Anexo I. Registro del Título del Trabajo Fin de Grado (TFG)

NOMBRE DEL ALUMNO: **GUILLERMO CAVERO SÁNCHEZ**
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Director Asignado: Martín Bujak, Karin

Apellidos Nombre

Título provisional del TFG:

INVESTING IN COMPANIES
LEVERAGING ARTIFICIAL INTELLIGENCE
USING MARKOWITZ AND SHARPE

INVESTING IN COMPANIES

LEVERAGING ARTIFICIAL INTELLIGENCE

USING MARKOWITZ AND SHARPE

Author: Guillermo Cavero Sánchez

Director: Karin Alejandra Irene Martín Bujack

INTRODUCTION

In today's dynamic investment landscape, investors are presented with an extensive spectrum of options. This overwhelming abundance of information oftentimes leads to confusion, leaving investors uncertain about their optimal course of action amidst the sheer volume of data available for financial analysis. Notably, companies specialising in artificial intelligence (AI) are experiencing striking growth, positioning themselves as exceptional investment opportunities.

According to McKinsey (2024), there has been an astonishing rise in the adoption of Artificial Intelligence (AI), with usage increasing from 55% of companies in 2023 to 72% in 2024. This implementation has propelled extraordinary business gains, encompassing both revenue increases and cost reductions. This tendency underscores the growing role of AI in driving operational excellence as well as maintaining sustainable competitive advantages across different industries.

As organizations increasingly leverage the power of AI, they unveil compelling investment opportunities within this transformative sector. This shift highlights the necessity for an effective strategic approach that empowers investors to navigate the intricacies of the investment landscape and uncover promising prospects.

GOAL

The goal of this project is to construct efficient investment portfolios consisting of companies that invest heavily in artificial intelligence and that differ significantly in terms of geographical location, industry, and sector. By applying the principles of Modern Portfolio Theory (MPT), introduced by Harry Markowitz, alongside the Sharpe Ratio, formulated by William Sharpe, the project aims to optimise risk-return trade-offs as well as accurately assess the performance of these portfolios. Ultimately, this approach will hopefully empower investors to make well-informed, strategic decisions in the rapidly evolving AI-driven landscape.

MARKOWITZ - MODERN PORTFOLIO THEORY (MPT)

Developed in 1952 by Novel Laureate Harry Markowitz, Modern Portfolio Theory (MPT) represents an absolutely groundbreaking for constructing efficient, well-diversified portfolios that maximise returns for given levels of risk or minimise risk for given levels of return (Markowitz, 1952). Initially published in “The Journal of Finance”, its renowned article “Portfolio Selection” originally generated little interest amongst the finance community.

At that time, many investors and analysts relied heavily on intuition and subjective judgment rather than rigorous quantitative models. Markowitz's unique emphasis on mathematical formulations, which involved complex statistical analyses to assess correlations and optimize returns, was revolutionary and challenged conventional investment practices. Many practitioners were unaccustomed to the notion of evaluating investments through the lens of risk-return trade-offs, making it obstructive for Markowitz’s ideas to penetrate the prevailing mindset, resulting in his ideas being dismissed and largely ignored by the investment community at that time (Bodie et al., 2013). Notwithstanding, it was only in the subsequent decades, as financial markets became increasingly complex, that the pressing need for robust analytical frameworks became unmistakably clear. Amidst this shifting landscape, Modern Portfolio Theory (MPT) gradually gained momentum, eventually earning its rightful recognition as a fundamental pillar of contemporary finance, shaping investment strategies and practices across the entire industry (Fabozzi et al., 2002) (Michaud, 1998).

Like many other robust models, Modern Portfolio Theory (MPT) is grounded in several fundamental assumptions. Firstly, investors are inherently risk-averse, meaning that they aim to maximise returns for given levels of risk or, conversely, minimise risk for given levels of return (Markowitz, 1952). Secondly, markets are efficient, meaning that all the important information required to make profitable investment decisions is readily available to all investors. Since prices reflect this information almost instantaneously, consistently achieving returns that exceed the market average through selective stock picking is pointless (Fama, 1970). Finally, markets are frictionless, which means that there are neither transaction costs nor taxes, thus enabling all participants to trade without any barriers or delays (Markowitz, 1952).

Harry Markowitz insisted that while investors can significantly reduce risk through strategic asset allocation, they cannot eliminate it entirely. This inherent limitation exists due to various overarching economic factors that create persistent correlations among assets, making total risk mitigation impossible. Nevertheless, investors willing to minimise risk should carefully consider actively implementing diversification strategies, which depend on asset correlations (Perold, 2004).

On the one hand, investors who allocate funds to assets that exhibit similar behavioural patterns face significant exposure to losses as it would only take one component (interdependent) to underperform to incur maximum losses (non-diversified portfolio). On the other hand, investors who allocate funds to assets that exhibit different behavioural patterns are less exposed to losses as it would take all constituents (independent) to underperform to incur maximum losses (diversified portfolio) (Fabozzi, et al., 2002). That being said, well-diversified portfolios consistently outperform non-diversified portfolios due to the existing imperfect correlation between the assets, which allows for higher return and lower risk (Markowitz, 1952).

Consequently, this approach necessitates the simultaneous resolution of two optimization problems: maximising returns while also minimising risk. This dual methodology employs quantitative techniques to calculate the maximum return achievable for each level of risk and, conversely, minimum risk attainable for each level of return in order to identify efficient portfolios.

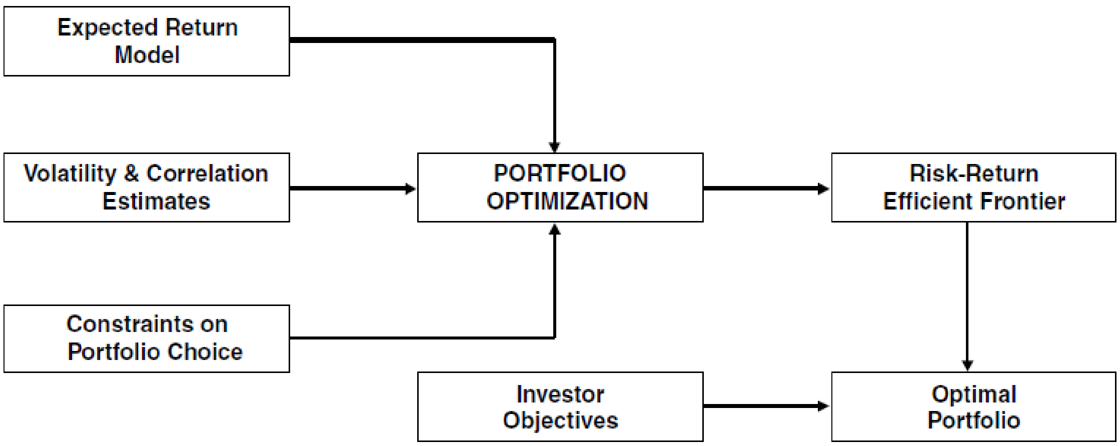
The efficient frontier is a key graphical representation that delineates the set of efficient portfolios, illustrating optimal risk-return trade-offs: the highest return for each unit of risk or, conversely, the lowest risk for each level of return. Portfolios on this frontier are optimal, meaning that any attempt to improve returns would require accepting higher levels of risk or reducing expected returns (Elton et al., 2009). By showcasing these risk-return combinations, the efficient frontier helps investors make informed decisions about portfolio allocations that best match their risk tolerance (Sharpe, 1964).

TOBINS SEPARATION THEOREM

Building on the foundational principles established by Harry Markowitz, James Tobin (1958) expanded the framework by introducing risk-free borrowing and lending. Tobin's "Separation Theorem" states that investors will construct efficient portfolios by combining risky assets with riskless assets.

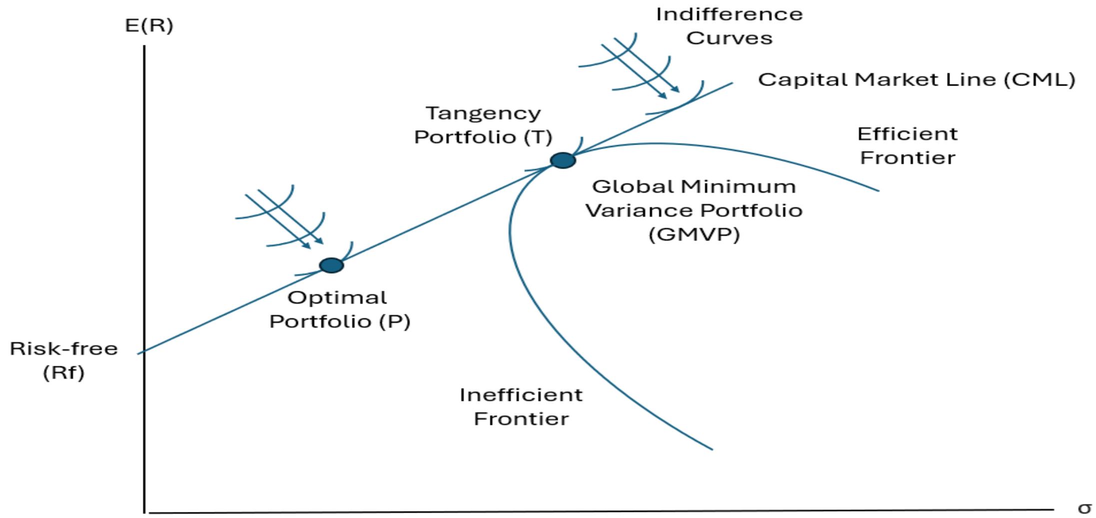
On the one hand, investors willing to allocate all their funds to the risk-free asset will surely obtain guaranteed returns with zero risk. However, this conservative investment strategy inherently sacrifices the potential for higher gains associated with riskier choices. On the other hand, investors who allocate funds to both risk-free and risky assets can effectively balance the stability offered by the risk-free component with the higher expected returns available from the risky assets. This hybrid approach enables investors to accept manageable levels of risk while still securing some guaranteed returns from the risk-free component (Tobin, 1958).

THE MPT PROCESS



The MPT Investment Process

The investment process begins with the foundational assumption that markets are perfectly efficient, which means investors have access to all relevant financial information necessary for making informed and profitable investment decisions. Armed with this knowledge, investors seek to mitigate risk through diversification, strategically selecting negatively correlated financial instruments to enhance overall portfolio stability. After this initial portfolio construction, they identify the Global Minimum Variance Portfolio (GMVP), portfolio that achieves the lowest possible risk while maximising return, to distinguish between efficient and inefficient portfolios. On the one hand, efficient portfolios, those that lie above the GMVP, offer optimal risk-return trade-offs, and should therefore be chosen. On the other hand, inefficient portfolios, those situated below the GMVP, offer suboptimal risk-return trade-offs, and thus should be avoided. When integrating both risky assets and a risk-free asset (R_f), investors aim to identify the Tangency Portfolio (T), optimal portfolio of risky assets when combined with a riskless asset, although they may initially remain uncertain about the precise allocation between the two asset classes. Ultimately, individual investor preferences and objectives come into play through utility curves, curves that represent different investors' preferences for risk and return, guiding them in selecting the portfolios that align with their unique risk tolerances and return expectations, thus culminating in customised Optimal Portfolios (P) tailored to their financial goals.



WILLIAM SHARPE - SHARPE RATIO

Named after its creator, William Sharpe, the Sharpe ratio is an established financial metric that evaluates the excess return earned per unit of risk incurred. This ratio serves as an essential metric for evaluating investment performance, enabling accurate comparisons amongst different investments (Sharpe, 1966).

The Sharpe Ratio is mathematically expressed as follows:

$$Sharpe\ Ratio\ (SR) = \frac{R(p) - Rf}{\sigma(p)}$$

Where:

- Rp: Portfolio return
- Rf: Risk-free rate
- σp: Portfolio risk

The Sharpe Ratio offers investors valuable insights into the risk-adjusted performance of their portfolios. By distinguishing between overperforming and underperforming investments, investors can make informed choices that align with their risk tolerance and financial goals. Its simplicity and effectiveness have solidified the Sharpe Ratio as an indispensable tool for both individual investors and financial analysts alike, empowering them to evaluate performance, identify potential investments, and optimise their overall investment strategies (Bodie et al., 2013).

METHODOLOGY

DATA COLLECTION

For this analysis, financial data has been compiled for 150 companies using FactSet, a leading provider of financial information. The selected companies are prominent investors in artificial intelligence (AI) and span various geographical regions, industries, and sectors. Additionally, these companies constitute two key indices: the iSTOXX AI Global Artificial Intelligence 100 Index and the Morningstar Global Next Generation Artificial Intelligence Index. The dataset includes firms of varying size, location, industry, and sector, aiming to provide comprehensive insights into AI investment trends.

ANALYTICAL FRAMEWORK

The portfolio construction process will involve assessing the historical returns and volatility of the selected companies to evaluate their individual risk profiles. Additionally, a correlation analysis will be conducted to understand the diversification potential among asset returns. Quantitative methods will then be utilized to identify the optimal asset mix that achieves the best risk-return trade-off, leading to the formation of efficient portfolios. Once portfolios are constructed, the Sharpe Ratio will be calculated for each to determine risk-adjusted performance in relation to the risk-free rate. This comparative analysis will evaluate the AI-focused portfolios against established benchmarks and other investment strategies, ascertaining their effectiveness.

Ultimately, this analytical approach aims to provide a robust methodology for constructing well-diversified and efficient portfolios that equip investors to navigate the complexities and opportunities presented by investments in AI.

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