The effects of increased regulation on the performance of pension funds

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Management Summary

This report studies the effects of regulation, in the form of the FTK (Financieel Toetsingskader) and the nFTK (Nieuw Financieel Toetsingskader), on the performance of pension funds over the past ten years. A tumultuous period which was marked with different macroeconomic events like the crisis. Performance is defined as the monthly return on the investments made by pension funds.

In this study regulation is assumed to have two identifiable effects:

- De-risking of investments, thereby increasing the fraction of fixed income investments.
- Adoption of one of three hedging structures: a classical 'longterm' approach, an 'overlay' strategy, or a 'matching and return' approach.

Due to these two effects, the research question: *What is the effect of regulation on the performance of pension funds*? is split into three sub-questions:

1. *What is the effect of a high fixed income investment ratio on the performance of pension funds?*
2. *What are the effects of the three different hedging structures on the performance of pension funds?*
3. *What combination of fixed income ratio and hedging strategy has performed best in the period after the introduction of the FTK up until the end of 2015?*

Dataset

These sub-questions are answered by utilizing a dataset that was provided by pension fund custodian KAS BANK. This dataset contains the anonymized returns of 74 pension funds over different periods of time between 2000 and 2015. Additionally, characteristics of the pension funds were provided. This allowed categorisation of each fund based on fixed income investment ratio, creating a group of funds with a high ratio and a group with a low ratio. Funds were also categorised based on their hedging structure. This allowed for creation of three groups which consisted of traditional 'longterm' funds, 'overlay' funds that hedge their risk by using financial products, and 'matching' funds which utilize a matching and return portfolio.

Methodology

This paper uses different types of event study methodology. This methodology is comprehensively described by MacKinlay (1997). Sub-question 1 is answered by adopting an adaptation proposed by Gur-Gershgoren et al., (2008) which enables greater testing power in long-term event studies. Sub-question 2 and 3 are answered by using a more traditional Buy-and-Hold-Abnormal-Return approach. This is done because the splintered dataset unfortunately doesn't allow for testing of questions 2 and 3 according to the adaptations suggested by Gur-Gershgoren et al., (2008).

Results and conclusions

The main findings of this report in regards to the three sub-questions are:

- A high fixed income investment share provides protection in times of crisis. Pension funds that were categorized as having a 'high fixed income rate' significantly outperformed the 'low fixed income rate' categorized funds in times of recession. Consequently, in times of rising markets the 'higher fixed income funds' were outperformed by 'lower fixed income funds'.
- If the different hedging structures are taken into account, it becomes clear that in the long run the 'overlay' structure outperforms the more traditional 'longterm' structure and the 'matching' structure. When looking at the time window surrounding the crisis the 'overlay' structure clearly outperforms the other hedging methods.

- When both effects are combined to form six different groups it is found that funds that combine an ‘overlay’ hedging structure with a low fixed income ratio and funds that combine a ‘longterm’ structure with a high fixed income ratio outperform the other groups. The ‘longterm’ structured funds with a low fixed income ratio perform the worst while ‘matching’ combined with a low fixed income ratio and ‘overlay’ combined with a high fixed income ratio have an average performance.

The main conclusion of this report is that both assumed effects of regulation have had a significant impact on the performance of pension funds. Utilizing a low fixed income ratio combined with a ‘longterm’ hedging approach yields the poorest performance, while a ‘longterm’ hedging structure combined with a high fixed income ratio, just as the ‘overlay’ group with a low fixed income ratio have created the biggest return.

Preface

This master’s thesis is the culmination of my time at the University of Twente. It serves as the capstone to my master education Industrial Engineering and Management.

I would like to thank Mark Schilstra for giving me the opportunity to do my internship at KAS BANK, Arjan de Caluwe for his day to day guidance and all other employees at KAS BANK for all the help and fun during my internship. From the University I would like to thank Toon de Bakker and Berend Roorda for their contributions and guidance during the writing process.

Pension funds are facing many difficulties and problems. Controversy exists on the solutions to tackle these problems, I hope that my efforts in writing this paper allows for some enlightenment as to the nature of these problems and how they might be tackled.

I hope you enjoy reading this paper!

1. Introduction

Section 1.1 will introduce the current state of pension funds in the Netherlands. It will give a short overview of the characteristics of pension funds and the problems they are facing. The continuing increase of regulation to tackle these problems might have adverse effects, these effects are at the centre of this report and serve as the main cause for the research question that is introduced in section 1.2. The methodology used for this research is shortly introduced in section 1.3. Section 1.4 describes the experience gained at KAS BANK and 1.5 serves as a global description of the report and its structure.

1.1 Pension funds in the Netherlands

Old-age pension is something that we, the Dutch, have long considered as axiomatic in life. During one's working years, regular payments are made to a scheme that guarantees a continued wage after you retire. At a predetermined age you will stop working, and start receiving the money that you, and your employer, have saved for during your career. This used to work out really well, everybody received their pension after the age of 65 and some people even got to retire at an earlier age without it causing any problems to the system. The Dutch pension funds were functioning great and were considered to be the leading pension funds in the world (Mercer, 2015).

Recently, major changes in the world's financial situation and the greying demographic of the Netherlands are causing trouble in paradise. The wealth of the pension funds is greater than ever, yet pension payments haven't been indexed for a long time. There was a public outcry when the government announced plans to gradually heighten the pension age from 65 to 67 and pension funds have to keep altering their payments to ensure a pension plan for everyone. This created a lot of tension and disappointment amongst the population and a doubt in the younger generation whether investing in pension funds is worth it. The main problem causing discontent seems to be that it is hard for the general public to grasp and understand the challenges that the pension funds are faced with.

In the Netherlands pension funds are monitored by the AFM (Authoriteit Financiële Markten) and the DNB (De Nederlandsche Bank). To tackle the problems they took multiple measures. One of these measures was the introduction of stricter regulation, the FTK (Financieel Toetsingskader), in 2007. This document contained rules and guidelines for pension funds to regain control of their money. More recently, at the start of 2015, they published the nFTK (nieuw Financieel Toetsingskader), further elaborating and expanding upon the current rules stemming from the FTK.

1.2 Research question

When thinking about the increased regulation one can wonder about the effects. Regulation sets out with objectives in the best interest of the pensioners. The introduction of the FTK and the nFTK have however been met with some controversy (Teulings & de Vries, 2005). Almost ten years later this report will explore the real implications of the FTK and more recently the nFTK. The requisites of the regulation force pension funds in their investment strategy. The main research question of this report will be: *What are the effects of increased regulation on the performance of pension funds?*

To this goal performance will be defined as the return on investments that were made by a pension fund. To answer the question we will look at three moments in time. The period after the introduction of the FTK (2007-2015) and the period after the introduction of the nFTK (2015-present). Furthermore the crisis that occurred after the summer of 2008 will be analysed in light of the regulation that may have affected the performance of pension funds. The methodology that will be used to answer the research question will be shortly introduced in section 1.3 and further elaborated upon in chapter 5.

1.3 Research framework

This paper will utilize a statistical procedure called an event study to analyse the impact of the FTK and the nFTK regulation on the performance of pension funds. Event studies have been around since 1933 when James Dolley (1933) published a study using this method. Over the years it got more and more sophisticated and complete. Publications by Ball and Brown (1968) and Fama *et al*. (Fama, Fisher, Jensen, & Roll, 1969) mark the beginning of 'modern' event studies. MacKinlay (1997) summarized the current state of affairs at the end of the 20th century, his article will serve as the backbone and starting point of the research methodology that is utilized.

1.3.1 Event studies

To analyse the impact of an event, event studies look at the returns of, for example, a stock and compares it to the movement of a benchmark, like the market. By doing this it is possible to isolate the impact of the event by taking into account normal price movements. In a traditional event study three windows have to be identified: An estimation window, an event window and a post-event window. During the estimation window an estimation of a normal return is made. With this estimation the abnormal returns in the event window can be determined.

1.3.2 Benchmark

In its traditional form, event studies use the historic performance of a fund to determine the expected performance after the event has taken place, furthermore a benchmark portfolio of different funds is created. These funds all experience their own independent event. This portfolio can then be used to create an expected return. In this case it is hard to test the effects of regulation in this way since pension funds are hugely affected by macroeconomic influences (like the crisis of 2008) and the introduction of regulation isn't independent like the events in a traditional event study. Because of this the performance should be compared to financial products that are not affected. When tackling long term event windows it is crucial that a well matched benchmark is selected that performs like the pre-event stock but is not affected by the event. Suitable benchmarks could be the performance of indexes, bonds and for example pre-regulation pension fund portfolios. Chapter 5, which deals with the methodology will further explore these difficulties.

1.3.3 Challenges

MacKinlay (1997) described the state of event study at the end of the 20th century. He notes that one of the main challenges is dealing with a long-horizon event window. When an event does not create an instantaneous effect on the value of a firm it becomes harder to determine the effect of the event. The influence of regulation is most likely an event of which the effects will only start to be noticeable over a longer time window. As a solution to this problem literature suggest two methods: the buy-and-hold abnormal return approach (BHAR) and the calendar-time portfolio approach (CTIME) (Jaffe & Mandelker, 1974). Mitchell & Stafford (2000) advocate the use of the CTIME method. Based on statistical evidence they show that assuming independence poses problems in long term performance methodology. Kothari & Warner (2004) wrote a literature review in which they concluded that short-horizon methods are quite reliable. Long-horizon methods, although much improved, contain some serious limitations. They conclude that there is no clear better choice between BHAR and CTIME.

The previous paragraphs make clear that a classical event study will not be suitable for the purpose of this paper. Luckily literature presents some adaptations to the methodology that will allow for effective testing. Section 5.1 will further describe the specifics of the methodology and section 5.2 will describe the modifications that have been made to the methodology to make it fit the needs of this specific situation.

1.4 Internship at KAS BANK

This report was written with information, insight and experience gained through an internship at the Data Management department at KAS BANK in Amsterdam. KAS BANK is a custodian that offers a wide range of financial services to their customers. It focusses mainly on the 'safekeeping' of pension funds. In the past they did this by physically securing for example stocks and bonds in vaults. Nowadays this 'safekeeping' amounts to digitally controlling the performance and investments decisions of asset managers that invest the money of the pension funds. They provide pension funds with an independent view of the performance and risk numbers and will alert pension funds when asset managers are acting out of the boundaries of their mandate.

Data management focusses on the correctness and integrity of the data and is therefore important for all the services KAS BANK provides. This is also the department where a large part of regulatory information is processed and therefore a great place to experience the influence of regulation first hand. KAS BANK has provided the dataset containing the monthly performance of pension funds that were administrated by KAS BANK in the period between 2000 and now.

1.5 Structure

This report will be structured as follows: Chapter 2 will explain the concept of pension funds. How do they work and how are they funded? Additionally it will explore the problems the funds are facing and it describes the role of the KAS BANK in being the custodian of pension funds. Chapter 3 will describe the contents of the regulation as it was introduced by the Dutch government. Both the FTK and nFTK will be researched and its implications described. In chapter 4 the dataset used to answer the research question is introduced and described and chapter 5 will explore the concepts and enhancements that were made to the event study methodology. Chapter 6 will present the results on which the conclusions and recommendations in chapter 7 will be based.

2. Pension funds

This chapter will give a more in-depth description of pension funds. Section 2.1 will give a short overview of the history of pension funds. In 2.2 the funding of pension funds is explored. Section 2.3 will give a more in depth description of the pension funds in the Netherlands. Section 2.4 will describe the relation between pension funds and KAS BANK. 2.5 will go in more depth about the problems facing pension funds and section 2.6 will look at some numbers provided by the Dutch Central Bank (DNB) to further illustrate the current state of the Dutch pension funds.

2.1 History of pension funds

A pension fund is basically nothing more than a continuation of wages after you stop working. These wages are financed by money you, and your employer, have accumulated during your working years. Pensions have existed for a long time; even during the time of the Roman Empire soldiers were awarded a military pension (Shapiro, 1985). In 1875 the American Express Company was the first company that launched a private pension plan in the United States (EBRI, 1998). Then in 1889 Otto von Bismarck was the first one to introduce a lawful state-pension. He set the retirement age at 70, later this was lowered to 65. State pensions have long been used to ensure the loyalty of the workers carrying out their policies (Robert, Craig, & Wilson, 2003). In literature Hardy (1892) was one of the first persons to write about the mathematics behind pensions. He proposed a methodology which could be used to determine the required contribution to properly fund a pension scheme.

Roughly three types of pension funds are discernible; *industry pension funds, company pension funds & occupational pension funds.* An industry pension fund manages the pensions from a certain branch, a company pension fund manages the pension of employees of a certain company and an occupational pension fund is an individual pension fund that exists between a company and an employer. Industry and company funds are most common in the Netherlands.

2.2 Funding

There are many ways to fund pension a pension scheme. The two most prominent methods are defined benefit (DB) and defined contribution (DC). The characteristics of both are elaborated upon in section 2.2.1 and 2.2.2. A comparison between the two is made in section 2.2.3.

2.2.1 Defined Benefit (DB)

A defined benefit plan determines an employee's pension based on years of service and wages. It can be considered a deferred annuity since benefits will only be received after an employee reaches a certain age (Bodie, Marcus, & Merton, 1988). In the Netherlands this is the most common funding scheme, 88% of all pension funds use this system. Of these DB funds, most, 87%, have an average salary policy (Dutch Association of Industry-wide Pension Funds (VB)).

2.2.2 Defined Contribution (DC)

Defined contribution plans are conceptually simpler. The employer and sometimes the employee contribute to a fund that is paid out at the end of one's career in either a lump sum or an annuity. Contributions and payments are tax deductible. Most of the time employees have a say in the investment strategy of their money. Since the payment received at the end directly correlates with the amount of money that is in the fund at the end of employment, the investment risk is fully carried by the employee (Bodie, Marcus, & Merton, 1988). If rates are low when the employee retires, he/she will be faced with a low return on his/hers pension savings, even if rates rise in later years.

DC systems have other drawbacks. Some scientist raise question about moving to a defined contribution system since individuals will likely use naïve diversification strategies that will negatively influence returns (Benartzio & Thaler, 2001). Furthermore employees are likely to follow the path of least resistance, e.g. choose the default option, when faced with a saving choice for their pension plan (Choi, Laibson, Madrian, & Metrick, 2002)

2.2.3 Defined Contribution vs Defined Benefit

When both funding schemes are compared it is clear that DC plans are by their nature fully funded while in DB schemes this doesn't have to be the case. Due to their straightforward approach, calculations for DC schemes aren't complicated. The calculations of DB schemes are much more complex (Bodie, Marcus, & Merton, 1988). DC plan benefits are based upon accumulated wages over the employee's entire career while in a DB plan the final or middle wage is continued. Therefore defined benefit schemes create an incentive for the employee to keep working standards high (Bodie, Marcus, & Merton, 1988).

An advantage of DB is that it offers to provide a stable replacement of an employee's income. An advantage of DC plans on the other hand is that they are predictable, more flexible and fully funded (Bodie, Marcus, & Merton, 1988). Bodie, Marcus & Merton (1988) suggest that DC and DB can be combined to take advantage of the best of both worlds. Zelinksy (2004) states that the difference between defined contribution and defined benefit mainly stems from a difference in risk allocation. In DB systems the risk is allocated to the employer while in DC systems the risk is shifted towards the employee.

2.3 Pension funds in the Netherlands

The Netherlands have a unique pension system that is revered as one of the best in the world (Mercer, 2015). It consists of three parts that together make up the social security system.

The three 'pillars' of the Dutch pension system are shown in the table below. The first pillar is a state pension that every citizen will receive once they reach the legal retirement age. The monthly amount receivable is based on the minimum wage and on the amount of years you have lived in the Netherlands. The second pillar consists of the collective pension scheme that employees collect during their working life. A premium is subtracted from the monthly wages and invested in a pension fund, employers also contribute a monthly fee to this fund. Once a person reaches the retirement this fund will provide a continuation of wages. The third pillar consists of individual pension products like annuities; one's paid off house or other financial products.

	Name	**Funding**
First Pillar	State pension (AOW)	Pay-as-you-go
Second Pillar	Collective pension schemes	Capital funding
Third Pillar	Individual pension products	Personal investments

Table 1: Overview of Dutch pension pillars. (Dutch Association of Industry-wide Pension Funds (VB))

The majority of DB-schemes in the Netherlands are so-called hybrid schemes meaning that when a fund gets into trouble all those involved will be affected. Employees, employers and those receiving a pension will all contribute to repair the deficit (Dutch Association of Industry-wide Pension Funds (VB)). Possible measures include increasing the pension contributions, limiting the indexation of the funds, altering investment decision, and in extreme cases reducing the already accumulated pension right.

2.4 Funds at KAS BANK

Currently KAS BANK does the administration of approximately 60 pension funds. These funds can be divided in three categories: debt funds, equity funds, indirect real estate, venture capital, hedge funds and other. The characteristics of each type are illustrated in the table on the next page.

Category	Description
Debt Funds	A pool of bonds
Equity Funds	A fund that invests in stock
Indirect Real Estate	Investment in property
Venture Capital	Investments to fund young firms
Hedge Funds	Investments in multiple products that often contain complex financial constructions
Other	All investments not applicable to the above categories

Table 2: Overview of fund categories at KAS BANK

Pension funds invest their money in a combination of the fund categories above, all categories having their advantages and disadvantages. According to Ackermann, McEnally & Ravenscraft (1999) hedge funds consistently outperform debt and equity funds. They don't outperform standard market indices. Investments in real estate are said to be a hedge against 'expected' inflation (Chan, Hendershott, & Sanders, 1990) and venture capital might be risky but can also give a higher payoff. Tonks (2002) stated that fund returns are dependent on the quality and skill of the asset manager. All in all pension funds are faced with a challenge to gain the highest return on their portfolio by making the right investment choices.

2.5 Pension problems

Lately pension funds have been finding themselves in heavy weather. The way funds are organized seems to be unsustainable in the long run. Due to greying, a rapid increase of longevity and rates that are at an all-time low pension funds have a very uncertain future (Goudswaard, 2013). Because of this pension funds are under pressure. A large number of solutions are presented by a lot of people. Some say the Netherlands should switch to a fully DC funded system. Some argue that governments should issue longevity bonds to ensure the spread of risk evenly among generations (Blake, Boardman, & Cairns, 2010). Others plead for the introduction of generational accounts (Teulings & de Vries, 2006). The following two paragraphs will shortly illustrate the underlying problems of pension funds. It will do so by illustrating the effect of greying, increased longevity and low rates on the liabilities and assets of the funds.

2.5.1 Liabilities

The liabilities of pension funds consist of all the pension payments they have to pay out over a certain amount of time. Each person retiring at a certain age is actually a group of monthly cash outflows starting at retirement age and ending when the pensioner deceases. All these cash flows add up to a very large portfolio of obligations with an ever expanding horizon. To determine the expected total exposure of a pension fund to these obligations the net present value of these cash flows is calculated by discounting future payments with a rate-curve based discounting rate. Payment horizons are adjusted for the expected mortality rate.

When examining the effects of greying, increased longevity and low rates it is clear that a fund's liabilities are influenced by increased longevity and low rates. Due to people living longer, each pension account will contain more cash outflows. A pensioner dying at the age of 85 will receive more pension payments than a pensioner dying at the age of 70. When more people reach a higher age this effect is multiplied by the size of a fund's portfolio. Low rates are also influencing the liabilities of pension funds. Rates are used to discount future payments to present value, when these rates are low, future payments will have a relatively high 'present value' and will weigh heavier on the total obligations faced by pension funds.

2.5.2 Assets

The assets of pension funds are financed by the money that is paid by people participating in the fund. A participant (and his/her employer) pays a monthly fee to save for pension payments when they retire. This money is accumulated in the fund and invested in financial products to ensure good returns. The asset side of the fund is heavily dependent on the inflow of money. Funds do not have many buffers (anymore), a decrease in inflow will therefore have a heavy adverse effect on the payments to pensioners. It is clear that the asset side is mainly influenced by the greying population and low rates. Due to greying the ratio between paying participants and receiving participants becomes smaller and smaller, meaning less cash inflow has to be matched with an increasing cash outflow. Furthermore the low rates mean that it is harder to receive good returns on invested money while this low rate also causes the present value of the liabilities to increase.

2.5.3 Ultimate Forward Rate

The rate which is used to determine the present value of obligations is rather important. Short term obligations can be easily discounted by using the prices of swaps in the market. This works fine up to a certain time horizon but after approximately 20 years the liquidity of swaps ceases to exist and a 'fictional' value needs to be used. For long Dutch pension funds were allowed to use a fixed value of 4% to calculate the net value of obligations.

On the second of July in 2012 the Dutch government introduced the Ultimate Forward Rate for insurance companies and later on the 30th of September it was also introduced for Dutch pension funds. The UFR uses an asymptote of 4.2% to estimate a realistic long term rate. On the 20th of July, 2015, the DNB enhanced the calculation technique of the UFR to be equal to the moving average of the 20-year forward rate. Effectively reducing the UFR asymptote from 4.2% to 3.3%. This means that all long term rates will eventually approach the UFR. The UFR starts after 20 years from t=0, up to that moment market rates are used.

2.5.4 Managing assets and liabilities

The main task of the pension fund is to manage the monthly inflow of money so it matches the outflow of money, now as well as in the future. Pension funds have been searching for ways to match the income to the outflow. One of the major problem stems from changes in the interest rates. When the interest rates drop future obligations will rise in value. Bonds and other financial products in possession of the pension fund will also rise in value. Most financial products however have a maturity date shorter than 20 years in the future while some obligations are more than 40 years in the future. This poses pension funds with a mismatch in the duration of their assets and liabilities.

2.6 The current situation in numbers

Since the introduction of the nFTK at the beginning of 2015 all pension funds have to report a quarterly overview of their financial situation to the DNB. The DNB publishes the results of these reports on their website. An analysis of this data provides some insight in the current state of the Dutch pension system. Table 3 summarizes the data as published by the DNB, the following paragraph will shortly discuss this data.

#	Quarterly Data DNB			
1		**2015Q1**	**2015Q2**	**2015Q3**
2	Number of registered funds	262	262	259
3	Pensionfunds experiencing shortage	160	168	179
4	-%	61%	64%	69%
5	Average coverage ratio	114,55%	113,58%	112,04%
6	Worsened coverage ratio	-	198	221
7	-%	-	76%	85%
8	Required coverage ratio increased	-	183	81
9	-%	-	70%	31%
10	Average quarterly return (annualized)	11%	-8%	-2%
11	Recovered funds		0	1

Table 3: Quarterly pension fund situation, data courtesy of the Dutch Central Bank (DNB)

The third row makes clear that more and more pension funds are experiencing shortage. A shortage means that the coverage ratio of a fund is lower than the required coverage ratio of that fund. The required coverage rate is based on the risk profile of the pension fund, the more risk a fund takes the more buffers it needs to hold to absorb possible future market shocks. A shortage means that either the coverage ratio has decreased, or the required coverage ratio has increased. Row 3 and 4 provide some insight in the changes of those values. A coverage ratio worsens when for example rates decrease because this will increase the value of future obligations.

The required coverage ratio can increase when a pension fund opts for a more aggressive investment strategy. When more risky investments are made, stress testing will require larger buffers and the required coverage ratio will increase.

When looking at these numbers it is clear that the funds are suffering from problems, problems that are probably caused by the decreasing rates. Because of this future obligations are rising and this decreases the coverage ratio by one percent point between Q1 and Q2 and with another 1.5 percent point towards the end of Q3. From the increase in required coverage ratio we can deduct that pension funds are on average increasing the riskiness of their investment portfolios. Even when the required coverage ratio is kept out of the picture it is clear to see that a lot of pension funds are suffering from worsening coverage ratios in Q2, 76% of pension funds gets worse, and in Q3, 85% gets worse.

The data also shows the quarterly returns on the investments of pension funds. The table shows the average return in a certain period. Regulation states that the coverage ratio should be expressed in an average of the coverage in the past 12 months. The returns shown above will therefore come to expression in later quarters.

When the coverage ratio of a fund drops below the required coverage ratio, the fund is obligated to set up a recovery plan and submit this to the DNB. The data shows that during 2015 only 1 fund has managed to recover from a 'in shortage' situation. It should however be noted that the DNB allows 10 years for a pension fund to recover.

2.7 Overview

All in all pension funds are having problems in all kinds of areas and are facing multiple challenges from external factors. The Dutch regulator has acknowledged the existing problems and put regulation in place to help funds improve their financial situation and to ensure that all participants of pension funds will receive the pension they deserve after they retire. An overview of this regulation is given in the next chapter.

3. Dutch regulation

This chapter will give an overview of the regulation introduced by the Dutch government. Section 3.1 will give an overview of the regulation introduced in the FTK, nFTK and the European regulation IORP it stems from. Section 3.2 will discuss the effects of existing regulation and how these effects are utilized to split the main research question into three sub-questions.

3.1 Overview of regulation

This section describes the existing regulation in the Netherlands. Paragraph 3.1.1 will illustrate the regulation as introduced in the 'Financieel Toetsingskader' (FTK) in 2007. Paragraph 3.1.2 further elaborates upon this by describing the changes made to the existing framework by the 'nieuw Financieel Toetsingskader' (nFTK) while paragraph 3.1.3 will elaborate upon the European IORP directive.

3.1.1 'Financieel Toetsingskader'

January 1st, 2007 marks the introduction of a new pension law in the Netherlands. This law contained the 'Financieel Toetsingskader', which freely translates to the 'Financial Testing Framework' and aimed to test whether pension funds were properly funded and to improve the risk management of pension funds. One of the main goals of regulation was to ensure that every participant was guaranteed, up to a certain level, that he or she would receive a pension in the future. The FTK provided a consistent method to valuate obligations and assets and set buffer sizes for the pension funds. A more detailed overview of the FTK can be found in a consultation document published by the Dutch 'Pensioen & Verzekeringskamer' in 2004. Roughly the FTK consists of three parts:

Present value calculation

All obligations and investments were to be valued according to a present value calculation. This meant that a more realistic view would be acquired. Furthermore the fictional, fixed, forward rate of 4% was replaced by a more dynamic yield structure that mirrored real world interest developments.

Coverage ratio

Pension funds need to determine their coverage ratio and it needs to be at least higher than 105%. To determine this coverage ratio investments need to be shocked according to the risk characteristics of the investments. The FTK introduced the following risk categories:

S_1: Rent risk
S_2: Share price risk
S_3: Currency risk
S_4: Resource risk
S_5: Credit risk
S_6: Insurance risk

For scoping purposes these formulas will not be discussed any further in this report.

Continuation analysis

This analysis should give an indication of the risk that the pension fund faces in the long run. It should take into account different scenarios and the way they will be managed so the pension fund can successfully deal with future risks. The FTK can be considered the first step into a more regulated pension world. Crucial aspect of the FTK was the different calculation method of the coverage ratio which resulted in changing investment strategies. More on this in section 3.2.

3.1.2 'nieuw Financieel Toetsingskader'

The nFTK consists mainly of adaptions to the original FTK. The new regulation was inducted at January 1st 2015. The overview below summarizes the main differences with the existing regulation.

- Coverage ratio should be determined by taking the average of the monthly coverage ratio of the past year. This will prevent funds from having to drastically react to heavy fluctuations on markets.
- The calculation of the required own capital will be more stringent causing required buffers to increase.
- Required capital is calculated utilizing the Ultimate Forward Rate instead of the market rate.
- Recovery plans will be bound to different rules. Funds will now have 10 years to recover, but during these 10 years no cuts have to be made as long as 5 years after starting recovery the recovery goals are reached. All current recovery plans are to be cancelled and from the first quarter in 2015 pension funds have to submit a new plan when and if buffers aren't sufficient.
- Indexation will only be possible once the legally required buffers are filled.
- Stress tests need to be performed utilizing a pre-determined set of scenarios.
- Indexation ambition needs to be considered when determining the premium.
- Pension funds should give a more detailed overview of their investment according to the so-called 'look through' principle. This means that all investments of external asset managers should be reported.
- The 'prudent person' principle is introduced, this principle states that the complexity of investments should be reflected in the knowledge available inside the organisation. Furthermore a strategic plan should be underlying investment policies, this plan should be consistently executed and monitored.

3.1.3 Institutions for Occupational Retirement Provisions (IORP) directive.

Next to the Dutch regulation, European law also plays a part in the increasing regulation of pension funds. In the year 2003 the IORP-directive was published. This directive consisted of a framework designed to help European countries to increase the availability of pension funds for citizen. It's main objectives were to ensure pension funds would have enough assets for their pension liabilities, increase the quality of pension fund management and increase transparency of investments, risk and management costs made by the pension fund. At the beginning of 2014 the second IORP-directive draft was published. This draft is now under consideration of members and is likely to influence Dutch pension regulation (just like IORP I did).

3.2 Effects of regulation and sub-questions

This section will describe the effects of the regulation described in section 3.1. Regulation might have led to more risk averse behaviour in pension fund investment decision. In the long run this might lead to an insufficiency in accumulated funds and thereby not enough money to pay out all pensioners. This effect has been described in recent literature. Amzallag, Kapp & Kok (2014) wrote a paper on the impact of regulation on investments and financial stability. They found that due to regulation pension funds are more likely to switch their investment allocation to less risky assets. Resulting in safer investments but also in smaller returns. Severinson & Yermo (2012) described the effects of regulation on the investment decision made by pension funds and insurance companies. They show that recent developments in which regulations moved towards fair-value principles have increased transparency and consistency, but have also created a greater focus on the short term horizon. Overall it is clear that de-risking is most prominent in the increased use of hedging instruments. They also conclude that regulation has declined the amount of equity investments by pension funds and pension insurance companies in the Netherlands.

l'Hoir & Sauve (2012) conclude that Solvency II regulation, which has comparable objectives to the Dutch pension regulation, has created an investment shift towards debt, reducing the amount of investments in equities. They also claim that if regulation impacts the value of funding rates that further de-risking of pension funds is imminent. Franzen (2010) argues that risk taking capacity is central to DB pension funds. Regulation is inhibiting this capacity and is therefore endangering the future existence of DB funds. Teulings & de Vries (2006) argue that regulation should not impose restrictions on investment decisions since this will have adverse macro-economic effects.

Engel, Oldenkamp & Petit (2014) note that the introduction of the FTK at the end of 2006 caused pension funds to invest money in financial products that hedged the interest risk pensions were faced with due to the introduction of fair value valuation. Before the FTK funds were allowed to value their obligations to a fixed rent of 4%, this meant that the 'value' of these obligations could be determined 'precisely'. When the FTK came into play pension funds were forced to value their obligations to a dynamic rent that is based on fair value principles and therefore took into account the current state of the market. To account for this ever changing factor funds started investing in rent hedges.

Engel, Oldenkamp & Petit (2014) note that in practice pension funds utilize one of three approaches to manage the rent risks they are facing. They either adopt a traditional 'longterm' approach, an 'overlay' structure or they use a 'matching & return' structure. These three approaches are further explained in the sections below.

3.2.1 Longterm

This approach can be seen as a 'traditional' approach to managing a pension fund and has existed long before the introduction of the FTK regulation. A long term risk appetite is decided upon and the portfolio is set up in a way so that it mirrors this risk appetite. The underlying idea of the approach is that in the long term all 'bumps' are evened out by a 'big long term return. The idea of managing rent risk is deemed largely unnecessary since it will eat out of the long term results. This approach might lead to an underestimation of short term rent risk and might face pension funds with great problems in times of crises and persistent low interest rates.

3.2.2 Overlay

Many pension funds did recognize the threat they were facing from a potential downfall of rents and 'upgraded' their 'longterm' portfolio with a derivatives overlay. This is a structure consisting of swaps and options that hedges for the rent risk up to a certain level. This approach can be seen as a long term portfolio that has an upgraded risk management aspect to it. Some smaller funds have invested in so-called LDI's (Liability Driven Investment). These investments are managed by bigger asset managers and allow smaller pension funds to use dynamic trading of derivatives to their advantage. A disadvantage of this approach is that the risk control aspect of the portfolio is not directly matched to the return portfolio.

3.2.3 Matching & return

This approach consists of an explicit split in a return and matching portfolio. The matching portfolio consists of financial products like bonds, options and derivatives that precisely matches the future obligations of the pension fund. The return portfolio is used for more risky investments to gain a higher yield and strive for indexation of pension payments. By making the difference between matching and return explicit the fund makes sure that it will be able to pay-out the pensions when it has to while still retaining the ability to create greater returns when markets are going up.

3.2.4 Summary and sub-questions

Overall it can be concluded that regulation has likely led to increased de-risking of investments and the birth of more complex hedging structures because it has caused changes in the calculation of the present value of obligations. As a reflex pension funds started investing more in fixed income instruments to hedge for declining rates in the future. Later in this report the ratio of fixed income investments will be used as a result of FTK introduction. Additionally the performance of the three hedging structures will be examined.

The main research question was defined as: *What are the effects of increased regulation on the performance of pension funds?* Since regulation is a very broad term and concerns many aspects of pension fund management it will be split into three more specific sub-questions that deal with two aspects that are documented to be effects of the pension regulation. These effects are:

- A shift towards fixed income investments
- The adoption of one of three hedging structures.

These are the three sub-questions that will be answered in the following chapters of this report:

1. *What is the effect of a high fixed income investment ratio on the performance of pension funds?*
2. *What are the effects of the three different hedging structures on the performance of pension funds?*
3. *What combination of fixed income ratio has performed best in the period after the introduction of the FTK up until the end of 2015?*

4. Dataset

This chapter describes the characteristics of the dataset that will be used to test the effects of regulation.

4.1 Returns

The dataset has been acquired at the ‘Performance and Risk’ department at KAS BANK. It contains the monthly returns of 74 pension funds that are, or have been, administrated by the bank. Data has been extracted starting from January 1st in 2000 up until the end of November 2015. Since most pension funds haven’t been administrated for the entire period of time roughly half of the data points are missing.

4.2 Pension fund characteristics

For increased background knowledge and testing purposes, the characteristics of pension funds have been collected, either through researching year reports and information published by the Dutch Central Bank as well as the information system present at KAS BANK. The size of each pension fund is determined by looking at the amount of money present in the fund over the years it’s administrated. Additionally a rough investment strategy is approximated by looking at the investment mix of each pension fund over the years it has been collected and by looking at the structure that was used to administrate the investments of the pension funds.

To answer sub-question 1 which deals with the effects of the fixed income investment ratio, the ratio is determined for each pension fund. Sub-question 2 will be answered by analysing the structure in which the investments each fund are administrated and sub-question 3 will be answered by combining the information from questions 1 and 2.

4.3 Anonymization

Due to the rather sensitive character of the data that is used in this report all pension funds have been anonymized. All pension fund names are substituted by a number to minimize the chance of sensitive data becoming public. The names of pension funds were known to the author of this report for research purposes.

5. Methodology

This chapter will describe the methodology that will be used to determine the effect of the introduction of regulation on the performance of pension funds. Section 5.1 will give a global introduction of the concept underlying an event study. The enhancements made to the methodology to allow for testing of the effects of regulation are described in section 5.2 while section 5.3 will describe the decisions made in methodology selection. This yields two methodology frameworks that will be used to answer the three sub-questions introduced at the end of 3.2. Section 5.4 will briefly introduce the time windows that will be used in the statistical procedures performed in chapter 6 while 5.5 will give a short summary of the methodology that is selected.

5.1 The event study

The concept of an event study is quite straightforward and simple. To illustrate this concept a simple and practical example is introduced in section 5.1.1. Afterwards a more theoretical approach will be taken.

5.1.1 A simple example

For this example consider Tom, a Dutch tomato farmer. Tom has two big greenhouses in which he cultivates tomato plants. The tomatoes yielded in this process are sold in bulk to supermarkets and the money acquired in this process provides for his income. A, somewhat shady looking, travelling salesman has visited the farmer recently and proposed to sell him a 'special' powder that will increase his yearly yields substantially and therefore will increase his income.

The farmer is quite sceptical but agrees to buy a small quantity of the powder to test the effects. The tests will be done by performing an event study. To this end the farmer reserves 10 of his plants and puts them in a separate corner of the greenhouse. The plants are treated with the powder and the farmer tracks the yield of the plants for 3 months.

After 3 months the farmer finds that all the plants have an increased yield of 50% to the yield that he expected through years of experience. He determines that the powder is indeed to be considered 'special' and calls the salesman to place an order that will allow him to treat all his plants.

The test performed by the farmer can be considered a 'classical' event study. The event in this case is the application of the 'magic' powder on the plants. The time window preceding the arrival of the salesman is used by Tom to create an expectation of the yield of a tomato plant. In the period up until 3 months after introduction of the powder Tom tracks the yield and when, after 3 months, the farmer concludes that the powder has increased the yield of the tomato plants that were treated with it, a conclusion is drawn. In its core the event study is nothing more than a statistical procedure to test the impact of a certain event on a variable over time.

5.1.2 The ten steps of MacKinlay

At the end of the 20th century MacKinlay (1997) published an article that contains a more formal definition of the event study. Since his publication not much has changed in the concept, therefore the ten steps that he has described in his article will serve as a backdrop to the methodology that will be used. The ten steps which are shortly described in the following overview should be taken into account when setting up an event study.

1. *First the event of interest needs to be defined*.
2. *Then the event window should be selected*. The event window is defined as the time window in which the effects of regulation should appear. When dealing with a traditional event study this event window will be one or two days long. Since in this case the event effects are probably spread over a longer period of time a longer event window is used.
3. *Determine the selection of inclusion criteria*. The dataset needs to be defined; in this case the dataset provided by KAS BANK is used. This dataset contains the annualized monthly returns of 74 pension funds, for more information on the dataset see section 4.1.
4. *Summarize the sample characteristics*. In this part the dataset is described, again see section 4.1.
5. *Determine the normal return over the event window.* The normal return needs to be determined; this can be done in several ways. The normal return can be determined as the expected return if the event wouldn't have occurred.
6. *Finding the abnormal return*. The abnormal return can be found by subtracting the normal return of the realized return.
7. *Define the estimation window.* The normal return is based on the actual return of the asset before the event occurred. The estimation window is the size of this window.
8. *Designing testing framework*. The testing framework contains hypotheses and the selection and settings of the statistical test that will be performed to determine the impact of the event. This framework is further elaborated upon at the beginning of chapter 5 in section 5.3.
9. *Presenting empirical results*. The results of the statistical procedures need to be presented and analysed, this will be done in section 6.2, 6.3 & 6.4.
10. *Conclusion and comments*. The results need to be put in perspective; chapter 7 will therefore contain the conclusions and comments on the procedure.

Crucial to the event study is the determination of a normal return. To illustrate the importance of this normal return farmer Tom returns once more.

Tomato farmer Tom determined the effect of the 'special' powder by relying on his long experience as a tomato farmer. The plants he tested yielded many more tomatoes than he expected and therefore he quickly marked the powder as 'special'. However, in his enthusiasm Tom forgot one thing, namely to account for changes in the process that had affected all his plants.

Without his knowledge, the supplier of the earth in which Tom planted his tomato plants had changed the composition of his product. This resulted in a more fertile soil and therefore more productive plants. After careful examination of his total yield, Tom had to conclude, to his dismay, that all his plants experienced a 50% yield increase and the 'special' powder has had no effect whatsoever on the yield.

This example makes clear that the mistake Tom has made in the determination of the normal return (based on historical results) has hugely affected the conclusion he draws on the effects of the powder (the event). It also illustrates that the determination of the normal return (expected return) is critical to the solidity of the statistical test and the outcomes.

5.1.3 Finding a normal return

In his article MacKinlay (1997) states that there are roughly three ways in which the normal return can be determined:

Statistical approach

MacKinlay suggests the use of the statistical approach, this approach uses the sample of returns in the estimation window (prior to the event) to determine an expected return in the event window and afterwards. When the abnormal return (AR) is found a cumulative abnormal return can be calculated (CAR) as well as the average abnormal return (AAR). Furthermore the AAR can be aggregated as well to form the cumulative average abnormal returns (CAAR). This process is pretty straightforward but seems to work pretty well in most situations. The example of tomato farmer Tom has demonstrated that this approach only works when no other 'events' occur in the event window.

Market model approach

Utilizing a market model approach means that the actual returns are compared to the returns of the market (AEX, S&P 500, etc.). This approach can be enhanced by adding selection criteria e.g. based on size or company type.

Benchmark approach

The third option would be to use a benchmark, which can be anything like a share price, value of a firm or portfolio performance (or other tomato plants). This benchmark needs to correlate with the share that is researched in the event study before the event occurs and should not be affected by the event.

When a normal return is defined this normal return can be compared to the actual return to find the abnormal return. In mathematical terms this calculation will look like:

$$AR = R - E(R)$$

Equation 1: Determination of Abnormal Return

Where AR is the abnormal return, R is the actual return and E(R) signifies the expected return.

5.1.4 Methodology problems

All things considered the event study as defined in the previous paragraphs is pretty straightforward and will work decently for the things it's designed to do. Originally this is testing the effects of stock-splits and profit warnings on the value of a stock. Characteristically these events have a lot in common; the event time can be determined precisely and due to market efficiency the news will be absorbed immediately by the stock and reflected in its value. Furthermore all events are independent, this allows for price developments to be shifted around and allow for the creation of a benchmark rooted in a statistical analysis of firm price developments.

Unfortunately the introduction of regulation and the effects it has caused have none of the aforementioned characteristics. Consequently the following three problems can be identified within the methodology framework:

1. It's largely unclear when most pension funds have started to anticipate the regulation contained in the FTK and nFTK and have changed their investment strategies.

2. The influence of regulation will not be immediately expressed in the returns of pension funds. It is more likely that the effects will 'seep through' over a longer period in time after the introduction.
3. The events aren't independent. All pension funds are faced with identical regulation at the same moment in time. This means that creation of a benchmark portfolio in which all events are shifted around isn't as straightforward as in a classical event study.

Furthermore the most popular abnormal return measures CAR and AAR measure the average periodic abnormal returns, in the case of an event study with a long time window this estimator will be biased. (Gur-Gershgoren, Hughson, & Zender, 2008).

To tackle these problems some assumptions have to be made and some enhancements will have to be made to the methodology. One of the enhancements will be to switch to a so-called long term event study. Long-term event studies are extensively covered in existing literature. Section 5.2 will describe the contents of this literature and how it may be used to test the influence of regulation.

5.2 Enhancements to the methodology and the long-term event study

The three problems stated at the end of the previous section will be tackled in 5.2.1, 5.2.2 and 5.2.3.

5.2.1 Anticipation of the regulation

It is important to clearly define the event time. Schwert (1981) states that the event date should be the date on which a regulation change is first anticipated. In this case the event we want to research is the introduction of regulation. According to Schwert the event date should be the announcement date of both the FTK (2007) and the nFTK (2015). In this case Schwert will however be ignored and the event dates will be set at the introduction date of the FTK and nFTK. This is done because these will be the moments on which investment strategies will have definitely changed, additionally using this event date will also allow for the distinction in the pension funds that will be made later on.

5.2.2 Regulation effects will 'seep through' in the returns

Because the effects of regulation on the returns of pension funds will likely become noticeable over a long period of time, enhancements have to be made to the original event study as it's described by MacKinlay (1997). Literature proposes a solution called the long-term event study. There are several studies that determine the long-term effects of events like initial public offerings and long run performance after mergers or analyse the particularities of long-term event studies. It is clear that much debate takes place on the methodology that should be utilized to perform a solid long-run event study (Barber & Lyon, 1997), (Fama E. F., 1998), (Ikenberry, Lakonishok, & Vermaelen, 1995) & (Mitchell & Stafford, 1999). Since a lot of views exist on the procedure of doing a long term-event study some of these will be explored in the following paragraphs.

Kothari and Warner (1997) emphasize the caution that needs to be taken when trying to draw conclusion from long-term event studies. They promote the use of non-parametric test and bootstrapping to prevent miss-testing. Barber & Lyon (1997), claim that 'traditional' test statistics are not suitable to determine the long-term effect of events. To overcome this problem they advocate the use of a calendar time approach (CTIME) over standard test statistics like AR and CAR when it comes to determining the long term impact of an event. In their article they identify three main weaknesses of sampling for long-term event studies, these weaknesses are:

- *New listing bias*- Sampled firms generally have a long range of post-event returns. Firms making up the reference portfolio include firms that started trading only after the event month.
- *Rebalancing bias*- This bias originates from monthly rebalancing of the reference portfolio while the reference portfolio is compounded without rebalancing.
- *Skewness bias*- Long-run abnormal returns are by their nature skewed.

Because of these biases using a CAR approach yields results with a positive bias while Buy-and-hold-abnormal-return (BHAR) yields results with a negative bias. A possible solution to the skewness problem is to compare the returns to the performance of a firm rather than a share. Barber and Lyon (1997) however show that this greatly reduces the power of the testing because the control firm performance is noisy compared to the use of a reference portfolio. To achieve a high power, a very large sample is required. Barber & Lyon (1997) also state that using a control firm or a buy-and-hold reference portfolio will eliminate new listing and skewness bias. Lyon, Barber & Tsai (1999) however advocate the use of a skewness-adjusted t-statistic.

It is clear that the main area of discussion is the way in which the abnormal returns are determined and the benchmark that is involved. Main concepts in this discussion are the calendar time approach (CTIME) and the buy-and-hold abnormal return (BHAR). Both concepts are elaborated upon in the following sections.

Calendar Time approach (CTIME)

The Calendar Time Approach originated from papers written by Jaffe (1974) and Mandelker (1974) and has been in use ever since. Fama (1998) promoted the use of it in his paper written on long term returns and market efficiency, furthermore the approach was used by Lee & Mas (2011) to determine the impact of unionizing on the value of firms. The CTIME approach can be described as a sort of rolling portfolio approach. Where firms are included based on the current time and the event time. After a certain amount of time has elapsed the firm/share is dropped out of the portfolio, firms are added when the event is within the set threshold values. A disadvantage of this approach is that it assumes market-model parameters to be constant. Nekrasiv, Shroff & Singh (2009) conclude that the CTIME approach is severely mis-specified in non-random samples. They also note that this view is shared by previous studies on the subject.

Buy-and-Hold abnormal return (BHAR)

The BHAR can be seen as the long term difference between the return of a firm minus the return of a benchmark firm or portfolio over the same period. Ritter (1991) used the buy-and-hold-abnormal-return to determine the long run performance of firms after an initial public offering. Barber & Lyon (1997) prefer the use of BHAR over CAR when determining the long term effects of an event. Furthermore Mitchell & Stafford (2000) identify a compounding effect in the BHAR approach which results in abnormal test statistics increasing when abnormal behaviour is persistent over the measured time window.

Gur-Gershgoren, Hughson and Zender (2008) describe a “simple but powerful” approach to long-run event studies. They propose an addition to the BHAR approach that uses multiple control firms to tackle the three biases that arise by using the traditional approach. It is shown that the power of test statistics increases dramatically when using up to three control firms, adding more firms results in significantly smaller increases of power. Moreover it also tackles the noise problem that comes with using a reference firm. Barber & Lyon (1997) show that testing power is greatly reduced when only using one reference firm. Using a reference portfolio will reduce this noise. The result of this method is a set of BHAR results for each of the funds that is tested. The equally weighted portfolio that is constructed will result in a non-skewed test statistic with high power test characteristics (Gur-Gershgoren, Hughson, & Zender, 2008).

Dutta (2014) (2015) introduces and tests an adaptation to the CTIME approach called the standardized calendar time approach. Dutta shows that this approach has a higher power than standard CTIME. Knif, Kolari & Pynnonen (2013) propose an approach based on Sharpe ratios.

Literature makes it clear that either a Calendar Time approach or a Buy-and-hold-abnormal return approach should be utilized. The choice between both for this research is however rather straightforward. Since regulation affects all pension funds (firms) at the same moment using a CTIME approach would be redundant since this approach thrives on the events being non contemporary. This report therefore opts for a BHAR approach. When answering the first sub-question it will utilize the framework that was presented by Gur-Gershgoren et al. (2008) in which firms are matched with up to three control firms. Utilizing more control firms will synthetically create more observations and therefore increase testing power.

For the second and third question a somewhat different BHAR approach will be used. To answer these questions multiple indexes will be created. These significance of the difference between these indexes will be evaluated by looking at the lognormal distribution of the cumulative returns. This approach resembles the approach by Barber & Lyon (1997). More on this in section 5.3.2.

5.2.3 Events aren't independent

Because the introduction of regulation is an event that is equal to each pension fund it is impossible to create a shifting portfolio that can be used to compare post-event performance. Because of this a suitable benchmark needs to be selected. This benchmark has to have comparable pre-event performance and should in no way whatsoever be affected by the event that is to be tested. This benchmark selection is rather difficult and precarious as you might expect. Since the effect of the FTK and the nFTK are bound to be small the benchmark needs to be precise. Just a small amount of 'noise' in the benchmark will make it almost impossible to find the small change that is due to the regulation. Selecting an index like the AEX or the S&P 500 for instance will yield a huge amount of noise that will leave a huge mark on the final results.

Additionally, the time frame that surrounds the introduction of the regulation is one that is marked by some major macroeconomic changes, most notably the housing crisis and the plummeting of rents. The volatile and changing market makes it even harder to find a perfectly matching product that can be used as a benchmark. This is added to the main issue at hand and that issue is that pension funds are rather unique. They have unique characteristics that aren't mirrored in any fund or firm whatsoever, like the sheer amount of money that is invested by them and the long horizon rent structures to ensure payments to following generations make it hard to find a product that matches the characteristics of a pension fund.

5.2.4 Conclusions on the methodology

The solution to the problems posed in 5.2.1, 5.2.2 & 5.2.3 is simpler than to be expected, if a pension fund is so unique, it should just be compared to another pension fund. This does however create another problem, namely the fact that all pension funds are affected by the regulation.

To tackle this problem multiple splits will be made in the dataset. A split is made between groups A and B. Where group A contains all pension funds exhibiting a higher-than-average fixed income investment ratio, group B will contain the lower-than-average funds. To answer the second sub-question a split will be made based on the hedging structure that pension funds utilize. This will yield three groups of pension funds. Sub-question three will be answered by combining the groups into six different groups.

5.3 Research framework

Now that the difficulties that have arisen in section 5.1 have been tackled this section will be used to describe the decisions that were made to structure this research. The section is split into three paragraphs. Each paragraph will explain the framework for each of the three sub-questions.

5.3.1 The effect of the fixed income investment ratio

A long term-event study will be used that is loosely based on the control firm approach by Gur-Gershgoren et al. (2008). Practically this means that up to three benchmark funds will be matched to each fund that is to be tested.

The independency problem of the event shall be tackled by splitting the dataset in two. A group of 'high adopters' or 'A' and a group of 'low adopters' or 'B'. Consequently up to three 'B' funds will be matched to each fund in the 'A' group.

Statistical testing will then be performed using the division described in the previous section. A straightforward t-test will be used to determine the effects of the event on both groups. Furthermore the hypothesis that will be used to test the effect of regulation is defined as follows:

H_0 = The returns of pension funds are independent from the fixed income investment ratio

The monthly test statistic $BHAR_{i,}$ for each pension fund i, is defined as:

$$BHAR_i = \prod_{t=1}^{h}(1 + r_{i,t}) - \frac{1}{3}((\prod_{t=1}^{h}(1 + r_{B1,t}) \ + \prod_{t=1}^{h}(1 + r_{B2,t}) \ + \prod_{t=1}^{h}(1 + r_{B3,t}))$$

Equation 2: BHAR determination

Where *i is* a pension fund in group A and *h* symbolizes the duration of the event window. This means that for each pension fund *i* in group A, an abnormal return is determined by subtracting the return of the benchmark portfolio made up by pension funds in group B. This formula contains the equally weighted portfolio as proposed by Gur-Gershgoren et. al (2008).

Since the BHAR is determined over a time window, a so called event window should be defined. This is the timespan over which the returns are accumulated. For sensitivity purposes this time window will be a variable called h. This variable will have a value of 12, 36 and 60 months (1, 3 and 5 years respectively) for the introduction of the FTK and 5 and 10 months for the introduction of the nFTK. The time windows will be more comprehensively detailed in section 5.4.

When the BHAR is determined for each pension fund in group A the average BHAR of the testing group can be determined according to the statistical procedure as described by Lyon, Barber and Tsai (1999):

$$\overline{BHAR} = \frac{1}{n} * \sum_{i=1}^{n} BHAR_i$$

Equation 3: Average BHAR Determination

Under H_0 the test statistic *t* can calculated, this statistic can be evaluated using a conventional t-test. It can be calculated as follows:

$$t_{BHAR} = \sqrt{n}\frac{\overline{BHAR}}{s_{BHAR}}$$

Equation 4: t-test statistic determination

Where s_{BHAR} is the standard deviation of each pension fund i over $\overline{BHAR}$. If regulation will not have any effect whatsoever on the returns t_{BHAR} should be equal to 0. When the tests show that a significant difference between the returns made by pension funds and the returns of the control funds it can be concluded that the regulation has had a significant impact on the returns of pension funds.

To address potential skewness problems in BHAR's determined by using a reference portfolio, Lyon, Barber & Tsai (1999) advocate the use of a skewness adjusted test statistic. To account for possible skewness the skewness adjusted-test statistic t_{BHARSA} will be determined according to the following formula. In this formula $\hat{\gamma}$ will be the skewness coefficient of the horizon values calculated by equation 2.

$$t_{BHARSA} = t_{BHAR} + \frac{\hat{\gamma}}{3\sqrt{n}}(t_{BHAR}^2 + \frac{1}{2})$$

Equation 5: Determination of skewness adjusted t-test statistic

5.3.2 The effect of the hedging structure

To allow for testing of the differences between the performances of the three hedging structures, that were introduced in section 3.2, a more basic event study methodology is utilized. This time the additions made to the methodology by Gur-Gershgoren et al., (2008) are not taken into account to prevent the 'splintered' return data that is available from influencing the result. Because of the increasing number of groups, coinciding data points are becoming increasingly scarce. To circumnavigate this problem three indexes are created by averaging the returns of all pension funds from one of three hedging groups identified by Engel, Oldenkamp & Petit (2014) in a certain month. This means that a straightforward BHAR approach as described in section 5.2 is used to compare the performance of the three groups.

The assumption that the returns of all three portfolios behave according to a Brownian motion and are normally distributed is made to create a framework that allows for statistical testing. Consequently this means that the portfolio value at a certain time *t* will be lognormally distributed. The standard deviation of this lognormal distribution is determined by calculating the standard deviation of the portfolio results.

$$\sigma = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Equation 6: Determination of Standard Deviation

The mean of the lognormal distribution is calculated by determining the continuously compounded increase in the cumulative value of each portfolio. By evaluating the following function r can be determined. This *r* will serve as the mean of the lognormal distribution. The *t* represents the time window over which the return is determined.

$$S(t) = S(0) * e^{rt}$$

Equation 7: Determination of r

By using these input parameters a 90% confidence interval can be created for each group. The cumulative results of the other two groups can then be compared to this confidence interval to see whether a significant difference in performance is present. The hypothesis that will be used to test the effects of the different hedging structures will be:

H_0 = The returns of pension funds are independent from the hedging structure that is used

5.3.3 The combination effect

The combination effect will be tested according to the same methodology as explained in section 5.3.2. The hypothesis used in testing procedures will be:

H_0 = The returns of pension funds are independent from the hedging structure and the fixed income investment ratio

5.4 Time windows

This section will describe the time windows that are used to calculate the performance of the different groups and thereby answer the research questions introduced in 3.2. Each event window will be defined by a starting month and a horizon month. These two numbers determine the period over which performance is tracked. Performance between groups is compared at the end of the time window.

5.4.1 The fixed income investment ratio

The effects of the fixed income investment ratio will be determined over two periods of time. The first starting at the introduction date of the FTK at the beginning of 2007 and the second at the introduction date of the nFTK at the beginning of 2015. The first period will have horizon months equal to 12, 36 and 60 months. The second period will be evaluated over 5 and 10 months.

This yields two testing windows:

1. Post FTK
2. Post nFTK

5.4.2 Hedging structures & combination effects

The hedging structures and the combination of hedging and fixed income investment ratio will be tested with different event windows. There will be two starting months, one at introduction date of the FTK (start of 2007). This starting month will be used with short horizon months (6,12,18,24 and 30) to look at the effects of the crisis and with long horizon months (12,24,36,48 and 60) to be able to determine the recuperation process of the different type of funds.

To take a more in depth look at the recuperation abilities of the differently structured funds an extra event date is introduced at the beginning of the credit crisis at the end of September 2008. This yields 3 testing windows:

1. Post FTK – short
2. Post FTK – long
3. Post crisis

5.5 Methodology overview

The table below will give an overview of the methodology framework utilized to answer each sub-question.

Sub-question	**Evaluates**	**# groups**	**Events**	**Methodology**
1	Fixed income investment ratio	2	FTK & nFTK	Gur-Gershgoren et. al
2	Hedging structure	3	FTK-short, FTK-long & post crisis	BHAR with lognormal cum. Return (Barber & Lyon, 1997)
3	Combination effects	6	FTK-short, FTK-long & post crisis	BHAR with lognormal cum. return (Barber & Lyon, 1997)

Table 4: Overview of methodology frameworks

6. Results

This chapter will describe the statistical tests that have been performed on the dataset that was described in chapter 4 according to the methodology that was presented in chapter 5. For structuring purposes this chapter is split into five sections. Section 6.1 will deal with the procedure of splitting the dataset based on the fixed income investment ratio (6.1.1) and type of hedging structure (6.1.2). Section 6.2 will describe the tests performed to measure the effect of the fixed income investments done by pension funds. Section 6.3 will determine the effects of the hedging structure on the returns and section 6.4 will look at the combination of hedging structure and fixed income ratio. Finally section 6.5 will give an overview of the results of section 6.2, 6.3 and 6.4.

6.1 Splitting the dataset

The following paragraphs will describe the splitting procedure involved with answering each of the 3 sub-questions.

6.1.1 Fixed income investment ratio

The introduction of regulation is regularly associated with an increase in fixed income investments (see section 3.2). At the beginning of 2007 pension funds are allocated to group A, the 'high-adopters' or group B, the 'low-adopters'. The data from 2007 is used to determine which fund belongs in which group. The group allocation used to compare returns after the FTK is also used to test the effect of the (n)FTK.

To make a substantiated split the asset mix of each pension fund has been extracted from a database at the performance and risk department at KAS BANK. This asset mix is used to determine the fraction of fixed income assets in the years that the pension funds have been administrated. Because the FTK was introduced at the beginning of 2007 data has been extracted from that moment in time. This extraction has yielded a dataset containing yearly time series of each fund, describing the fixed income fraction in the asset-mix. This overview can be found in Appendix I.

When looking at some of the key statistics of the dataset visualised in Appendix I it becomes clear that since 2006 the relative share of fixed income investments has increased from 0,55 to a value fluctuating around 0,60. Furthermore the standard deviation stays globally the same over the entire period in time. The median stays pretty close to the average suggesting the absence of skewness.

To split the dataset all pension funds with a ratio below the average fixed income ratio at the end of 2006 will be marked as funds with a low fixed income ratio and placed in group B, also known as the "Benchmark" group. All pension funds with a ratio equal or above the average will be marked as high fixed income ratio funds and placed in group A. This splitting procedure yielded two groups were group A will contain the funds that will be compared to the benchmark funds in group B.

Group A	high (n)FTK adopters	Testing group
Group B	low (n)FTK adopters	Benchmark

Table 5: Overview of testing groups

Some difficulties arise when a pension fund has not been administrated at the end of 2006. These pension funds will be rated according to the first administrated value after 2006 and compared to the average of that year. The division of funds over group A and B can be observed in Appendix II.

It should be noted that pension funds 19, 41, 45, 60, 70, 72 & 73 are removed from this overview. After consultation with a specialist at KAS BANK these funds were deemed unsuitable for testing because while said funds could be considered pension funds from a purely theoretical view, in practice they are not and using them would unwantedly influence the testing results. These pension funds will therefore not be included in the tests.

6.1.2 Hedging structures

Although the three hedging strategies and the use of them are not widely described in scientific literature, the funds in the dataset acquired at KAS BANK can all clearly be classified in one of three hedging strategies. This was done by looking at the investments that were made and how they were structured. At KAS BANK all administrated pension funds were administrated according to the structure they used to manage their investments. This means that the structure at KAS BANK mirrors the structure used by pension fund management. The following sections describe the categorization procedure used to categorize each pension fund. Tables 6, 7 & 8 are taken straight from the administrator files provided by KAS BANK and show the headers signifying the categories in which investments of pension funds are registered. The categories are structured like a 'tree' in which the dots before the name of the category signify whether a category is part of a higher level category. A more in depth description of the characteristics of the different hedging structures can be found in section 3.2.1, 3.2.2 and 3.2.3.

Longterm portfolio

Long-term portfolios are identified by an absence of hedging products like 'swaptions' and a simple investment structure. Like the structure below. No clear distinction is made between hedging products and products aimed at creating returns. This means that the interest risks the pension fund should be more difficult to control.

. Totaal	. . Equity	. . Fixed Income	. . Real Estate	. . Private Equity	. . Commodities	. . Cash

Table 6: example of a typical 'longterm' portfolio

This type of hedging structure will be referred to as 'longterm' from now on.

Derivative overlay

These portfolios were identified by the clear use of derivatives like 'swaptions', investments in hedge funds and options. Furthermore the presence of overlay structures was used as an identifier of the use of a derivative overlay structure.

. Total	. . Fixed Income	. . . Cash Commitment	. . . Credits	. . . Deposits	. . . Forward currency
. . . Government Bonds	. . . Swaps	. . . Options	. . . Securitized	. . . Repo	. . Cash

Table 7: example of a typical 'overlay' structure (for readability purposes it has been restyled).

This hedging structure will be referred to as 'overlay' from now on.

Matching and return portfolios

Matching and return portfolios were identified by the easily recognizable matching and return structure that these pension funds utilize. All investments are combined under either the matching group or the return group.

. Total	. . Matching Portfolio	. . . Duration Matching	. . Return Portfolio	. . . Vastrentende waarden return	. . . Equity

Table 8: example of a typical matching and return structure

This hedging structure will be called 'matching' from now on.

The results of the splitting procedure can be found in Appendix III.

6.1.3 Combination of hedging structure and fixed income investment ratio

The splits made in 6.1.1 and 6.1.2 are combined to form 6 portfolios in which each hedging structure is actually split into two parts, one with a high fixed income investment ratio and one with a low ratio. This procedure yields the following groups:

Group	Contains
Longterm A	All “Longterm” funds with a high fixed income investment ratio
Longterm B	All “Longterm” funds with a low fixed income investment ratio
Overlay A	All “Overlay” funds with a high fixed income investment ratio
Overlay B	All “Overlay” funds with a low fixed income investment ratio
Matching A	All “Matching” funds with a high fixed income investment ratio
Matching B	All “Matching” funds with a low fixed income investment ratio

Table 9: Overview of combination groups

6.2 Effects of the fixed income investment ratio

This section will answer the first sub-question that was introduced in section 3.2: *What is the effect of a high fixed income investment ratio on the performance of pension funds.* Two time windows will be used in this analysis, one starting at the beginning of 2007 when the FTK was introduced and the other starting at the beginning of 2015 after the introduction of the nFTK. The hypothesis that will be used in the statistical procedures is:

H_0 = The returns of pension funds are independent from the fixed income investment ratio

In the coming paragraph pension funds will be matched according to the theory presented in Gur-Gershgoren et al (2008). Afterwards the testing procedure will be explained and the results interpreted.

6.2.1 Matching procedure

After splitting all pension funds over their respective groups the theory of Gur-Gershgoren et al. (2008) is applied. This theory states that when comparing the performance of a firm, in this case the firm is interpreted as a pension fund, it should be compared to up to three other funds. To achieve this a matching matrix is constructed. In this matrix three pension funds from group B are matched to each pension fund in A. Matching is done based on fund sizes in 2006. If no data was available for 2006 the first year in which the fund was administrated was used. The results of this matching process can be found in Appendix IV. In these tables all pension funds grouped in A are placed in the first column. B funds are in the first row and a 1 at an intersection signifies a match. Each A fund is matched with exactly three B funds. B funds that weren’t administrated in the period after the introduction of FTK were excluded from the matching procedure. The second table contains the matching procedure for the nFTK. Since different funds were administrated at that time a different outcome is realized. These matching matrices are used in the testing procedures in the following sections.

6.2.2 Testing procedure

This section will describe the steps that were made during the statistical testing. First the different time series returns data was split, this meant that 2 datasets were generated. Return data before the 1st of January 2007 was removed and the remaining data was converted to a cumulative returns table, reflecting a “Buy-And-Hold” return. The same was done for the period after introduction of the nFTK (data was cut off before January 2015). The cumulative returns table was used to extract horizon return for each pension fund. The results can be seen in the two tables in Appendix IV. These horizon returns were then compared with the horizon return for the benchmark funds in group B of which the returns data can also be found in Appendix V.

After this step the matched horizon returns from group B were averaged and compared to the horizon returns of the pension funds in A. This yielded the BHAR's that can be found in Appendix VI. The acquired BHAR's were then used to determine the testing statistics according to the formulas that were summarized in section 5.3 (Lyon, Barber, & Tsai, 1999).

$$t_{BHAR} = \sqrt{n}\frac{\overline{BHAR}}{s_{BHAR}}$$

Equation 8: Determination of t-test statistic

The results are presented in the tables below:

FTK	**BHAR(12)**	**BHAR(36)**	**BHAR(60)**
AVERAGE BHAR	-0,021	0,026	0,041
# Funds	14	11	8
Standard deviation s	0,040	0,086	0,167
t(bhar)	-1,958	0,979	0,695
Critical value	-1,771	-1,812	-1,895
Significant?	Yes	No	No

Table 10: t_{bhar}-values FTK

nFTK	**BHAR(5)**	**BHAR(10)**
AVERAGE BHAR	-0,084	-0,001
# Funds	16	12
Standard deviation s	0,015	0,021
t(bhar)	-22,062	-0,101
Critical Value	-1,753	-1,796
Significant?	Yes	No

Table 11: t_{bhar}-values nFTK

The average BHAR is calculated by averaging the BHAR's of the different funds in group A. The #firms equals the amount of funds that are administrated during that time period and the standard deviation s is calculated by finding the standard deviation of the different BHAR's. When these values are combined in (4) it returns a t_{bhar} value. This value is compared to a standard t-distribution with a confidence interval of α = 0,95. The degrees of freedom are determined by subtracting 1 from the number of funds. This means that the t-value is compared to a critical value dependent on the amount of observations.

To tackle the skewness problem apparent in long-term event studies the skewness adjusted version of the t-test, is also determined according to the formula suggested by Lyon, Barber & Tsai (1999) and Knif, Kolari & Pynnonen (2013). The results can be seen in tables 6 and 7.

$$t_{BHARSA} = t_{BHAR} + \frac{\hat{\gamma}}{3\sqrt{n}}(t_{BHAR}^2 + \frac{1}{2})$$

Equation 9: Determination of skewness adjusted t-test statistic

FTK	BHAR(12)	BHAR(36)	BHAR(60)
Skewness estimator γˆ	-1,215	-0,391	0,243
t(bharsa)	-8,524	0,348	0,921
Critical value	-1,771	-1,812	-1,895
Significant?	Yes	No	No

Table 12: t_{bharsa}-values FTK

nFTK	BHAR(5)	BHAR(10)
Skewness estimator γˆ	0,483	-1,428
t(bharsa)	291,419	-0,943
Critical Value	1,753	-1,796
Significant?	Yes	No

Table 13: t_{bharsa}-values nFTK

The skewness estimator is determined by determining the skewness of the BHAR results from Appendix IV.

6.2.3 Interpretation

In this paragraph the results from the previous section will be put into perspective. As can be seen in tables 10, 11, 12 and 13 all t-values are compared with the critical value (with α=0,95) of a standardized t-distribution. The following paragraphs will describe the interpretation of the results obtained in 6.2.2

FTK

Testing results for the FTK can be found in table 10 and 12. Remarkable of these results is that directly after the introduction of the FTK a significant difference is measured in the performance of groups A and B. After 36 months the difference between group A and B is reduced to an insignificant amount. So what does this mean? To answer this question it will be revealing to look at the averaged cumulative returns of the pension funds in group A and B. The average cumulative results over the months following January 2007 can be found in figure 1.

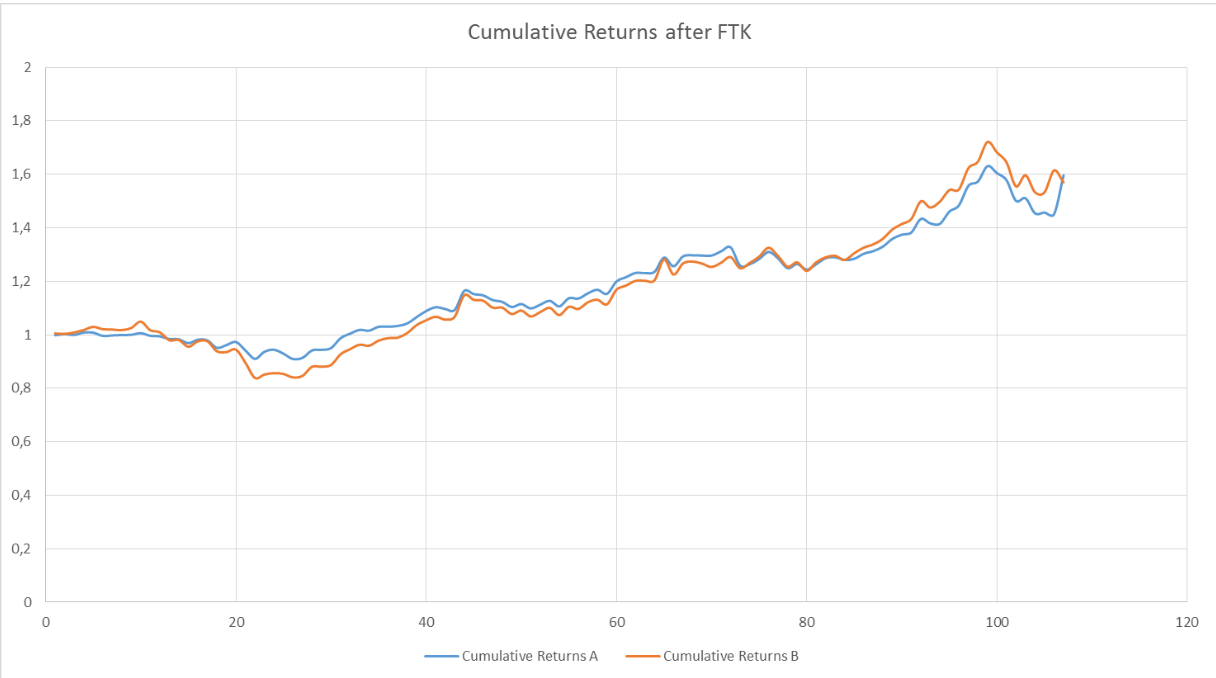

Figure 1: Cumulative Returns post FTK

The orange line signifies the returns of the 'B' funds and the blue line represents the average returns of the 'A funds. The significant difference over the first 12 months can clearly be identified.

At the 20 month mark something notable happens, both lines drop but the orange one drops much deeper. It shouldn't come as a surprise that the 20 month mark corresponds to the fall of 2008, in which a worldwide financial crisis occurred. Looking at the graph it seems as though the pension funds with a high fixed income ratio suffered less than the funds with a lower fixed income ratio. This begs the question, was this the FTK in action?

When a closer look is taken at the situation it becomes clear that while both groups suffered, the 'B' pension funds where hit much harder. In the 4 months from September 2008 up until the end of that year, the 'regulated' funds from group A lost nearly 3 percentage-points in cumulative returns (-0,029) while the 'under-regulated' funds in group 'B' lost almost 9 percentage-points (-0,088).

Group B was clearly outperforming group A over the first period in time due to the fact that it was managed in a more risk-loving way. The fraction of fixed income investments was smaller than in group A. When markets went down in the summer of 2008 it's clear that while the returns of B plummet, group A seems to limit its losses. This is reflected in the test statistics because of the compounding effect that was emphasized by Michell & Stafford (2000); at first group B heavily outperforms the high-adopters. But over the years that followed group A has caught up to create a non-significant difference. Overall it seems that the 'high-regulated' pension funds in group A exhibit a higher grade of disconnectedness with the market.

The test statistic t that was adjusted for skewness yields no other outcomes, it is striking however that the significance at h=12 seems to be magnified. Utilizing a fund based reference portfolio might have indeed solved the skewness problems existent in the BHAR approach (Gur-Gershgoren, Hughson, & Zender, 2008).

nFTK

Test statistics from table 11 and 13 make clear that 5 months after the introduction of the nFTK a substantial difference between the performance of group A and B can be observed. The test statistic of -22,06 reflects an underperformance of group A. The magnitude of this t-value and especially the skewness adjusted version suggests a huge difference, which in fact is apparent. The performance difference over the first 5 months is 4 times bigger than the performance difference over the first 12 months in the FTK test.

To understand this difference it is interesting to take a look at the performance of the market in this period of time. In this illustration the AEX index (as shown in figure 2) is used as a proxy for market performance. At the beginning of 2015 the market enters a 'bubble-like' phase in which it rises from a value around 420 at the beginning of January, to a peak of 507 at the beginning of April before returning to 422 at the end of October.

Figure 2: 5 year historical results of AEX index. (Google, 2016)

Testing statistics show that the funds in group B exhibit a much higher return than the funds in group A. This can be seen as the cause for the extreme t-value. Once the 'bubble' has burst the t value decreases to a non-significant value. Plotting the cumulative returns of both groups yields the graph in the following figure and supports the idea that the 'low-regulated' group of pension funds follows the market more closely than the 'high-regulated' group. The cumulative returns of both groups are shown in figure 3 below. In this graph the amount of months after the introduction of the nFTK in January 2015 can be found on the horizontal axis and the cumulative return on the vertical axis.

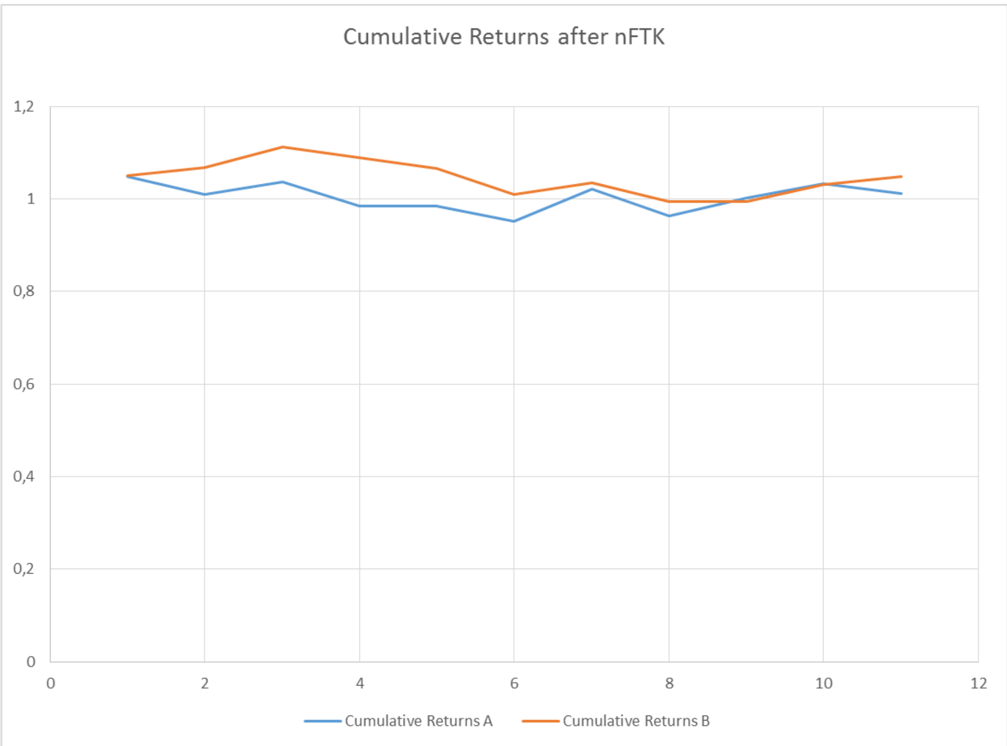

Figure 3: Grouped Returns post nFTK

The skewness adjusted t-test again yields magnified testing statistics but has no influence on t-values being significant or not.

6.2.4 Results

The effect of the fixed income investment ratio can be summarized in one sentence: A higher fixed income ratio will offer protection in times of crisis and will eat out of your profits in times of a rising market.

This means that the hypothesis that was reintroduced at the beginning of this section:

H_0 = The returns of pension funds are independent from the fixed income investment ratio

Will be rejected because a significant difference exists between the two groups that are defined in section 6.1.1 It should however be noted that this difference only exists when looking at the 'short term' performance (12 and 5 months). In the long run the differences seem to diminish and the significance disappears.

6.3 Effects of the hedging structure

This section will answer the second sub-question that was introduced in 3.2: *What are the effects of the three different hedging structures on the performance of pension funds?* Three event dates and corresponding windows will be utilized; post FTK short, post FTK long and post crisis (see 5.4). The hypothesis to this research question is:

H_0 = The returns of pension funds are independent from the hedging structure that is used

This hypothesis will be researched by performing a BHAR event study over the different time windows with varying horizon months.

In the following paragraph a short statistical exploration will be performed to put the results of the three groups that were formed in 6.1 into perspective. Next the three time windows will be used in the statistical testing procedure that was introduced in 5.3.2. After that the results will be interpreted.

6.3.1 Statistical exploration

For testing purposes the returns of the pension funds in each category are grouped and averaged. This creates three performance indexes from the beginning of 2000 up to the end of 2015. The difference between the returns of the three groups is determined by performing a paired t-test over a time period of 158 months starting at the end of October 2002 (since that month data of all three 'portfolio groups' is available). The results of this t-test can be found in table 14.

t-Test: Paired Two Sample for Means	*Longterm*	*Matching*	*Overlay*	*Matching*	*Longterm*	*Overlay*
Mean	1,0054	1,0059	1,0063	1,0059	1,0054	1,0063
Variance	0,0003	0,0004	0,0003	0,0004	0,0003	0,0003
Observations	158	158	158	158	158	158
Pearson Correlation	0,9421		0,9359		0,9204	
df	157		157		157	
t Stat	-0,7798		0,6947		-1,5053	
P(T<=t) two-tail	0,4367		0,4882		0,1342	
t Critical two-tail	1,9752		1,9752		1,9752	

Table 14: T-test on the returns of the three groups

When the difference between the three 'portfolios' is analysed by performing three independent paired t-tests it becomes clear that there is no clear difference between the three grouped portfolios meaning all monthly returns could have been drawn from the same population. The results of this comparison are shown in table 14.

When these returns are however multiplied so they reflect the cumulative returns of each 'portfolio' a different image is obtained. The horizontal axis shows the amount of months that have passed since January 2000 while the vertical axis shows the cumulative return.

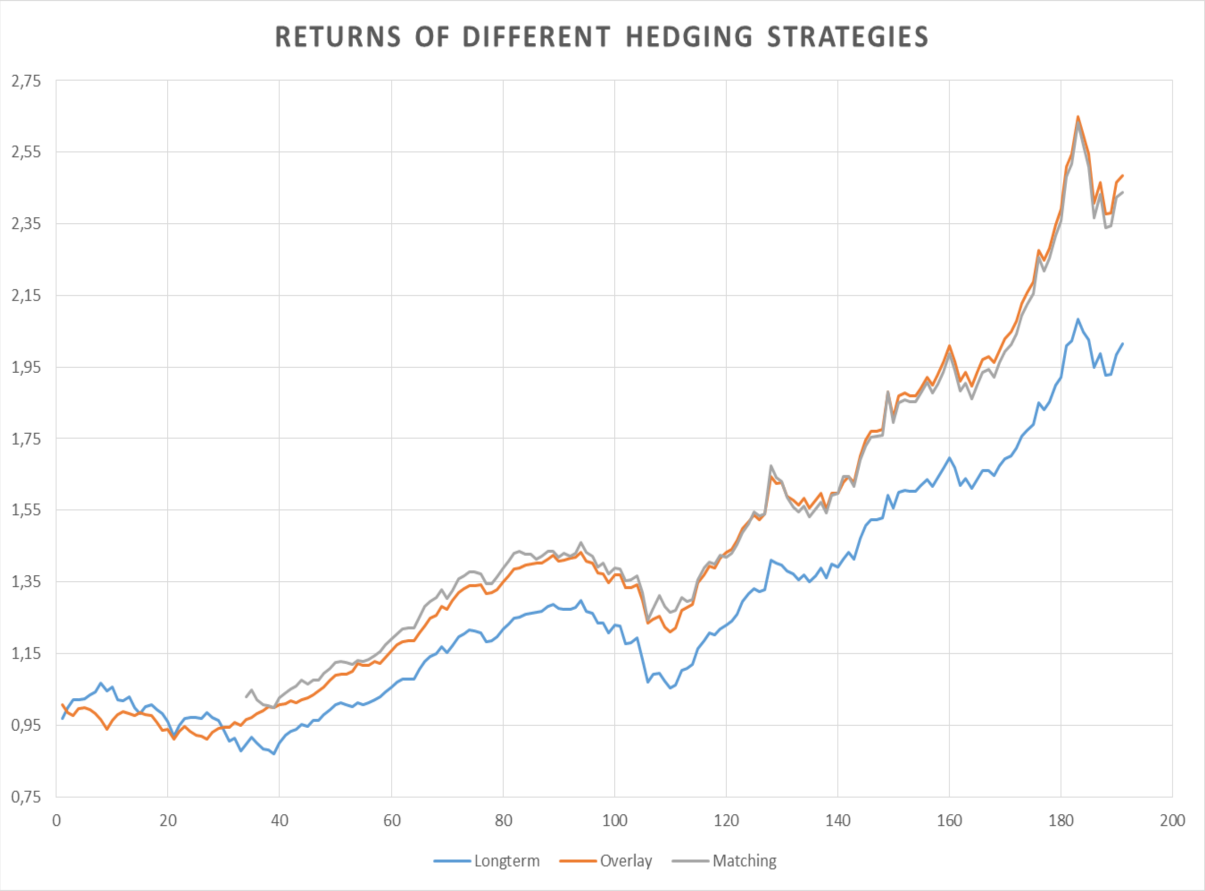

Figure 4: Cumulative returns of the 3 hedging strategies.

Figure 4 makes it clear that the 'longterm' group is substantially outperformed by the 'overlay' and 'matching' portfolios. Figure 5 looks at the difference between the cumulative returns of each portfolio. It becomes clear that over time the 'longterm' structured portfolio keeps losing terrain on the 'overlay' and 'matching' structured portfolios.

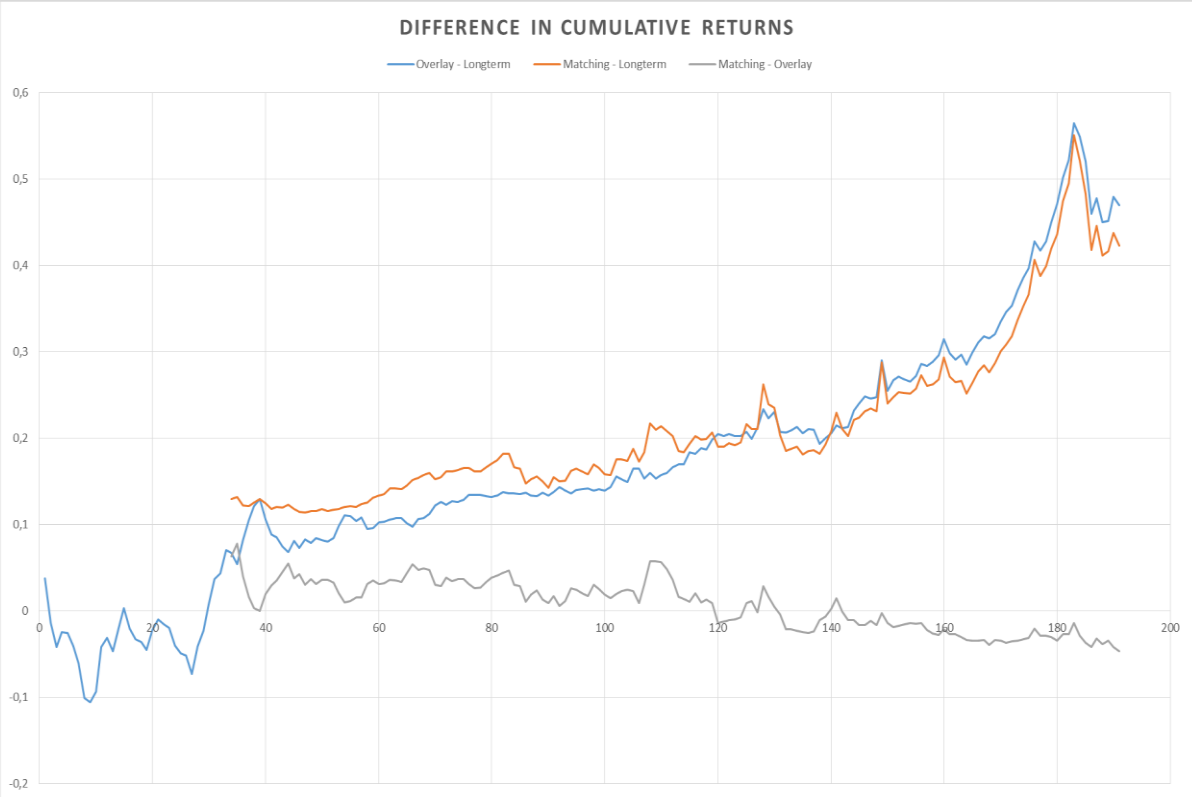

Figure 5: Difference in cumulative returns of the 3 hedging strategies.

This graph strengthens the idea that 'overlay' and 'matching' strategies yield a similar performance. Both strategies outperform the more traditional 'longterm' portfolio approach. A more precise comparison on different time windows is made in the following paragraphs.

6.3.2 Post FTK -short term

First the horizon returns are determined by calculating the product of the returns in the 'event-window'. These horizon values can be found in table 15 below. Furthermore a graphic representation can be found in the graph in figure 6 on the next page. This graph shows the return on the vertical axis and the amount of months that have passed since the 'event' on the horizontal axis.

Horizon Return (months)	**6**	**12**	**18**	**24**	**30**
Longterm return	*1,012*	*1,001*	*0,934*	*0,868*	*0,887*
Overlay return	*1,009*	*1,004*	*0,955*	*0,898*	*0,923*
Matching return	*0,994*	*0,997*	*0,949*	*0,919*	*0,913*

Table 15: Horizon returns

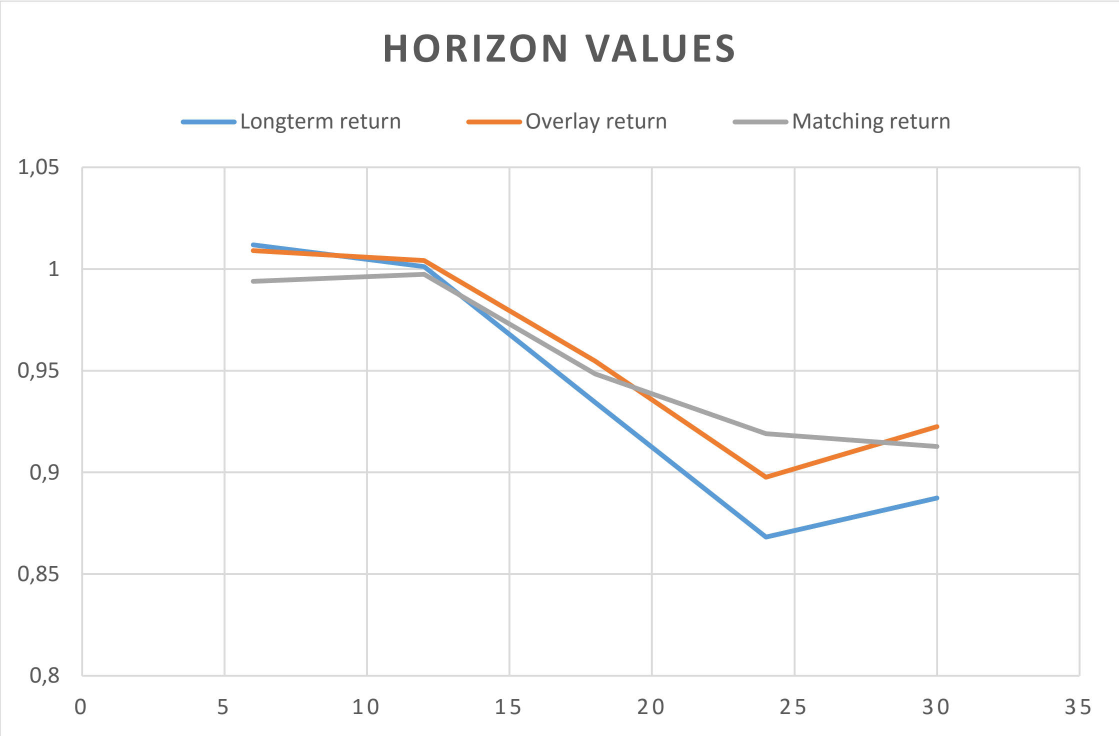

Figure 6: Horizon values of the three hedging groups

First the standard deviation, or volatility, is determined over the averaged historic returns of each hedging group in the specified time window. Then the continuously compounded return is determined over the same time window to find the 'mean' of the returns.

The standard deviation and return *r* are used as input for an inverse lognormal distribution. This distribution is used to find the lower bound at p=0,05 of the distribution and p=0,95 at the upper bound to determine a confidence interval.

The graph above suggests that the 'overlay' styled hedging portfolio outperforms the 'longterm' hedge structure. Furthermore it seems to be more sensitive to the crisis that occurs between the 18 and 24 month horizons. It does however recuperate faster than the other 2 groups. To test the significance of this the 90% confidence interval of each portfolio type for each time horizon is determined. The results of this procedure are presented in table 16 on the next page.

Boundary Determinitation

Significance Level	0,90

Volatilities	6	12	18	24	30
Longterm return	0,006	0,009	0,014	0,020	0,020
Overlay return	0,006	0,008	0,011	0,015	0,017
Matching return	0,008	0,011	0,013	0,019	0,019

r (continuously compounde	6	12	18	24	30
Longterm return	0,012	0,001	-0,068	-0,141	-0,119
Overlay return	0,009	0,004	-0,046	-0,108	-0,081
Matching return	-0,006	-0,003	-0,053	-0,084	-0,091

Lower Bound	6	12	18	24	30
Longterm return	1,002	0,986	0,913	0,840	0,858
Overlay return	0,999	0,991	0,937	0,875	0,898
Matching return	0,980	0,980	0,929	0,890	0,885

Upper Bound	6	12	18	24	30
Longterm return	1,021	1,016	0,957	0,897	0,918
Overlay return	1,019	1,017	0,973	0,921	0,948
Matching return	1,008	1,015	0,969	0,949	0,941

Table 16: Boundary determination for FTK-short tests.

Setting up the confidence intervals and comparing the performance of the other groups to it led to this significance overview in table 17 below:

Significance Testing

Months	6	12	18	24	30
Longterm vs. Overlay	No	No	Yes	Yes	Yes
Longterm vs. Matching	Yes	No	No	Yes	No
Overlay vs. Longterm	No	No	No	Yes	Yes
Overlay vs. Matching	Yes	No	No	No	No
Matching vs. Longterm	Yes	No	No	Yes	No
Matching vs. Overlay	Yes	No	No	No	No

Table 17: Overview of significance

These results make clear that the 'longterm' hedging structure has suffered a lot during the crisis. While outperforming the 'matching' group at first, it never really recuperates from the hits it has taken. Furthermore the 'overlay' group seems to be more vulnerable to the crisis but also shows that it recuperates faster than the 'matching' group which seems to be less vulnerable to the effects of the crisis. This does however only gives a short insight in the effects of the crisis. The following two sections will further explore these effects.

6.3.3 Post FTK -long term

The procedure followed to find the significance of the results is identical to the procedure in 6.3.2. First the horizon values are determined, these can be seen in table 18.

Horizon Return (months)	12	24	36	48	60
Longterm return	*1,001*	*0,868*	*0,975*	*1,089*	*1,167*
Overlay return	*1,004*	*0,898*	*1,026*	*1,131*	*1,219*
Matching return	*0,997*	*0,919*	*0,995*	*1,092*	*1,186*

Table 18: Horizon returns of the event windows after the introduction of FTK.

Again a graphic representation of these horizon values can be found in figure 7.

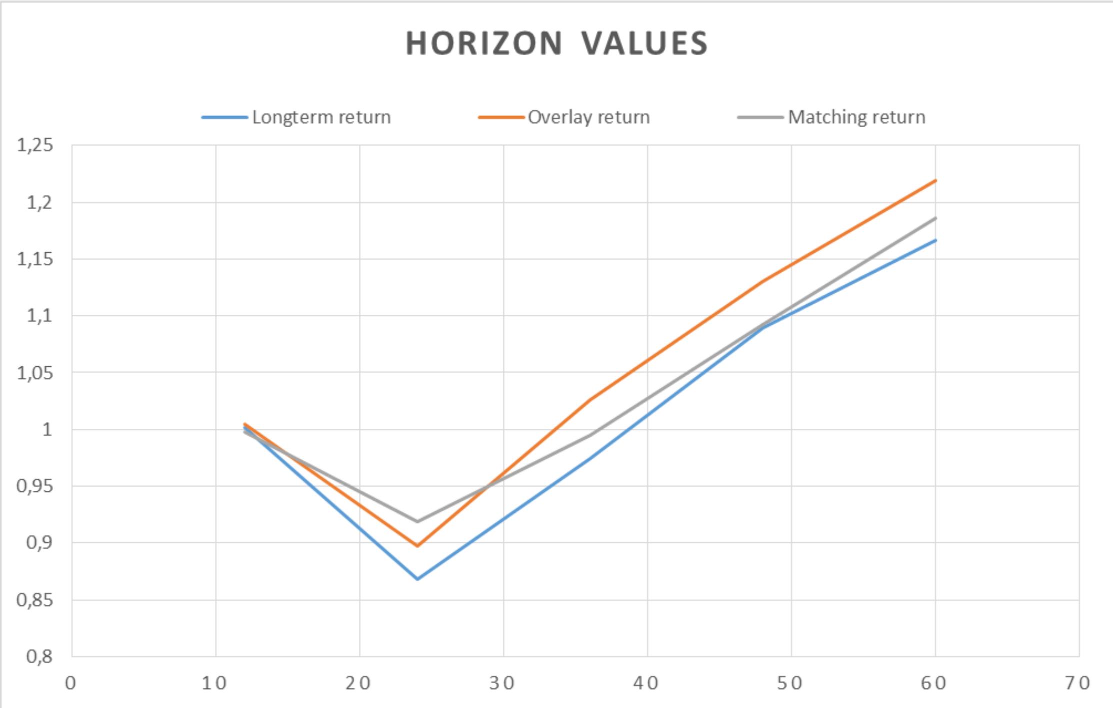

Figure 7: FTK Horizon returns graphed over time.

Then, the boundaries of each group are calculated so that significance can be determined. The boundaries are shown in table 19 while an overview of the significance can be found in table 20.

Boundary Determinitation

Significance Level	0,90				
Volatilities	**12**	**24**	**36**	**48**	**60**
Longterm return	0,009	0,020	0,021	0,021	0,020
Overlay return	0,008	0,015	0,018	0,019	0,020
Matching return	0,011	0,019	0,019	0,022	0,022
r (continuously compounded	**12**	**24**	**36**	**48**	**60**
Longterm return	0,001	-0,141	-0,026	0,086	0,154
Overlay return	0,004	-0,108	0,026	0,123	0,198
Matching return	-0,003	-0,084	-0,006	0,088	0,171
Lower Bound	**12**	**24**	**36**	**48**	**60**
Longterm return	0,986	0,840	0,942	1,053	1,129
Overlay return	0,991	0,875	0,996	1,095	1,181
Matching return	0,980	0,890	0,963	1,052	1,144
Upper Bound	**12**	**24**	**36**	**48**	**60**
Longterm return	1,016	0,897	1,008	1,127	1,207
Overlay return	1,017	0,921	1,057	1,168	1,259
Matching return	1,015	0,949	1,027	1,133	1,230

Table 19: Boundary determination for FTK-long

Significance Testing

Months	**12**	**24**	**36**	**48**	**60**
Longterm vs. Overlay	No	Yes	Yes	Yes	Yes
Longterm vs. Matching	No	Yes	No	No	No
Overlay vs. Longterm	No	Yes	Yes	Yes	Yes
Overlay vs. Matching	No	No	No	No	No
Matching vs. Longterm	No	Yes	No	No	No
Matching vs. Overlay	No	No	Yes	Yes	No

Table 20: Significance testing for FTK-long

Table 20 above shows the results of comparing the results of each group to the confidence interval of the other groups. It's clear that after 24 months 'overlay' outperforms the 'longterm' portfolio. There is a significant difference between 'matching' and 'longterm' 2 years after the introduction of the regulation. This difference however disappears after another year. The 'overlay' portfolio also shortly significantly outperforms the 'matching' portfolio. This difference however also decreases over the fifth year.

These results match the graph in Figure 8. Shortly after the introduction of FTK regulation the economic markets are hit by the credit crisis. This crisis is reflected by the three lines all dropping somewhere around the 24 month line. It's interesting to see that while all three groups are hit, the traditional 'longterm' hedging structure is hit the hardest and clearly performs worse than the alternatives in the period of crisis.

6.3.4 Post crisis

The effects of the crisis are determined in the same manner as in 6.3.2. The horizon returns are show in table 21. A plot of these returns is shown in figure 8.

Horizon Return (months)	**12**	**24**	**36**	**48**	**60**
Longterm return	*0,986*	*1,126*	*1,185*	*1,357*	*1,389*
Overlay return	*1,010*	*1,156*	*1,199*	*1,402*	*1,453*
Matching return	*1,001*	*1,135*	*1,174*	*1,364*	*1,406*

Table 21: Horizon values post crisis

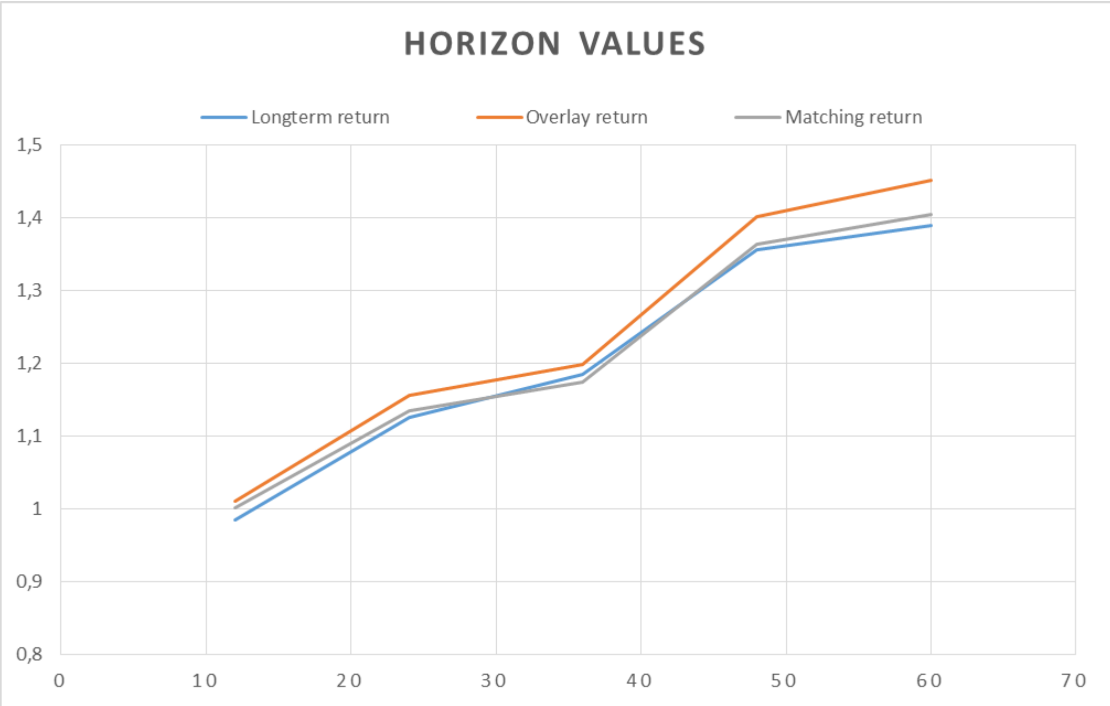

Figure 8: Graphed horizon values post crisis

Based on these returns the boundaries of the confidence intervals are determined and shown in table 22.

Boundary Determinitation

Significance Level	0,90				
Volatilities	**12**	**24**	**36**	**48**	**60**
Longterm return	0,029	0,023	0,022	0,022	0,021
Overlay return	0,026	0,020	0,022	0,023	0,022
Matching return	0,028	0,022	0,025	0,026	0,025
r (continuously compounde	**12**	**24**	**36**	**48**	**60**
Longterm return	-0,015	0,118	0,170	0,305	0,329
Overlay return	0,010	0,145	0,182	0,338	0,373
Matching return	0,001	0,127	0,161	0,311	0,341
Lower Bound	**12**	**24**	**36**	**48**	**60**
Longterm return	0,939	1,084	1,142	1,309	1,343
Overlay return	0,968	1,118	1,157	1,350	1,401
Matching return	0,956	1,095	1,127	1,307	1,350
Upper Bound	**12**	**24**	**36**	**48**	**60**
Longterm return	1,034	1,168	1,230	1,407	1,437
Overlay return	1,055	1,195	1,244	1,457	1,506
Matching return	1,048	1,177	1,224	1,424	1,464

Table 22: boundary determination post crisis

Comparing these boundaries to the horizon values yields a significance overview as visualized below in table 23.

Significance Testing

Months	**12**	**24**	**36**	**48**	**60**
Longterm vs. Overlay	No	No	No	No	Yes
Longterm vs. Matching	No	No	No	No	No
Overlay vs. Longterm	No	No	No	No	Yes
Overlay vs. Matching	No	No	No	No	No
Matching vs. Longterm	No	No	No	No	No
Matching vs. Overlay	No	No	No	No	No

Table 23: Significance overview post crisis

The results of this test make clear that the 'overlay' structure again outperforms the other two hedging styles. In this period of time the market is recuperating from the credit crisis. Over the 5 years it's clear that the 'longterm' portfolio is significantly outperformed by the 'overlay' portfolio over the 60 month window.

6.3.5 Results

Summarizing the results of these tests yields the following observations:

- Pre-crisis, the 'matching' and 'overlay' approach outperform the portfolio that is hedged according to a traditional 'longterm' hedging structure.

- During the crisis all funds are hit, although it seems that 'matching' based structures are hit less hard. Albeit not significantly.
- Post crisis performance seems comparable, although in the long run the 'overlay' group outperforms the 'longterm' portfolio.

This means that a significant difference does exist between the performance of the three hedging groups and that the hypothesis stated at the beginning of this section:

H_0 = The returns of pension funds are independent from the hedging structure that is used

has to be rejected.

6.4 Combination effects

This section will answer the third sub-question that was introduced in section 3.2:

What combination of fixed income ratio and hedging structure performs best?

This will be done by performing the same statistical procedures as in section 6.3 for the same time windows. Six different groups will be compared. Each group will contain a different combination of the hedging structures tested in 6.3 and the high or low fixed income investment ratio groups from section 6.2. The hypothesis that will be used is:

H_0 = The returns of pension funds are independent from the combined hedging structure and the fixed income investment ratio

This section will again start with a short statistical exploration, followed by an exploration of the three time windows that were introduced in 5.4.2. After that a summary of the results will be presented. All statistical tests will be performed like the test in 6.3.1.

6.4.1 Statistical exploration

To gain some insight in the returns behaviour of the six groups, the cumulative returns are plotted in figure 9 on the next page. The horizontal axis represents the amount of months passed since January 2000 and the vertical axis represents the return that is realized. Although market shocks seem to be apparent in all groups, three of them seem to be outperforming the other three. The top performers consist of: 'Overlay B', 'Matching B' and 'Overlay A'.

In the following sections the differences will be evaluated more thoroughly.

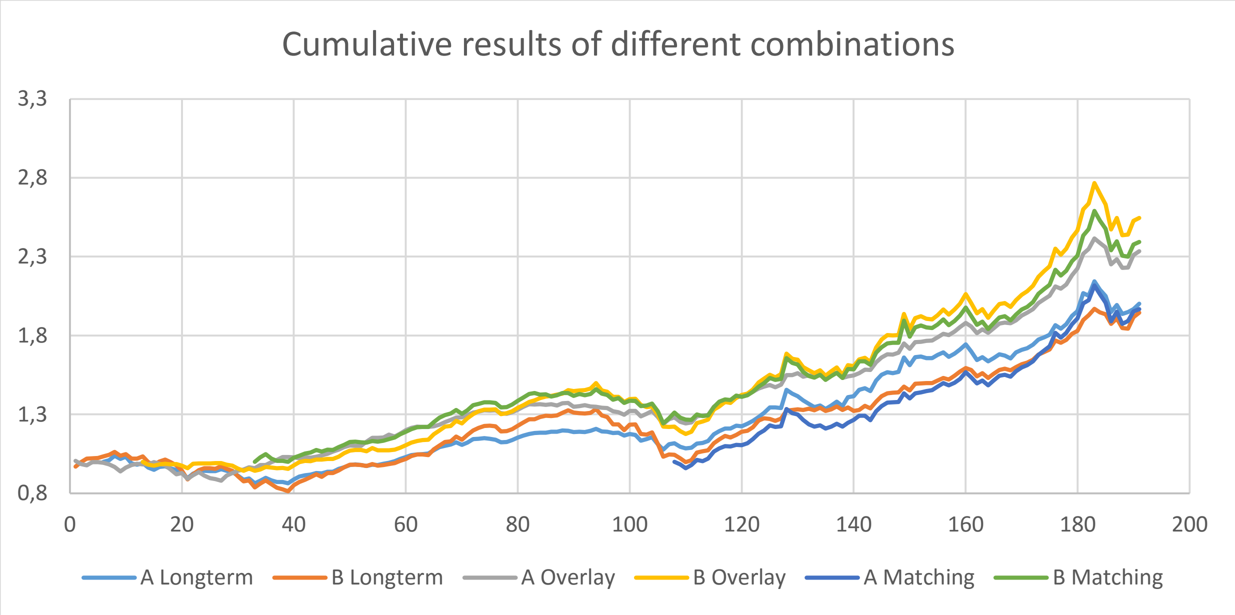

Figure 9: Cumulative results of combined categories

6.4.2 Post FTK – short

This section presents the results for the post FTK- short evaluation window. The empty cells stem from the fact that for the first 100 months no returns data is present in the 'Matching A' group. Therefore no calculations can be made for this group. The horizon returns are shown in table 24 below.

Horizon Return (months)	**6**	**12**	**18**	**24**	**30**
Longterm A	*1,002*	*1,005*	*0,957*	*0,943*	*0,955*
Longterm B	*1,021*	*0,999*	*0,915*	*0,813*	*0,835*
Overlay A	*0,989*	*0,982*	*0,944*	*0,939*	*0,950*
Overlay B	*1,031*	*1,028*	*0,969*	*0,872*	*0,903*
Matching A					
Matching B	*0,994*	*0,997*	*0,949*	*0,919*	*0,907*

Table 24: Horizon returns for combination groups

A visualization of these horizon values can be found in figure 10 on the next page. This graph shows the return on the vertical axis and the amount of months that have passed since the selected 'event' on the horizontal axis.

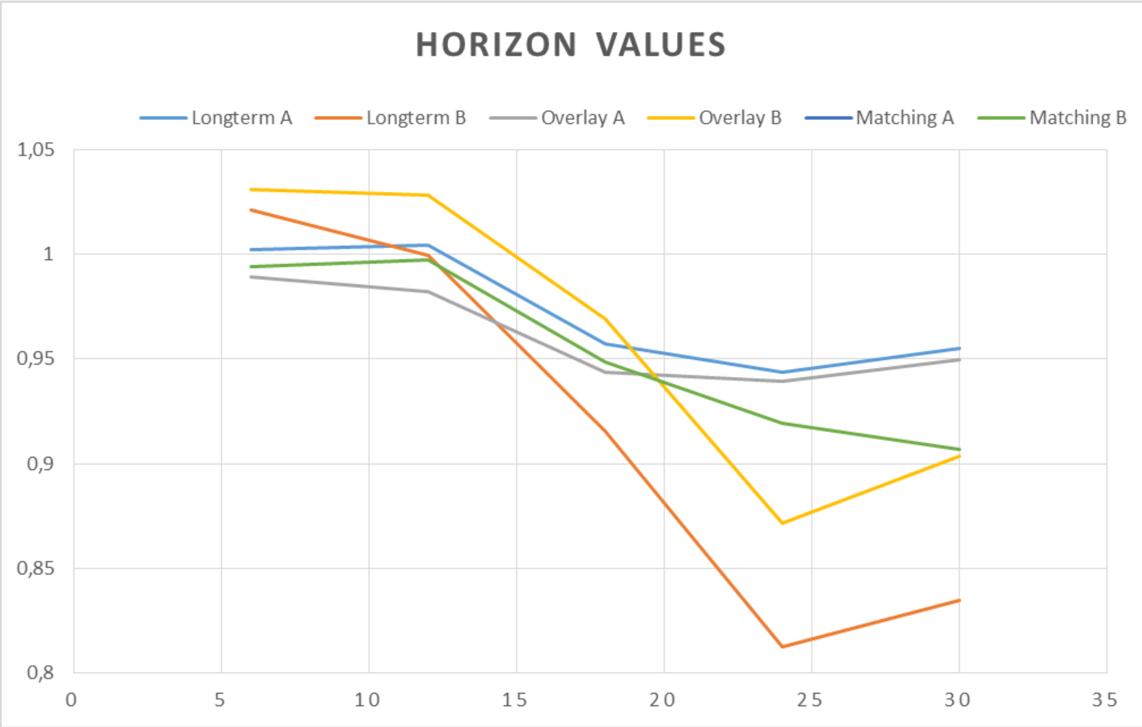

Figure 10: Graphic representation of horizon values

Table 25 gives an overview of the boundaries that were determined based on the returns of the different groups.

Boundary Determinitation

Significance Level	**0,90**				
Volatilities	**6**	**12**	**18**	**24**	**30**
Longterm A	0,005	0,006	0,010	0,015	0,015
Longterm B	0,008	0,012	0,019	0,025	0,025
Overlay A	0,008	0,006	0,010	0,014	0,015
Overlay B	0,006	0,012	0,015	0,018	0,020
Matching A					
Matching B	0,008	0,011	0,013	0,019	0,019
r (continuously compounde	**6**	**12**	**18**	**24**	**30**
Longterm A	0,002	0,005	-0,044	-0,058	-0,046
Longterm B	0,021	-0,001	-0,088	-0,208	-0,181
Overlay A	-0,011	-0,018	-0,058	-0,063	-0,051
Overlay B	0,030	0,028	-0,031	-0,137	-0,102
Matching A					
Matching B	-0,006	-0,003	-0,053	-0,084	-0,098
Lower Bound	**6**	**12**	**18**	**24**	**30**
Longterm A	0,994	0,994	0,942	0,920	0,932
Longterm B	1,008	0,979	0,887	0,780	0,801
Overlay A	0,975	0,971	0,928	0,917	0,927
Overlay B	1,021	1,007	0,946	0,846	0,875
Matching A					
Matching B	0,980	0,980	0,929	0,890	0,879
Upper Bound	**6**	**12**	**18**	**24**	**30**
Longterm A	1,010	1,015	0,973	0,967	0,979
Longterm B	1,035	1,020	0,945	0,846	0,870
Overlay A	1,003	0,992	0,960	0,962	0,973
Overlay B	1,040	1,049	0,993	0,898	0,933
Matching A					
Matching B	1,008	1,015	0,969	0,949	0,935

Table 25: Boundary determination

Comparing the returns to the boundaries results in the significance overview in table 26.

Group vs.	group	6	12	18	24	30
Longterm A	Longterm B	Yes	No	Yes	Yes	Yes
Longterm A	Overlay A	No	Yes	No	No	No
Longterm A	Overlay B	Yes	Yes	No	Yes	Yes
Longterm A	Matching A					
Longterm A	Matching B	No	No	No	No	Yes
Longterm B	Overlay A	Yes	Yes	Yes	Yes	Yes
Longterm B	Overlay B	Yes	Yes	Yes	Yes	Yes
Longterm B	Matching A					
Longterm B	Matching B	Yes	No	Yes	Yes	Yes
Overlay A	Overlay B	Yes	Yes	Yes	Yes	Yes
Overlay A	Matching A					
Overlay A	Matching B	No	No	No	No	Yes
Overlay B	Matching A					
Overlay B	Matching B	Yes	Yes	Yes	Yes	No
Matching A	Matching B					

Table 26: Significance Testing

It seems as though the groups ‘Overlay B’ and ‘Longterm B’ are hit the hardest by the crisis. ‘Longterm B’ however drops significantly lower than all the other groups and doesn’t seem to recuperate that well. ‘Overlay B’ does present a sharp recuperation angle. ‘Longterm A’ and ‘Overlay A’ seem to more immune to the effects of the crisis and therefore drops significantly less low. ‘Matching B’ seems to be hit less hard by the crisis than ‘Overlay B’ and ‘Longterm B’ but seems to suffer from the effects much longer.

6.4.3 Post FTK – long

The testing procedure will be identical to the procedure in 6.4.2. The horizon returns are show in table 27 and a graphical representation of the data is presented in figure 11.

Horizon Return (months)	12	24	36	48	60
Longterm A	*1,005*	*0,943*	*1,034*	*1,154*	*1,279*
Longterm B	*0,999*	*0,813*	*0,926*	*1,040*	*1,076*
Overlay A	*0,982*	*0,939*	*1,040*	*1,134*	*1,195*
Overlay B	*1,028*	*0,872*	*1,014*	*1,125*	*1,228*
Matching A					
Matching B	*0,997*	*0,919*	*0,989*	*1,082*	*1,186*

Table 27: Horizon returns

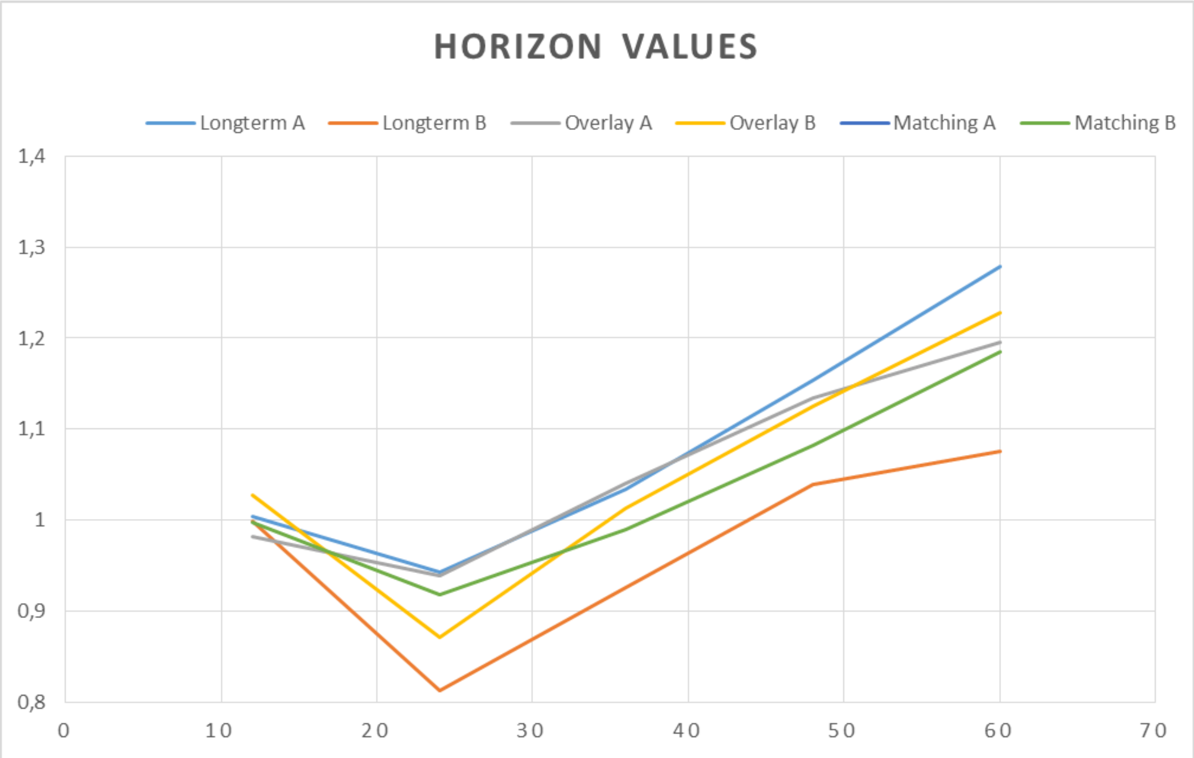

Figure 11: Graphical representation of horizon values

The boundary determination overview can be found in table 28.

Boundary Determinitation

Significance Level	0,90				
Volatilities	**12**	**24**	**36**	**48**	**60**
Longterm A	0,006	0,015	0,016	0,020	0,020
Longterm B	0,012	0,025	0,025	0,024	0,022
Overlay A	0,006	0,014	0,016	0,015	0,015
Overlay B	0,012	0,018	0,021	0,023	0,024
Matching A					
Matching B	0,011	0,019	0,019	0,022	0,022
r (continuously compounde	**12**	**24**	**36**	**48**	**60**
Longterm A	0,005	-0,058	0,033	0,143	0,246
Longterm B	-0,001	-0,208	-0,076	0,039	0,073
Overlay A	-0,018	-0,063	0,039	0,126	0,178
Overlay B	0,028	-0,137	0,014	0,118	0,205
Matching A					
Matching B	-0,003	-0,084	-0,011	0,079	0,170
Lower Bound	**12**	**24**	**36**	**48**	**60**
Longterm A	0,994	0,920	1,008	1,117	1,237
Longterm B	0,979	0,780	0,889	1,000	1,037
Overlay A	0,971	0,917	1,013	1,106	1,166
Overlay B	1,007	0,846	0,979	1,082	1,181
Matching A					
Matching B	0,980	0,890	0,958	1,043	1,143
Upper Bound	**12**	**24**	**36**	**48**	**60**
Longterm A	1,015	0,967	1,061	1,192	1,323
Longterm B	1,020	0,846	0,966	1,081	1,116
Overlay A	0,992	0,962	1,068	1,164	1,225
Overlay B	1,049	0,898	1,049	1,169	1,276
Matching A					
Matching B	1,015	0,949	1,021	1,123	1,230

Table 28: Boundary determination

When these boundaries are compared to the returns of each group, the significance overview in table 29 is acquired.

Group vs.	group	12	24	36	48	60
Longterm A	Longterm B	No	Yes	Yes	Yes	Yes
Longterm A	Overlay A	Yes	No	No	No	Yes
Longterm A	Overlay B	Yes	Yes	No	No	Yes
Longterm A	Matching A					
Longterm A	Matching B	No	No	Yes	Yes	Yes
Longterm B	Overlay A	Yes	Yes	Yes	Yes	Yes
Longterm B	Overlay B	Yes	Yes	Yes	Yes	Yes
Longterm B	Matching A					
Longterm B	Matching B	No	Yes	Yes	Yes	Yes
Overlay A	Overlay B	Yes	Yes	No	No	No
Overlay A	Matching A					
Overlay A	Matching B	No	No	Yes	Yes	No
Overlay B	Matching A					
Overlay B	Matching B	Yes	Yes	No	Yes	No
Matching A	Matching B					

Table 29: Significance test

These results seem to strengthen the observations that were made in the previous section. 'Overlay A' and 'Longterm A' seem most immune to the effects of the crisis while 'Longterm B' and 'Overlay B' seem to be hit the hardest. While 'Overlay B' has the ability to recuperate 'Longterm B' never catches up with the other groups. The 'matching' portfolio doesn't excel in the short term or in the long term.

6.4.4 Post crisis

Again, testing procedures will be identical to the procedure in 6.4.2. The horizon returns can be found in table 30.

Horizon Return (months)	12	24	36	48	60
Longterm A	*1,027*	*1,171*	*1,232*	*1,453*	*1,453*
Longterm B	*0,953*	*1,088*	*1,148*	*1,275*	*1,332*
Overlay A	*1,034*	*1,142*	*1,182*	*1,349*	*1,410*
Overlay B	*0,987*	*1,154*	*1,197*	*1,418*	*1,460*
Matching A					
Matching B	*0,994*	*1,124*	*1,171*	*1,366*	*1,393*

Table 30: Horizon returns

Plotting these horizon returns yields the graph in figure 12.

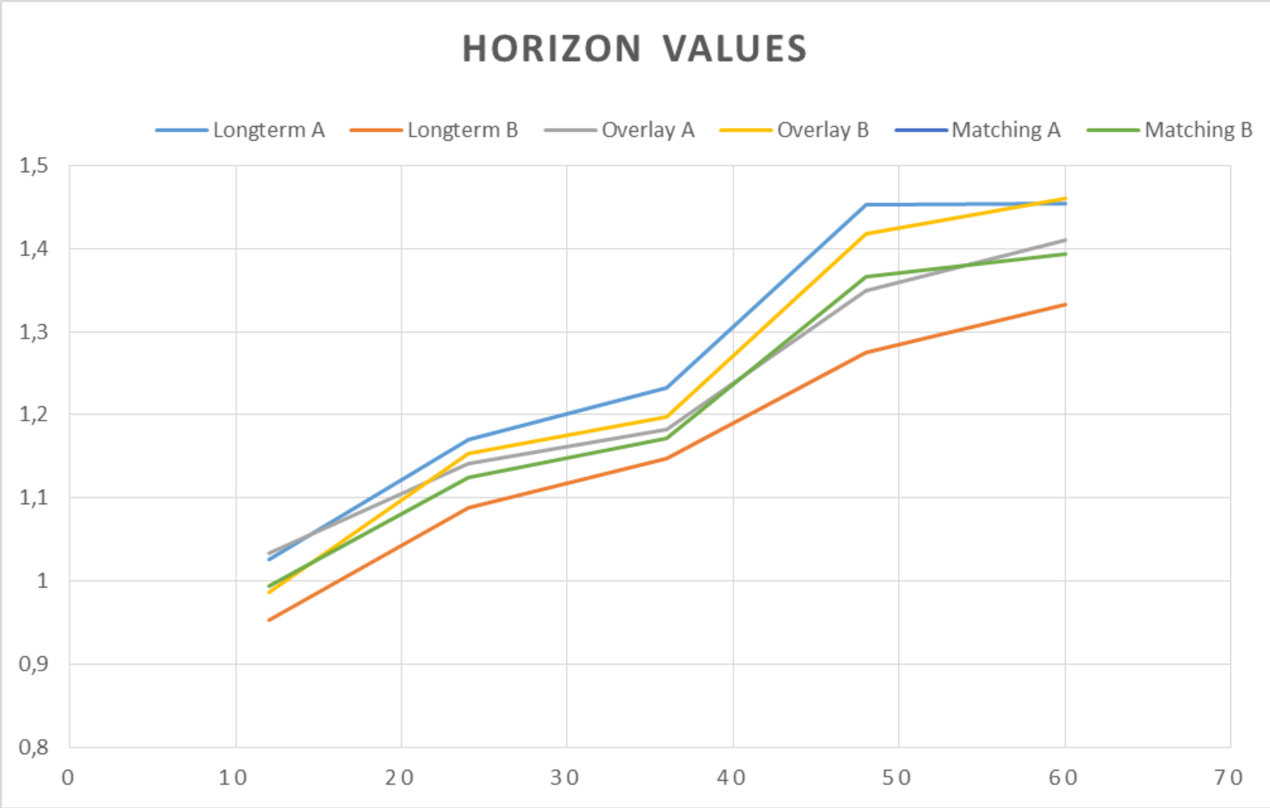

Figure 12: Graphical representation of horizon returns

Significance boundaries are then determined and shown in table 31.

Boundary Determinitation

Significance Level	0,90				
Volatilities	**12**	**24**	**36**	**48**	**60**
Longterm A	0,023	0,018	0,023	0,024	0,023
Longterm B	0,035	0,027	0,024	0,022	0,021
Overlay A	0,023	0,017	0,016	0,016	0,015
Overlay B	0,029	0,023	0,026	0,028	0,027
Matching A					
Matching B	0,028	0,022	0,025	0,027	0,026
r (continuously compounde	**12**	**24**	**36**	**48**	**60**
Longterm A	0,026	0,158	0,208	0,373	0,374
Longterm B	-0,048	0,084	0,138	0,243	0,287
Overlay A	0,033	0,132	0,167	0,299	0,344
Overlay B	-0,013	0,143	0,180	0,349	0,379
Matching A					
Matching B	-0,006	0,117	0,158	0,312	0,331
Lower Bound	**12**	**24**	**36**	**48**	**60**
Longterm A	0,989	1,137	1,186	1,397	1,400
Longterm B	0,900	1,040	1,104	1,229	1,288
Overlay A	0,996	1,110	1,151	1,313	1,375
Overlay B	0,941	1,111	1,146	1,354	1,398
Matching A					
Matching B	0,949	1,085	1,123	1,306	1,335
Upper Bound	**12**	**24**	**36**	**48**	**60**
Longterm A	1,066	1,206	1,280	1,510	1,508
Longterm B	1,010	1,138	1,194	1,323	1,378
Overlay A	1,073	1,174	1,215	1,385	1,447
Overlay B	1,036	1,199	1,251	1,485	1,526
Matching A					
Matching B	1,040	1,165	1,221	1,429	1,454

Table 31 Boundary Determination:

When these boundaries are compared to the returns of each group the significance overview in table 32 is found.

Significance Testing

Group vs.	group	12	24	36	48	60
Longterm A	Longterm B	Yes	Yes	Yes	Yes	Yes
Longterm A	Overlay A	No	No	Yes	Yes	Yes
Longterm A	Overlay B	No	No	No	No	No
Longterm A	Matching A					
Longterm A	Matching B	No	Yes	Yes	Yes	No
Longterm B	Overlay A	Yes	Yes	Yes	Yes	Yes
Longterm B	Overlay B	Yes	Yes	Yes	Yes	Yes
Longterm B	Matching A					
Longterm B	Matching B	No	No	No	Yes	Yes
Overlay A	Overlay B	No	No	No	Yes	No
Overlay A	Matching A					
Overlay A	Matching B	No	No	No	No	No
Overlay B	Matching A					
Overlay B	Matching B	No	No	No	No	Yes
Matching A	Matching B					

Table 32: Significance Test

In the post-crisis time window three 'clusters' seem to exist who at the 60 month horizon all perform significantly different. 'Longterm A' and 'Overlay B' seem to perform best. Then 'Overlay A' and 'Matching B' perform a little less well. 'Longterm B' clearly has the lowest performance of all 5 groups.

6.4.5 Results

Summarizing the results of the previous sections yields the following observations:

- 'Longterm A' and 'Overlay A' seem to be most immune to the effects of the crisis.
- 'Longterm B' has a high pre-crisis performance but is hit the hardest by it and seems unable to recover from its effects in the long run.
- In the long run three 'performance clusters' exists. 'Longterm A' and 'Overlay B' perform significantly better than the other groups.
- The effects of the fixed income investment ratio seems to be most present with the 'longterm' hedging structure and makes the difference between the worst performance and the best performance where a high fixed income investment ratio means more returns. With the 'Overlay' hedging group this effect seems to be inverted. A lower fixed income investment ratio means higher returns in the long run, although the higher fixed income return ratio does offer some protection during the crisis.

This means that the hypothesis that was reintroduced at the beginning of this section:

H_0 = *The returns of pension funds are independent from the combined hedging structure and the fixed income investment ratio*

should be rejected.

7. Conclusions, Limitations and Recommendations

This chapter will conclude the report. In section 7.1 the results from the previous chapter are reflected upon and conclusions are drawn. In the second section the limitations of the study are described and based on these limitations recommendations for further research are made in 7.3.

7.1 Conclusions

This report will be concluded by looking back at the goal that was set by the Dutch regulator. Freely it translates to: *The (n)FTK aims to ensure that all participants of pension funds will receive their pension payments in the future.* The goal of this report was to find out whether the boundaries that were set by the regulator caused a decrease of the returns acquired by these funds.

To this end two direct effects of regulation are introduced in section 3.2.

- The introduction of the FTK has caused an increase in fixed income investments under pension funds.
- The introduction of the FTK has caused pension funds to utilize one of three hedging structures: 'longterm', 'overlay' or 'matching'.

This report has measured the impact these effects have had on the returns of pension funds.

7.1.1 Fixed income investment ratio

Statistical testing revealed a significant effect in the returns of pension funds that had a high fixed income investment ratio and pension funds with a low ratio. Therefore the hypothesis:

H_0 = The returns of pension funds are independent from the fixed income investment ratio

was rejected.

This means that, if an increase in the fixed income ratio is accepted as an effect of regulation, the introduction of regulation in the form of the FTK has indeed affected the performance of pension funds.

Somehow it seems as though regulation, the FKT and the nFTK, has caused increased disconnectedness from market returns. In periods of extreme market returns, be it low or high, it seemed that the funds with a high fixed income ratio displayed a smaller amount of market correlation. Analysing the results also revealed that the funds that were sorted in group A exhibited a more constant and reliable performance than the funds in group B.

All in all this result seems to fit the goal of regulation. In times of market failures (crash of 2008) and in times of market success ('market bubble' at the start of 2015) the high-adopters seemed to perform more constant, avoiding the extreme lows but also the extreme highs.

7.1.2 Hedging structures

If the different hedging structures are taken into account it becomes clear that in the long term the 'overlay' structured funds outperform the more traditional 'longterm' structure and the 'matching' structure. When looking at the returns at the depth of the crisis the 'overlay' and 'matching' structure significantly outperform the 'longterm' structure. This means that the hypothesis:

H_0 = The returns of pension funds are independent from the hedging structure that is used

should be rejected, since grouping on different structures yields significant differences in returns.

7.1.3 Combination effects

When both effects are combined to form six different groups it is found that the groups 'Overlay B' and 'Longterm A' significantly outperform the other groups. 'Longterm B' performs the worst while 'Matching B' and 'Overlay A' seem to take the middle road. Because of this it is clear that

H_0 = *The returns of pension funds are independent from the combined hedging structure and the fixed income investment ratio*

should be rejected.

7.1.4 Implications

Based on the results of this report pension funds should do well to adopt an 'overlay' hedging structure. If they do however want to keep their traditional 'longterm' hedge structure it would be advisable to increase their fixed income investments. Adopting a 'matching and return' hedging structure would be ill-advised based on the results of this research. It will prevent deep drops in returns during times of recession, but in the long term when markets might go up, not enough money is made to keep up with the 'overlay' portfolio.

A possible explanation of these results might be that there is a really fine line when it comes to risk management and risk hedging. If the 'matching' hedge structure is considered the most save and best hedged investment strategy, the past 10 years clearly show that in the long-run this will eat too much out of the profits. Keeping a long term orientation and matching it with bigger investments in fixed income or with a derivative overlay for extra protection creates the biggest returns over the period after the introduction of the FTK.

If the situation would be considered in a somewhat black-and-white view one could claim that the pension funds with a low fixed income investment ratio and a 'longterm' hedging structure can be considered the most uninfluenced pension funds. The returns and the results over the years between 2007 and 2015 definitely show that these 'old-fashioned' pension funds were hit the hardest by the economic crisis and it remains a question whether these funds will ever be able to completely recover. If regulation indeed has caused pension funds to move away from this type of investment structure it should be considered a success.

Furthermore the results also show a hint of the effects of 'over-hedging' which was already noted by several authors (Amzallag, Kapp, & Kok, 2014) (Severinson & Yermo, 2012) (Franzen, 2010). Pension funds utilizing a matching & return portfolio are outperformed by the less intensively hedged 'overlay' structured funds (Engel, Oldenkamp, & Petit, 2014).

7.2 Limitations

One of the main limitations of this research was the lack of a proper benchmark. Due to the nature of long term event studies a benchmark is crucial for its statistical significance. The lack of one therefore direly undermines the statistical structure of this research. The workaround, in which pension funds were split into multiple groups, did however provide a feasible solution to the problem. If a better benchmark can be constructed, or if the splitting procedure, which now rested on one assumption, can be improved it will provide better insight and a clearer and more realistic picture of the events that occurred after regulation was imposed on the funds. Additionally all funds were affected by the regulation creating a bias in the results that increased the chances of wrongly accepting the 0-hypothesis.

A substantial limitation is the assumption that was made considering the effects that were caused by regulation. It is impossible, with the available data, to pinpoint the precise reaction of pension funds to the regulation that was introduced.

Another limitation of this study is the relatively small sample size that was used. A smaller sample size results in a smaller amount of observations and therefore less reliable statistical results. Although the creation of benchmark portfolios has synthetically raised the amount of observations, sample size is definitely one of the problems threatening the strength of this study.

It should be noted that this study only took into account the performance of funds in the form of the achieved returns. The introduction of regulation has also faced pension funds with costs necessary to implement the regulation. Although this cost might be substantial in regards to the total costs made by a pension fund it has been kept out of the scope of this paper. It is assumed that these costs will be comparable amongst all funds and are therefore 'negligible' in the context of this study.

Additionally determining long run abnormal returns remains a dangerous and treacherous business that requires precise and stringent procedures to retain its strength (Lyon, Barber, & Tsai, 1999). The conclusions might benefit from more testing from diverse angles.

7.3 Recommendations for future research

It would be interesting to research the effects of the regulation on investment decisions made by pension funds and the mandates that were given to asset managers. Empirical research might be able to prove whether the assumption that regulation has led to a larger share of fixed income investments is one that holds. Furthermore this research might also shed some light on the time it takes for regulation to 'seep through' in the investment decision. Is regulation anticipated or is it delayed?

An exciting extra step would be to increase the scope of the research towards bigger pension funds in the Netherlands. Due to the nature of the data that was acquired at KAS BANK this research focussed mainly on the returns made by small to medium size pension funds. It would be interesting to see whether the effects that were found in this study are also observed when taking into account the larger funds. Monthly returns data is however required to achieve this.

Because this research has taken place shortly after the introduction of the nFTK, the available data only spanned 10 months. It would be interesting to take a closer look at the effects of the nFTK in a couple of years. Especially since the "look through" principle it has introduced will allow future research to research the investment decisions that were made by pension funds and asset managers. This will allow for a more substantiated splitting of funds. Furthermore the investment behaviour of pension funds will also be an exciting field of research especially when it can be looked at really closely through the availability of 'lookthrough' data.

A larger dataset will allow for more comprehensive matching according to the methodology proposed by Gur-Gershgoren et al., (2008). This will increase testing power because of an increase in the amount of observations and thereby also an increase in synthetic observations created by the matching procedure that is utilized.

Another interesting research approach will be to perform a survey on the decisions made by managers of pension funds. It could be enlightening to discover the way these managers have implemented the regulation and how it has the policies of these pension funds. If this survey could prove the effects that were assumed in this report: an increase in fixed income investments and the switch to one of three hedging structures. It might give more conclusive evidence of the effects of the regulation.

Although the costs of regulation has been largely ignored in this research it is probably an area of interest in future explorations of the effect of regulation on pension funds. This paper assumed for research purposes that the cost of complying with regulation is equal for all funds. It might be interesting to see whether this statement holds in the real world and if for instance larger pension funds might profit from regulation costs over smaller funds due to economies of scale. Furthermore it might also be exciting to determine the long term ‘costs’ of missed income by the de-risking caused by regulation. Pelsser, Bernard & Chen (2008) have researched these costs for insurers in regards to Solvency II regulation.

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Appendix

I. Fixed income fraction in the investment mix of each pension fund.

CONFIDENTIAL

II. Results of the fixed income ratio split:

CONFIDENTIAL

It should be noted that pension funds 19, 41, 45, 60, 70, 72 & 73 are removed from this overview because while in theory they could be considered a pension fund, in practice they were not and would disturb the statistical results.

III. Results of the split on hedging structure.

#	Category	#	Category
1	Longterm	*36*	Longterm
2	Longterm	*37*	Matching
3	Overlay	*38*	Matching
4	Overlay	*39*	Matching
5	Matching	*40*	Overlay
6	Overlay	*42*	Longterm
7	Longterm	*43*	Longterm
9	Longterm	*44*	Overlay
10	Matching	*46*	Overlay
11	Longterm	*47*	Matching
12	Longterm	*48*	Overlay
13	Longterm	*49*	Overlay
14	Overlay	*50*	Overlay
15	Overlay	*51*	Matching
16	Overlay	*52*	Longterm
17	Overlay	*53*	Overlay
18	Overlay	*54*	Longterm
20	Overlay	*55*	Matching
21	Overlay	*56*	Overlay
22	Overlay	*57*	Overlay
23	Longterm	*58*	Overlay
24	Overlay	*61*	Longterm
25	Longterm	*62*	Overlay
26	Matching	*63*	Longterm
27	Overlay	*64*	Overlay
28	Longterm	*65*	Longterm
29	Longterm	*66*	Overlay
30	Longterm	*67*	Matching
31	Longterm	*68*	Longterm
32	Longterm	*69*	Matching
33	Longterm	*71*	Overlay
34	Matching	*74*	Overlay
35	Longterm		

Table 33: Funds allocated based on hedging structure

IV. Matching matrices for FTK and nFTK tests.

FTK	1	3	4	5	6	10	11	13	16	17	20	21	23	25	26	27	29	31	34	35	38	39	40	46	48	49	53	54	55	63	64	65	66	67	71
2																1					1														1
7										1						1														1					
9																	1		1	1															
12																	1		1	1															
14														1					1												1				
15																								1							1	1			
18																								1							1	1			
22																								1							1	1			
24														1					1												1				
28														1																	1	1			
30										1														1						1					
32																	1		1	1															
33														1			1		1																
36																	1		1	1															
37																	1		1	1															
42														1			1		1																
43																								1							1	1			
44																1					1														1
47	1																				1												1		
50																								1							1	1			
51																								1							1	1			
52																	1		1	1															
56																	1		1	1															
57	1																				1												1		
58														1			1		1																
61										1						1														1					
62	1																				1												1		
68										1						1														1					
69																								1							1	1			
74														1																	1	1			

Table 34: Matching matrix for FTK

nFTK	1	3	4	5	6	10	11	13	16	17	20	21	23	25	26	27	29	31	34	35	38	39	40	46	48	49	53	54	55	63	64	65	66	67	71
2		1		1											1																				
7									1																1					1					
9					1													1													1				
12					1													1													1				
14					1							1																			1				
15					1							1																			1				
18												1														1	1								
22					1							1															1								
24					1							1																			1				
28					1							1																			1				
30									1				1												1										
32					1													1													1				
33					1													1													1				
36					1													1													1				
37					1													1													1				
42					1													1													1				
43					1							1															1								
44		1		1											1																				
47				1																									1				1		
50					1							1															1								
51												1														1	1								
52					1													1													1				
56					1													1													1				
57	1																					1											1		
58					1													1													1				
61										1																				1				1	
62																						1							1				1		
68										1																				1				1	
69					1							1																			1				
74					1							1																			1				

Table 35: Matching matrix for nFTK

V. Horizon values for funds in group A and B.

FTK	h(12)	h(36)	h(60)
2	1,0070	0,9850	1,2066
7	1,0187	1,0477	
9			
12			
14	0,9031	1,0516	1,1395
15	1,0133	1,0373	1,2430
18	0,9439		
22			
24	0,9706	0,8625	0,9462
28			
30	0,9906	1,0453	1,2624
32			
33			
36	1,0104	1,1271	1,2534
37			
42	1,0256		
43			
44	1,0207	1,0091	1,2209
47			
50			
51			
52	1,0060		
56	1,0172	1,0021	
57			
58			
61	0,9891	1,0535	
62	1,0038	1,0998	1,2968
68			
69			
74			

nFTK	h(5)	h(10)
2	0,9724	1,0285
7		
9		
12		
14		
15	0,9816	
18		
22	1,0093	1,0387
24	1,0050	1,0289
28		
30	0,9688	
32	1,0026	0,9905
33		
36		
37	0,9785	1,0334
42		
43		
44	0,9758	1,0290
47	0,9786	1,0334
50	1,0017	1,0441
51	0,9609	1,0310
52		
56		
57	0,9765	1,0310
58	0,9840	1,0414
61		
62	0,9721	
68		
69	0,9765	
74	1,0072	1,0622

Table 36: Horizon values for funds in group A

FTK	h(12)	h(36)	h(60)
1	1,0025	0,8731	0,9707
3	0,9722	0,9794	1,3976
4			
5			
6			
10			
11	0,9884	0,7854	
13			
16			
17	1,0143	0,9649	1,1294
20			
21			
23	1,0014	0,8737	1,0699
25	1,0093	0,9473	
26			
27	1,0169	1,0978	1,3088
29	1,0172	1,0593	
31			
34	1,0099	0,9808	
35	0,9736	0,8425	0,9786
38	0,9846	1,0663	
39			
40			
46	1,1253	0,9248	
48			
49			
53			
54			
55			
63	1,0078	1,0099	1,1529
64	1,0234	1,0234	1,1542
65	0,9721	1,0035	1,2131
66	1,0196	1,0018	1,0501
67			
71	1,0233	1,0932	

nFTK	h(5)	h(10)
1	1,08861	1,063726
3	1,061526	1,032347
4	1,060747	
5	1,049004	1,012677
6	1,083458	1,054843
10		
11		
13	0,99974	
16	1,076414	1,021782
17	1,067344	1,031721
20	1,076121	1,022935
21	1,063612	1,016109
23	1,044464	1,01848
25		
26	1,076042	1,034857
27	1,056178	1,010494
29		
31	1,081765	1,055316
34		
35		
38		
39	1,08224	1,021563
40		
46		
48	1,069204	1,018037
49	1,069846	1,015965
53	1,057125	1,006211
54		
55	1,088999	1,057025
63	1,071696	1,054776
64	1,053522	1,02922
65		
66	1,063691	1,035905
67	1,071155	1,025447
71		

Table 37: Horizon values for funds in group B

VI. BHAR values for FTK and nFTK

FTK	BHAR(12)	BHAR(36)	BHAR(60)
2	-0,00130071	-0,10073	-0,102216132
7	0,00573397	0,0234587	
9			
12			
14	-0,11106713	0,0677812	-0,014629603
15	-0,02695703	0,0533917	0,059374672
18	-0,09629119		
22			
24	-0,04361312	-0,121377	-0,207976414
28			
30	-0,05852386	0,0787528	0,121241263
32			
33			
36	0,01016913	0,1662141	0,274792942
37			
42	0,01344527		
43			
44	0,01243907	-0,076681	-0,087950598
47			
50			
51			
52	0,00577356		
56	0,01695998	0,0411981	
57			
58			
61	-0,02395049	0,02934	
62	0,00158171	0,119384	0,286370949
68			
69			
74			

nFTK	BHAR(5)	BHAR(10)
2	-0,08979217	0,001852
7		
9		
12		
14		
15	-0,08521838	
18		
22	-0,0587655	0,0129876
24	-0,06185642	-0,004501
28		
30	-0,09459105	
32	-0,07034017	-0,055982
33		
36		
37	-0,09438545	-0,01307
42		
43		
44	-0,08639116	0,0024065
47	-0,08860981	-0,001768
50	-0,06635656	0,0183336
51	-0,10261441	0,0182503
52		
56		
57	-0,10171761	-0,009418
58	-0,08896414	-0,00509
61		
62	-0,1062287	
68		
69	-0,09038142	
74	-0,05961848	0,0287734

Table 38: BHAR's for FTK and nFTK