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Trabajo Fin de Grado

Optimización de Carteras de Inversión en el Sector Financiero Europeo
Opmization of Investment Portfolios in the European Financial Sector

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RESUMEN

Este trabajo analiza la optimización de carteras de inversión aplicando métodos cuantitativos, con un enfoque particular en el sector financiero europeo. Se emplean modelos teóricos, como el de media-varianza de Markowitz y la aproximación continua de Merton, para construir carteras eficientes ajustadas al perfil de riesgo del inversor. A partir de un análisis macroeconómico y sectorial, se seleccionan empresas del sector financiero europeo utilizando criterios de valoración, rentabilidad, crecimiento y estabilidad. Posteriormente, se construye y optimiza una cartera de inversión diversificada, cuyo rendimiento se compara frente a un índice de referencia (iShares MSCI Europe Financials ETF). Los resultados demuestran que, mediante el uso riguroso de herramientas de análisis financiero y optimización, es posible superar modestamente al mercado, aunque asumiendo mayor volatilidad. El trabajo destaca la utilidad práctica de los modelos de optimización para la toma de decisiones financieras en entornos complejos y subraya su aplicabilidad tanto en contextos académicos como profesionales.

ABSTRACT

This thesis explores investment portfolio optimization through quantitative methods, focusing on the European financial sector. The analysis applies both the Markowitz mean-variance model and Merton's continuous-time approach to build efficient portfolios tailored to different investor risk profiles. Following macroeconomic and sector-specific analysis, a selection of European financial firms is made based on valuation, profitability, growth, and stability criteria. A diversified investment portfolio is then constructed and optimized, with its performance evaluated against a benchmark index (iShares MSCI Europe Financials ETF). The results show that rigorous application of optimization techniques can lead to modest outperformance, albeit with increased volatility. The study emphasizes the practical value of portfolio optimization models in complex decision-making environments and highlights their relevance in both academic and professional contexts.

Contents

1. Introduction

The decision-making process in financial markets is inherently complex, given the wide range of investment alternatives and the volatility of economic environments. Investors are continuously challenged to construct portfolios that align with their return expectations while managing risk efficiently. In this context, portfolio optimization emerges as a crucial tool for supporting rational investment strategies grounded in quantitative analysis.

This work focuses on the optimization of investment portfolios in the European financial sector, applying theoretical models developed throughout the history of modern portfolio theory. Since the pioneering work of Harry Markowitz in the 1950s, mathematical and statistical tools have been essential in addressing the problem of how to allocate wealth across multiple assets. The relevance of this topic persists in today's financial landscape, where uncertainty and market dynamics make efficient diversification more necessary than ever.

The general objective of this thesis is to analyze the construction of optimized investment portfolios based on the risk-return profile of investors. More specifically, the work aims to: (1) examine the theoretical foundations of portfolio optimization under the mean-variance framework; (2) implement the Markowitz model and Merton's continuous-time model in a practical context; and (3) evaluate the composition and performance of portfolios formed by equities from the European financial sector. Through this analysis, the project seeks to identify how varying risk preferences influence asset allocation and portfolio behavior.

The significance of this study lies in its applicability to both academic and professional fields. On one hand, it serves as a comprehensive introduction to portfolio optimization techniques, valuable for students and researchers in finance. On the other hand, it provides a framework that can assist individual investors and financial analysts in structuring portfolios more effectively, especially in a sector as relevant and sensitive to macroeconomic factors as the financial industry.

The thesis is structured into six main chapters. Following this introduction, Chapter 2 provides a macroeconomic analysis of the European environment and its influence on the financial sector. Chapter 3 provides microeconomic analysis of the European financial

sector, helping assess its state and health. Chapter 4 describes the methodology used for portfolio construction and the selection criteria of the assets. Chapter 5 presents the results of the optimization process, including graphical representations and interpretations of the efficient frontier and portfolio composition. Chapter 6 evaluates the performance of the strategy against a benchmark in terms of both return and risk metrics. Finally, Chapter 7 offers the conclusions and potential areas for further research.

2. Macroeconomic Analysis

In this section, the focus will be on evaluating the European macroeconomic environment using both lagging and leading indicators, each providing a distinct perspective on economic conditions.

2.1 Overall View

Prior to indicator analysis, two key metrics for evaluating economic and financial sector health will be examined.

Inflation, a lagging indicator reflecting past price changes, influences future decisions as it shapes inflation expectations, prompting policy adjustments (e.g., interest rate changes by central banks) and influencing investment strategies in both public and private sectors. These actions, in turn, aim to mitigate or adapt to future inflationary pressures.

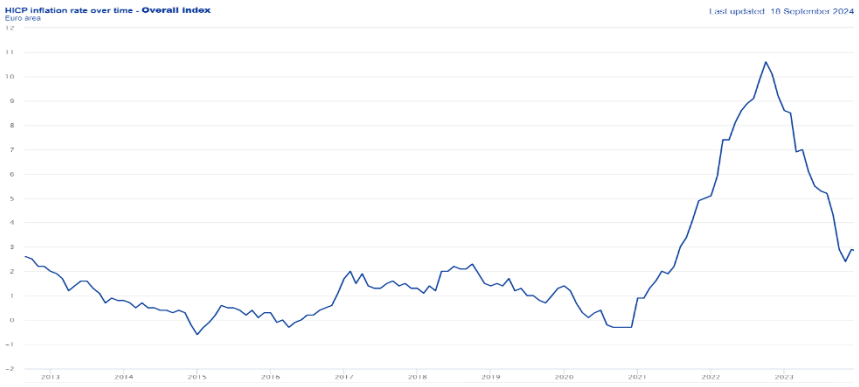


Figure 2.1.1: European Central Bank, Inflation Rate Evolution in the Eurozone.

European Central Bank (ECB) data (Figure 2.1.1) shows a 2.9% year-over-year inflation rate, exceeding the ECB's 2% target despite recent cooling. This deceleration may prompt interest rate cuts, potentially impacting financial sector profitability (e.g., compressed net interest margins), and asset values (e.g., increased bond prices).

While influenced by prevailing economic conditions, **interest rates**, particularly those set by central banks like the ECB, function as policy instruments. Adjusted based on lagging data (e.g., inflation, GDP growth), they aim to proactively guide the economy, acting as a blend of lagging and leading indicators.

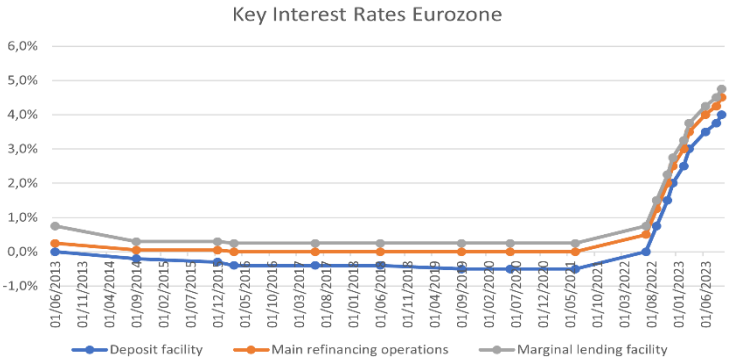


Figure 2.1.2: Eurostat Data, Key Interest Rates in Eurozone Countries. Own Elaboration.

As shown in Figure 2.1.2, interest rates have risen in response to inflation, directly impacting financial institutions. Higher rates reduce the market value of fixed-income assets, potentially leading to losses if sold. Tighter monetary conditions also increase default risks for households and businesses. However, this environment creates opportunities: market volatility may benefit active investors, and higher yields improve the attractiveness of new fixed-income investments.

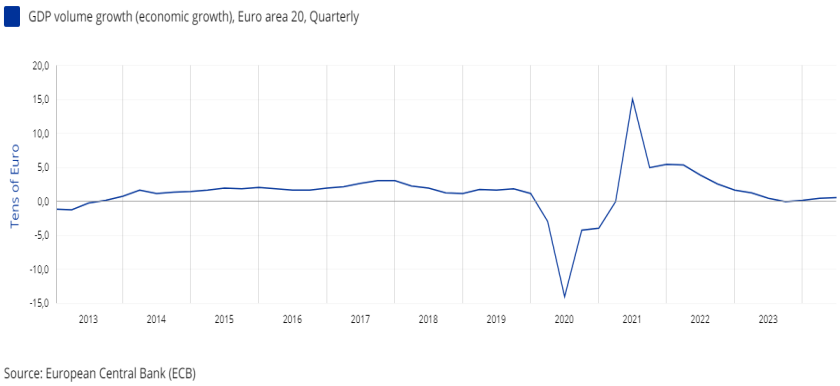
2.2 Lagging Indicators

Lagging indicators represent the economic performance of the past and are generally used to confirm long-term trends. While they provide valuable insights into the historical context of the economy, they are less effective for predicting future conditions. For this reason, they will not be relied upon as much for this macroeconomic analysis[1].

Having examined inflation as a lagging indicator, the analysis will now address GDP (Gross Domestic Product):

[1] KLEIN A., MOORE P., GEOFFREY. NATIONAL BUREAU OF ECONOMIC RESEARCH. *Business Cycle Indicators and Their Predictive Power* [online]. Working Paper 941. Cambridge, MA, 1982. [Consulted 20 November 2024]. Available At: https://www.nber.org/system/files/working_papers/w0941/w0941.pdf

Figure 2.2.1: European Central Bank, GDP Evolution in the Euro Area.



Euro Area real GDP growth of 0.2% in Q4 2023, while modest, suggests resilience amidst high inflation. However, this growth rate remains below investor expectations[2].

2.3 Leading Indicators

Leading indicators are used to forecast economic trends. Three leading indicators relevant to assessing future Eurozone economic conditions during the investment period will be analyzed.

The first indicator is the Purchasing Managers' Index (PMI). The direction of the trend in the PMI tends to precede changes in the trend in major estimates of economic activity and output, such as the GDP, industrial production, and employment. Paying attention to the value and movements in the PMI can yield profitable foresight into developing trends in the overall economy[3].

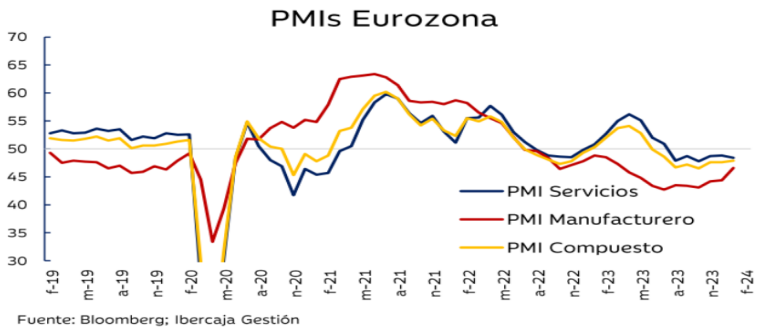


Figure 2.3.1: Bloomberg Data, Visualization by Ibercaja Gestión.

An index value below 50 signals economic contraction, which in this case affects both manufacturing and services. A shrinking economy can weigh heavily on the financial sector through reduced investment activity (impacting banks that depend on advisory services), lower loan

[2] S&P Global Ratings. Economic Outlook Eurozone Q4 2023: Slower Growth, Faster Tightening [online]. S&P Global, December 2023. [Consulted 8 December 2024]. Available at: https://www.spglobal.com/ratings/en/research/articles/230925-economic-research-economic-outlook-eurozone-q4-2023-slower-growth-faster-tightening-12856216.

[3] KOEING E. *Using the Purchasing Managers' Index to Assess the Economy's Strength and the Likely Direction of Monetary Policy* [online]. Federal Reserve Bank of Dallas. Volume 1, Number 6. Dallas, 2002. [Consulted 15 December 2024]. Available at: https://fraser.stlouisfed.org/title/review-federal-reserve-bank-dallas-5730/volume-1-number-6-2002-583819

demand, and heightened credit risk—leading to a rise in non-performing loans and weaker asset quality.

The Consumer Confidence Index, also reviewed in this section, serves as a barometer of economic health by capturing household sentiment toward the economy, the labor market, and personal finances. It is based on monthly surveys in which respondents indicate positive, negative, or neutral expectations.

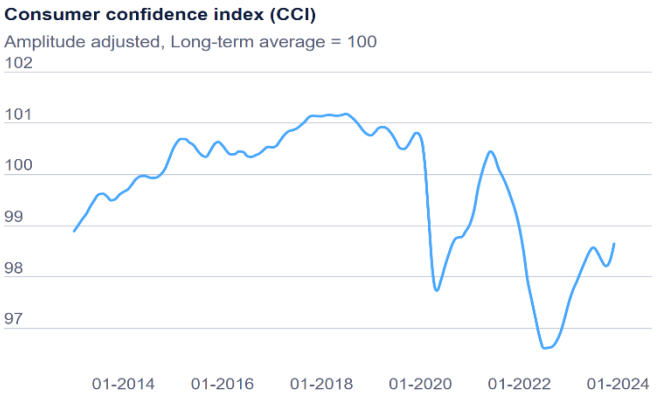


Figure 2.3.2: OECD, Consumer Confidence Index Eurozone.

The Consumer Confidence Index in the Eurozone remains below 100 (98.65, Figure 2.3.2), reflecting persistent pessimism about economic prospects. This sentiment may lead to higher saving and lower spending, reducing demand for loans and financial services. For banks, this translates into lower interest and fee income, while excess deposits in a low-loan-demand environment can compress net interest margins. However, the gradual recovery from 2022 lows suggests a potentially improving outlook that could support investor sentiment.

The last leading indicator is the Retail Sales in the Eurozone YoY:

Figure 2.3.3: Eurostat Data, Visualization by Trading Economics.

As shown in Figure 2.3.3, they are as of 31st of December 2023, -0.2%, which signals a recovery and can be interpreted as positive for next year if the upwards trend continues.

2.4 Analysts Thoughts

Ernst & Young analysts highlight Europe's heightened vulnerability to energy price increases compared to other major economies, particularly the US. Central and Eastern European countries would be most affected by potential price spikes, experiencing significant GDP declines and inflationary pressures. Conversely, faster disinflation, coupled with improved supply, productivity, and labor market rebalancing, could lead to lower interest rates and stronger growth.

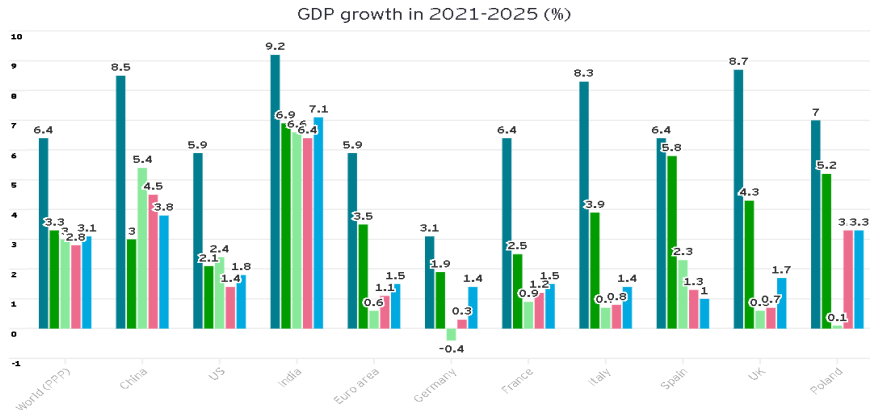


Figure 2.4.1: Oxford Economics Data, Visualization by EY

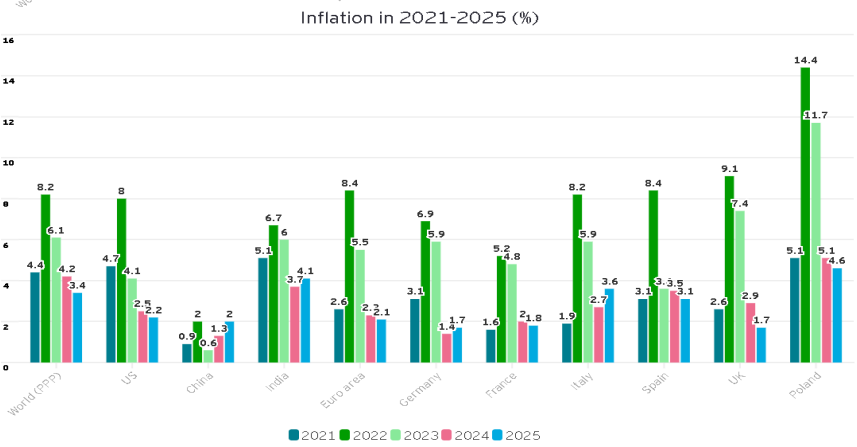


Figure 2.4.2: Oxford Economics Data, Visualization by EY

From a personal point of view, opportunities in currently more stressed European economies, but with good growth prospects, may arise in case geopolitical tensions and conflicts do not scale. Further analysis of local markets will be crucial to assess whether investment opportunities exist or not.

3. European Financial Sector Analysis

This section focuses on evaluating the European financial sector using both quantitative indicators, broader macroeconomic influences and qualitative indicators, supported by expert analysts' opinions. These tools are essential for identifying the sector's strengths, risks, and growth opportunities, offering a well-rounded view of its current state and future prospects.

Before delving into the sector's health, it is important to outline its scale and economic relevance. According to 2021 data from the European Commission, the financial and insurance activities sector generated €1 trillion in value added and €2.3 trillion in net turnover, representing approximately 11% of the European Union's total value added. The sector employed 4.9 million people across the EU, highlighting its weight in the regional economy. It is worth noting that figures from the United Kingdom are excluded from datasets with reference dates after 2020.

Figure 3.1 provides a breakdown of the main contributors to value added within the industry.

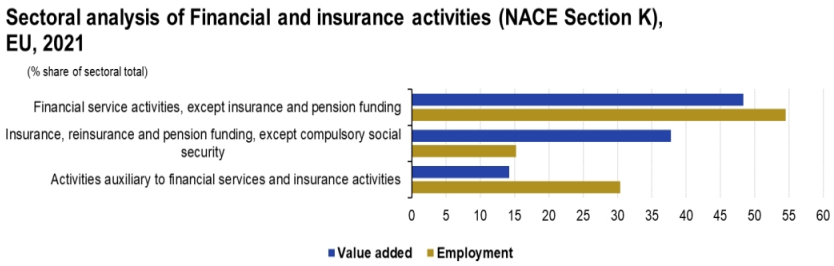


Figure 3.1: Eurostat, Sectoral Analysis, Businesses in financial and insurance activities sector.

The largest shares are attributed to financial service activities (excluding insurance and pension funding) and to insurance, reinsurance, and pension funding (excluding compulsory social security). As a result, the analysis in the following sections will focus on these two subsectors, which represent the bulk of the industry's revenue.

3.1 Quantitative Indicators

Profitability and solvency metrics are essential for understanding the operational performance, valuation, and financial health of institutions within the European financial sector. These indicators help identify both challenges and opportunities, offering insight into the sector's overall stability and future outlook.

3.1.1 Price-to-Book

The price-to-book (P/B) ratio is a key valuation metric for assessing how markets perceive the health and prospects of the banking sector. It compares a bank's market capitalization to its book value, offering insight into investor confidence and expectations of future profitability. In capital-intensive industries like banking (where assets and liabilities are often marked to market), this ratio is particularly informative. A higher P/B ratio typically signals market optimism, while a lower one may reflect concerns over

profitability or risk.[4].

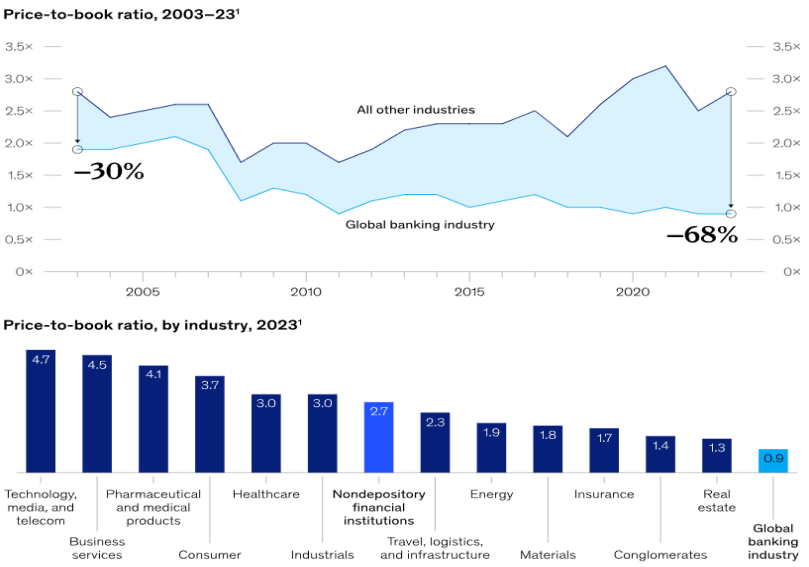


Figure 3.1.1.1: McKinsey Panorama; McKinsey Value Intelligence.

Figure 3.1.1.1 shows that global banks currently trade at a P/B ratio of 0.9 (the lowest among all industries), implying that investors expect the sector to erode value rather than create it. The gap between financial services and other sectors has widened, reflecting scepticism despite recent improvements in returns (largely driven by rising interest rates). The evolution of Return on Tangible Equity (ROTE) will be explored later in this section.

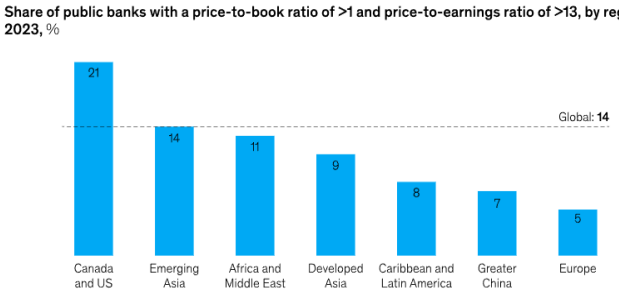


Figure 3.1.1.2: MdKinsey Panorama; McKinsey Value Intelligence.

When compared against other regions, the European banking sector appears especially undervalued. Figure 3.1.1.2 highlights Europe as the region with the lowest P/B valuations globally. According to McKinsey, this is due to structural challenges: a reliance on short-term rate-driven profitability, persistent regulatory pressures, low labor productivity (despite high tech spending), and competition from more agile players in private credit, payments, and wealth management. Still, opportunities may exist in countries with stronger growth prospects, more productive banking models, or undervalued institutions.

3.1.2 Return On Tangible Equity (ROTE)

ROTE is a key profitability measure that excludes intangible assets, offering a clearer view of returns generated from tangible capital. This makes it especially useful in

[4] Wikipedia**.** *P/B Ratio* [online]. Last updated 8 December 2024. [Consulted 9 December 2024]. Available at: https://en.wikipedia.org/wiki/P/B_ratio.

banking, where intangibles can distort comparisons. By focusing on core resources, ROTE provides a more accurate assessment of operational efficiency and resilience.

As shown in Figure 3.1.2.1, recent improvements in Return on Tangible Equity have been largely driven by rising Net Interest Margins, a trend closely linked to higher interest rates.

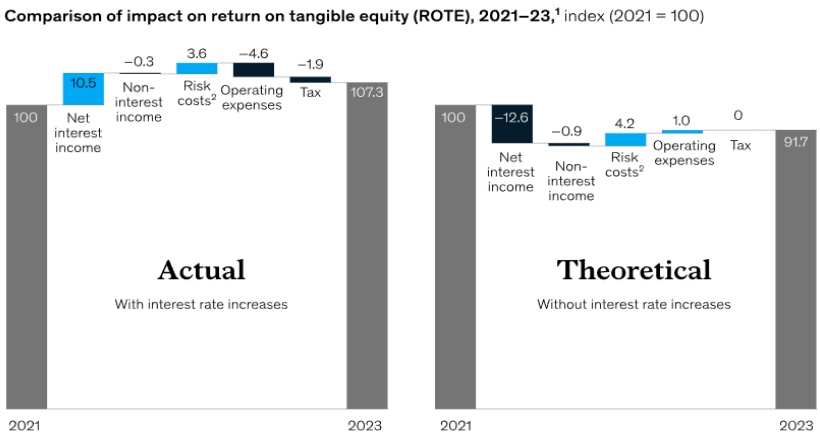


Figure 3.1.2.1: McKinsey Global Banking Pools; McKinsey Panorama.

It should also be noted that the picture is not even across all regions. Diving into the European market, according to McKinsey analysts, the banking industry in the United Kingdom and Germany has improved its performance, meaning that better NIM is not coming only from higher interest rates in the region.

3.1.3 Non-Performing Loans (NPL)

The Non-Performing Loans (NPL) ratio is a key indicator of credit risk and financial stability in the European banking sector. It reflects the share of loans unlikely to be repaid, directly affecting banks' profitability and lending capacity. By the end of 2023, rising interest rates in Europe increased repayment burdens for households and businesses, raising concerns about future NPL growth.

According to the ECB's Financial Stability Review, NPL ratios remained low—just above 2%—but early signs of deterioration appeared in portfolios exposed to cyclical downturns[5].

[5] European Central Bank. *Financial Stability Review* [online]. May 2024. [Consulted 4 December 2024]. Available at: https://www.ecb.europa.eu/press/financial-stability publications/fsr/html/ecb.fsr202405~7f212449c8.en.html.

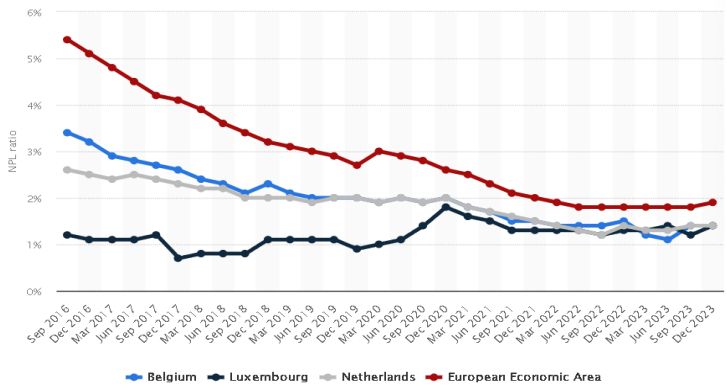


Figure 3.1.3.1: Statista; Non-Performing Loans Ratio in the European Economic Area & Benelux.

Figure 3.1.3.1 shows NPL values across the European Economic Area and the Benelux region, with countries like Poland exceeding 4%. While not alarming yet, such levels should be monitored, especially in economies with high inflation and fast growth, where financial stress could escalate. Tracking the relationship between interest rates and NPLs remains critical to understanding the resilience of the banking sector.

3.1.4 Premium Growth Prospects (Insurance)

Premium growth serves as a key indicator of the European insurance industry's long-term health, revealing market demand and highlighting segments with expansion potential. Forecasts suggest continued global growth in non-life insurance, supported by economic recovery and rising demand for risk protection, particularly in areas such as health, property, and cyber coverage.

Figure 3.1.4.1 show premium growth projections by geography and insurance type.

The 2023-24 Real Terms Premium Growth Forecast for Non Life and Life Insurance

	Non-life insurance		*Life Insurance*	
	2023F	2024F	2023F	2024F
World	1,4%	1,8%	0,7%	1,5%
North America	0,7%	0,8%	-0,2%	-1,3%
Advanced Europe, Middle East, and Arica	0,9%	2,1%	-0,8%	1,2%
Advanced Asia	1,5%	2,4%	-0,1%	1,6%
Emerging Asia (excluding China)	5,8%	6,7%	6,9%	6,7%
China	6,8%	5,8%	4,0%	4,7%

Table 3.1.4.1: Data from Swiss Re Institute. Deloitte 2024 Global Insurance Outlook. Own Excel Visual.

In contrast to the non-life segment, life insurance growth remains uneven. While regions like Asia and China benefit from younger populations and expanding middle classes, Europe lags, weighed down by an aging demographic and slower economic momentum[6]. In aging societies, demand for life insurance tends to plateau or decline as the share of younger, policy-seeking individuals shrinks. On the other hand, aging also increases demand for non-life products such as health and long-term care coverage, shifting the growth focus within the industry.

[6] Deloitte**.** *2024 Global Insurance Outlook* [online]. Last updated 2024. [Consulted 9 December 2024]. Available at: https://www2.deloitte.com/us/en/insights/industry/financial-services/financial-services-industry-outlooks/insurance-industry-outlook-2024.html.

These patterns are critical when building a portfolio focused on the European financial sector. Insurers concentrated in life insurance may face structural growth limitations, while those with diversified or non-life-focused operations offer more compelling investment prospects.

3.1.5 Solvency Coverage Ratio (SCR)

The Solvency Coverage Ratio (SCR) is a key measure of the financial strength of insurance companies. It evaluates whether an insurer has sufficient eligible capital to cover its solvency capital requirement, ensuring it can meet claims even under stressed conditions. A ratio above 1 (100%) indicates strong financial health and the ability to absorb shocks.

SCR levels are highly sensitive to the valuation of assets, particularly fixed-income securities, which typically make up a large share of insurers' portfolios. When interest rates rise, the market value of existing bonds declines, reducing the value of insurers' assets and potentially pressuring their SCR. Conversely, declining rates can inflate asset values and temporarily boost solvency positions. This dynamic makes the SCR a useful proxy for how well insurers manage market volatility and interest rate risk. According to the European Insurance and Occupational Pensions Authority (EIOPA), interest rate movements are among the primary drivers of changes in SCRs, and insurers are increasingly adapting their asset-liability management strategies to address this sensitivity [7] [8].

[7] FasterCapital. *Solvency Ratio: Assessing Financial Health of Insurance Companies* [online]. 2024 Edition. Dubai, 2024. [Consulted 13 December 2024]. Available at: https://fastercapital.com/content/Solvency-Ratio--Assessing-Financial-Health-of-Insurance-Companies.html.

[8] EIOPA**.** *Insurance Statistics: Own Funds* [online]. Last updated 2024. [Consulted 9 December 2024]. Available at: https://www.eiopa.europa.eu/tools-and-data/insurance-statistics_en#own-funds.

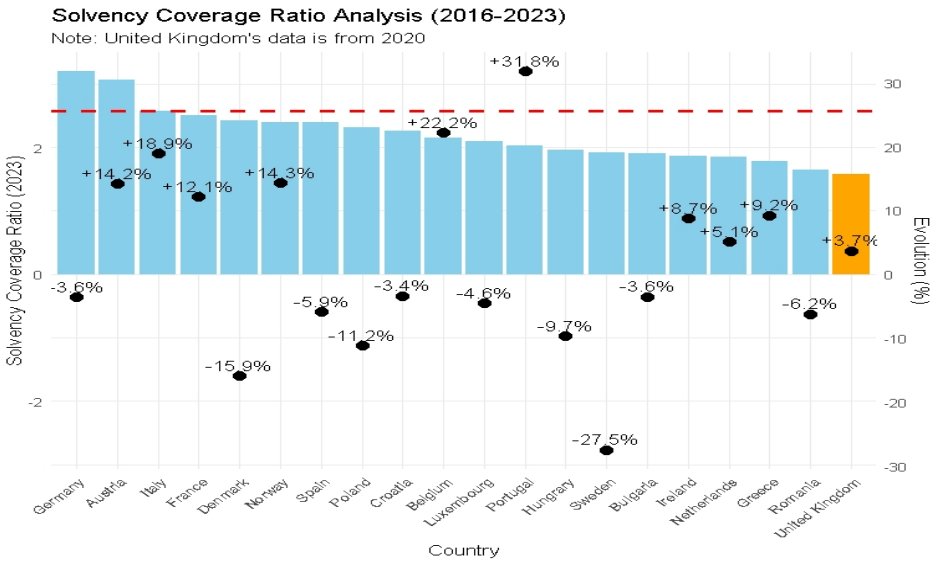


Figure 3.1.5.1: European Insurance and Occupational Pensions Authority data. Own plot created using R.

As shown in Figure 3.1.5.1, all European countries reported SCR values above 1 in 2023, with the regional average at a solid 2.57. The figure illustrates the evolution of SCR levels from 2016 to 2023 (black dots), individual country values (bars), and the European average (red line). Notably, Portugal demonstrated significant resilience, with a 31.8% rise in its SCR and a 10.2% increase in profitability (refer to Figure 3.1.1.4). This reflects strong risk management and capital positioning amid a shifting interest rate environment.

3.2 Qualitative Indicators

To assess the health of Europe's financial sector at the end of 2023, incorporating qualitative indicators such as regulatory environment, technological adoption, and geopolitical stability is essential. These factors provide context beyond quantitative metrics, offering a comprehensive understanding of the industry's condition.

The European financial sector benefits from a robust and evolving regulatory framework that supports investor confidence and institutional resilience. According to the European Banking Authority's 2023 Annual Report, stricter supervisory standards have enhanced systemic stability[9]. However, this regulatory intensity (especially when compared to more flexible frameworks like those in the United States) may also constrain the competitiveness and agility of European firms. In addition, the growing importance of sustainable finance regulation is reshaping the sector. New disclosure requirements, ESG-based risk assessment, and the integration of sustainability goals into supervisory

[9] European Banking Authority (EBA). *Annual Report 2023* [online]. Last updated 2023. [Consulted 31 December 2024]. Available at: https://www.eba.europa.eu/publications-and-media/publications/annual-report-2023.

expectations are pushing institutions toward more responsible, yet more complex, business models.

Technological adoption also plays a key role. In late 2023, the European Central Bank advanced preparations for the launch of a digital euro, with implementation potentially beginning by 2025–2026. This move reflects the region's broader push toward digital transformation, with financial institutions actively integrating new technologies to stay competitive and meet regulatory demands.[10].

Lastly, the geopolitical landscape has remained relatively stable, fostering a conducive environment for financial operations. The International Monetary Fund's Global Financial Stability Report indicates that this stability has positively influenced market confidence and cross-border financial activities[11].

4. Companies Selection

This section focuses on the selection of at least 15 European financial firms for the investment portfolio. The aim is to identify companies that align with the portfolio's objectives of optimizing returns while managing risk. A multi-faceted approach will be employed, combining both fundamental and technical analyses.

The process will integrate valuation multiples, such as Price-to-Earnings and Price-to-Book ratios, alongside the Gordon-Shapiro model to assess intrinsic value. Technical analysis will be utilized to identify trends and patterns in stock performance, while risk-return measures, including beta and CAPM, will evaluate volatility and expected returns. This comprehensive methodology ensures the inclusion of companies with strong financial fundamentals, favorable market positioning, and growth potential within the European financial sector.

4.1 Metrics for Filtering

Before selecting the firms, the specific metrics to be considered will be laid out, then they will be taken into consideration as filters in a stock screener (Yahoo). After having filtered the data, the companies that fit in the provided criteria will be analyzed more in

[10] Wikipedia. *Digital Euro* [online]. Last updated 2023. [Consulted 31 December 2024]. Available at: https://en.wikipedia.org/wiki/Digital_euro.
[11] International Monetary Fund (IMF). *Global Financial Stability Report* [online]. Last updated 2023. [Consulted 31 December 2024]. Available at: https://www.imf.org/en/Publications/GFSR.

depth. Thus, employing technical analysis and models that will help evaluate if the company's stock represents a sound investment.

4.1.1 Valuation Metrics

In financial analysis, valuation metrics are essential tools for assessing the intrinsic value of financial institutions. These metrics provide insights into how the market appraises a company relative to its fundamental financial indicators, guiding investors in making informed decisions. Focusing on the European financial sector as of the end of 2023, two primary valuation metrics will be utilized: the Price-to-Earnings (P/E) ratio and the Price-to-Book (P/B) ratio. These metrics are considered the most basic and essential ones when studying firms in the financial industry[12].

4.1.1.1 Price-to-Earnings Growth (PEG) Ratio

The P/E ratio compares a company's current share price to its per-share earnings, serving as a gauge of market expectations regarding a firm's future profitability. A higher P/E ratio may indicate anticipated growth, while a lower ratio could suggest undervaluation or potential challenges. However, it's important to note that P/E ratios face some challenges when assessing a company's value; P/E ratios can vary significantly across institutions and economic environments. But more importantly, the P/E ratio does not allow for "apples-to-apples" comparisons in the financial industry since there are many sub sectors which present different growth rates that should be factored in. Therefore, the PEG will be used, seeking a value below 1 to consider the stock an attractive investment opportunity[13].

4.1.1.2 Price-to-Book (P/B) Ratio

The P/B ratio measures a company's market value relative to its book value, offering insights into how the market perceives the firm's net asset value. A P/B ratio below 1 can indicate that the market values the company less than its book value, potentially signaling undervaluation. Conversely, a ratio above 1 suggests that the market values the company more than its book value, which could imply overvaluation. As seen in previous sections

[12] Investopedia**.** *What Metrics Can Be Used to Evaluate Companies in the Financial Services Sector?* [online]. Last updated 2023. [Consulted 9 December 2024]. Available at: https://www.investopedia.com/ask/answers/030215/what-metrics-can-be-used-evaluate-companies-financial-services-sector.asp.

[13] Investopedia**.** *What Is Considered a Good PEG (Price/Earnings-to-Growth) Ratio?* [online]. Last updated 2023. [Consulted 9 December 2024]. Available at: https://www.investopedia.com/ask/answers/012715/what-considered-good-peg-price-earnings-growth-ratio.asp.

2023, the global banking industry's P/B ratio was approximately 0.9x, highlighting a valuation discount compared with other industries[14].

4.1.2 Profitability Metrics

Profitability metrics are crucial for assessing the financial health and performance of institutions within the European financial sector. Three primary indicators—Net Interest Margin (NIM), Return on Equity (ROE) and Return on Assets (ROA)—offer valuable insights into a firm's efficiency in generating profits.

4.1.2.1 Net Interest Margin (NIM)

Net interest margin (NIM) is a measure of the difference between the interest income generated by banks or other financial institutions and the amount of interest paid out to their lenders (for example, deposits), relative to the amount of their (interest-earning) assets. It is like the gross margin (or gross profit margin) of non-financial companies[15].

In previous sections, when analyzing the overall health of the European financial industry, the NIM was considered as a key profitability metric for the sector. It was inferred that it was the key reason for improvements seen in ROTE in recent years.

For this section, it will be used as a benchmark, to compare companies filtered through the stock screener and compared with their countries' average NIM.

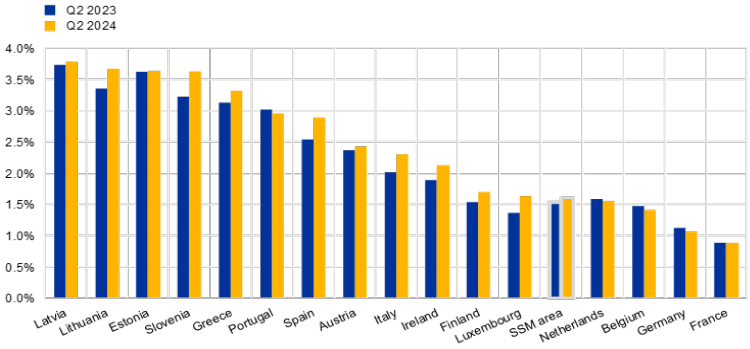


Figure 4.1.2.1.1: European Central Bank. Supervisory Banking Statistics for Significant Institutions. Net Interest Margin by Country.

Figure 4.1.2.1.1 NIM per country in Europe is plotted, although the data is for Q2 2023 and Q2 2024, it will serve as a benchmark for the latter selected companies.

[14] McKinsey & Company. *Global Banking Annual Review* [online]. 2023 Edition. New York, 2023. [Consulted 9 December 2024]. Available at: https://www.mckinsey.com/industries/financial-services/our-insights/global-banking-annual-review.
[15] Investopedia. *Net Interest Margin (NIM) Definition: Formula and Example* [online]. Last updated 2023. [Consulted 6 January 2025]. Available at: https://www.investopedia.com/terms/n/netinterestmargin.asp.

4.1.2.2 Return On Equity (ROE)

As seen in previous sections; ROE measures a company's ability to generate profit from its shareholders' equity. A higher ROE indicates more efficient utilization of equity capital. As of 2023, European banks have demonstrated notable improvements in profitability. According to the European Banking Authority (EBA), the average ROE for EU/EEA banks was 11%, reflecting a stable performance compared to the previous year[16] .

When considering only significant financial institutions (see figure 4.1.2.2.1), ROE stood above 10% for significant institutions, which also show improvements from previous years.

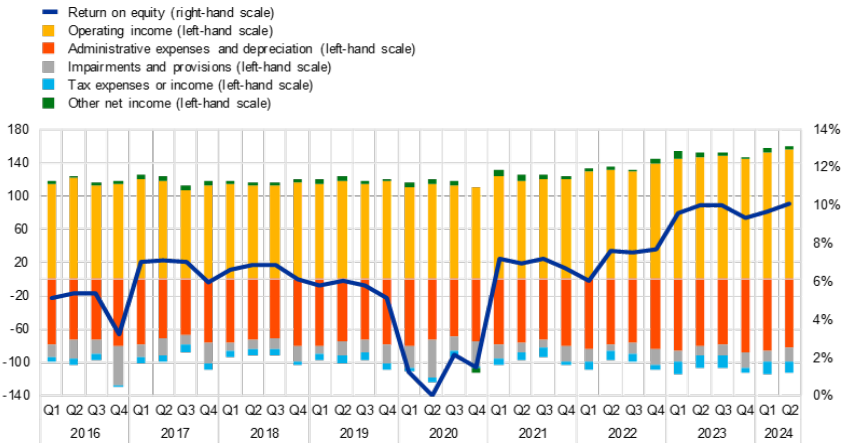


Figure 4.1.2.2.1: European Central Bank. Supervisory Banking Statistics for Significant Institutions. Return on Equity and Composition of Net Profit and Loss.

For investment decisions, it will be used as a benchmark for the required ROE.

4.1.2.3 Return On Assets (ROA)

ROA evaluates how effectively a company uses its assets to generate profit. An increase in ROA signifies better asset utilization.

As expressed by Investopedia analysts and writers, the return on assets ratio is commonly expressed as a percentage using a company’s net income and average assets. A higher ROA means a company is more efficient and productive at managing its balance sheet to generate profits. A lower ROA indicates there's room for improvement.

[16] European Banking Authority (EBA). *Net Interest Margin of EU/EEA Banks Slightly Decreased on a Quarterly Basis* [online]. Last updated 2023. [Consulted 2 January 2025]. Available at: https://www.eba.europa.eu/publications-and-media/press-releases/net-interest-margin-eueea-banks-slightly-decreased-quarterly-basis.

Businesses are about efficiency. Comparing profits to revenue is a useful operational metric but comparing them to the resources a company used to earn them displays the feasibility of that company's existence. Return on assets is the simplest of these corporate bang-for-the-buck measures. It reveals what earnings are generated from invested capital or assets[17].

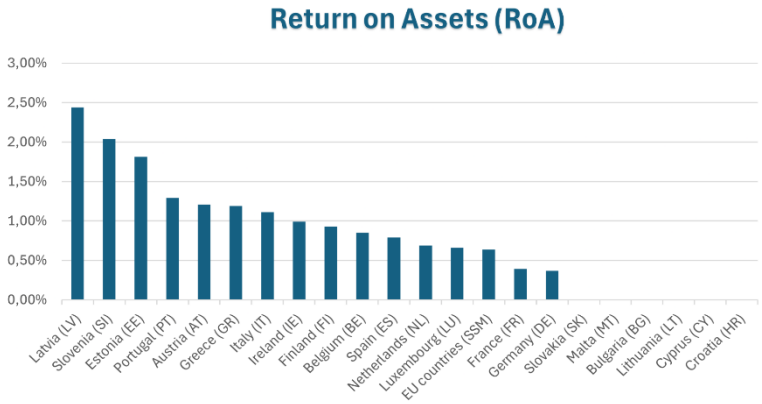


Figure 4.1.2.3.1: European Central Bank Data. Plotted in Excel. Balance sheet composition and profitability for Significant Institutions.

In the Figure 4.1.2.3.1, it can be appreciated that the Return on Assets varies greatly among European countries, with the average for significant banking institutions monitored by the European Central Bank being 0.64% at the end of 2023. This information will serve, as other metrics, as a benchmark to compare the selected firms to region and country's averages.

4.1.3 Growth Metrics

Growth metrics are critical for evaluating the expansion and future potential of financial institutions. These indicators provide insights into a company's ability to increase revenue, earnings, and market share over time, which are essential for identifying firms with strong long-term prospects.

Earnings growth and the expansion of loans and deposits are pivotal metrics in evaluating the performance and strategic positioning of financial institutions. Earnings growth reflects a company's ability to enhance profitability over time, serving as a key indicator of financial health and operational efficiency. Concurrently, the growth in loans and deposits offers insights into a bank's capacity to attract and retain customers, manage risk, and support economic activities through lending.

[17] Investopedia. *Return on Assets (ROA): Formula and Calculation* [online]. Last updated 2023. [Consulted 18 January 2025]. Available at: https://www.investopedia.com/terms/r/returnonassets.asp.

4.1.3.1 Operating Income

In the European financial sector, recent data provides a nuanced view of these metrics. The operating income growth rate of the EU banking industry increased in recent years, reaching approximately 16% in 2023[18]. This uptick underscores the sector's resilience and adaptability in a dynamic economic environment.

For the selection of the securities that will make up the portfolio this data will be considered so that the equities selected present, at least, average income growth rates.

4.1.3.2 Loans and Deposits

However, the landscape for loans and deposits presents a more complex picture. According to the European Banking Federation, deposits from households rose by 1.4% compared to a year earlier, while business deposits decreased by 0.1%[19]. This slight decline suggests a cautious approach in lending activities, possibly influenced by economic uncertainties and evolving regulatory frameworks.

Moreover, the European Central Bank's survey indicates that euro area banks moderately tightened their credit standards for loans or credit lines to enterprises in the fourth quarter of 2023. This tightening adds to the substantial cumulative tightening since 2022, contributing, along with weak demand, to a significant decline in loan growth to firms[20].

These metrics are critical for avoiding the selection of firms (specifically banks) that present outsized increases in deposits while they do not own assets of great quality and have losses on them due to the recent interest rate increases or other reasons. Which could lead to failure of the institution[21].

4.1.4 Risk and Financial Stability Metrics

Risk and stability metrics are essential tools for assessing the financial resilience of institutions within the European financial sector. These indicators evaluate a firm’s ability

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[18] Statista. *EU Bank Industry Income Growth Rate 2015–2023* [online]. Last updated 2023. [Consulted 18 January 2025]. Available at: https://www.statista.com/statistics/1314184/eu-bank-industry-income-growth-rate/.
[19] European Banking Federation (EBF). *Facts and Figures* [online]. Last updated 2023. [Consulted 24 January 2025]. Available at: https://www.ebf.eu/factsandfigures/
[20] European Central Bank (ECB). *Bank Lending Survey – Fourth Quarter of 2023* [online]. Last updated 2023. [Consulted 21 January 2025]. Available at: https://www.ecb.europa.eu/stats/ecb_surveys/bank_lending_survey/html/ecb.blssurvey2023q4~6d56dfebf7.en.html.
[21] Fast Company. *Why SVB Failed: Inside the Silicon Valley Bank Collapse* [online]. Last updated 2023. [Consulted 14 January 2025]. Available at: https://www.fastcompany.com/90864027/why-svb-failed-silicon-valley-bank-collapse.

to manage risks, maintain solvency, and adapt to adverse market conditions. By focusing on both regulatory and operational measures, this section aims to identify companies with robust risk management frameworks and financial stability. Metrics such as the Liquidity Coverage Ratio (LCR) and the Common Equity Tier 1 (CET1) ratio will be analyzed to evaluate liquidity strength and capital adequacy, respectively, ensuring a comprehensive assessment of financial health.

Indicators of this kind have been analyzed in the previous section to assess the overall health of the industry in the region. Nevertheless, further indicators will be used to dive into specific equities that have been selected throughout the screening process.

4.1.4.1 Liquidity Coverage Ratio

The Liquidity Coverage Ratio (LCR) is a regulatory measure designed to ensure that financial institutions maintain sufficient high-quality liquid assets (HQLA) to meet short-term obligations during periods of market stress. A higher LCR indicates stronger liquidity management and greater resilience to sudden cash outflows. As of the end of 2023, regulatory requirements mandate a minimum LCR of 100%, with the average for significant European banking institutions sitting at 164.32% at the end of 2023 and less-significant banking institutions at 217.47%[22].

4.1.4.2 Common Equity Tier 1 (CET1) Ratio

The Common Equity Tier 1 (CET1) ratio is a critical metric for assessing a bank's capital strength and ability to absorb losses. It measures the ratio of core equity capital to risk-weighted assets, ensuring that banks have adequate buffers to protect against financial instability. A higher CET1 ratio signals stronger capital adequacy and compliance with regulatory standards, which are particularly crucial for maintaining confidence in the banking sector amidst volatile economic conditions.

This ratio stood at 16-18% at the end of 2023 fo European financial institutions[23]. The Basel III Framework: Mandates a minimum CET1 ratio of 4.5% of risk-weighted assets. Additionally, banks are required to maintain a capital conservation buffer of 2.5%, effectively setting the minimum CET1 ratio at 7.0%[24].

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[22] European Central Bank (ECB) *Banking Supervision. Statistics and Data* [online]. Last updated 2023. [Consulted 25 January 2025]. Available at: https://www.bankingsupervision.europa.eu/framework/statistics/html/index.en.html.
[23] Ibid

These metrics prove the overall financial strength of financial institutions in Europe while they provide context, acting as benchmarks, to be required as minimums for the selected equities.

4.2 Stock Screening

After taking into consideration metrics and the values to be used as threshold for the selection of the equities, this section focuses on the screening of equities meeting such criteria requisites. To optimize the process, a stock screener will be used, in this case Yahoo Finance screener[25]. The screener allows for the filtering of the equities using the following fields:

- Region: Europe.
- Sector: Financial Services.
- Price to Earnings Growth (PEG): < 1.
- Price to Book Ratio (P/B): <= 1.
- Return on Equity (ROE): > 10%.
- Operating Margin (as NIM, due to lack of data): > 3.5%.
- Return on Assets (ROA): > 0.64%.
- Change in Net Income: >= 5%.
- Current Ratio (as LCR): Over 1.

The before-laid-out metrics are not mandatory to be fulfilled for all equities, especially those which cannot be gathered exactly due to data limitations. Although equities that fulfil most requirements will be favored, some firms that do not achieve one or more of the desired values may be selected for other reasons such as growth prospects, reasons for slowdowns in some metrics that are considered temporary, or analyst recommendations.

4.3 Financial Models

Together with the filtering of equities, with the use of a stock screener with the above-mentioned conditions, financial models such as the Gordon-Shapiro model will be used to evaluate the investment options.

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[24] Bank for International Settlements (BIS). *Definition of Capital in Basel III* [online]. Last updated 2023. [Consulted 26 January 2025]. Available at: https://www.bis.org/fsi/fsisummaries/defcap_b3.pdf.
[25] Yahoo Finance. *Equity Screener – Research Hub* [online]. Last updated 2023. [Consulted 26 January 2025]. Available at: https://uk.finance.yahoo.com/research-hub/screener/equity/.

More precisely a Dividend Discount Model that combines the use of Gordon-Saphiro Model and the CAMP model will be used to evaluate the fair price of the firm shares. The result of this financial modelling will not be definitive as some firms may not pay dividends or, due to the limitations of this model, may be fairly priced by the market even if the model indicates the opposite is true.

In the below table (4.3.1), the final selection of firms for the portfolio is available. As stated before, some of the selected firms may not achieve all the desired values for the studied metrics or financial models but still be selected due to reasons stated before and for benchmark comparison, geographical exposure, or valuation gaps seen in financial modelling.

Equities	Region	Subsector	PEG	P/B	ROA	ROE	Operating Margin	Change in Net Income	Current Ratio
SAN.MC	Spain	Banks - Diversified	0,69	0,64	0,74%	12,87%	41,60%	16,62%	0,35
CS.PA	France	Insurance - Diversified	-1,01	1,3	0,98%	13,16%	12,67%	43,55%	7,78
ALV.DE	Germany	Insurance - Diversified	1,71	1,69	0,87%	16,65%	14,66%	32,32%	2,2
UBS	Switzerland	Banks - Diversified	0,32	1,17	0,28%	5,28%	24,81%	265,01%	1,14
SAB.MC	Spain	Banks - Diversified	0,08	0,44	0,65%	11,35%	46,75%	56,10%	0
JYSK.CO	Denmark	Banks - Regional	0,86	0,7	0,77%	12,43%	53,39%	59,25%	NA
EFGD.F	Greece	Banks - Regional	NA	0,76	1,62%	17,08%	64,10%	-15,37%	1,02
UCG.MI	Italy	Banks - Regional	0,52	0,67	1,30%	16,71%	59,70%	46,18%	0,86
HSBA.L	United Kingdom	Financial Data & Stock Exchanges	0,64	0,85	0,81%	12,64%	49,12%	56,36%	0,96
MUV2D.XC	Germany	Insurance - Reinsurance	0,19	1,85	1,68%	19,29%	8,90%	-13,31%	0,26
ETE.AT	Greece	Banks - Regional	-3,2	0,79	1,76%	16,71%	61,49%	-1,25%	0,26
SOR.OL	Norway	Banks - Regional	0,2	0,36	1,13%	10,90%	65,36%	37,87%	NA
BBVA.MC	Spain	Banks - Diversified	1,1	0,97	1,33%	18,36%	55,24%	26,44%	1,01
LSEG.L	United Kingdom	Financial Data & Stock Exchanges	-1,7	2,11	0,35%	13,00%	20,10%	-41,60%	1
ISP.MI	Italy		0,73	0,75	0,84%	12,00%	57,00%	76,39%	1,1
CABK.MC	Spain	Banks - Diversified	0,1	0,78	0,87%	14,96%	51,04%	67,92%	0

Table 4.3.1: Selection of firms after financial modelling and metrics comparison.

4.4 Technical Analysis

Alongside metrics and the Dividend Discount Model, Technical Analysis will be employed to gauge market sentiment for the financial sector and selected equities. This

approach interprets historical price and volume data to identify trends and potential price movements.

Given its contrast with Modern Portfolio Theory (MPT)[26]. Technical Analysis will play a supporting role rather than a primary decision-making tool. Individual firms will be technically analyzed, but this section focuses on the MSCI Europe Financials ETF, which serves as the portfolio's benchmark. The rationale for selecting this benchmark will be discussed in a later section.

Figure 4.4.1: TradingView. iShares MSCI Europe Financials ETF from 2022 to the end of 2023. Own analysis.

Above analysis of the iShares MSCI Europe Financials ETF from 2022 to the end of 2023 (Figure 4.4.1) reveals a well-defined upward price channel, indicating a sustained bullish trend. Two key support levels (5.52 GBP and 4.80 GBP) have historically prevented significant declines, while the upper channel boundary has acted as resistance.

Bollinger Bands highlight periods of volatility, with price action frequently reaching the upper band during bullish phases, suggesting overbought conditions and potential short-term corrections. The RSI, which entered overbought territory (> 70) by late 2023, further supports this, signalling a possible slowdown in momentum.

The ETF's price action reflects strong risk appetite for financial equities, with further upside contingent on macroeconomic factors and sector fundamentals. A breakout beyond the upper resistance would confirm continued strength, while a breach of support levels could indicate weakening sentiment.

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[26] Wikipedia. *Technical Analysis – Volume-Based Indicators* [online]. Last updated 2023. [Consulted 21 January 2025]. Available at: https://en.wikipedia.org/wiki/Technical_analysis#Volume-based_indicators.

5. Portfolio Optimization

After selecting the companies, the next phase will focus on optimizing the investment portfolio. The optimization process will be based on Markowitz's Modern Portfolio Theory (MPT).

Portfolio optimization is a fundamental process in financial decision-making, aiming to allocate capital efficiently among a set of assets to achieve an optimal balance between risk and return.

One of the most widely used frameworks for this purpose is Markowitz's Modern Portfolio Theory, which defines the optimal portfolio as the one that minimizes risk (variance) for a given expected return or maximizes return for a given level of risk. While the theoretical foundations of MPT are robust, practical implementation—especially through computational tools such as Microsoft Excel's Solver—presents significant challenges, particularly regarding diversification. Then, Merton's approximation will be developed. Merton's model provides a theoretical solution based on continuous-time investment and dynamic asset allocation. Comparing these two techniques will offer valuable insights into their effectiveness in constructing an optimal portfolio.

5.1 Solver

When implementing MPT through Solver with the objective of minimizing portfolio variance, the optimization model tends to concentrate investments in a small subset of the available assets, often leading to under-diversification. This phenomenon arises because the model prioritizes securities with the most favorable covariance structure, meaning that assets with low correlations to the overall portfolio or exceptionally low individual variance receive disproportionately higher allocations. Consequently, unless explicit constraints are introduced, the model may allocate all capital to a limited number of securities, excluding others even if they are theoretically attractive investments.

Before presenting the results of the optimization and the assessment of its diversification grade, the calculations performed should be explained.

As a first step, the average returns of each of the selected equities over the last ten years are calculated. The prices are from the end of the year and adjusted for stock splits. For each asset *i*, the average return over the last ten years is calculated as:

$$R_i = \frac{1}{T}\sum_{t=1}^{T} r_{i,t}$$

Being:

- R_i = average return of asset *i*.
- T = number of years (in this case, 10).
- $r_{i,t}$ = realized return of asset *i* in year *t*.

Once the average returns are computed, the next step is to measure the risk of each asset by calculating its standard deviation. The standard deviation quantifies the volatility of an asset's returns over time, helping assess its risk level in portfolio optimization. For each asset *i*, the risk is calculated as follows:

$$\sigma_i = \sqrt{\left\{\frac{1}{T-1}\sum_{t=1}^{T}\left(r_{\{i,t\}} - R_i\right)^2\right\}}$$

After the risk of each of the assets has been assessed, the restriction for the sum of the weights of each of the assets is laid down, ensuring that the total weight of the assets equals 100%, this way, all capital is invested.

$$\sum w_i = 1$$

Where *wi* is equal to the weight of asset *i* in the portfolio.

Once the expected return and the risk of the asset have been obtained, both these metrics should be calculated at a portfolio level. The expected return of the portfolio is calculated as follows:

$$RE\left(P\right) = W' \times \overline{R}$$

Where:

- $\overline{R} = \left[\overline{R}_1 \;\; \overline{R}_2 \;\; \cdots \;\; \overline{R}_n\right]$

- $$W' = \begin{bmatrix} w_1 & w_2 & \cdots & w_n \end{bmatrix}$$

After the return of the portfolio has been calculated, the risk of it should be measured. For it, the covariance-variance matrix of the returns of the assets is obtained. Then, the risk of the portfolio can be calculated as follows:

$$RI\,(P) = \sqrt{W' \times \sum \times W}$$

Where:

- $$W' = \begin{bmatrix} w_1 & w_2 & \cdots & w_n \end{bmatrix}$$
- $$\sum = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \cdots & \sigma_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{n1} & \sigma_{n2} & \cdots & \sigma_n^2 \end{bmatrix}$$

Now, the following risk minimization problem is solved:

$$min\text{: } RI(P) \text{Subject to:}$$

$$E(\,R_p\,) \;=\; RE\,(P)$$

$$\sum w_i \;=\; 1$$

In the case of the portfolio built in the previous section, the optimization of the portfolio assigns the following weights to five of the selected assets:

ALV.DE	JYSK.CO	MUV2D.XC	SOR.OL	CABK.MC
31,06%	4,50%	32,43%	24,96%	7,05%

This optimization leads to a highly concentrated portfolio composed by five equities out of sixteen that were selected and classified as attractive investment opportunities.

The root cause of this issue lies in the mathematical nature of variance minimization.

$$min\text{: } RI(P)$$

subject to the constraint:

$$\sum w_i \;=\; 1, \qquad w_i \geq 0, \qquad \forall\, i$$

where *w* represents the weight vector of portfolio allocations. In the absence of additional constraints, Solver naturally assigns zero weights to securities that do not contribute meaningfully to risk reduction, favoring a concentrated selection of assets with strong risk-adjusted characteristics.

This lack of diversification contradicts the initial premise of constructing a well-balanced portfolio composed of multiple attractive securities. In practical investment settings, diversification is essential for mitigating idiosyncratic risk and ensuring robustness against unforeseen market fluctuations. To address this limitation, researchers and practitioners incorporate additional constraints into the optimization model.

Although before considering the use of any constraint and assessing its impact on the portfolio composition, Merton's approximation will be carried out. It must be considered that the only restriction this approximation includes is that the weight of the assets (w_i) in the portfolio must be equal to 1.

$$\sum w_i = 1$$

For this reason, the same problem may arise where even short positions are considered to achieve a certain expected return for the portfolio.

5.2 Merton's Approximation

In portfolio theory, the Efficient Frontier represents the set of optimal portfolios that maximize expected return for a given level of risk. While Markowitz's (1952) Mean-Variance Optimization provides a solution based on covariance matrices, Merton (1972) introduced an alternative analytical method that simplifies portfolio optimization through scalar parameters. This approach reduces computational complexity, particularly when dealing with large numbers of assets, by expressing the Efficient Frontier as a hyperbola in risk-return space.

By defining key scalars and eliminating the need for direct covariance matrix manipulations, Merton's approximation offers a more structured and computationally efficient way to determine the optimal portfolio weights.

As a first step for Merton's approach the covariance-variance matrix of the portfolio assets must be obtained.

After the matrix is obtained, the scalars must be arranged. For it, a portfolio composed of *n* assets is considered, with returns vector:

$$\overline{R} = \left[\overline{R}_1 \;\; \overline{R}_2 \;\; \cdots \;\; \overline{R}_n\right]$$

and portfolio weights vector:

$$W' = (w_1, w_2, \ldots, w_n)$$

Since the sum of all weights must equal 1:

$$W'U = 1$$

where *U* is a vector of ones.

Then, the inverse of the covariance-variance matrix is needed, the inverse of this matrix will be $\sum^{-1}$.

The scalars can be calculated as follows:

$$A = U' \sum -1 \, E(R_p)$$

$$B = E'(R_p) \sum -1 \, E(R_p)$$

$$C = U' \sum -1 \, U$$

$$D = BC - A^2$$

After values for the scalars have been obtained, the expected return for the portfolio in function of $\lambda_1$is obtained.

In the mean-variance optimization framework, we solve the quadratic optimization problem (risk minimization) previously stated.

Using the Lagrange multiplier method, the Lagrangian function is:

$$\mathcal{L} = W' \overline{R} \; - \frac{\lambda}{2} W' \sum W - \lambda_1 (\sum W'U - 1)$$

Taking the First Order Condition (FOC) with respect to W:

$$\overline{R} - \lambda \sum W - \lambda_1 U = 0$$

Rearrange for W:

$$W = \frac{1}{\lambda} \sum^{-1} (\overline{R} - \lambda_1 U)$$

Since W is a row vector, we take the transpose on both sides:

$$W' = \frac{1}{\lambda} (\overline{R}' - \lambda_1 U) \sum^{-1}$$

Thus, the portfolio weights are a linear function of λ_1.

How the Expected Return and Variance of the portfolio depend on λ_1.

$$E(R_p) = W'\overline{R} = \frac{1}{\lambda} (\overline{R}' - \lambda_1 U) \sum^{-1} \overline{R}$$

As λ_1 increases, the expected return increases, because a higher λ_1 value for prioritizes assets with higher expected returns.

In the case of the variance:

$$Var(R_p) = W' \sum W = \frac{1}{\lambda^2} (\overline{R}' - \lambda_1 U) \sum^{-1} (\overline{R} - \lambda_1 U)$$

Portfolio variance is a quadratic function of λ_1, meaning risk increases as we move along the efficient frontier.

As previously stated, λ_1 represents the trade-off between return and risk. Mathematically, the more positive λ_1 is, the more are overweighted assets with higher expected returns. Conversely, the more negative it is, the more are overweighted assets with lower expected returns (which is theoretically possible).

The financial interpretation differs, as a rational investor seeks higher returns for a given level of risk, making large negative λ_1 unrealistic. This would mean preferring assets with poorer returns, which contradicts rational investment behavior.

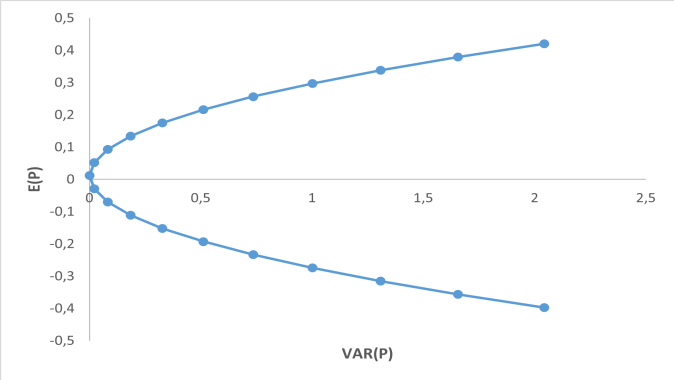

Figure 5.2.1: Efficient Frontier. Own Excel visual.

The representation of the variance values and return of the portfolio for different λ_1 levels, can be plotted as in Figure 5.2.1. Where a higher risk in the portfolio is corresponded with higher return. If the expected return was replaced in the y -axis with λ_1, the shape of the hyperbola would remain unchanged, only its scale would change.

After establishing the efficient frontier and analyzing how the risk profile parameter λ_1 influences the expected return and variance of the portfolio, we now examine how the allocation of individual assets changes as we move along this frontier.

Figure 5.2.2: Basic Problem. Own Excel visual.

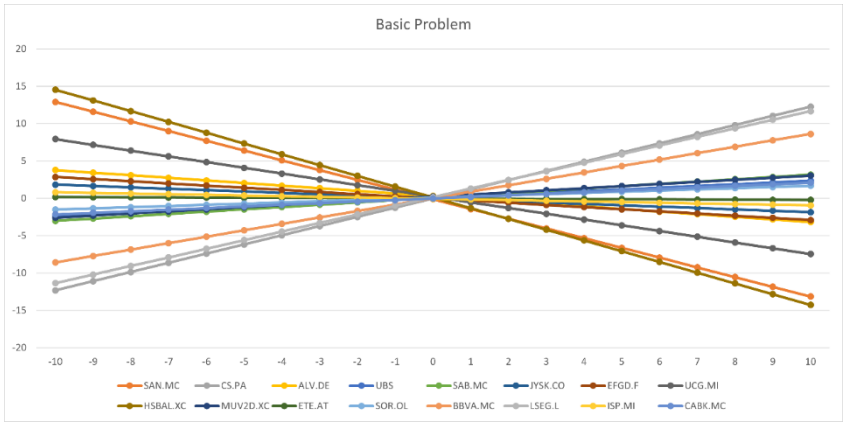

Figure 5.2.2 illustrates how the allocation of individual assets evolves across different points on the efficient frontier. The x-axis represents the values of λ_1, the parameter that determines the investor's risk profile, while the y-axis shows the portfolio weights assigned to each asset. This visualization allows us to understand how the composition of the optimal portfolio changes as we move from risk-averse to risk-seeking strategies.

At λ_1 = 0, the portfolio weights appear to be relatively balanced, with no extreme allocations. This corresponds to a neutral risk preference, where the selection of weights is dictated primarily by the statistical properties of the assets—expected return and covariance—without a strong emphasis on risk-taking or risk aversion. As λ_1 increases, the portfolio composition shifts towards assets with higher expected returns. These assets see their weights grow significantly, while others are gradually

reduced or even assigned negative values, indicating short positions. This behavior aligns with the theoretical expectation that a more risk-seeking investor will allocate a larger portion of capital to assets offering higher potential returns, even at the cost of increased volatility. Conversely, for negative values of λ_1, the portfolio moves towards lower-risk assets, reinforcing the idea that risk-averse investors prioritize stability over return maximization.

The nearly symmetric pattern observed in the figure around $\lambda_1 = 0$ suggests that each high-risk portfolio configuration has a corresponding low-risk counterpart where asset weightings are effectively inverted. Assets that receive positive allocations in a risk-seeking portfolio tend to be underweighted or even shorted in a risk-averse one. Furthermore, the evolution of asset weights is not uniform. Some assets exhibit gradual changes across different risk profiles, maintaining a stable presence in the portfolio, while others experience sharp transitions, indicating that their relevance is highly dependent on the investor's risk preference.

This analysis highlights how the risk profile parameter λ_1 influences not only the overall expected return and variance of the portfolio but also the specific composition of asset allocations.

Since the benchmark being used takes only long positions[27] and the selected securities have all been considered, after careful research, investment opportunities, some constraints will be applied ensuring the portfolio is optimized for a certain return on investment while it also contains only long positions and does not overweight excessively any security.

These include:

1. Minimum allocation constraints: Setting a lower bound on the weight of each asset $w_i \geq \varepsilon$ (in our optimization with additional constraints, $\varepsilon = 3\%$) ensures that every security receives a nonzero allocation.

[27] Morningstar. *ETF Snapshot: 0P0001L6KM* [online]. Last updated 2025. [Consulted 24 January 2025]. Available at: https://www.morningstar.es/es/etf/snapshot/snapshot.aspx?id=0P0001L6KM.

2. Maximum allocation constraints: Placing an upper limit on the weight of any single asset ($w_i \leq \lambda$ with λ being equal to 10% in the new optimization) prevents excessive concentration in a few securities.
3. Expected return constraints: Specifying a minimum required return forces the model to consider higher-return securities, often leading to a more diversified allocation. The benchmark to which the portfolio will be compared was incorporated in 2020, which does not provide enough reliable data for its average return. Since its incorporation, the average return has been 14.2%, this return comes from favorable markets during recent years. This restriction can be used but will not be applied during this optimization. Although a return higher than 0.9% will be higher than the average return offered by the historical returns of the firms considered as investment opportunities. The past returns of these firms and the benchmark ETF are not comparable given the different time periods.

$$\sum w_i R_i \geq R_{\{\{target\}\}}$$

These modifications allow the model to align more closely with practical investment considerations while retaining the core principles of variance minimization. Ultimately, optimizing a portfolio requires a balance between theoretical efficiency and real-world applicability. By carefully structuring constraints, investors can ensure a more diversified, stable, and realistic asset allocation strategy.

The application of the constraints results in an expected return $RE\ (P)$ = 1.1%, with the risk of the portfolio $RI\ (P)$ = 2.4%. Which provides an expected return higher than the average historical return when investing the same proportion of funds in each of the selected securities.

This final portfolio will be referred to as EuroFinance Alpha. The composition of EuroFinance Alpha is the following:

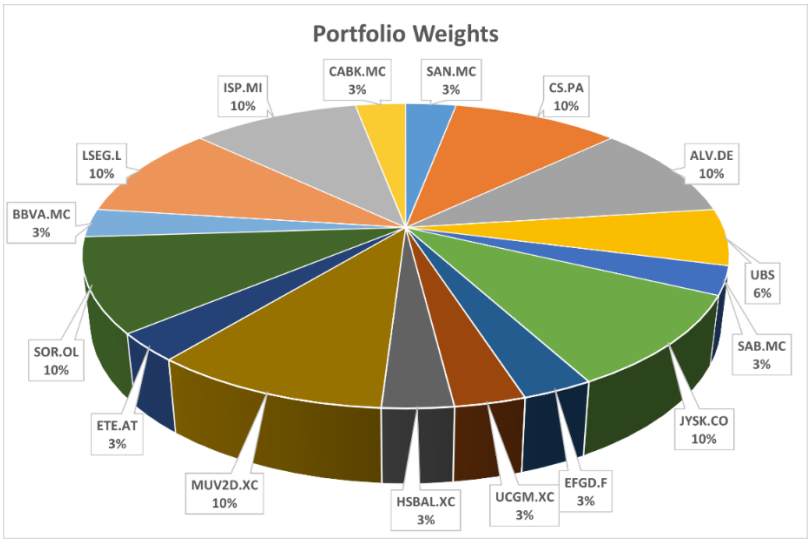

Figure 5.2.3: EuroFinance Alpha Portfolio Composition. Own Excel visual.

6. Strategy Performance Evaluation

To assess the effectiveness of the optimized portfolio constructed, it is necessary to compare its performance against an appropriate benchmark. Given the specific focus of this analysis on the European financial sector, the iShares MSCI Europe Financials Sector UCITS ETF (ESIF.L) has been selected as the reference index. This ETF provides broad exposure to financial institutions across Europe and serves as a relevant performance benchmark for evaluating the return potential of the portfolio.

6.1 Cumulative Return

For this comparison, the weekly cumulative return of ESIF.L in 2024 is taken as a reference point. As of the latest available data, the ETF has generated a total return of 20.46% over the period. It must be noted that the returns are computed only during 2024 and may differ with sources which consider the price evolution including the first week against the end of 2023.

This figure reflects the aggregate performance of the European financial sector, encompassing a diversified basket of banks, insurance companies, and other financial institutions. Given that the optimization strategy pursued in this research is constructed using individual securities within this same sector, the relative return of the optimized portfolio offers insight into the effectiveness of the model in generating superior risk-adjusted returns.

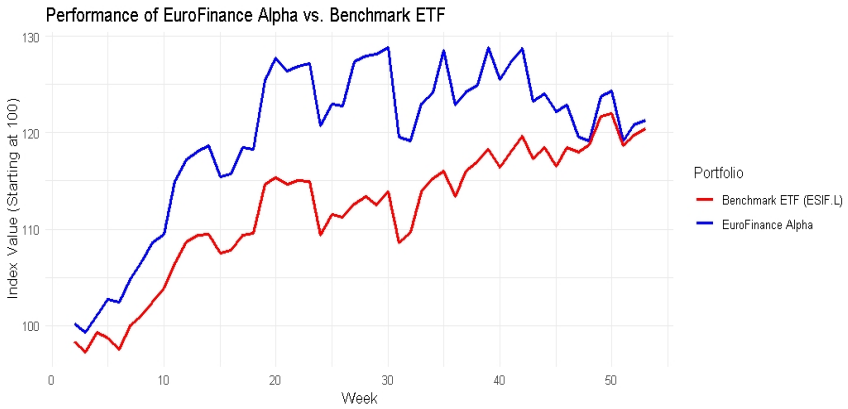

Figure 6.1: Performance of EuroFinance Alpha vs ESIF.L. Own R visual.

At this stage, as it can be inferred from Figure 6.1, the exact return of the optimized portfolio has been determined, with EuroFinance Alpha delivering a final return of 21.35% during the selected period, slightly outperforming the benchmark ETF's 20.46% return. This result indicates that the optimization process has provided a competitive edge, though the margin of outperformance remains modest. While this validates the portfolio's ability to generate returns above the benchmark, it also suggests potential areas for refinement—such as enhanced risk management, alternative weighting strategies, or further adjustments to factor in broader market dynamics. These considerations could help strengthen the practical applicability of the model and further improve performance relative to market benchmarks.

6.2 Risk Profile

Beyond the absolute return comparison, evaluating the volatility profile of both portfolios is crucial in assessing risk efficiency. Merton's framework is grounded in mean-variance optimization, which seeks to maximize returns while maintaining effective risk control.

The standard deviation of EuroFinance Alpha (0.02498) is higher than that of the benchmark ETF (0.01813), indicating that while the portfolio has outperformed in terms of return (21.35% vs. 20.46%), it has done so with increased volatility. This suggests that the additional return comes at the cost of higher fluctuations in value.

Furthermore, the beta of the portfolio (β) is 1.2217, meaning EuroFinance Alpha is 22.17% more volatile than the benchmark. This implies that the portfolio is more sensitive to market movements, amplifying both gains and losses relative to the ETF. While this can be beneficial in upward-trending markets, it also introduces greater downside risk.

$$\beta = \frac{Cov(R_{p,} \quad R_m)}{Var(R_m)}$$

Where:

$$R_p \ ;EuroFinance\ Alpha$$

$$R_m \ ;ESIF\ .\ L$$

If this higher risk exposure aligns with the investor's risk tolerance and return objectives, the strategy remains justified. However, if the objective is to achieve superior risk-adjusted efficiency, alternative risk management techniques, such as hedging or diversification adjustments, may be necessary to mitigate excessive volatility.

6.3 Additional Metrics

Sharpe Ratio	Treynor Ratio	Jensen's Alpha
7.21	0.1473 or 14.73%	-0.0292 or -2.92%
Excellent total risk-adjusted return	Strong return per unit of market risk	Underperformed relative to CAPM expectations

Figure 6.3.1: Additional Performance Metrics for EuroFinance Alpha.

Despite achieving higher returns than the benchmark, the EuroFinance Alpha portfolio underperformed in terms of Jensen's Alpha, suggesting that the excess return was not sufficient given its exposure to market risk. However, both Sharpe and Treynor Ratios indicate strong risk-adjusted performance overall, with particularly efficient use of total and systematic risk. These mixed results highlight the importance of evaluating performance from multiple perspectives.

7. Conclusions

This thesis set out to analyze investment portfolio optimization through quantitative methods, focusing specifically on the European financial sector. By combining theoretical models with empirical implementation, it explored how investor preferences (particularly risk tolerance) shape portfolio composition and performance.

The findings confirm that portfolio optimization remains a powerful tool for informed investment decisions. The use of the Markowitz mean-variance framework allowed for

the construction of efficient portfolios based on risk-return trade-offs, while Merton's continuous-time model added depth by modelling how asset weights shift with investor risk profiles. These results are consistent with the initial objectives and demonstrate both the theoretical and practical value of optimization techniques.

The conclusions are relevant for both academic and professional audiences. The thesis serves as an example of how financial theory can be applied to real-world portfolio construction and provides a replicable framework for navigating market uncertainty (particularly within the European financial sector).

One key insight is that optimal portfolio composition changes significantly depending on risk appetite. The evolution of asset weights along the efficient frontier revealed patterns aligned with theoretical expectations. Even without a risk-free asset, the study showed that robust portfolios can still be built through proper optimization techniques.

Despite its contributions, the study presents certain limitations. The empirical analysis was constrained to a specific sector and a finite number of assets, which, while justified for tractability and relevance, limits the generalizability of the conclusions. Additionally, the models applied rely on historical data and assume that asset returns follow stable statistical distributions (typically normal distributions in the case of mean-variance optimization). In reality, financial returns often exhibit characteristics such as fat tails, skewness, and volatility clustering, which violate these assumptions and can lead to underestimation of extreme risks. This means that the optimized portfolios derived from the models may not fully reflect the risk dynamics observed in real markets, especially during periods of financial stress or structural shifts[28]. Future research could extend the approach by incorporating time-varying parameters, non-Gaussian return distributions, or robust optimization techniques to address these shortcomings more effectively.

In conclusion, the results support the goals initially set and highlight the practical usefulness of portfolio optimization in navigating complex investment decisions.

[28] Science Direct: Gilli, M., & Këllezi, E. *The choice of the distribution of asset returns: How extreme value theory can help* [online]. Last updated 2006. [Consulted 07 April 2025]. Available at: https://www.sciencedirect.com/science/article/pii/S0378426604001505.

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