Lisbon School of Economics & Management
Universidade de Lisboa

MASTER OF SCIENCE IN

FINANCE

MASTERS FINAL WORK

PROJECT

INVESTMENT POLICY STATEMENT:

LUSITANIA INVESTMENT FIXED RATE

CAROLINA HENRIQUES DE OLIVEIRA

JUNE 2024

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SUPERVISORS:

RAQUEL MEDEIROS GASPAR

PAULO MARTINS SILVA

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Abstract

This Investment Policy Statement (IPS) is tailored for a specific investment product of Lusitania Vida S.A., namely the "Lusitania Investment Fixed Rate 3 years – 2023." The primary return objective is to achieve an annual return exceeding 3.2%, with a focus on fixed income products. The risk constraints are defined by a maximum portfolio volatility of 7.5%, ensuring that the portfolio maintains a low-risk profile. The time horizon is three years, with specific circumstances requiring consideration of duration matching and cash flow matching.

The investment philosophy emphasizes investing more than 80% of the portfolio in bonds, with the remaining allocation in equities. The strategic asset allocation is designed to meet client requirements, including risk tolerance and return objectives. The proposed portfolio reveals an allocation spread across 23 securities.

A comprehensive risk analysis is conducted, employing Value at Risk (VaR) and Expected Shortfall (ES) metrics derived from historical data and simulations. The VaR and ES values at various percentiles (1%, 5%, and 10%) indicate that the portfolio can withstand adverse market conditions.

In conclusion, this IPS provides a well-rounded investment strategy that aligns with the client's objectives and constraints, ensuring a balanced approach to risk and return. The IPS serves as a guiding framework for future investment decisions related to the investment product, promoting sustained growth and financial security. This IPS is developed in accordance with the CFA guidelines.

JEL classification: C6; G22; G38; G11

Keywords: IPS; Institutional Investor; Duration Matching; Cash Flow Matching; Liabilities; Volatility; Returns.

Resumo

Este Relatório de Política de Investimento (IPS) é adaptado para um produto de investimento específico da Lusitania Vida S.A., nomeadamente o "Lusitania Investimento Taxa Fixa 3 anos – 2023." O objetivo principal de retorno é alcançar um retorno anual superior a 3,2%, com foco em produtos de renda fixa. As restrições de risco são definidas por uma volatilidade máxima da carteira de 7,5%, garantindo que a carteira mantenha um perfil de baixo risco. O horizonte temporal é de três anos, com circunstâncias específicas que exigem a consideração do matching de duração e do matching de fluxos de caixa.

A filosofia de investimento enfatiza investir mais de 80% da carteira em obrigações, com a alocação restante em ações. A alocação estratégica de ativos é projetada para atender aos requisitos do cliente, incluindo tolerância ao risco e objetivos de retorno. A carteira proposta revela uma alocação distribuída por 23 títulos.

Uma análise de risco abrangente é realizada, utilizando métricas de Valor em Risco (VaR) e Shortfall Esperado (ES) derivadas de dados históricos e simulações. Os valores de VaR e ES em vários percentis (1%, 5% e 10%) indicam que a carteira pode suportar condições adversas de mercado.

Em conclusão, este IPS fornece uma estratégia de investimento bem equilibrada que se alinha com os objetivos e restrições do cliente, garantindo uma abordagem equilibrada ao risco e retorno. O IPS serve como um quadro orientador para futuras decisões de investimento relacionadas com o produto de investimento, promovendo crescimento sustentado e segurança financeira. Este IPS é desenvolvido de acordo com a estrutura CFA.

Classificação JEL: C6; G22; G38; G11

Palavras-Chave: IPS; Investidor Institucional; Duration Matching; Cash Flow Matching; Passivos; Volatilidade; Rentornos.

Acknowledgements

After a two-year journey filled with highs and lows, achievements and challenges, I would like to take a moment to express my gratitude to those who have supported me along the way.

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To the friends I made in Lisbon, thank you for making these past two years easier and more joyful. A special thanks to my dear friend Gonçala for your companionship and support.

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Abbreviations

ASF - Pension Funds Supervisory Authority

CFA - Chartered Financial Analyst

CIO - Chief Investment Officer

CMVM - Portuguese Securities Market Commission

CRO - Chief Risk Officer

CVaR – Conditional Value-at-risk

EEA – European Economic Area

EIOPA – European Insurance and Occupational Pensions Authority

ES - Expected Shortfall

ESG - Environmental, social, and governance

IPS - Investment Portfolio Statement

LTCMAs - Long-term capital market assumptions

MVT - Mean-Variance Theory

OECD – Organisation for Economic Co-operation and Development

S.A. – Sociedade Anónima (Public Limited Company)

S&P – Standard & Poor's

SAA - Strategic Asset Allocation

VaR - Value-at-Risk

Table of Contents

List of Figures

List of Tables

1 Executive Summary

This Investment Policy Statement (IPS) has been developed for Lusitania Vida, S.A., a leading Portuguese life insurance and pension fund management company founded in 1987 and predominantly owned by Montepio Geral – Associação Mutualista. More specifically this IPS is focused on an investment product of Lusitania Vida called "Lusitania Investment Fixed Rate 3 years - 2023". This product guarantees capital and income with a fixed annual interest rate of 3.2% over three years.

The governance structure of the company includes the Board of Directors and key committees such as the Risk, Investment, Internal Control, and Business Committees, overseeing strategy, risk management, and operational controls.

Investment objectives for this concrete proposed aim at generating cash flows over three years to meet obligations and maximize returns, primarily through fixed-income securities. The strategy prioritizes liquidity, aligning cash flows with policyholder obligations, and achieving a fixed annual yield of 3.2%. Risk management is conservative, focusing on capital preservation and minimizing volatility.

Lusitania Vida deals with various risks, including mortality, longevity, disability, expenses, discontinuity, catastrophic life risks, and market risks such as interest rate, equity, currency, spread, and concentration risks. Mitigation strategies include appropriate pricing, underwriting analysis, reinsurance, efficient claims management, and asset diversification.

Risk management follows the Prudent Person Principle, focusing on portfolio quality, liquidity, profitability, and solvency. The Risk Committee employs methods like standard deviation, Value-at-Risk (VaR), and Expected Shortfall to measure and manage risks. Effective risk management involves proactive identification, analysis, and response to business risks, ensuring stability, informed decision-making, and resilience.

In conclusion, this concrete Lusitania Vida's IPS aligns investment strategies with client needs, regulatory requirements, and robust risk management principles, ensuring sustainable and profitable investment outcomes. This project provides a comprehensive analysis of these elements, offering valuable insights into effective investment management for institutional investors.

2 Investment Policy Statement

2.1 Scope and Purpose

The institutional investor is Lusitania Vida, S.A., a Portuguese insurance company focused on life insurance and reinsurance and managing pension funds. This company was founded in 1987 and is currently owned by Montepio Geral – Associação Mutualista in 99,79%. Lusitania Vida's mission is to "Offer Life Insurance and Capitalization Operations to Montepio's Private Customers, and complementarily to other Private Customers through the Mediator Network, in Portugal and in the emigrant communities." And its vision as a Portuguese insurance company integrated into the Montepio Group is "to achieve superior levels of profitability and solvency, based on humanist values, solid partnerships and a flexible, motivated organization with high efficiency and quality."

The purpose of this Investment Portfolio Statement (IPS) is to evaluate the portfolio's investment policies in accordance with the client's profile, analyzing asset allocation and security selection alongside risk management criteria. Being for an institutional investor, the document details compliance and regulatory requirements that must be adhered to. Additionally, this IPS aims to explain and quantify the asset allocation models and risk assessment measures employed by the management team. Furthermore, as required by legislation, this document provides an understanding of the nature, risks, costs, and potential gains and losses associated with the portfolio for the client.

Concretely, this IPS aims at developing the portfolio associated with a particular investment product offered by Lusitania Vida, the "Lusitania Investment Fixed Rate 3 years - 2023.". This investment product is a capitalization insurance with income capitalization, featuring guarantees for capital and income. This means that generated income is reinvested in the insurance, ultimately enhancing the amount received by the insured. Combining protection with investment, especially against the risk of early surrender and the insurer's death, the product offers capital investment and a consistent financial return. At the end of the period of the contract, investors' receive the invested capital plus a capitalized interest of 3,2% per year.

In terms of structure, the company employs 32 individuals and comprises various corporate bodies as stipulated in the Commercial Companies Code. The General Assembly, represented

in Figure 1, consists of shareholders with voting rights. The Board of Directors is responsible for business strategy, human resources management, organizational governance, and overseeing the company's Risk Management and Internal Control Systems. Another key component of the General Assembly is the Supervisory Board and the Statutory Auditor, who are responsible for oversight. Annually, they prepare a supervisory report and provide an opinion on the management report and the annual accounts presented by the Board of Directors to the General Assembly. The Insurer also has a Remuneration Committee, which manages the compensation of the members of both the Board of Directors and the Supervisory Board.

The Board of Directors includes several management committees, specifically:

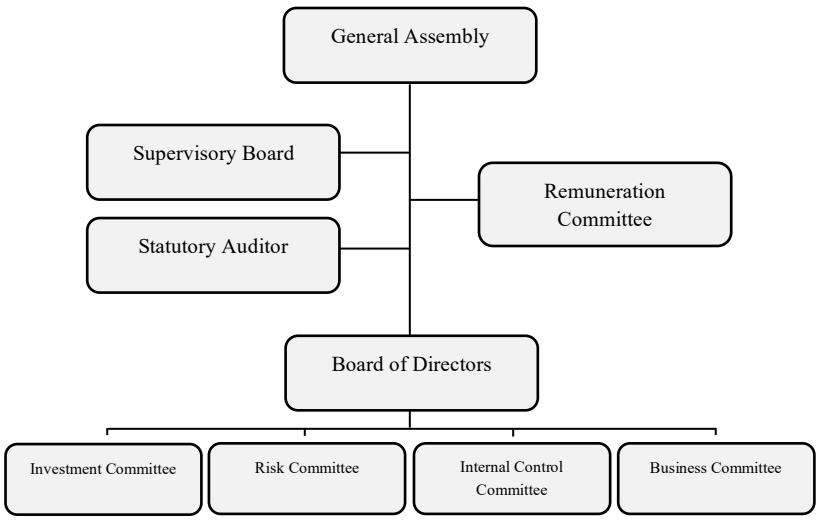
- Risk Committee: This committee aims to establish the company's risk management framework, support the definition of risk management principles, and monitor risk levels.

- Investment Committee: Responsible for defining and monitoring the Investment Policy Statement, tracking the performance of financial investments, and assessing deviations from exposure and risk limits.

- Internal Control Committee: Oversees the adequacy of the Internal Control System and the implementation of the Internal Control Policy.

- Business Committee: Focuses on defining and monitoring the Underwriting Policy, evaluating risk acceptance based on the decided risk appetite, and making timely decisions regarding the acceptance/underwriting of highly complex and/or large-scale transactions.

Figure 1 - Structure of Lusitania Vida



Source: Lusitania Vida Solvency and Financial Status Report, 2022

2.2 Governance

The system of Governance at Lusitania Vida is based on the principle of sustainable value creation. In the context of corporate governance, this principle goes beyond prioritizing immediate profits for shareholders. The company's long-term viability and its social and environmental impact are important. This strategy underscores the necessity of responsible conduct, ethical business practices, and the incorporation of environmental, social, and governance (ESG) considerations to ensure enduring success. Guarantee the trust of its clients, support its intermediaries, satisfy its employees and partners, and win the recognition of its shareholders, are the principal goals of the company's governance.

As referred, this IPS is developed for Lusitania Vida's Board of Directors, with inputs from the Investment Committee. The statement provides information about the company's risk tolerance, asset allocation, and investment strategies.

Under the guidance of the Chief Investment Officer (CIO), the Investment Department implements investment decisions in alignment with the IPS. The CIO oversees the investment team, ensuring adherence to the established guidelines. The Investment Committee routinely assesses the portfolio's performance against IPS benchmarks, identifying any deviations and recommending necessary adjustments to the Board regularly.

The Risk Committee, led by the Chief Risk Officer (CRO), works directly with the Investment Committee, to assure investments are made according with company's risk profile and adequate. Their key responsibilities include proactively identifying, assessing, and mitigating investment risks. They also conduct stress testing to analyze the portfolio's resilience, which informs risk mitigation strategies. Additionally, the department provides regular reports on risk exposure and recommended mitigation strategies. This comprehensive approach ensures the sound management of risks associated.

This type of governance allows Lusitania Vida to comply with all requirements of the Solvency II regime, which is an European regulatory regime that entered into force on January 2016. This regime mandates that insurance companies implement new disclosure procedures concerning their solvency and financial status.

The Board of Directors conducts regular assessments of the effectiveness of Lusitania Vida's Governance System. These assessments occur at least once every four years and may take place

more frequently if exceptional circumstances necessitate it. Additionally, policies and procedures undergo annual reviews as part of this process.

2.3 Investment, Return and Risk Objectives

2.3.1 Investment objective

As described before, this IPS is developed around a fixed investment product, which is a capitalization insurance with income capitalization, and at the end of the period of the contract the investor receives the invested capital plus a capitalized interest of 3,2% per year, so the return for the client is fixed. This financial product commenced on 01/01/2024 and matures on 31/12/2026. The initial capital is €100,000,000.

Implicitly, the selected investments must maintain liquidity to fulfill obligations at the conclusion of each fiscal year. Furthermore, portfolio construction necessitates consideration of both Cash Flow Matching and Duration Matching principles to deal with the product's associated liabilities.

In the event of the insured individual's survival until the contract's maturity, they are entitled to the initial capital alongside accrued annual earnings. However, should the insured individual pass away during the contract term, beneficiaries receive the initial capital plus the annual returns accumulated up to the end of the preceding annuity period.

The annual yield in the initial annuity is determined by applying the annual net interest rate, net of charges, to the invested capital. Thus, in subsequent years, the annual return is computed by applying the annual net interest rate, less charges specific to that annuity, to the total accumulated from the prior annuity. Early redemption is permissible following the free resolution period. In the first year, the redemption value equals the invested capital minus 2.5%. From the second year onwards, the redemption value comprises the invested capital plus the accumulated annual returns from the previous year, with a deduction of 1.5% if redemption occurs during the second year.

2.3.2 Return and risk requirements

In essence, the investment objective is to generate cash flows over a 3-year period at the lowest feasible cost to meet Lusitania's obligations while maximizing returns. This objective is approached conservatively, ensuring volatility remains below 7.5% annually and returns

exceed 3.2% per year. Lusitania Vida has a low-risk tolerance, the focus is on capital preservation and minimizing investment risk while achieving the target return.

Table 1 - Return and risk requirements

Return and risk requirements	
Standard Deviation	< 7,5% per year
Return	≥ 3,2% per year

Source: Author

2.3.3 The risk tolerance of the investor

In terms of risk profile, as a life insurance company, Lusitania Vida faces specific insurance risks including mortality risk, longevity risk, disability risk, expenses risk, discontinuity risk, and catastrophic life risk.

- Mortality Risk: This risk is associated with insurance obligations that require payments upon the death of the insured during the contract period.
- Longevity Risk: Related to insurance obligations where payments are made throughout the policyholder's lifetime, this risk arises when decreasing mortality rates necessitate higher technical provisions.
- Disability Risk: Linked to various insurance types that provide reimbursement for losses caused by changes in morbidity or disability rates.
- Expenses Risk: This risk is calculated by the reduction in equity resulting from a continuous increase in actual costs used for the best estimate.
- Discontinuity Risk: Corresponds to the risk of losses due to unexpected changes, either positive or negative, in policy cancellation rates, premium payment releases, or early redemptions.
- Catastrophic Life Risk: This risk stems from extreme events like pandemics, which are not covered by other specific insurance risks.

The main actions to mitigate these specific risks in the insurance sector include establishing appropriate prices, conducting underwriting analysis, utilizing reinsurance, managing claims efficiently, and diversifying risks.

In addition to insurance-specific risks, Lusitania Vida also faces market risk, which includes interest rate risk, equity risk, currency risk, spread risk, and concentration risk.

- Interest Rate Risk: This refers to the potential devaluation of assets, liabilities, or financial instruments caused by fluctuations in interest rates. Capital requirements for this risk are calculated by assessing the impact on equity from shifts in the interest rate curve. In 2022, Lusitania Vida implemented a "derisking" plan to align asset durations with liabilities, focusing on continuous asset/liability management.
- Equity Risk: Evaluates the vulnerability of assets and equity investment funds to market fluctuations, with capital requirements based on the immediate impact of stock price declines. For stocks listed on regulated markets in EEA or OECD countries, a 39% shock with symmetrical adjustment is applied, and a 49% shock for stocks from non-EEA or non-OECD countries, unlisted stocks, alternative investments, or investment funds without the transparency principle.
- Currency Risk: Lusitania Vida is not exposed to currency risk as it relies exclusively on contracts and investments denominated in euros.
- Spread Risk: Arises from the sensitivity of asset and liability values to changes in credit spreads. Capital requirements are determined by assessing the impact on equity, encompassing obligations, structured products, and credit derivatives. Despite the exposure of many portfolio assets to this risk, a significant portion is invested in government bonds, which are exempt from capital charges.
- Concentration Risk: Occurs when exposures are heavily concentrated on a single counterparty. Lusitania Vida monitors this risk quarterly and diversifies its asset portfolio to avoid undue concentration, especially with lower credit-rated debtors. Efforts are also made to reduce investments within the economic group itself to mitigate overall risk.

Credit Risk involves potential losses or unexpected deterioration in the credit positions of entities related to the company, affecting various assets such as reinsurance, accounts receivable, and cash deposits. Mitigation strategies include selecting highly rated reinsurers and diversifying exposure across multiple counterparts.

Operational Risk evaluates the potential for losses stemming from inadequate internal procedures, personnel actions, system failures, external events, and fraud. This assessment is conducted using EIOPA's standard formula.

To address Liquidity Risk, Lusitania Vida began adjusting the durations of its liabilities and assets in March 2022 to ensure the company meets financial obligations to policyholders when due. This adjustment aims to protect policyholder interests in products with guaranteed yield rates, leading to changes in the management of associated financial assets.

These risks are also relevant to the product profile of "Lusitania Investment Fixed Rate 3 years" and must be considered in portfolio construction and during the IPS. Given these risks, Lusitania Vida exhibits a conservative risk tolerance. The investment strategy prioritizes safety and predictability of returns over potentially higher returns from riskier assets.

2.3.4 Relevant constraints

The risks associated with the "Lusitania Investment Fixed Rate 3 years - 2023" product lead to the development of several constraints:

- Investment Constraints:

The allocated capital should be directed towards financial investments primarily composed of fixed-income securities issued by OECD member states. These securities must make up at least 80% of the portfolio and be sourced from both public and private entities, adhering to the minimum criteria of investment-grade bonds. These bonds are characterized by a reduced risk of default, typically issued by companies with strong credit ratings from major credit rating agencies. Specifically, bonds rated Baa by Moody's and BBB by S&P and Fitch are included, ensuring high credit quality and appropriate investment types. Shortselling is forbidden.

- Liquidity and Returns:

The portfolio must maintain sufficient liquidity to meet policyholder obligations at the end of each year. Additionally, the annual guaranteed returns need to be 3.2%, necessitating careful management of the investment strategy to meet these returns while maintaining liquidity.

- Cash Flow and Duration Matching:

Cash flow and duration matching are critical constraints. The investment strategy must ensure that cash flows from the portfolio align with the product's obligations throughout its life. This includes accounting for potential early redemptions by policyholders, with redemption fees factored into the overall return calculations.

- Death Benefit:

In the event of the policyholder's death, the investment strategy must ensure that sufficient funds are available to pay the initial capital plus accrued interest, adding another layer of constraint to the investment decisions.

- Losses:

In terms of constraints related to losses, Lusitania imposes that the maximum allowable loss for one year is 10% of the portfolio.

- Legal and Regulatory Requirements:

Lusitania Vida must adhere to regulations set by the Portuguese Securities Market Commission (CMVM), the Bank of Portugal, and the Portuguese Insurance and Pension Funds Supervisory Authority (ASF), which oversees Portugal’s insurance sector. Additionally, the company must comply with the Solvency II Directive, a European directive that establishes a risk-based framework for solvency capital adequacy. This directive requires insurers to hold sufficient capital to cover potential risks associated with their insurance products, incorporating quantitative and qualitative risk management elements, including market risk, credit risk, and underwriting risk.

These constraints ensure that the investment strategy for the "Lusitania Investment Fixed Rate 3 years - 2023" remains conservative, prioritizing safety and predictability of returns while complying with stringent regulatory standards and maintaining adequate liquidity to meet policyholder obligations.

2.4 Risk Management

Lusitania adheres to the Prudent Person Principle by investing only in assets that ensure portfolio quality, liquidity, profitability, and solvency. Internal limits on asset concentration and diversification are strictly enforced, with prohibitions on derivative investments.

The Risk Committee, responsible for risk management and analysis, delivers detailed risk data regularly. Risk measurement employs various methods, with standard deviation being the most common risk measure. Standard deviation gauges market volatility by quantifying the extent to which individual asset prices deviate from their average

Effective risk management is crucial for evaluating company performance and stability. It entails identifying, analyzing, and responding to business risks to proactively control future outcomes. Strategies include avoiding risk causes, mitigating risks, and accepting unavoidable risks through contingency planning. Prioritizing high-risk areas and providing crucial information for informed decisions ensures ongoing profitability and resilience.

In addition to standard deviation, Value-at-Risk (VaR) and Expected Shortfall are computed to provide further risk information. According to Yamai and Yoshiba (2005), "VaR represents the maximum possible loss over a given holding period within a fixed confidence level. Mathematically, VaR at the 100(1 - x) % confidence level is defined as the upper 100x percentile of the loss distribution. It is calculated as the supremum of all possible loss values such that the probability of exceeding this value is less than or equal to x. This definition applies to both discrete and continuous loss distributions." The Expected Shortfall, also called conditional VAR, is defined by the same authors as "the conditional expectation of loss given that the loss is beyond the VaR level" and "indicates the average loss when the loss exceeds the VaR level".[1]

[1] Unlike Value at Risk (VaR), which does not meet the subadditivity criteria, Conditional Value at Risk (CVaR) is a coherent risk measure. As a result, CVaR is thought to be more reliable when evaluating financial risk. Because it guarantees that the total risk of an asset portfolio is not higher than the sum of the individual risks of those assets, subadditivity is a crucial component of risk measurement.

3 Investment Design

3.1 Investment Philosophy

The final portfolio, recommended at the end of the Investment Policy Statement (IPS), is based on an optimization strategy utilizing Mean-Variance Theory (MVT). This theory, founded by Markowitz (1952), is a fundamental principle in portfolio optimization, aiming to maximize returns for a given level of risk or minimize risk for a targeted level of return. Mean-variance analysis. It focuses on two key metrics: variance, which measures the spread of returns within a dataset and indicates risk, and expected return, which estimates the potential return probability of an investment. In portfolio construction, securities with lower variance are preferred if they offer the same expected return, while those with higher returns are favored if they exhibit similar variance. The main goal of mean-variance analysis is to diversify investments across assets with different risk-return profiles, aiming to minimize the potential for significant losses during market fluctuations.

The proposed portfolio, however, must all rely on cash flow matching and duration matching strategies. According to Kocherlakota et al. (1988, 1990), cash flow matching aligns the cash flows generated by investments with the timing of future liabilities, such as expenses or obligations. This involves structuring an investment portfolio to ensure a steady stream of cash inflows to cover anticipated future cash outflows, typically achieved by investing in assets with cash flows closely matching the timing and amount of the liabilities. The goal is to create a reliable income stream that effectively meets financial obligations over time. As Iyengar and Ma (2009) note, “if the stream of liabilities can be matched perfectly with the asset cash flows, the resulting portfolio is truly immunized to the change of interest rates. However, if the liabilities have a longer time horizon compared to the maturities of the bonds available in the market, cash flow matching does not have a solution.” Therefore, achieving an immunized portfolio through cash flow matching requires careful consideration of bond maturities, which is why both cash flow matching and duration matching are used to construct the portfolio designed for Lusitania Vida.

Duration is a fundamental metric in finance that quantifies the sensitivity of a bond or fixed-income portfolio's price to changes in interest rates. Interest rate risk is crucial to understand due to the inverse relationship between bond prices and interest rates. When interest rates rise,

bond prices fall because the discount rate for cash flows increases, leading investors to demand higher yields. Conversely, when interest rates fall, bond prices rise as new bond returns are lower, prompting investors to accept lower yields on existing bonds.

The duration matching approach directly corresponds to portfolio immunization, an investment strategy wherein the duration of fixed-income securities aligns with that of the liabilities. This alignment mitigates interest rate risk and stabilizes the portfolio against fluctuations, as outlined by Bierwag et al. (2005).

The investment strategy primarily focuses on fixed-income assets, with limited allocation to equity, since the company demands stability and fixed-income products offer more stability than equities. Fixed-income securities in the portfolio are issued by OECD member states with strong credit ratings to ensure less volatility and predictable cash inflows, aligning with the cash flow matching strategy. All securities are invested in euros to avoid currency risk exposure.

Diversification is another key consideration, with the portfolio including both sovereign bonds and corporate bonds. Sovereign bonds, according to Corporate Finance Institute, are debt securities issued by national governments to fund spending programs, cover interest payments, or repay old debts. Like other bonds, sovereign bonds guarantee periodic interest payments and the repayment of the face value upon maturity, with their rating reflecting creditworthiness. Corporate bonds are issued by corporations and typically mature within 1 to 30 years. They generally offer higher yields than government bonds but carry greater risk. These bonds can be categorized by the market sector of the issuing company and whether they are secured by collateral or unsecured (according to Corporate Finance Institute).

This comprehensive approach aligns with the conservative strategy Lusitania Vida intends to implement, aiming to construct the best portfolio for the company.

3.2 Strategic Asset Allocation

To construct the optimal portfolio, taking into account the cash flow matching and duration matching, firstly it is necessary to calculate the liabilities. In the event of the insured individual's survival until the contract's maturity, they are entitled to the initial capital alongside accrued annual earnings. However, should the insured individual pass away during the contract term, beneficiaries receive the initial capital plus the annual returns accumulated up to the end of the preceding annuity period.

The annual yield in the initial annuity is determined by applying the annual net interest rate, net of charges, to the invested capital. Subsequently, in subsequent years, the annual return is computed by applying the annual net interest rate, less charges specific to that annuity, to the total accumulated from the prior annuity. Full redemption is permissible following the free resolution period. In the first year, the redemption value equals the invested capital minus 2.5%. From the second year onwards, the redemption value comprises the invested capital plus the accumulated annual returns from the previous year, with a deduction of 1.5% if redemption occurs during the second year.

Given this information, it is necessary to consider the liabilities associated with early redemptions and those linked to investor mortality. To compute liabilities of investor mortality, an annual mortality rate of 1.19% (as per PORDATA's Portuguese mortality rate of 2022) is utilized. For testing purposes this assumption is feasible, however, once the product is placed and the effective population of policyholders is known, a new mortality rate is calculated using the reference Mortality Table. Furthermore, to assess the probability of early redemption, information provided by Lusitania indicates a redemption probability of 3.7% in the first year and 4% in the second year. The total liability for each year is depicted in Table 2. In year 1 the liabilities are 4 835 580,00€, in the second year 5 083 551,92€ and in the third year 99 514 242,47€.

Table 2 - Cash flows and Liabilities

	Year 1 (2024)	Year 2 (2025)	Year 3 (2026)
Invested Capital	100 000 000,00 €	98 364 420,00 €	96 428 529,52 €
Annual Return (3,2%)	3 200 000,00 €	3 147 661,44 €	3 085 712,94 €
Sum of CF	103 200 000,00 €	101 512 081,44 €	99 514 242,47 €
Liability in case of death	1 228 080,00 €	1 207 993,77 €	
Liability in case of early redemption	3 607 500,00 €	3 875 558,15 €	
Total liabilities	**4 835 580,00 €**	**5 083 551,92 €**	**99 514 242,47 €**

Source: Author

The liability in case of death is determined by multiplying the cash flow of the year to the annual mortality rate of 1.19%. In case of early redemption, the liability is obtained by multiplying, the invested capital of the year minus the deducted interest, times the probability of redemption of the year. For example, in the first year, the liability is equal to (100 000 000,00€ - 100 000 000,00€ x 2,5%) x 3,7% = 3 607 500,00€.

Following the calculation of liabilities, it is important to consider the duration of these liabilities in the context of duration matching. The duration of the liabilities approximates 2.859, calculated using the formula,

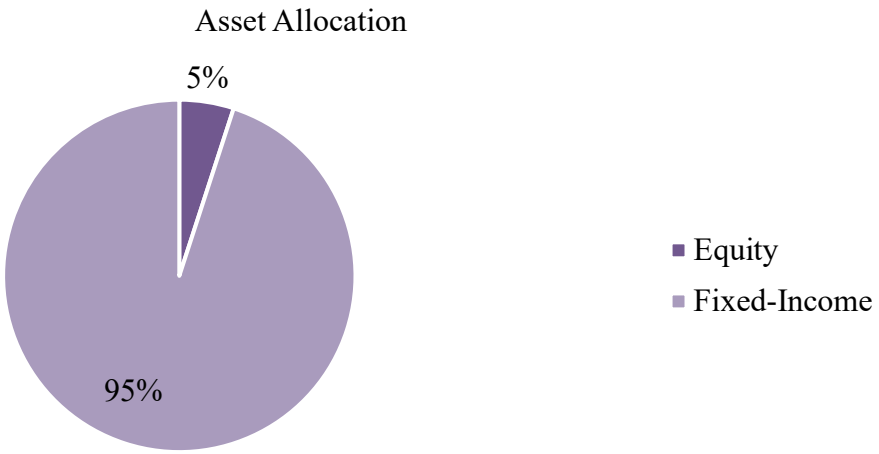
$$(1)\ \ Liabilities\ Duration = \frac{\sum_{t=1}^{n} t\ X\ PV_t}{\sum_{t=1}^{n} PV_t}.$$

The Strategic Asset Allocation (SAA) is meticulously designed to adhere to specific restrictions and criteria set by the investor, encompassing both equities and bonds as outlined in the investment objective. The goal is to ensure that fixed-income assets constitute over 80% of the portfolio.

Crafted with careful consideration, the SAA optimizes returns while meeting the investor's specific requirements. It allocates 5% to stocks, with a dedicated portion to sustainable stocks, and the remaining 95% to bonds, as illustrated in Figure 2. Diversification across different asset classes and sectors is a key strategy, ensuring a resilient and tailored investment portfolio that

carefully balances risk and return factors. This final portfolio is computed using the mean-variance theory.

Figure 2 - Asset Allocation



Source: Author

3.3 Security Selection and Portfolio Composition

To gather the necessary data for portfolio construction, is used information from Bloomberg, Refinitiv, Lusitania Vida reports, and the JPMorgan 2024 Long-Term Capital Market Assumptions Report. The portfolio primarily comprises fixed income, with a small allocation to equity. In crafting the optimal portfolio for the client, the initial phase involved selecting six distinct benchmarks—two equity-based and four fixed income-based—outlined in Table 2.

Table 3 - Benchmarks

Asset class	Benchmark
Equity	Dow Jones Sustainability Europe Index (DJEUR)
Equity	MSCI Europe ESG Leaders Index (EUSI)
Fixed Income	Markit iBoxx EUR Sovereigns Eurozone AAA Total Returns Index (I8KW)
Fixed Income	Bloomberg Euro 1-3 Year Treasury Bond Index (LET1TREU)
Fixed Income	Bloomberg Euro 0-3 Year Corporate Bond Index (BRC3TREU)
Fixed Income	Markit iBoxx EUR Corporates Overall Total Return Index (QW5A)

Source: Author

All benchmarks are selected to align with Lusitania's preferences and underscore the significance of diversification in achieving more conservative and secure outcomes. Each benchmark denominated in euros originates from OECD member states, ensuring adherence to investment-grade bond standards. Both equity benchmarks prioritize sustainability, reflecting the contemporary significance of this theme in light of concerns surrounding CO2 emissions and their implications for human life on the planet. In today's context, sustainability has emerged as a dominant consideration, influencing investment decisions as stakeholders increasingly recognize its impact on environmental and social well-being and long-term economic viability.

Taking into account each benchmark individually and in more detail, the Dow Jones Sustainability Europe Index (DJEUR), a component of the Dow Jones Sustainability Indices (DJSI), identifies top European sustainability performers through S&P Global's Corporate

Sustainability Assessment. By employing ESG criteria and a best-in-class approach, these indices offer investors objective benchmarks for managing sustainable portfolios, enabling the construction of portfolios featuring companies that lead in sustainability within their industries.

The MSCI Europe ESG Leaders Index (EUSI) is a weighted index representing companies selected from the MSCI Europe Index based on Environmental, Social, and Governance (ESG) criteria, excluding certain business activities, ESG ratings, and controversies. It aims to maintain sector weights in line with the parent index and includes large and mid-cap companies across 15 developed markets countries. Constituents are chosen primarily based on ESG rating, rating trend, and industry adjusted ESG score, with a target of 50% coverage of each Global Industry Classification Standard sector.

The Markit iBoxx EUR Sovereigns Eurozone AAA Total Returns Index (I8KW) is a conservative investment choice offering exposure to high-quality government bonds from Eurozone countries, and it exclusively includes euro-denominated bonds issued by Eurozone governments with the highest credit rating (AAA) to minimize default risk. The index diversifies across the yield curve, encompassing bonds with varying maturities.

The Bloomberg Euro 1-3 Year Treasury Bond Index (LET1TREU) goal is to replicate the performance of the short-term Eurozone government bond market, which includes bonds from several Eurozone countries and spans maturities of one to less than three years, denominated in euros or legacy euro currencies.

The Bloomberg Euro 0-3 Year Corporate Bond Index (BRC3TREU) seeks to replicate the performance of short-term Euro-denominated corporate bonds, focusing on fixed rates and investment-grade ratings. It includes bonds from industrial, utility, and financial sectors with maturities under three years.

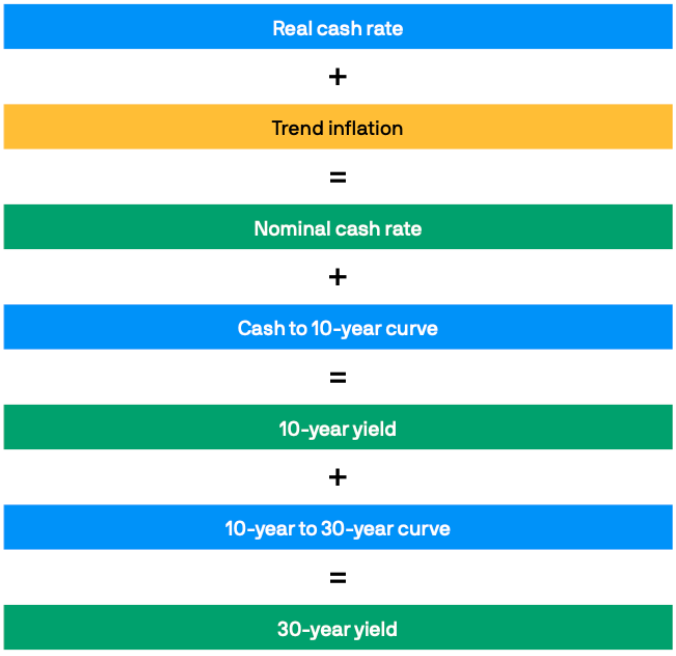
The Markit iBoxx EUR Corporates Overall Total Return Index (QW5A), managed by S&P Dow Jones Indices, monitors the performance of investment-grade euro-denominated corporate bonds issued by European companies. It comprises liquid bonds across the entire euro corporate bond yield curve and undergoes monthly rebalancing, serving as one of the most widely used benchmarks for European corporate bonds.

In terms of returns and volatility computations, the expected returns of the benchmarks utilized are derived from the JPMorgan 2024 Long-Term Capital Market Assumptions Report. The fixed income return forecasts in the JPMorgan report, are generated through a comprehensive

and systematic process. It begins with a building-block approach that uses long-term growth and inflation projections as fundamental inputs. Real cash rate estimates are combined with the latest Long-Term Capital Market Assumptions (LTCMAs) inflation projections to estimate nominal cash rates. Then, the slopes of government bond curves are forecasted to derive 10-year and 30-year bond yields, with interpolation used for other maturities, resulting in a sovereign yield curve for each currency. These sovereign yield curves form the basis for all fixed income assumptions. This process is possible to observe in the Figure 3.

In addition to these curves, spread forecasts for corporate and other non-sovereign debt sectors are incorporated. These forecasts are determined based on the projected macroeconomic environment and anticipated structural changes. By combining an expected transition path from current yields to these projected yields over time with the compositional characteristics of each relevant debt market index, the process ultimately produces forecast returns across all fixed income markets.

Figure 3 - LTCMA fixed income returns



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

On the other hand, volatility is evaluated by analyzing daily data spanning the past decade sourced from Bloomberg. To annualize the volatilities, the standard deviation was multiplied by the square root of 252. To calculate the volatilities is used the following formula:

$$(2)\ \sigma i\ =\ \sqrt{Var(Ri)} * \sqrt{252}$$

$$(3)\ Var(R_i)\ =\ E[(R_i\ -\ \bar{R}_i)^2]$$

The volatilities obtained and expected returns considered of which indices are comprehensively outlined in Table 4.

Table 4 - Volatilities and expected returns of benchmarks

Benchmark	Volatility	Expected Return
DJEUR	16,0847%	8,00%
EUSI	16,8171%	7,30%
I8KW	5,0834%	3,50%
LET1TREU	1,8455%	4,00%
BRC3TREU	2,3617%	3,50%
QW5A	3,1371%	4,00%

Source: Author

To start the process of the construction of the optimal portfolio For Lusitania Vida, as referred before, it is used the mean-variance theory, that also requires as input the variance-covariance matrix. To calculate correlations, the CORREL function in Excel was employed, incorporating the daily returns of each security over the past decade, ensuring accuracy in portfolio analysis and optimization. The variance-covariance matrix was obtained using the following formula, which is based on the formula for calculating the correlation:

$$(4)\ Covariance\ (i,j) = [volatility\ (i).volatility(j)]\ .Correlation\ (i,j)$$

The correlation and variance-covariance matrices are reported in tables A2 and A3 in the appendix.

Following this, various portfolios were considered, before achieving the propped and the final portfolio for Lusitania, taking into account the risk and return characteristics and the investment constraints: the minimum variance (MV), the tangent (T), and the Roy (R) portfolio.

These portfolios solve the following maximization problems:

- Tangent

$$(5)\quad \max \frac{X' Rbar - Rf}{\sqrt{X'VX}} \quad \text{s.t. } X'\mathbb{1} = 1$$

$$xi \geq 0 \ \forall i$$

$$Rbar = X'Rbar$$

$$Rf = 3Y\ Bund$$

$$V = Variance\ matrix$$

where X is the vector of weight to be determined,

- Minimum variance

$$(6)\quad \min\ X'VX \quad \text{s.t. } X'\mathbb{1} = 1$$

$$xi \geq 0 \ \forall i$$

- Roy

$$(7)\quad \min Probl\ (X'R \leq RL) \text{ s.t. } X'\mathbb{1} = 1$$

$$RL = 10\%$$

$$xi \geq 0 \ \forall i$$

$$<=> \max \frac{X'R - RL}{\sqrt{X'VX}}$$

Since Lusitania does not allow for shortselling positions all these optimization problems are numerically solved. The risk-free asset that is used is the 3y Bund with a return of 2,043%.

The minimum variance (MV) portfolio is selected as the combination of assets that offers the lowest possible level of volatility since this strategy aims to minimize portfolio risk. In this case, as shortselling is forbidden, it is necessary to maintain a fully invested and non-negative weight structure, and because of that the MV portfolio resides within the hyperbola due to this constraint. It is possible to observe the portfolio in Figure 4.

It is also calculated the tangent (T) portfolio. The tangent is the portfolio with the highest Sharpe ratio. It is possible to observe the portfolio in Figure 4, and as the shortselling is forbidden, the portfolio is inside the envelop hyperbola.

The Lusitania had a restriction related to losses, which is that the maximum allowable loss for one year is 10% of the portfolio. To satisfy this condition, the Roy (R) Portfolio. Roy's Safety-First Criterion is the investment that minimizes the probability of a bad outcome, given a fixed level of returns RL,

$$(8)\ \ Roy\ =\ min\ Prob\ (Rp < RL).$$

To facilitate the calculation with different distributions, the variable Rp is normalized, which means that has a mean equal to 0 and a standard deviation equal to 1. In this case, the cumulative distribution function (Φ). Rewriting the probability Prob (Rp < RL) in terms of the normalized variable,

$$(9)\ \ Prob\ (Rp < RL) =\ Prob\ \left(\frac{Rp - Rbar}{sigma} < \frac{RL - Rbar}{sigma}\right) =\ \Phi\ \left(\frac{RL-Rbar}{sigma}\right).$$

Regardless of the distribution of income from the portfolio returns Φ,

$$(10)\ \ Roy\ =\ min\ Prob\ (Rp < RL) <=> max\ (\frac{Rbar_p - RL}{sigma_p}).$$

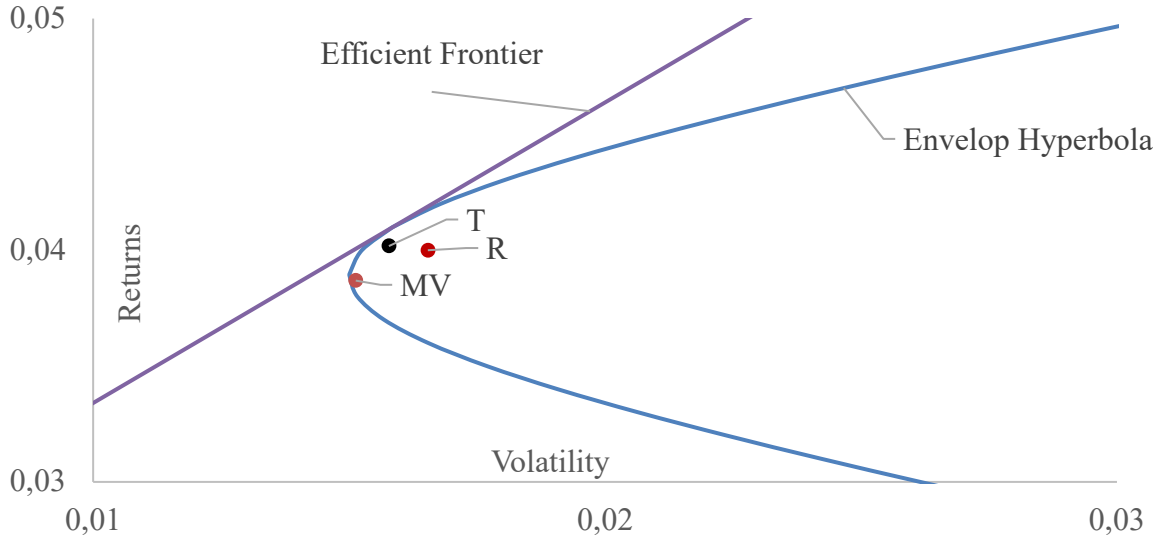
The RL is the threshold, and in this case is -10%.

The MV portfolio obtained had an expected return of 3,8689%, and a volatility of 1,5130% which corresponds to a Sharpe ratio of 1,2067. The T portfolio obtained has an expected return of 4,0180%, and a volatility of 1,5777% which corresponds a Sharpe ratio of 1,2516.

The R portfolio has an expected return of 4%, a volatility of 1,6538%, and a sharpe ratio of 1,1832. The probability that the portfolio returns less than 10% (Prob(Rp < RL)) is close to zero, indicating a very low likelihood of the portfolio underperforming this threshold.

The weights of which benchmark for these portfolios are presented in Table 5, and it is possible to observe the portfolios in Figure 4. In Figure A1 in the appendix, is possible to view the equivalent portfolios if shortselling would be permitted.

Figure 4- Graph with minimum variance portfolio, tangent portfolio, and Roy portfolio without shortselling



Source: Author

Table 5 - Weights of minimum variance portfolio, tangent portfolio, and Roy portfolio without shortselling

	Benchmark	MV portfolio	T portfolio	R portfolio
Equity	DJEUR	0,00%	2,06%	0,00%
	EUSI	0,00%	0,00%	0,00%
Fixed-Income	I8KW	0,00%	0,00%	0,00%
	LET1TREU	59,35%	67,37%	69,05%
	BRC3TREU	26,22%	12,91%	0,00%
	QW5A	14,43%	17,65%	30,95%
	Expected Return	3,87%	4,02%	4,00%
	Volatility	1,51%	1,58%	1,65%
	Sharpe ratio	1,20665	1,25163	1,1832

Source: Author

As it is possible to observe in Table 5, none of the portfolios is adequate for Lusitania, because the portfolios are not sufficiently diversified. After all, the investment is just in some of the benchmarks, and most of them are invested just in fixed-income.

Given the inadequacy of the portfolios, the proposed portfolio is crafted by prioritizing the minimization of Prob(Rp<RL), as Roy imposes, along with a cap on volatility below 7.5%, and

a requirement of over 80% allocation to fixed income. Additionally, to enhance diversification and overall portfolio safety, each security is constrained to represent no more than 50% of the portfolio. Another restriction imposed is that equity must represent at least 5% of the portfolio. Fufure A.4 illustrates some of the alternative portfolios considered. The optimization problem to obtain the proposed portfolio is formulated as follows:

$$(11) \quad min\ Pr(Rp < RL) \ \text{ s.t. } \sqrt{X'VX} \leq 7{,}5\%$$

$$X'Rbar \geq 3{,}2\%$$

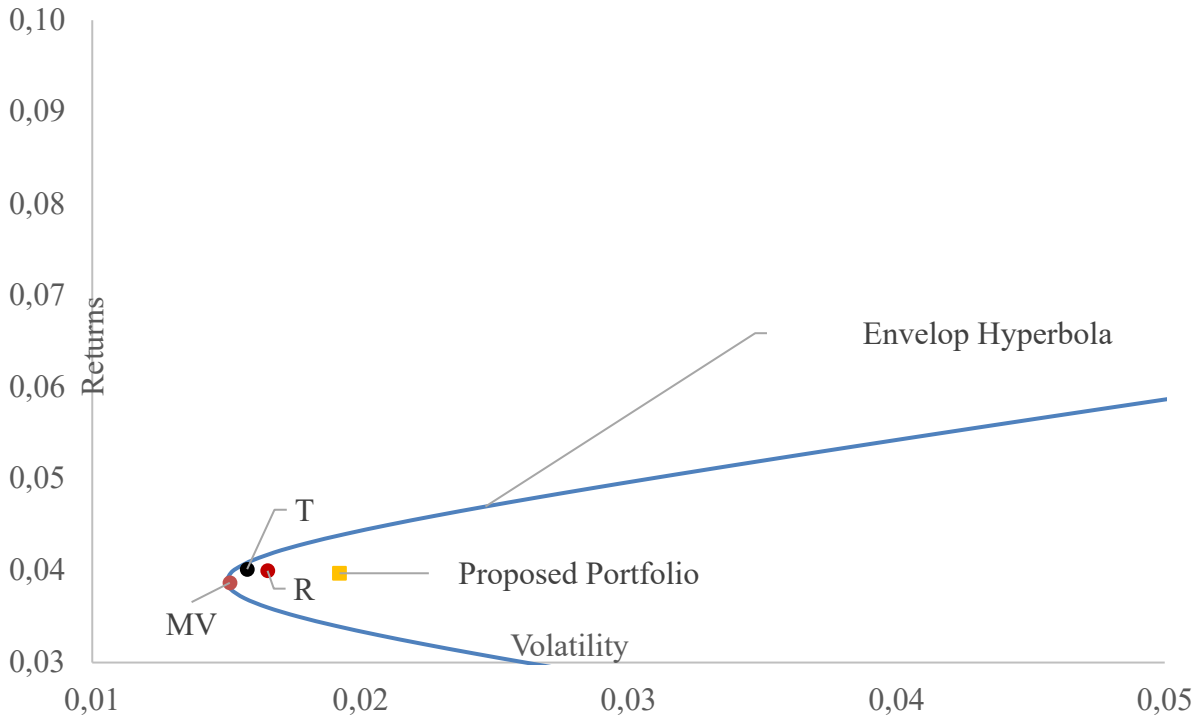
$$X\ bonds \geq 80\%$$

$$X\ equity \geq 5\%$$

$$0{,}5 \geq xi \geq 0\ \forall i.$$

These constraints ensure the portfolio is well-diversified and aligned with the specified risk and return objectives. The proposed portfolio is represented in Figure 5.

Figure 5 - Graph with MV portfolio, T portfolio, R portfolio, and Proposed Portfolio



Source: Author

The composition of the proposed Portfolio, as illustrated in Figure 5, includes the weights presented in Table 6.

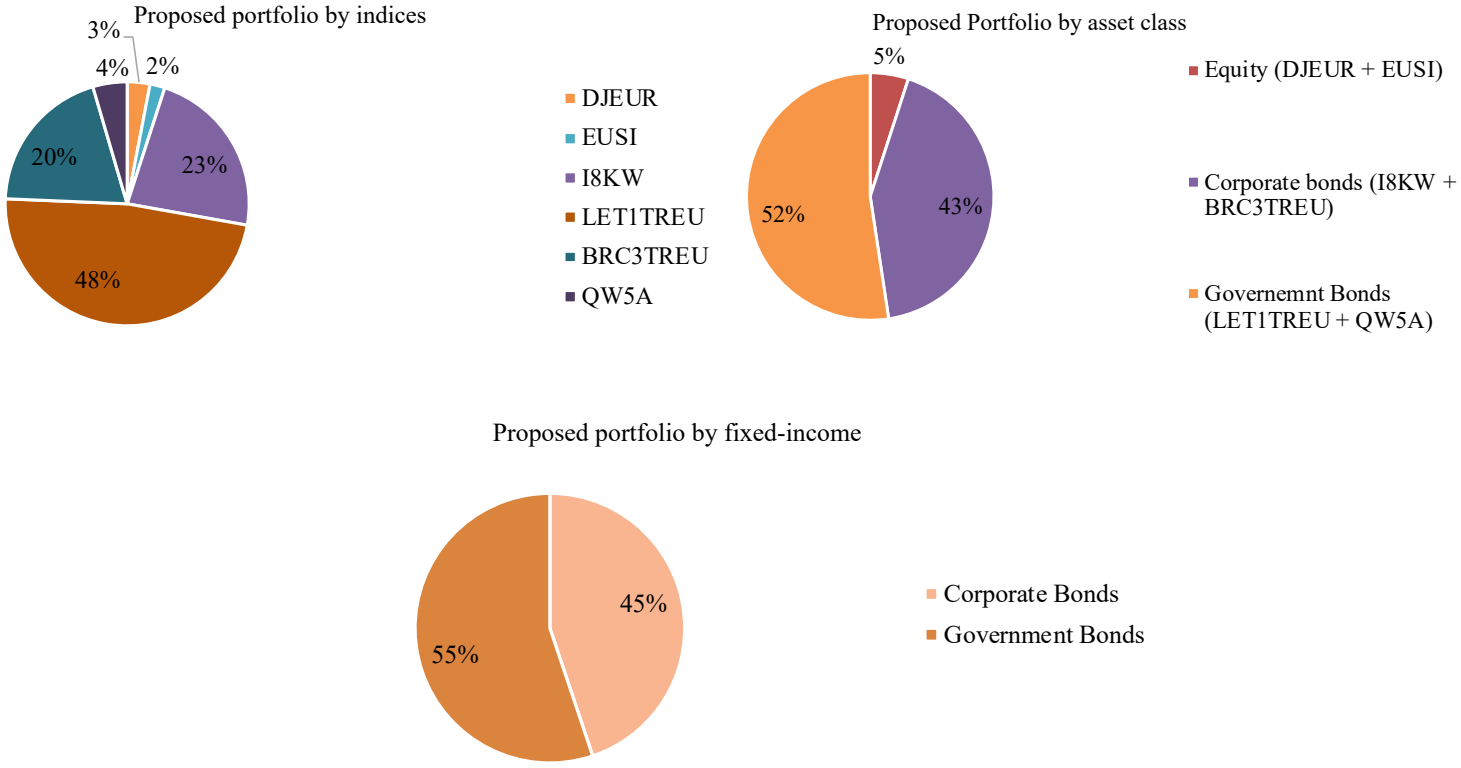
Table 6 - Weights of Final Portfolio

	Benchmark	Volatility	Expected Return	Weight
Equity	DJEUR	16,0847%	8,00%	3,02%
	EUSI	16,8171%	7,30%	1,98%
Fixed-Income	I8KW	5,0834%	3,50%	22,81%
	LET1TREU	1,8455%	4,00%	47,85%
	BRC3TREU	2,3617%	3,50%	19,80%
	QW5A	3,1371%	4,00%	4,54%

Source: Author

The final Portfolio is composed, as referred, of 5% by equity, and 95% by fixed income. In terms of bonds, 44,85% are classified as corporate bonds and the remaining (55,15%) are government bonds. All the fixed-income assets are Investment Grade bonds denominated in euros. It is possible to observe the composition of the Proposed portfolio in different ways in Figure 6.

Figure 6 – Composition of Proposed Portfolio (3 different graphs)



3.4 Expected Performance

Considering the results obtained for indices, the Final Portfolio was created using specific securities and optimized with the SOLVER function in Excel. In addition to the restrictions imposed when constructing the portfolio with indices, duration matching, and cash flow matching were also imposed when constructing the final portfolio with specific assets from the benchmarks referred to before. The optimization problem to obtain the final portfolio is formulated as follows:

$$(12)\ \ min\ Pr(Rp < RL)\ \text{ s.t. } \sqrt{X'VX} \leq 7{,}5\%$$

$$X'Rbar \geq 3{,}2\%$$

$$X\ DJEUR = 3{,}02\%$$

$$X\ EUSI = 1{,}98\%$$

$$X\ I8KW = 22{,}81\%$$

$$X\ LET1TREU = 47{,}85\%$$

$$X\ QW5A = 4{,}54\%$$

$$\text{Portfolio duration} = \text{liabilities duration}$$

$$\text{Amount invested} = 100\ 000\ 000€$$

$$\text{Expected CF 2024} \geq \text{Liabilities 2024}$$

$$\text{Expected CF 2025} \geq \text{Liabilities 2025}$$

$$\text{Expected CF 2026} \geq \text{Liabilities 2026.}$$

The expected cash flow for equity is calculated using the amount invested in the security and the annual equivalent rate. For fixed-income investments, the expected cash flow is calculated based on the amount invested in each security, including the coupon and maturity. More details about the securities can be found in Figure A.4 of the appendix.

Table 7 presents the portfolio obtained through the optimization problem described earlier. By imposing all the specified restrictions and considering the 10 top constituents from the six benchmarks referred before, it is determined through SOLVER that the optimal portfolio

consists of 23 assets. Table 7 provides a detailed overview of the specific securities in the final portfolio and the respective amounts invested in each.

Table 7- Securities of the Final Portfolio

Benchmark	Weight of the portfolio	Security	Weight	Amount Invested	Quantitaty
EQUITY					
DJEUR	3,02%	ASML HOLDINGG NV	3,02%	€3 015 103,16	4547
EUSI	1,98%	ASML HLDG	0,15%	€154 742,88	233
		HSBC HOLDINGS	1,83%	€1 830 161,73	251624
		Total	5%	€5 000 007,77	256404
FIXED-INCOME					
I8KW	22,81%	BBG01C6SYFN8 Germany (Federal Republic) 33 2.3 15/02/33	15,69%	€15 693 518,12	153582
		Republic Of Germany 15/02/26	2,87%	€2 865 020,41	29766
		Republic Of Germany 8/26	4,25%	€4 250 686,21	44960
LET1TREU	47,85%	France 3.5 04/25/2026	3,17%	€3 169 834,37	30949
		France 0.5 05/25/2026	4,26%	€4 262 892,27	44564
		France 2.5 09/24/2026	4,51%	€4 510 516,07	44987
		France 0 02/25/2026	0,73%	€731 216,01	7726
		France 0.5 05/25/2025	14,81%	€14 809 498,95	152757
		France 0 02/25/2027	11,96%	€11 958 033,82	128462
		France 0.25 11/25/2026	3,54%	€3 541 227,42	37574
		France 1 11/25/2025	2,05%	€2 046 424,93	21713
		Bundesrep Deutch 0.5 02/25/2026	0,96%	€958 017,09	9953
		France 6 19/25/2025	1,86%	€1 864 158,80	17586
BRC3TREU	19,80%	Volkswagen Leasing Gmbh 3.625 10/11/2026	2,05%	€2 050 097,54	20523
		Banco Santander Sa 3.5 01/09/2028	17,75%	€17 751 093,70	178176
QW5A	4,54%	Cooperatieve Rabobank Ua 04/26/2026	0,93%	€932 632,76	9791
		Anheuser-Busch Inbev SA/NV 03/31/2026	0,57%	€572 059,47	5753
		Jpmorgan Chase & Co 02/19/2026	0,38%	€377 709,34	3800
		Volkswagen International Finance Nv 11/15/2025	1,43%	€1 430 868,19	14141
		Bnp Paribas Sa 11/29/2024	1,22%	€1 224 486,76	12602
		Total	95%	€94 999 992,23	969366
Final Portfolio totals		23	100%	€100 000 000,00	1225769

Portfolio Duration	2,85856
Portfolio E.Return	3,8848%
Portfolio Volatility	1,9222%
Prob(Rp<RL) =	0,000000000000

Source: Author

The final portfolio ensures duration matching, with the duration of the liabilities set to 2.8586, and cash flow matching. By the end of 2024, the cash flow is €8,766,093.41, while the liabilities for that year amount to €4,835,580. By the end of 2025, the cash flow is projected to be €28,802,197.70, with liabilities of €5,083,551.92. In 2026, the cash flow is expected to be €99,514,242.47, matching the liabilities exactly. The surplus cash flows from 2024 and 2025 provide the company with the opportunity to invest in other financial products, as is assumed that there is no reinvestment of the excess cash flow.

The portfolio allocation is diversified across 23 securities, with an expected return of 3.8848% and a volatility of 1.9222%. Given the low volatility, it is highly expected that the actual returns closely align with the calculated expected returns, providing a reliable forecast for future performance. Furthermore, the probability of the portfolio return (Rp) being less than the required return (RL) is close to zero, indicating a high level of confidence in meeting or exceeding the target returns.

Comparing the MV portfolio, the T portfolio, and the Final portfolio (Table 8), it is possible to observe that the tangent portfolio naturally has the highest expected return and the best risk-adjusted return (highest sharpe ratio) making it an attractive option for maximizing returns. The Minimum Variance portfolio provides the lowest volatility, making it the most suitable option for risk-averse investors who prioritize stability over higher returns. The final portfolio, chosen as the Roy portfolio, strikes a balance with a reasonable expected return and slightly higher volatility. It also includes both equity and fixed-income investments, offering diversification benefits. In the case of the T portfolio, the investment is just in one benchmark of equity and three benchmarks of fixed-income, and in the case of the MV portfolio, the investment is only in three benchmarks of fixed-income.

Given these comparisons, the Final portfolio is selected for its diversified investment approach, despite its realtively lower Sharpe ratio and higher volatility compared to the other portfolios. This portfolio aligns with the constraints of Lusitania while ensuring a diversified investment mix.

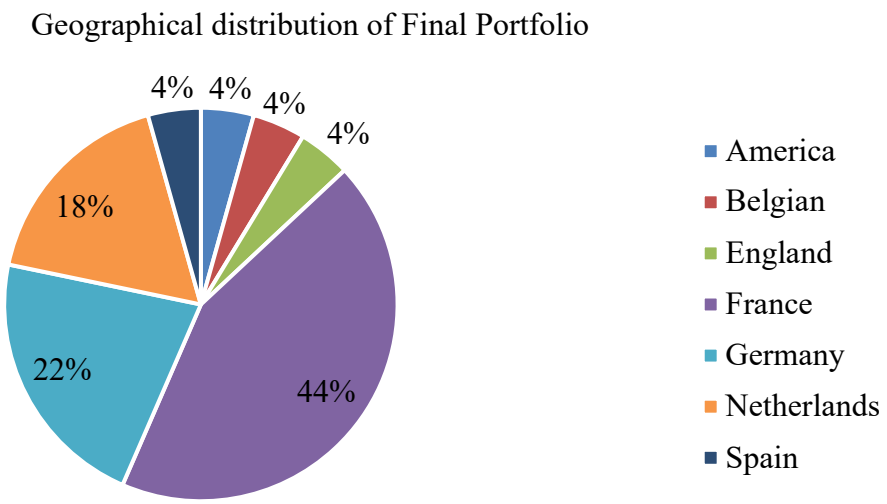
Table 8 - Comparison of MV, T, and Final portfolio

	MV portfolio	T portfolio	Final portfolio
Expected Return	3,87%	4,02%	3,88%
Volatility	1,51%	1,58%	1,92%
Sharpe ratio	1,21	1,25	0,96
Prob (Rp<RL)	0,00	0,00	0,00

Source: Author

In terms of geographical distribution, the assets of the final portfolio are diversified across seven different countries, all of which are members of the OECD, as it is possible to observe in Figure 7. All investments are denominated in euros due to the use of hedging.

Figure 7 - Geographical distribution of final portfolio



3.5 Risk Analysis

In this section, is presented a detailed risk analysis of the proposed final portfolio using historical data and simulation methods. The risk metrics employed are Value at Risk (VaR) and Expected Shortfall (ES), both calculated from historical data and through simulation.

For the purpose of this risk assessment, the focus is on the benchmarks rather than on individual assets.

The portfolio has a total value of €100,000,000 and is allocated across six different indices with the weights that are presented in Table 6.

VaR and ES are standard risk measures used to estimate the potential loss in value of a portfolio over a given time period for a given confidence interval, in this case is used a daily period. VaR provides a measure of the maximum expected loss over one day with a specified confidence level. The following results are derived both from 3 years of historical daily data and simulations.

The VaR for historical data is calculated by considering the daily returns of the benchmarks, weighted according to their proportions in the final proposed portfolio. The daily returns are sorted in rank from smallest to largest to determine different confidence intervals. Subsequently, the PERCENTILE.INC function in excel is used to obtain the results for the confidence intervals.

The VaR simulation assumes a normally distributed set of returns, using the mean and standard deviation of the historical returns to ensure the simulation is representative. The formula in excel for this purpose is NORM.INV, applied to random values to generate the simulated returns. At the 1% percentile, the historical data indicates a VaR of €413 340,57, in other words, in more practical terms, there's a 1% chance that will lose €413,340.57 or more the next day, while the simulation shows €365 849,13. At the 5% percentile, the historical data indicates €262 261,17, and the simulation shows €259 772,00. At the 10% percentile, the historical data indicates €188 810,34, and the historical shows €212 031,82. All these values are daily. Table 9 summarizes the results.

Table 9 - VaR and ES results

Percentile	VaR historical Data	% of portfolio	VaR simulation	% of portfolio	ES historical data	% of portfolio	ES simulation	% of portfolio
1%	€413 340,57	0,41%	€391 757,20	0,35%	€518 636,68	0,52%	€511 117,91	0,44%
5%	€262 261,17	0,26%	€274 806,66	0,24%	€427 976,26	0,43%	€334 003,51	0,33%
10%	€188 810,34	0,19%	€206 173,39	0,19%	€291 815,97	0,29%	€275 432,56	0,26%

Source: Author

Expected Shortfall (ES), also known as Conditional VaR, represents the average loss given that the loss exceeds the VaR level. The following results are derived from historical data and simulations.

The ES from historical data is calculated using the returns ranked from the lowest to the highest. For each percentile, only the returns up to the necessary average are considered. With a total of 768 observations, the 1% percentile corresponds to 7.68 observations. Therefore, the first 8 observations in the ranking are considered. For the 5% percentile, 38 returns are considered, and for the 10% percentile, 77 returns are considered.

The formula to calculate the ES from historical data is as follows:

$$(13)\quad ES = \frac{1}{(percentile \times total\ number\ of\ observations)} \times \sum \begin{pmatrix} number\ of\ observations \\ in\ the\ rank\ up\ to\ the\ percentile \end{pmatrix}.$$

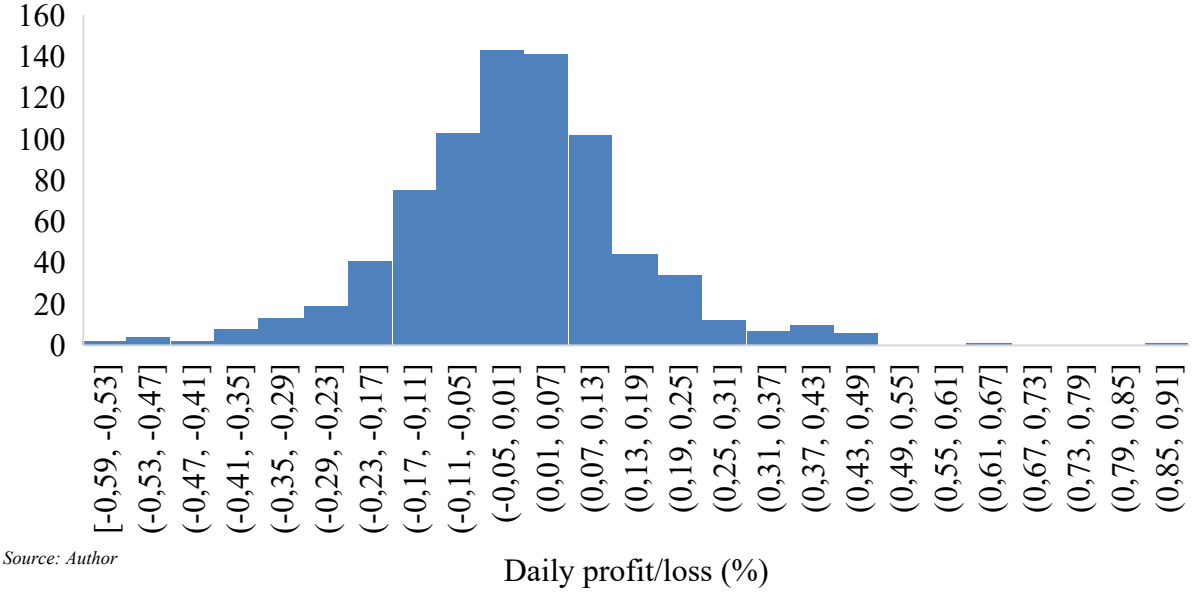
For the ES simulation, the calculation method is similar but requires the VaR from historical data in non-monetary terms, instead of using the percentile times the total number of observations. The returns considered for the sum are the random returns calculated for the VaR simulation, as previously explained.

At the 1% percentile, the historical data indicates an ES of €518 636,68, while the simulation shows €511 117,91. At the 5% percentile, the historical data indicates €427 976,26, and the historical simulation shows €334 003,51. At the 10% percentile, the historical data indicates €291 815,97, and the simulation shows €275 432,56. All these values are daily. As is present in Table 9.

The differences between the results obtained by historical data and simulation could be justified by the fact that the historical data reflects events that happened in the past while the simulated values follow a normal distribution that does not fully capture the reality and complexity of the markets, as well as the events. It is important to consider both approaches because while historical data is limited by the time period considered, potentially failing to reflect all possible future market conditions, the simulations allow for the exploration of hypothetical scenarios and the testing of portfolio robustness under various market conditions, providing a broader perspective on potential outcomes. Together, these methods ensure that risk management decisions are well-informed and comprehensive, enhancing the portfolio's resilience against a variety of potential future events.

The histogram in Figure 8, illustrates the 3-year historical distribution of the portfolio's daily returns considered. The distribution is approximately centered and normal, around a mean daily return of zero. This symmetry suggests a relative returns stability with a relatively low standard deviation, with most returns concentrated between -0.05% and 0.13%. Extreme variations, whether positive or negative, occur infrequently, indicating a moderate level of portfolio volatility. The shape of the distribution appears symmetrical, with no significant skewness, which supports the low probability of returns falling below the required return (RL).

Figure 8 – Historical portfolio returns histogram

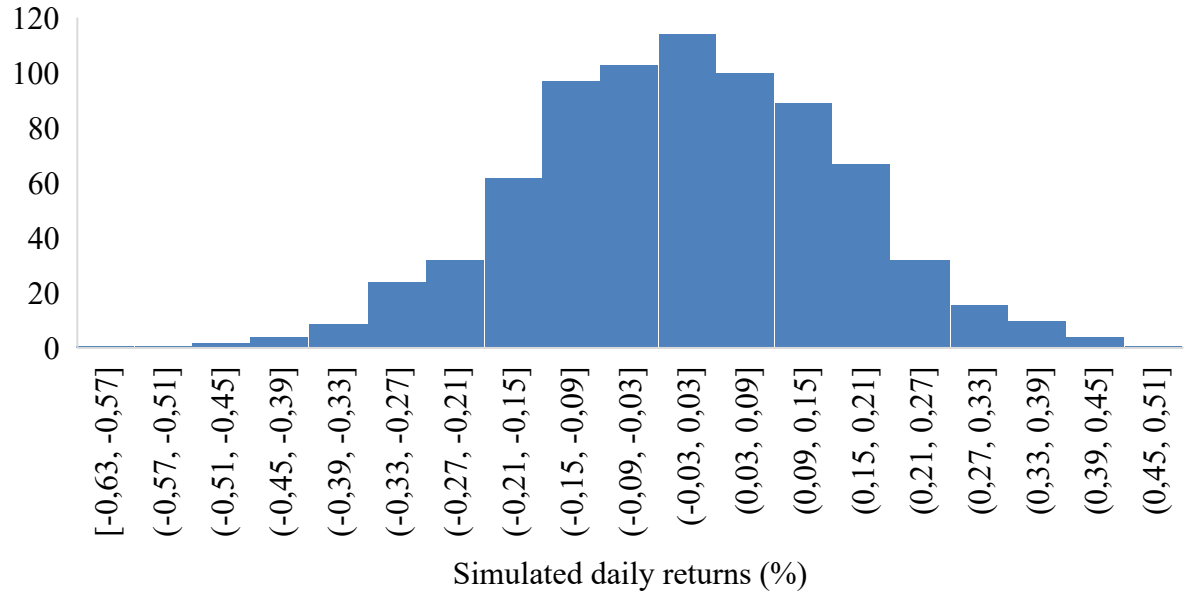


Source: Author

The histogram in Figure 9, is the 3-year simulated historical distribution of the portfolio's daily returns. It has a normal distribution and a symmetrical distribution that is centered around zero. This indicated that most daily returns are small and between -1.5% and 1.5%. This graph

suggests relative stability and moderate volatility, with extreme returns being rare, highlighting that significant daily gains or losses are infrequent for this portfolio.

Figure 9 – Simulated portfolio returns histogram



Source: Author

The risk analysis indicates that the constructed portfolio maintains a risk profile within acceptable limits. The VaR and ES values provide insights into potential maximum losses at various confidence intervals, ensuring that the portfolio can withstand adverse market conditions. This highlights the robustness of the investment strategy, ensuring that the portfolio not only meets return expectations but also adheres to stringent risk management criteria.

This aligns with the overarching goals of the Investment Policy Statement (IPS), providing a reliable investment strategy.

The Investment Policy Statement (IPS) is well-suited for the Lusitania Vida product, meeting all specified characteristics and constraints. However, it is crucial to continuously monitor and evaluate the investment portfolio, the behavior of policyholders, and revise the mortality rate estimates of policyholders, as an effective population of investors will exist post-launch. Additionally, ongoing assessment of performance against benchmarks and risk indicators is essential.

It is also important to note, in conclusion, that the solvency requirements were not calculated within this IPS. To determine these requirements, profit testing is necessary.

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Appendices

Table A.1 Client's Profile

Executive Summary	
Name	Lusitania Vida, SA
Portfolio Type	Institutional
Country	Portugal
Return goal	> 3,2%
Objectives	Face the liabilities of the investment product
Time Horizon	3 years

Table A.2 Correlation Matrix

	DJEUR	**EUSI**	**I8KW**	**LET1TREU**	**BRC3TREU**	**QW5A**
DJEUR	1,000000	0,966303	-0,146794	-0,002245	0,187230	0,145145
EUSI	0,966303	1,000000	-0,135973	-0,003518	0,185896	0,159254
I8KW	-0,146794	-0,135973	1,000000	0,052683	0,162839	0,819827
LET1TREU	-0,002245	-0,003518	0,052683	1,000000	0,184561	0,068060
BRC3TREU	0,187230	0,185896	0,162839	0,184561	1,000000	0,326879
QW5A	0,145145	0,159254	0,819827	0,068060	0,326879	1,000000

Table A.3 Variance Matrix

	DJEUR	**EUSI**	**I8KW**	**LET1TREU**	**BRC3TREU**	**QW5A**
DJEUR	0,025872	0,026138	-0,001200	-0,000007	0,000711	0,000732
EUSI	0,026138	0,028281	-0,001162	-0,000011	0,000738	0,000840
I8KW	-0,001200	-0,001162	0,002584	0,000049	0,000195	0,001307
LET1TREU	-0,000007	-0,000011	0,000049	0,000341	0,000080	0,000039
BRC3TREU	0,000711	0,000738	0,000195	0,000080	0,000558	0,000242
QW5A	0,000732	0,000840	0,001307	0,000039	0,000242	0,000984

Figure A. 1 Chart with alternative portfolios to the Roy portfolio

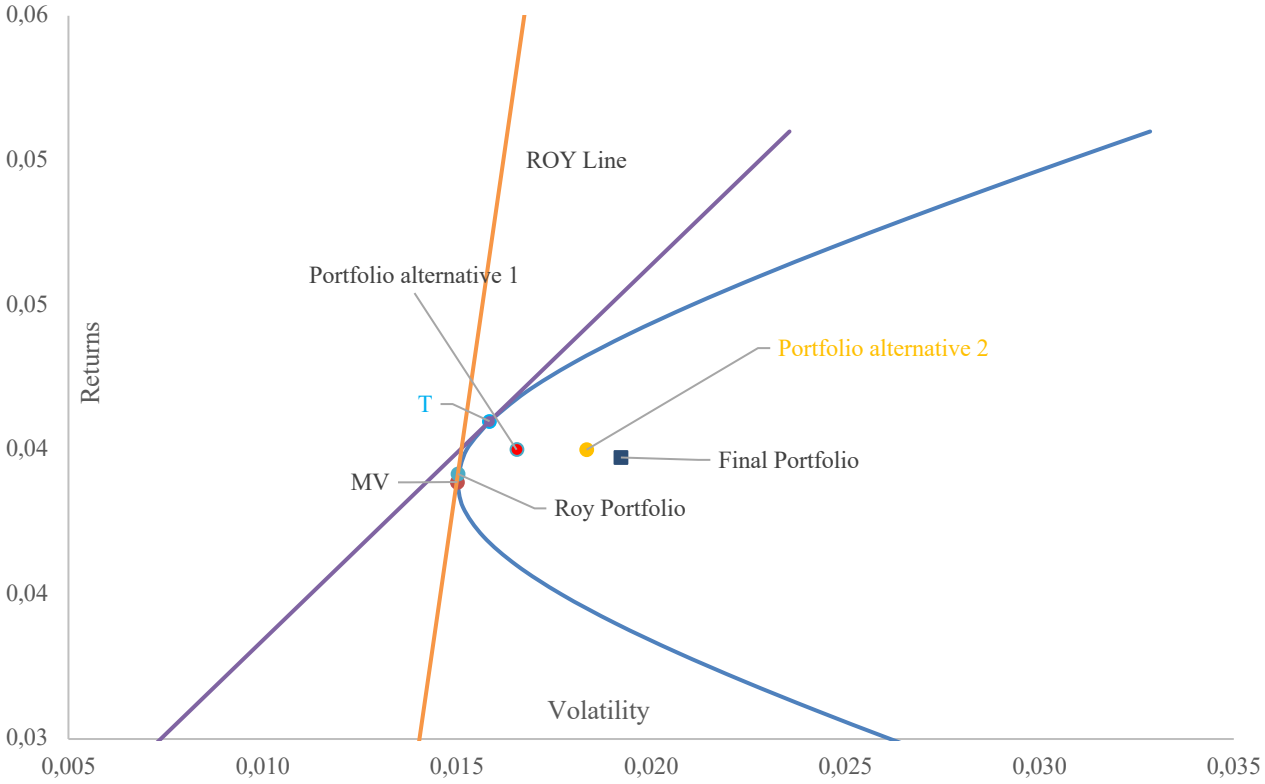

Table A.4 Individual Assets detailed

Benchmark	Security	Modified Duration	Price € (02/01/2024)	Annual Eqv. Rate/YTM	Weight	Weight of the portfolio	Amount Invested	Quantity	Coupon (annual)	Expected Cash flow 2024	Expected Cash flow 2025	Expected Cash flow 2026
DJEUR	ASML HOLDINGG NV		663,124	26,1785%	3,0151%	3,02%	3 015 103,16 €	4547		€3 804 411,94	€4 800 349,92	€6 057 009,52
EUSI	ASML HLDG		663,124	26,1785%	0,1547%	1,98%	154 742,88 €	233		€195 252,25	€246 366,36	€310 861,37
	HSBC HOLDINGS		7,27341	3,9341%	1,8302%		1 830 161,73 €	251624		€1 902 162,12	€1 976 995,08	€2 054 772,04
I8KW	BBG01C6SYFN8 GERMANY (FEDERAL REPUBLIC) 33 2.3 15/02/33	7,896	102,183	2,47%	15,6935%	22,81%	15 693 518,12 €	153582	2,30	€360 950,92	€360 950,92	€360 950,92
	REPUBLIC OF GERMANY 15/02/26	1,807	96,253	2,95%	2,8650%		2 865 020,41 €	29766	0,50	€14 325,10	€14 325,10	€2 879 345,51
	REPUBLIC OF GERMANY 8/26	2,299	94,544	2,79%	4,2507%		4 250 686,21 €	44960	0,00	€0,00	€0,00	€4 250 686,21
LET1TREU	France 3.5 04/25/2026	1,85	102,42	3,10%	3,1698%	47,85%	3 169 834,37 €	30949	3,50	€110 944,20	€110 944,20	€3 280 778,57
	France 0.5 05/25/2026	2,001	95,658	3,01%	4,2629%		4 262 892,27 €	44564	0,50	€21 314,46	€21 314,46	€4 284 206,74
	France 2.5 09/24/2026	2,28	100,262	2,98%	4,5105%		4 510 516,07 €	44987	2,50	€112 762,90	€112 762,90	€4 623 278,97
	France 0 02/25/2026	1,787	94,64	3,06%	0,7312%		731 216,01 €	7726	0,00	€0,00	€0,00	€731 216,01
	France 0.5 05/25/2025	1,047	96,948	3,38%	14,8095%		14 809 498,95 €	152757	0,50	€74 047,49	€14 883 546,45	-
	France 0 02/25/2027	2,761	93,086	2,90%	11,9580%		11 958 033,82 €	128462	0,00	€0,00	€0,00	€0,00
	France 0.25 11/25/2026	2,509	94,248	2,92%	3,5412%		3 541 227,42 €	37574	0,25	€8 853,07	€8 853,07	€3 550 080,48
	France 1 11/25/2025	1,532	94,25	3,15%	2,0464%		2 046 424,93 €	21713	1,00	€20 464,25	€2 066 889,17	-
	Bundesrep deutch 0.5 02/25/2026	1,758	96,253	2,93%	0,9580%		958 017,09 €	9953	0,50	€4 790,09	€4 790,09	€962 807,18
	France 6 19/25/2025	1,406	106,001	3,18%	1,8642%		1 864 158,80 €	17586	6,00	€111 849,53	€1 976 008,33	-
BRC3TREU	VOLKSWAGEN LEASING GMBH 3.625 10/11/2026	2,293	99,893	3,79%	2,0501%	19,80%	2 050 097,54 €	20523	3,63	€74 316,04	€74 316,04	€2 124 413,57
	BANCO SANTANDER SA 3.5 01/09/2028	2,526	99,627	3,73%	17,7511%		17 751 093,70 €	178176	3,50	€621 288,28	€621 288,28	€62 128 827,96
QW5A	Cooperatieve Rabobank UA 04/26/2026	2	95,252	3,19%	0,9326%	4,54%	932 632,76 €	9791	0,63	€5 828,95	€5 828,95	€938 461,71
	Anheuser-Busch InBev SA/NV 03/31/2026	1,87	99,442	3,28%	0,5721%		572 059,47 €	5753	2,70	€15 445,61	€15 445,61	€587 505,08
	JPMorgan Chase & Co 02/19/2026	1,81	99,394	3,15%	0,3777%		377 709,34 €	3800	3,00	€11 331,28	€11 331,28	€389 040,62
	Volkswagen International Finance NV 11/15/2025	1,54	101,185	3,79%	1,4309%		1 430 868,19 €	14141	4,13	€59 023,31	€1 489 891,51	-
	BNP Paribas SA 11/29/2024	0,65	97,163	4,21%	1,2245%		1 224 486,76 €	12602	1,00	€1 236 731,63	-	-
				Bonds percentage	95,000%					€8 766 093,41	€28 802 197,70	€99 514 242,47
				Equity Percentage	5,000%							
				Total	100,00%	100%	100 000 000,00 €					

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