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ECONOMICS &  
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**MASTER**  
MATHEMATICAL FINANCE

**MASTER'S FINAL WORK**  
PROJECT

UK PENSION FUNDS: FUND PORTFOLIO  
PERFORMANCE ANALYSIS

MARIANA FLOR EIRAS SOARES

NOVEMBER- 2020

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**SUPERVISION:**

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## Abstract

In the UK, individuals receive a pension after their retirement or their spouse's death. This pension can be provided by the state, but one of the most common cases is that people will receive it from their occupational pension fund (in result of their work path). This type of pension is sponsored by the employer and it accumulates benefits that will generate the income of a person after their retirement. To fund the pensions of the employees, employers need to create investment portfolios, that include different funds and asset classes (some seek higher growth while assuming higher risk, and others seek guaranteed, but lower returns). To monitor the performance of these portfolios and understand if the management is being done efficiently, one needs to take into consideration: risk management, asset allocation and selection decisions. For this effect, we use the attribution analysis method, which tells us the value that has been added to the portfolio by the active management decisions. In a period of pandemic, that affected the financial markets considerably, the study practiced in this project, aims to understand what was the impact of the situation in four different portfolios, with different investment strategies, and mainly to study the different positions that were assumed by the different managers, in order to keep the portfolios stability after the rough market crash that came with the economic shutdown in the beginning of 2020.

**Keywords:** Pension funds, Defined Benefit schemes, asset allocation, managers, benchmarks, excess returns, risk.

## Resumo

No Reino Unido, indivíduos recebem uma pensão depois da sua reforma, ou se se der o falecimento de sua/seu esposa/o. Esta pensão pode ser oferecida pelo estado, mas um dos casos mais comuns é; as pessoas recebem-na do seu fundo de pensão ocupacional (derivado do seu caminho de trabalho). Este tipo de pensão é fornecido pelo empregador e acumula benefícios que irão gerar o salário do empregado depois da sua reforma. Para financiar as pensões, os empregadores devem criar um portfólio de investimento destinado para o mesmo, que inclui diversos fundos e classes de ativos (alguns que pretendem gerar maiores retornos, assumindo maiores riscos, e outros que pretendem gerar retornos seguros, mas mais baixos). De modo a monitorizar o desempenho destes fundos, com o fim de entender se está a ser feita uma gestão adequada dos mesmos, é necessário ter em conta os seguintes fatores: gestão de risco, alocação dentro das diferentes classes de fundos e seleção de fundos. Para este efeito é utilizado o método de análise de atribuição, que nos diz o valor que foi adicionado ao portfólio proveniente das decisões do gestor. No atual período de pandemia, que afetou os mercados financeiros de forma considerável, o estudo desenvolvido neste projeto, visa perceber qual foi o impacto desta situação em quatro portfólios diferentes, com diferentes estratégias de investimento, e maioritariamente estudar as diferentes posições que foram assumidas pelos diferentes gestores, com o objetivo de manter a estabilidade do desempenho dos portfólios depois da grande queda dos mercados que se deu com o fecho da economia no início de 2020.

**Palavras-chave:** Fundos de pensão, Esquemas de benefício definido, alocação de fundos, gestores, *benchmarks*, excesso de retornos, risco.

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## List of Abbreviations

<b>BM</b>	Benchmark
<b>CS</b>	Client Specific
<b>DB</b>	Defined Benefit
<b>DC</b>	Defined Contribution
<b>IR</b>	Information Ratio
<b>LDI</b>	Liability Driven Investment
<b>OPRA</b>	Occupational Pension Regulatory Authority
<b>PF</b>	Pooled Fund
<b>PVFB</b>	Present Value of Future Benefits
<b>REL.</b>	Relative Performance
<b>S2P</b>	State Second Pension
<b>SHPs</b>	Stakeholder Pensions
<b>SIPPs</b>	Self-Invested Personal Pension
<b>SPA</b>	State Pension Age
<b>TE</b>	Tracking Error
<b>UK</b>	United Kingdom

# 1. Introduction

The present report is the result of a project on UK Pension Funds: Fund Portfolios Performance Analysis. The motivation for the choice of this subject, was related to the interest in the subject that arose from my work and the need to develop further the theme on this thesis. Understanding it involves methodologies related to: Analysis of the investment markets, the performance of many funds, and their associated risk, which are factors that were always very present in everything we studied in the Mathematical Finance master, as well as it being a subject that highly caught my attention, I decided that this would be a perfect fit for my master's final work.

## 1.1 Introduction of the Topic of Analysis

A pension is the money that one individual will receive when they retire or if their spouse's die. In the United Kingdom, these can be provided by the state or accumulated by the personal, but one of the most common cases is that individuals will receive them from their employers, who provide the employees with a **pension scheme**, that accumulates benefits to generate the income of that person after their retirement. The most common type of pension schemes are the Defined Benefit schemes, which allow for the calculation of the value of benefits, with a formula that takes into account mainly; income and years of service, and which value can be known before the actual retirement. The funding of the benefits of the pension scheme is done through investments in different **funds**, which with a previously defined allocation and selection, will constitute an **investment portfolio**.

The study presented on this project will be focused on the analysis of multiple portfolios of pension funds, with different investment strategies, throughout their respective active years and especially focusing on the most recent months for a period up to September of 2020, and on the effects of the COVID-19 pandemic on these investments.

The portfolios are composed by UK Funds and all of them correspond to Defined Benefit schemes, which are still active and on their funding process. The methodology used on the analysis is the **attribution analysis**, which is a methodology used in finance to identify and quantify the excess returns of a portfolio, in order to understand the extra value added by active management choices of selection and allocation, as well as risk management. This methodology requires a comparison of the actual portfolio returns and the benchmarks returns, as well as their respective risks and should also take into consideration tracking errors and information ratios for further analysis (when necessary). This analysis fits the category of a **comparative analysis**.

The main goal of the analysis performed in this project is to answer the following investigation questions: (1) Are all the studied investment strategies efficient? (2) is

there one strategy that has shown to perform significantly better than the others in the presented pandemic scenario? (3) to what extent were the management decisions important to handle this situation? and (4) what could have been done better (if anything) in order to face this situation in the best way possible? (5) Were the consequences of this pandemic scenario severely negative on these portfolios overall performance? In summary, we aim to study the active management decisions and evaluate their importance in a scenario where a pandemic forced a lockdown, which caused the economy to be highly affected, and consequently a crash of the investments market.

## **1.2 Structure**

This project is divided in 5 parts. The first chapter is the introduction, which includes a presentation of the subject, the general project, and the thesis of research. In the second chapter, the literature review, we mainly relate a brief presentation of the pension fund system context in the United Kingdom, the types of pension schemes that exist in there and each of those types' characteristics. The third chapter, portfolio performance notions, includes all the concepts and variables that are relevant for the actual portfolio analysis that will be performed, such as: the types of funds assessed (growth and matching), the investment policy, benchmarks, tracking errors, and the different methods of analysis that can be performed on pension funds, focusing on the attribution analysis, which is the one used in this report. On the fourth chapter of the project, is where the data for portfolios is presented, as well as the methodology used, and the whole analysis, with the relevant graphs, tables, data, and results. Finally, the last chapter (5) is the one where the answers to the investigation questions (conclusions) of the study are presented with its limitations, and future research on the subject.

## 2. Literature Review: UK Pensions

In this chapter the goal is to briefly explain how the United Kingdom pension system is structured, defining what are the pensions funds and types of pensions that exist in the UK.

A **pension** is what we call the compensation that one will use to live when they are retired and no longer generating work income. Most people will get it from the government, but an occupational and/or a personal can also be subjected to a **pension scheme**<sup>1</sup> with the aim of saving for retirement as well. This is possible with the help of **pension funds**; known as the vehicle to fund the pension benefits (through contributions from employers, employees and/or organizations), and the **pension plan**; which is the document that establishes the rules to access the pension benefits. These benefits may be paid as lump sum, annuity and/or through a combination of both, and their value depends mainly on the employment status and lifetime of the beneficiary. [Kagan, 2020]

The United Kingdom pension system can be categorized in three main groups: (i) mandatory State Pensions, (ii) voluntary Occupational Pensions, with a compulsory auto-enrolment, and (iii) voluntary Individual/Personal pensions.<sup>2</sup> And one can belong to several of them, which means, for instance, that even if a person is part of an occupational plan, they can still benefit from a personal one.<sup>3</sup> We're going to see each type in more detail throughout this chapter.

### 2.1 State Pensions

State pensions are, as the name suggests, ensured by the state. They're universal and meant for all elder people who cannot do payed work anymore, with the main goal of ensuring that all retired people have enough money to face their basic needs. [Bozio, Crawford & Tetlow, 2010, pg. 6]

UK state pension was originally introduced by the Old State Pensions Act 1908, and it consisted of means-tested non-contributory benefits. But the acts suffered many changes with time, some other relevant acts were: the first contributory scheme, that emerged in the Widows, Orphans and Old Age Contributory Pensions Act 1925, which was compulsory only for manual and low-wage workers. On 1942, happened a major break with the past, that was marked by the introduction of universal coverage based on a social insurance model. This originated the National Insurance Act 1946. [Bozio, Crawford & Tetlow, 2010, pg. 7-8]. In 2011, it came the Pensions Act 2011, which

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<sup>1</sup> <https://www.pensionsadvisoryservice.org.uk/about-pensions/pensions-basics/what-is-a-pension-scheme>

<sup>2</sup> [https://en.wikipedia.org/wiki/Pensions\\_in\\_the\\_United\\_Kingdom](https://en.wikipedia.org/wiki/Pensions_in_the_United_Kingdom)

<sup>3</sup> <https://www.pensionsadvisoryservice.org.uk/about-pensions/pensions-basics/contract-based-schemes/personal-pensions>

introduced changes in the State Pension Age timetable, and implemented other changes. Finally, in 2014 was introduced the Pensions Act 2014, which is the most recent, which introduced a reform of the state pension, that will bring changes to the future, like: the rise of the state pension age between 2026 and 2028. [GOV.UK, 2013]

To be able to start receiving this type of pension, it's defined in the pension plan a minimum age required, known as the **state pension age** (SPA). This age may differ from the age required to start receiving other types of pension and it's defined based on **birth date** and **gender** of the person in question. Reaching it does not mean necessarily that people are required to stop working, but they won't have to pay national insurance any longer, and they will also have the possibility to request flexible working arrangements that are adequate for their needs, like: working from home or personalized working hours.

There exist two types of state pension in the UK: The **Basic State Pension** and the **State Second Pension (S2P)** also known as New State Pension. The **Basic State Pension** can be claimed by men and women born before the 6 of April of 1951 and 1953 respectively, (the ones who reached the SPA before 6 of April 2016). To be able to get it, one must have been paid or have been credited with national insurance. The most that can be earned now is £134.25 per week, and it increases every year by the highest of: earnings, prices or 2.5%<sup>4</sup>. To this total, may be added an extra amount of money, which is known as the **Additional State Pension** (only for people qualified for Basic State Pension)<sup>5</sup>. People reaching the **state pension age** after the 6 of April of 2016, are only eligible for the **New State Pension**. Usually it's required at least 10 years (not necessary in a row) of national insurance record to get any state pension, which means that one should have: worked and been paid national insurance contributions, unemployed but getting national insurance credits or voluntarily paying them. It's also eligible for people who have worked abroad and who paid married women/widow reduced rate contributions<sup>6</sup>. [GOV.UK]

## 2.2 Occupational Pensions

Occupational pensions, also known as **workplace, company, or work-based** pensions, are a type of retirement plan that is arranged by one's employer, labor union or professional organization.<sup>7</sup> In this type of pension, the following things are mandatory: (1) The employer needs to make an occupational pension available for their employees and (2) the employees will be enrolled automatically (if they are eligible to receive it), although, in the case of Defined Contribution Schemes, an *option-out* choice is always

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<sup>4</sup> <https://www.gov.uk/state-pension>

<sup>5</sup> <https://www.gov.uk/additional-state-pension>

<sup>6</sup> <https://www.gov.uk/new-state-pension>

<sup>7</sup> <https://www.gov.uk/workplace-pensions>

available<sup>8</sup> for those who do not wish to have a percentage of their salary transferred to their retirement account. If the beneficiary leaves their occupation, they will be removed from the current pension plan, and the benefits will be transferred to the pension scheme provider by the new employer. [Blake, 2003, pg: 22]. Workplace pensions are usually governed by legislations that intend to protect the employee's benefits, while bringing tax advantages for both the employer and employee. [Broadbent, Palumbo & Woodman, 2006, pg.3]

In the UK, most of these types of plans are what we call **pension trust funds**, where the assets are provided by the **sponsor** (usually the employer), but they are held by the **trustees**, to fund the benefits granted to the **beneficiaries** (usually the employees and their spouse and minor kids, whose interests are set in the trust deed). **The trustees** are the group of people that manages the pension scheme in a way that meets the best interests of the beneficiaries of said scheme, they also act accordingly to the schemes rules, the Occupational Pension Regulatory Authority (OPRA) and with the best faith and honesty. [Blake, 2003, pg: 94-95]

This type of retirement plan is divided in two major categories: the **defined-benefit plans (DB)**<sup>9</sup> and **defined-contribution plans (DC)**<sup>10</sup>, which have very different characteristics when it comes to the risks shared between the employers and employees, the sensitivity of the benefits to inflation, the funding flexibility, and the importance of government supervision. [Bodie, Marcus & Merton, 1985, pg. 1]. It is possible to find also **hybrid plans**, which combine characteristic from both DB and DC pension plans.

### 2.2.1 Defined Benefit Schemes

DB schemes, usually a **final salary schemes**<sup>11</sup>, are employer-sponsored type of plans, granting to the eligible workers (not necessarily retired), a benefit based on a formula that considers two main factors: years of service and the salary received. The employee doesn't have much control over the funds and it's the employer (sponsor of the DB plan) who administers the management of the portfolio, since they are the one responsible for its funding, meaning that they should guarantee, at any time, that established funds contain assets that are enough to cover the expected pension obligation, and if at any time this is not verified, the employer is required to make additional payments to the fund. [Hyatt & Pesando, 1996, pg:2]

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<sup>8</sup> <https://www.citizensadvice.org.uk/debt-and-money/pensions/types-of-pension/workplace-pensions/>

<sup>9</sup> Where, as the name suggests the benefits payed to members are clearly specified.

<sup>10</sup> Where the rate of contribution payed by the employer/employee is clearly specified.

<sup>11</sup> Where the value of the pension promised under the pension plan, corresponds to a given percentage of the final salary at retirement date.

On this type of plan members can predict the value of their pension by applying the pension formula. Since pension benefits are payed only in a far future, to be able to compute the inherent liabilities some assumptions must be made, these are called the **actuarial assumptions**, and there are two main types: **Economic** (which include assumptions on salary increases, interest rates, inflation and market changes) **and demographic** (which have to deal with the participant's life path, meaning their life expectancy, retirement expectancy...).

The **present value of future benefits**, which gives us the present value of liabilities required to fund all the future pension benefits of the plan member, can be computed by the following formula for any current worker (active participant of the pension fund) with age  $x$  and retirement age  $RA$ : [Pension Committee of the American Academy of Actuaries, 2004]

$$\begin{aligned}
 PVFB_x & \\
 &= benefit_{RA} \times annuity_{RA} \\
 &\times probability\ of\ survival\ valid\ and\ active\ until\ the\ age\ RA \\
 &\times discount\ factor\ of\ RA - x\ years
 \end{aligned} \tag{1}$$

The present value of future benefits will depend on the assumptions considered when computing its value, meaning that future costs may be higher or lower than it, depending if the reality is worse or better than assumed, respectively. [Pension Committee of the American Academy of Actuaries, 2004]

There are also different kinds of risk involved; when it comes to **employees**, they are subject to **insolvency risk**<sup>12</sup>, which arises if the company declares bankruptcy while the plan is still not fully funded, the **inflation risk**, the **vesting risk** (the risk of giving a right to a future benefit), but most importantly the **accrual risk**, which reflects changes that might happen, for instance in the benefits formula, that will affect the payment of the benefits.

The **employer** also bears many different risk types: **salary replacement risk**; from the percentage of the employee's income that is paid by the pension program, **market timing risk**; if assets fall under the required at the time of the retirement, **longevity risk**: if plan beneficiaries live longer than what is expected, resulting in longer paying periods, **inflation risk**, but most importantly, the **investment risk**, if returns of assets fall under expectations. [Broadbent, Palumbo & Woodman, 2006, pg.4-5]

A summary of the risk distribution is presented in the following table:

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<sup>12</sup> To minimize the negative impact of the insolvency risk in UK exits the UK Pension Protection Fund, which in case of insolvency, would take the responsibility of paying a portion of the expected amount of the pension



TYPE OF RISK	WHO ASSUMES IT?
INVESTMENT	Employer
INFLATION	Employee/ Employer
LONGEVITY	Employer
MARKET TIMING	Employer
ACCRUAL (PORTABILITY)	Employee
VESTING	Employee
EMPLOYER INSOLVENCY	Employee/ taxpayers
SALARY REPLACEMENT RISK	Employer

Table 1 - Risk Distribution in a DB Pension Plan, Source: Broadbent, Palumbo & Woodman, 2006

### 2.2.2 Defined Contribution Schemes

Also known as **money purchase** pensions, consist of the employer and sometimes, even the employee, making contributions of a defined amount (which is a fraction of the employee's salary) into their retirement account. The deductions are made directly from the pay. Contrary to what happens on a DB plan, in a DC plan, the employee does not know the retirement income that they will receive prior to the actual retirement, as the value of the pension will depend on the contributions made during their work time and the returns earned from the investments. [Broadbent, Palumbo & Woodman, 2006, pg.6]

This means that; the benefit from the plan is based on the accumulation of contributions made on the member's behalf, to the investment fund, and the benefit that is received upon retirement is dependent mainly on the performance of the fund, although not fully, as other factors also influence it, like: taxes and the value of life annuities that will be practiced by insurer companies. [Hyatt & Pesando, 1996, pg:2]

The risk distribution is also very different from the BD plan, the most important difference is that in defined contribution schemes, the employee is the one that bears all the investment risk and the longevity risk. The employee also bears the salary replacement risk, which means that they should make investment decisions to meet their goals. The employers bear only the fiduciary and legal risk. [Broadbent, Palumbo & Woodman, 2006, pg.8-9]

A summary can be seen in the following table:

TYPE OF RISK	WHO ASSUMES IT?
INVESTMENT	Employee
INFLATION	Employee
LONGEVITY	Employee
MARKET TIMING (TEMPORAL)	Employee
ACCRRUAL (PORTABILITY)	DC plans are portable
VESTING	Employee
EMPLOYER INSOLVENCY	DC plans always fully funded
SALARY REPLACEMENT RISK	Employee
FIDUCIARY/LEGAL RISK	Employer

Table 2 - Risk Distribution in a DC Pension Plan, Source: Broadbent, Palumbo & Woodman, 2006.

### 2.2.3 Hybrid Schemes

Hybrid Pension Schemes are those that combine some characteristics of both DC and DB schemes. As we've seen in the two previous types of schemes, employers and employee's face and bear different kinds of risk, mainly separately, but in hybrid schemes they can share some parts of the risk. Knowing this, a hybrid scheme can sometimes be interesting, as DC schemes can be considered non-suitable and DB schemes also may be expensive and not feasible alternatives. [pensionsauthority, 2007]

In hybrid schemes, the plans for tax, accounting and regulatory are defined as in DB plans, being the most popular type of hybrid scheme: the **cash balance (CB)**, where the benefits are defined as a lump sum, that one can benefit from not only at retirement, but if one changes jobs, or at the termination of the plan. [Broadbent, Palumbo & Woodman, 2006, pg.10]

But there also exist many other different types of hybrid schemes, such as the following: **combination schemes**; where a member can accumulate different types of benefits at the same time, **underpin schemes**; where there's both defined benefit and defined contribution basis for the benefits, among others. [pensionsauthority, 2007]

Main risks and its distribution are therefore as follows:

RISK FEATURE	WHO ASSUMES IT?
INVESTMENT	Both
ANNUITY CONVERSION	Both
SALARY INFLATION	Both

Table 3 - Risk Distribution in a Hybrid Plan, Source: Author, Based on: Wesbroom, K. 2007.

### 2.3 Personal Pensions

Personal pensions are a type of defined contribution scheme. The main characteristic of this pension type, is that, unlike occupational pensions, one doesn't need an employment partnership to be an eligible participant of the fund, so the people who benefit from this type of plan are usually self-employed or not working (but employed people can benefit from them as well). They are based on contracts between the person who will be the benefited and the pension provider. For employed beneficiaries, their employer can contribute to the personal plan, and so can other people (examples of this are: contributions for one's partner personal pensions or their children). The value of the benefits is determined by the amount of the contributions that are made to one's personal plan (which are subject to the contribution periods) as well as the investment returns. These contributions are invested in funds, usually there are many different funds to choose from where one can invest in and they can also choose to change the funds they are invested in during their work life. [pensionadvisoryservice, 2020 (a)]

In the UK, exist two main types of personal pension: **Stakeholder Pensions** (SHPs) and **Self-Invested Personal Pensions** (also known as SIPP). SHPs is a contract between the beneficiary, the member, and the pension provider. One can benefit from it when they are employed, self-employed and not employed. They are flexible, which means that one can still contribute to the plan even if they change jobs, and in their new job, the employer can also contribute to it. SIPPs are a contract between the beneficiary and the pension provider only, and they offer wider investment choices than, for instance, group personal pensions (another type of personal pension). These investment choices include the possibility to invest not only in UK but overseas assets, collective investments, investment trust, among other benefits. SIPPs, like SHPs are also flexible. [pensionadvisoryservice, 2020 (b)]

## 3. Portfolio Performance Notions

### 3.1 Asset Classes and Allocation

When making an investment plan, investors can choose between a wide variety of funds, which have different risk profiles. Higher risk funds can provide higher returns on the long term, but they are also more unpredictable and bring higher uncertainty. Funds with low risk on the other hand can be safer, depending on what the investor is interested in. For the purpose of this work, we will be focus on two main categories of investment: **Growth** and **Matching** funds.

**Growth funds:** Also called **return seeking investments**, have the goal of growing the investment returns, over a given horizon of investment and level of risk, which means that they aim primarily to enhance returns over time.<sup>13</sup> This type of investment is ideal for investors seeking higher returns, but who are also willing to take risks, as investing in this type of assets requires accepting a risk inherent to a high target return. These types of investments are less predictable and more volatile, which means that investors must be prepared for some periods of negative returns, and other periods of higher returns. Knowing this, it's expected that when setting a benchmark for these assets, the real assets allocation might shift substantially from the fund benchmark at the end of the studied period, sometimes, being a lot lower/higher. Despite of the risk they carry, they also have benefits attached, like the obvious higher returns, and the fact that they can improve the funding position of the scheme. Some examples of growth investments are in property and alternative funds.

**Matching funds:** Also known as **defensive** funds or **low risk**, have the main objective of reducing risk, taking a given matching portfolio (benchmark), which means that investors will have them as safer investments in their portfolios, so when situations of uncertainty happen, they still have investments that will guarantee returns according to expectance. Because these assets are less volatile, their performance tends to be more predictable, usually having returns very close to the set benchmark, if not an exact match. Also, since they have lower risk, they tend to bring lower excess returns on the long-term. Matching assets are held in the scheme of investors as a way of managing the investment risk relative to the liabilities. Different types of matching assets may match different liabilities, bringing different expected levels of return. Some examples of matching investments are in cash and fixed income assets<sup>14</sup>.

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<sup>13</sup> <https://www.thepensionsregulator.gov.uk/en/document-library/regulatory-guidance/db-investment/db-growth-assets>

<sup>14</sup> <https://www.thepensionsregulator.gov.uk/en/document-library/regulatory-guidance/db-investment/matching-db-assets>

Investors, as mentioned before, may have different investment strategies depending on their preferences. The goal is to set the **diversification** strategy, between the different investment asset classes, that better suits that preferences in terms of return vs risk, this creates sub portfolios inside the main portfolio, this split between asset classes is what we call **asset allocation**. But this diversification strategy can and will most likely change over time, because 1) the time horizon of the investment changes and 2) the preferences in terms of return vs risk are dynamic changing as the fund gather experience regarding accumulated return and risk, this is called **rebalancing** and the name of the strategy is the **dynamic asset allocation**. [Chen, 2018]

### 3.2 Investment Policy

Because investment funds are a limited resource, every organization that works with them needs to have their own investment policy, in order to make the best use of these resources. The investment policy is a pre-defined document, which includes all the parameters that should be considered while operating with the funds, so that everything is according to “*core philosophy, belief, mission and the goals*” of the investor company. It is also very important for the managers of the portfolios, as they cannot make investment decisions that deviate from what’s established in said policy. The policy also needs to consider possible new investment funds, and not only the investments that already exist at the time of its definition, as those possible future investments also need to be in accordance. The main advantage of having an investment policy, is the elimination of possible tempting or emotional investments.

The key elements that should be present on every investment policy, are the following: **Policy objectives**; which helps defining a clear direction for the investments, allowing for investors to choose the most appropriate teams according to knowledge and experience to reach those objectives. **Risk tolerance**; as inventors have different risk profiles, it is very important to define the risk that one is willing to take, with the goal of making the best possible split in safe investments and riskier investments, in order to obtain a diversified portfolio that is in accordance to that accepted risk. **Permissible assets**: The investment policy must state exactly what assets and asset classes the fund allows to be invested in, and what ones should be avoided. And finally, the portfolio **rebalancing**: rebalancing is a very important concept in investing, and the investment policy needs to state the frequency of the portfolio rebalancing, and how this rebalancing should be made. [investmentuk, 2020]

The investment policy is also subjected to the country’s legislation which might for example be more or less permissive regarding the investments choices in foreign countries. The most recent amendment to the UK regulation regarding the pension funds investment policy is from the year 2019 and it includes many topics related to this, which have been updated after the Brexit. The key points that are stated in the

document have to do with: the definition and measurement of overseas investments (like the types of overseas investments, recommendations...), investment liberalization and protection (which includes information about many types of international agreements, including updated Brexit terms), investment promotion and facilitation, and the regulation of UK inward investments (which includes blocking harmful investments and proposes an investment regime). [UK investment policy, 2019]

### 3.3 Benchmarks

The most basic form of pension fund performance measurement is done based on **rate of return**, **variance** and **standard deviation**, and even though these provide us with a simple measure of the investment growth, they have proven to not be enough, since those measurements neglect the cash flows timings, usually not controlled by the fund's investor.

For a more accurate fund performance analysis, we study the fund performance in comparison to a set **benchmark**, which will determine if the fund is performing better, in accordance or lower than expected. Benchmarks represent a theoretical portfolio of assets, that sets the reference for the expected performances and risk of each fund. The benchmark can take the form of a **market index**, which considers portfolios that focus on a specific market (like the MSCI World Equity Index), a **peer group average** (groups or entities that share similarities, making them easy to compare) or even a **median** (the middle figure in a distribution of values, ranked according to size). [Investment Dictionary, 2014]

In the next table, is presented a summary of the most used indexes of assets to set the reference benchmark.

ASSET CLASS	INDICES
EQUITY	FTSE, MSCI, S&P
BOND	Markit iBoxx, BofAML, FTSE
PROPERTY	MSCI Ex-IPD
CASH	LIBOR, LIBID
HEDGE FUNDS	Dow Jones Credit Suisse Hedge Funds HFR Index.

*Table 4 - Commonly Used Asset Benchmark Indexes, Source: Author, Based on: Market Indices Research.*

The benchmarks help us assess different factors, like 1) how the strategic allocation is helping the assets to grow (versus the liabilities); 2) how said allocation is itself performing in contrast to the target allocation; 3) how the individual assets of the portfolio are performing and their impact on the whole portfolio; and 4) how the **investment managers** are performing in aggregate and individual terms.

It also helps to evaluate if one is taking too much risk, or too little, and gives a guideline for the allocation rebalancing period that one should take, with the aim of help managing said risk. [Rudolph & Sabat, 2016].

Hence, how well the fund performs when compared to a benchmark depends on: the **asset's selection** within each asset class (bonds, equity, etc.), the **split** between the asset classes (fund allocation in growth or matching funds), and how often a **rebalancing** happens (time intervals in between a change of weights between assets classes. All composite benchmarks need to have a defined rebalancing period, or frequency). [Investment Dictionary, 2014]

When building a benchmark portfolio, especially when it comes to pension funds, since they are built with the objective of optimizing the pensions of individual people at their retirement age, it is very important that other aspects are well defined and taken into account, such as: **long-term objectives** of the contributors, **diversified market indices** to which the benchmark need to be in accordance... etc. Hence, it is a complex process that requires a strong knowledge on the investors profile and their long-term objectives, the pension fund system, the governance structure, appropriate methodologies, and the market itself (as the portfolios may face market fluctuations and need to be strong enough to resist). But most importantly, it is required that these benchmarks be built according to the **pension fund industry**, as only that way, can we make sure these objectives are met. [Rudolph & Sabat, 2016]

### 3.4 Performance evaluation

Fund portfolio performance evaluation can be done through the following methods: **Performance measurement, performance appraisal and performance attribution**. The first one, **performance measurement**; is a process of qualitative and/or quantitative analysis, that consists of the calculations of the fund's historic return on its investments. This method can be used to evaluate the performance of the portfolio, as well as the performance of each individual asset classes. It is calculated on a time-weighted rate of return basis, which is not affected by the external cashflows, and it tells us, simply, what was the account's performance. The second method, **performance appraisal**: this method evaluates the manager's skills, and achievements (or lack of them), which leads us to understand if the performance of the fund were achieved due to a good management job, or otherwise if they were just reached due to luck. And finally, performance attribution or **attribution analysis**; is the one that tells us why the account produced the observed returns. This is the method that will be used, and it is seen more in depth a continuation.

### 3.4.1 Attribution Analysis

Attribution analysis is a set of different techniques that can be used to do the study of identification and quantification of excess returns of a portfolio, compared to its benchmark. This is because the creation of a long-term portfolio benchmark allows for a separation between **market returns** and **excess returns**. Which we understand by: market returns (Beta) represent the risk and reward of one's portfolio, explained by being in a specific market, while the excess returns (Alpha) are the returns of the fund portfolio in excess compared to its benchmark, these are the ones that allow the portfolio to "beat" the market. [Bacon & Wright, 2012]

The objective is to understand the consequences of decisions of the **fund's active management**. The process takes into consideration the steps taken in the investment management process, such as: the **asset allocation, selection** of the stocks, the currency management... among others. Through the **allocation** we understand the value that is added to the portfolio by having different sector weights in the portfolio and the benchmark, and by **selection** we perceive the value of individual assets/funds, which are also given different weights than the benchmark (in both cases, of course, the manager will look forward to overweighting out-performing sectors and funds, and vice versa). As we can understand from comparing the portfolio to the respective benchmarks, this method will determine over-performance or under-performance, and from that we can conclude if the management process has added value to our portfolio, or lost value. [Bacon & Wright, 2012]

To determine the value added by the **allocation** we need to calculate the return of the notional fund which represents a portfolio that includes the manager allocation choices, but not the selection. The allocation notional fund return has the following formula:

$$B_s = \sum_{i=1}^{i=n} w_i B_i \quad (2)$$

Where:

$w_i$  = Weight of  $i$ th sector in the portfolio

$B_i$  = Return of the benchmark in the  $i$ th sector

$n$  = Number of sectors or funds

$B_s$  = Notional fund (allocation choices)

While the contribution from the asset allocation can be calculated as the difference of the notional fund return and the benchmark return, as follows:



$$B_s - B = \sum_{i=1}^{i=n} w_i B_i - \sum_{i=1}^{i=n} W_i B_i = \sum_{i=1}^{i=n} (w_i - W_i) B_i \quad (3)$$

Where:

$B$  = Benchmark Return

And for the **selection**, we do the same thing, calculate the return of a notional fund, but this time for the selection. This one includes all the manager decisions regarding selection and excludes all the allocation ones. The return formula is as follows:

$$R_s = \sum_{i=1}^{i=n} W_i R_i \quad (4)$$

Where:

$R_i$  = Return of the portfolio assets in  $i$ th sector

$W_i$  = Weight of the  $i$ th sector in the benchmark

$R_s$  = Notional fund (selection choices)

Hence, like before, the contribution from the selection is calculated as the difference of the notional fund return and the benchmark return:

$$R_s - B = \sum_{i=1}^{i=n} W_i R_i - \sum_{i=1}^{i=n} W_i B_i = \sum_{i=1}^{i=n} (R_i - B_i) W_i \quad (5)$$

Where:

$B$  = Benchmark Return

There's also a third factor considered in the return attribution, which is the **interaction** (between both). Only introducing the interaction can we achieve values that add up to the arithmetic difference between the fund and the benchmark returns. The interaction is calculated:

$$Interaction = P - R_s + B - B_s \quad (6)$$

Where:

$P$  = Portfolio Return

And then:

$$\begin{aligned} & Selection + Allocation + Interaction \\ & = (R_s - B) + (B_s - B) + P - R_s + B - B_s = P - B \end{aligned} \quad (7)$$

The following graph shows a summary of all of this:

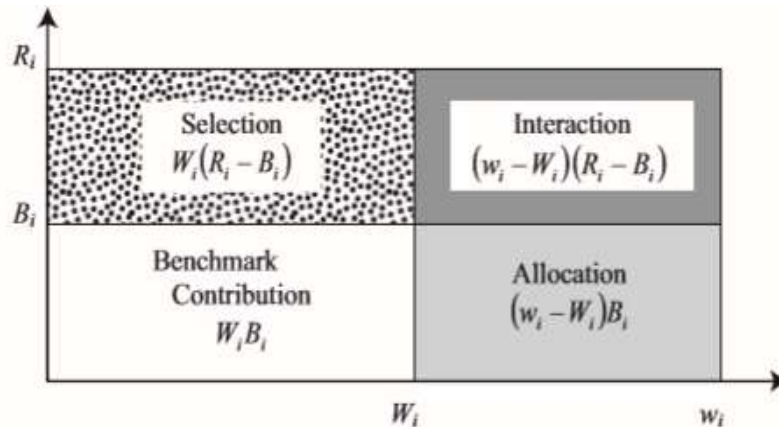


Figure 1- Attribution Analysis Summary, Source: R. Bacon, C., A. Wright, M., 2012.

This return distribution is extremely important for fund performance analysis, as it is what allows for managers to be able to add value to their portfolios and achieve the most efficient returns. This is because managers will make their decisions of allocation and selection, in a way that they expect will over-perform the markets with positive returns, but since these decisions are made based on an overall benchmark, they will also seek to over-perform that overall benchmark. Otherwise, the portfolio, as well as the manager, will lose value. Hence, this division is what allows us to understand if portfolios are **efficient**. [Bacon & Wright, 2012]

### 3.4.2 Tracking Errors

When comparing portfolio returns with those of their benchmarks, another important aspect to consider is the tracking error. The tracking error is a variable which helps measuring how consistent the portfolio tracks its benchmark (meaning; how closely the fund follows the set index). It is extremely important in portfolio analysis because, even portfolios that are perfectly indexed, usually behave differently from the benchmark.

Tracking errors are used to quantify this deviation, between the portfolio return behavior and the benchmark return behavior, and they are also helpful in evaluating the portfolio's active management, as for instance, if a manager has low returns, but a high tracking error, it shows poor management performance, since a bigger tracking error means a bigger allowance for the returns to deviate from the index.

Hence, we can understand the tracking error as the standard deviation of the difference between the portfolios returns and benchmarks, and it can be calculated with the following formula:

$$TE = \sqrt{\frac{\sum_{t=1}^k (P - B)^2}{N - 1}} \quad (8)$$

With:

$P =$  *Portfolio Return*

$B =$  *Benchmark Return*

$N =$  *Number of periods*

[Chen, 2020]

## 4. Portfolio Analysis

### 4.1 Data and Methodology

The data presented in this project corresponds to four different portfolios, invested exclusively in growth and matching funds, that operate in UK markets, sourced from a company whose name we will keep anonymous, as well as the name of the portfolios. The data includes performance relative to the four portfolios: **returns** (which correspond to asset-weighted average gross returns), **benchmarks** (which were previously built with a similar style as the evaluated portfolios) and their respective **risks** (which is the measure of the volatility of the returns, and is presented as standard deviation of annual returns over the period). The data comes as monthly performances for both the returns and the benchmarks of each portfolio, which were calculated arithmetically, with the formulas as presented in the attribution analysis chapter (which means they already include the effects of allocation and selection decisions).

The monthly returns were then used to calculate year returns and since start date performances for this analysis purpose. The performances are then taken yearly (for all years) since the beginning of each portfolio's implementation (given that all of them are older than 5 years, except for portfolio 4 which is only 4 years old), and up to the most recent month with available data; September of 2020.

The analysis will consider the performances and risk from all these years (in which the portfolio has been operating) and will be specially focused on the current year, in order to understand the impacts of the COVID-19 pandemic. This impact will be measured by looking at the comparison of the average returns up to December 2018, December 2019 (before the COVID period), and then up to September 2020 (after).

Attribution analysis will be used to calculate the excess returns and consequently, to compare the different portfolios performances, and make the conclusions about the impacts of the active management of the funds given the effects of the pandemic. This methodology fits in a **comparative analysis**, which is a method that: *"compares two or more objects or ideas (...) and shows us how two subjects are different"* [Bukhari, 2011]

This kind of methodology, hence, requires two conditions be met: (1) We should have data on two or more things, which can be whatever topics of our choice (in this case different portfolios) and (2) We have to attempt to explain the reasoning behind our results, rather than only describing it. If these conditions aren't both verified, it means the data is only presented but the differences and similarities are not explained, which cannot be considered "analysis". [Pickvance, 2011]

## 4.2 Reference and Thesis

The portfolios being compared are divided into two main categories according to the investment model: **Pooled Fund Model** and **Client Specific Model**. The strategies are similar in what comes to the types of funds they invest (growth and matching) but they differ in many other aspects, such as the following: **Client Specific** model is destined for investors who want to be more involved in the managing process of their funds. This is because those who invest in those strategies, have more freedom at the time of deciding in which asset classes they wish to be invested in, at any point, while the scheme is active (clients invested in this type of strategy can invest and de-invest in any funds they would like, at any time). When it comes to **Pooled Fund** model, those who invest in it have way less involvement in their portfolio managing decisions. The most important example of this, is that they can only invest (as the name suggests) in a type of growth fund, which is the **pooled fund** (hedged and unhedged, usually investing in both). This types of funds are growth-seeking, and generate their returns by investing in a range of different asset classes such as equities, property, commodities... Except that these asset classes cannot be chosen by the investors, but only by the managers, and all clients investing in these funds, will be subject to the same asset classes (unlike client specific investors, who will have much more diversified portfolios). Keeping in mind the freedom of investment differences, it is easy to understand that client specific model can have different types of sub-strategies. This is because some investors, at the time of deciding their strategy, can decide that they do not want to invest in a specific asset class (which makes it their own strategy). While pooled fund clients cannot have sub-strategies, as they understand at the time of choosing their model, they will not be able to have decisions when it comes to the asset classes (one example of this effect is that in pooled fund usually there are passively managed funds included, which doesn't always verify in client specific).

In the choice of the four portfolios to consider on the performance analysis, we seek to select funds with different investment strategies, so that we could directly compare and contrast different management techniques, different types of funds and asset classes, as well as different sub-investment decisions (riskier and safer strategies) for the period being analysed. We have considered two pooled fund portfolios and two client specific portfolios.

The analysis focuses on the most recent months available, corresponding to the year 2020 and the effects of the COVID-19 pandemic on the investments. With the aim of understanding the following: (1) Are all the investment strategies efficient? Specially during the economic drawdown? (2) Is there a strategy that performed exceptionally better than the others in this scenario? (3) do the portfolios show exceptional excess returns performance? To what extent were the management decisions important to handle the situation? and (4) what could have been done better (if anything) to face this situation? And finally, (5) were the consequences of the COVID-19 pandemic lockdown

and market crash severe on the performance of these portfolios? In summary, we want to study the active management decisions and evaluate their importance in a scenario of a sudden (negative) market change.

### **4.3 Data Analysis**

To understand the fund portfolio performance analysis, we first need to have a general understanding of the market situation for the studied years. The year 2020 particularly, since we want to understand the repercussions of the global pandemic COVID-19, which is affecting the markets since the general shutdown of economic activity in March. After 2019 being a very strong year, the investment markets collapsed in the first quarter of 2020, resulting in it being the worst since the end of 2008. (No similar drawbacks had been verified in the other shown periods, except for the end of 2018, where risky assets weakened significantly).

The years before were generally good, 2019 in concrete saw an expanding economy, led by the United States. In the UK, emerging markets softened in the beginning of the year, which lead to better trade fronts. The second quarter of the year was a volatile one and the third one saw a sell-off during August, with trade tensions and fears of a slowdown, but both ended up recovering well, finishing those quarters on a positive end. On the last quarter, the equity markets increased their performances, as well as unhedged investments (due to sterling appreciation), while bond markets performed well throughout the whole year.

However, in the first quarter of 2020 the situation changed significantly, entering in what is expected to be the most severe downturn since the Great Depression in the economy. Equity markets plummeted, as well as bond markets, and the UK specifically had one of the worst performing markets. The shutdown of economic activities and collapse in corporate earnings, led investors into avoiding equity markets, moving their investments into safe assets, which resulted in the worst equity sales since 2008. Defensive assets still performed well in general, but unsurprisingly, risky assets weakened significantly.

The following graphs show us a comparison between the portfolios returns and their benchmarks, for every month since the start (their implementation dates). Portfolio 1 and 2 correspond to pooled fund portfolios, while portfolios 3 and 4 correspond to the client specific strategy. (see appendix 1 for the full monthly returns and benchmarks data).

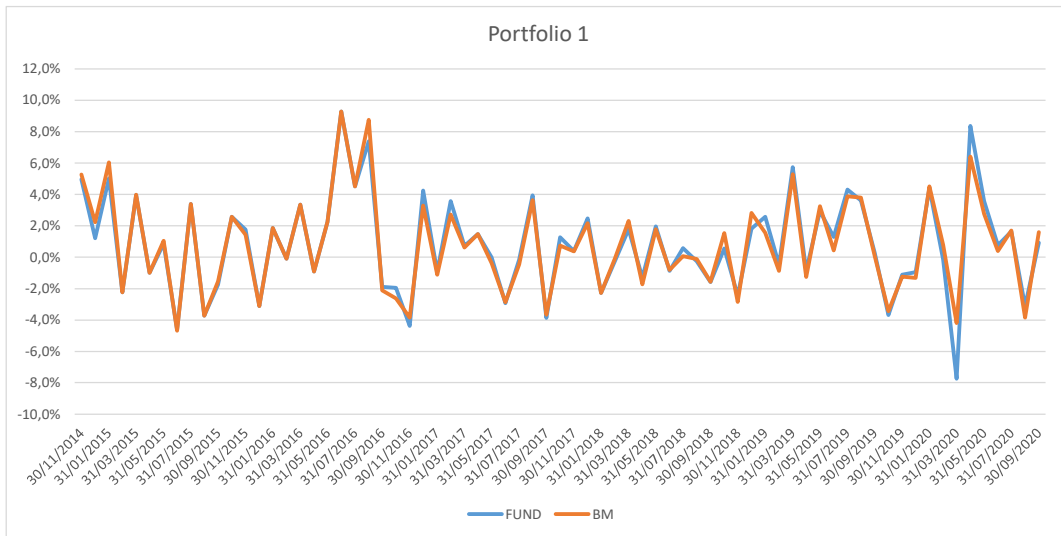


Figure 2 - Total Scheme monthly performance of Portfolio 1, Source: Author, Based on: Portfolio data.

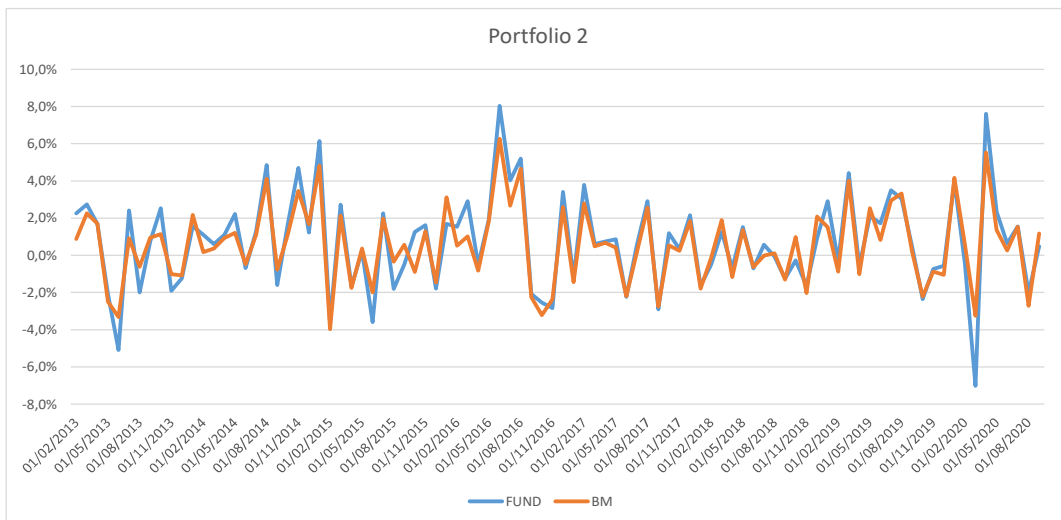


Figure 3 - Total Scheme monthly performance of Portfolio 2, Source: Author, Based on: Portfolio data.

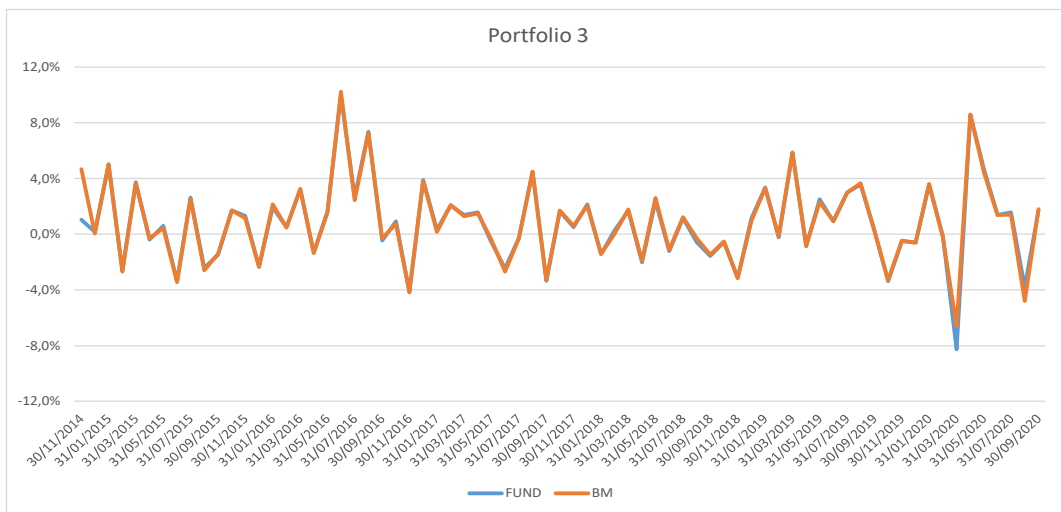


Figure 4 - Total Scheme monthly performance of Portfolio 3, Source: Author, Based on: Portfolio data.

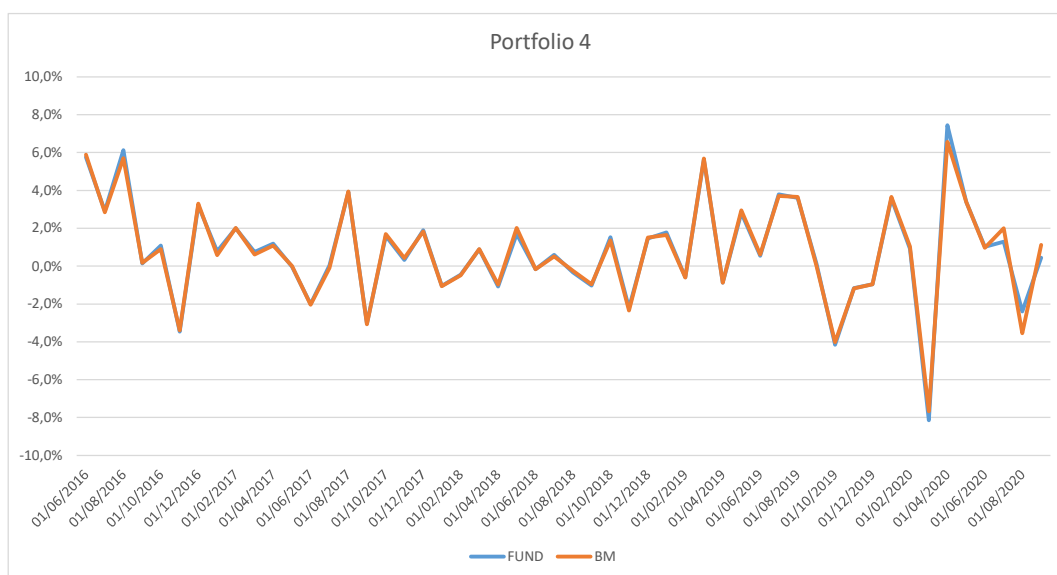


Figure 5 - Total Scheme monthly performance of Portfolio 4, Source: Author, Based on: Portfolio data.

First noticeable thing that we can observe from the previously presented graphs, is that all portfolios have a similar stable positive performance throughout the years when it comes to returns, and that there are no major downfalls before the year 2020 for any scheme, being that the returns never fell considerably (never under around -4.0%, which is a lower but fairly normal return due to volatility).

Overall it should make sense for portfolio returns to be (mostly) in line with their benchmarks, since the benchmarks of these portfolios are aggregates of the underlying portfolio, mainly indexes, defined separately, corresponding to each fund that is part of the portfolio and they were set in a similar style as the portfolios funds. But this can vary if managers take more risk on their funds than the risks of the benchmarks. To confirm this behavior in these portfolios, tracking errors were calculated for every portfolio. The calculation method was through the standard deviation of the relative performance (portfolio – benchmark), as shown in the previous chapter.

The results can be seen in the table below<sup>15</sup>:

	<b>PORTFOLIO 1</b>	<b>PORTFOLIO 2</b>	<b>PORTFOLIO 3</b>	<b>PORTFOLIO 4</b>
	<b>(%)</b>	<b>(%)</b>	<b>(%)</b>	<b>(%)</b>
<b>TRACKING ERROR</b>	2.1	3.2	0.4	0.3

Table 5 - Tracking Error for Portfolios, Source: Author, Based on: Portfolio Data.

As we can observe from the results, tracking errors for CS portfolios are very small, approximately zero, which means that we can confirm that returns should very closely follow their benchmarks for this type portfolios. PF portfolios on the other hand, show

<sup>15</sup> For portfolios 1 and 3, first year annualized returns were not considered for accuracy purposes. (As these included only two months, they do not accurately portray portfolio’s real behaviour).



a higher tracking error, which tells us that the returns should deviate from the indexes more, depending on how much volatility is taken.

We can indeed notice this behavior on the previous graphs: client specific type portfolio return and benchmark lines overlap for all periods, which shows that they tend to behave in line, with returns only slightly ever over/under-performing the benchmarks, this shows management is being done well and meeting investor expectations. Pooled fund portfolios on the other hand, show a more deviating tendency (lines deviate from each other for many periods), meaning that those tend to over/under-perform their benchmarks more. This can partly be explained by the fact that they invest in a pool of funds, which includes different asset classes but with an overall average benchmark. Hence, they are more likely to be able to over-perform it if management is done right. Knowing that they do indeed, most of the time, over-perform the benchmarks, can lead us to assume, so far, that management is showing to be very well done, and adding value to these portfolio in all their periods, however there are other factors that weight on this analysis, which we will see further in this study.

Lastly, we can also notice that management returns are positive throughout all the periods, up until the 2020 breakdown, where we can observe that performance was very negative for both portfolio types. Not only that, but it also way below its benchmark for pooled fund portfolios, while for client specific they acted almost accordingly (at least very close) to the benchmarks. This is not surprising, as like we have seen from the tracking error, returns for this strategy usually follow the benchmarks very closely.

Nonetheless, we can also perceive that there was a high performance rebound in a period of only a month, ending the second quarter of 2020 on a very positive note, with returns significantly over-performing benchmarks for pooled fund model. As for client specific portfolios, these also rebounded but showed returns that were in line with the benchmarks. We can see the monthly returns (%) for all the portfolios, for the 2020 period on the following table:

DATE	PORTFOLIO 1 (%)		PORTFOLIO 2 (%)		PORTFOLIO 3 (%)		PORTFOLIO 4 (%)	
	Return	BM	Return	BM	Return	BM	Return	BM
JAN 2020	4.4	4.5	4.0	4.2	3.5	3.6	3.6	3.7
FEB 2020	-0.2	0.8	-0.4	0.6	-0.1	-0.2	0.9	1.0
MAR 2020	-7.7	-4.2	-7.0	-3.2	-8.3	-6.6	-8.1	-7.7
APR 2020	8.4	6.4	7.6	5.5	8.6	8.6	7.4	6.6
MAY 2020	3.6	2.8	2.3	1.4	4.6	4.4	3.4	3.4
JUN 2020	0.8	0.4	0.6	0.3	1.4	1.4	1.0	1.0
JUL 2020	1.6	1.7	1.6	1.5	1.6	1.4	1.3	2.0
AUG 2020	-3.1	-3.8	-2.0	-2.7	-3.8	-5.0	-2.4	-3.5
SEP 2020	0.9	1.6	0.5	1.2	1.7	1.6	0.4	1.1

Table 6 - Monthly portfolios and benchmarks returns, Source: Author, Based on: Portfolio Data.

Now on, to actually understand the effect of the active management decisions on the portfolios, we need to take into consideration the following variables in our analysis: (1) **Excess returns**: also known as relative performance, it's the difference between the portfolio and the benchmark returns (P-BM), and amounts the value added by the active management (2) **Respective risks**: Making an analysis of the excess returns on their own could be tricky, as the manager could be obtaining better results by taking a lot more risk than the risk of the benchmark, hence we need to consider the risk associated with both the benchmark and the returns, and compare them.

To make the analysis of the data, **year performances** were calculated for every portfolio as a product of the monthly performances already available, as well as the benchmarks, (and, of course, just like the monthly performances they already include selection and allocation decisions which will later be explained).

When it comes to the **risk**, it was calculated as well for both; the performances and benchmarks, as a **standard deviation** for yearly periods, as follows:

$$\sigma = \sqrt{\frac{\sum_{t=1}^k (R - \bar{R})^2}{N - 1}} \quad (9)$$

Similarly, to the tracking error, but with:

$R^* = \text{Return (of P and B)}$

$\bar{R} = \text{Mean of Returns}^{16}$

We will analyze both types of strategies separately, to better understand their different behaviors and the explanations behind them.

### 4.3.1 Pooled Fund Portfolios

Pooled fund portfolios are very similar when it comes to the funds which they are invested in. Of course the growth part of the portfolio will be the exact same and they are composed only by *Pooled fund (hedged and unhedged)* funds (which will include the exact same asset classes for all portfolios), while the matching part of the scheme changes (even though it is also very similar for both portfolios). We can see in appendix 2, that the funds included in both portfolios 1 and 2 are similar, as well as their asset allocation percentage.

We can see the impacts of their differences in the following graphs, which show us the Portfolios' 1 and 2 returns, benchmarks, and respective risk for every year since their starting date. All years include the product of the twelve months except for their first

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<sup>16</sup> Where returns and mean of returns apply for both the returns of the portfolios and the benchmarks

years (as neither of the portfolios began in the first month of the year) and the last year, 2020, as it includes only the information up to September 2020.

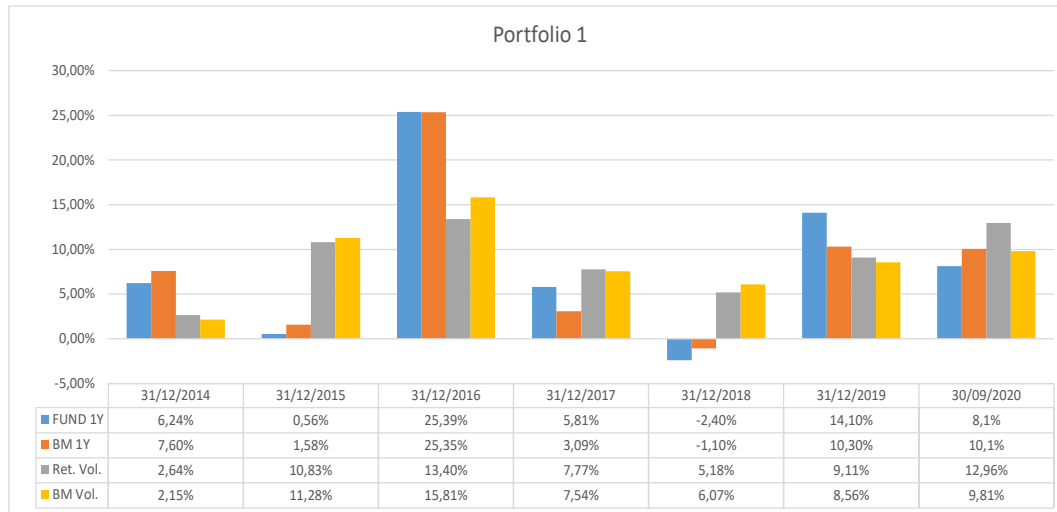


Figure 6 - Year return, benchmarks, and risk of portfolio 1, Source: Author, Based on: Portfolio data.

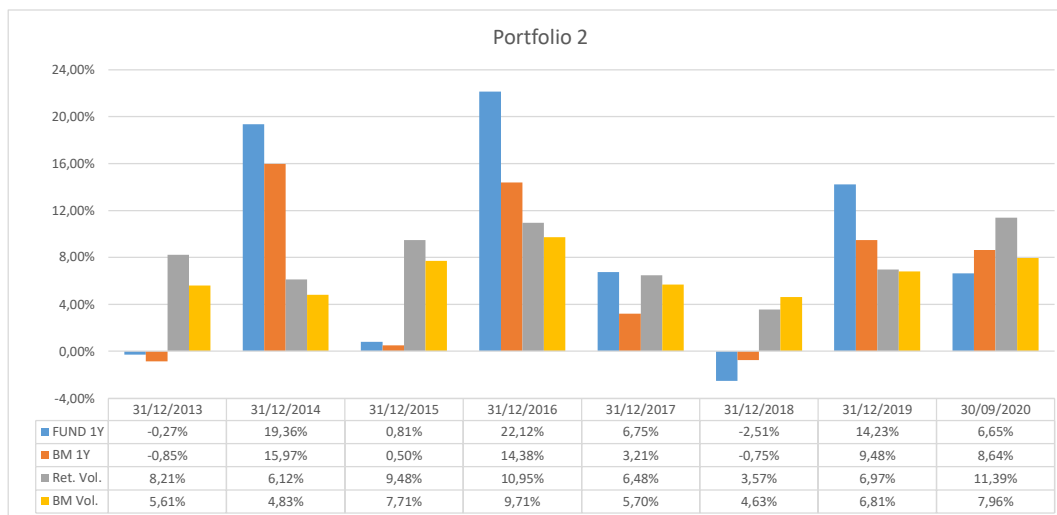


Figure 7 - Year return, benchmarks, and risk of portfolio 2, Source: Author, Based on: Portfolio data.

Comparing both graphs and their corresponding tables, we can confirm that as already seen in the whole monthly performance graphs, both portfolios returns deviate from their benchmarks a lot, this can be explained by how the volatility for both is also usually slightly different. This tells us that managers usually take more (or sometimes, less) risk than the risk of the portfolio’s benchmarks, hence achieving higher returns.

However, we can also see that the differences in actual performance and benchmark, compared to the differences between their risks are way higher (or lower), which tells us that even though managers assume a little more risk in order to obtain the higher returns, value is also being added by their selection and allocation decisions. We can especially see this effect in portfolio 2, which seems to achieve the best results of the two.

Portfolio 2 generally shows better returns than portfolio 1, including some very high performing years like 2016, where portfolio 1 also had very positive performance, but not over-performing the benchmark. We can also observe that (excluding starting period years) the only negatively performing year was the year 2018, where the relative performance was negative for both portfolios (-1.3% and -1.8% respectively). As we have seen this is explained by the global slowdown that happened in that year, in which growth seeking assets performed extremely poorly. Knowing that a situation like this had such negative impact on these portfolios, we could only expect that it would happen again this year (2020) with the economic shutdown.

These results are also a reflection of the managers usually opting for taking higher risks on their funds than the risks of the index benchmarks, as a change in the standard situation can affect the returns significantly. We can see in the graphs' tables that this situation led the managers to take on even more risk with the aim of stabilizing their returns. This is a sign that tells us, that management selection should not be done only based on past performance, but also other important factors, like their skill to handle these kinds of situations.

Since these portfolios are very similar in terms of selection, to check the previously mentioned; the **information ratio** (which tell us the units of return that are being added by taking additional risk) was calculated for both portfolios, for all of their periods of activity, with the following formula:

$$IR = \frac{P - B}{TE} \quad (10)$$

With variables (similarly to previous formulas):

$P = \text{Portfolio Return}$

$B = \text{Benchmark Return}^{17}$

$TE = \text{Tracking Error}$

The results of the calculation can be seen in the table below<sup>18</sup>:

PORTFOLIO	2013	2014	2015	2016	2017	2018	2019	2020
1	-	-	0.5	0.0	1.3	-0.6	1.8	-0.9
2	0.2	1.1	0.1	2.5	1.1	-0.6	1.5	-0.6

Table 7 - Information Ration for PF Portfolios, Source: Author, Based on: Portfolio Data.

These results indeed tell us that that for almost every period, except for the expected periods of 2018 and 2020, additional returns (excess returns) were obtained by the

<sup>17</sup> And where (in this case), the nominator (P-B) represents the average of the annual excess returns.

<sup>18</sup> 2014 was not included for portfolio 1, as it accounts for only 2 months which don't accurately portray the performance of the portfolio.

managers taking additional risk units. Periods where risk increases tend to show higher IR, while periods where it decreases show a lower one (example of 2018). However, in 2020 this is not verified, we can see that even though risk increased significantly, the IR was negative for both portfolios. This confirms that the managers were not ready to face this sudden increase in volatility and not able to adapt to it quickly, which affected the portfolios.

As it was already predictable, a similar impact to the one of the crisis in 2018 can be noticed again in the year 2020. Being that it is the only other period of the portfolios being active, where returns under-performed their benchmark indexes (as well as a negative IR). Knowing that managers up until that point were achieving higher results for their portfolios, this was not verified as soon as the COVID crisis started in the beginning of 2020. Their returns were negative for all months of the first quarter of the year, but the lowest performing month was with a noticeable difference: march, when the lockdown began. The fast change in the market situation lead the portfolios to have relative performances of -3.6% for portfolio 1 and -3.8% for portfolio 2.

Looking at the volatility from both portfolios, we can see that it increased significantly in 2020 for indexes, this was mostly what affected the performances, as managers could not predict this change and were not ready to face it so quickly. However, in the following months, this also led managers to having to increase the risk taken on the investments as well, in order to be able to bring their performances back up and eventually recover from the immense drawdown. We can see that this strategy was efficient, as the portfolios were able to rebound in only a month, achieving excess returns of 2.0% and 2.1% respectively, and maintained the positive excess returns in the rest of the year months.

Nonetheless, we can understand that this decision was not enough to ensure a positive year excess return (by the end of September 2020), as the worst months had a huge impact on the performance, while the positive ones were not able to balance it. So, both portfolios have shown negative relative performance in year terms, as we can see in the following table<sup>19</sup>.

	PORTFOLIO 1			PORTFOLIO 2		
	Return (%)	BM (%)	Rel. (%)	Return (%)	BM (%)	Rel. (%)
<b>2020</b>	8.1	10.1	-1.9	6.6	8.6	-2.0

Table 8 - PF Portfolios: January to September 2020 Performance, Source: Author, Based on: Portfolio Data.

Apart from the risk management, since both portfolios are composed by mainly the same funds and asset classes, we cannot identify much selection impact differences, so these decisions impact were mostly due to the **allocation**. Seeing the portfolios funds

<sup>19</sup> Totals may not be exact due to rounding.

and the allocation (Appendix 2) we can notice that both portfolios have an allocation strategy that invests mostly (around 40%) on the *Pool Fund Hedged* and highly also on *Tailor Credit* (around 30% for portfolio 1 and 23% for portfolio 2). This can explain why the portfolios experienced such low returns on the first quarter of 2020, in a time of uncertainty where growth assets weakened significantly, and where returns were hard to predict, returns for both *Pooled* fund unhedged and hedged were -11.9% and -17.1% respectively. Having such a high investment in those assets was extremely dangerous.

However, it also explains why the portfolios recovered, in following quarters, but not as strongly as other portfolios might have. As from April on, equity markets started to quickly rebound and achieving very good performances, being invested in *pooled funds*, which include many other asset classes (that were not performing as well), was not the best strategy (keeping in mind, these type of portfolios are not able to choose the asset classes included in the pooled fund, which means they couldn't have changed their investment to better performing assets).

Hence, what we can conclude from both the pooled fund model portfolios is: When it comes to the effects of the market crash that came from the pandemic, it affected both portfolios considerably, especially in the months when the lockdown happened and the economy shutdown (first quarter of 2020).

While risk increased significantly, in a time where it was extremely hard to manage, taking higher risks on the funds than the indexes was a dangerous thing to do. Both portfolios faced a very high increase in risk and a very low performance, and even though they were able to rebound from it in the months that followed the lockdown, it was not enough to ensure a positive relative performance for the year so far.

Finally, between the pooled fund portfolios, we cannot identify one that has been more efficient than the other, but we can say that this type of strategy might not have been the most efficient in this scenario, due to all the restrictions that it is subject to. Nonetheless we cannot blame the managers for this, as even given those restrictions and the bad market scenario, we see that they were able to perform well in periods that followed March of 2020.

### 4.3.2 Client Specific Portfolios

When it comes to the **Client Specific portfolios**, things change from previously. The presented portfolios are very different from each other and can even be considered as two different sub-strategies. We can see these different strategies in the following: Portfolio 3 invests in property funds and cash, while 4 decides not to. Portfolio 3 invests mostly in growth funds, being that it only includes three matching funds on the portfolio (and it was been like that for every period of its existence), while 4 doesn't invest as much in growth, but more in matching and even decides to de-invest in all matching

funds in 2020. This tells us that 3 is more growth seeking and risk-taking, while 4 is a safer strategy.

Just like for the previous section, the following graphs show us the Portfolios' 3 and 4 returns, benchmarks, and respective associated risks:

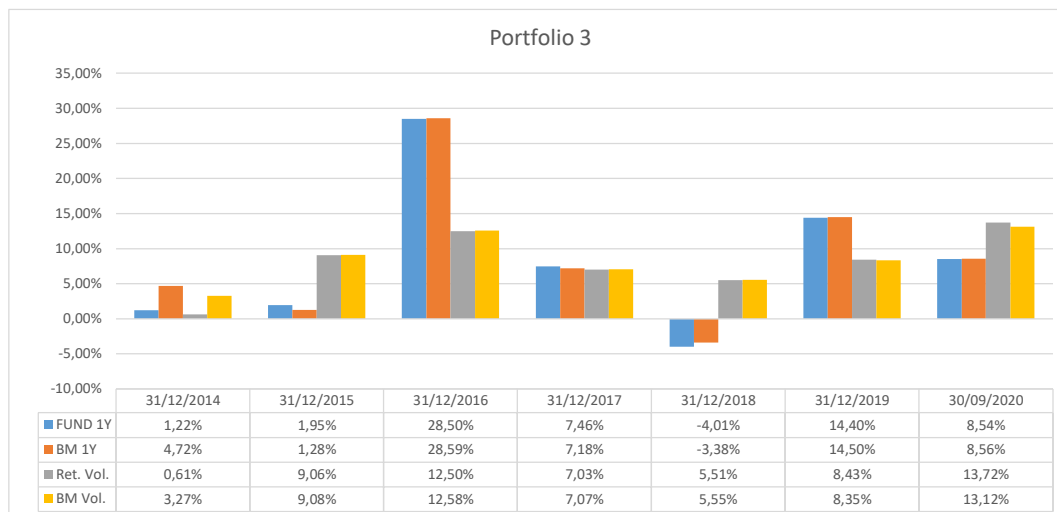


Figure 8 - Year return, benchmarks, and risk of portfolio 3, Source: Author, Based on: Portfolio data.

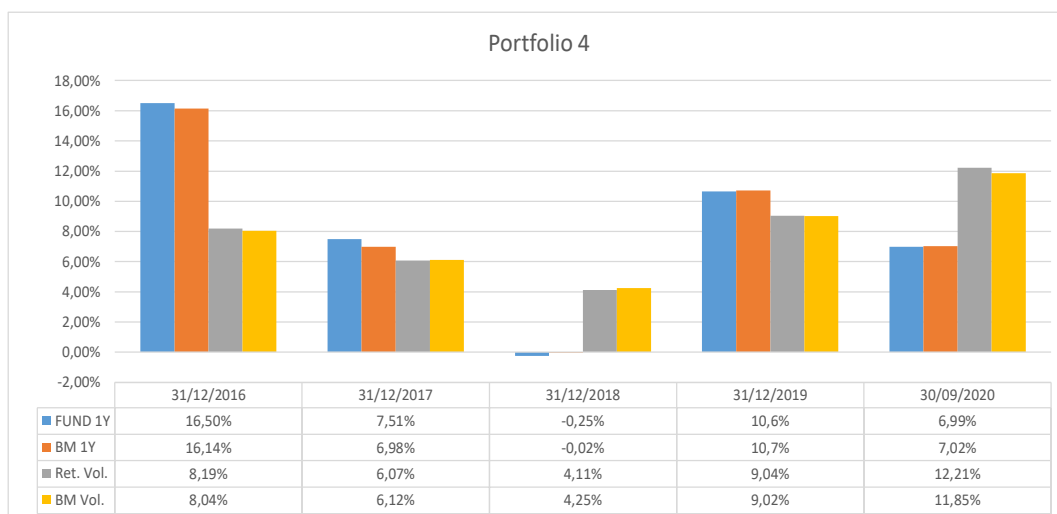


Figure 9 - Year return, benchmarks, and risk of portfolio 4, Source: Author, Based on: Portfolio data.

We can observe that unlike pooled fund portfolios, for the case of client specific, risks are in line (with a difference close to zero) for returns and benchmarks, in every period since their first year of being active. This is only not verified for portfolio 3 in the period of 2014 as it includes two months only, since the portfolio started in November of that year. Being that in the beginning of an investment risk is harder to control, the fact that the total only accounts for two very volatile months, explains the difference in risk between the benchmark and the return. This is not verified for portfolio 4, as it's first year of existence accounts for 6 months, which allowed for an enough period to stabilize

volatility. We can also notice that the volatility had a repercussion in the performance of portfolio 3 in the first year, as it under-performed its benchmark significantly.

It's also noticeable that for these portfolios, in all their periods of activity, the relative performances (Fund- BM) for both, oscillate more between being positive and negative in different periods. However, they were always around zero, which means they performed according to their indexes. This makes sense because, like it was already mentioned, the differences between the performance and the benchmarks risks, that are assumed by the manager, are also zero (or extremely close to zero).

The following table shows the results of the IR calculations for CS portfolios:

PORTFOLIO	2015	2016	2017	2018	2019	2020
3 <sup>20</sup>	1.7	-0.2	0.7	-1.6	-0.2	-0.1
4	-	1.3	1.9	-0.8	-0.2	-0.1

Table 9 - Information Ratio for CS Portfolios, Source: Author, Based on: Portfolio Data.

As we can see from the results, we confirm that no pattern is observed when it comes to higher risk bringing higher returns (for some periods where volatility is higher, IR is also higher, but for some other periods where the volatility remains higher, the IR is lower and sometimes even negative). Hence for most periods no excess returns were obtained by taking additional risk units (meaning returns were in line with the benchmarks). Nevertheless, we can see that in 2020, the IR was not as low as the pooled fund portfolios, so we see that the increase in volatility did not have major negative repercussions in the performance of these portfolios as they have a smaller tracking error and again, returns were able to be in line with the benchmarks.

Keeping this in mind, and looking at the graphs, we see that just like the pooled fund portfolios, the only noticeably poorly performing periods are 2018 (for the same reasons) and 2020 (January to September), but we can also see the (previously mentioned) differences, CS portfolios performed fairly well for what was expected from the situation, not showing negative relative performance.

We can see this in the following year totals table<sup>21</sup>:

	PORTFOLIO 3			PORTFOLIO 4		
	Return (%)	BM (%)	Rel. (%)	Return (%)	BM (%)	Rel. (%)
2020	8.5	8.6	0.0	7.0	7.0	0.0

Table 10 – CS Portfolios: January to September 2020 Performance, Source: Author, Based on: Portfolio Data.

<sup>20</sup> 2014 was not included for portfolio 3, as it accounts for only 2 months which don't accurately portray the performance of the portfolio.

<sup>21</sup> Totals may not be exact due to rounding.



Nonetheless, although the annualized returns for 2020 are positive overall, this doesn't mean that returns were positive for every month of the year (as we have seen in the monthly performance graphs).

The reasoning behind these portfolio's performance is more interesting than for the pooled fund model, as (like mentioned before) the portfolios are way more diversified which means that more value was added both through **allocation** and **selection** (see appendix 3).

Portfolio 3 has an allocation of 50-50% divided between growth and matching assets, even though funds with the higher investment (namely Inflation-Linked LDI Bonds) are in the safer part, the fact that almost half of the investment is in growth funds, shows that the portfolio seeks a high growth strategy and is willing to take on more volatile funds in order to achieve these returns faster (although, always following these funds index benchmark risk and not pursuing any additional risk in order to obtain higher returns). Portfolio 4, on the other hand, has an allocation of over 70% on the matching part of the portfolio, which means that the investors are not willing to take unnecessary risk just to reach their desired returns in a shorter time. Hence it is not so surprising to see, that in the beginning of 2020, when the pandemic forced the lockdown to happen, and the uncertainty started arising, the portfolio de-invested in all of its growth assets, leaving their investment 100% allocated to matching assets, turning the risk from the growth part into 0% and changing it mostly into matching credit risk. (see appendix 3 for allocation and funds).

For portfolio 2, keeping the allocation of almost 50%-50% to both growth and matching assets is the explanation for the portfolios returns in all quarters of the current year. As we can see in appendix 3, the portfolio invests in many different equity funds, and knowing that equity markets were some of the most affected in the beginning of 2020, it is easy to understand why the portfolio obtained such low returns in those months, especially in march (-1.6% relative performance) when the lockdown began. Some examples of very low performing equity funds were *emerging markets equity* (with -19.6 return), *small cap equity* (-29.1 return) ... among others that performed extremely negatively. At such a low point, even though 50% of their investment was still in matching funds (which performed almost normally) it was not enough to ensure the positive performance of the total portfolio.

When it comes to portfolio 4 this reasoning also verifies, however, it is for different reasons. Since this scheme decided to de-invest in all growth assets, with the aim of hedging their portfolio and avoiding the extreme plum of the equity markets from affecting it. Even though this strategy brought stable returns to portfolio 4 in the months that followed the lockdown, this decision shows to not have been the best when it comes to returns achieved and risk taken. The reason for this, is that markets and especially managers, adapted well to this new situation, and funds like: fixed income

and alternative investments also recovered very well in the months that followed, but equity markets definitely led the improvement of the growth portfolios recovery, with *global low volatility, sustainable equity, and emerging markets equity* funds (for instance) performing over expectations.

Knowing that both portfolios follow different benchmarks, its easy to understand that portfolio 4 is following a less risky benchmark, hence its returns are expected to be lower than portfolio 3, which is in fact verified in annual returns' terms (7.0% compared to 8.5%, respectively) as well as in monthly returns. This is especially noticeable in the last three months available (July, August, and September) where portfolio 3 managed to obtain always positive relative performance (0.2%, 1.2% and 0.1%, respectively), while portfolio 3 was only able to achieve positive excess returns in August.

It is also relevant to keep in mind that neither of the portfolio's managers take excess risk on their portfolios, then the risk of the respective benchmarks. Hence, the obtained performances are only attributed to managers allocation, but mainly selection decisions.

So, we can conclude that: for these portfolios both allocation and selection, but also risk management, had an important impact on the performances achieved. Management seems to have been well done for both portfolios throughout the whole pandemic and lockdown period (even though returns were negative in the worst months of 2020). With strategies that were very different in fund selection but also in allocation, both were able to attain positive performances. Although, from a COVID situation perspective, the strategy of portfolio 4, of de-investing in all growth funds, seems to have been less effective, as it prevented it from making the most of the quickly recovering equity markets.

### 4.3.3 Results

When it comes to the impact of the pandemic on the analyzed portfolios returns: As we have seen in the previously presented tables, the performances (corresponding to the product of the monthly returns) of 2020, were not significantly negative for the client specific portfolios which were able to perform in line with their benchmark indexes, ensuring a 0.0% relative performance. Pooled fund on the other hand, were considerably affected, with overall year relative performance being negative for both portfolios (this was mainly due to their strategy of taking higher risk than the risk of the fund's benchmarks). Hence, knowing that portfolios 3 and 4 act more according to benchmark risk, it is not surprising that these were the best performing ones.

But taking into account that pension funds have a long term investment horizon, to see the actual consequences of the pandemic in the returns, we consider the average of returns before this period and after, to check if any significant differences can be noticed. For this effect average annualized returns and standard deviations were

calculated since the first month of the 4 portfolios' activity, up to December 2018, up to December 2019, and then up to September 2020.

The results (%) can be seen in the following table:

			UP TO DEC. 2018	UP TO DEC. 2019	UP TO DEC. 2018	UP TO DEC. 2019	ENTIRE PERIOD	ENTIRE PERIOD
	Portfolio	Data Since	Average Return (%)	Stand. Dev. (%)	Average Return (%)	Stand. Dev. (%)	Average Return (%)	Stand. Dev. (%)
PF	1	2014	7.12	9.96	8.28	9.22	8.26	8.54
	2	2013	7.71	9.66	8.64	9.23	8.39	8.66
CS	3	2014	7.03	11.34	8.26	10.71	8.30	9.92
	4	2016	7.29	6.84	8.60	6.04	8.28	5.44

Table 11 - Average returns and standard deviations up to Dec/18, Dec/19 and Sep/20, Source: Author, Based on: Portfolios Data.

As we can see from the table above, average returns were not significantly impacted for the portfolios except for portfolio 2, which went down a bit. This is only a significant difference because the pandemic period represents only 9 months of performance in a period of over 7 years. While portfolio 3 also had a lower average than previous period, the difference is that it accounts with less three years of returns than portfolio 2, (as well as a less risk-taking strategy). But despite being the one that showed the biggest decrease of the average returns, we can notice that for all periods, portfolio 2 shows the highest average of the four, including for the entire period (which accounts with the pandemic repercussions), hence we can conclude that even with the biggest drawdown in average returns, it is still the best performing one of the four.

However, the repercussions, were not major for any of the portfolios, as these have been operating for many years before, where unpredictable situations such as the COVID-19 did not happen. And even after the negative returns and the volatility increase, that came for all portfolios when the lockdown started, the managers adapted rapidly to the new situation, bringing returns back to a positive end as soon as the months that followed the lockdown. Some choosing to make safer decisions (portfolio 4) and others choosing to take even more risk in order to bring the performance back up.

Also, keeping in mind that pension fund investments are long term investments, they still will have a long period of being active in the next years, so, if this situation is able to keep being controlled in the future and no more unpredictable changes come from it, the impact of COVID will be almost none for pension funds.

As for management, the conclusions we can take are: in the presented pandemic situation, managers of client specific strategies were the most prepared, as they take the risk on their investment funds, according to the risk set for the benchmarks, hence, they couldn't be much surprised by the increase in volatility. So, in a situation like this, this type of management strategy has been the most efficient in terms of being able to achieve returns that did not fall under expectations, as this management strategy is based on following the benchmarks of the funds very closely and not taking higher risks looking for higher rewards, so even in a situation of market alteration, the sudden volatility increases did not have major repercussions on these portfolios and managers were still able to perform according to the set benchmarks. While for the pooled fund portfolios, since this is a strategy that acts on taking higher volatility units to obtain higher returns, in a situation where the market changed unexpectedly, managers were not prepared to face this new situation. As volatility suddenly increased, even higher than what they were already taking, it was impossible to control it soon enough. Hence, for these portfolios, management on the first quarter mainly, has shown to have been done poorly at first, being that returns were not only very negative but also significantly below the benchmark, and even though managers were able to adapt as fast as possible, achieving exceptionally positive returns, the performance of the year (up to 2020) was already compromised.

For these same reasons, we can understand that pooled fund strategy usually brings higher returns in a regular market situation, hence being generally more efficient, but not in a situation like the present pandemic. Since portfolios 3 and 4 performed noticeably better, we can conclude that client specific strategies were the most efficient in a time like this. Mainly due to the freedom of allocation and selection that this strategy holds; while portfolio 4 decided to change into a more safer investment strategy (even though risk still was much higher than usual for this portfolio), portfolio 3 still decided to keep their investment in riskier funds, while adapting easily to the new market scenario, and both portfolios ended up performing well.

## 5. Conclusion

The main conclusion that can be taken from this study is that it is extremely important for investors to make the decisions on their portfolio managers based on aspects other than their past performance, as a situation of uncertainty and sudden market alteration, as well as unexpected volatility increases, can completely affect a whole portfolio performance if management is not done efficiently. In the portfolios studied, the management decisions have shown to be extremely important when it comes to risk management and asset allocation, but also fund selection. One important example of this during the pandemic were the equity markets, which were some of the most affected in the beginning of the lockdown, but also some of the best performing in the months that followed, and only portfolio 3 managers were able to take advantage of this quick recovery.

From the studied portfolios and strategies, we can conclude the following: Client specific strategy has shown to be the most effective during this period. With more freedom of choice when it comes to fund selection, investors and managers were able to adapt (in the way they intended most adequate), their portfolios to the presented situation, achieving returns that were not too bad for the time being (we can't classify them as good, as even if it was only by decimals, the portfolios returns still under-performed their benchmark for the year total). Pooled fund strategy was not able to perform the same way relative to their benchmarks (returns being way below it), and even though it rebounded well in the second quarter of 2020, the performance of the overall year was impacted by the awful first quarter.

As for the efficiency of the strategies, we have seen that all of them are generally efficient in regular market scenarios. However, we can identify one that has shown to be more affected by this particular situation than the others, which was portfolio 2. The one that initially showed to have the best performance, usually over-performing its index returns, ended up being the one that had their average returns lowered the most. As we have been seeing throughout the analysis, this is due to the strategy of usually taking higher risk on returns than on the benchmark, as well as having many investment restrictions. Nonetheless, despite having their returns affected by this situation the most, it still maintained the highest average of the four portfolios, and knowing that assuming higher risk than the benchmark means higher losses on a crashing market situation, but higher in a growing markets situation (which seems to be the usual strategy of this portfolio), this drawdown can easily be compensated in better periods in the future.

When it comes to what could have been done better, given that all portfolios adapted to the situation well rebounding in the following periods, it seems that the choices were all well made. Although for pooled fund portfolios, this adaptation to the risk increase should have been done sooner, and allocation choices could have been more efficient,

achieving better returns, if managers decided to change a bigger part to the investment allocation to the safer part of the portfolio (matching assets), this way given that the pooled funds include many asset classes that could not easily be controlled in a time of uncertainty especially as a whole fund, such low returns could have been avoided and the year performance of the portfolios wouldn't have suffered such bad repercussions.

Finally, in relation to the overall performance, we conclude the following: Surprisingly, a situation which was expected to have very negative consequences on the investments market, ended up only actually affecting the performances of these portfolios in the first quarter of 2020. As we have seen, all portfolios (as well as its funds) were able to rebound in a very short period of time, the following months performances were already very positive due to adaptation of the managers and their strategies decisions. Hence, even though the consequences were severe in the quarter of the lockdown, comparing the average returns since start date before and after this year, we saw that they did impact the portfolios performance generally, and stabilized the usually increasing average, but only portfolio 2 decreased significantly. Nevertheless, knowing that these portfolios are long term investments, if the situation remains controlled like it was in the second quarter of 2020, these impacts will be non-existent in the long term.

Finally we need to mention that there are some drawbacks in this analysis, such as the following: Pension funds' investments are usually long term investments, and since the analyzed portfolios still don't have very long periods of existence, we cannot fully understand the relevance of the impact of this period on them, as they probably won't have a major effect in the long term (if the situation stabilizes), and also this is a study up until September of 2020, with results of the following quarter still unknown, and with the pandemic still affecting the world in general, and seemingly only increasing, the future situation is still uncertain, and the recover that has been progressively done up until this moment can be lost if another unexpected situation like the lockdown that happened in march happens again, hence we cannot know for sure how the market and the portfolios will be impacted in the future, and the study of this topic will certainly be going on for a long time.

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Appendix 1- Monthly and year return and BM for all portfolios.

DATE	POOLED FUND								CLIENT SPECIFIC							
	Portfolio 1				Portfolio 2				Portfolio 3				Portfolio 4			
	FUND	BM	FUND 1Y	BM 1Y	FUND	BM	FUND 1Y	BM 1Y	FUND	BM	FUND 1Y	BM 1Y	FUND	BM	FUND 1Y	BM 1Y
28/02/2013					2,245%	0,87%										
31/03/2013					2,747%	2,26%										
30/04/2013					1,686%	1,70%										
31/05/2013					-2,086%	-2,48%										
30/06/2013					-5,081%	-3,32%										
31/07/2013					2,420%	0,91%										
31/08/2013					-1,989%	-0,62%										
30/09/2013					0,748%	0,94%										
31/10/2013					2,522%	1,14%										
30/11/2013					-1,909%	-1,01%										
31/12/2013					-1,230%	-1,08%	-1,2%	0,60%								
31/01/2014					1,560%	2,16%										
28/02/2014					1,092%	0,18%										
31/03/2014					0,605%	0,35%										
30/04/2014					1,109%	0,94%										
31/05/2014					2,214%	1,20%										
30/06/2014					-0,681%	-0,48%										
31/07/2014					1,284%	1,10%										
31/08/2014					4,849%	4,11%										
30/09/2014					-1,598%	-0,78%										
31/10/2014					1,663%	1,12%										
30/11/2014	4,959%	5,26%			4,686%	3,45%			1,041%	4,67%						
31/12/2014	1,222%	2,22%			1,227%	1,67%	19,4%	15,97%	0,173%	0,05%						
31/01/2015	5,033%	6,03%			6,138%	4,81%			4,998%	5,00%						
28/02/2015	-2,232%	-2,23%			-3,627%	-3,96%			-2,614%	-2,69%						
31/03/2015	3,972%	3,99%			2,718%	2,14%			3,722%	3,63%						
30/04/2015	-0,984%	-0,98%			-1,662%	-1,76%			-0,389%	-0,30%						
31/05/2015	0,855%	1,05%			0,229%	0,37%			0,593%	0,45%						
30/06/2015	-4,632%	-4,68%			-3,597%	-1,99%			-3,374%	-3,45%						
31/07/2015	3,395%	3,40%			2,245%	1,99%			2,622%	2,54%						
31/08/2015	-3,732%	-3,73%			-1,813%	-0,34%			-2,433%	-2,61%						
30/09/2015	-1,750%	-1,55%			-0,488%	0,57%			-1,469%	-1,43%						
31/10/2015	2,587%	2,58%			1,268%	-0,89%			1,705%	1,70%						
30/11/2015	1,757%	1,44%			1,620%	1,29%			1,312%	1,16%						
31/12/2015	-3,126%	-3,13%	0,56%		-1,777%	-1,45%	0,8%	0,50%	-2,330%	-2,34%	1,95%	1,28%				
31/01/2016	1,869%	1,87%			1,691%	3,11%			1,934%	2,15%						
29/02/2016	-0,090%	-0,09%			1,539%	0,53%			0,469%	0,47%						
31/03/2016	3,353%	3,35%			2,904%	1,02%			3,229%	3,25%						
30/04/2016	-0,905%	-0,90%			-0,494%	-0,83%			-1,332%	-1,34%						
31/05/2016	2,257%	2,26%			1,908%	1,83%			1,645%	1,57%						
30/06/2016	9,291%	9,29%			8,030%	6,26%			9,971%	10,23%	5,750%	5,89%				
31/07/2016	4,510%	4,51%			4,031%	2,66%			2,657%	2,44%	2,920%	2,84%				
31/08/2016	7,387%	8,75%			5,190%	4,64%			7,361%	7,26%	6,133%	5,71%				
30/09/2016	-1,879%	-2,12%			-2,088%	-2,25%			-0,463%	-0,30%	0,135%	0,17%				
31/10/2016	-1,957%	-2,62%			-2,541%	-3,22%			0,924%	0,74%	1,078%	0,91%				
30/11/2016	-4,375%	-3,84%			-2,835%	-2,37%			-4,169%	-4,13%	-3,450%	-3,39%				
31/12/2016	4,258%	3,29%	4,26%	3,29%	3,404%	2,60%	22,1%	14,38%	3,871%	3,84%	28,50%	14,81%	3,202%	3,31%	16,1	16,1
31/01/2017	-0,926%	-1,11%			-1,224%	-1,44%			0,314%	0,15%	0,774%	0,57%				
28/02/2017	3,574%	2,72%			3,778%	2,79%			2,084%	2,09%	2,005%	2,02%				
31/03/2017	0,729%	0,63%			0,607%	0,48%			1,380%	1,29%	0,761%	0,62%				
30/04/2017	1,473%	1,48%			0,731%	0,67%			1,574%	1,51%	1,192%	1,09%				
31/05/2017	-0,009%	-0,36%			0,864%	0,40%			-0,575%	-0,38%	-0,038%	-0,01%				
30/06/2017	-2,927%	-2,86%			-2,229%	-2,19%			-2,459%	-2,69%	-1,997%	-2,04%				
31/07/2017	-0,157%	-0,45%			0,553%	0,17%			-0,254%	-0,31%	0,037%	-0,11%				
31/08/2017	3,939%	3,63%			2,911%	2,56%			4,473%	4,49%	3,920%	3,93%				
30/09/2017	-3,872%	-3,66%			-2,910%	-2,75%			-3,357%	-3,30%	-3,039%	-3,07%				
31/10/2017	1,273%	0,74%			1,189%	0,53%			1,637%	1,70%	1,588%	1,70%				
30/11/2017	0,388%	0,37%			0,336%	0,25%			0,506%	0,59%	0,333%	0,42%				
31/12/2017	2,476%	2,18%	5,81%	3,09%	2,156%	1,84%	6,8%	3,21%	2,142%	2,05%	7,46%	12,46%	1,907%	1,83%	7,5	7
31/01/2018	-2,3%	-2,3%			-1,632%	-1,79%			-1,416%	-1,41%	-1,048%	-1,06%				
28/02/2018	-0,3%	-0,1%			-0,487%	-0,15%			0,242%	0,04%	-0,453%	-0,48%				
31/03/2018	1,8%	2,3%			1,267%	1,89%			1,680%	1,76%	0,872%	0,90%				
30/04/2018	-1,3%	-1,7%			-0,675%	-1,17%			-2,020%	-1,89%	-1,074%	-0,98%				
31/05/2018	2,0%	1,8%			1,511%	1,36%			2,368%	2,61%	1,689%	2,02%				
30/06/2018	-0,9%	-0,8%			-0,704%	-0,62%			-1,214%	-1,13%	-0,166%	-0,16%				
31/07/2018	0,6%	0,1%			0,574%	-0,01%			1,146%	1,22%	0,602%	0,52%				
31/08/2018	-0,3%	-0,1%			-0,066%	0,11%			-0,579%	-0,30%	-0,329%	-0,26%				
30/09/2018	-1,6%	-1,6%			-1,257%	-1,30%			-1,565%	-1,47%	-1,022%	-0,96%				
31/10/2018	0,6%	1,5%			-0,267%	0,98%			-0,578%	-0,51%	1,522%	1,35%				
30/11/2018	-2,4%	-2,8%			-1,646%	-2,02%			-3,141%	-3,16%	-2,209%	-2,33%				
31/12/2018	1,8%	2,8%	-2,40%	-1,10%	0,906%	2,08%	-2,5%	-0,75%	1,145%	0,97%	-4,01%	8,58%	1,449%	1,52%	-0,3	-0,1
31/01/2019	2,6%	1,6%			2,914%	1,52%			3,351%	3,30%	1,791%	1,65%				
28/02/2019	-0,5%	-0,9%			-0,307%	-0,87%			-0,225%	-0,15%	-0,585%	-0,62%				
31/03/2019	5,7%	5,3%			4,417%	4,00%			5,857%	5,85%	5,626%	5,68%				
30/04/2019	-0,9%	-1,3%			-0,581%	-1,01%			-0,871%	-0,82%	-0,887%	-0,88%				
31/05/2019	2,9%	3,3%			2,096%	2,53%			2,503%	2,31%	2,817%	2,95%				
30/06/2019	1,3%	0,4%			1,734%	0,83%			0,914%	0,94%	0,555%	0,62%				
31/07/2019	4,3%	3,9%			3,493%	2,95%			2,974%	3,00%	3,779%	3,71%				
31/08/2019	3,6%	3,8%			3,048%	3,31%			3,567%	3,66%	3,614%	3,65%				
30/09/2019	0,3%	0,1%			0,463%	0,20%			0,283%	0,26%	0,112%	0,01%				
31/10/2019	-3,7%	-3,4%			-2,362%	-2,21%			-3,375%	-3,31%	-4,149%	-4,02%				
30/11/2019	-1,1%	-1,2%			-0,737%	-0,88%			-0,501%	-0,44%	-1,153%	-1,18%				
31/12/2019	-0,9%	-1,3%	14,10%	10,30%	-0,562%	-1,05%	14,2%	9,48%	-0,593%	-0,62%	14,40%	9,67%	-0,960%	-0,96%	10,6	10,7
31/01/2020	4,4%	4,5%			4,0%	4,2%			3,542%	3,60%	3,577%	3,66%				
29/02/2020	-0,2%	0,8%			-0,4%	0,6%			-0,099%	-0,23%	0,916%	1,04%				
31/03/2020	-7,7%	-4,2%			-7,0%	-3,2%			-8,268%	-6,63%	-8,141%	-7,66%				
30/04/2020	8,4%	6,4%			7,6%	5,5%			8,573%	8,59%	7,438%	6,56%				
31/05/2020	3,6%	2,8%			2,3%	1,4%			4,619%	4,39%	3,398%	3,39%				
30/06/2020	0,8%	0,4%			0,6%	0,3%			1,367%	1,38%	1,013%	0,96%				
31/07/2020	1,6%	1,7%			1,6%	1,5%			1,563%	-1,620%	1,29%	1,56%				
31/08/2020	-3,1%	-3,8%			-2,0%	-2,7%			-3,81%	-5,68%	-2,40%	-4,07%				
30/09/2020	0,9%	1,6%	8,13%	10,07%	0,5%	1,2%	6,65%	8,64%	1,70%	0,17%	8,54%	3,09%	0,45%	0,65%	6,99%	5,48%

**Appendix 2- Pooled Fund Portfolios (1 and 2): Asset Classes and allocation as at 30 September 2020.**

<b>Portfolio 1</b>		<b>Portfolio 2</b>	
<b>Fund</b>	<b>Allocation (%)</b>	<b>Fund</b>	<b>Allocation (%)</b>
<b>Growth</b>	<b>50.0</b>	<b>Growth</b>	<b>50.0</b>
Pooled Fund	10.4	Pooled Fund	10.2
Pooled Fund (Hedged)	39.6	Pooled Fund (Hedged)	39.8
<b>Matching</b>	<b>50.0</b>	<b>Matching</b>	<b>50.0</b>
Tailored Credit	26.9	Tailored Credit	22.5
UK Long Gilts	1.0	UK Long Gilts	9.7
Inflation-Linked Bonds	2.5	Inflation-Linked Bonds	4.9
Medium Fixed Bonds	1.2	Nominal LDI Bonds	4.6
Long Fixed Bonds	3.6	Medium Fixed Bonds	2.5
Short Real Bonds	4.1	Long Fixed Bonds	0.9
Medium Real Bonds	2.1	Short Real Bonds	2.2
Long Real Bonds	3.5	Medium Real Bonds	0.4
Short Inflation Bonds	4.5	Short Inflation Bonds	2.5
UK Cash	0.5	-	-

**Appendix 3-** Client Specific Portfolios (3 and 4): Asset Classes and allocation as at 30 September 2020.

Portfolio 3		Portfolio 4	
Funds	Allocation (%)	Funds	Allocation (%)
<b>Growth</b>	<b>50.0</b>	<b>Growth</b>	<b>0.0</b>
Passive Global Equity (Hedged)	6.7	-	-
Low Volatility Equity	0.7	<b>Matching</b>	<b>100.0</b>
Low Volatility Equity (Hedged)	3.1	UK Long Gilts	1.0
Global Small Cap Equity	2.5	Inflation-Linked Bonds	37.0
Global Small Cap Equity (Hedged)	0.4	Long Fixed Bonds	1.0
Sustainable Global Equity (Hedged)	3.2	Short Real Bonds	1.6
Global Infrastructure Equity (Hedged)	2.0	Medium Real Bonds	2.0
Emerging Markets Equity	4.7	Long Real Bonds	1.0
Passive Global REITS (Hedged)	1.0	Short Inflation Bonds	6.8
Emerging Markets Debt	3.2	Tailored Credit	49.5
Global High Yield Bonds (Hedged)	3.0	-	-
Credit (Hedged)	7.4	-	-
Absolute Return Fixed Income (Hedged)	3.0	-	-
Property	1.8	-	-
UK Cash	7.0	-	-
<b>Matching</b>	<b>50.0</b>	-	-
Tailored Credit	4.7	-	-
Nominal LDI Bonds	11.6	-	-
Inflation-Linked LDI Bonds	33.6	-	-