundamental valuation factors are all supportive of Euro credit markets. This reinforces our belief that maintaining a majority allocation in this asset class is reasonable, not only in the current market environment but also over the medium to long term. By incorporating this perspective into the investment strategy, we aim to provide a stable and reliable proposal for the client.

To determine the optimal portfolio allocation, several key variables are examined: expected returns, risks (volatilities), and correlations of the assets. We analyze the weights of the tangent portfolios with and without short selling to gain initial insights into potential weightings for each benchmark. This analysis provides a foundation for understanding how different assets contribute to the portfolio's overall performance. Despite the initial findings, these weightings often diverge from the previously selected 40/60 allocation, necessitating the creation of alternative portfolios to achieve the desired asset mix.
The final allocation of benchmarks adhering to constraints specified by our client is reported in *Table 3*. The optimization process starts with the use of the Solver function. We impose restrictions requiring a maximum allowable standard deviation of 7.8 percent per year and a minimum expected return of 4.5 percent and a minimum investment of 2.5 percent in each index. Such constraints ensure that the portfolio proposed meets the client's return expectations and, contemporarily, maintains an acceptable level of risk.
The Solver function repeatedly adjusts the weights in order to find the optimal solution meeting the specified constraints while maximizing the Sharpe ratio.

This last stipulation is crucial as it prevents the exclusion of any benchmark, maintain the portfolio diversified and, mostly important, balanced.

Table 3: Final Portfolio Information *Source: Made by Author*

BENCHMARKS	VOLATILITY	R_BAR	WEIGHT
EURODSCN	18,250%	8,300%	0,025
EUSI	15,060%	7,300%	0,375
I8KW	5,070%	3,500%	0,025
LBEATREU	5,070%	3,500%	0,025
QW5A	5,030%	4,000%	0,55
			100,00%
Portfolio			
Return	**5,32%**		
Variance	0,005075472		
vol (sigma)	**7,12%**		
Sharpe ratio	0,44215275		
volatility cap	7,80%		

The weights for each benchmark are determined to optimize the trade-off between return and risk, resulting in a customized investment strategy that meets the specific needs and preferences of Intesa Sanpaolo Vita Long-Term Line.

3.2.3 Security Selection

Individual Asset Selection and Final Portolio

After completing the allocation of benchmarks and determining their weights, it is possible to proceed with the analysis of the individual assets that can be included in the final portfolio proposed to the client.

The initial list comprises a total of fifty individual assets, with ten assets belonging to each previously considered index. While more assets could have been included, limiting each benchmark to ten assets facilitates the selection process. So, starting with a total of twenty stocks and thirty bonds, given that we have two equity indices and three fixed-income indices, it is possible to begin with the analysis of our collected data. This phase prioritizes the unique characteristics of each asset, including their annualized historical performance over a 10-year horizon (daily historical data spanning from 31/01/2014 to 31/01/2024), as well as the duration and Yield to Maturity (YTM) for bonds. Upon initial review, the list enlightens assets from various countries and sectors, aligning with the client's preferences for diversification.

The subsequent step entails a reduction in the number of assets to a maximum of 20, ensuring compliance with the benchmark weights as described earlier in the text. This process is facilitated through the use of Excel, particularly through the Solver function, which enables the imposition of constraints and the determination of final individual asset weights. By employing Solver, assets not congruent with client objectives are systematically eliminated, consequently resulting in the creation of a final portfolio version.

The resulting optimal portfolio, comprising 18 assets, meticulously adheres to specified constraints and mirrors the performance of benchmark portfolio established in earlier stages of the process. The decision to maintain an 18-asset portfolio reflects industry-standard practices in portfolio construction, balancing diversification, expected returns, and volatilities, all while aligning with client goals. *Table 4* and *Table 5* present the final 18 individual assets.

Table 4: Equity assets selected *Source: Made by Author*

Index	Security Name	Thicker	Price	AER
EURODSCN	BE SEMICONDUCTOR INDUSTRIES W	BESI	139,80	43,2461%
	IMCD NV	IMCD	142,00	22,8517%
	BANCO BPM SPA	BAMI	5,01	-3,5015%
EUSI	NOVARTIS	NOVN	95,84	9,6673%
	HSBC HOLDINGS	HSBA	7,25	4,3105%
	UNILEVER PLC	ULVR	44,69	8,2465%

Table 5: Fixed-Income assets selected *Source: Made by Author*

Index	Security Name	Thicker	Price	Duration	YTM
I8KW	BBG01C6SYFN8 GERMANY (FEDERAL REPUBLIC) 33 2.3 2/33	ZM198538	101,62	7,869	2,4658%
	4% BRD BUNDESANLEIHE 2037	ED783809	118,68	10,083	2,5879%
	REPUBLIC OF GERMANY 2/26	JV503423	96,26	1,807	2,9546%
LBEATREU	FRANCE (GOVT OF) 0 11/25/2030	BJ789948	84,90	6,461	2,7492%
	FRANCE (GOVT OF) 2.75 10/25/2027	EJ346891	101,34	3,305	2,7738%
	FRANCE (GOVT OF) 0.5 05/25/2026	JK270632	95,63	2,061	2,9185%
	FRANCE (GOVT OF) 2.5 09/24/2026	ZL004994	100,13	2,33	2,8844%
QW5A	UBS GROUP AG 06/22/2042	BX157894	95,65	12,52	4,2370%
	ANHEUSER-BUSCH INBEV SA/NV 01/23/2035	AQ688741	88,97	9,39	3,4490%
	ELECTRICITE DE FRANCE AS 10/12/2034	BZ537868	107,32	7,97	3,9500%
	JPMORGAN CHASE & CO 03/19/2043	ZK538309	105,57	8,01	3,9870%
	VOLKSWAGEN INTERNATIONAL FINANCE NV 02/15/2028	ZN213981	102,70	3,52	3,7520%

Below, the selected individual assets are described more in detail:

EURODSCN

- *BE Semiconductor Industries W* (**BESI**): it is a Dutch company specializing in semiconductor assembly equipment. The products include die attach, packaging, and plating equipment, along with related services. They serve global semiconductor and electronics industries, with clients such as multinational chip manufacturers and electronics companies. The company has been established in 1995, and is headquartered in Duiven, the Netherlands.
- *IMCD NV* (**IMCD**): established in 1995 and headquartered in the Netherlands, it distributes specialty chemicals and ingredients worldwide. Their products include adhesives, pigments, plasticizers, and personal care ingredients (sunscreens and fragrances). They also operate the oil, gas, and energy sectors.
- *Banco BPM SPA* (**BAMI**): based in Verona, Italy, offers banking and financial services to individual, business, and corporate clients throughout Italy. Current accounts, credit cards, loans, insurance, investment funds, and internet platforms are among the services they offer. In January 2017, Banco Popolare Società Cooperativa Scarl, the company's previous name, was renamed to Banco BPM Società per Azioni.

EUSI

- *Novartis* (**NOVN**): based in Basel, Switzerland, is a global healthcare company known for its research, development, and marketing of prescription medicines. Focusing on areas such as: cardiovascular, immunology, neuroscience, oncology, ophthalmology, and hematology. Novartis AG collaborates with Alnylam Pharmaceuticals and Dawn Health for innovative therapies. Established in 1996.
- *HSBC Holdings* (**HSBA**): based in London (UK), HSBC is a global banking and financial services provider. Through Wealth and Personal Banking, Commercial Banking, and Global Banking and Markets segments, the company offers

different services to individuals, businesses, and institutions all over the world. Established in 1865.

- *Unilever PLC* (**ULVR**): established in London, UK, is a global consumer goods company with five segments: Beauty & Wellbeing, Personal Care, Home Care, Nutrition, and Ice Cream. Established in 1860, Unilever offers a wide range of products including hair care, skin care, oral care, fabric care, dressings, plant-based meat, beverages, and ice cream. The company is also known for brands like Dove, Lipton, and Magnum.

I8KW

In the context of this index, the selection of three distinct German Sovereign bonds with varying maturities - 2026, 2033, and 2037 - embodies a strategic approach aimed at bolstering portfolio diversification across different investment horizons. Each bond represents a cornerstone of stability and security within the global financial landscape, reflecting the robust creditworthiness and fiscal prudence synonymous with the German government.

- GERMANY (FEDERAL REPUBLIC) 2.3 2/33 (*ZM198538*).
- 4% BRD BUNDESANLEIHE 2037 (ED783809).
- REPUBLIC OF GERMANY 2/26 (*JV503423*).

Renowned for their security and stability, these bonds are a good choice for investors looking to protect their money and generate steady returns over time. Even though the allocation of the index is not geographically diversified within Germany, it is important to remember that an equivalent government bond from another nation is suggested in the index that follows, providing investors with a wider range of investment options while adhering to stability and risk management.

LBEATREU

In line with the previous index, a similar approach has been taken, this time focusing on France, widely regarded as one of the safest economic environments in Europe. The selection encompasses a range of French government bonds, each exemplifying the nation's esteemed creditworthiness and stable fiscal position:

- FRANCE (GOVT OF) 0 11/25/2030 (*BJ789948*)

- FRANCE (GOVT OF) 2.75 10/25/2027 (*EJ346891*)
- FRANCE (GOVT OF) 0.5 05/25/2026 (*JK270632*)
- FRANCE (GOVT OF) 2.5 09/24/2026 (*ZL004994*)

While the index may exhibit reduced geographical diversification, the inclusion of high-quality French government bonds ensures a stable and dependable income stream for investors. The yields offered by these bonds are deemed satisfactory, aligning with the client's investment objectives and providing a compelling proposition within the Euro-denominated fixed-income market.

QW5A

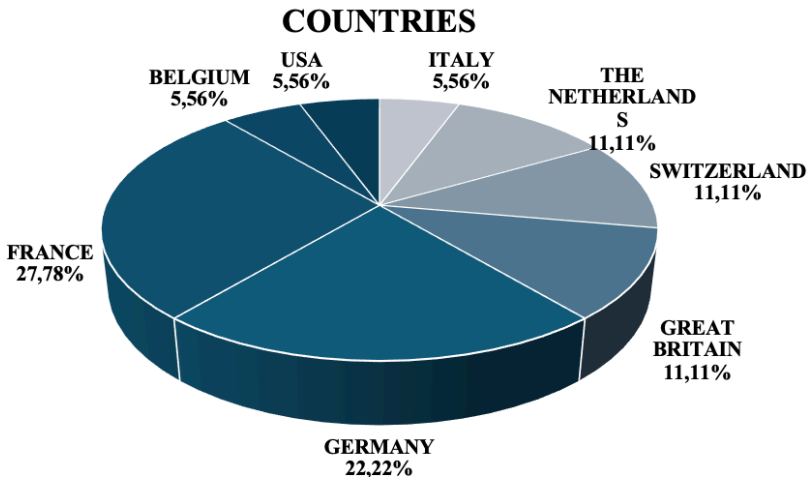
- *UBS GROUP AG 06/22/2042*: UBS GROUP AG (Switzerland) operates internationally, providing a range of financial services including wealth management, investment banking, asset management, and retail banking. This corporate bond, maturing in 2042, offers fixed interest payments and is rated as investment-grade, reflecting the company's strong creditworthiness and stable financial position.
- *ANHEUSER-BUSCH INBEV SA/NV 01/23/2035*: ANHEUSER-BUSCH INBEV SA/NV, based in Leuven, Belgium, is a leading global brewer known for brands like Budweiser, Stella Artois, and Corona. This corporate bond, maturing on January 23, 2035, offers fixed interest payments and holds an investment-grade rating, indicating the company's solid financial stability and creditworthiness.
- *ELECTRICITE DE FRANCE AS 10/12/2034*: ELECTRICITÉ DE FRANCE (EDF), headquartered in Paris, France, is a leading global energy company specializing in electricity generation, transmission, and distribution. This corporate bond, maturing on October 12, 2034, offers fixed interest payments and holds an investment-grade rating, demonstrating EDF's solid financial health and reliable credit profile.
- *J.P. MORGAN CHASE & CO 03/19/2043*: J.P. Morgan Chase & Co., headquartered in New York City, USA, is a leading global financial services firm offering a wide range of services, including investment banking, asset management, treasury, and securities services. This corporate bond, maturing

on March 19, 2043, holds an investment-grade rating, reflecting J.P. Morgan Chase's robust financial health and dependable credit standing.

- *VOLKSWAGEN INTERNATIONAL FINANCE NV 02/15/2028*: this company, based in Amsterdam, Netherlands, is a prominent financial entity associated with the Volkswagen Group. This corporate bond, maturing on February 15, 2028, holds an investment-grade rating, underlining VOLKSWAGEN INTERNATIONAL FINANCE NV's resilient financial position and trustworthy creditworthiness.

The geographical diversification achieved through the inclusion of bonds from different European countries and multinational corporations significantly mitigates country-specific risks. While the sovereign bonds are exclusively from Germany and France, representing two of the most stable and robust economies in Europe, the corporate bonds include issuers with a broad international footprint. This geographical diversification ensures that the portfolio does not overly rely on the economic conditions of a single country. Instead, it spreads risk across various regions and sectors, thereby enhancing the portfolio's resilience against local economic, regulatory, or political issues (*Figure 7*).

Figure 7: Geographical Distribution *Source: Made by Author*



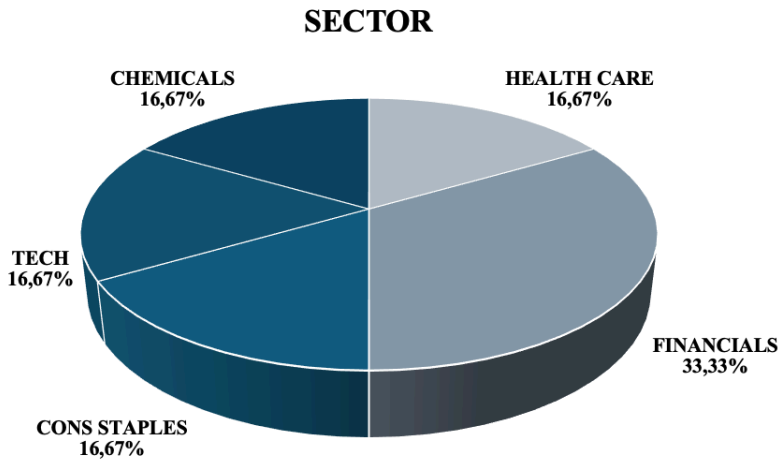
Investing in German and French sovereign bonds is a strategic choice due to the economic stability and strong credit ratings of these nations. German Bunds are known for their safety and liquidity, making them a preferred choice for conservative investors. Similarly, French government bonds offer a favorable combination of safety and yield.

By selecting bonds with different maturities, the portfolio benefits from diversification across time horizons, reducing the risk associated with any single bond's maturity date.

The inclusion of high-grade corporate bonds from multinational corporations adds another layer of diversification. These corporations are leaders in their respective industries, with strong financial health and global operations. The investment-grade quality of these bonds ensures a balance between higher yield opportunities and risk management.
Each corporate bond is selected based on the issuer's creditworthiness and ability to generate stable cash flows, contributing to the portfolio's overall stability. Balancing investments across multiple jurisdictions provides several advantages. It reduces the impact of adverse economic events in any single country on the entire portfolio. For example, economic downturns, changes in regulatory policies, or political instability in one country may not affect bonds from another country or those issued by multinational corporations operating globally. This diversification strategy enhances the portfolio’s resilience, making it less susceptible to localized risks.

Diversification extends beyond the geographical point of view and includes sector diversification in order to mitigate risk even more effectively. By allocating investments across different industry sectors, the proposed portfolio reduces sector-specific risk exposure and increases overall stability. Consequently, the portfolio not only aims for long-term stability but also seeks positive and consistent performance across different financial conditions. Sector diversification complements the overall strategy, in line with the conservative profile of the client. *Figure 8*, in the next page, exhibits this diversification graphically:

Figure 8: Sector Diversification *Source: Made by Author*



3.2.4 Expected Performance

According to Li (2023), the maximization of the Sharpe ratio, is an effective method for constructing robust investment portfolios. Using numerical methods also at the individual assets level, we ensure that the final portfolio meets the client's specific needs for both return and risk.

$$Sharpe\ Ratio = \frac{(\bar{R}_P - R_F)}{\sigma_P}$$

We maintain also previously mentioned restrictions imposing in addition that the weight associated with the asset belonging to a given index must be as in Table 3.

The optimization process results in a portfolio with an expected annual return of 5.32 percent and a volatility of 7.12 percent. This portfolio aligns with the client's risk tolerance and investment objectives, balancing the need for stable returns with controlled risk exposure. The maximized Sharpe ratio indicates that the portfolio is efficient, providing the best possible return for the level of risk taken.

Table 6: Individual Assets and specific Weights *Source: Made by Author*

Index	Security Name	Thicker	Weight	Tot. Weight
EURODSCN	**BE SEMICONDUCTOR INDUSTRIES W**	BESI	0,2352%	2,50%
	IMCD NV	IMCD	0,2982%	
	BANCO BPM SPA	BAMI	1,9666%	
EUSI	**NOVARTIS**	NOVN	3,8934%	37,50%
	HSBC HOLDINGS	HSBA	5,4705%	
	UNILEVER PLC	ULVR	28,1361%	
I8KW	**BBG01C6SYFN8 GERMANY (FEDERAL REPUBLIC) 33 2.3 2/33**	ZM198538	0,8638%	2,50%
	4% BRD BUNDESANLEIHE 2037	ED783809	0,7843%	
	REPUBLIC OF GERMANY 2/26	JV503423	0,8519%	
LBEATREU	**FRANCE (GOVT OF) 0 11/25/2030**	BJ789948	0,6069%	2,50%
	FRANCE (GOVT OF) 2.75 10/25/2027	EJ346891	0,6321%	
	FRANCE (GOVT OF) 0.5 05/25/2026	JK270632	0,6299%	
	FRANCE (GOVT OF) 2.5 09/24/2026	ZL004994	0,6311%	
QW5A	**UBS GROUP AG 06/22/2042**	BX157894	13,6361%	55,00%
	ANHEUSER-BUSCH INBEV SA/NV 01/23/2035	AQ688741	8,7624%	
	ELECTRICITE DE FRANCE AS 10/12/2034	BZ537868	11,2435%	
	JPMORGAN CHASE & CO 03/19/2043	ZK538309	10,0206%	
	VOLKSWAGEN INTERNATIONAL FINANCE NV 02/15/2028	ZN213981	11,3373%	

The selected portfolio includes a carefully curated mix of equity and fixed-income assets, reflecting the benchmarks and adhering to the strategic asset allocation previously determined (see *Table 6*). This combination leverages the growth potential of equities and the stability of fixed-income securities, ensuring a well-rounded investment approach.

Figure 9: MVT and Hyperbola *Source: Made by Author*

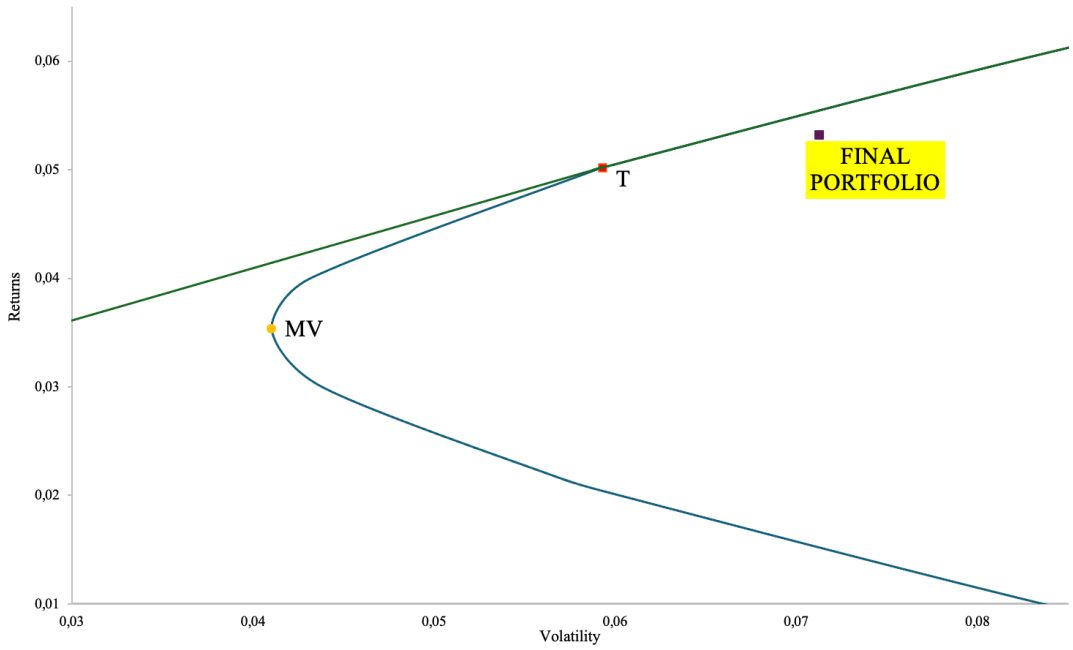


Table 7 below presents a comparison of the different weights for the Final Portfolio, the Minimum-Variance Portfolio, and the Tangent Portfolio (with no short-selling):

Table 7: Final Portfolio, MV and T Weights Comparison *Source: Made by Author*

	Weights		
	Final Portfolio	**MV**	**T (no Short-Selling)**
EURODSCN	2,500%	1,903%	20,099%
EUSI	37,500%	-7,256%	0,000%
I8KW	2,500%	25,962%	0,000%
LBEATREU	2,500%	35,486%	0,000%
QW5A	55,000%	43,906%	79,901%

The Sharpe ratio of the final portfolio is 0.442, reflecting the moderate and conservative approach chosen by the client. This relatively lower Sharpe ratio is consistent with the client's preference for minimizing risk while achieving steady returns. If the client had opted for a more aggressive approach, the portfolio's expected return could increase. In such a scenario, the allocation would likely shift towards higher-risk assets, such as equities, to capitalize on their greater return potential. *Figure 9* shows the efficiency of the proposed portfolio comparing it to the minimum-variance (MV) and tangent (T) portfolios.

Table 8: MV, Tangent and Final Portfolio Comparison *Source: Made by Author*

	Exp. Return	**Volatility**	**Sharpe Ratio**
MV Portfolio	3.54%	4.10%	0.332959
Tangent Portfolio	4.87%	5.62%	0.479421
Final Portfolio	5.32%	7.12%	0.442153

By maximizing the Sharpe ratio, we create a portfolio that not only meets but exceeds the client’s expectations for return and risk. This methodical approach, grounded in modern portfolio theory and supported by optimization techniques, provides a scientifically sound and practical solution for achieving the client's financial goals. *Table 8* compares the proposed portfolio with the theoretical minimum-variance (MV) and tangent (T) portfolios.

3.2.5 Risk Analysis

In finance, conducting a thorough risk analysis is crucial to build a robust investment portfolio. Utilizing multiple methodologies for risk assessment is essential, as it ensures a comprehensive evaluation of downside risk and potential losses across various market conditions and scenarios. In our case, we analyzed the final proposed portfolio in terms of Value at Risk (VaR) and Conditional Expected Shortfall (CES) are computed using two distinct methods: historical performance analysis and Monte Carlo simulations. These measures are chosen for their established reliability and widespread acceptance in quantifying portfolio risk.

To enhance our risk assessment, we employ Geometric Brownian Motion (GBM) as a fundamental stochastic process to model the evolution of our portfolio value. GBM facilitates Monte Carlo simulations and the estimation of historical VaR and CES, allowing for a more comprehensive evaluation of risk. The GBM's mathematical framework relies on a stochastic differential equation that tracks how an asset's price changes over time,

$$dS_t = \mu S_t dt + \sigma S_t dW_t \ ,$$

it encompasses two key elements: deterministic components for the expected long-term trend (drift) and stochastic components for the random fluctuations (volatility) in the asset's price.

The application of Geometric Brownian Motion (GBM) in Monte Carlo simulations involves generating simulated paths of asset prices to assess portfolio risk under various future scenarios.

For our analysis, we compute VaR and CES using both historical performance and Monte Carlo simulations. Historical Performance analysis involves computing the portfolio value over time using current weights, determining historical returns, and subsequently computing the risk measures.

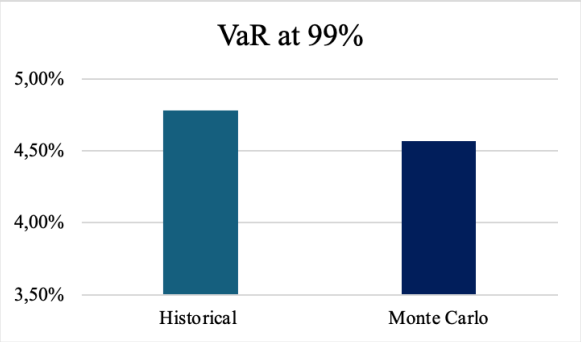
For Monte Carlo simulation, the process begins by selecting a suitable risk-free rate, which stands at 2.17 percent, representing the ten-year German bund rate as of January 31, 2024. This rate is used to discount future cash flows and calculate the returns of our portfolio.
The expected return and volatility of the portfolio, derived from historical data, are used as inputs to simulate future price paths using GBM. Portfolio returns are then simulated over 10000 iterations, with each iteration aggregating the randomly generated returns of individual assets weighted according to their portfolio allocation.

The simulated portfolio returns are used to construct a distribution, illustrated with a histogram, as it is possible to observe in *Figure A3* of the Appendix, which provides insights into the range of possible portfolio performances. VaR at 99% confidence level is then calculated from this distribution, representing the threshold below which the portfolio's performance will not fall more than 1% of the time. CES represents the average loss exceeding the VaR threshold, focusing on tail risk and offering a more comprehensive view of potential worst-case scenarios.

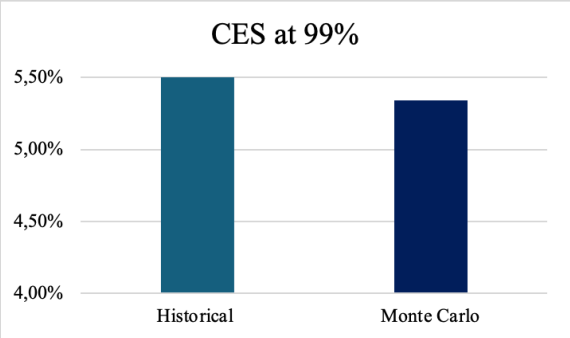
The simulated risk measures are validated against historical data to assess the model's accuracy and reliability (see *Figure 10* and *Figure 11*). This process ensures a deeper understanding of the of the portfolio's risk profile, enabling more informed decision-making and effective risk management strategies.
The historical VaR at 99% is € -5.258.000, while the Monte Carlo VaR at 99% is € -5.027.000. For CES, the historical figure is € -6.127.000 and the Monte Carlo CES is € -5.874.000 all based on a trading month of 21 days. These findings demonstrate that assuming Gaussian returns (as in GBM) is not the most conservative approach.

Figure 10-11: 99% Conf. Int. VaR (left) and 99% Conf. Int. CES (right). Source: Made by Author

	Historical	Monte Carlo
VaR at 99%	-5.258.000,00 €	-5.027.000,00 €



	Historical	Monte Carlo
CES at 99%	- 6.127.000,00 €	- 5.874.000,00 €



This dual-method approach facilitates informed decision-making to optimize risk-return dynamics.

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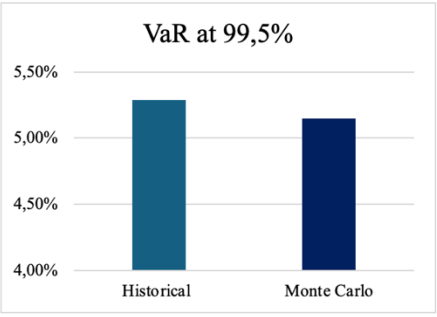
Appendices

Table A1*: Final Portfolio Individual Assets*

Index	Security Name	Ticker	Price	Duration	AER/YTM	Weight	Tot. W.	Amount Invested	Quantity	Tot. Amount	Type	Country
EURODSCN	**BE SEMICONDUCTOR INDUSTRIES W**	BESI	139,80	/	43,2461%	0,2352%	2,50%	258.734,89 €	1850,75031		Equity	The Netherlands
	IMCD NV	IMCD	142,00	/	22,8517%	0,2982%		327.985,60 €	2309,75778		Equity	The Netherlands
	BANCO BPM SPA	BAMI	5,01	/	-3,5015%	1,9666%		2.163.279,50 €	431792,3158	2.750.000,00 €	Equity	Italy
EUSI	**NOVARTIS**	NOVN	95,84	/	9,6673%	3,8934%	37,50%	4.282.752,20 €	44685,03423		Equity	Switzerland
	HSBC HOLDINGS	HSBA	7,25	/	4,3105%	5,4705%		6.017.554,04 €	830427,8227		Equity	Great Britain
	UNILEVER PLC	ULVR	44,69	/	8,2465%	28,1361%		30.949.693,75 €	692578,8547	41.250.000,00 €	Equity	Great Britain
ISKW	**BBG011C6SYFN8 GERMANY (FEDERAL REPUBLIC) 33 2.3 2/33**	ZM1198538	101,62	7,869	2,4658%	0,8638%	2,50%	950.191,84 €	9350,165242		Sovereign	Germany
	4% BRD BUNDESANLEIHE 2037	ED783809	118,68	10,083	2,5879%	0,7843%		862.761,30 €	7269,459857		Sovereign	Germany
	REPUBLIC OF GERMANY 2/26	JV503423	96,26	1,807	2,9546%	0,8519%		937.046,85 €	9734,439216	2.750.000,00 €	Sovereign	Germany
LBEATREU	**FRANCE (GOVT OF) 0 11/25/2030**	BJ789948	84,90	6,461	2,7492%	0,6069%	2,50%	667.544,84 €	7863,08946		Sovereign	France
	FRANCE (GOVT OF) 2.75 10/25/2027	EJ346891	101,34	3,305	2,7738%	0,6321%		695.285,38 €	6860,646756		Sovereign	France
	FRANCE (GOVT OF) 0.5 05/25/2026	JK270632	95,63	2,061	2,9185%	0,6299%		692.933,92 €	7246,216275		Sovereign	France
	FRANCE (GOVT OF) 2.5 09/24/2026	ZL004994	100,13	2,33	2,8844%	0,6311%		694.235,85 €	6933,622122	2.750.000,00 €	Sovereign	France
QWSA	**UBS GROUP AG 06/22/2042**	BX157894	95,65	12,52	4,2370%	13,6361%	55,00%	14.999.677,74 €	156826,5747		Corporate	Switzerland
	ANHEUSER-BUSCH INBEV SA/NV 01/23/2035	AQ688741	88,97	9,39	3,4490%	8,7624%		9.638.686,52 €	108336,3664		Corporate	Belgium
	ELECTRICITE DE FRANCE AS 10/12/2034	BZ537868	107,32	7,97	3,9500%	11,2435%		12.367.891,66 €	115243,1202		Corporate	France
	JPMORGAN CHASE & CO 03/19/2043	ZK538309	105,57	8,01	3,9870%	10,0206%		11.022.700,81 €	104407,3429		Corporate	USA
	VOLKSWAGEN INTERNATIONAL FINANCE NV 02/15/2028	ZN213981	102,70	3,52	3,7520%	11,3373%		12.471.043,26 €	121431,7747	60.500.000,00 €	Corporate	Germany
							100,00%			110.000.000,00 €		

Figure A1*: Results of Risk Analysis at 99,5% Confidence Interval*

	Historical	Monte Carlo
VaR at 99,5%	-5,29%	-5,15%



	Historical	Monte Carlo
CES at 99,5%	-5,92%	-5,88%

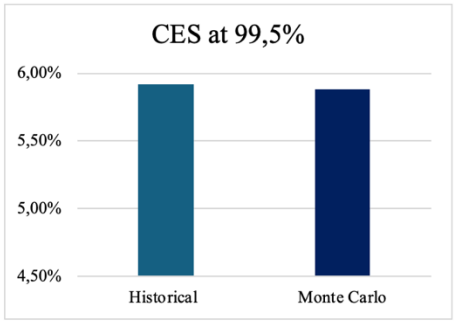
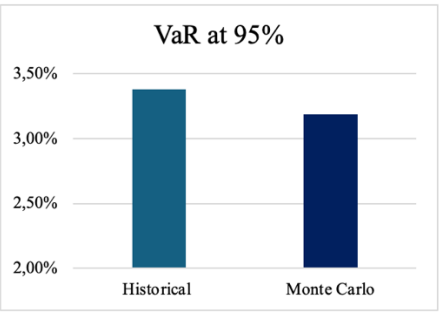


Figure A2*: Results of Risk Analysis at 95% Confidence Interval*

	Historical	Monte Carlo
VaR at 95%	-3,38%	-3,19%



	Historical	Monte Carlo
CES at 95%	-4,22%	-4,05%

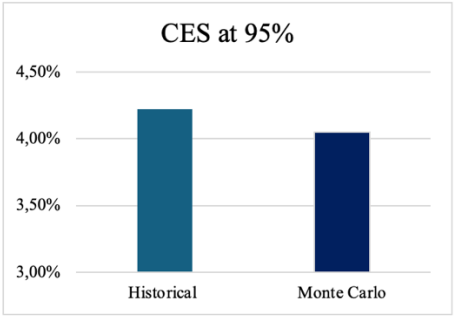
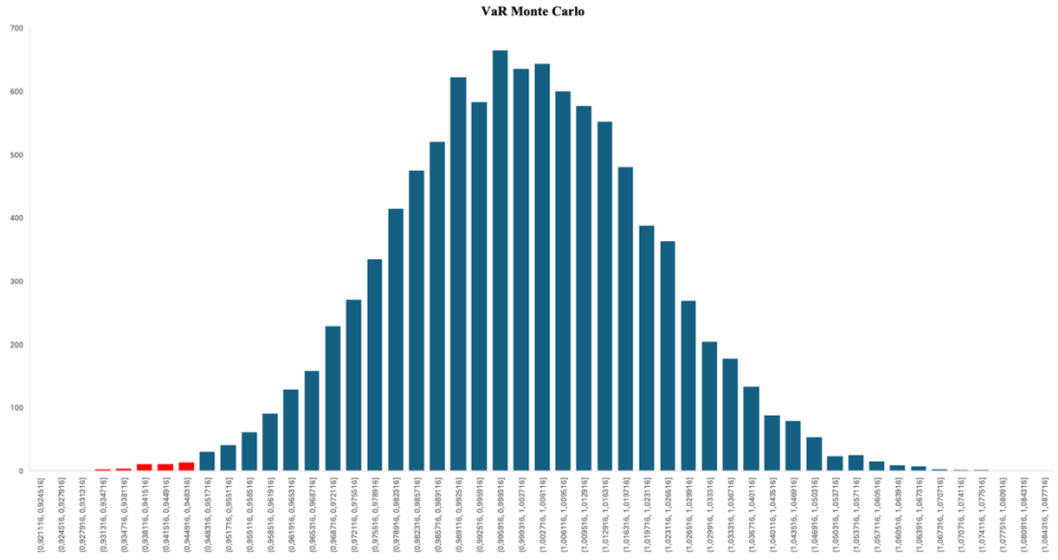


Figure A3*: Monte Carlo distribution with 99% Confidence Interval*



(the red part on the left shows the 1% probability of having at least a 4,57% loss over the trading month)

Figure A4*: Map of Countries involved in the Asset Selection*

AI Disclaimer

I disclose that AI tools were employed during the development of this thesis as follows:

- AI-based research tools were used to assist in literature review and data collection.
- AI-powered software was utilized for data analysis and visualization.
- Generative AI tools were consulted for brainstorming and outlining purposes. However, all final writing, synthesis, and critical analysis are my own work. Instances where AI contributions were significant are clearly cited and acknowledged.

Nonetheless, I have ensured that the use of AI tools did not compromise the originality and integrity of my work. All sources of information, whether traditional or AI-assisted, have been appropriately cited in accordance with academic standards. The ethical use of AI in research and writing has been a guiding principle throughout the preparation of this thesis.

I understand the importance of maintaining academic integrity and take full responsibility for the content and originality of this work.

Simone Avanzini – 12/06/2024

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