Department of Banking and Financial Management,

School of Finance and Statistics,

M.Sc. in Banking and Finance

University of Piraeus

A Thesis submitted in partial fulfilment of the requirements for the degree of

Master of Science in Banking and Finance

Comparison of multi-asset strategies for investments

IOANNIS SIAKOULIS

mxrh2230

Academic Supervisor

Associate Professor Michail Anthropelos

Examination Committee

Assistant Professor Panagiotis Asimakopoulos

Assistant Professor Nikolaos Englezos

Piraeus, June 2024

To my beloved family,

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to my supervisor, Associate Professor Michail Anthropelos, whose constant support, patience and expertise guided me through every step of this dissertation. His constructive feedback has been invaluable through this process.

My sincere thanks go to the members of my dissertation committee, Assistant Professor Panagiotis Asimakopoulos and Assistant Professor Nikolaos Englezos for their critical evaluation and insightful comments.

I would like to acknowledge Panagiotis Troupis for our valuable discussions and encouragement which kept me motivated, as well as my colleagues from the M.Sc. in Banking and Finance class 2022 for their friendly and collaborative spirit.

Finally, I owe a debt of gratitude to my beloved brother Thanasis and my parents Themistoklis and Sofia for their unconditional love, support and encouragement during this challenging journey.

ABSTRACT

The purpose of the thesis is to analyze and compare investment strategies in multi-asset portfolios.

Distinguishment between different asset classes and then their allocation holds significant importance in diversifying the investment portfolio. The criteria for selecting suitable assets may vary.

Depending on the expectations of each investor, appropriate strategies are applied that can bring higher returns, which may show some volatility, or lower and stable returns with lower risk exposure.

Keywords: asset classes, asset allocation, excess return, performance metrics, multi-asset strategies, momentum, valuation, combined strategy, optimal risky portfolio

ΠΕΡΙΛΗΨΗ

Σκοπός της διπλωματικής εργασίας ειναι η ανάλυση και η σύγκριση των στρατηγικών για επενδύσεις, σε χαρτοφυλάκια πολλαπλών περιουσιακών στοιχείων.

Ο διαχωρισμός μεταξύ των διαφόρων κατηγοριών των περιουσιακών στοιχείων και στη συνέχεια η κατανομή τους παίζουν καθοριστικό ρόλο στην διαφοροποίηση του επενδυτικού χαρτοφυλακίου. Τα κριτήρια για την επιλογή των κατάλληλων περιουσιακών στοιχείων μπορεί να ποικίλουν.

Ανάλογα με τις προσδοκίες του κάθε επενδυτή, εφαρμόζονται οι κατάλληλες στρατηγικές που μπορούν να φέρουν υψηλότερες αποδόσεις, οι οποίες μπορεί να εμφανίζουν κάποια αστάθεια, είτε χαμηλότερες και σταθερές αποδόσεις με χαμηλότερη έκθεση στον κίνδυνο.

Λέξεις-κλειδιά: κατηγορίες περιουσιακών στοιχείων, κατανομή περιουσιακών στοιχείων, πλεονάζουσα απόδοση, ορμή, αποτίμηση, βέλτιστο χαρτοφυλάκιο

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

This chapter presents some fundamental definitions, on which this dissertation will be framed. The chapter begins by introducing the different types of Asset Classes and presents the Asset Allocation process, as well as the factors that may affect an investor's decision. After outlining the asset allocation strategies, the chapter highlights the important role these strategies possess in portfolio construction.

1.1 Asset Classes

Asset classes consist of different types of securities, each carrying a dinstict degree of risk, that have similar characteristics and behave similarly in the market.

Investors use asset classes to group different types of investments based on their similarities.

The main categories of asset classes consist of **Equities**, **Bonds** (being referred to as fixed income), **Real Estate**, **Cash** and **Commodities**.

As mentioned above, each type of asset class is unique and carries their specific characteristics, for instance, they differ in risk levels, the chance of positive or negative returns and how they might behave under various market environments.

Public limited companies issue shares, commonly known as **Equities**, which are traded on official stock exchanges. Capital growth for an investor can occur when the price of shares goes up, and/or income can be earned through dividends – these allow shareholders to benefit from a company's financial success, relative to their shareholding size, usually two times annually. However, investors face a risk that the share price might drop below the initial investment level, therefore dividend payments are not guaranteed. Accordingly, an investment in equities is subject to risk, as the investors get exposure to the company's gains and losses. Essentially equities carry more risk than other asset classes and every investor must consider how much risk they wish to incur.

Fixed Income investments generally pay a fixed interest rate or dividend until maturity. Upon reaching maturity, investors receive back the initial capital they put in. The most frequent fixed-income instruments are government and corporate bonds, which can be issued by the national government, as well as local authorities. By purchasing a government bond, an investor is basically loaning money to the government. In exchangem the government commits to providing the investor with periodic interest payments, until the bond matures (usually semi-annually or yearly) until the bond matures. Historically bonds offer more consistent returns, with lower risk than equities, though they have yielded lower returns over

the long term . Additionally, government bonds often have higher liquidity in the market, which helps keep their interest rates lower.

Cash and cash equivalents are the lowest risk, most liquid asset class, meaning that these assets can be easily accessed and are designed not to incur any significant losses. Savings accounts and money market funds, as well as CDs (certificates of deposit) are examples of cash and cash equivalents. It is often used by multi asset portfolio managers to protect a fund against adverse market movements during volatile periods.

Real estate is a tangible asset that can be used for various purposes, such as residential, commercial, or industrial. Real estate can be a good investment for generating income or for long-term appreciation. However, it's important to note since real estate tends to be illiquid asset, it is challnging to sell in a short time frame.

Commodities, such as gold, oil and wheat, serve as the fundamental resources for manufacturing goods and providing services. They can be a volatile asset class, but they can also offer diversification benefits.

Both Real Estate and Commodities belong to the **Alternative Investments**, which also include non standard approaches to investing as well, such as **private equity funds** and **hedge funds**.

Multi Asset Funds: An investment spread, across various asset classes, including stocks, bonds, cash and alternative assets like real estate and infrastructure, is known as multi asset class investment.

Typically, investors can shoose multi-asset funds with a balanced mix of different asset types, instead of buying funds focused on a particular asset class, sector, or region, usually covering several geographical markets.

Since the principal aim for an investor is a consistent income, or capital growth, a diversified blend of assets can often reduce the risk that comes from putting all of the money into one specific investment, by adopting asset allocation strategies that can effectively increase expected returns, while managing risk.

Particularly, investing in just one asset is extremely risky, because if it does not perform well, the investor will lose money, conversely having exposure to more than one asset classes can easily balance the level of risk, so that a loss in a single asset won't significantly impact the portfolio's overall performance. As a result, the top performing assets should counterbalance the underperforming ones, leading to more steady returns overall.

This diversified approach implies that these asset classes perform differently to one another, as market conditions change, providing protection in times of market stress.

1.2 Asset Allocation

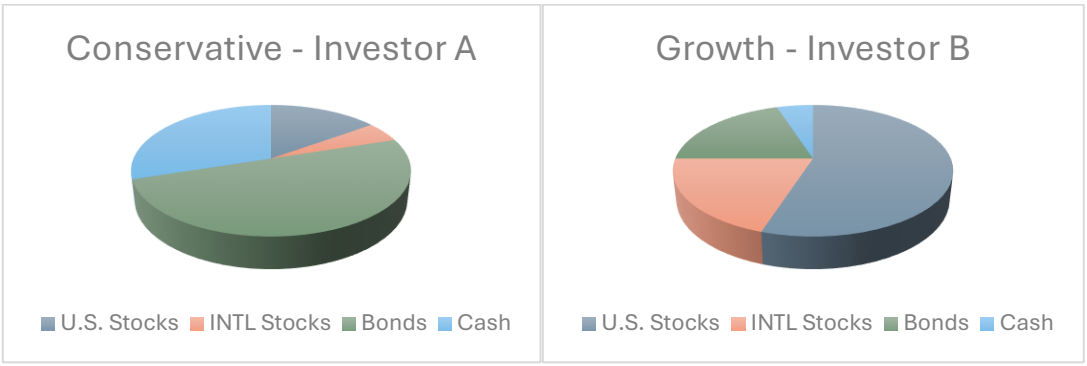
The process of spreading the investment's portfolio money between stocks, bonds and cash is known as asset allocation. The objective of asset allocation is to have a framework that maximises investor satisfaction from their portfolio for a given level of risk. Simply achieving higher returns is not sufficient if the investor is unable or unwilling to maintain their portfolio holdings during times of market volatility. Not surprisingly, the ideal allocation may shift depending on the timing, meaning that the the percentage allocated to each asset is influenced by the investor's time horizon, along with the **risk tolerance**.

It has been observed that investors with a short time horizon appear to be more risk averse, as they invest mostly on low-risk assets, such as cash, ideal for conservative portfolio. On the other hand, for long time horizon investors who usually have years until they achieve their financial goal, the idea of focusing on equities seems more attractive for potentially greater returns, despite all the risk or volatility that may arise.

Risk tolerance represents how much money of the original investment an investor is determined to sacrifice, in exchange for higher returns. For instance, low risk tolerances hold a more conservative portfolio, while investors who feel more comfortable with big market fluctuations proceed with more aggressive portfolios.

Apparently, the asset allocation choice can be easily influenced by both time horizon and risk tolerance. Let's consider two different types of investors who organize their retirement portfolio, investor A will be retiring soon, while the 20 years old investor B started working recently. For investor A, losing money is not a good option, as they have a limited time horizon, so they will purchase a low-risk portfolio that mainly helps preserve their capital. As expected, investor B appears to have high risk tolerance, as their time horizon until retirement is obviously much more extended than investor A, so their aim will be the capital growth over the next years.

Chart 1, Pie charts representing two different types of investor profiles



The pie charts reflect the two different investor profiles that were analyzed above. Investor A purchased a conservative portfolio, based mainly on bonds, which bring a fixed income, while the stocks possess only a small percentage of the total portfolio. Conversely, the other proportion of assets, of the portfolio next focused on US and INTL stocks, characterizes the most risk tolerant investor B who is looking for the potential high returns the equities may bring.

1.3 Asset Allocation Strategies

Strategic Asset Allocation (SAA)

Strategic Asset Allocation also known as 'buy and hold' is a long-term strategy that provides an investor with a static asset allocation mix, which concerns the formation and maintenance of an appropriate ratio of various classes in a portfolio. This asset allocation mix is determined based on investor's profile, time horizon, risk tolerance, etc.

However, given that the ratios are exposed to the market turbulences, a periodic portfolio rebalancing is required, usually once per year - ideally when the allocation of an asset class alters by more than a specific percentage set in advance, to ensure that the proportion of individual assets in portfolio remains protected and unchanged under the market condition movements. In other words, an investor can offload investments from areas that have too much exposure and use the money to purchase assets in categories that are underweight, until the portfolio is back into its original asset allocation mix.

Tactical Asset Allocation (TAA)

Tactical Asset Allocation is a variant of the strategic asset allocation (SAA), which involves tactically changing the distribution of different asset categories within a portfolio, to take advantage of changing markets.

The reason TAA is often called 'momentum strategy' is because it understands market movements and suggests modifying the portfolio's asset mix, according to short-term predictions. Particularly, TAA is ideal for someone who seeks opportunities to make quick short-term gains by dynamically rebalancing a portfolio's allocations, within or across different asset classes, markets, and/or sectors, rather than through individual security selection.

For example, during a market downturn, in order to get benefited from the lower prices of quality stocks, an investor increases the equity exposure in their investment portfolio. When markets recover later, these stocks can be sold at a profit to bring to the investor higher returns. A critical skill for an investor is to be able to identify when short-term opportunities have been expired, so that the portfolio is rebalanced to the long-term asset position.

Dynamic Asset Allocation

This strategy also gives investors the ability to alter the allocation to cash in on favourable markets, by using automated systems based on financial models, in contrast to TAA where investors use to buy and sell investments manually.

1.4 Portfolio Construction and Asset Allocation Strategies

A portfolio construction can be performed by defining the investor's **market expectations (Capital Market expectations)**, determining a **Strategic Asset Allocation**, modifying it tactically as needed, through **Tactical Asset Allocation**, which concludes with the selection of securities.

In case the portfolio management has been addressed to a financial advisor, an **Investment Policy Statement (IPS)** is required to be approved. This strategic document essentially provides the investment goals and describes analytically the strategies that the manager needs to implement to reach the goals.

Capital market expectations reflect the investor's outlook on the risk and return possibilities of different asset classes, mostly Equities, Bonds and Alternative Investments.

For instance, equities and bonds can be categorized into domestic/foreign, whether they are traded in developed or emerging markets. Especially for equities, someone can distinguish them between Large/Mid/Small Cap stocks, while bonds can be divided into investment grade or high yield bonds (the first concern bonds that carry credit ratings of at least BBB- and the high yield bonds, below BBB-).

Figure 2, Diversification between asset classes

Equities	
Large-Cap US Stocks	**Small-Cap US Stocks**
Developed Nation Stocks	**Emerging Market Stocks**

Bonds	
Investment Grade Bonds	**High Yield Bonds**
Global fixed-income securities	**Emerging Market Debt**

Alternative Investments	
Hedge Funds	**PE Funds**
Commodities	**Real Estate**

The process of capital market expectations setting involves the outline of the expectations that are required, the investor's time horizon, research of historical record, analysis of the methods that will be used, conclusions documentation and comparison between outcomes and forecasts.

Overall, the asset classes chosen should roughly cover the full spectrum allowed in IPS. After specifying the range of asset classes, the portfolio manager will obtain data on expected long-term returns, standard deviation of returns (concerning return volatility) and Correlation of the Returns with those of other asset classes.

Once the capital market expectations have been set, the next step includes determining the strategic asset allocation.

The expected returns, the risk measure (standard deviation) and the correlation of returns of the various asset classes contribute to the *Efficient Frontier* construction, so that the *Capital Allocation Line* can be determined.

Depending on the risk and return objectives from the IPS, the portfolio which best meets the requirements for an investor represents the optimal risky portfolio and the asset allocation for this optimal portfolio is the **Strategic Asset Allocation (SAA)**.

At this point, portfolio management can be split into *passive* and *active*.

Let's assume that for an investment portfolio it has been decided asset allocation of 50% to US large-cap stocks, 20% Investment Grade Bonds and 30% US Treasury Bonds as the risk-free asset - with a guaranteed future value and no potential for loss.

In case the proportions of the assets are maintained as per the SAA and nothing changes, this would be a *passive portfolio*.

Otherwise, the **Tactical Asset Allocation (TAA)** could play a major role as it deviates from the SAA to take advantage of perceived short-term opportunities.

For example, if the analysis show that stocks are overvalued relative to bonds, investor can deviate from the SAA by underweighting stocks and overweighting bonds in the short-term reflecting for instance 45% to US large-cap stocks, 25% Investment Grade Bonds and 30% US Treasury Bonds.

When required, *active management* takes one step further to Security Selection by deviating from the index weights within each asset class.

For example, within US large-cap stocks, if the weight of A shares is currently 8% and the analysis show that A stock is undervalued, portfolio manager may choose to overweight on A stock up to 10%.

CHAPTER 2 ASSET SELECTION CRITERIA

This chapter discusses the asset selection criteria and focuses on explaining the importance of choosing assets covering a wide variety of sectors, industries and markets, which is an essential step for creating a well-diversified portfolio. In addition, there is an analysis of the assets' qualitative characteristics, as well as a brief description of each asset.

2.1 Asset selection criteria

The selection of the asset classes is based on a comprehensive set of criteria that should be taken into account, to ensure that the portfolio is balanced, resilient and capable of achieving long-term financial goals.

Asset Class Diversity is an essential criterion when choosing assets for a well diversified-portfolio. The asset selection is performed between a broad range of asset classes, for instance Equities, including Domestic and International stocks, large-cap, mid-cap companies, Fixed Income, especially government bonds, corporate, as well as high yield bonds, Real Estate mainly property investments and real estate investment trusts (known as REITs), Commodities, such as gold and oil, Cash and Cash Equivalents, mainly money market funds, hedge funds and private equity (which are counted as Alternative Investments). By distributing investments among different asset classes

Risk and Return Characteristics includes the selection of assets with varying levels of risk (low, medium and high-risk assets), to maintain a balanced risk profile within the portfolio. By incorporating a mix of assets with different risk levels, the portfolio indeed is beetter protected against the effects of any one event or a market condition. In general, high-risk assets can offer higher returns, however they bring higher volatility. Low-risk assets on the other hand, provide stability which can counterbalance the volatility of higher-risk assets. The selection of assets which are low or even negatively correlated to each other would increase the heterogeneity of the investment universe, and eventually this would reduce the overall portfolio volatility.

Sector and Industry Diversification ensures exposure to a variety of sectors and industries to avoid concentration risk. In other words, allocating investments among different sectos and industries, such as energy, technology, finance, real estate, healthcare reduces the risk of significant losses due to negative events affecting a single sector. For example, if an investment is heavily focused on a specific sector and there is a downturn, inevitably the entire portfolio could suffer.

Different sectors and industries often lead market growth at different times, by diversifying, investors can capture growth opportunities in various sectors than missing the opportunity by being overexposed to a single sector that may underperform. This is highly related to the sensitivity of sectors to economic cycles, since some sectors tend to perform well during economic expansions, while other sectors may perform better to economic downturns, such as utilities and healthcare sector.

Apart from the economic conditions or market events, sectors and industries within a portfolio can be affected by geopolitical and regulatory risks, leading to fluctuations in assets values and changes in profitability. For example, geopolitical tensions such as instability in the MENA region, can result in volatility in oil prices. If a major oil-producing country faces sanctions, oil supply can be disrupted, causing prices to spike. This impacts the profitability of companies in the energy sector and can lead to increased costs for industries reliant on oil. For financial services sector, the EU's General Data Protection Regulation (GDPR) imposes privacy rules on companies handling EU citizens' data. Thus, financial services firms must invest heavily in data management and security measures.

Liquidity of assets plays a vital role in the asset selection process. Particularly, measures the ease with which an asset can be quickly transformed into cash, with the minimum impact to its price. High liquid assets offering flexibility are often preferred, as they can be quickly bought/sold and this is a vital factor on an investor's decision who may need to access cash or adjust their portfolios rapidly, without facing transaction costs or price fluctuations.

2.2 Assets qualitative characteristics

Considering the above criteria for the selection of different asset classes, this dissertation utilizes a well-diversified portfolio including twelve assets from a wide range of sectors and industries, with various return, risk profiles and different liquidities.

As shown below, Table 1 reflects a sample of twelve assets, distinguished in two asset classes: **equities** and **bonds**.

The main reasons that contributed to the decision of considering these asset classes (stocks and bonds) against other classes, are the following:

- Real Estate investments do not provide such liquidity, as stocks and bonds have. Additionally, Real Estate markets appear to be more exposed to price fluctuations, due to changing economic conditions, including inflation, interest rates or local market dynamics.
- Commodities are closely related to price volatility, occurred either by weather conditions, or by geopolitical events, that can certainly determine supply and demand globally.

- Cash or Cash equivalents practically offer low returns, therefore holding a portion of a portfolio in cash may cause missed opportunities to invest in other promising for higher returns assets.

Table 1, Investment portfolio of twelve assets, including equities from different sectors/industries, and government bonds

Asset Class		
US Equity Markets	US large-cap stocks	Microsoft Corporation (MSFT)
		Walmart Inc. (WMT)
		Exxon Mobil Corporation (XOM)
		Caterpillar Inc. (CAT)
		BlackRock, Inc. (BLK)
	US mid-cap stocks	Bruker Corporation (BRKR)
		BXP, Inc. (BXP)
INTL Equity Markets	INTL large cap stocks	ESAB India Limited (ESABINDIA.BO)
		Unilever PLC (ULVR.L)
INTL BOND MARKETS		JAPAN GOVERNMENT BOND JGB
		GERMAN GOVERNMENT BONDS
		UK GOVERNMENT BONDS

As discussed in Chapter 1, equities offer the potential for higher returns through capital appreciation and dividends, with higher market risk and volatility, while bonds provide lower and more predictable returns through fixed interest payments, with lower market risk.

In order to hedge the higher risk, **equities** of the sample have been split into US and International equity markets, which implies diversification on the risk and returns. Particularly, equities from different markets can help mitigate the portfolio's risk exposure.

Next, there is a further diversification between large-cap and mid-cap equities, depending on their market capitalization, or simply market cap, which refers to the overall value of a company's total shares in circulation (outstanding shares).

More specifically, firms with a strong market presence that typically have a market capitalization of $10 billion or higher are known as large-cap companies. While, mid-cap companies are not stable enough, as the large-cap companies, with market capitalization between $2 - $10 billion, however they appear to have higher growth potential.

A brief description of each stock of the portfolio, provides details on the stock sector/industry, as well as the company:

1. **Microsoft Corporation (MSFT)**: is a large-cap US-based firm, which is estimated to have a market cap of $3,04T. Microsoft engages in the development, support of software, services, devices, and solutions. It operates through the following business segments: Productivity and Business Processes; Intelligent Cloud; and More Personal Computing. Sector: Technology Services, Industry: Packaged Software.

2. **Walmart Inc. (WMT)**: engages in retail and wholesale business and it operates through the following business segments: Walmart U.S., Walmart International, and Sam's Club. Each segment focuses on different areas, such as consumer products, management of supermarkets, hypermarkets, warehouse clubs, and cash and carry outside of the United States. Walmart, Inc. is a large-cap company. Sector: Retail Trade, Industry: Specialty Stores.

3. **Exxon Mobil Corporation (XOM)**: focuses on the exploration, development, and distribution of oil, gas, and petroleum products. It operates through the following segments: Upstream, Downstream and Chemical. The Upstream segment produces crude oil and natural gas. The Downstream segment manufactures and trades petroleum products. The Chemical segment offers petrochemicals. Sector: Energy, Industry: Integrated Oil.

4. **Caterpillar Inc. (CAT)**, is a US large-cap company that engages in the business of manufacturing construction and mining equipment, off-highway diesel and natural gas engines, industrial gas turbines, and diesel-electric locomotives. It operates through the following segments: Construction Industries, Resource Industries, Energy and Transportation, Financial Products, and All Other. Sector: Producer Manufacturing, Industry: Trucks/Construction/Farm Machinery.

5. **BlackRock, Inc. (BLK)** provides investment management, risk management, advisory services for institutional and retail clients worldwide and is a large-cap company. Its products include single and multi-asset class portfolios investing in equities, fixed income, alternatives, and money market instruments. Sector: Finance, Industry: Investment Managers.

6. **Bruker Corporation (BRKR)** with a market cap less than $10 billion, is considered to be a mid-cap company engages in the business of developing, manufacturing and distributing high-performance scientific instruments and diagnostic solutions that enable customers to explore life and materials at microscopic, molecular, and cellular levels. Sector: Health Technology, Industry: Medical Specialities.

7. **BXP, Inc. (BXP)** is a US mid-cap company and functions as a real estate investment trust (REIT), handling the development, acquisition, management and ownership of a range of premium Class A properties across many geographical locations in the United States. Sector: Finance, Industry: REITs.

8. **ESAB India Limited (ESABINDIA.BO)** is a large-cap India based company that specializes in the manufacture and supply of welding and cutting products. It offers welding, cutting, and allied products and engineering, support, and consulting services. ESAB India Ltd functions through the Domestic and Overseas divisions. Sector: Producer Manufacturing, Industry: Electrical Products.

9. **Unilever PLC (ULVR.L)** is headquartered in London, United Kingdom and engages in the manufacture and sale of consumer goods. It operates through the following segments: Beauty & Wellbeing, Personal Care, Home Care, Nutrition, and Ice Cream. Unilever Plc is a large-cap company. Sector: Consumer Non-Durables, Industry: Household/Personal Care.

[The details of the stocks provided above have been collected by the website 'TradingView']

The portfolio also includes **Bonds** and particularly three Government long-term Bonds issued by national governments of Japan, Germany and the United Kingdom, with maturities up to 30 years. Since all three countries are considered to have stable economies, their government bonds appear to be low-risk investments.

CHAPTER 3 DATA AND ANALYSIS

This chapter presents the data, the sources, the correlation of the assets and analyses the techniques and methodologies employed in this study. Furthermore, it includes a step-by-step analysis of each of the investment strategies employed to the portfolio separately.

3.1 Data

The sample period for this study has been set from February 2004 to December 2022, covering almost 19 years. Apparently, short-term data can be highly volatile, thus a long sample period can extinguish any anomalies and provide a clearer picture of the historical data.

It is also worth mentioning that the period this dissertation focuses on, captures several geopolitical and economic conditions that affected markets, considering the 2007-2008 global financial crisis (GFC), the European Debt crisis (2010-2012), Covid-19 Pandemic (2020) and Supply Chain Crisis (2021-2022).

Historical data for this study includes monthly adjusted closing prices for the stocks, as well as monthly returns for the government bonds. Furthermore, for valuation purposes, historical data captures the monthly P/E ratios and yields, for stocks and government bonds respectively, over the sample period of 19 years.

It should be noted that due to the long-term sample period, specific assets that originally had been considered, due to inadequate data, they were eventualy taken out of portfolio over this long period.

The data was collected mainly from the S&P 500 index, which includes a diverse set of 500 of the largest companies, across various sectors in the U.S. stock markets. Particularly the US large/mid-cap stocks of the portfolio are listed on stock exchanges in the U.S.

Historical data for BRKR, ESABINDIA.BO, ULVR.L was collected from Yahoo Finance, while data for government binds has been extracted indirectly from Deutsche Bundesbank, Ministry of Finance of Japan and Bank of England.

For the calculations of the assets' excess returns, this dissertation utilizes monthly data for the risk-free rate R_f from the French and Fama 3 Factor Model (3FF), which was developed by E. Fama and K. French.

3.2 Analysis

As mentioned, the data includes historical monthly adjusted closing prices and P/E ratios of the stocks, as well as historical monthly returns and yields of the government bonds. The analysis is performed into stages, including statistical measurements, leading to useful findings.

3.3.1 Monthly Returns

The monthly returns of the assets, based on their adjusted closing prices, were calculated by the formula below:

$$Monthly\ Return = \frac{P_{end} - P_{start}}{P_{start}} = \frac{P_{end}}{P_{start}} - 1$$

where P_{end} is the adjusted closing price of the asset at the end of the month and

P_{start} the adjusted closing price of the asset at the start of the month.

Given that the sample period is Feb 2004 – Dec 2022, the monthly returns of the assets expressed in percentage form, start counting as from March 2004 (essentially excluding February) and the calculations were repeated monthly until December 2022.

Moreover, the reason why monthly returns are more preferrable than daily returns, is because this study analyses a long-term period, so monthly returns provide a more manageable point of view, eliminating the impact of short-term market noise and volatility.

3.3.2 Covariance-Variance Matrix

The variability and relationships between assets' returns of the portfolio are reflected in the covariance matrix.

In general, the covariance matrix is always a square matrix where the count of rows and columns matches the toal number of assets. Each element α_{ij} of the matrix represents the measure of how returns from asset i and j move together, known as covariance.

So, for the twelve assets it should be a 12x12 matrix with the following structure:

$$\begin{pmatrix} \alpha_{11} & \cdots & \alpha_{1,12} \\ \vdots & \ddots & \vdots \\ \alpha_{12,1} & \cdots & \alpha_{12,12} \end{pmatrix}$$

where the diagonal elements (α_{ii}) reflect the variance of each asset's returns. Alternatively, we can say that it evaluates the spread of an asset's returns around its average value. On the other hand, the off-diagonal elements (α_{ij}) depict the covariance between the returns of different assets and practically measures the degree two assets shift together.

Table 2, Variance-Covariance matrix of the twelve assets' monthly returns

VARIANCE - COVARIANCE MATRIX												
	MSFT	WMT	CAT	BRKR	ULVR.L	ESABINDIA.BO	BXP	XOM	BLK	JAPAN GOVT BOND	GERMAN GOVT BOND	UK GOVT BOND
MSFT	0.00429	0.00071	0.00223	0.00256	0.00114	0.00197	0.00186	0.00105	0.00292	0.00000	0.00007	0.00022
WMT	0.00071	0.00248	0.00087	0.00046	0.00055	0.00019	0.00084	0.00027	0.00126	0.00004	-0.00001	-0.00002
CAT	0.00223	0.00087	0.00815	0.00430	0.00165	0.00108	0.00311	0.00258	0.00435	0.00002	0.00010	0.00012
BRKR	0.00256	0.00046	0.00430	0.01478	0.00178	0.00281	0.00174	0.00182	0.00423	0.00003	0.00005	-0.00007
ULVR.L	0.00114	0.00055	0.00165	0.00178	0.00288	0.00049	0.00118	0.00087	0.00170	0.00003	0.00004	0.00010
ESABINDIA.BO	0.00197	0.00019	0.00108	0.00281	0.00049	0.01324	0.00157	0.00043	0.00161	-0.00007	0.00007	0.00012
BXP	0.00186	0.00084	0.00311	0.00174	0.00118	0.00157	0.00626	0.00149	0.00268	0.00003	-0.00004	0.00013
XOM	0.00105	0.00027	0.00258	0.00182	0.00087	0.00043	0.00149	0.00440	0.00170	-0.00002	-0.00009	-0.00011
BLK	0.00292	0.00126	0.00435	0.00423	0.00170	0.00161	0.00268	0.00170	0.00687	0.00004	0.00006	0.00014
JAPAN GOVT BOND	0.00000	0.00004	0.00002	0.00003	0.00003	-0.00007	0.00003	-0.00002	0.00004	0.00006	0.00007	0.00007
GERMAN GOVT BOND	0.00007	-0.00001	0.00010	0.00005	0.00004	0.00007	-0.00004	-0.00009	0.00006	0.00007	0.00031	0.00029
UK GOVT BOND	0.00022	-0.00002	0.00012	-0.00007	0.00010	0.00012	0.00013	-0.00011	0.00014	0.00007	0.00029	0.00041

It should also be noted that most of the returns have low variance, as it is shown on the diagonal elements, except for BRKR and ESABINDIA.BO which appear to have higher volatility. Regarding off-diagonal elements, positive values of the two assets show that they align in direction, whereas negative values imply that the returns move counter to each other, which enhances the diversification of the investment portfolio as mentioned in Chapter 2. The negative covariance values of the returns are met between stocks and bonds, and this is expected as for over two decades, there has been a tendency for stock prices and bond prices to move in reverse directions. For instance, Treasury bonds are considered to be a safer investment, compared to stocks, therefore it is not a surprise when invetsors would rather purchasing Treasury bonds, to hedge risk. It is interesting though to note that the covariance of the returns is close to zero in some asset pairs in Table 2, which practically indicates that the two assets are weakly related.

3.3.3 Correlation Matrix

In general, the goal of asset allocation is to minimize fluctuations in the portfolio. Diversifying with asset categories that have minimal correlation decreases the portfolio's

volatility and enables the portfolio manager to take on more risk, according to KenFaulkenberry,. (founder of the Arbor Investment Planner).

The Correlation matrix represents the linear relationships between pairs of assets and ranges from -1 to 1, indicating the trend and intensity of the relationships.

For the twelve assets, the correlation is reflected in a 12 x 12 symmetric matrix, where each element c_{ij} symbolizes the correlation coefficient.

$$Corr = \begin{pmatrix} 1 & \cdots & c_{1,12} \\ \vdots & 1 & \vdots \\ c_{12,1} & \cdots & 1 \end{pmatrix}$$

While the diagonal elements (c_{ii}) are all 1, meaning that each asset return is perfectly correlated with itself.

Table 3, Correlation matrix between the returns of the twelve assets

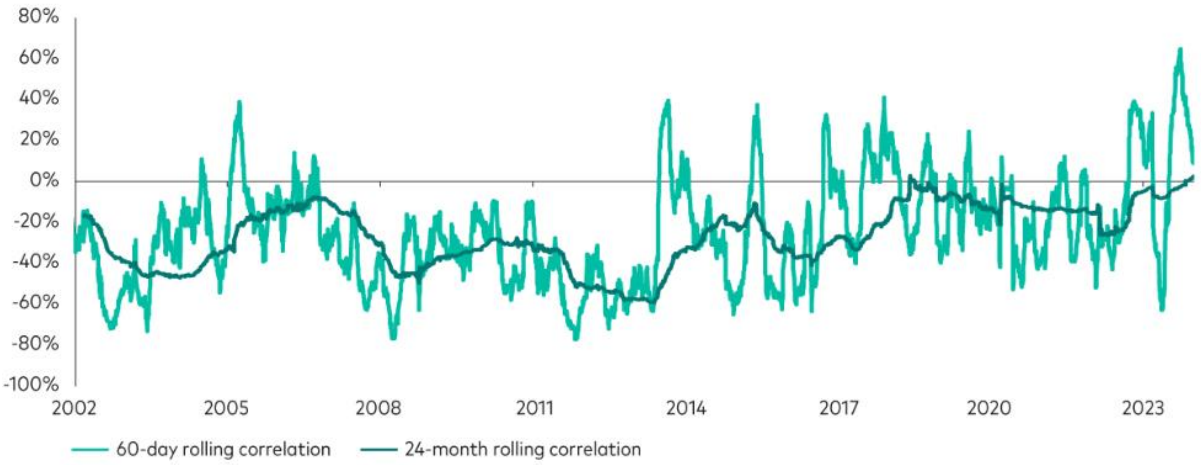
CORRELATION MATRIX												
	MSFT	WMT	CAT	BRKR	ULVR.L	ESABINDIA.BO	BXP	XOM	BLK	JAPAN GOVT BOND	GERMAN GOVT BOND	UK GOVT BOND
MSFT	1	0.21843	0.37633	0.32173	0.32313	0.26130	0.35884	0.24113	0.53795	-0.00639	0.05802	0.16203
WMT	0.21843	1	0.19391	0.07601	0.20514	0.03286	0.21246	0.08256	0.30468	0.09938	-0.01590	-0.01931
CAT	0.37633	0.19391	1	0.39198	0.34056	0.10375	0.43587	0.43132	0.58067	0.03245	0.06397	0.06726
BRKR	0.32173	0.07601	0.39198	1	0.27298	0.20092	0.18124	0.22560	0.42014	0.03250	0.02184	-0.02992
ULVR.L	0.32313	0.20514	0.34056	0.27298	1	0.08005	0.27842	0.24282	0.38118	0.07020	0.03742	0.09011
ESABINDIA.BO	0.26130	0.03286	0.10375	0.20092	0.08005	1	0.17290	0.05613	0.16899	-0.07580	0.03668	0.05116
BXP	0.35884	0.21246	0.43587	0.18124	0.27842	0.17290	1	0.28306	0.40806	0.04334	-0.03111	0.08062
XOM	0.24113	0.08256	0.43132	0.22560	0.24282	0.05613	0.28306	1	0.30854	-0.04639	-0.07936	-0.08118
BLK	0.53795	0.30468	0.58067	0.42014	0.38118	0.16899	0.40806	0.30854	1	0.06481	0.04376	0.08507
JAPAN GOVT BOND	-0.00639	0.09938	0.03245	0.03250	0.07020	-0.07580	0.04334	-0.04639	0.06481	1	0.51758	0.47224
GERMAN GOVT BOND	0.05802	-0.01590	0.06397	0.02184	0.03742	0.03668	-0.03111	-0.07936	0.04376	0.51758	1	0.81420
UK GOVT BOND	0.16203	-0.01931	0.06726	-0.02992	0.09011	0.05116	0.08062	-0.08118	0.08507	0.47224	0.81420	1

As usual, positive correlations indicate asset returns that tend to move together, while negative correlations are captured for returns that move in different directions, however this turns to be valuable for the portfolio, as it potentially reduces overall portfolio risk. “Negative correlation is at the heart of balanced strategies, according to Jason Zhang, CFA, Portfolio Manager, SLGI Asset Management Inc.

Chart 2 below, illustrates the correlation of daily stock and bond returns over 60 business days and over 505 business days, between January 2002 and April 2023. Over the two-year periods, the correlation has been negative for the past 20 years, but it is not uncommon for it to turn positive over shorter time frames. Occasional shifts into positive correlation territory

are typically in response to economic shocks or surprises. More specifically, positive stock/bond correlations occur during supply-side economic shocks or when inflation exceeds central bank targets, prompting policymakers to adopt a more proactive monetary policy. The reason equity and bond returns are positively correlated under these circumstances requires an understanding of the two main variables that impact equity and bond prices: dividend cashflows and interest rates. ["Understanding the dynamics of stock/bond correlations", Vanguard]

Chart 2, Short and long-term stock and bond return correlation. Source: Vanguard



3.3.4 Excess Returns

Excess Return, also known as Alpha is considered a key metric for investors to evaluate the performance of their portfolios, investment strategies or individual securities. Essentially, excess returns refer to the return generated by a portfolio that exceeds either a risk-free rate of return or a benchmark. In other words, it gauges the performance of an investment relative to its projected or desired rate of return. The Excess Return formula involves subtracting the return of a risk-free rate of return, from the return on the investment:

$$Excess\ Return = R_i - R_f$$

where R_i is the return of the investment, while R_f represents the risk-free rate.

In general, excess returns posses a major role in the evaluation of the investment strategies, as they help understanding whether a strategy is delivering returns above what could be achieved with a risk-free asset or a relevant benchmark.

The **risk-free rate** denotes the return an investor anticipates from an investment that carries no risk, such as U.S. Treasury Bond. The reason that U.S. Treasurys are considered to be the guaranteed asset that investors can own, is because they are guaranteed by the federal government and the risk of a US government default is essentially nil.

According to E. Napoletano, ["The Risk-Free Rate", Forbes Advisor] U.S. Treasury bills, commonly referred to as T-bills, offer the shortest maturity debt securities issued by the federal government and are the closest investors can get to a zero-risk investment, for two reasons: As mentioned above, they are supported by the U.S. government's strong creditworthiness, which has never defaulted and additionally, the market for U.S. government debt is the most extensive and liquid worldwide. It is interesting to mention that the yield on a three-month T-bill is quoted as the day's risk-free rate for U.S. based investors.

The risk-free rate data for this dissertation has been collected by the Kenneth R. French Data Library and is typically derived from the returns on 1-month U.S. Treasury bills.

The formula to calculate Excess Return over a benchmark index is the following:

$$Excess\ Return = R_i - R_b$$

where R_b is the return of the benchmark rate. The most common benchmarks are the S&P 500 Index (used to reflect the U.S Stock Market), Russell 3000 Index (includes both large-cap and small-cap stocks) and Barclays U.S. Aggregate Bond Index (ideal for US investment-grade bonds).

Excess Return – CAPM

The CAPM (Capital Asset Pricing Model) formula shows that the excess return of an investment is proportional to the market risk premium, scaled by the investment beta (β_i), as shown below,

$$E(R_i) = R_f + \beta_i\big[E(R_m) - R_f\big] \quad or \quad E(R_i) - R_f = \beta_i\big[E(R_m) - R_f\big]$$

where $E(R_i) - R_f$ is the excess return of the investment, over the risk-free asset, $E(R_m) - R_f$ is the market risk premium -essentially the excess return of the market over the risk-free rate, while β_i represents the beta, which is typically the sensitivity of the investment's returns to the returns of the markets.

A fund's total performance on a risk-adjusted basis can be performed by using alpha (excess return) and beta (volatility risk).

Positive excess returns suggest that an investment has surpassed its anticipated results, while negative excess returns signify it has lagged behind the benchmark.

As an evaluation metric for portfolio performance, apart from benchmarking, excess returns may also be a vital indicator for investors to spot which components of their investments contribute more to the overall performance. Furthermore, in terms of active management evaluation, if an active manager generates positive excess returns, this implies that their decisions are adding value, otherwise it may show that their investment approach requires re-adjustment.

Table 4, Excess Returns in Different Financial Instruments, Source: Finance Strategists

FINANCIAL INSTRUMENT	POTENTIAL FOR EXCESS RETURN
Stocks	High-Risk Stocks, Particularly Those in Rapidly Growing Sectors, May Provide Significant Excess Returns
Bonds	Corporate Bonds Can Yield Excess Returns, Especially if the Issuing Company Performs Exceptionally Well
Mutual Funds	Well-Managed Mutual Fund Can Outperform Its Benchmark, Leading to an Excess Return for Investors
Exchange-Traded Funds (ETFs)	ETFs Tracking Specific Sectors or Themes Can Generate Excess Returns if Those Sectors or Themes Outperform the Market
Real Estate	Can Produce Excess Returns Through Increased Property Values or Higher-Than-Expected Rental Income

As shown on the Table 4 above, Excess Returns can be applied a range of financial products, including stocks, bonds, mutual funds, ETFs, Real Estate.

3.3.5 Key Metrics for Investment Strategy Performance Management

Total Return

Total Return is considered the most integrated measure of an investment's performance, as it takes into consideration capital gains, dividends, as well as interest income.

$$Total\ Return = \frac{(P_{end} - P_{start}) + D}{P_{start}}$$

where P_{start} : initial asset price, P_{end} : ending asset price and D: Dividends received during period.

Essentially, total return is the principal indicator for assessingportfolio performance, which is usually measured against a benchmark and gives a clear view of the investment's growth.

In order to compare investment performance over different time spans, it is necessary to compute the annualized returns.

Alpha

As discussed above, Alpha typically denotes the excess return of an investment relative to the return of a benchmark index. Alternatively, Alpha indicates how better or worse an investment (or strategy) has performed, compared to what would have been expected considering the given risk. A positive alpha suggests outperformance, on the other hand negative show underperformance. From investment strategies perspective, alpha is an indicator of a strategy's effectiveness, as a positive alpha implies that a strategy is beneficial for an investor, while negative alpha may suggest reconsideration of this strategy.

Standard Deviation

Volatility of an investment or a portfolio is measured by Standard Deviation, which reflects the total risk of the investment. In order to hedge risk and reduce volatility, a healthy portfolio practically contains a blend of high and low-volatility assets. The formula to calculate standard deviation is the following:

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{n}}$$

where μ: population average, x_i: individual population value and n: total number of populations. (Since this dissertation analyses data which represents an entire population, the formula concerns the population standard deviation)

Apparently, greater standard deviation usually suggests more significant price fluctuations or higher volatility relative to the average performance, while low volatility translates to more stable prices.

Beta

The beta (β_i) of an investment, which was mentioned briefly above, is a statistical risk metric that qualifies an investment's sensitivity to market movements.

$$\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)}$$

where β_i is the beta investment's beta, $Cov(R_i, R_m)$: the covariance between the returns of the investments R_i and market returns R_m, while $Var(R_m)$ is the variance of the market returns.

Beta is used mainly to measure the systematic risk of a particular asset in order to predict its returns relative to the market portfolio.

When $beta < 1$ it implies lower volatility, while $beta > 1$ higher volatility than the market. A beta value of 1 suggests that the investment tracks the market movements.

R-squared (R^2)

The coefficient of determination, or simply R^2 helps determine to which the portfolio's performance is influenced by changes in the benchmark.

$$R^2 = 1 - \frac{SSR}{SST} = 1 - \frac{\sum_i (R_{p,i} - \hat{R}_{p,i})^2}{\sum_i (R_{p,i} - \bar{R}_p)^2}$$

where SSR is the sum squared regression, SST is the total sum of squares. The approach above concern portfolio returns, where $R_{p,i}$is the actual portfolio return in period i, $\hat{R}_{p,i}$: predicted portfolio return, $\bar{R}_p$: mean of the actual portfolio returns.

From statistical point of view, it reflects the proportion of the variance, in a dependent variable (usually the returns of a portfolio) that can be clarified by the variance in an independent variable (typically the returns of a benchmark).

From regression's perspective, R^2 is a measure of how well the regression line approximates the actual data, thus it is an important tool that can be used when a statistical model is used in the testing of hypotheses.

In terms of evaluating mutual funds and ETFs' performance, R-squared provides an insight on how effectively market movements determine the portfolio's performance. Apparently, high R-squared (close to 1) implies that the portfolio returns are effectively influenced by market changes, leading to lower potential for diversification gain. Not surprisingly, a low R-squared value (close to to 0) shows lean correlation between the portfolio's returns with the benchmark index, which indicates greater diversification potential.

Sharpe Ratio

The Sharpe Ratio analyzes the return on an investment after adjusting for riks by considering excess return per volatility or more accurately by comparing the investment's return to the risk-free rate and by dividing it by its standard deviation.

$$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_i}$$

where σ_i is the standard deviation of the investment returns, R_p: portfolio investment returns, R_f: risk-free rate. Particularly, subtracting the risk-free rate R_f from the investment's return R_p gives the excess return which typically represents the additional return earned over what would have received with a risk-free investment. As usual, standard deviation σ_i measures the risk or volatility of the portfolio. So, the Sharpe Ratio is calculated by dividing the excess return by the standard deviation of the excess return.

A higher Sharpe Ratio implies better risk-adjusted performance. For instance, comparing two investments with same average returns, the investment with higher Sharpe Ratio is considered superior, since it achieved same return with less risk.

In general, this metric is widely used to compare different asset classes' performances, while its outcome can help investors to decide on which type of management (active or passive) suits better to their investment.

For the purpose of this study, Sharpe Ratio is used to compare and evaluate the performance of different investment strategies.

Sortino Ratio

In fact, Sortino Ratio is considered to be a modification of the Sharpe Ratio, as it focuses exclusively on downside volatility by comparing the performance relative to the downside deviation.

$$Sortino\ Ratio = \frac{R_p - R_f}{\sigma_d}$$

where R_p is the portfolio or investment return, R_f the risk-free rate if return and σ_d is the downside deviation, as it represents the standard deviation of losses.

According to Kent Thrune ["6 Metrics to Measure Portfolio Performance", Seeking Alpha], many investors prefer Sortino Ratio ignoring the risk that may arise from upside volatility (large price increases). Thus, for portfolios with high volatility the Sortino Ratio might be the most effective risk measure, whereas the Sharpe Ratio is preferable for those with lower volatility.

Tracking Error

Tracking Error is an indicator of how close an index ETF's performance is relative to its benchmark. In other words, it shows how much the excess returns oscillate around the portfolio's benchmark during a specific period. The formula below is used to calculate the tracking error:

$$Tracking\ Error = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(R_{p,i} - R_{b,i})^2}$$

where N: number of periods, $R_{p,i}$ the return of the portfolio in period *i* and $R_{b,i}$ the return of the benchmark in period *i*.

Tracking error is considered to be a measure of volatility. Compared to a high standard deviation which refers to the overall volatility, a large tracking error signifies that the returns of the investment are varying considerably from the benchmark.

Information Ratio (IR)

This is another performance metric, which represents the excess return over a benchmark, divided by a tracking error, or alternatively it measures how much excess return is being generated per unit of risk.

$$Information\ Ratio\ (IR) = \frac{Portfolio\ Return - Benchmark\ Return}{Tracking\ Error}$$

The difference between Information Ratio and Sharpe Ratio is that the second compares the risk-adjusted return in relation to the return of the risk-free rate, while the Information Ratio considers the relation to a benchmark.

Valuation metrics

Valuation metrics for assessing the value of an investment vary, depending on the type of asset they are evaluating and can be split into metrics for stocks and bonds. The following metrics that have been described in detail are considered to be the key valuation metrics and also have been employed in this study when testing the valuation strategy for investment.

For Stocks:

- **Price-to-Earnings ratio (P/E)** stands out as one of the most commonly employed metrics for valuing stocks and typically it is the most considerable factor that leads to investment decisions. The P/E ratio is computed by dividing the market value price per share by the company's earnings per share (EPS)

$$P/E\ Ratio = \frac{Market\ Price\ per\ Share}{Earnings\ per\ Share\ (EPS)}$$

Earnings per share (EPS) briefly depicts the company's net earnings divided by the number of shares; however it can be easily affected by one-time items, which might not illustrate the company's ongoing performance.

A high P/E ratio implies that a stock is overpriced and portends good news for the company's future growth, while a low P/E ratio suggests that a stock is undervalued and apparently it is not an encouraging signal for the company's growth potential.

- **Earnings Yield (E/P)** relates to the earnings per share (EPS) in a period, divided by the current share price and is the inverse of the P/E ratio.

$$E/P = \frac{Earnings\ per\ Share\ (EPS)}{Market\ Price\ per\ Share}$$

The earnings yield typically shows how much a shareholder has earned per share held and also provide a clear view on the yielding status of the shares, compared to other companies in the same industry.

Positive E/P translates to positive earnings and indicate a profitable company, and conversely negative earnings may characterize a currently unprofitable company with losses.

At this point, it is worth mentioning that a negative earnings yield, doesn't mean that an investment should automatically be excluded, but it essentially rings a bell for a careful analysis of the company's future prospects.

For Bonds:

- **Yield to Maturity (YTM)** is the expected annual rate of return earned on a bond, under the assumption that it is held until maturity.

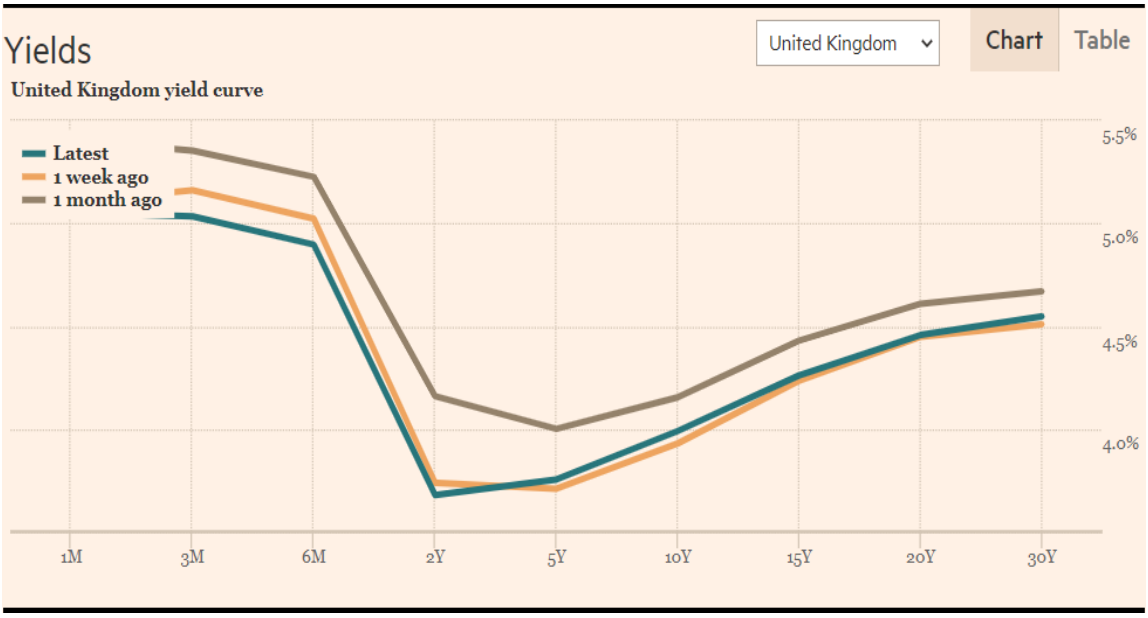
$$Yielt\ to\ Maturiy\ (YTM) = \frac{C + \frac{FV - PV}{n}}{\frac{FV + PV}{2}}$$

where C: Coupon Payment (is the periodic payment distributed by the bond issuer to the bondholders), FV: Face Value of the bond (the amount to be repaid to a bondholder on the date of maturity), PV: Present Value (current market price) and n: number of compounding periods.

From a bond investor's perspective YTM is the internal rate of return that matches the present value of a bond's future cashflows to its current price, assuming that the bond is held until maturity. Alternatively, we can say that YTM measures what should happen when an investor buys a bond (but often does not).

The chart below (Chart 1) represents a yield curve for United Kingdom Government Bonds, showing yields at different maturities, while yield curve is plotted for three different time periods (most recent data, 1 week ago, 1 month ago)

Chart 3, Yield curve for UK Government Bonds, Source: Financial Times



The chart displays how the yields have changed over time for different maturities, while yield curve indicates the way bond yields change in relation to their maturiy lenghts at different times.

At this point, it should be noted that most of the metrics analysed above have been employed on this dissertation. However, there are several more that haven't been mentioned, concerning either performance assess or valuation of both or stocks.

3.3 Strategies

This dissertation develops, employs, analyses and finally evaluates the following Investment Strategies on the twelve asset portfolio: **Momentum**, **Valuation** and a **Combined Strategy** (which contains a 50-50% mix of the above two), as presented in Table 5 below.

Table 5, Strategies that are employed for the portfolio of the twelve assets

Momentum	Valuation	Combination Strategy
1 month		50-50 strategy (Momentum + Valuation)
6-6 months		
12 months		

As per Table 5, momentum strategy is split into variations, including **1 month momentum**, a **6-6-month momentum** and **12 months momentum** strategies, while the Combined Strategy is essentially a mix between Momentum and valuation strategies.

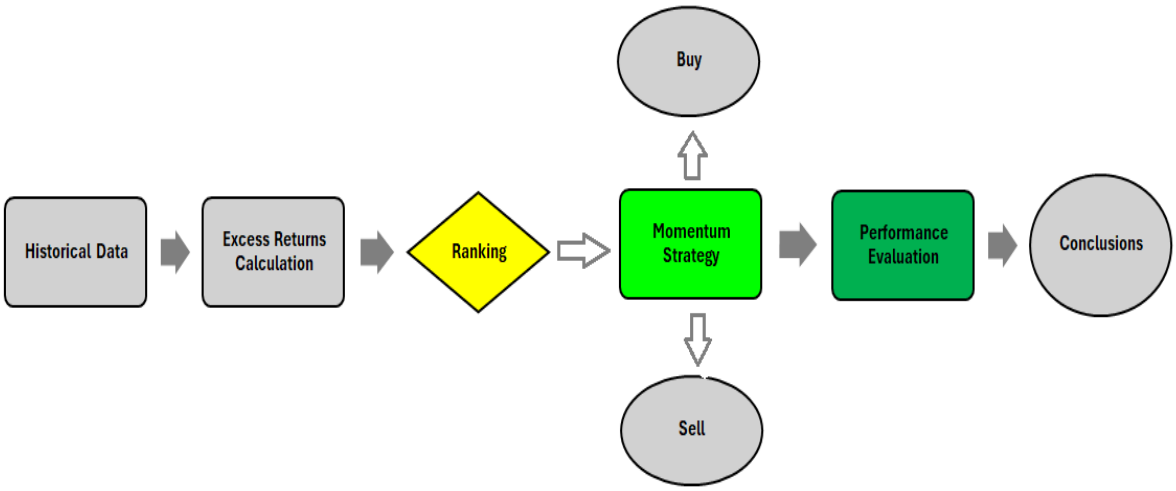
Momentum Strategy

The main concept of the Momentum Strategy is the assumption that the securities that have excelled in the near past, are predicted to continue their success in the future. Thus, Momentum Strategy suggests investors purchasing assets that have demonstrated an upward price trend, while selling (or avoiding) those that are trending downwards, with the belief that current market trends will persist. In fact, this strategy enhances the continuous capitalization of the existing trends in the market, by buying securities that are gaining, and selling that are losing.

The effectiveness requires the strategy to have a rather limited time range where it can be employed, which typically shouldn't exceed the 3 years, in order to avoid any overlapping phenomena with value strategies, while a short-term momentum strategy may last only a few days.

Historically, during strong trend periods momentum strategies have outperformed the market and conversely in periods of high volatility they can lead to inaccurate investment decisions that may bring significant loses.

Figure 1, the flow of the momentum strategy step-by-step



The development and employment of the momentum strategy, for the sample period February 2004 - December 2022, includes the following steps:

Historical Data refers to monthly historical prices of the stocks, and more specifically to the adjusted closing prices of the stocks. This stage includes a calculation of the monthly returns, using the formula provided in Chapter 3. At this point it should be noted that since the source for the government bonds provided directly the monthly returns, so there was no need to perform any calculation.

The **Excess Returns calculation** has been performed as said in previous chapter; by using the risk-free rate data from E. French and K. Fama Data Library and it depicts the returns on 1-month U.S. Treasury bills each month.

The **Ranking** process is a fundamental step for the momentum strategy and is closely related to the previous months' asset returns, since the recent performance of the assets determines the future investment decision to buy or sell. This step includes the ranking of the assets in an order, so that we can have a clear view on which marked the higher price returns

Momentum Strategy as mentioned precisely above involve buying assets that have performed well recently and selling the underperformed. For this thesis it was adopted to buy assets corresponding to the 6 top-performing assets of the previous month(s), while selling those that underperformed. After repeating this process monthly, we can proceed to the Momentum Strategy's **Performance Evaluation.**

By calculating the relevant metrics, and annualizing the values, in order to be comparable with all strategies, we can decide on whether momentum is beneficial for the investment portfolio.

1 month momentum

The 1m momentum strategy includes ranking the assets, based on their **previous month's** performance.

For example, for the sample period February 2004 – December 2022, the 1m strategy starts counting as from March 2004, as it requires the excess returns data from February 2004 to investigate asset performance.

Based on the asset ranking result for the previous month, the process for 1m momentum includes buying assets that marked higher returns for previous month (considering the top 6 performers), while selling the rest that underperformed (the rest 6 assets). For instance, when applying 1m momentum for March 2004, this will add returns of the top 6 assets that overperformed previous month, while subtracting the other 6 assets' performance.

This process will be occurred on a monthly basis, until the end of the sample period (Dec 2022), generating monthly returns for our 12-asset portfolio.

6-6month momentum

The 6-6 m momentum strategy takes into consideration the returns from the previous 6 months performance. Thus, it is required to calculate first the average excess returns, from the previous 6 months for each asset. For example, for the given sample period, the 6-6m momentum can be employed no earlier than Aug 2004, as the performance ranking goes back to Feb 2004, covering 6 months trending period.

As expected, the 6 month-returns ranking of the twelve assets will lead to the consideration of the top 6 performers for the previous 6 months, while subtracting the returns of the remaining 6 assets. This is how the 6-6 m process generates returns monthly, starting as from August 2004, ending in December 2022.

12month momentum

Similarly, the 12m momentum ranking takes into consideration the previous year asset returns. For the calculation of the current month's 12m momentum return, we add the current returns of the assets that recorded the higher performance on the previous year, while subtracting returns of the remaing assets for the current month.

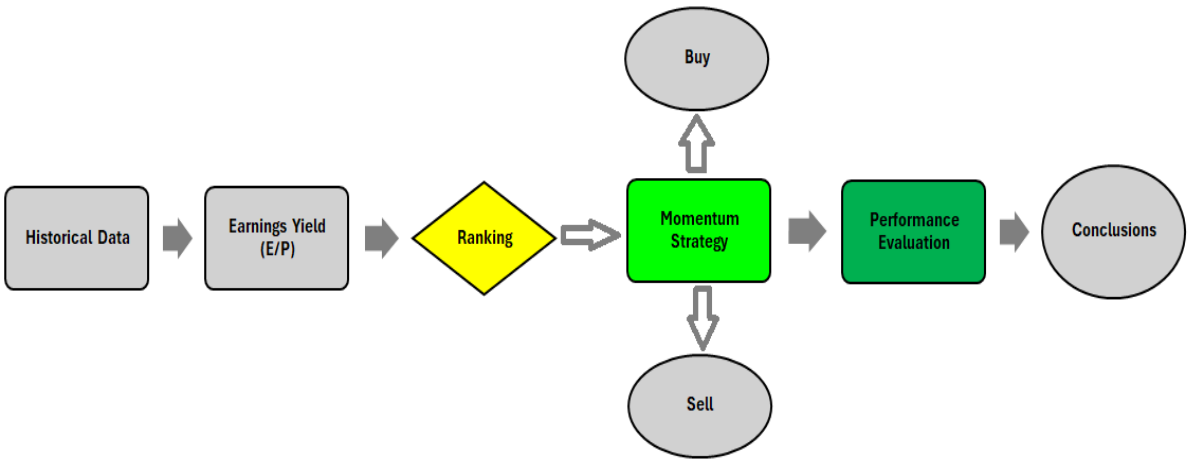
This process similarly generates monthly returns for the 12-asset portfolio, based on the the assets' returns ranking for the previous year, starting as from Feb 2005, moving forward on a monthly basis until the sample perio concludes.

Valuation Strategy

The valuation strategy apparently uses the scores of the valuation metrics to conclude which asset returns should contribute positively and which should be subtracted from the calculation of the 12-asset portfolio's monthly return.

Particularly, for stocks the earnings yield (E/P) metric provides a clear view on the yielding status of the shares, compared to other companies in the same industry, while yield to maturity (YTM) metric is used for the portfolio's bonds valuation. Essentially, as per Figure 2, the only change is that the asset ranking for this strategy is based on asset valuation, not performance metrics scores.

Figure 2, the flow of the valuation strategy



After sorting and ranking assets considering their valuation scores of the previous month, for the portfolio's monthly return calculation, the valuation strategy suggests that we add the excess returns of 6 assets that recorded the highest valuation scores in the previous month, while remaining 6 assets' excess returns contribute negatively. This process is performed

monthly, providing monthly average returns scores for the portfolio, starting as from March 2004 until December 2022.

"50-50" Combination Strategy

This strategy is a combination of both Momentum and Valuation strategies, and more specifically each strategy contributes 50%.

Since this dissertation studies the performance of three different variations of the momentum strategy (1m, 6-6m and 12m), the weights for the combined strategy are distributed as illustrated in Table 6 below,

Table 6, weghts of each strategy contributing to the "50-50" combined strategy

Weights	
Strategies	
1m momentum	16.67%
6-6m momentum	16.67%
12 m momentum	16.66%
Valuation	50%
Total Weights	**100.00%**

It should be noted, the total sum of the weights must equal to 100%.

By putting together, monthly returns of the 12-asset portfolio, as they are generated by momentum and valuation strategies, the 50-50 Combined Strategy generates monthly returns based on the formula below:

16.67%*(1m) + 16.67%*(6-6m) + 16.66%*(12-1m) + 50%*(valuation)

The formula indicates each strategy's contribution to the combination strategy. Depending on the weights, the total sum of the contributions of the momentum strategy variations is 50%, while the total contribiution of both momentum and valuation strategies is 100%.

Since starting date each of the strategies generates portfolio returns varies, for example 1m momentum starts as from March 2004, while the 12m strategy is valid as from February

2005, the Combination Strategy is valid as from January 2005 when all the other strategies generate monthly returns.

CHAPTER 4 MAIN RESULTS – DISCUSSION

After introducing the methodologies and the theoretical concepts of momentum and variation strategies in previous chapter,the Chapter 4 presents the main findings of employing both strategies, discusses the performance evaluation of each strategy and compares the results with those of a theoritical optimal risky strategy.

4.1 Comparison of strategies

This section includes the comparison and the identification of the strengths and weaknesses of each strategy. By evaluating key performance metrics, such as mean returns, volatility, alpha, beta, R-squared, risk-adjusted performance (measured by the sharpe ratio) and finally by providing the cumulative returns chart we aim to provide a complete overview of the long-term effectiveness, risk and performance of the strategies.

Momentum Strategies

- **1m momentum**

Table 7, Key performance metrics for the 1m momentum strategy

Mean Return	-0.26%
Annualized Mean Return	-3.13%
Standard Deviation	2.19%
Annualized Standard Deviation	7.57%
Sharpe Ratio	-0.12
Annualized Sharpe Ratio	-0.42

The 1m momentum strategy has a negative mean return of -0.26% over the sample period (Feb 2004 – Dec 2022), indicating that this strategy was not profitable, as on average, it recorded losses of 0.26%. The annualized mean return of -3.13% (losses of 3.13% per year)

translates to the strategy's underperformance over the year. The volatility of 2.19% is moderate, while the annualized standard deviation of 7.57% indicates that while strategy recorded losses, it also had a degree of volatility over the year.

Apparently, the negative Sharpe Ratio of -0.12 implies that the strategy's returns were less than the risk-free rate resulting a loss when adjusted for risk, while the annualized Sharpe Ratio of -0.42 further emphasizes the poor risk-adjusted performance of the 1m strategy on an annual basis. Alternatively, we can say that over the course of a year, the strategy not only lost money, but also did in a away that was not hedged by a higher yield for the level of risk undertaken.

Table 8, regression analysis for 1m strategy

Regression Statistics	
Multiple R	0.12
R Square	0.01
Adjusted R Square	0.01
Standard Error	2.18%
Observations	226

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.001429361	0.001429	3.00611	0.084327
Residual	224	0.106508754	0.000475		
Total	225	0.107938115			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.22%	0.001468903	-1.527	0.13	-0.00514	0.00065	-0.005	0.0007
Mkt-RF	-5.64%	0.032538661	-1.73381	0.08	-0.12054	0.00771	-0.121	0.0077

The Table 8 represents the output of a linear regression analysis. The most essential conclusions that can be extracted by this table concern R-squared, the Alpha and Beta. The R-sqared represents the amount of variability in the dependent variable (the strategy returns) that is attributable to the independent variable (the market returns). The very low R-squared indicates that only 0.01 or 1% of the variance is explained by the markets. Since the intercept (alpha) is -0.22% and the coefficient for Mkt-Rf (beta) is -5.64%, with p-values 0.13 and 0.08 respectively, this suggests that neither is statistically significant at the 5% level.

- **6-6m momentum**

Table 9, Key performance metrics for the 6-6m momentum strategy

Mean Return	0.06%
Annualized Mean Return	0.67%
Standard Deviation	2.27%
Annualized Standard Deviation	7.86%
Sharpe Ratio	0.02
Annualized Sharpe Ratio	0.08

The low mean return of the 6-6m momentum strategy indicates that it recorded small positive returns 0.06%, on average over the sample period, while the annualized mean return of 0.67% shows that indeed the strategy did not provide substantial gains over the year. In terms of the volatility, we can say that it remains in a satisfying low level. The very close to zero Sharpe Ratio of 0.02 implies that the return was almost negligible when adjusted for risk. Athough the strategy may provide some positive returns, these returns were not sufficient, given the amount of risk incurred.

Table 10, regression analysis for 6-6m strategy

Regression Statistics	
Multiple R	0.00793
R Square	6.29E-05
Adjusted R Square	-0.0045
Standard Error	2.28%
Observations	221

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.15244E-06	7.15244E-06	0.013772	0.90668664
Residual	219	0.113736152	0.000519343		
Total	220	0.113743304			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.06%	0.001554063	0.376863818	0.71	-0.00247716	0.003649	-0.0024772	0.0036485
Mkt-RF	-0.40%	0.034140157	-0.117354572	0.91	-0.07129181	0.063279	-0.0712918	0.0632788

From the regression analysis, 6-6m strategy appear to have a very low R-squared, almost close to zero, which indicates that the market explains **none** of the strategy's returns. On the other hand, the intercept (alpha) which is -0.06% and beta which is -0.40%, with p-values 0.71 and 0.91 respectively, are not statistically significant, since the observed values do not seem to represent a true characteristic of the strategy. This practically proves that the strategy's performance is not well-explained by market movements (beta) and any excess returns, refering to alpha are likely not reliable.

- **12-1 m momentum**

Table 11, Key performance metrics for the 1m momentum strategy

Mean Return	0.06%
Annualized Mean Return	0.76%
Standard Deviation	2.22%
Annualized Standard Deviation	7.69%
Sharpe Ratio	0.03
Annualized Sharpe Ratio	0.10

Table 12, regression analysis for 12m strategy

Regression Statistics	
Multiple R	0.07781112
R Square	0.01
Adjusted R Square	0.00138816
Standard Error	2.22%
Observations	215

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00064161	0.00064161	1.297479	0.255954
Residual	213	0.105329569	0.000494505		
Total	214	0.105971179			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.09%	0.0015361	0.593064497	0.55	-0.002117	0.0039389	-0.00212	0.003939
Mkt-RF	-3.81%	0.033447597	-1.13906944	0.26	-0.10403	0.0278316	-0.10403	0.027832

Except for the Sharpe Ratio which appears to be slightly better than the respective rate of the 6-6m momentum and the volatility, which is almost negligibly lower, compared to 6-6m momentum, the other key performance metrics in Table 11, along with regression analysis in Table 12 do not appear to have significant differences with those for 6-6m momentum strategy.

- **Valuation Strategy**

Table 13, Key performance metrics for the valuation strategy

Mean Return	0.13%
Annualized Mean Return	1.62%
Standard Deviation	1.97%
Annualized Standard Deviation	6.82%
Sharpe Ratio	0.07
Annualized Sharpe Ratio	0.24

The 0.13% mean return suggests that the valuation strategy yields small gains in each period, while the 1.62% annualized return is modest, indicating that the strategy is not very aggressive, but afterall it records gains. The volatility degree, compared to previous momentum strategies appears lower, indicating that the valuation strategy is more stable over a year. Although that the Sharpe Ratio appears to be significantly higher than the momentum strategies, it is still considered low implying that the strategy is not delivering a strong risk-adjiusted return.

Table 14, regression analysis for valuation strategy

Regression Statistics	
Multiple R	0.0035072
R Square	1.23E-05
Adjusted R Square	-0.004452
Standard Error	0.0197885
Observations	226

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.07897E-06	1.08E-06	0.0027554	0.9581836
Residual	224	0.087714688	0.000392		
Total	225	0.087715767			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.14%	0.00133302	1.01304	0.31	-0.0012765	0.0039773	-0.001276	0.003977
Mkt-RF	-0.16%	0.029528623	-0.05249	0.96	-0.0597394	0.0566394	-0.059739	0.056639

Same situation regarding statistical significance between alpha and beta, as above, while the very small R-squaredmean that the benchmark used to explain performance may not be appropriate for evaluating the strategy.

- **"50-50" Combination Strategy**

Table 15, Key performance metrics for the "50-50" Combination strategy

Mean Return	0.04%
Annualized Mean Return	0.46%
Standard Deviation	1.33%
Annualized Standard Deviation	4.62%
Sharpe Ratio	0.03
Annualized Sharpe Ratio	0.10

The mean returns of 0.04% and the annualized of 0.46% indicate small gains for the combination strategy, but not in significant degree. Compared to previous strategies, the combination strategy has a very small degree of risk (low volatility of 4.62 on a yearly basis) which shows that this strategy is significantly stable.

Table 16, regression analysis for valuation strategy

Regression Statistics	
Multiple R	0.05476727
R Square	0.003
Adjusted R Square	-0.0016813
Standard Error	1.34%
Observations	215

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00011486	0.00011486	0.640806	0.4243112
Residual	213	0.03817814	0.00017924		
Total	214	0.038293			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.05%	0.00092481	0.53643964	0.59	-0.001327	0.0023191	-0.00133	0.0023191
Mkt-RF	-1.61%	0.02013711	-0.8005034	0.42	-0.055813	0.0235737	-0.05581	0.0235737

As shown in Table 16, nothing changes significantly for the regression analysis.

Covariance and Correlation between the strategies

As explained in Chapter 3, covariance matrix provides a scale of the relationships between the strategies, in other words how much the strategies change together, while correlation matrix standardizes the covariances by the standard deviations of the variables.

Table 17, Covariance matrix between momentum and valuation strategies

COVARIANCE MATRIX				
	1m momentum	**6-6m momentum**	**12m momentum**	**Valuation Strategy**
1m momentum	0.000551	0.000159	0.000088	0.000029
6-6m momentum	0.000159	0.000678	0.000479	0.000053
12m momentum	0.000088	0.000479	0.000727	-0.000005
Valuation Strategy	0.000029	0.000053	-0.000005	0.000396

The small covariance values between strategies on the Table 17 above show that the strategies have very low linear relationship in their returns and their shifts are significantly independent of each other. The negative value of the covariance between Valuation and the 12m momentum strategies imply that the strategies move in opposite directions. From diversification's perspective this turns to be useful, as blending strategies with negative covariance may lower the risk for our portfolio.

The correlation matrix on the other hand reflects the strength of the linear relationship between pairs of strategies.

Table 18, Correlation matrix between momentum and valuation strategies

CORRELATION MATRIX				
	1m momentum	**6-6m momentum**	**12m momentum**	**Valuation Strategy**
1m momentum	1	0.263409	0.152460	0.078811
6-6m momentum	0.263409	1	0.558449	0.091588
12m momentum	0.152460	0.558449	1	-0.001706
Valuation Strategy	0.078811	0.091588	-0.001706	1

The correlation values above indicate a weak positive relationship between strategies, which practically means that strategies have a slight tendency to move similarly. In contrast, the negative correlation between Valuation and 12m momentum strategy imply that when the

first performs well, the other strategy is likely to underperform. Not surprisingly, again the negative correlation may hedge the overal portfolio risk, since it balances out the effects of volatility between the strategies.

4.2 Optimal Risky Portfolio

The optimal risky portfolio reflects the best blend of strategies that optimizes expected return for a specified level of risk. This can determine how an investor can allocate capital between momentum and valuation strategies to achieve maximum gains.

The process of finding the optimal risky strategy requires to split the sample period in two phases. The In-Sample Period (Feb 2004 – Jan 2013) and the Out-of-Sample Period (Feb 2013 - Dec 2022). The main concept for this is to see how the "50-50" Combined Strategy performs throughout In-Sample-Period, and after having a clear view to apply rules and functions, using the "Solver"function in the file to maximize the Sharpe Ratio. As said, a high Sharpe Ratio shows that an investment achieves better return relative to the amount of risk assumed, so by maximizing this rate and setting the relative parameters, "Solver" function returns the relevant strategies weights, for which the overal portfolio achieves maximum performance.

Table 19, weights for the optimal risky strategy

Weights	
1m	0.00%
6-6m	0.00%
12m	20.86%
valuation	79.14%

At this point, before we conclude that the above weights represent the optimal portfolio strategy, we must test the performance of this new strategy during the out-of-sample period, recording it and comparing with the in-sample-period.

The findings show that the performance of this new strategy over the out-of-sample period is slightly better that it used to be during the in-sample-period, as shown in the Table 20 below,

Table 20, performance over the In-sample and Out-of-sample period

	In-Sample-Period	Out-of-Sample Period
Mean Return	0.12%	0.18%
Standard Deviation	1.67%	1.59%
Sharpe Ratio	0.07	0.12

This implies that this combination of momentum and valuation strategies composes the **Optimal Risky Strategy**, providing the highest possible Sharpe Ratio.

Table 21, Key performance metrics for the optimal risky portfolio

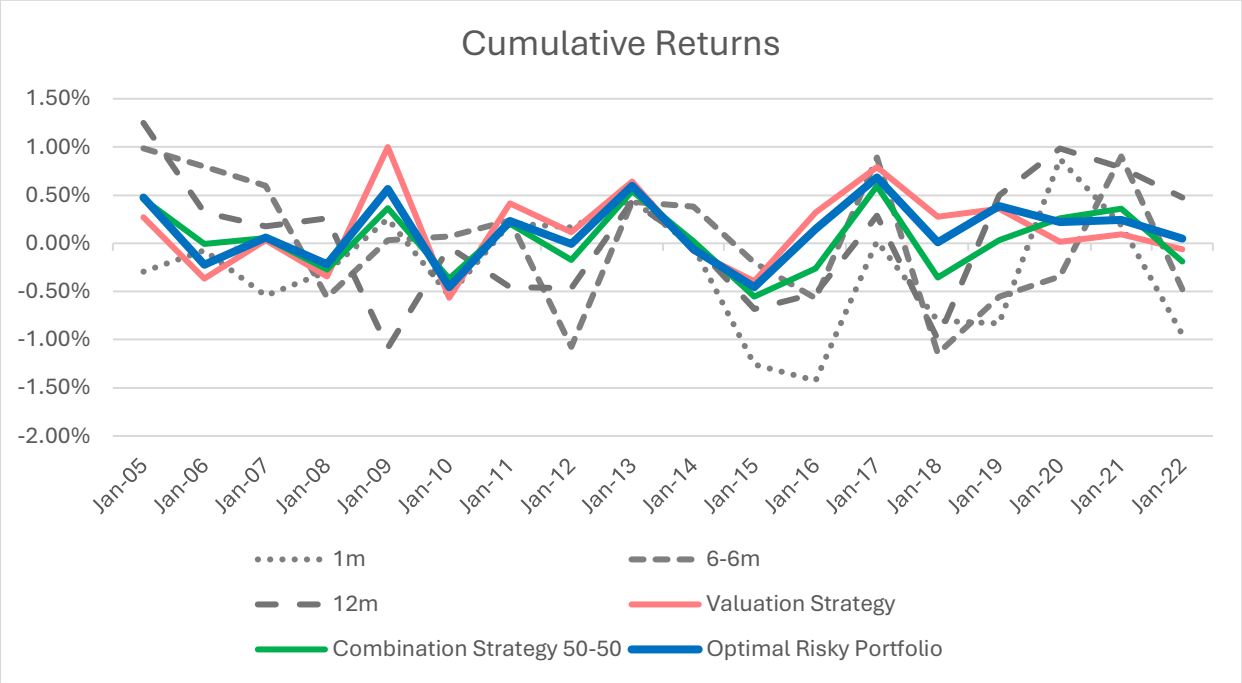
Mean Return	0.12%
Annualized Mean Return	1.49%
Standard Deviation	1.62%
Annualized Standard Deviation	5.63%
Sharpe Ratio	0.08
Annualized Sharpe Ratio	0.26

At this point it would be interesting to compare the cumulative returns of each strategy, employed to our portfolio.

Table 21, Total annual returns for each strategy

	1m	6-6m	12m	Valuation Strategy	Combination Strategy 50-50	Optimal Risky Portfolio
Dec-05	-0.30%	0.99%	1.25%	0.27%	0.46%	0.47%
Dec-06	-0.07%	0.80%	0.32%	-0.37%	-0.01%	-0.22%
Dec-07	-0.55%	0.60%	0.18%	0.03%	0.05%	0.06%
Dec-08	-0.29%	-0.56%	0.26%	-0.35%	-0.27%	-0.22%
Dec-09	0.25%	0.03%	-1.08%	1.00%	0.37%	0.56%
Dec-10	-0.55%	0.07%	-0.04%	-0.57%	-0.37%	-0.46%
Dec-11	0.21%	0.24%	-0.45%	0.41%	0.21%	0.23%
Dec-12	0.16%	-1.08%	-0.46%	0.11%	-0.17%	-0.01%
Dec-13	0.45%	0.43%	0.44%	0.64%	0.54%	0.60%
Dec-14	-0.03%	0.38%	0.00%	-0.08%	0.02%	-0.06%
Dec-15	-1.26%	-0.20%	-0.68%	-0.39%	-0.55%	-0.45%
Dec-16	-1.43%	-0.57%	-0.52%	0.32%	-0.26%	0.15%
Dec-17	0.02%	0.89%	0.29%	0.79%	0.59%	0.68%
Dec-18	-0.81%	-1.14%	-1.00%	0.27%	-0.35%	0.01%
Dec-19	-0.83%	-0.55%	0.50%	0.36%	0.03%	0.39%
Dec-20	0.88%	-0.34%	0.99%	0.02%	0.26%	0.22%
Dec-21	0.19%	0.90%	0.79%	0.10%	0.36%	0.24%
Dec-22	-0.95%	-0.48%	0.48%	-0.06%	-0.19%	0.05%

Chart 4, Cumulative Returns for different investment strategies



The cumulative return chart above includes the total returns of the momentum strategies (1m, 6-6m and 12m), valuation, along with the "50-50" combination strategy of both and the optimal risky strategy returns alike. It should be noted that the steep trajectory, for the valuation strategy's curve, indicates strong performance, while smoother line for the combined strategy shows more stable returns and lower volatility, which practicly means less risk exposure. Not surprisingly the valuation strategy's line is consistently above the combined strategy's line, which indicates the higher annual mean returns of the valuation strategy, however the frequent sharp updas and downs of its curve capture the higher volatility of this strategy.

CONCLUSIONS

This dissertation provides an analysis of multi asset strategies for investments.

The high importance of portfolio diversification is emphasized throughout this study, as different asset classes, low correlated create a more stable portfolio, resistant to risk that composes a continuous changing economic environment. From an investor's perspective, factors such as risk tolerance along with the investment time horizon, may compose an investor's profile. Depending on the goals and expectations that an investor has set as a priority, portfolio construction turns to be a rather challenging task.

The primary objective of this study was to analyze and compare different investment strategies on a multi-asset portfolio for a sample period of almost twenty years.

Each strategy's pros and cons are analyzed systematically leaving space for thoughts and curiosity to explore different asset blends for new portfolios, or employment of different strategies.

It wouldn't be wise if we spontaneously say that the most beneficial strategy is the valuation or the momentum, because we need to take seriously into consideration the investor's expectations. For example a promising strategy that records a high return performance over the last decade, but appears to be sensitive to geopolitical conditions which indicate high volatility, may not be a good choice for a conservative investor's profile who wishes to hold a stable portfolio, ignoring the high gains.

REFERENCES

Admati, AR. (1985) ‘A noisy rational expectations equilibrium for multi-asset securities markets’, Econometrica: Journal of the Econometric Society, Vol. 53, pp. 629-658

Alexander, C. and Venkatramanan, A. (2012) ‘Analytic Approximations for Multi-Asset Option Pricing’, Mathematical Finance, Vol. 22, Iss. 4, pp. 667-689, https://doi.org/10.1111/j.1467-9965.2011.00481.x

Asness, C.S. (1997) ‘The interaction of value and momentum strategies’, Financial Analyst Journal, Vol. 53, pp. 29-36

Asness, C.S. (1997), ‘The interaction of Value and Momentum Strategies’, Financial Analyst Journal, Vol. 53, pp. 29-36

Azmi, W., Anwer, Z., Azmi, SN. and Nobanee, H. (2023) ‘How did major global asset classes respond to Silicon Valley Bank failure?’, Finance Research Letters, Vol. 56 https://doi.org/10.1016/j.frl.2023.104123

Baresa, S., Bogdan, S. and Ivanovic, Z. (2013) ‘Strategy of stock valuation by fundamental analysis’, UTMS Journal of Economics, https://hdl.handle.net/10419/105304

Bendall, H. and Stent, A.F. (2003) ‘Investment strategies in market uncertainty’, Maritime Policy & Management, Vol. 30

Bendoly, E. and Rosenzweig, ED. (2007) ‘Performance metric portfolios: a framework and empirical analysis’, Production and Operations Management, Vol. 16, Iss. 2, https://doi.org/10.1111/j.1937-5956.2007.tb00179.x

Bernstein, S., Lerner, J. and Schoar, A. (2013) ‘The Investment strategies of sovereign wealth funds’, Journal of Economic Perspectives, Vol. 27, No.2, pp.219-38

Bessler, W., Opfer, H. and Wolff, D. (2017) ‘Multi-asset portfolio optimization and out-of-sample performance: an evaluation of Black–Litterman, mean-variance, and naïve diversification approaches’, The European Journal of Finance, Vol. 23, pp. 1-30, Taylor & Francis Online

Blitz, D. and P. Van Vliet (2008) ‘Global Tactical Cross-Asset Allocation: Applying Value and Momentum Across Asset Classes’, The Journal of Portfolio Management, 23-28

Blitz, D., Pang, J. and P. Van Vliet (2013) ‘The Vol. atility effect in emerging markets’, Emerging Markets Review 16, pp. 31-45

Block, SB. and French, DW. (2002) ‘The effect of portfolio weighting on investment performance evaluation: The case of actively managed mutual funds’, Journal of Economics and Finance, Vol. 26, pp. 16-30

Chan, LKC. And Jagadeesh, N. (1999) ‘The profitability of momentum strategies’, Financial Analysis Journal, Vol. 55, pp. 80-90

Chan, LKC. And Jegadeesh, N. (1996) ‘The Journal of Finance’, Wiley Online Library, Vol. 51,pp. 1681-1713

Chen, Z. and Knez, PJ. (1996), ‘Portfolio performance measurement: Theory and applications’, The Review of Financial Studies, Vol. 9, Iss. 2, pp. 511-555, https://doi.org/10.1093/rfs/9.2.511

Cooper, I., Mitrache, A. and Priestley,R. (2022) ‘A global macroeconomic risk model for value, momentum, and other asset classes’, Journal of Financial and Quantitative Analysis, Cambridge University Press

Cox, J.C. and Leland, H. (2000) ‘On dynamic investment strategies’, Journal of Economic Dynamics and Control, Vol. 24, pp.1859-1880

Day, G. and Fahey, L. (1988) ‘Valuing market strategies’, Journal of Marketing, Vol. 52, Iss. 3, https://doi.org/10.1177/002224298805200305

Deelstra, G., Grasselli, M. and Koehl, PF. (2003) ‘Optimal investment strategies in the presence of a minimum guarantee’, Incurance: Mathematics and Economics, Vol. 33, pp. 189-207

Dzikevičius, A. and Vetrov, J. (2012) ‘Analysis of asset classes through the business cycle’, Business, Management and Education, pp. 10

Fama, E and French, K. (2015) ‘A five-factor asset pricing model’, Journal of Financial Economics, Vol. 116, pp. 1-22

Fama, E. and French, K. (1996) ‘Multifactor Explanations of Asset Pricing Anomalies’, The Journal of Finance, Vol. 51, pp. 55-84

Fama, EF. (1972) ‘Components of investment performance’, The Journal of finance, Vol. 27, No. 3, pp. 551-567

Feibel, BJ. (2003) ‘Investment performance measurement’, John Wiley & Sons, Ltd

Financial Times, ‘Bonds’, Data retrieved from: https://markets.ft.com/data/bonds

Fraser-Sampson, G. (2006) ‘Multi asset class investment strategy’, John Wiley & Sons, Ltd

Garcia-Feijoo, L. and Jensen, GR. (2012) ‘The effectiveness of asset classes in hedging risk’, Journal of Portfolio, Vol. 38, London

Garvin, MJ. and Cheah, CYJ (2004) ‘Valuation techniques for infrastructure investment decisions’, Construction management and economics, Vol. 22, Iss. 4, pp. 373-383

Glantz, M. and Kissell, R. (2013) ‘Multi-asset risk modeling: techniques for a global economy in an electronic and algorithmic trading era’, Academic Press

Griffin, JM., Ji, S. and Martin, JS. (2004) ‘Global momentum strategies: A portfolio perspective’, Available at SSRN 492804

Khoroshilov, Y. (2012) ‘Momentum trading strategy and investment horizon: an experimental study’, Journal of Economic Studies, Vol. 39, No.1, pp. 4-12 https://doi.org/10.1108/01443581211192071

Klement, J. (2020) ‘Improving Momentum Strategies’, Available on website: https://klementoninvesting.substack.com/p/improving-momentum-strategies

Kumar, V. (2018) ‘A theory of customer valuation: Concepts, metrics, strategy, and implementation’, Journal of Marketing, Vol. 82, Iss. 1, https://doi.org/10.1509/jm.17.0208

Lapierre, J., Filiatrault, P. and Chebat, JC. (1999) ‘Value Strategy rather than quality strategy: A case of business-to business professional services’, Journal of Business Research, Vol. 45, Iss. 2, pp. 235-246

Li, M., Zhou, J. and Deng, SJ. (2010) ‘Multi-asset spread option pricing and hedging’, Quantitative Finance, Vol. 10, pp. 305-324, https://doi.org/10.1080/14697680802626323

Litman, J. and Frigo, ML (2004) ‘When Strategy and Valuation Meet’, Strategic Finance, Montvale, Vol. 86, Iss. 2, pp. 30-39

Meng, R. (2008) ‘A patent race in a real options setting: Investment strategy, valuation, CAPM beta, and return Vol. atility’, Journal of Economic Dynamics and Control, Vol. 32, Iss. 10, pp. 3192-3217

Meucci, A. (2005) ‘Risk and asset allocation’, Springer

Minas, N., (2022) ‘Modern Investment Strategies of Hedge Funds’, https://dione.lib.unipi.gr/xmlui/handle/unipi/14690

Mudambi, R. (1998) ‘The role of duration in multinational investment strategies’, Journal of International Business Studies, Springer, Vol. 29, pp. 239-261

Napoletano, E. (2022) ‘The Risk-Free Rate, Forbes Advisor’, Available on website: https://www.forbes.com/advisor/investing/risk-free-rate/

Perold, A.F. and Sharpe, W.F. (1995) ‘Dynamic strategies for asset allocation’, Financial Analysts Journal, Vol. 51, pp. 149-160

Sabri, SRM. And Sarsour, WM. (2019) ‘Modelling on stock investment valuation for long-term strategy’, Journal of Investment and Management, doi: 10.11648/j.jim.20190803.11

Samarakoon, LP. And Hasan, T. (2005), ‘Portfolio performance evaluation’, The Encyclopedia Of Finance, C.F. Lee, ed., Springer, pp. 617-622

Schneeweis, T., Crowder, GB. and Kazemi, HB. (2010) ‘The new science of asset allocation: risk management in a multi-asset world’, John Wiley & Sons, Ltd

Sharpe W.F. (1992) ‘Asset allocation: Management style and performance measurement’, Journal of portfolio Management, pp. 7-19

Sharpe, W.F. (1987) ‘Integrated asset allocation’, Financial Analyst Journal, Vol. 43, pp.25-32, https://doi.org/10.2469/faj.v43.n5.25

Soni, R. (2017) ‘Designing a portfolio based on risk and return of various asset classes’, International Journal of Economics and Finance, Vol. 9, No. 2, : http://dx.doi.org/10.5539/ijef.v9n2p142

Su, C. (2021) ‘A comprehensive investigation into style momentum strategies in China’ Financial Markets and Portfolio, Springer, Vol. 35, pp. 101-144

Teisberg, E.O (1993), ‘Capital Investment strategies under uncertain regulation’, The RAND Journal of Economics, Vol. 24, No.4, pp. 591-604

Ter Ellen, S., Hommes, CH. and Zwinkels, RCJ. (2021) ‘Comparing behavioural heterogeneity across asset classes’, Journal of Economic Behavior & Organization, Vol. 185, pp. 747-769

Tsopeis, E., (2023) ‘Pension Funds’ Investment and Economic Growth’, https://dione.lib.unipi.gr/xmlui/handle/unipi/15786

Zervos, M. Johnson, T.C. and Alazemi, F. (2013) ‘Buy-low and sell-high investment strategies’, Wiley Online Library, Vol. 23, pp.560-578 https://doi.org/10.1111/j.1467-9965.2011.00508.x