



Lisbon School
of Economics
& Management
Universidade de Lisboa

MASTER OF SCIENCE IN FINANCE

MASTERS FINAL WORK PROJECT

INVESTMENT POLICY STATEMENT:

LUSITANIA

**NON-LIFE PORTFOLIO (EXCLUDING WORKMAN'S
COMPENSATION)**

ANA CATARINA EMÍDIO MARTINS

JUNE 2023



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Abstract

The Following Investment Policy Statement (IPS) report was written following the CFA Institute recommended format and considers the public information available until the 15th of May 2023, any available information after this date was not considered. Lusitania is an insurance company, founded in 1986, with 100% of Portuguese capital. Lusitania offers a wide range of products, including accidents, motor, housing, and health insurance. The stated objective of this IPS encompasses the creation of two distinct portfolios. The first portfolio aims to achieve immunization by funding the liabilities at the lowest possible cost. The second portfolio pursues optimization, targeting a minimum return of 2.5% above risk-free rate, while simultaneously maintaining volatility below 7.5%. It is crucial that the construction of these portfolios adheres rigorously to all specified restrictions, including exposure limits within asset classes. Additionally, all investments within the portfolios are denominated in euros, ensuring uniformity in currency denomination. The construction of these portfolios was executed, considering the limitations specified by Lusitania. Various strategies, such as duration and cash flow matching, were employed to attain the defined objectives, especially in the immunization portfolio. Sources, including Refinitiv, Lusitania Reports, and the JP Morgan “2023 Long Term Market Expectations” document, were consulted and utilized in the preparation of this report. The investment committee must deliver detailed risk data every quarter in addition to performance reports, such as Value at Risk.

JEL classification : C63; G11; K22; G28; G22

Keywords: Asset Management; Portfolio Theory; IPS; Mean Variance Theory; Cash-Flow Matching; Duration Matching; Monte Carlo Simulation; Insurance Company

Resumo

O presente relatório Investment Policy Statement foi escrito em linha com o formato recomendado pelo CFA Institute e considera a informação pública disponível até ao dia 15 de Maio de 2023, qualquer informação posterior não foi considerada. Lusitania, é uma companhia de seguros, fundada em 1986, de capitais totalmente nacionais. A Lusitania oferece um vasto leque de produtos, dos quais se destacam os seguros de acidente, automóvel e saúde. O principal objetivo deste IPS é a criação de dois portfólios distintos. O primeiro portfólio visa alcançar a imunização, financiando as responsabilidades ao menor custo possível. O segundo portfólio visa a otimização, com um retorno mínimo de 2,5% e uma volatilidade abaixo de 7.5%. É crucial que a construção desses portfólios adira rigorosamente a todas as restrições especificadas, incluindo limites de exposição dentro das classes de ativos. Além disso, todos os investimentos nos portfólios são denominados em euros, eliminando o risco cambial. A construção desses portfólios foi feita levando em consideração as limitações especificadas pela Lusitania. Diversas estratégias, como a *duration matching* e *cash-flow matching*, foram utilizadas para alcançar os objetivos definidos, especialmente no portfólio de imunização. Fontes como Refinitiv, Relatórios Lusitania e “2023 Long-Term Market Expectations” do JP Morgan, foram consultadas e utilizadas na preparação deste relatório. O comitê de investimentos deve fornecer, além de relatórios de *performance*, dados de risco detalhados trimestralmente, como *Value at Risk*.

Classificação JEL: C63; G11; K22; G28; G22

Palavras-Chave: Gestão de Activos; Teoria da Carteira; IPS; Teoria da Minima Variância; Cash-Flow Matching; Duration Matching; Monte Carlo; Seguradora

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1 Executive Summary

This Investment Policy Statement (hereinafter referred to as the “IPS”) is a crucial document that outlines guidelines for a Portfolio for Lusitania (hereinafter referred to as the “Client”), aiming to achieve target returns with minimal risk while adhering to applicable regulations. It plays a strategic role in the company's management and profitability objectives, also provides strategic advice for planning and executing the investment program, specifying the investment goals of the Plan, and identifying the entities responsible for overseeing the investments.

The primary goals of applying this IPS are to ensure the safety, quality, appropriate return, and liquidity of investments. It is important to note that we have two distinct portfolios, each of that serves a different function: The immunization portfolio's main focus is balancing assets and liabilities to reduce interest rate risk and ensure balancing assets and liabilities to make sure the client can meet its long-term commitments. The portfolio is constructed to generate cash inflows that exceed the company's liabilities (excluding workman compensation), over the next 11 years, these liabilities include motor vehicle insurance, other motor insurance, marine, aviation, and transport insurance, fire and other damage to property insurance, general liability insurance, credit, and suretyship insurance, legal expenses insurance, assistance, and miscellaneous financial loss. Duration and Cash Flow matching techniques are used to maximize financial stability, effective cash flow management, and reduce risks associated with the obligation structure. Additionally, the optimization portfolio attempts to manage risk and produce the best possible investment returns, giving the client more money to pay claims, cover operational expenses, and maybe increase dividends or profits to policyholders.

The portfolio is designed to achieve an average annual return of at least 2.5% above risk-free rate with an average annual expected volatility of no more than 7.5%, preserving capital while allowing flexibility for future liabilities. Adhering to the Company's Risk Appetite Policy is essential, with a focus on fixed-income securities to address liquidity risk and prioritize predictable cash flows. Given the 11-year time horizon and risk profile, a conservative approach emphasizing fixed-income investments is recommended to preserve capital and ensure sufficient liquidity in both portfolios.

2 Investment Policy Statement

2.1 Scope and Purpose

The purpose of this IPS is to establish guidelines for a Portfolio for Lusitania and is designed to establish our investment philosophy and management procedures. It explains how the client is categorized and the risk assessment process. This document provides a deeper understanding of our recommended asset model and helps the client feel more confident in the assessments made by our investment team. After reading this document and reaching an agreement on the points covered, the client can expect to:

- Gain a clear understanding of their investment goals and objectives, as well as the strategies and processes that are to be used to achieve those goals.

Specifically, a client can expect to find the following information in an IPS:

- Learn how our asset model works and how it can impact long-term investment returns and associated risks:
- Understanding the expected asset model is crucial in creating a long-term investment strategy and the potential range of outcomes.
- Set investment goals and establish guidelines for communication and regular meetings with our team.

The company's main goal is to build a strong portfolio that appropriately protects against its all-non-life liabilities (except workman compensation). It combined duration matching and cash flow matching approaches to achieve this. These strategies minimize any potential mismatched risks and assure the availability of sufficient cash, when necessary, by coordinating the timing and duration of its assets and liabilities. This will be the immunization portfolio.

The client operates in the following Non-Life business lines of direct insurance, exclusively in Portugal:

- Work Accidents
- Workman Compensation
- Personal Accidents
- Health Insurance

- Motor Vehicle Liabilities
- Fire and Other Damages
- General Liability
- Marine, Transport, and Air

In addition to these business lines, other less significant lines are consolidated under the diverse class.

According to the solvency and financial position report published by the client in 2021, all liabilities except for workman compensation accounted for 52% of the total liabilities in both 2021 and 2020. This represents a substantial value for the client, amounting to 67,268 thousand euros in 2021 and 68,119 thousand euros in 2020.

The portfolio complies with the rules outlined by Solvency II, a comprehensive regulatory framework created to improve the solvency and stability of insurance firms and other financial institutions. By following these guidelines, the company assures responsible risk management, proper capitalization, and successful risk mitigation techniques.

In addition, the EIOPA curve is being considered, which is an important benchmark for evaluating interest rate risk in the context of Solvency II. We can make knowledgeable decisions regarding asset allocation, liabilities valuation, and risk management thanks to the EIOPA curve for the term structure of interest rates.

We work to build a portfolio that adequately covers its liabilities and guarantees regulatory compliance through implementing cash flow and duration matching strategies into practice, adhering to Solvency II principles, and taking the EIOPA curve into account. The company increases its financial resiliency and maintains its capacity to fulfill its obligations sustainably by implementing these cautious actions.

It is important to note that achieving perfect portfolio immunization strategies is nearly impossible due to various constraints. Factors such as equal duration alignment between assets and liabilities and cash flows precisely covering each yearly liability, and other considerations pose significant challenges.

We also have an optimization portfolio where we attempt to manage risk and produce the best possible investment returns, giving the client more money to pay claims, cover operational expenses, and maybe increase dividends or profits to policyholders.

2.2 Governance

The several units are accountable for the implementation and supervision of procedures to ensure the acquisition, analysis, handling, and generation of top-level management information aimed at strategic decision-making.

The subsequent stakeholders assume the primary obligations of the procedure:

- The board of directors bears the responsibility of approving the Investment Policy and the Investment Strategy, and this involves laying down a comprehensive strategy for the company, and the policy related to risk management, reviewing, and updating such policy. They must also approve emergency actions to deal with danger factors. To achieve the client's financial goals, the Board must make sure that the company's workers manage investments responsibly, at a fair cost, and while maintaining the investments' quality and security. The Board may also ask the employees and investment consultants to offer information and recommendations on issues affecting the client's investment activity.
- The Investment Committee takes on a key role in monitoring and managing investment performance versus benchmarks, ensuring that all investments are managed responsibly, optimizing returns, and lowering risks. All investments should be aligned with the client's values. They are also responsible for monitoring investment performance against the benchmark, as well as the financial returns, and recommending actions to reduce potential structural deviations from set limits and tolerance levels.
- The Risk Committee is tasked with the responsibility of identifying and measuring risk while ensuring compliance through stress testing of the company and the assets of Lusitania, analyzing current and future volatility of international financial instruments and assets to ensure compliance and awareness of associated risks for client. Furthermore, they should identify and evaluate ways to manage or even mitigate the potential risks that may arise from the investments. The Committee also seeks to limit the overall level of risk appropriate with the chosen Policy Asset Allocation and to address that they conduct regular reviews of the investment portfolio.
- The Audit Committee bears the responsibility of providing oversight of the company's internal control system, the financial reporting process, the audit process, and compliance with laws and regulations related to the investments activities. They also review the IPS to guarantee that all controls and processes on the investment are in line

with both internal and external regulations, also they must ensure that the IPS is being followed.

Future investment options, as well as future investment performance monitoring and evaluation, are based on this IPS. The Committees update and change it as necessary to reflect the IPS's evolving aims and objectives. It is adopted by the Committees by the terms of the IPS, on the recommendation of financial and legal professionals, and is meant to bind all individuals with control over Plan Investments.

Every month, the Investment Committee meets, and a significant portion of the agenda is set aside for a thorough assessment of the IPS in light of the current situation. All attendees should be given the chance and the proper consideration to suggest and discuss any changes, additions, or modifications to the IPS that the Chief Investment Officer (CIO) and their diligent team have.

The CIO is given authority by the Investment Committee to choose, oversee, and dismiss investment management firms in charge of looking after the Client's assets. The Chief Investment Officer is responsible for making sure that these managers uphold all of their contractual commitments, including the Investment Guidelines, performance standards, and organizational requirements. The CIO provides updates on the performance during the Investment Committee's monthly meetings.

The Chief Financial Officer (CFO) and his or her team are in charge of keeping track of the Client's positions concerning the portfolio's optimal distribution of capital among the various investments. For each asset class and each investment manager account, the CFO provides independent monthly accounting reports for each position. The portfolio's financial risks and any potential threats to its performance are also examined by the CFO, who also guarantees accurate and timely financial reporting for the portfolio. The CFO must express in writing that she/he has received the document and agree with its contents.

We work closely with our client to ensure they are comfortable with the asset model and risk profile suggested. We also explain in detail the expected returns and potential investment losses associated with the risks.

2.3 Investment, Return, and Risk Objectives

2.3.1 Investment Objective

The immunization portfolio of Lusitania is purposefully constructed to generate cash inflows that surpass the company's liabilities (all liabilities except workman compensation), during the next 11 years. The purpose of this portfolio is to fund the liabilities at the lowest cost possible. The portfolio matches investment duration with the duration of these liabilities by using duration-matching techniques. Notably, in both 2020 and 2021, these liabilities comprised over 60% of the entire company's liabilities. By concentrating on this goal, it is possible to maximize financial stability, manage cash flow effectively, and reduce risks related to its obligation structure. The duration matching method is essential for reducing the effects of interest rate changes and cash flow inconsistencies. The client also seeks to preserve a stable financial situation and guarantee long-term profitability through wise management. The optimization portfolios seek returns of at least 2.5% above risk-free rate.

2.3.2 Return and Risk Requirements

To fulfill the return objectives of Lusitania, the portfolio is designed with specific constraints. It is required to have an expected annual return of at least 2.5% above risk-free rate while maintaining an annual expected volatility of no more than 7.5%. These constraints are in place to ensure that capital is preserved at a relatively low risk still providing sufficient returns to allow for flexibility in meeting future liabilities.

Table 1: Return and Risk Requirements

	Percentage (%)
Standard Deviation	≤ 7.5
Return	≥ 2.5 above risk-free rate

Source: Lusitania

2.3.3 Risk Tolerance

The Investment management should adhere to the Company's Risk Appetite Policy (*POL.PR_APRIS.001*). That has the following main objectives:

- Ensure the adequacy of the Company's Capital:

From a Solvency perspective, the Risk Appetite limitations strongly emphasize the suitability of risk and capital levels. As a result, the Company's specified risk appetite guarantees the development of a risk strategy that is integrated into the decision-making process, as well as assuring compliance with regulatory requirements and maintaining an adequate solvency position

- Protect Shareholder Value:

To make sure that the level of risk it chooses to tolerate does not affect shareholder returns, the company has developed its risk appetite framework. The company has also put in place certain risk appetite indicators and limitations that enable monitoring the impact of stress events that might compromise the value generated by the company and support corrective action plans on capital limits.

The company's activities are led by risk-based management, taking into consideration its capability and strategic goals, according to the principles established in the risk management policy. Additionally, it defines risk classifications, evaluation techniques, and management strategies. Furthermore, it makes the connection between the regulatory capital requirements, the company's risk tolerance levels, and the instructions for the stakeholders' actions in the risk management system.

As previously mentioned, the primary objective is to ensure that cash inflows are sufficient to cover future cash outflows. Therefore, addressing liquidity risk is of utmost importance. Insufficient assets to meet future liabilities would pose a significant problem, emphasizing the need to preserve capital. Consequently, prioritizing fixed-income securities with lower volatilities but high yields (or return potential through discounted purchases below par value) becomes crucial. Given the non-negotiable liquidity constraint, the asset class allocation should primarily consist of securities with predictable cash flows, particularly leaning toward fixed income. Considering the risk profile, it is evident that the portfolio should aim to preserve capital and offer sufficient liquidity during the time horizon of 11 years. This suggests a more conservative approach with a focus on fixed-income investments.

2.3.4 Relevant Constraints

- Liquidity Constraints

Given the utilization of cash flow and duration matching strategies, it is crucial to address any potential shortfall of assets to meet future liabilities, this emphasizes how crucial capital preservation is. The portfolio of our client uses capital preservation as a liquidity constraint to make sure there are enough assets on hand to meet future obligations. By emphasizing capital preservation, we are annulling the possibility that the client does not have enough money to cover their obligations on the next over 11 years, while still having the required freedom to handle their financial obligations successfully.

- Evaluation Horizon

The portfolio has an 11-year time horizon, based on the institution's liabilities' timing as well as the goal of matching cash flow and duration. The intention is to make sure that the investment strategy properly manages risk and maximizes returns throughout the designated period by matching the time horizon of the portfolio with the institution's liabilities. The performance of investment managers and asset classes must be assessed by the investment officer on a rolling quarter basis, except for illiquid asset classes (real estate), which must be assessed on a rolling 3-year basis.

- Tax Constraints

The client is taxed on capital gains (“Imposto sobre mais valias”), dividends, and interest income, and corporate income tax at 21%. Nevertheless, any capital losses are eligible for a tax deduction.

- Legal Constraints

The management of this portfolio complies with various legal requirements including adherence to the laws and regulations set by the Portuguese Securities Market Commission (CMVM) and the Bank of Portugal and, compliance with anti-money laundering regulations imposed by the Portuguese government to prevent financial crime. The Solvency II Directive must also be considered for an insurance company doing business in Portugal. Insurance companies must properly analyze and manage risks, maintain a suitable amount of capital, and comply with reporting and disclosure requirements under this directive. Additionally, insurance companies are required to adhere to guidelines established by the Portuguese

Insurance and Pension Funds Supervisory Authority (“Autoridade de Supervisão de Seguros e Fundos de Pensões” - ASF). The ASF is in charge of regulating compliance in Portugal's insurance sector, including licensing, capital adequacy, reporting, and risk management.

- Leverage constraints

The portfolio of the client does not use any form of leveraged positions.

- Investments in foreign securities

The portfolio is limited to exposure to the European Markets. To account for currency risk, all investments made in the Client's portfolio is be made in euros. Investments in foreign securities are only made in countries that, in the view of the Investment Committee and its guidelines, provide adequate legal protections for shareholder interests. Lusitania intends to reduce currency risks by adhering to these rules and giving priority to investments that go along with its investment goals and risk management plan.

- Duration Constraint:

The duration of the portfolio's assets must closely align with the duration of liabilities, with a maximum deviation of 2 years. By adhering to this guideline, we aim to optimize the portfolio's ability to meet future obligations while minimizing exposure to interest rate fluctuations.

- Exposure Limits within asset classes

The financial asset portfolios follow an investment plan that includes a central allocation. This method intends to allow asset managers to practice tactical management while also adjusting income and risk expectations to the shifting dynamics of the financial markets. Tolerance bands are created around each asset class's core value to help with this. The investment strategies for the portfolio are meticulously developed each year after a thorough analysis of the market environment, the company's liability structure, and its risk profile. This can be seen in Table A.1, in the appendix.

2.4 Risk Management

2.4.1 Performance Measurement

The investment committee regularly holds market update meetings to assess current market trends and risks, and these assessments are applied to all company-held assets in the company portfolio. Based on the overall portfolio and individual asset assessments, the CIO reviews, and issues recommendations to the portfolio manager.

2.4.2 Metrics for Risk Measurement and Evaluation

The investment committee must deliver detailed risk data quarterly in addition to performance reports. These risk measurements are essential for evaluating the performance and stability of the investment portfolio. The Value at Risk (VaR) must be calculated twice in the committee's reports, once using historical data, and once using Monte Carlo simulation.

The VaR calculates the largest possible loss that the portfolio might sustain within a given level of confidence by considering past returns and their corresponding probability. This technique assumes that future returns will exhibit a pattern like those in the past.

The VaR estimated using the Monte Carlo simulation method, on the other hand, takes a stochastic approach. With this approach, hypothetical market conditions are used to generate a huge number of random scenarios for the performance of the portfolio in the future. By using statistical methods and random sampling from probability distributions, such scenarios are generated. The VaR is calculated by selecting the worst-case outcomes within a certain confidence level and simulating multiple scenarios.

Additionally, both methods can provide insights into the expected shortfall. The expected shortfall, also known as conditional VaR, represents the average magnitude of losses that exceed the VaR. It provides a measure of the potential losses beyond the specified VaR level.

2.4.3 Rebalance Policy

The portfolio is regularly evaluated for rebalancing decisions on a quarterly basis, on the 7th working day of the month. This helps prevent significant unwanted deviations from the overall portfolio in volatile market conditions. Considering the current uncertain market conditions, any asset weight change of +/- 5% or more in each month triggers immediate rebalancing. We take into consideration to minimize unnecessary transaction costs. If the cost of commissions outweighs the benefits of rebalancing the portfolio, the portfolio manager does not proceed with any rebalancing decisions. The rebalancing is executed within one business day by a team that is specifically allocated for making these trade decisions. Client has the option to request a special review of portfolio positions and rebalancing towards a safer portfolio at no extra cost, and the investment advisor provides their opinions and proceed with the agreed decision after obtaining the client's signed consent.

The investment committee share information and knowledge daily, which allows the company to review and adjust investment strategies on a 3-month rolling basis through rebalancing and restructuring. The investment committee also evaluates investment opportunities on a weekly basis, to generate new investment ideas and optimize management. The client has access to

review the quarterly updated interest schedule and performance statement online, as well as in printed form upon request with the client manager. An annual gain/loss report is also made available to the client at the end of the financial year and can be sent directly to their tax consultant if needed. In case of any extraordinary events, the client will be immediately notified via email and given the option to liquidate their positions if they feel uncomfortable with the risk. The Sharpe Ratio and other key performance indicators are calculated for the client to evaluate the portfolio manager's performance and are available online and updated in real-time.

2.5 Investment Design

2.5.1 Investment Philosophy

As previously mentioned, we have 2 portfolios the Immunization Portfolio and the Optimization portfolio. Long-term liabilities held by the client may be susceptible to variations in interest rates, that is why an immunization portfolio is created; to mitigate the effect of interest rate changes on the liabilities of the client. The client wants to minimize the danger of any mismatch by building an immunization portfolio using cash flow and duration matching techniques. By doing this, it becomes easier to fulfil future obligations to policyholders with stability and predictability. The goal of the optimization portfolio is to allocate funds in a way that optimizes returns while maintaining reasonable risk levels. Based on the company's risk tolerance and investment goals, this entails diversification investments across various asset classes, such as equity, cash, fixed income, and real estate.

It is advised to implement a cautious strategy that concentrates on less volatile securities and predictable cash inflows to pay future liabilities at certain times in time. Fixed income securities and real estate are the best asset classes for this strategy. For added protection against default risk, a portfolio made up of bonds with credit ratings of at least BBB+ from Fitch and Baa1 from Moody's is recommended (see section 2.5.3 "Security Selection and Portfolio Composition").

Portfolio immunization becomes a critical tactical component in line with the conservative strategy and to handle liquidity and interest rate threats. This requires the use of techniques like duration and cash flow matching.

While cash flow matching effectively mitigates liquidity mismatches, it is not comprehensive enough to tackle interest rate risk and the overall value of the portfolio. As stated in the IPS, an additional technique exists that can fully or nearly eliminate both price risk and reinvestment

risk associated with interest rates. By combining duration matching with cash flow matching, this approach offers the optimal method for managing risks and safeguarding against uncertainties in the future economic environment.

However, it is important to note that achieving perfect portfolio immunization strategies is nearly impossible due to various constraints. Additionally, constraints regarding asset class weights and other factors must also be considered. Therefore, in practice, it is more feasible to implement a duration constraint that falls within an interval rather than aiming for an exact duration match. This approach acknowledges the complexities and limitations of achieving perfect immunization strategies while still working towards minimizing risk and optimizing portfolio performance.

2.5.2 Strategic Asset Allocation

It has previously been indicated that Fixed Income would be the asset class receiving the largest portion of the investment in terms of asset allocation. In addition to the type of an insurer's company and, consequently, its risk tolerance, the Client's weight constraints, shown in Table A.1, in the appendix, must also be taken into consideration. It is important to understand that two distinct portfolios were built: an immunization portfolio and an optimization portfolio. This helps clarify the asset selection process and how weights were calculated.

This division was primarily brought about by the computation of Cash Flow and Duration Matching, standards set by the industry for portfolio management techniques, and the development of mean-variance theory and the efficient frontier, which will be covered in more detail later in this document.

The immunization portfolio will be discussed first. As was previously said, Cash Flow Matching is crucial for managing liabilities, reducing risk, and building portfolios. However, this process is impossible without an immunization portfolio. This is so that we can precisely match the future liabilities to the cash flows in our portfolio, which must be foreseeable. It is possible to forecast inflows at a specific point in time if we invest in a fixed income set of securities. The maturity date and par value at maturity date, as well as the amount and date of fixed coupons payments, are all publicly available information (and in this case it was taken from Refintiv). Therefore, it is possible to predict when and how much of our inflows will occur.

However, the optimization portfolio is different due to the unpredictability of ETF capital gains and inflows. This is why our immunization portfolio is entirely composed of individual fixed

income assets in order to accurately match Cash Inflows to future liabilities and determine the overall cost of this portfolio. The liabilities per year can be seen in table A.2, in the appendix.

In table 2, it is possible to see the cash inflow per year, as well as the cash outflow and the difference between both; it can be concluded that the cash inflows are always greater than the cash outflows, and the total portfolio cost is around 84,3 million euros (the total cost of the portfolio, using prices as of March 3, 2023, was computed by multiplying the price of each asset by its weight.)

Table 2: The Difference between the Cash Inflows and Cash Outflows

Year	Cash Outflows	Cash Inflow	Difference
1	€ 37,228,824.59	€ 37,242,153.03	€ 13,328.44
2	€ 13,308,686.67	€ 13,308,690.65	€ 3.98
3	€ 9,984,736.48	€ 9,987,871.25	€ 3,134.77
4	€ 7,854,562.39	€ 7,884,857.50	€ 30,295.11
5	€ 6,433,488.30	€ 6,516,857.50	€ 83,369.20
6	€ 5,101,886.64	€ 5,189,737.50	€ 87,850.86
7	€ 4,170,514.23	€ 4,199,417.50	€ 28,903.27
8	€ 3,212,037.41	€ 3,470,920.00	€ 258,882.59
9	€ 1,964,399.56	€ 1,966,620.00	€ 2,220.44
10	€ 1,633,750.41	€ 2,032,200.00	€ 398,449.59
11	€ 1,455,273.35	€ 3,135,000.00	€ 1,679,726.65
Total	€ 92,348,160.03	€ 94,934,324.93	€ 2,586,164.89

Source: Lusitania and author's calculations

In order to calculate the weight of each asset, it was used excel solver with the objective to minimize the Capital Required, by changing the quantity of each asset, with the following restrictions:

- The weight of each asset was to be greater than zero (no short selling).
- The cash inflow from assets must be at least equal to the associated liability (i.e., $CF_n \geq \text{Liability}_n$)
- The duration of the assets must be equal to the duration of the liabilities.

Moreover, obtaining the Macaulay duration for each bond within the immunization portfolio is essential, since this metric accounts for cash flows and the time value of money, and also helps manage interest rate fluctuations (through duration matching). As the modified duration is taken from Refinitiv, it was utilized to calculate the Macaulay duration using the following formula:

$$\text{Macaulay Duration} = \text{Modified Duration} \times \left[1 + \frac{\text{Yield}}{\text{Frequency}} \right] \quad (1)$$

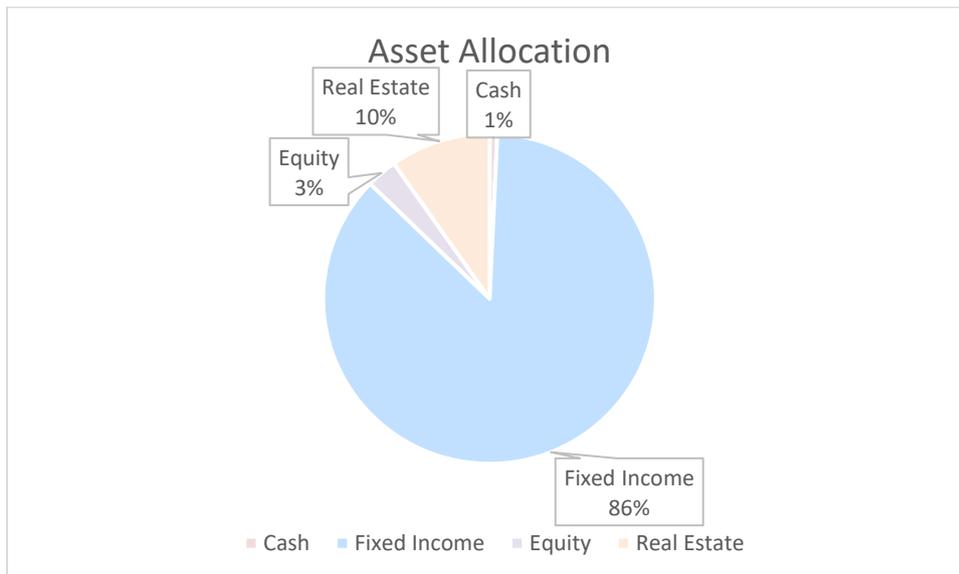
The information for the optimization portfolio was gathered from the 2023 JPMorgan Long Term Capital Market Assumptions document, and it was required to select several indices from various asset classes in order to compute the optimal portfolio and the efficient frontier.

In order to calculate the weight of each asset, it was used solver in excel, with the objective to minimize the Variance of the portfolio, by changing the quantity of each asset, with the following restrictions:

- The weights should respect the exposure limits seen in table A.1, in the appendix.
- The return should be greater than 2.5% above risk-free rate and the volatility should be lower than 7.5%.
- The duration of the portfolio's assets must closely align with the duration of liabilities, with a maximum deviation of 2 years.

Please note that the immunization portfolio accounts for 70% of the overall asset set, while the optimization portfolio accounts for 30%. The portfolio composition can be seen in Figure 1, to obtain this composition it was necessary to multiply the weight of each asset of the first portfolio by 70% and the weight of each asset of the second portfolio by 30%.

Figure 1: Asset Allocation of the portfolio considering the optimization and immunization portfolios



Source: Author's calculations

By summing the weighted duration of both portfolios, the portfolio's Macaulay Duration is calculated as 3,486,262 years, being above the duration of the liabilities, that is 2,974,351 (the difference between both is 0,511,911 years, complying with the 2 years constraint range).

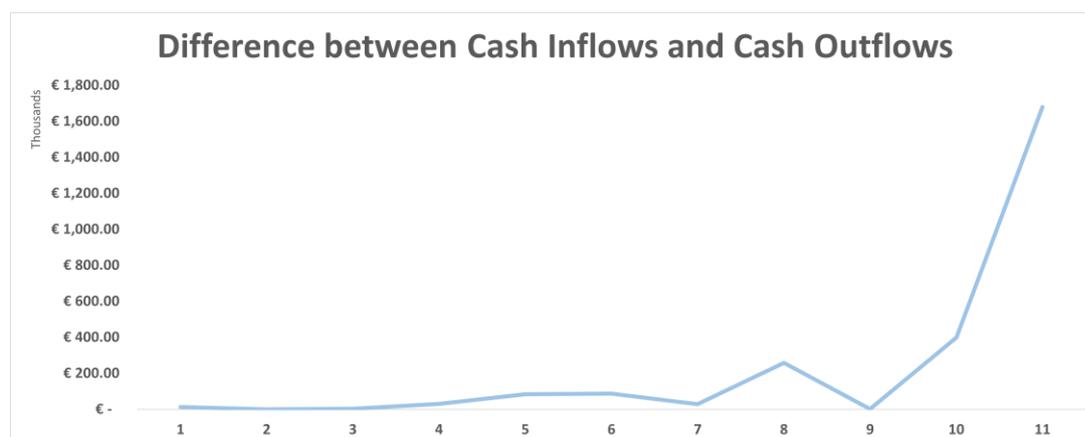
2.5.3 Security Selection and Portfolio Composition

The construction of the optimal immunization portfolio involved the implementation of duration and cash flow matching techniques. Immunization, the underlying concept, aims to establish a portfolio of investments capable of generating a stable income, irrespective of fluctuations in interest rates. Cash flow matching ensures synchronization between the timing and amount of the assets' cash flows with the liabilities' cash flows. Duration matching, on the other hand, focuses on aligning the duration of assets with that of the liabilities.

In accordance with insights from sources such as the European Central Bank and the JP Morgan ("2023 Long-Term Capital Market Assumptions") report, it is anticipated that inflation rates will experience a moderate decline in 2023 and 2024, despite recent concerns. As such, certain assumptions have been made for the purposes of this analysis. The assumed inflation rate stands at 3%. Furthermore, all investments are denominated in euros, eliminating any currency risk. It is worth noting that all bonds considered have fixed and annual coupons and have high credit ratings (ratings from Fitch greater than BBB+ and Moody's greater than Baa1). One bond matures each year to cover the corresponding annual liability. For instance, it is assumed that the investment begins in 2024, so the responsibility for the fiscal year 2028 is covered by an individual bond with 4 years until the maturity (the liability payment date is considered always to be on the 31st of December).

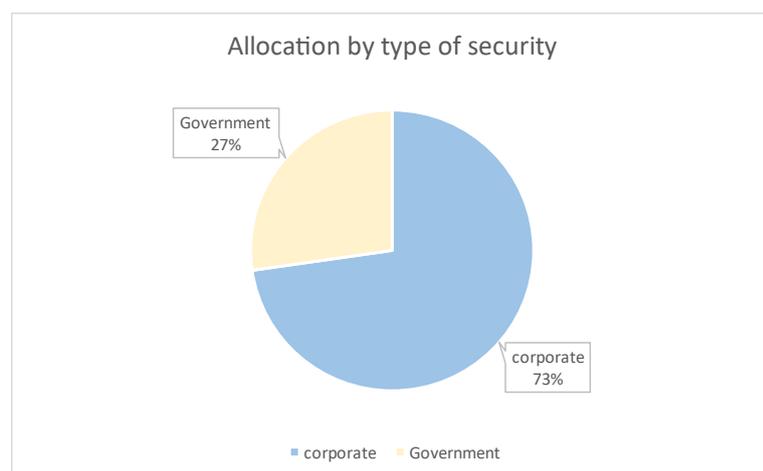
To compile the necessary data, Refinitiv has been used as the main data source. Detailed information pertaining to the bonds utilized in the analysis can be found in Table A.3, in the appendix. Figure 2 visually presents the cash inflows consistently exceeding the cash outflows, successfully fulfilling the model's objective. Additionally, Figure 3 offers a visual breakdown of the allocation by type of security, while Table 2 provides the specific quantities of each bond required to cover the outflows. The total cost of this portfolio amounts to 84,298,430.18 euros.

Figure 2: Difference between Cash Inflows and Outflows



Source: Lusitania and author's calculations

Figure 3: Allocation by type of security in immunization portfolio



Source: Author's calculations

Table 3: Bond's Quantity and Investment

ISIN	Name	Quantity	Investment
XS2557084733	ABN Amro Bank NV	30	€ 2,960,610
XS0160553441	Natixis SA	18	€ 1,826,604
PL244760279	Poland (Government)	1688	€ 1,524,770
XS0123523440	BNP Paribas SA	3	€ 3,220,650
DE000A289XG8	Mercedes Benz Group AG	3642	€ 3,398,459
ES0413790264	Banco Santander	44	€ 4,886,200
DE000BLB9RX8	BAYERISCHE LANDESBANK	56	€ 5,121,144
FR001400DZM5	Societe Generale SA	67	€ 6,743,081
DE000LB384E5	Landesbank Baden Wuerttembg	8557	€ 8,432,752
FR0000571150	France (Government)	11205490	€ 12,185,858
DE0001134922	Germany (Government)	3307195518	€ 33,998,301

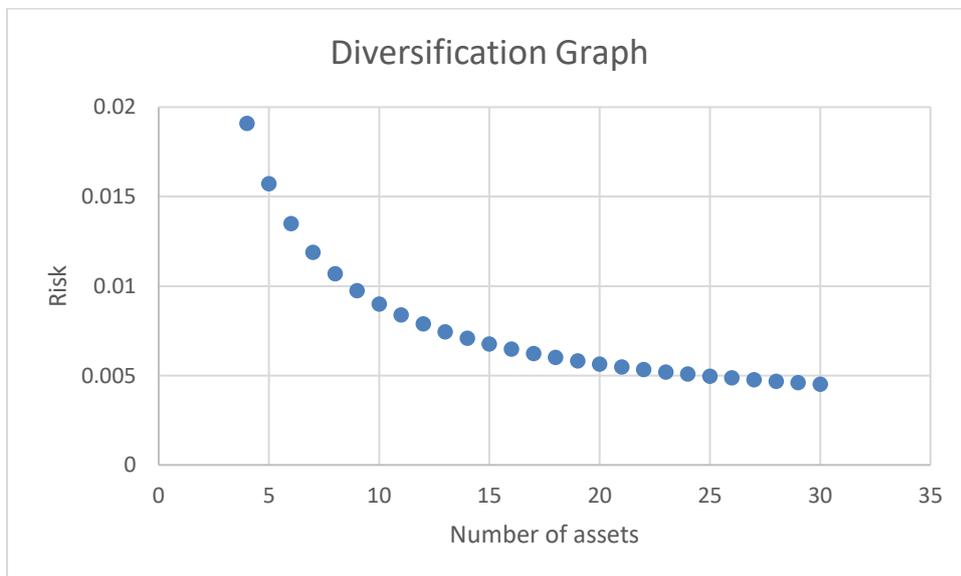
Source: Refinitiv and author's calculations

To construct an optimization portfolio tailored to the Client’s needs, a comprehensive selection of 12 indexes was made. These indexes encompass the four distinct asset classes, namely Fixed Income, Equity, Cash and Real Estate, thus ensuring a well-diversified allocation. The exposure limits for each asset class, as specified in the “Relevant Constraints” section, can be found in Table A.1 of the appendix, (considering all investment constraints and risk tolerance, the majority of the weight of the portfolio is on Fixed Income). It is noteworthy that all selected indices represent assets denominated in euros, aligning with the investment strategy focused on the Eurozone.

The diversification graph shown in Figure 4 demonstrates the justification for choosing 12 indexes. The graph shows how adding too many assets to a portfolio may not be beneficial owing to the resulting rise in risk. While having a sizable number of assets can help diversify a portfolio and reduce risk to some extent, there comes a point where adding more assets fails to significantly improve diversity. The following formula it is used to calculate the variance of each n (number of assets):

$$\sigma H^2 = \frac{1}{n} \overline{\sigma_i^2} + \frac{n-1}{n} \overline{\sigma_{ij}} \quad (2)$$

Figure 4: Diversification Graph



Source: Author’s calculations

The 12 sub-asset classes chosen were the following:

1. Euro Inflation: Can help the client to be protected from inflation.
2. Euro Cash: This type of investment provides stability and liquidity, which is one of the main goals of the client.

3. Euro Aggregate Bonds: Within the Eurozone, this index offers diversified exposure to a wide range of fixed-income assets.
4. Euro Investment Grade Corporate Bonds: These bonds have a lower credit risk than government bonds while still offering a greater yield.
5. Euro High Yield Bonds: This index offers higher rates; however, it assumes greater credit risk.
6. Euro Government Bonds: Represents bonds that are issued by governments in the Eurozone, considered as low-risk investments. These types of bonds can help the client protect its capital.
7. Euro Government Inflation-Linked Bonds: Like Euro Inflation Assets offer insurance against inflation.
8. Hedged World Government Bonds: This asset class can help diversify the fixed-income portfolio outside of the Eurozone by investing in World Government Bonds with currency exposure hedged (avoiding currency risk).
9. Global Multiverse Bonds Hedged: Offers a wider investment opportunity set, by investing in a variety of fixed-income securities with different characteristics and with currency exposure hedged (avoiding currency risk).
10. European Large Cap Equities: It may offer opportunities for capital growth, dividend income, and benefits from diversification.
11. European Small Cap Equities: It may offer opportunities for capital growth, dividend income, and benefits from diversification.
12. European Core Real Estate: It offers stable and consistent returns and acts as a hedge against inflation.

In Table 4, it is displayed the asset classes along with their respective expected returns, standard deviation, and weight (%), the calculations are made as it was explained in the security selection section.

Table 4: Return, SD, and Weights of the chosen indexes

	Asset Class	Expected Return	Expected Volatility (SD)	Weights (%)
Cash	Euro Inflation	1.80%	1.06%	1.5%
	Euro Cash	1.30%	0.61%	1.0%
Fixed Income	Euro Aggregate Bonds	3.00%	4.48%	5.0%
	Euro Inv Grade Corp Bonds	3.60%	5.10%	5.0%
	Euro High Yield Bonds	5.70%	9.70%	10.0%
	Euro Government Bonds	2.80%	4.88%	10.0%
	Euro Govt Inflation-Linked Bonds	2.60%	5.32%	10.0%
	World Government Bonds hedged	2.60%	3.70%	10.0%
	Global Multiverse Bonds Hedged	3.10%	3.55%	5.0%
Equity	European Large Cap Equities	8.40%	16.98%	0.0%
	European Small Cap Equities	9.20%	17.88%	10.0%
Real Estate	European Core Real Estate	4.70%	10.15%	32.5%

Source: 2023 Long-Term Capital Market Assumptions, JPMorgan

To calculate the investment opportunity set, it was used the Mean Variance Theory (MVT) to identify the pairs of Risk/Return of each possible combination of assets (risky and risk-free).

The process of creating the efficient frontier and identifying the tangent portfolio, which includes allowing short selling, entails some steps and considerations. The first was to do the asset selection process (explained in previous section). Following MVT process, the expected return and expected standard deviation for each asset were retrieved from the JP Morgan document (Table 4).

To proceed, the correlation matrix was obtained from the same document, serving as an input for calculating the covariance matrix. The covariance matrix was calculated, utilizing the following formula:

$$Covariance(x, y) = Correlation(x, y) * \sigma x * \sigma y \quad (3)$$

In Appendix 4 it is displayed the correlation matrix and in Appendix 5 the covariance matrix.

Subsequently, the portfolio with the minimum variance was calculated by analyzing the hyperbola and its scalars, using the following formulas.

$$\sigma_p^2 = \frac{A\bar{R}_p^2 - 2B\bar{R}_p + C}{AC - B^2} \quad (4)$$

Where $A = 1'V^{-1}1$, $B = 1'V^{-1}\bar{R}$ and $C = \bar{R}'V^{-1}\bar{R}$

The formula below denotes the optimal weight of each asset in the minimum variance portfolio:

$$X_{mv} = \frac{1}{A}V^{-1}1 \quad (5)$$

In table 5, and table 6 it is possible to observe the weights assigned to each asset within the minimum variance portfolio, as well as its return and standard deviation.

Table 5: Asset's weights of the Minimum Variance Portfolio

	Weights
Euro Inflation	22.88%
Euro Cash	75.75%
Euro Aggregate Bonds	-41.57%
Euro Inv Grade Corp Bonds	6.66%
Euro High Yield Bonds	1.37%
Euro Government Bonds	32.64%
Euro Govt Inflation-Linked Bonds	-1.76%
World Government Bonds hedged	-0.53%
Global Multiverse Bonds Hedged	3.61%
European Large Cap Equities	-1.11%
European Small Cap Equities	1.21%
European Core Real Estate	0.84%

Source: Author's calculations

Table 6: Return, SD, and Variance of the Minimum Variance Portfolio

Return Portfolio	1.49%
SD Portfolio	0.502%
Variance Portfolio	0.0025%

Source: Author's calculations

Subsequently, the calculation of the tangent equation was undertaken, using the following formula:

$$Z = V^{-1}(\bar{R} - R_f1) \quad (6)$$

The Risk-Free Rate used was the average deposit rate in the eurozone.

Then, it was necessary to calculate the optimal weights for the tangent portfolio and these weights can be seen in the table below:

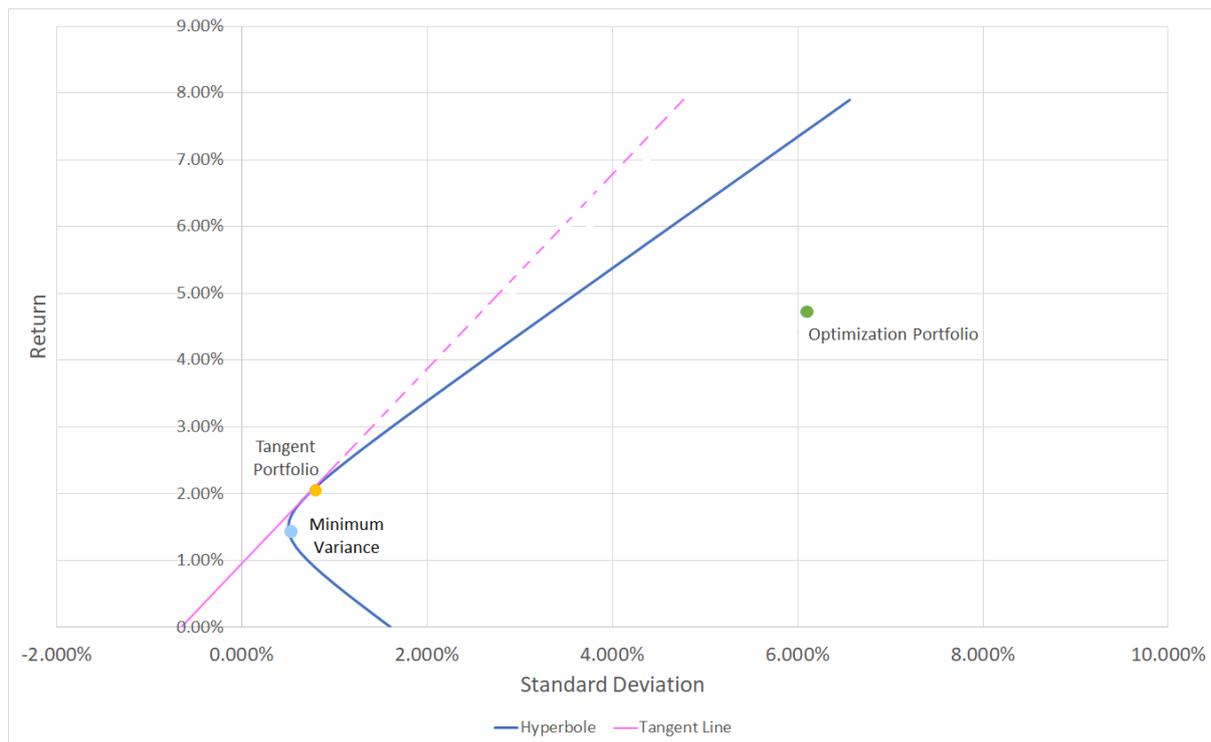
Table 7: Weights of the Tangent Portfolio

Asset Class	Weight (%)
Euro Inflation	53%
Euro Cash	36%
Euro Aggregate Bonds	-85%
Euro Inv Grade Corp Bonds	7%
Euro High Yield Bonds	4%
Euro Government Bonds	74%
Euro Govt Inflation-Linked Bonds	-7%
World Government Bonds hedged	-13%
Global Multiverse Bonds Hedged	29%
European Large Cap Equities	-3%
European Small Cap Equities	3%
European Core Real Estate	2%

Source: Author's calculations

The investment opportunity set is plotted using the envelop hyperbola, tangent equation, and data from both the lowest variance portfolio and tangent portfolio. This investment opportunity set can be seen in Figure 5 as the area below the Tangent line (capital market line) until the tangent point and below the hyperbola, representing the efficient frontier. As seen in the same Figure, it does not include the possibility of taking loans to invest in risky assets (that would be the dashed line). "Portfolio T" (orange point), is a portfolio present in the investment opportunity set with the highest Sharpe-ratio possible. This portfolio has an annual expected return of approximately 1.94% and 0.68% expected volatility, also this portfolio considers the possibility of short selling. It is also possible to see that the Optimization Portfolio (green point) is inside the Investment Opportunity Set, with 4.34% of return and 5.31% of volatility. The minimum variance portfolio, ignoring all the restrictions would be the portfolio in the light blue point, with 1.49% return and 0.502% volatility.

Figure 5: Mean Variance Theory (without any restrictions)

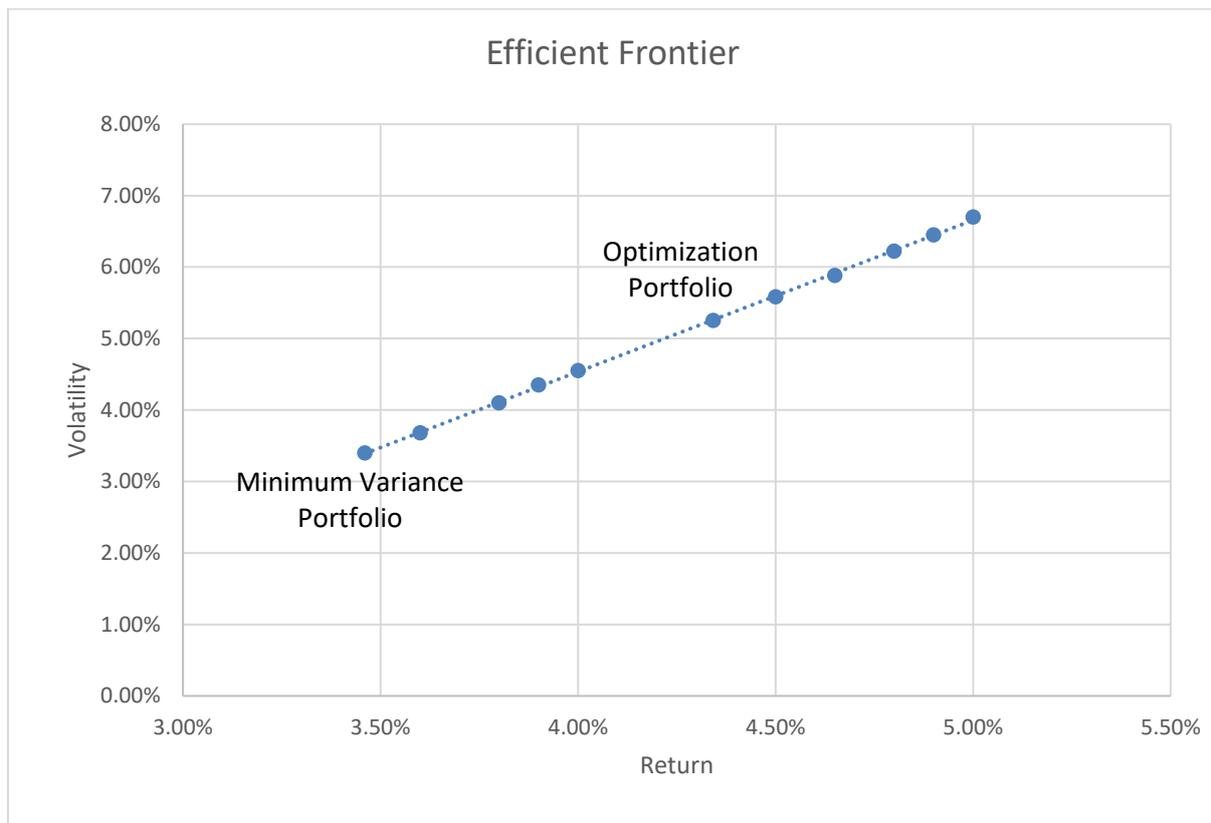


Source: Author's calculations

In figure 6 it is possible to see the efficient frontier, considering the various constraints imposed on the optimization portfolio. These constraints include exposure limits within asset classes, the duration constraint, a minimum required return of 2.5% above risk-free rate, a maximum volatility limit of 7.5%, the exclusion of short selling, and the inability to take loans. The construction of the graph involved two main steps. Firstly, the portfolio with the minimum variance was identified while considering all the abovementioned restrictions. This portfolio has a return of 4.34% and a volatility of 5.31%. Secondly, a simulation was conducted to have different return levels while accounting for the imposed constraints, resulting in different volatilities.

Although the portfolio lies within the investment opportunity set when disregarding the restrictions, it is worth noting that when the restrictions are taken into consideration, the portfolio lies on the efficient frontier. Therefore, it can be considered as an efficient portfolio even in the presence of these restrictions.

Figure 6: Efficient Frontier (with restrictions)



Source: Author's calculations

2.5.4 Expected Performance

The estimated performance of the portfolio is 4.34%, and this projection was originated by considering the individual returns of each portfolio item as well as their corresponding weights. To determine the return of each asset, we have relied on the 2023 JP Morgan Long Term market expectations. We have performed a complete study to determine the anticipated overall performance of the portfolio by combining these return forecasts and weighting each asset in accordance with its importance within the portfolio. An advantageous result is shown by the portfolio's predicted return of 4.34%, which suggests that return will likely exceed the minimal need.

A Monte Carlo Simulation Model was used to evaluate the expected returns to determine the expected performance. This requires the use of data on the amount of capital required, expected return, volatility, and time horizon. Apart from the initial investment, it was assumed that no more annual investments would be made.

The average yearly expected returns and volatility previously estimated (4.34% and 5.31%, respectively) were used to generate a random return at first. Excel's NORM.INV function was

used to produce this computation (RAND();4.34%;5.31%). The resultant value of the portfolio at the conclusion of this period might then be calculated by assuming random annual returns for the defined time horizon of the portfolio (11 years).

Table 8: Random Annual Returns

Year	Return	Ending Value
1	10.42%	€ 93,079,701.17
2	2.39%	€ 95,306,581.99
3	5.13%	€ 100,200,339.68
4	0.66%	€ 100,865,002.02
5	-3.21%	€ 97,631,049.32
6	2.95%	€ 100,513,464.54
7	6.60%	€ 107,146,208.57
8	10.53%	€ 118,432,691.20
9	2.30%	€ 121,155,982.21
10	-4.06%	€ 116,235,060.02
11	10.84%	€ 128,838,652.24

Source: Author's calculations

10,000 different simulations were run to estimate the ending portfolio value before computing the average value to produce more logical results. This strategy is essential because it ensures that the estimated average value is relatively stable even when the portfolio's final value may show significant variances. Employing the Monte Carlo Method, the average concluding portfolio value, based on 10,000 simulations, is estimated to be approximately 88 million euros.

Table 9: Data concerning the 10,000 iterations

Current Investment	€ 84,298,430.18
Average Return	4.34%
Standard Deviation	5.31%
Time Horizon (years)	11
Mean	€ 87,957,772.35
Median	€ 87,961,105.67
Standard Deviation	4524762.924
Percentiles	
5%	€ 80,526,096.65
25%	€ 84,919,790.63

Source: Author's calculations

2.5.5 Risk Analysis

As previously mentioned, the committee's report should contain the VaR using two different two methods: Historical Method and Monte Carlo Simulation.

1) Historical Method VaR

To calculate the VaR using the historical method, several key concepts and steps are involved. To begin the calculation of VaR using the historical method, it is necessary to gather relevant data, including the initial investment amount, mean annual returns, and standard deviation of the portfolio.

The mean investment and the standard deviation of the investment are calculated based on the available data. These values help in understanding the average performance and the level of variability in the investment returns. To determine the Absolute Value at Risk at a 1% significance level, the initial portfolio investment is subtracted from the cut-off value. The cut-off value is obtained using an Excel function that relies on the inverse of the normal distribution. Specifically, the cut-off is given by the formula: NORMINV (Mean Investment, Standard Deviation, Significance Level).

Considering a 99% confidence level, the z-score corresponding to this level can be obtained from statistical tables, which is 2.236. By subtracting the cut-off level from the initial portfolio investment, the Absolute Loss VaR is computed. In this case, the Absolute Value at Risk is €6,754,754.99 million euros at a 1% significance level. To determine the relative VaR, this value can be divided by the initial investment, resulting in 8%. This means that there is a 1% probability that the maximum potential loss will not exceed 8% of the total portfolio over a one-year period. In other words, with 99% confidence, the portfolio is not expected to lose more than 8%, equivalent to €6,754 million euros.

Moreover, the Expected Shortfall, also known as Conditional Value at Risk, can be calculated using the following formula for a specific significance level:

$$\text{Initial Investment} * (1\text{-Year VaR} + (\text{Z-Score} * \text{Standard Deviation})) \quad (7)$$

The Expected Shortfall represents the average magnitude of losses beyond the VaR; and in this case at a 99% confidence level, the Expected Shortfall in terms of relative loss to the total portfolio is 20%. This means that there is a 1% probability that the investment loss will be worse than the VaR, and if such an event occurs, the average magnitude of losses would be 20%.

Table 10: VaR - Historical Method

Investment	€ 84,298,430.18
Mean Return	4.34%
Standard Deviation	5.31%
Mean Investment	€ 87,959,089.47
Standard Deviation of Investment	€ 4,475,458.88
Cutoff 1% level	€ 77,547,615.21
Cumulative PDF	1%
Z-Score	2.236
1 year VaR at 1% level	€ 6,750,814.97
1 year VaR at 1% level (in %)	8.01%
Conditional Value at Risk (1% level)	€ 16,757,941.04
CVaR (1% level in %)	20%

Source: Author's calculations

2) Monte Carlo Simulation Method VaR

The Value at Risk (VaR) was also determined using a Monte Carlo Simulation methodology. The objective was to generate 10,000 different scenarios for the portfolio utilizing an initial portfolio investment value and a mean standard deviation as reference points for a seed value.

However, the 10,000 iterations' seed value calculation was done in a different way, using random variables with a particular adjustment drawn from a normal distribution. The risk-free rate was not considered when determining the seed value in this case, which was obtained using the Black Scholes Merton Model for Pricing Options. The justification for this exclusion was that the risk-free rate does not apply to this adjusted situation and is only relevant when assessing options. As a result, the following formula was used to determine the seed value:

$$\text{EXP}((-0.5\text{SD}^2) + \text{SD} * \text{NORM.S.INV}(\text{RAND} ())) \quad (8)$$

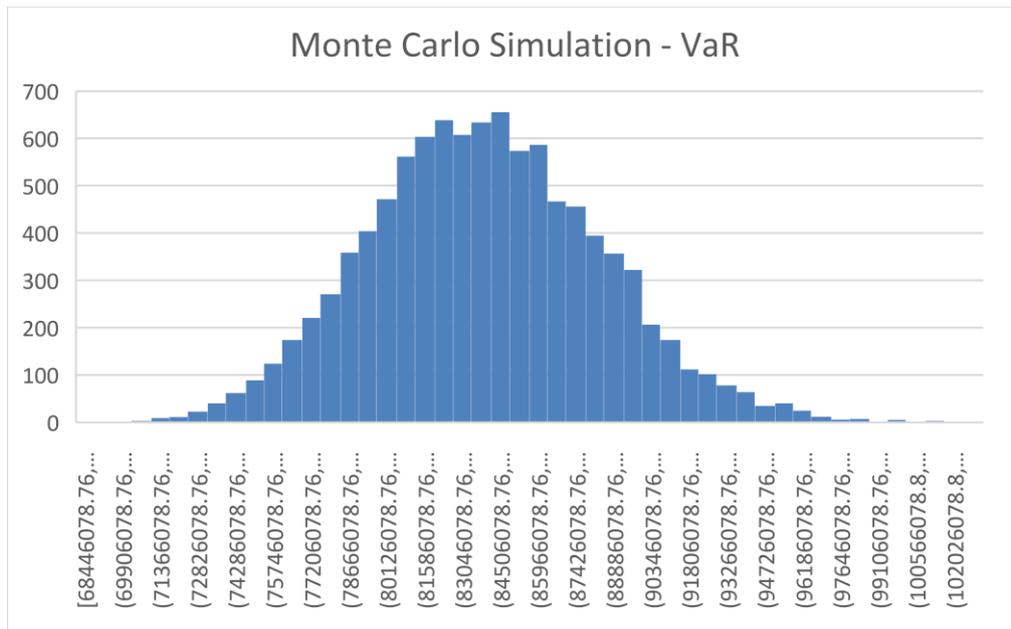
By employing this formula, a base scenario value (seed iteration) of 0.925433 was obtained. However, an additional 10,000 scenarios were computed, considering the potential gain or loss over a one-year period. Each simulation was multiplied by the initial portfolio value to yield multiple scenarios reflecting the expected value after one year.

To calculate the VaR at a 1% significance level, the 100th worst loss among the 10,000 simulations was determined using the SMALL (range, 100) function in Excel, which identifies the 100th smallest value. In this case, the VaR at a 1% significance level was determined to be

11%. This implies that there is a 1% probability that the portfolio will experience losses exceeding 11%.

Furthermore, the Expected Shortfall, also known as Conditional VaR, provides insight into the average potential losses beyond a certain probability level, namely the VaR. By employing the AVERAGEIF (range, ">VAR", range) function in Excel, the conditional VaR can be computed. The average loss impact, in case it exceeds the VaR, on average, 11%. In summary, the Monte Carlo Simulation approach was employed to compute the VaR by generating multiple scenarios for the portfolio value. The seed value, based on the Black Scholes Merton Model without the risk-free rate, served as the foundation for these simulations. The VaR represented the 100th worst loss among the 10,000 scenarios at a 1% significance level, while the Expected Shortfall indicated the average losses beyond the VaR.

Figure 7: Monte Carlo Simulation



Source: Author's calculations

3 Conclusion

Regarding the immunization portfolio, the primary objective was to efficiently fund the liabilities at the lowest cost by ensuring a consistent inflow of funds that exceeds outflows. This objective has been successfully achieved, the cash inflows effectively cover the cash outflows, as evidenced in Figure 2; Meaning that the client has liquidity to cover all liabilities (excluding workman's compensation). This liquidity is attained through a portfolio consisting exclusively of fixed income assets, enabling accurate prediction of all future cash flows. The selection of these assets took into consideration various criteria, including coupon type, credit ratings, maturity date, and duration. By adhering to these criteria, a portfolio with an investment of approximately €84 million was constructed (for further details, please see Table 3).

In terms of the optimization portfolio, the primary objective aimed to achieve a target return of 2.5% above the risk-free rate, while minimizing portfolio volatility. Construction of this portfolio was based on assumptions and indexes outlined in the JP Morgan document. The expected return for this portfolio is 4.34%, accompanied by a volatility of 5.31%. Considering the risk tolerance of the client, fixed income securities dominate the portfolio composition, accounting for 55% of the total investment. A summarized overview of the IPS is provided in Table A.6, in the appendixes.

Furthermore, a risk analysis utilizing VaR was conducted to evaluate the final investment. The results indicate that there is a 1% probability that the maximum potential loss will not exceed 8% of the total portfolio over a one-year period. In other words, with 99% confidence, it is expected that the portfolio will not incur losses exceeding 8%, equivalent to €6,754 million euros.

Appendices

Table A.1. Exposure Limits within asset classes

Asset Class	Minimum Tolerance	Central Allocation (%)	Maximum Tolerance	Benchmark
Fixed Income	30%	55%	100%	Bloomberg Barclays Euro Aggregate Bond Index; Bloomberg Barclays Euro Corporate Bond Index Markit iBoxx EUR High Yield Bond Index Bloomberg Barclays Euro Treasury Bond Index Bloomberg Barclays Euro Government Inflation-Linked Bond Index Bloomberg Barclays Global Aggregate Treasury Hedged Index
Equity	0%	10%	10%	FTSE World Government Bond Index MSCI Europe Small Cap Index
Cash	2,5%	2,5%	5%	Bloomberg Barclays Eurozone Inflation Linked Bond Index
Real Estate	10%	32,50%	45%	ECB Deposit Facility Rate FTSE EPRA/NAREIT Developed Europe Index

Source: Lusitania

Table A.2. Cash Out Flows

Liability (in €)/Year	1	2	3	4	5	6	7	8	9	10	11
Motor vehicle liability insurance	23,019,640	10,888,189	8,458,811	6,855,808	5,656,645	4,500,721	3,726,625	2,824,835	1,697,495	1,363,410	1,161,540
Other motor insurance	2,306,893	89,688	57,458	31,882	16,037	7,848	-3,624	-3,673	-5,366	1,365	0
Marine, aviation, and transport insurance	1,080,235	497,809	434,432	222,607	85,826	87,358	79,857	43,646	36,001	19,703	12,980
Fire and other damage to property insurance	8,669,947	1,456,589	699,035	529,722	502,975	372,308	259,382	226,899	175,895	183,838	196,095
General liability insurance	1,848,351	365,789	328,211	210,785	170,118	132,731	108,699	120,760	61,002	65,274	84,658
Credit and suretyship insurance	283,112	9,847	6,308	3,500	1,761	862	-398	-403	-589	150	0
Legal expenses insurance	16,942	637	396	213	104	49	-22	-22	-31	8	0
Assistance	3,660	138	85	46	22	11	-5	-5	-7	2	0
Miscellaneous financial loss	46	2	1	1	0	0	0	0	0	0	0
Sum of CF	37,228,825	13,308,687	9,984,736	7,854,562	6,433,488	5,101,887	4,170,514	3,212,037	1,964,400	1,633,750	1,455,273

Source: Lusitania

Table A.3. Detailed Information about the bonds

ISIN	Name	Type	Dirty Price	Coupon rate	Yield	Rating (Moody's)	Description
XS2557084733	ABN Amro Bank NV	Corporate	98.69%	4.50%	4.69%	A1	Bond issued on November 11 of 2022, with a maturity date on November 21 of 2034. The amount issued was 1,000,000,000 eur. The bond pays a coupon fixed of 4.50% (annually)
XS0160553441	Natixis SA	Corporate	101.48%	5.40%	5.26%	A1	Bond issued on January 9 of 2003, with a maturity date on January 9 of 2033. The amount issued was 60,100,000eur. The bond pays a coupon fixed of 5.40% (annually)
PL244760279	Poland (Government)	Government	90.33%	2.75%	4.28%	A2	Bond issued on May 25 of 2022, with a maturity date on May 25 of 2032. The amount issued was 2,000,000,000 eur. The bond pays a coupon fixed of 2.75% (annually)
XS0123523440	BNP Paribas SA	Corporate	107.36%	6.41%	5.38%	Aa3	Bond issued on January 23 of 2001, with a maturity date on January 23 of 2031. The amount issued was 30,000,000 eur. The bond pays a coupon fixed of 6.41% (annually)
DE000A289XG8	Mercedes Benz Group AG	Corporate	93.31%	2.38%	3.34%	Aa2	Bond issued on May 22 of 2020, with a maturity date on May 22 of 2030. The amount issued was 750,000,000eur. The bond pays a coupon fixed of 2.38% (annually)
ES0413790264	Banco Santander	Corporate	111.05%	5.28%	3.43%	A2	Bond issued on July 3 of 2013, with a maturity date on June 28 of 2029. The amount issued was 14,700,000 eur. The bond pays a coupon fixed of 5.28% (annually)
DE000BLB9RX8	BAYERISCHE LANDESBANK	Corporate	91.45%	2.27%	4.04%	Aa3	Bond issued on June 6 of 2022, with a maturity date on June 13 of 2028. The amount issued was 100,000,000eur. The bond pays a coupon fixed of 2.27% (annually)
FR001400DZM5	Societe Generale SA	Corporate	100.64%	4.00%	3.64%	A1	Bond issued on November 16 of 2022, with a maturity date on December 16 of 2027. The amount issued was 1,000,000,000 eur. The bond pays a coupon fixed of 4% (annually)
DE000LB384E5	Landesbank Baden Wuerttemberg	Corporate	98.55%	2.88%	2.90%	A1	Bond issued on January 23 of 2023, with a maturity date on March 23 of 2026. The amount issued was 1,000,000,000 eur. The bond pays a coupon fixed of % (annually)
FR0000571150	France (Government)	Government	108.75%	6.00%	2.45%	Aa2	Bond issued on October 25 of 1993, with a maturity date on November 25 of 2025. The amount issued was 30,653,928,118 eur. The bond pays a coupon fixed of 6% (annually)
DE0001134922	Germany (Government)	Government	102.80%	6.25%	2.52%	Aaa	Bond issued on January 4 of 1994, with a maturity date on January 4 of 2024. The amount issued was 12,750,000,000 eur. The bond pays a coupon fixed of 6.25% (annually)

Source: Refinitiv

Table A.4. Covariance Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
Euro Inflation (1)	0.000112	-0.000001	-0.000218	-	-	-0.000217	-	-	-	-	-	0.000173
				0.000205	0.000144		0.000102	0.000176	0.000179	0.000144	0.000266	
Euro Cash (2)	-0.0000011	0.000037	0.000082	0.000037	-	0.000089	0.000042	0.000074	0.000070	-	-	-
					0.000006					0.000156	0.000142	0.000193
Euro Aggregate Bonds (3)	-0.0002184	0.000082	0.002007	0.001782	0.001391	0.002143	0.001597	0.001426	0.001435	0.001219	0.001524	-
												0.001279
Euro Inv Grade Corp Bonds (4)	-0.0002054	0.000037	0.001782	0.002601	0.003413	0.001643	0.001736	0.001000	0.001377	0.004335	0.005021	0.000260
Euro High Yield Bonds (5)	-0.0001439	-0.000006	0.001391	0.003413	0.009409	0.000663	0.002013	0.000251	0.001397	0.011543	0.012849	0.003265
Euro Government Bonds (6)	-0.0002173	0.000089	0.002143	0.001643	0.000663	0.002381	0.001688	0.001607	0.001476	0.000498	0.000524	-
												0.001643
Euro Govt Inflation-Linked Bonds (7)	-0.0001015	0.000042	0.001597	0.001736	0.002013	0.001688	0.002830	0.000945	0.001111	0.003165	0.003143	-
												0.000217
World Government Bonds hedged (8)	-0.0001765	0.000074	0.001426	0.001000	0.000251	0.001607	0.000945	0.001369	0.001199	-	-	-
										0.000629	0.000464	0.001623
Global Multiverse Bonds Hedged (9)	-0.0001794	0.000070	0.001435	0.001377	0.001397	0.001476	0.001111	0.001199	0.001296	0.001102	0.001418	-
												0.001028
European Large Cap Equities (10)	-0.0001442	-0.000156	0.001219	0.004335	0.011543	0.000498	0.003165	-	0.001102	0.028900	0.027996	0.008150
								0.000629				
European Small Cap Equities (11)	-0.0002656	-0.000142	0.001524	0.005021	0.012849	0.000524	0.003143	-	0.001418	0.027996	0.032041	0.008399
								0.000464				
European Core Real Estate (12)	0.0001730	-0.000193	-0.001279	0.000260	0.003265	-0.001643	-	-	-	0.008150	0.008399	0.010404
							0.000217	0.001623	0.001028			

Source: Author's Calculation

Table A.5. Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
Euro Inflation (1)	1.000	-0.017	-0.460	-0.380	-0.140	-0.420	-0.180	-0.450	-0.470	-0.080	-0.140	0.160
Euro Cash (2)	-0.017	1.000	0.300	0.120	-0.010	0.300	0.130	0.330	0.320	-0.150	-0.130	-0.310
Euro Aggregate Bonds (3)	-0.460	0.300	1.000	0.780	0.320	0.980	0.670	0.860	0.890	0.160	0.190	-0.280
Euro Inv Grade Corp Bonds (4)	-0.380	0.120	0.780	1.000	0.690	0.660	0.640	0.530	0.750	0.500	0.550	0.050
Euro High Yield Bonds (5)	-0.140	-0.010	0.320	0.690	1.000	0.140	0.390	0.070	0.400	0.700	0.740	0.330
Euro Government Bonds (6)	-0.420	0.300	0.980	0.660	0.140	1.000	0.650	0.890	0.840	0.060	0.060	-0.330
Euro Govt Inflation-Linked Bonds (7)	-0.180	0.130	0.670	0.640	0.390	0.650	1.000	0.480	0.580	0.350	0.330	-0.040
World Government Bonds hedged (8)	-0.450	0.330	0.860	0.530	0.070	0.890	0.480	1.000	0.900	-0.100	-0.070	-0.430
Global Multiverse Bonds Hedged (9)	-0.470	0.320	0.890	0.750	0.400	0.840	0.580	0.900	1.000	0.180	0.220	-0.280
European Large Cap Equities (10)	-0.080	-0.150	0.160	0.500	0.700	0.060	0.350	-0.100	0.180	1.000	0.920	0.470
European Small Cap Equities (11)	-0.140	-0.130	0.190	0.550	0.740	0.060	0.330	-0.070	0.220	0.920	1.000	0.460
European Core Real Estate (12)	0.160	-0.310	-0.280	0.050	0.330	-0.330	-0.040	-0.430	-0.280	0.470	0.460	1.000

Source: 2023 Long-Term Capital Market Assumptions, JP Morgan

Table A.6 Overview of IPS

	Asset Class	Asset	Investment (%)
Immunization Portfolio (70%) Objective: Covering Liabilities	Fixed Income	ABN Amro Bank NV	3.5%
	Fixed Income	Natixis SA	2.2%
	Fixed Income	Poland (Government)	1.8%
	Fixed Income	BNP Paribas SA	3.8%
	Fixed Income	Mercedes Benz Group AG	4.0%
	Fixed Income	Banco Santander	5.8%
	Fixed Income	BAYERISCHE LANDESBANK	6.1%
	Fixed Income	Societe Generale SA	8.0%
	Fixed Income	Landesbank Baden Wuerttembg	10.0%
	Fixed Income	France (Government)	14.5%
	Fixed Income	Germany (Government)	40.3%
Optimization Portfolio (30%) Objective: Return Seeking	Cash	Euro Inflation	1.5%
	Cash	Euro Cash	1.0%
	Fixed Income	Euro Aggregate Bonds	5.0%
	Fixed Income	Euro Inv Grade Corp Bonds	5.0%
	Fixed Income	Euro High Yield Bonds	10.0%
	Fixed Income	Euro Government Bonds	10.0%
	Fixed Income	Euro Govt Inflation-Linked Bonds	10.0%
	Fixed Income	World Government Bonds hedged	10.0%
	Fixed Income	Global Multiverse Bonds Hedged	5.0%
	Equity	European Large Cap Equities	0.0%
	Equity	European Small Cap Equities	10.0%
	Other Investments	European Core Real Estate	32.5%

Source: Author's Calculation

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Abbreviations

ASF – Autoridade de Supervisão de Seguros e Fundos de Pensões

CEO – Chief Executive Officer

CIO – Chief Investment Officer

CFO – Chief Financial Officer

IPS – Investment Policy Statement

SD – Standard Deviation

VaR – Value at Risk

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