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The importance of market movements, asset allocation policy and active management for government pension funds – evidence from GPFG, CPP and GPIF

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Table of contents

Abstract

The motivation behind this paper is to identify how important market movements, asset allocation policy and active management is for the Norwegian, Canadian and Japanese government pension funds' returns. We use data from the funds' financial reports to examine this importance in terms of variance, and further estimate how each fund's active management contributes value to returns. Our results are in line with previous literature, namely that market movements explain the bulk of the variance in returns. Further, asset allocation policy and active management explain about the same amount. We also find evidence suggesting that two of three funds add value through their active management.

Acknowledgement

We would like to thank our supervisor Leon Bogdan Stacescu for his knowledge-sharing and feedback.

1 Introduction

Something all fund managers must understand is what drives their performance, be it the general market movements lifting all boats, the asset allocation policy they are given or the active management they perform. Accepting that the market moves freely, a fund can only impact their return by making strategic choices to their asset allocation policy and on their deviation from that policy at the correct time and with the correct asset.

The background for this realization is the research done by Brinson, Hood & Beebower, who introduced the concept of return decomposition in 1986. A common misconception of the work of Brinson et al. (1986) is that they provide an answer to how much asset allocation policy and active management contribute to the level of returns, while they really answer how much they contribute to the variance of returns. Further, the researchers failed to include market movements in their estimations, hence their results, while still valid, is somewhat overshadowed by later research including the market. Such research includes the work of Xiong, Ibbotson, Idzorek and Chen (2010) and Aglietta, Brière, Rigot and Signori (2012), and through development it has become general knowledge that the return of a fund can be decomposed into (1) market movements, (2) asset allocation policy and (3) active management.

A natural extension of the research on return decomposition, is to develop an intuition of whether a return component also adds value to the level of returns. Specifically, if the variance from active management adds value. This question is more interesting for any fund manager as only looking at variance ignores if the volatility is good or bad for returns.

Previous research has looked at average calculations across mutual funds, pension funds, DB funds, endowment funds, balanced funds, equity funds and other assets and geographical specific funds. We focus on three government pension funds specifically and to our knowledge there have not been such studies on these funds earlier. The funds we study are the Norwegian, Canadian and Japanese pension funds known as Government Pension Fund Global (GPFG), Canada Pension Plan (CPP) and Government Pension Investment Fund (GPIF). These were chosen because of their specific and varying investment profiles and their size. GPIF and GPFG are the largest and second largest government pension funds in the world, while CPP is fifth (Willis Towers Watson, 2018). The funds' size makes them interesting as other funds look to them for suitable investment profiles for their own ventures. Hence, it is interesting to shed light on what drives these giants' returns. Further, the investment model of both GPFG and CPP have been recognized as pioneering and has been coined The Norway Model and The Canada Model. GPIF's investment profile also fits as it adopts some concepts from each of these two models, hence, we have the possibility to contrast between them. The funds differ quite substantially in terms of asset allocation, governance, liability profile, and what asset classes are permitted. This means that the funds differ in the way they look at markets and how they allocate their resources. GPFG and GPIF are mainly beta investors, while CPP is more actively managed and thus have a higher tolerance for risk. Meaning that CPP has a stronger belief that they can generate higher returns with an equal amount of risk, or an equal amount of return with lower risk. Through this paper, one can learn about how different investment profiles obtain different returns, how this return compare in terms of a risk-return relationship and if active management is a benefit for the funds. Also, it allows us to compare profiles and conclude in terms of a best practice.

As we are interested in how important each return component is to the variation in returns for these three funds and if that variation contributes value, a natural research question is as follows:

> *How much do market movements, asset allocation policy and active management explain of the funds' variation in returns, and do active management add value to the level of returns?*

To answer this twofold question, we use the existing methodology to decompose the returns of GPFG, CPP and GPIF. After the decomposition, we run three univariate regressions on the return of each fund. First, we run the return against a market portfolio, then against a policy benchmark and then against an active management variable. We then obtain the R^2s which tells us how much the three components explain of the variance of the funds' returns. We also use a common ratio to evaluate if the variation of active management adds or destroys value for the funds' returns. Further, we present our extension of this ratio and assess how market timing and security selection separately contribute to the funds' active management. We also combine this with the Sharpe ratio to give an indication as to whether each fund has performed better than their own policy benchmark on a risk-adjusted basis. Hence, our main contribution to the literature is to bring the concepts of return decomposition, the ratio of value added from active management and the Sharpe ratio together.

We manually gather return data for each asset class per fund from their quarterly financial reports. The classes are public equities, fixed income and a constructed asset class which include public equities and alternative investments (PAI). PAI was constructed because GPFG and CPP allocate assets to alternative investments without proper benchmarks, and we need to account for the return and volatility attributed to these investments. We use the difference between public equities and PAI to highlight the importance of proper benchmarks. Having return data per asset class allows us to run our regressions per asset class and check how the three components affect the variance of each of them. In line with the literature and the nature of our funds, we vary the market portfolio weights to account for differences in allocation and analyze the sensitivity of the market movements.

To go deeper with our analysis, we present variations of our methodology. The first variation we present is using quarterly data for GPFG and GPIF. This was not available for CPP. We perform the same regressions and find more accurate estimations of the R^2s than we did when using yearly data, confirming our results. The second variation is to perform the same regressions as above but in excess form, meaning that we remove the market movements from the equation. This further confirms our results in the main analysis. The last variation is using the longest constant allocation period to control for the effect that a fund changes its asset allocation policy throughout the full sample period. This also confirms our results in the main analysis.

Answering the first part of our research question, market movements are the most important driver for return variance for all three funds. For GPFG, active management is more important than asset allocation policy. For CPP, asset allocation policy is more important than active management. For GPIF, neither are especially important though asset allocation policy is slightly more important than active management. Per asset class, we see that market movement is still the most important driver for return variance. Which component of asset allocation policy and active management is more important, varies for each fund. Although varying, these results confirm existing research and contribute to the literature by studying government pension funds.

Addressing the second part of our research question, we find that active management adds value to the total fund return of GPFG and CPP while it destroys value for GPIF. As we have not discovered any papers doing this researching on government pension funds, we consider our results new to the literature. When looking at the Sharpe ratio for actual return compared to the policy benchmark, we find that CPP has a better risk-return relationship while GPFG and GPIF has a worse risk-return relationship. In terms of how financial markets work, our results show that risk-taking has implied higher returns. Thus, it is possible to generate returns in excess of market beta. However, only one fund has performed better than their policy when adjusting for risk. Reason being diversification between asset classes, confirming the framework in the Modern Portfolio Theory.

In section 2 we present the theory and perform a literature review. We proceed by presenting the three funds in section 3. Here we focus on the funds' governance, liability profile, policy allocation, benchmarks and investment strategy, and summarize the characteristics in a table. In section 4, we go through our data collection process in general and for each fund. Section 5 is dedicated to our methodology. Here we present the existing methodology and our extensions. In section 6, we present our results and summarize them. Finally, in section 7 we conclude our thesis.

2 Theory and literature review

In the following chapter, we will present the theoretical background and go through the existing literature that forms the basis for our thesis.

2.1 Theoretical background

Fund performance and asset allocation policy has been thoroughly investigated in the literature for many decades. One of the papers forming the framework behind several more recent theories is Portfolio Selection, written by Harry Markowitz in 1952. Markowitz developed and outlined the Modern Portfolio Theory (MPT), describing ways of diversifying and allocating assets in a portfolio to maximize expected return given the investor's risk tolerance. The MPT is a mathematical framework to construct a portfolio of different assets which are not perfectly correlated. Implicitly, including the correct assets or asset classes to a portfolio increases the positive diversification effects (Markowitz, 1952).

Following the MPT, the Endowment Allocation Model (EAM) was set forth by David F. Swensen during the early 1990s. At the time, Yale University's endowment fund made a shift from a simple equity investment approach to a more diversified portfolio with additional focus on active asset management (Chambers & Dimson, 2015). The strategy of the EAM is to attain liquidity premiums from alternative investments. Following this evolution, many funds has turned to alternative assets and to asset managers with niche expertise, special flexibility and unique market access (Leibowitz, Bova, & Hammond, 2010).

Funds desire to hold an optimal portfolio of assets and maximize returns for a given level of volatility. The work by Markowitz and Swensen is important to understand the policies and strategies underlying a fund's investments. As the nature of pension funds and sovereign wealth funds are their vast asset size, professional management and long time-horizon, policy allocation and active choices are of severe importance to their wealth accumulation. The long-term focus enables the funds to take advantage of the full universe of asset classes, while the managers must decide whether to allocate resources for the purpose of generating active alpha returns, or follow the market and generate beta returns. From this research area, the topic of return decomposition has risen, which lays the foundation for our thesis. In the following section, we will go through the different research papers and the important findings that our paper builds on.

2.2 Literature review

2.2.1 Variance of return

Several papers have tried to answer the question of the importance of asset allocation policy in determining performance. Specifically, the field of long-term asset allocation policy versus active asset management has been investigated the last 30 years. The study of Brinson, Hood and Beebower (1986) was the first paper to come up with an answer to this question. Their goal was to determine which investment decision; investment policy, market timing, and security selection, had the most impact on the total return and variance of that return.

The authors constructed a benchmark, or an "investment policy" portfolio, from a fund's long-term asset classes weighted by their long-term allocation. The returns from this portfolio are then compared with the actual returns from the investments, i.e. market timing and security selection. They found that investment policy accounted for 93,6 percent on average of the variance in total return over time, measured by the R^2.

The findings of Brinson et al. (1986) have been broadly used in the literature. In 1991, Brinson, Singer and Beebower published a follow-up study of the 1986 paper where they investigated the relationship between active investment decisions by asset managers and performance. They found that active investment decisions did little on average to improve performance in the time-period 1977 to 1987. In 1999, Blake, Lehmann and Timmermann also researched this topic. The authors used data from UK pension funds and investigated the impact asset allocation dynamics had on pension fund performance, and found evidence to support Brinson et al. (1986). Vardharaj and Fabozzi (2007) also found evidence in support of Brinson et al. (1986) when they analyzed the importance of allocation by economic sector, size and style in US equity portfolios, and the importance of regional asset allocation policy in international equity portfolios.

One essential notion that the abovementioned researchers did not consider is the importance of market movements. Hensel, Ezra and Ilkiw (1991) introduced a discussion of the inclusion of market movements, and this was further developed by Ibbotson and Kaplan (2000). They both highlighted that the majority of the variance in fund returns is explained by market movements, "substituting" the high explanatory power of asset allocation policy found by Brinson et al. (1986). Further, the authors demonstrate the importance of a correct benchmark. They emphasize that if we are to correctly evaluate the effect of any fund's asset allocation policy, we should use a benchmark that includes the average asset allocation of the relevant peer group. So, a benchmark should include the stock market as it is more volatile than the other assets and hence capture most of the market movement (Ibbotson, 2010). From the findings of Hensel et al. (1991) and Ibbotson and Kaplan (2000), building on Brinson et al. (1986), it is clear that the return of a fund can be decomposed into three different sources:

(1) return from overall market movements,
(2) return from the asset allocation policy, and
(3) return from active management,

where the market movements are dominating.

Figure 1 below shows the development described above. The two bars on the left are the results from Brinson et al. (1986) where the asset allocation policy dominates the return decomposition. The two right hand bars are the results from Hensel et al. (1991) and Ibbotson and Kaplan (2000), and gives a more accurate decomposition of returns. It shows the asset allocation policy return in excess of the market return, and hence, how market movements are the dominant driver of fund returns. Brinson et al. (1986) combined (1) and (2) and compared it with (3), while Hensel et al. (1991) and Ibbotson and Kaplan (2000) compared (2) with (3).

So, from this literature, on average, roughly three quarters of the variance in fund returns are attributed to market movements, after controlling for an interaction effect. The findings of Hensel et al. (1991) and Ibbotson and Kaplan (2000) have led to more "agreement" in the field of return decomposition and variance in returns.

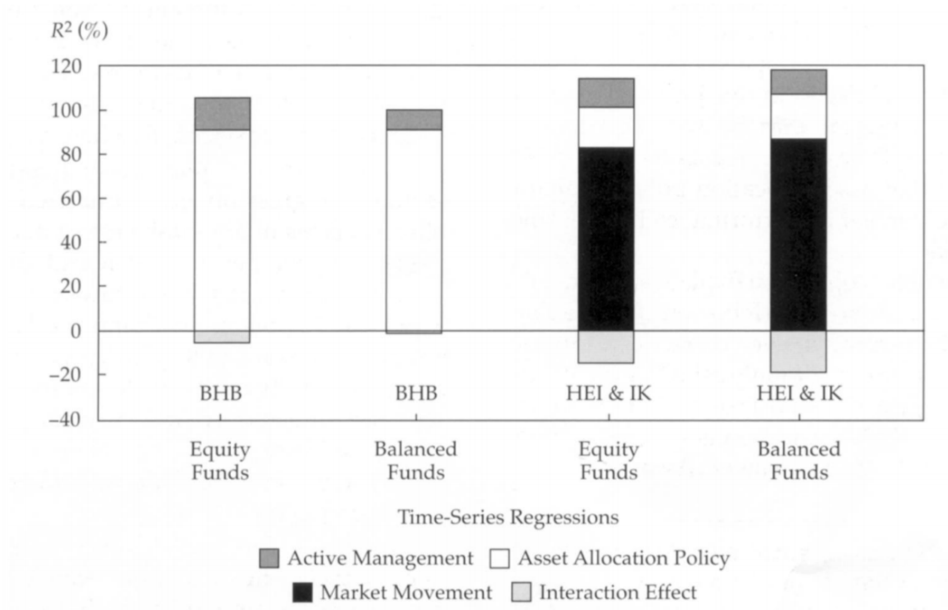

Figure 1: "Decomposition of Time-Series Total Return Variance" (Xiong, Ibbotson and Idzorek, 2010, pp. 23).

Note: BHB stands for Brinson, Hood and Beebower (1986),
HEI stands for Hensel, Ezra and Ilkiw (1991) and
IK stands for Ibbotson and Kaplan (2000).

In 2010, Xiong, Ibbotson, Idzorek and Chen released a paper based on the abovementioned findings, also written about by Bailey, Richards and Tierney (2007) and Solnik and McLeavey (2003). The paper demonstrated that the results from Brinson et al. (1986) actually mean that the variance in returns of a fund is mostly explained by market movements. The authors use data from US mutual funds and investigate the importance of asset allocation policy versus active management in explaining the variance in returns. In addition to showing that the return can be divided into the three components mentioned earlier, they find that roughly 80 percent of the variance in returns are explained by market movements. This is in line with the previous literature but Xiong et al. (2010) showed this result further by excluding the effects of market movements from the total returns and the policy returns, obtaining the same answer. Xiong et al.

(2010) also introduced that asset allocation policy and active management are equally important in explaining variance of returns for US mutual funds and concluded that they explain roughly 20 percent each.

Our paper has roots in all the research mentioned but has even closer ties to the paper of Aglietta, Briere, Rigot and Signori (2012). They were, to our knowledge, the first to look at the variance from each source of return per asset class such as equity, bonds, cash, real assets and other alternative asset classes. They used a high-quality dataset of US defined-benefit pension funds and confirmed the previous literature, namely that market movements explain most of the total return variance on average. The authors found the same effect on equities (96 percent) and fixed income (70 percent) specifically, but interestingly show that active management explain 20 percent of the variance in returns for fixed income. Lastly, Aglietta et al. (2012) found that in all the asset classes except equities and fixed income, active management was the greatest source of performance. On average, active management explain 26 percent of the funds' return volatility and asset allocation policy only 4 percent. This is a new result in the literature and shows the importance of active management for a pension fund, at least on the performance of alternative assets.

Several studies have used the models discussed above directly and also extended them. Arbaa and Benzion (2016) uses data from Israeli provident funds to check the relative importance of market movements and asset allocation policy against active management, segmented into security selection and timing. They find that market movements are the dominant driver of return variance and that asset allocation policy and active management explains return variance equally. This is in line with the results of Xiong et al. (2010) Arbaa and Varon (2018) researches Israeli government and corporate bond funds and find that active management is far more important than policy for corporate bond funds, while the opposite is true for government bonds. The former is in line with the findings of Aglietta et al. (2012) and the latter with the general findings. Briére et al. (2014), Brown et al. (2010) and Henke (2016) all extend the general research models presented above but report results that support the findings of both Xiong et al. (2010) and Aglietta et al. (2012).

2.2.2 Level of return

The findings above all try to explain the importance of market movements, asset allocation policy and active management on the variance of returns but offer no answers to the second part of our research question, namely how the latter affects the level of returns. Surz, Stevens and Wimer (1999) offers a method of how to evaluate this importance, which has been used in several studies such as Ibbotson and Kaplan (2000), Drobets and Köhler (2002) and Ferruz and Vicente (2010). Surz et al. (1999) argue that the R^2, or (1-R^2), can be interpreted as a measure of managers' conviction of the insights they have. They say that the R^2 explains the deviation from the passive investment strategy of investing close to the asset allocation policy, and if the deviation is low the managers have a low conviction and vice versa. Hence, the higher R^2, the lower the conviction and the closer the fund follows its asset allocation policy. Surz et al. (1999) introduced a ratio to assess if the deviation from the policy added or destroyed value and defined it as the asset allocation policy return divided by the total return. Hence, the ratio offers a possibility to check whether active management adds or destroys value, where active management consist of market timing and security selection. According to Sharpe (1991), mutual funds should not be able to gain additional value above their asset allocation policy, on average, because of market equilibrium conditions. We will elaborate on the calculation of the ratio in our methodology section.

3 Background on the funds

In the following section, we will present a detailed background on the funds and highlight the most important information regarding governance, liability profile, policy allocation, benchmarking, and investment strategy. This is done as we need to identify differences between the funds to complement our results.

3.1 Government Pension Fund Global

In the 1960s, the idea of an "oil fund" was formed in Norway as the government claimed sovereignty over the Norwegian continental shelf. The core of the idea was to build a long-lasting investment management profile which benefited the entire population and future generations. The concepts were further developed during the 1980s, and in 1990 the government established the Government Petroleum Fund, which was renamed the Government Pension Fund Global (GPFG) in 2006. At the end of 2018, the market value of the GPFG was NOK 8 256,0 billion, roughly USD 949,4 billion (NBIM, 2018a).

3.1.1 Governance

The Parliament has laid down the formal framework for GPFG, while the Ministry of Finance has overall responsibility for the management and for formulating policies and guidelines. In 1998, the Ministry appointed Norges Bank to manage the fund and the Norges Bank Investment Management (NBIM) was created as a subdivision of Norges Bank. NBIM manages the fund within the given guidelines from the Ministry and seek to safeguard the long-term financial interests of the fund. The governance and policy of the GPFG is known as “the Norway Model” (Chambers, Dimson & Illmanen, 2012).

3.1.2 Liability profile

GPFG’s funding primarily comes from Norway’s petroleum revenues. Also, the fund is fully integrated with the state budget and is to cover a potential budget deficit. Hence, if the state budget has a deficit, meaning that the petroleum revenues does not cover it, the Ministry withdraws money from GPFG to make up the difference. If the petroleum revenues are enough to cover the state budget, the surplus is kept in the fund (NBIM, 2017). The investment policy is therefore based on the expected long-term annual budget deficit. NBIM and the Ministry manages the fund with a goal of achieving an expected annual real return of 3 percent. At this point, this is the only liability of the fund. Whether the fund will be used to cover pension liabilities in the future is not politically decided. The benefit of having a predictable liability profile is being able to manage the fund with a truly long-term perspective.

3.1.3 Policy allocation and benchmarking

The Ministry and Parliament sets benchmarks for GPFG, which concerns asset mix and regional allocation of the fund. By policy, it is decided that all GPFG’s assets are to be invested outside of Norway to avoid oil price fluctuations and to prevent overheating of the Norwegian economy given the fund's large asset size and financial impact. GPFG can invest in public equities, fixed income, real estate and infrastructure. Within these asset classes, the fund is exposed to a broad specter of countries and currencies. Today, the fund is permitted to invest 70 percent in equities and 30 percent in bonds. These limits are set as a risk management tool and as a measurement of NBIM's performance. The benchmarks set by the Ministry are subject to a quite low tracking error of 1.25 percent. The underlying benchmarks are given in section 3.4.

In 2010, the Ministry allowed for investments in real estate and in 2017 increased the mandate to a maximum of 7 percent, where NBIM themselves regulate their positions (NBIM, 2018b). In the beginning of the second quarter 2019, the Ministry also opened for investments in unlisted infrastructure. For now, NBIM is allowed to invest up to 2 percent of GPFG's assets in infrastructure projects within renewable energy. By year-end 2018, the allocation of assets were 66,3 percent in equities, 30,7 percent in fixed income and 3,0 percent in unlisted real estate (NBIM, 2018a). The GPFG is owned by the people and managed thereafter, hence the fund has a conservative relationship towards risk and exposure. The allocation of the fund has moved gradually from fixed income only, to 40 percent equities, then to 60 percent equities and now 70 percent, gradually allowing more volatility. See figure 2 below for the development of the allocation policy. Further, NBIM measures the market exposure with a reference portfolio given by the Ministry and as mentioned the allowed relative volatility is quite small. In 2018, the tracking error was below 0,4 percentage point (NBIM, 2018b).

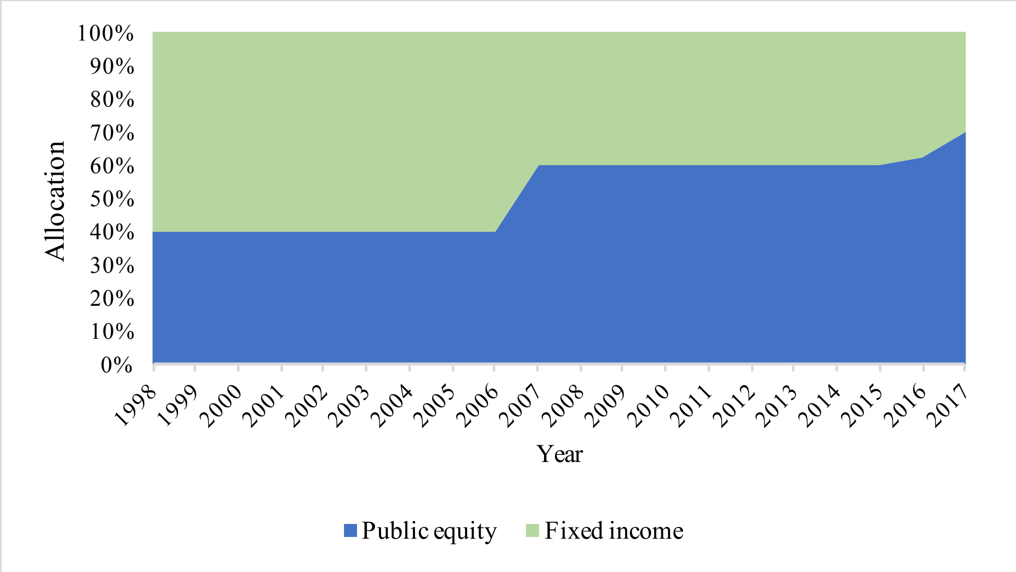

Figure 2: Overview of the asset allocation policy for GPFG

3.1.4 Investment strategy

The investment strategy of the fund is to diversify across most public markets to achieve a broad exposure towards global growth and value creation. At the end of 2018, the fund was invested in 9158 companies worldwide, located in 73 different countries, and 4811 bonds (NBIM, 2018a). The GPFG is managed in coherence with the notion that markets are efficient, and follows the "modern" investment theory based on the Keynesian investment framework. Hence, that investors have the same information and rely on similar investment models, which leads to similar expected returns (Ambachtsheer, 2015). The fund relies on beta returns, not alpha, and the general belief that no investor can make excess returns is fundamental in the GPFG. Still, the Ministry allows for a small part to be more actively managed to generate returns in excess of the strategic benchmarks and the general market.

An enabling factor of GPFG's active management is the Operational Reference Portfolio (ORP) which is an internal benchmark created by NBIM in 2011. The idea behind it is that the risk profile of the strategic benchmark set by the Ministry can be replicated using fewer securities, and NBIM states that the goal of using the ORP is to achieve a better risk-return relationship (NBIM, 2018c). The ORP serves as a tailored version of the strategic benchmark and offers enhanced diversification and allows the fund to efficiently reap systematic factor risk premiums (Ang, Brandt, & Denison, 2014). In summary, Ang, Brandt and Denison states that the NBIM uses ORP for three purposes. Namely, diversifying more widely than standard benchmarks, taking on systemic factor risk exposure, and implementing smart rebalancing of the positions.

3.2 Canada Pension Plan

The contribution-based Canada Pension Plan (CPP) is an important part of the Canadian pension system. With an aging population, the fund must contribute to the people's retirement income for several generations. To assure this, the sustainability of the fund is the fundamental interest of the Chief Actuary of Canada. Even though the fund had an increasing level of contributions until the mid-1990s, the Canadian government was still concerned with the long-term sustainability of the fund. To address their concern, the government introduced a reform program consisting of three main pillars in 1997. First, contributions to the fund were increased from 6 percent of earnings in 1997 to 9,9 percent in 2002. Second, it opened for investments other than domestic bonds which it had been restricted to previously. Lastly, the Canada Pension Plan Investment Board (CPPIB) was created to manage the fund's assets.

After its first establishment in 1966, CPP has gone through several reforms and governance changes and has now become the world's fifth largest government pension fund, restricted to funds sponsored by national authorities (Willis Towers Watson, 2018). At the end of year 2018, the value of the fund was CAD 368,5 billion, or USD 269,0 billion (CPPIB, 2019a).

3.2.1 Governance

The CPPIB is an independent and professional manager operating separately from the government, and has no specific requirements or limitations regarding the preferred investments. CPPIB's mandate is to invest the assets of CPP with a vision of achieving a maximum rate of return without an unnecessary risk of taking losses (CPPIB, 2019b). Being independent also means that CPPIB can focus merely on the investment results without political interference disturbing the main tasks and priorities. The management reports to an independent Board of Directors consisting of 12 members, each appointed by the federal finance minister in consultation with the provinces.

With its government arrangements, CPPIB has successfully managed to create a sustainable and high-performing public pension fund, and several other Canadian pension funds has adopted its structure and investment strategy. Although CPPIB operates independently from the government, it does so in a highly transparent way. Balancing independence, professionalism and experience against transparency, accountability and representation has been one of the hallmarks of "the Canada Model" of institutional fund management (Rozanov, 2017).

3.2.2 Liability profile

The inflows to CPP comes from two sources. First, it has contributions from employers and employees, and second, it gains return by investing in financial assets. The overall goal of the investment portfolio is to gain an annual real return of 3,9 percent in the following 75 years, projected in the last Actuarial Report (Office of the Chief Actuary, 2016). Based on these long-term projections, it is estimated that contributions will finance approximately two thirds of future CPP benefits, while investment returns must cover the remaining one third.

One of the three main pillars in the reform of 1997 was increased contributions to the fund. The effect of increasing contributions to 9,9 percent of earnings was more stable expectations, allowing the fund to fully take benefit of its long time-horizon. Also, it was intended to increase the funding ratio of actuarial pension liabilities from 8 percent to 20 percent. The contribution rate is reviewed every three years and is meant to sustain CPP over the next 75 years.

3.2.3 Policy allocation and benchmarking

The policy of CPP has been continuously changing since the fund's inception. Many restrictions were gradually removed after CPPIB was established as an independent management body. One of these restrictions was regarding public equities, and the fund started investing in passive market indices of Canadian and global equities in 1999. Two years later, in 2001, the fund engaged in external investments consisting of private equities and real estate. CPPIB then began active equity investing and also bought infrastructure assets. The last restrictions on global investments were removed in 2005. The fund then developed into a typical multi-asset class portfolio of a modern long-term institutional investor (Rozanov, 2017).

Since 1998, the asset allocation has undergone severe adjustments. By the end of 2018, the fund had an allocation of 39 percent in public equities, 17 percent in fixed income, 20 percent in private equities and 24 percent in real assets, compared to 5 percent in public equities and 95 percent in fixed income in 2000 (CPPIB, 2019a). The most unique feature of CPPIB's way of strategically allocating assets and measuring its performance is the Opportunity Cost Model (OCM). Underlying this strategy is the "Reference Portfolio" (RP), consisting of broad market indices which is scalable and easy to implement at a low cost (CPPIB, 2018). The RP defines the risk and return preferences for the fund. The RP currently has a mix of 85 percent in public equities and 15 percent in fixed income, and the development since 1998 is illustrated in figure 3. The underlying benchmarks are described in section 3.4.

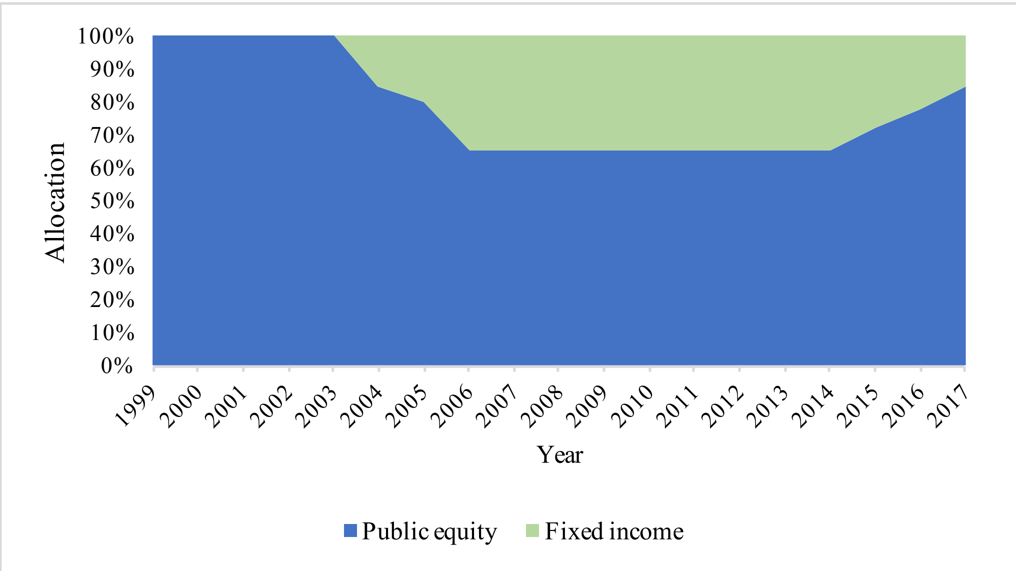

Figure 3: Overview of the asset allocation policy for CPP

3.2.4 Investment strategy

In 2006, CPPIB decided to increase the share of active management across all asset classes, resulting in higher management costs both internally and externally. Rozanov (2017) points out three unique endowments which allow the fund to be more active in its investment strategy, being its large asset size, its stable liability profile and the long time-horizon. The combination of the three increases the capacity for risk-taking and thus being able to capture greater returns. Given the risk profile set in the OCM, CCPIB sets a "Strategic Portfolio" (SP) of six asset classes and four geographical areas and tries to maximize expected return. All active investment choices CPPIB does are then compared to the RP to capture excess return and measure risk, while also considering the additional costs. The SP currently consists of 33 percent public equities, 22 percent private equities, 39 percent fixed income and 25 percent real assets. This is financed by short-term cash positions of negative 20 percent.

CPPIB lists a four-tier pyramid of return, where the bottom tier is the RP or the traditional public market beta (Horie, 2017). The next tier is the SP, constructed differently than the traditional market to capitalize from the long time-horizon. This is comparable to the ORP designed by NBIM, which is an example of a smart beta with long-term factor tilts. The next tier in CPPIB's pyramid consist of a private market alternative beta, including real estate, infrastructure and private equity. Lastly, on the top, the fund seeks to gain alpha returns from various active programs. While the scalability and transparency is highest for the lower tiers, the complexity and costs increases towards the top.

3.3 Government Pension Investment Fund

The Japanese Government Pension Investment Fund (GPIF) was established in 2001 and replaced the Pension Welfare Service Public Corporation. It was further organizationally changed in 2006 to the "new" GPIF as it is structured today. The GPIF is meant to contribute to the stability of the Employees' Pension Insurance and the National Pension Programs, and is solely for future pension use.

3.3.1 Governance

The GPIF was created as an Independent Administrative Institution and its governing body is the Ministry of Health, Labor and Welfare. The core of the pension fund management stems from three laws, the Employees' Pension Insurance Act, National Pension Act and the Act on the Government Pension Fund. The acts postulates that the pensions should be managed safely and efficiently with a true long-term perspective. The Ministry sets instructions on the medium-term objectives, i.e. required rate of return on investments to sustain the fund, approve the medium-term plan and statement of operations (GPIF, 2017).

In 2017, severe changes were made to the organization of the fund and a Board of Governors and an Audit Committee was created. The purpose was to move away from an individual decision-making model to the council system and the fund separated the decision-making and supervision from execution (GPIF, 2017). The fund also uses external asset managers such as Trust Banks and Financial Instrument Businesses.

3.3.2 Liability profile

The GPIF is a pay-as-you-go pension fund where pensions collected from the working generation supports the older generation. The fund manages and invests the reserve funds of the government pension plans based on the three central laws mentioned above, and profits are to be put in "special accounts" for the government pension plans to maintain liquidity for pension payouts based on the actuarial valuation of the pension scheme (GPIF, 2017; GPIF, 2019b). The fund is the largest pension fund in the world and managed YEN 150 663,0 billion, roughly USD 1 386,1 billion by the end of 2018, representing nearly one third of the country's GDP.

3.3.3 Policy allocation and benchmarking

Based on the laws and the medium-term objectives, the GPIF has established an asset allocation called the Policy Asset Mix. This is formed from a long-term perspective with diversification, and the fund's investments are carried out based on this Policy Asset Mix. Following is a description of how the Policy Asset Mix has changed over time. The numbers given in parenthesis are the upper and lower deviation boundaries.

From 2006 to 2012, GPIF had a policy allocation of 20 percent equities and 80 percent bonds. They divided the 20 percent equities into 11 percent domestic (+/- 6) and 9 percent foreign (+/- 5) equities. Of the 80 percent in bonds, 67 percent should be domestic (+/- 8), 11 percent in foreign (+/- 5) and 5 percent in short-term bonds. From 2013, they adjusted the total allocation to 24 percent in equities and 76 percent in bonds. Of the 24 percent equities, 12 percent should be domestic (+/- 6) and 12 percent foreign (+/- 5). The bonds should be comprised of 60 percent domestic (+/- 8), 11 percent foreign (+/- 5) and 5 percent short-term bonds. In mid 2014, they did another adjustment of the policy allocation, which is the one they use today. They moved to 50 percent equities comprised of 25 percent domestic (+/- 9) and 25 percent foreign equites (+/- 8). The bond allocation also shifted to 50 percent, split into 35 percent domestic (+/- 10) and 15 percent foreign bonds (+/- 4). We refer to figure 4 below for a visualization of the policy allocation development.

According to the GPIF, the fund's benchmark is the market average rate of return, given by the weights above. The benchmarks are set by GPIF in conjunction with the Ministry of Health, Labor and Welfare. They set benchmarks for both asset classes, fixed income and public equities, and for each subgroup, domestic and foreign, so that the total policy benchmark return is the compound rate of return obtained from these separate ones. The benchmarks can be seen in the summary and observations section 3.4 below.

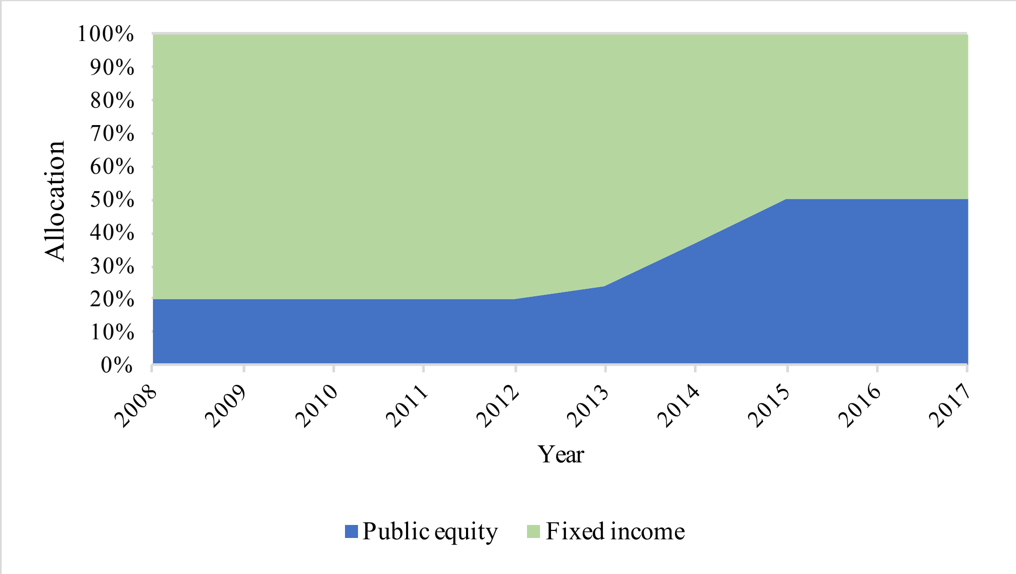

Figure 4: Overview of the asset allocation policy for GPIF

3.3.4 Investment strategy

As stated by the Ministry, the GPIF is required to achieve a long-term real return of 1,7 percent with minimal risk, while also maintaining enough liquidity for the pension payouts. The fund's investment strategy is based on secure, diversified and efficient long-term investments. This can be seen from the significant allocation to fixed income the fund has had in the previous years. The allocation has since been altered to include more equities and hence giving the fund more exposure to volatile markets and a higher risk profile. This has been met with severe debate in Japan but the fund maintains the 50-50 split they decided upon in 2014. A large part of GPIF's assets are invested by external managers selected and monitored by the GPIF managers. Most of the investments done by the fund is passive and seeks to reflect the market index return of each asset class. The fund also seeks some short-term market fluctuations, but the core is pursuing stable and efficient long-term returns with minimum risk.

GPIF does not share the actual tracking error allowed but communicates that it should remain small. When checking the tracking error of internal and external managers per asset class, it ranges from 0-5 percent, and the total tracking error for 2017 was close to 0,5 percent (GPIF, 2012; GPIF 2017).

3.4 Summary and observations

In this section, we make a summary and list the most important features and differences of the three funds. We also provide our observations based on the structural and strategical differences.

	GPFG	CPP	GPIF	Observations
Governance	The Parliament of Norway has the formal framework, while the Ministry of Finance has the overall responsibility and formulates policies NBIM manages the assets within the given guidelines from the Ministry	CPPIB manages the fund independently from the government and reports to a separated Board of Directors The Canada Model is known as highly transparent and professional	GPIF is governed by the Ministry of Health, Labor and Welfare. The Ministry sets medium-term objectives A Board of Governors and an Audit Committee was created to separate decision-making and execution	The Norway Model may limit the management and execution of strategies because of political agendas The Canada Model allows CPPIB to take advantage of its long time-horizon and apply a multi-asset class model With the newly created Board, GPIF may prove to become more professionally managed
Liability profile	Funded by Norway's total state budget surplus, including petroleum exporting revenues No pension liabilities at this point. Covers budget deficit corresponding to the fund's expected real rate of return	Receives annual contributions from employers and employees, currently at 9,9 percent of earnings Projected yearly payouts the next 75 years equals approximately 10 percent of contributions (Office of the Chief Actuary, 2016)	Pay-as-you-go pension plan, meaning beneficiaries contributes to the fund and the working generation supports the older generation GPIF contributes about 10 percent of Japan's annual pension budget (GPIF, 2017)	GPFG has a predictable liability profile and no short-term concerns affecting allocation policy CPP has low payouts compared to contributions GPIF is required to hold a certain level of liquidity for pension payouts, which may affect policy decisions

Policy allocation	The Ministry set policy allocation for the fund, based on the desired risk profile and expected return GPFG is currently allowed to invest 70 percent in public equities and 30 percent in fixed income. Also, NBIM can allocate up to 7 percent in real estate and 2 percent in unlisted infrastructure from the equity-budget	The OCM outlines an equity/bond risk equivalence portfolio (the RP) of the multi-asset class portfolio The RP has currently a mix of 85 percent in equities and 15 percent in fixed income	The Policy Asset Mix set by the Ministry defines the asset allocation After the adjustment in 2014, the allocation is currently 50 percent in public equities (25 percent domestic) and 50 percent in fixed income (35 percent domestic)	The allocation measures suggest that CPP should have the highest expected return of the three funds. Higher allocation to equities also implies higher volatility in returns The different risk profiles outlined in the funds' policy allocation corresponds to the different expected rate of return described below, whereas GPIF has the lowest and CPP the highest
Benchmark	The benchmark is constructed according to the policy asset mix for public equities and fixed income The equity portion of the benchmark is based on FTSE Global All Cap Index, while fixed income is based on Bloomberg Barclays Indices	The actual fund return is compared to the RP with the abovementioned allocation mix The benchmarks used are S&P Global LargeMidCap for equities and FTSE TMX for Canadian Government bonds	Benchmark constructed as compound rate of return of the following indices: MSCI ACWI for foreign equities, TOPIX for domestic equities, FTSE World Government Bond Index for foreign bonds and a customized index of NOMURA-BPI for domestic bonds (GPIF, 2018).	Different use of policy benchmarks makes it difficult to compare actual fund returns in excess of their respective benchmarks

Investment strategy	Relies mainly on beta returns, subject to a tracking error of 1,25 percent from the benchmark. Active programs where factor risk premiums are pursued The ORP enhances diversification and states smart rebalancing of the positions	The CPP has four tiers of return, the traditional public market beta, smart beta with long-term factor tilts, private market alternative beta and various active programs designed to generate alpha returns	Most investments are passive beta positions in public equities and fixed income Seek some short-term market fluctuations, although this is not their core objective Extensive use of external managers	Expect the GPFG and the GPIF to follow the market more closely due to their beta approach. Different definition of "market" and thus beta for the funds Expect the CPP to deviate more from the market and policy than their counterpart, given their multi-asset style and active approach
Expected real rate of return	Goal of achieving an expected annual real return of 3 percent	Projects an annual real return of 3,9 percent	Required to achieve a long-term real return of 1,7 percent	Expect the risk-taking of CPP to be higher than for GPFG and GPIF

4 Data collection

In this section, we first present the general data collection and then proceed to present the data collection process for each specific fund. In the end, we present summary statistics in a table and some graphs.

4.1 General data collection

To properly conduct our analysis, we need data from the funds, data to construct benchmarks, and exchange rates. Data from the funds consist of yearly gross and net total returns, asset class returns, policy returns and policy asset allocation. We also gather quarterly data on total returns, asset class returns, policy returns, and benchmark returns from GPIF and GPFG. This is not obtainable from CPP. All data and information is manually gathered from the funds' own yearly and quarterly financial reports.

We collect quarterly returns from the MSCI All Country World Index (MSCI) and Bloomberg Barclays Global Aggregate Bond Index (Barclays) from the Bloomberg Terminal. We use these indices to construct the market portfolio with the equity return (MSCI) and the fixed income return (Barclays), varying the weights. We explain the reasoning behind why we choose MSCI and Barclays in our methodology section. Further, we gather the quarterly JPY/USD and the CAD/USD exchange rates from the Bloomberg Terminal to convert the returns from GPIF and CPP to USD returns. All the funds report their own benchmarks in a highly complex way. We do not have the opportunity to replicate the benchmarks reported by the funds, hence, we gather the policy benchmark returns from the funds themselves.

As the financial reports vary substantially across funds and years we make some necessary changes to make the data comparable. One issue we deal with is the funds' definition of a fiscal year (FY). We use GPIF's definition of a FY which is Q2 + Q3 + Q4 + next year's Q1, in a calendar year. An illustrative example is that FY 2012 consist of Q2, Q3 and Q4 2012 plus Q1 2013. We shift the quarters for GPFG and CPP respectively to fit this FY, shown in table 1 below where e.g. the quarters marked in blue correspond to each other.

GPIF Fiscal	GPFG Calendar	CPP Fiscal
Q4 2009	Q4 2009	Q4 2009
Q1 2010	Q1 2010	Q1 2010
Q2 2010	Q2 2010	Q2 2010
Q3 2010	Q3 2010	Q3 2010
Q4 2010	Q4 2010	Q4 2010
Q1 2011	Q1 2011	Q1 2011
Q2 2011	Q2 2011	Q2 2011
Q3 2011	Q3 2011	Q3 2011
Q4 2011	Q4 2011	Q4 2011
Q1 2012	Q1 2012	Q1 2012

Table 1: Definition of the fiscal year

As we collect all the data manually from the financial reports of the funds, we realize that notational errors could occur. To counteract this, we both collect the data from the funds separately and then use Excel to compare and check for mistakes and correct them.

4.2 Fund specific data collection

We now describe the data collection relevant for each fund.

4.2.1 Government Pension Fund Global

4.2.1.1 Return and allocation

For GPFG we collect both yearly and quarterly data from 1998 to 2017 from the fund's financial reports. First, we collect the market value of equities, fixed income and real estate and then calculate the quarterly allocation. This is done until 2012, and from 2013 NBIM reports the allocation directly. We obtain the actual return and the asset allocation policy return from an Excel file provided by NBIM on their webpage (NBIM, 2018c).

4.2.1.2 Fiscal year

As GPFG reports their numbers on a calendar year basis, we shift their return numbers one quarter to align with the GPIF FY definition, as shown in table 1 above.

4.2.1.3 Costs

We gather data on management cost per asset class from a table provided by NBIM (NBIM, 2017). The table include all costs from the total fund and per equities, fixed income and real estate.

4.2.1.4 Currency

The data provided by NBIM is given in USD so no further processing is necessary.

4.2.2 Canada Pension Plan

4.2.2.1 Return and allocation

We obtain yearly, but not quarterly data for CPP. The reason being that the CPPIB's quarterly reports do not provide necessary numbers for all asset classes, or only at aggregate level for the total fund. Also, equities are not split between public and private, making the comparison to GPIF and GPFG difficult. In the yearly reports, CPPIB divides the asset classes into public and private equities, fixed income and real assets. Equities are further divided into subgroups of Canadian, developed and emerging markets. Fixed income contains marketable and non-marketable bonds, inflation-linked bonds and a minor allocation to other types of debt. Domestic and foreign government bonds are present in the largest group of marketable bonds. Lastly, real assets are divided into real estate, infrastructure and some other inflation-linked assets.

As we are interested in the returns and allocation on an asset class level, we calculate total public and private equity, total fixed income and total real asset return by the subgroups' portfolio weight, according to equation (1) below. For calculation purposes, this implies assumption (1), that weighted allocation is constant for one period, and assumption (2), that end-of-period allocation is applied for each period. For the total fund return we use reported numbers, given in the yearly reports.

Policy returns and allocation are divided into the same subgroups as the abovementioned, but only contains public equities and fixed income. Thus, private equities and real assets have no associated policy return. We explain how we deal with this in the methodology in section 5.

An important notice and limitation in our data regards CPP's asset allocation from 1998 to 2004. When CPPIB was created in 1997, their responsibility was to create and manage a portfolio of equity investments, although the fund had an existing allocation to government bonds. The bond investments were not under CPPIB's management before 2004, meaning CPPIB only reported return and allocation for the equity investments. We are not able to obtain numbers for the bond portfolio until 2004 when the investments were included in CPPIB's universe. The result of this exclusion is that CPP has a higher allocation to equities than the total fund actually had in the period 1998 to 2004.

$$Asset\ return = \frac{A_i * R_i}{\Sigma A_{i,n}} + \frac{A_j * R_j}{\Sigma A_{i,n}} + \cdots + \frac{A_n * R_n}{\Sigma A_{i,n}} \qquad (1)$$

where:

A_i = *Allocation to asset i*

R_i = *Return from asset i*

i, n = *Assets/sub-assets*

4.2.2.2 Fiscal year

Regarding the reporting and definition of a year, CPPIB also reports a FY starting in Q2 and ending in Q1 the following calendar year. However, we shift CPPIB's FY one year to align with GPIF's FY.

4.2.2.3 Costs

Transaction costs, external management fees and operating expenses are reported quarterly only, and are given as numbers. We use the numbers to calculate total fund costs as a percentage of total market value for each period. From this we take the average of the four quarters to provide annual costs. We then calculate net returns for the total fund.

4.2.2.4 Currency

As all returns of the CPP are given in CAD, we convert it into USD by following equation (2) below.

$$R_t = \left(\frac{M_t}{M_{t-1}}\right) * \left(\frac{S_t}{S_{t-1}}\right) - 1 \qquad (2)$$

where:

R_t = *Return in time t*

M_t = *Market value in time t*

S_t = *Spot exchange rate in time t*

4.2.3 Government Pension Investment Fund

4.2.3.1 Return and allocation

For GPIF, it is possible to collect both yearly and quarterly data from 2008 to 2017. For equities, GPIF divides the return and allocation into domestic and foreign, and for bonds the fund divides return and allocation into domestic, foreign, FILP and short-term. Using this, we first calculate the total equities and bond allocation, and then use this to calculate the asset return according to equation (1). This gives us quarterly equity and bond returns, which in turn is used to calculate the yearly equity and bond returns.

The fund reports its policy allocation on a yearly basis, and this allocation changes three times from 2008 to 2017. When calculating the yearly policy return for equities and bonds, we use the policy allocation given as domestic and foreign equities and bonds, and the policy return given in the same manner. We use equation (1) for our calculations. In 2014, the policy allocation changed mid-year so we calculate the average policy allocation and use this as a total yearly policy allocation.

Further, we collect quarterly policy return from 2009 to 2017. This is given by GPIF in the same way as above, which means we calculate total equity and total bond returns. This is done in roughly the same way as above but here we make the same assumption (1) and (2) as for CPP. GPIF only reports FY Q1, Q2 and Q3 and total so we goal seek every Q4 return for both equity and bonds.

4.2.3.2 Costs

The fund reports both their yearly gross and net returns, so nothing further must be done with the data.

4.2.3.3 Currency

As all returns of the GPIF are given in YEN, we convert it into USD by following equation (2) above.

4.3 Summary statistics

Table 2 below contains the summary of the funds' average returns and the volatility of the returns, in terms of standard deviation. We show our calculations for the full period for all the funds, post the financial crisis in 2008 and the total returns in excess of the funds' policy benchmark.

		GPFG (1998-2017) *		CPP (1999-2017) **		GPIF (2008-2017)	
		Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.
Full period	Total fund gross	6,3 %	14,5 %	9,0 %	20,4 %	3,4 %	7,4 %
	Public equities	6,3 %	24,1 %	8,5 %	24,7 %	7,2 %	19,3 %
	Fixed income	5,1 %	9,2 %	6,5 %	12,7 %	1,5 %	7,7 %
	Real assets	4,6 %	8,2 %	6,1 %	23,5 %	N/A	N/A
	Private equities	N/A	N/A	12,9 %	15,4 %	N/A	N/A
Post financial crisis (2009-2017)	Total fund gross	10,2 %	13,5 %	11,5 %	12,7 %	4,6 %	6,8 %
	Public equities	13,6 %	19,6 %	12,7 %	21,0 %	12,6 %	14,2 %
	Fixed income	4,7 %	7,1 %	6,4 %	12,8 %	1,5 %	8,2 %
	Real assets	3,5 %	8,2 %	7,2 %	6,8 %	N/A	N/A
	Private equities	N/A	N/A	13,7 %	6,3 %	N/A	N/A
Total returns in excess of policy benchmark	Total fund gross	0,4 %		0,6 %		-0,2 %	
	Total fund net	0,3 %		0,5 %		-0,2 %	
	Public equities	0,6 %		-0,4 %		1,0 %	
	Fixed income	0,2 %		1,3 %		0,2 %	
	Public equities & AI	0,6 %		-0,3 %		N/A	

* GPFG: Real assets (2011-2017)
** CPP: Fixed income (2002-2017), Real assets (2001-2017), Private equities (2003-2017)

Table 2: Summary statistics. Fund returns and volatility.

Figures 5, 6 and 7 below shows the actual allocation together with the asset allocation policy for all three funds. They are similar to the figures shown above but these figures are marked with a line called "Policy allocation". This line indicates where the policy allocation divides between public equities and fixed income. The area below the line is public equities and above the line is fixed income. It is meant to illustrate how and when the funds diverge from their policy allocation. Figure 8 shows the yearly return for each fund. Appendix 1 contains graphs for cumulative returns for the three funds.

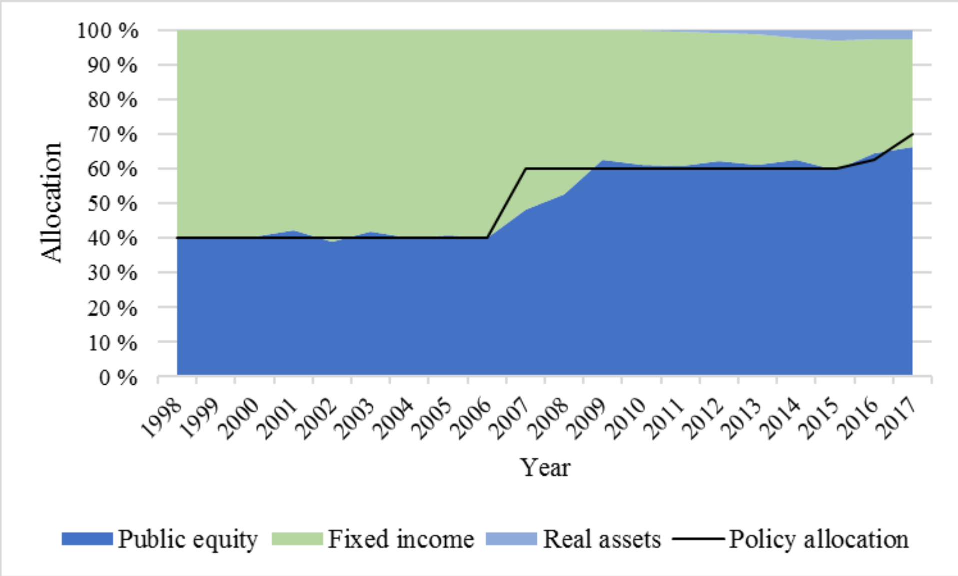

Figure 5: Actual and asset allocation policy for GPFG

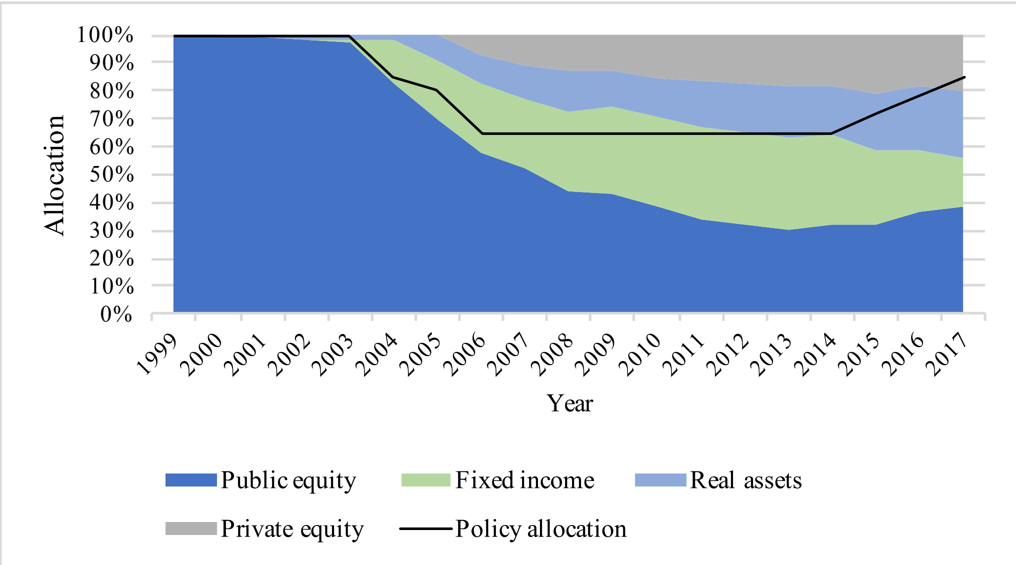

Figure 6: Actual and asset allocation policy for CPP

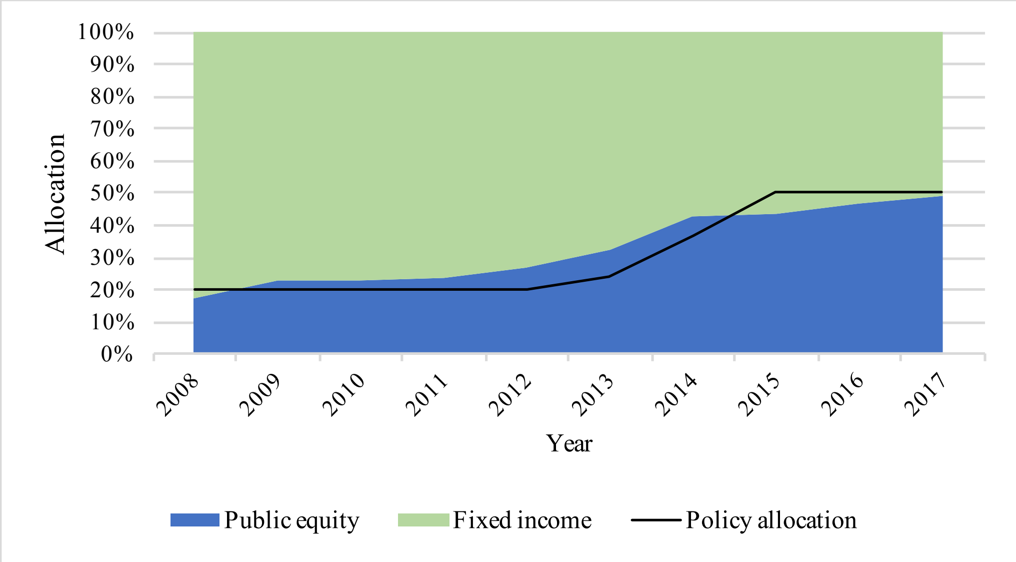

Figure 7: Actual and asset allocation policy for GPIF

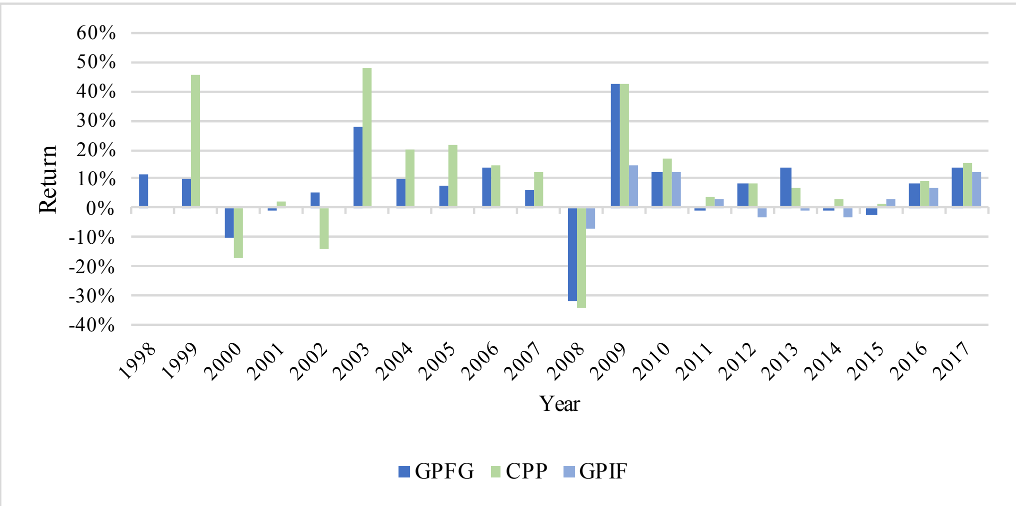

Figure 8: Yearly return for all funds

4.4 Limitations

In this section, we present some of the challenges in the data collection process as well as some limitations the data has put on our thesis.

The funds' financial reports sporadically report inflows to the funds in total. Unfortunately, it is not possible to obtain an accurate course of the inflows and how it is distributed between the asset classes. This means that we cannot adjust for possible additional effects in return due to inflows, e.g. high inflow to equities in a year with abnormal equity returns. In all return calculations however, inflows are accounted for such that only investment gains are reported.

The structure of the financial reports varies quite substantially between funds and from one year to another. Hence, it is possible that the funds have changed some underlying assumptions in their calculations which impacts the data we collect. Even if this is the case, we assume this to be of little to no importance as we do not find any evidence of severe changes. We could also experience an issue of self-reporting bias, which is not uncommon in the study of pension fund performance. However, we do not believe this is a major problem as all of the three funds have quite detailed reports and are regulated by national authorities.

As mentioned, the funds' financial report differs a lot. The way they report costs of the funds is also quite different. We cannot obtain accurate cost reports per asset class and hence only collect or calculate total costs for all the funds.

5 Methodology

5.1 Variance of return

Our methodology has roots in the work of Brinson et al. (1986) which was later refined by Xiong et al. (2010) and by Aglietta et al. (2012). Their methodology differs substantially from Brinson et al. (1986) when measuring the impact a funds asset allocation policy has on the variation of returns. As mentioned in our literature review, Brinson et al. (1986) does not include the market movements in their calculations. Hence, the main difference in methodology is showed by how asset allocation policy impacts the variation of returns. The asset allocation policy is now measured in excess of the market.

As mentioned several times, a fund's returns can be decomposed into three sources:

(1) return from market movements,

(2) return from the asset allocation policy (in excess of the market), and

(3) return from the active management (in excess of the policy),

shown as:

$$R_{i,t} = M_t + (P_{i,t} - M_t) + (R_{i,t} - P_{i,t}) \qquad (3)$$

where:

$R_{i,t}$ = *Total return of the fund or asset class*

M_t = *Return from market movements (defined below)*

$(P_{i,t} - M_t)$ = *Return from asset allocation policy in excess of market movements*

$(R_{i,t} - P_{i,t})$ = *Return from active management in excess of asset allocation policy*

When measuring the contribution each of the three sources has on the total variance of returns, we run three univariate regressions for each fund, in line with Xiong et al. (2010). All regressions are modeled and executed in MATLAB. The regressions are run for the fund's total return against the three components described above, such that: $R_{i,t} = M_t$, $R_{i,t} = (P_{i,t} - M_t)$, and $R_{i,t} = (R_{i,t} - P_{i,t})$, obtaining the R^2 from each regression. This gives the decomposition with the following regression line:

$$R_{i,t} = \alpha + \beta_m M_t + \beta_p (P_{i,t} - M_t) + \beta_s (R_{i,t} - P_{i,t}) + \varepsilon_{i,t} \qquad (4)$$

Because the three variables explain all the variance by construction, the sum of the R^2s we obtain must sum to one. Hence, we have an interaction effect working as a balancing term such that:

$$R^2_{i,M} + R^2_{i,P} + R^2_{i,S} + R^2_{i,\varepsilon} = 1 \qquad (5)$$

Obtaining the three R^2 from our univariate regressions, lets us measure the percentage of the variance in total return explained by the different sources, market movements, asset allocation policy and active management. In our case, we do not need to adjust the R^2s as we only have one independent variable in each regression. The $R^2_{i,\varepsilon}$ is the residual effect, also called the interaction effect, and is the result of the difference between 1 and the sum of $R^2_{i,M} + R^2_{i,P} + R^2_{i,S}$ as shown in equation (5). The $R^2_{i,\varepsilon}$ represents the interaction between the three sources of return, and measures the percentage of the variance of the total returns explained by this interaction (Aglietta et al., 2012). The process described above is done for each fund's total return and each asset class, i.e. public equities, fixed income, and public equities and alternative investments (PAI). PAI is a constructed asset class where the returns are weighted by allocation according to equation (1), and contains public and private equities, real estate and infrastructure. The reason we construct PAI is that GPFG and CPP allocate assets to alternative investments without proper benchmarks, and we need to account for the returns attributed to these investments. We use the difference between public equities and PAI to highlight the importance a proper benchmark has.

When defining the market portfolio, both Xiong et al. (2010) and Aglietta et al. (2012) used the average returns of the funds in their respective universe. In our case, this would not be appropriate as we only have three funds. Instead, we use the average allocation in public equities and fixed income of our funds and multiply this with the returns from MSCI and Barclays, creating a weighted market portfolio. Based on this approach, we choose two different weightings of 59/41 and 50,2/49,8 in public equities and fixed income respectively. The 59/41 weighting is the average allocation for the full sample period (1998-2017) and the 50,2/49,8 weighting is the average allocation for the last 10-year period (2008-2017). We refer to these weightings as weighting (A) and weighting (B) respectively from now on. These averages are conveniently close to the commonly used weighting in the literature, which is 60/40 or 50/50. An alternative method could be to use the average policy allocation instead of the actual allocation. This would yield similar result as the actual allocation fluctuates around the policy allocation and on average over time should be quite close.

We check the correlation of both MSCI and Barclays against the return of the public equities and fixed income of the funds and find clear relationships, as we show in Figures 9 and 10 below. We experiment with different indexes but find that MSCI and Barclays in general are the best measures of the market the three funds operate in. MSCI and JP Morgan Global Aggregate Bond Index US were used by Aglietta et al. (2012) in their robustness check and they used a 65/35 weighting. MSCI covers approximately 2,400 securities across 23 developed and

26 emerging markets, thus captures all sources of equity returns (MSCI, 2019) We use Barclays instead of JP Morgan as we need an index for the world bond market. Barclays is a measure of global investment grade debt from 24 local currency markets and includes treasury, government, corporate, and securitized fixed-rate bonds from both developed and emerging markets (Bloomberg, 2019).

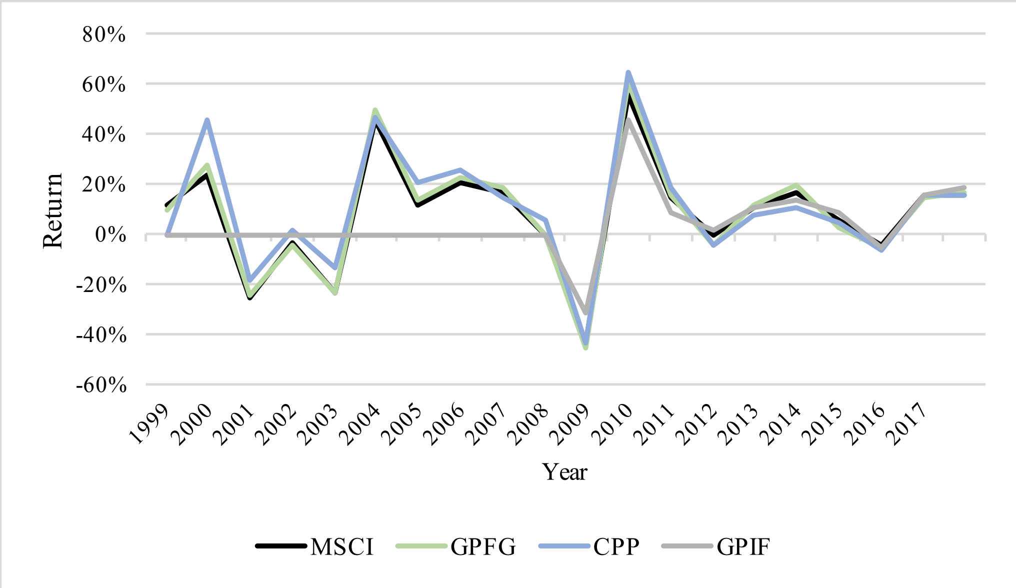

Figure 9: Funds' equity return versus MSCI

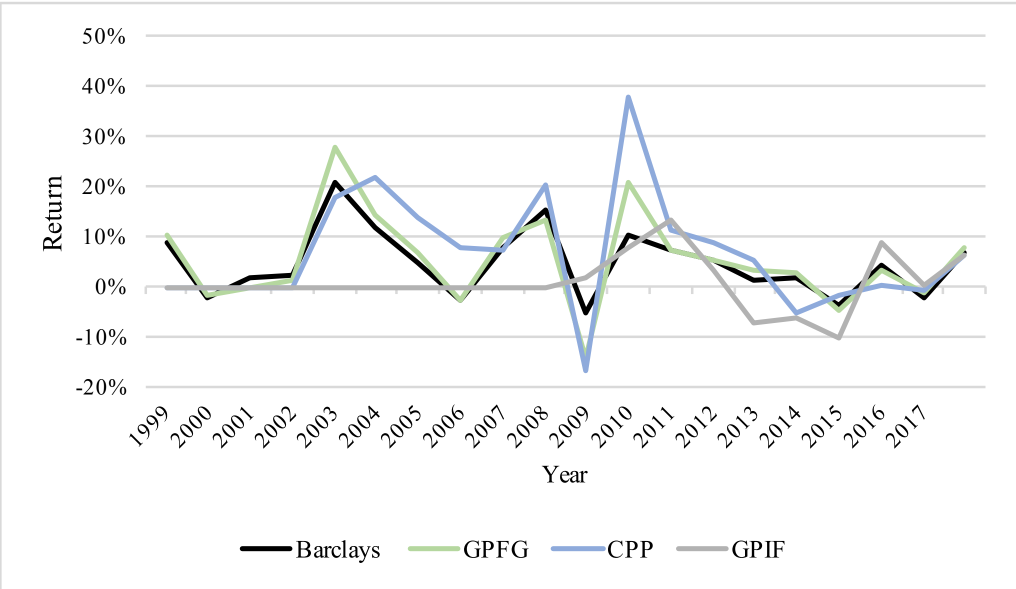

Figure 10: Funds' fixed income return versus Barclays

The asset allocation policy in excess of the market variable is designed to capture the funds' return as a result of long-term asset allocation, and how it might deviate from the market portfolio. Because of this, it is important that we use the same market portfolio for all three funds, and the fund-specific asset allocation policy, when running our regressions. The active management variable captures how the security selection, timing, and short-term overweighting or underweighting of an asset class done by each fund affects the variation relative to the policy allocation.

5.2 Level of return

To properly address the second part of our research question, we rely on the methodology presented by Surz et al. (1999), further made clear by Ibbotson and Kaplan (2000), Drobetz and Köhler (2002) and Andreu et al. (2010), and compute the ratio mentioned in the literature review. The method is mathematically simple and is defined as the return from asset allocation policy divided by the total return, as in equation (6) below. It is used as a tool to evaluate the impact active management (market timing and security selection) has on the level of returns. Or in other words, if they have added or destroyed value for the fund.

$$Ratio\ of\ compounded\ returns_i = \frac{Policy\ returns_i}{Total\ returns_i} \qquad (6)$$

where subscript *i* denotes the different asset classes.

To compute the ratio, we first calculate the geometric mean of both the total return and the asset allocation policy return. Once this is done, we divide the asset allocation policy return by the total return. Theory states that if the value of the ratio is 1, the fund follows a passive investment strategy and does not deviate from their asset allocation policy. If the result is below 1, the fund deviates from their asset allocation policy and the deviation adds value to the fund. If the ratio is above 1, the fund deviates from their asset allocation policy but the deviation destroys value. We calculate this ratio with both gross and net total fund returns where our data allows it, and with public equities, fixed income and PAI.

As mentioned, active management consist of both market timing and security selection and our data allows us to investigate this ratio further. We have the possibility to isolate the effect of market timing and security selection, to check which of the two drives the value added or destroyed. We use the same principle as in the ratio calculation presented above, but with slight variations, presented in our results section 6 below.

6 Results and discussion

We present our results by first reporting and discussing the findings from the time-series regressions on total returns, which is the main analysis described in detail in the methodology section. This analysis will provide answers to the first part of our research question, namely how much the three components explain of the funds' variance of returns. Then we proceed to describe and present three different variations to the main analysis, meant to confirm the results or to discover further explanations. Lastly, we will answer the second part of the research question by presenting the return level ratios and Sharpe ratios. The ratios will offer an answer to whether active management adds or destroys value for each fund.

6.1 Variance of return

6.1.1 Time-series regression on returns (yearly data)

In table 3 below, the average time-series R^2 of each of the three components in the return decomposition are listed for each fund and for each asset class. The R^2 is to be interpreted as a specific component's contribution and importance to the total return variance of $R_{i,t}$.

Data: Yearly, full period		GPFG	CPP	GPIF	Average
Asset: Total fund **Market weights:** 59/41 (A)	Market movements	0,94	0,86	0,57	0,79
	Policy allocation	0,00	0,77	0,15	0,31
	Active management	0,66	0,23	0,07	0,32
	Interaction effect	-0,60	-0,86	0,22	-0,41
Asset: Total fund **Market weights:** 50,2/49,8 (B)	Market movements	0,96	0,83	0,59	0,79
	Policy allocation	0,23	0,83	0,11	0,39
	Active management	0,66	0,23	0,07	0,32
	Interaction effect	-0,84	-0,90	0,24	-0,50
Asset: Public equities **Market:** MSCI	Market movements	0,99	0,93	0,98	0,97
	Policy allocation	0,27	0,16	0,50	0,31
	Active management	0,34	0,00	0,36	0,24
	Interaction effect	-0,60	-0,09	-0,85	-0,51
Asset: Public equities & alternative investments (PAI) **Market:** MSCI	Market movements	0,99	0,90	0,98	0,96
	Policy allocation	0,27	0,16	0,50	0,31
	Active management	0,31	0,28	0,36	0,32
	Interaction effect	-0,57	-0,34	-0,85	-0,59
Asset: Fixed income **Market:** Barclays	Market movements	0,89	0,53	0,46	0,63
	Policy allocation	0,62	0,74	0,62	0,66
	Active management	0,28	0,45	0,06	0,26
	Interaction effect	-0,79	-0,72	-0,13	-0,55

Table 3: R^2s from yearly time-series regressions on returns

Before we proceed to list and discuss the results for the different asset classes, we will briefly comment upon a general remark that applies to almost all our regressions. We observe a high negative interaction effect for most of the three return components combined. Normally, a negative interaction effect comes from the negative covariance between the total return and a residual term. By construction, the three components together explain 100 percent of total return variance and thus have an R^2 of 1. Since we run three univariate regressions, the interaction effect is a term making the combined R^2s sum to 1. Because we run the regressions for one fund at the time and not on a panel data, we seem to capture higher R^2 numbers. Hence, it makes the negative interaction effect high as the three components cannot explain more than 100 percent combined.

6.1.1.1 Total fund

When assessing the total fund returns, we find that market movements explain 79 percent of the total volatility on average for the three funds, dominating policy allocation and active management. This is consistent with previous literature, such as Ibbotson and Kaplan (2000), Xiong et al. (2010), and Aglietta et al. (2012). Further, we find that policy allocation and active management on average contributes equally to return variation, both accounting for 31 to 39 percent depending on market weighting, which we comment on below. The R^2s we find for the two components are higher than in earlier studies, but this can perhaps be explained by the high interaction effect we experience, making the numbers abnormally high. However, the equal importance of policy allocation and active management when measuring total fund return is in line with the results by Xiong et al. (2010) and Aglietta et al. (2012).

We find interesting differences when we proceed to study the results fund by fund. The results are not sensitive to the different market weightings applied, therefore we will not allocate a separate paragraph for this but rather report both going forward. For GPFG, with market weighting (A), policy allocation has close to zero explanatory power (0,4 percent). The reason being that the excess market policy returns are so small that the variable captures nearly no variation. We believe this confirms their investment strategy to pursue beta returns and our observation that the fund has constructed a policy benchmark that closely follows the market benchmark we define. With market weighting (B), the return from policy allocation explain 23 percent of the variance, which is still small, and implies that this market weighting is less similar to the fund's average long-term allocation. Active management has a higher explanatory power of 66 percent, indicating that NBIM's active programs affects return variance. Whether these effects are positive or negative will be emphasized when we go through the level of return in section 6.2.

The results for CPP show that the specific features of the fund give rise to different importance of the components in the return. Active management has a lower explanatory power (23 percent) of total fund return for CPP than for GPFG. This is a bit surprising, as we expected to find higher active variation based on the fund's investment approach. The use of alternative assets such as private equities and real estate increases the active management. However, some of the variation from active management may be captured by the policy allocation, since this is the deviation from the market portfolio and is constructed to gain risk premiums and represent their risk profile. For the two market weightings, (A) and (B), we find that policy allocation explains 77 and 83 percent of total variance. This implies that CPP constructs a policy benchmark not set to follow the market nor capture beta returns, but rather to seek more volatility than the market and generate higher returns. On the other hand, the high explanatory power of policy allocation could also be explained by the fact that the fund has changed their allocation through the sample period. Hence, the excess variable captures most of return variance because the policy allocation may vary a lot from the market allocation which is the average of all periods. Because of this possibility, we decided to make a variation of the analysis and show R^2 results for each fund for the longest period the fund has a constant policy allocation. These results are shown in section 6.1.4.

For GPIF, the results are also quite similar for both market weightings. Market movements account for 57 (A) to 59 (B) percent of variance in total fund return, which is the lowest in our comparison group. This could be explained by GPIF's extensive use of domestic assets within both asset classes, with other attributions than the global market. Regarding policy allocation and active management, neither of the two components offers much to variation in total returns. Active management explains 7 percent, while policy allocation explains 15 percent. More interestingly, GPIF is the only fund where we find a positive interaction effect of the three components. This means that the return components are dependent on each other for them to explain the entire variance.

6.1.1.2 Public equities

Due to the nature of the market for public equities, being high correlation across geographical zones and sub-assets, this asset class is the most homogenous sample. Research has found that the correlation is above 80 percent between developed public equity markets (Hyde, Bredin, & Nguyen, 2007). The homogeneity makes it more difficult for a manager to select securities that outperforms the market.

For the three funds on average, market movements account for 97 percent of return variance in public equities, followed by policy allocation (31 percent) and active management (24 percent). For market movements, our result is as expected and consistent with Aglietta et al. (2012). It also makes sense because of the correlation in sub-asset classes as calculated by Hyde et al. (2007). Policy allocation and active management contributes significantly to variation in equity returns for GPFG and GPIF, and less for CPP. Policy allocation proves to be more important than active management for GPIF and CPP, while for GPFG we find the opposite result albeit with a marginal difference.

An important remark regarding the policy allocation return is that it captures the choice of benchmarks for each specific fund. Therefore, it is difficult to assign correctly how much variation that originates from the funds' expertise in over or underweighting sub-assets, and how much that comes from the fact that the funds choose a different benchmark than MSCI with features more closely connected to their own investment strategy. Nevertheless, the regression result is still attributable to policy allocation in excess of the market movements either way. This discussion of assignment also holds for fixed income which will be reported below.

6.1.1.3 Public equities and alternative investments (PAI)

We are interested in the effects that alternative investments have on the variation of returns originating from active management. We find this effect by adding alternative investment returns to the public equity returns, weighted by their actual allocation, while we still hold the market constant as MSCI. GPFG has a small portion invested in real estate, making the regression result nearly identical to the one reported above, with only a slight decline from 34 to 31 percent. For CPP, the explanatory power increases from 0,2 to 28 percent. This is a significant increase, indicating that alternative investments add volatility for CPP. It also explains why active management for the total fund return is present, even though the active management of public equities alone contribute with close to 0 in variation. GPIF has no alternative investments, hence the R^2 remains the same.

6.1.1.4 Fixed income

Opposed to public equities, fixed income has greater heterogeneity in the sub-asset classes. We use Barclays as the market for these regressions which, as mentioned, contains treasury, government, corporate, and securitized fixed-rate bonds from both developed and emerging markets. Although Barclays is a good representation of the global fixed income market, two of our three funds display great deviation from the market. The reason for this could be due to different risk profiles, such as favoring government bonds over corporate bonds, political interference, or home bias. Home bias is not the case for GPFG, as the fund only invest in foreign assets. Therefore, we find that market movements account for 89 percent of variance in fixed income returns for GPFG, by far the highest number in our comparison group. On average, market movements explain 63 percent of the variance, closely corresponding to the results from Aglietta et al. (2012).

An interesting result when studying fixed income is that policy allocation proves to be more important than market movements for CPP and GPIF. This is a new result, not consistent with what we see in previous literature. Also, for CPP, active management is almost as important as market movements. We believe this could make sense because it is easier to generate active return variance in fixed income by seeking higher volatility than the market, e.g. by preferring sub-asset classes such as corporate bonds. Since we have not controlled for each fund's allocation to sub-asset classes within fixed income, we cannot give a definitive explanation as to where the funds' return variation is attributable.

6.1.2 Variation: Time-series regression on returns (quarterly data)

As we obtained quarterly actual and policy return for GPFG and GPIF, we run the same regressions as above with quarterly data and will now present and discuss the main findings when comparing yearly and quarterly results. What we see in Table 4 is that the R^2 numbers are lower, confirming our discussion above that fewer observations indicates higher R^2. This makes quarterly data somewhat more reliable, as also the interaction effect decreases in most cases, making the importance of each component easier to interpret. However, the study of quarterly data confirms that the relative importance between e.g. policy allocation and active management remains the same for yearly as for quarterly data in most cases.

Data: Quarterly, full period		GPFG	GPIF	Average
Asset: Total fund **Market weights:** 59/41 (A)	Market movements	0,90	0,33	0,62
	Policy allocation	0,01	0,05	0,03
	Active management	0,47	0,03	0,25
	Interaction effect	-0,39	0,58	0,10
Asset: Total fund **Market weights:** 50,2/49,8 (B)	Market movements	0,93	0,38	0,65
	Policy allocation	0,26	0,08	0,17
	Active management	0,47	0,03	0,25
	Interaction effect	-0,66	0,51	-0,08
Asset: Public equities **Market:** MSCI	Market movements	0,98	0,88	0,93
	Policy allocation	0,14	0,01	0,08
	Active management	0,24	0,18	0,21
	Interaction effect	-0,37	-0,07	-0,22
Asset: Public equities alternative investments (PAI) **Market:** MSCI	Market movements	0,98	0,88	0,93
	Policy allocation	0,14	0,01	0,08
	Active management	0,20	0,18	0,19
	Interaction effect	-0,33	-0,07	-0,20
Asset: Fixed income **Market:** Barclays	Market movements	0,86	0,61	0,74
	Policy allocation	0,42	0,70	0,56
	Active management	0,13	0,02	0,07
	Interaction effect	-0,40	-0,33	-0,37

Table 4: R^2s from quarterly time-series regressions on returns

We will not compare the average R^2 of our funds, as the analysis of quarterly data does not contain CPP. One special finding in this sample is that market movements explain as little as 33 percent of variance in total return for GPIF with market weighting (A) and 38 percent with market weighting (B). Also, the explanatory power of policy allocation and active management has decreased so that the positive interaction effect is quite high (0,51 to 0,58 percent). For fixed income in GPIF we observe the opposite change, where the R^2 has increased for both market movements and policy allocation. In summary, there is no severe changes in results by going from yearly to quarterly data, such as e.g. a component suddenly failing to show any importance.

6.1.3 Variation: Time-series regression on excess returns (yearly data)

In this variation of the main analysis, we follow the methodology by Xiong et al. (2010) and perform a time-series analysis of excess market returns. The purpose of this exercise is to identify a more precise relative importance between asset allocation and active management by removing the effect of market movements. Now, we regress actual return in excess of the market against the return from policy allocation and active management. The latter two are defined as before, while the actual excess return is now given by $R_{i,t}$ - M_t. Table 5 below summarizes the decomposition and show the new R^2 results.

Yearly, full period		GPFG	CPP	GPIF	Average
Asset: Total fund **Market weights:** 59/41 (A)	Policy allocation	0,82	0,90	1,00	0,91
	Active management	0,10	0,03	0,00	0,04
	Interaction effect	0,07	0,07	0,00	0,05
Asset: Total fund **Market weights:** 50,2/49,8 (B)	Policy allocation	0,85	0,93	1,00	0,92
	Active management	0,50	0,06	0,00	0,19
	Interaction effect	-0,35	0,01	0,00	-0,11
Asset: Public equities **Market:** MSCI	Policy allocation	0,80	0,82	0,86	0,82
	Active management	0,40	0,25	0,37	0,34
	Interaction effect	-0,20	-0,06	-0,23	-0,16
Asset: Public equities & alternative investments **Market:** MSCI	Policy allocation	0,79	0,42	0,86	0,69
	Active management	0,40	0,40	0,37	0,39
	Interaction effect	-0,19	0,18	-0,23	-0,08
Asset: Fixed income **Market:** Barclays	Policy allocation	0,52	0,95	0,99	0,82
	Active management	0,71	0,41	0,02	0,38
	Interaction effect	-0,23	-0,36	-0,01	-0,20

Table 5: R^2s from quarterly time-series regressions on excess returns

6.1.3.1 Total fund

For total fund return with market weighting (A), policy allocation explains 91 percent of return variance on average, while active management now only explains 4 percent. This shed new light on the relative importance between the two components, where we found equal importance in the main analysis. For GPFG, the contribution from policy allocation has increased from 0,4 percent to 82 percent, while active management has decreased from 66 percent to 10 percent. Why the importance has turned around could possibly be explained by the very small numbers in the variable policy allocation. Since the explanatory power was 0,4 percent in our previous analysis, it did not contain any volatility at all. Now that also total fund return is in excess numbers, both variables have many observations close to zero, making the explanatory power greater.

With market weighting (B), active management seem to matter more for GPFG, indicating that active short-time timing is a factor in explaining return variance. For GPIF, active management proves to have no importance, and for CPP barely any.

6.1.3.2 Public equities

On average, policy allocation explains 82 percent and active management 34 percent of return variance in public equities. The results are quite similar for all three funds. For CPP, we find that active management now account for 25 percent of variance in this asset class, a different result than earlier when the R^2 was 0,2 percent. For all the funds, these results prove that active management is a significant source of return in public equities, despite the difficulties in outperforming the market.

6.1.3.3 Public equities and alternative investments (PAI)

The inclusion of alternative investments severely affects the results for CPP in two ways. The importance of active management increases and policy allocation decreases. The first makes sense as real estate and private equity investing require active management, and the latter because a stock market index is not a fitting benchmark for alternative investments. We find an equal importance of the two components.

6.1.3.4 Fixed income

When analyzing fixed income, we can confirm that policy allocation plays a major role. For CPP and GPIF it explains 95 and 99 percent of the asset class' return variance. GPFG stands out with active management as the most important component.

6.1.4 Variation: Longest constant allocation period

To control for the effect that a fund changes its asset allocation policy throughout the full sample period, we run our main regressions for each fund for the period where the fund has its longest constant asset allocation. The market weights applied now matches each fund's asset allocation in order to avoid an unrealistically high contribution to return variance from policy allocation. Market weights for each fund are given in the table description. We applied yearly data for CPP and quarterly data for GPFG and GPIF. The time-series R^2s are shown in Table 6.

This control analysis suggests only marginal changes in explanatory power for GPFG. The R^2 of policy allocation increases, indicating that this variable primarily captures choice of benchmark, rather than GPFG's deviation from an average market asset allocation. Again, we find active management to explain nearly two thirds of total fund return variance, confirming our first result.

In the case of CPP, explanatory power is shifted from policy allocation to market movements, which confirms our suspicion leading to the analysis of a constant allocation period. This means that because CPP has done severe changes in their long-term asset allocation from 1999 to 2017, the variable policy allocation captures more variation in the time-series data than reasonable. Some of this variation should rather be attributed to market movements. That being said, our results show that CPP still deviates significantly from the market.

Interestingly, GPIF gives us the opposite adjustment of relative importance between market movements and policy allocation from the main analysis. Since the allocation of the market and policy is the same, at 20/80, it shows clearly that the manager sets an asset allocation policy and benchmark not consistent with a global market-cap approach. Rather, these results confirm that GPIF overweights domestic assets and nearly have equal importance of all three return components.

		GPFG	CPP	GPIF
Asset: Total fund **Market weights:** 60/40 **Data:** Quarterly (FY Q1 2007-Q3 2016)	Market movements Policy allocation Active management Interaction effect	0,98 0,28 0,63 -0,90		
Asset: Total fund **Market weights:** 65/35 **Data:** Yearly (2006-2014)	Market movements Policy allocation Active management Interaction effect		0,97 0,60 0,21 -0,78	
Asset: Total fund **Market weights:** 20/80 **Data:** Quarterly (FY Q1 2009-Q4 2012)	Market movements Policy allocation Active management Interaction effect			0,44 0,26 0,31 0,00

Table 6: R^2s from the longest constant allocation period

In Appendix 2 we show regression results for a forth variation of the analysis, where we split the sample-period and show results from before and after the financial crisis. We decided not to include these results as they did not provide additional intuition.

6.2 Level of returns

In this section, we present the results of our analysis aiming to answer the second part of our research question, namely if active management adds value to the level of return. We calculate the contribution of active management and further separate the contribution into both market timing and security selection. This calculation is done for the total fund returns and for each asset class. We also calculate the ratio with both gross and net returns where our data allows it. Note that the ratios are not directly comparable between the funds as the funds themselves have different policy benchmarks, therefore the excess returns depends on choice of benchmark. Even though the ratios cannot be directly compared, we can still evaluate if one fund performed better given their risk appetite. Because the ratios are not directly comparable, we have decided to use the results from the quarterly data for GPFG and GPIF as they yielded better R^2 measures. We also make use of the excess return's R^2 we calculated in section 6.1.3 to contrast the importance of our findings.

When presenting the results, we also show the Sharpe ratios for each fund's actual and policy return, and discuss the results in light of them (Sharpe, 1994). The Sharpe ratio is relevant as a measure of risk-adjusted return rather than absolute returns. Common understanding in finance states that higher risk appetite leads to higher expected return. The mean-variance analysis is a method of weighting risk against expected return. The analysis allows a fund manager to decide which asset offers the best relationship between variance and expected return. MPT takes this theory one step further and introduces the importance of different levels of variance and expected return in a portfolio, rather than looking at individual financial assets. MPT also states that a fund manager can increase diversification effects by adding assets or asset classes with low correlation to a portfolio (Markowitz, 1952). Increased diversification implies a higher Sharpe ratio. The ratio can evaluate and compare a fund's actual performance to a benchmark, and has therefore become an acknowledged method of calculating risk-adjusted return.

First, we clarify our calculations and then present our results. We start by presenting the total result for active management as a whole, and then proceed to isolate the effects of both market timing and security selection.

6.2.1 Active management

Equations (7) and (8) below are variations of equation (1). They are used to highlight the difference between using actual allocation ($W_{a,i}$) and policy allocation ($W_{p,i}$), and between actual return ($R_{a,i}$) and policy return ($R_{p,i}$). In the equations, subscript i defines what asset class is used. Our results can be seen in table 7 below. Green boxes show where the component adds value, and red boxes where it destroys value. As is to be expected, the contribution from active management is lower for all net calculations than for gross calculations. The Sharpe ratios can be seen in table 8.

$$Total\ Return\ (TR) = \sum_i W_{a,i} * R_{a,i} \qquad (7)$$

$$Policy\ Return\ (PR) = \sum_i W_{p,i} * R_{p,i} \qquad (8)$$

	Equations	GPFG	CPP	GPIF
Total (gross)	$\frac{PR_{tot}}{TR_{tot,gross}}$	0,958	0,895	1,052
Total (net)	$\frac{PR_{tot}}{TR_{tot,net}}$	0,971	0,908	1,062
Public equities (gross)	$\frac{PR_{eq,gross}}{TR_{eq,gross}}$	0,922	1,049	0,802
PAI (gross)	$\frac{PR_{eq,gross}}{TR_{PAI,gross}}$	0,955	0,947	0,802
Fixed income (gross)	$\frac{PR_{fi,gross}}{TR_{fi,gross}}$	0,971	0,762	0,873

Table 7: How active management adds value to the total return

		GPFG	CPP	GPIF
Total	Actual return	0,444	0,447	0,479
	Policy return	0,470	0,374	0,496
Public equities	Actual return	0,268	0,353	0,395
	Policy return	0,254	0,370	0,294
PAI	Actual return	0,259	0,455	N/A
	Policy return	0,254	0,370	N/A
Fixed income	Actual return	0,571	0,531	0,206
	Policy return	0,629	0,457	0,177

Table 8: Sharpe ratios of actual return and policy return

6.2.1.1 Government Pension Fund Global

6.2.1.1.1 Total fund

As can be seen from table 7, GPFG's active management adds value to the total returns, and, as seen in table 3 above, the R^2 from GPFG's active management is 47 percent in total. Combining these results, we see that active management adds value to level of returns and this value is also quite important in explaining return variance.

As seen in table 5, the active management R^2 for the total fund from our excess return calculations is somewhat contrasting our quarterly calculations (from 47 percent to 10 percent). When changing the market weights, the R^2 becomes quite similar to the main result (47 percent to 50 percent). Still, the differences in results mean that even though active management adds value to the total returns, we must be careful in our interpretations of the importance.

Looking at the Sharpe ratio for GPFG's total fund return, we see that the fund's policy return has a higher ratio than the actual return. Hence, even though the fund gets a higher absolute return from their investments, the fund has, according to the theory mentioned above, undertaken too much risk to achieve it

6.2.1.1.2 Public equities and PAI

The results in table 7 indicates that GPFG's active management adds value to the return of both public equities and PAI. As seen in table 3, the R^2s for the fund's active management are 24 percent for public equities and 20 percent for PAI. Combining these results, we see that active management adds value to the returns from public equities and PAI, and this value is also quite important. We see that when including the real estate investments, the contribution, while still positive, goes down slightly. A possible reason for this could be that returns from real estate investments in general takes longer to realize than those from public equities and that this lowers the return volatility. The R^2 from our excess calculations further confirms our results as it moves from 24 and 20 percent to 40 and 40 percent for public equities and PAI respectively. Hence, the importance of the added value increases.

The Sharpe ratio is higher for the actual return than for the policy return, which is the case for both public equities and PAI. This means that GPFG generates higher return than their policy benchmark through active management, without undue increase of risk.

6.2.1.1.3 Fixed income

Looking at fixed income, we see that active management again adds value to the returns. Also, the R^2 is 13 percent and combined we see that the active management adds value and that this is somewhat important. The R^2 jumps to 71 percent in our excess calculations, indicating an even greater importance.

The Sharpe ratio for fixed income is higher for the policy return than for the actual return. This indicates that even though the fund's active management adds value, the risk-adjusted return is still better for the policy benchmark return than for the actual return, with the same theoretical interpretation as for the total fund above.

6.2.1.2 Canada Pension Plan

6.2.1.2.1 Total fund

We see from table 7 that active management adds value to the total return of the fund. This combined with the R^2 of 23 percent for both market weights indicate that active management is of some importance for the fund's return. With our excess calculations, the R^2 decreases to 3 and 6 percent respectively for each weighting. This indicates that even though active management adds value, the importance nearly disappears when the market movements is removed.

Looking at the Sharpe ratios for total returns, we see that the ratio for the actual total return is distinctively higher than the policy return. This shows that CPP not only adds value to level of return through active management, but also benefits when risk-adjusting. This is an important finding, and according to theory, CPP has thus managed to create a more efficient portfolio than their policy by adding different assets.

6.2.1.2.2 Public equities and PAI

Our results indicate that active management destroys value for public equity return. However, the R^2 for public equities is 0 and it seems that the destruction is of low importance. When looking at our excess calculations, we see an R^2 of 25 percent which indicates that the destruction is of some importance when market movements are removed. This result changes when we include PAI which has an R^2 of 28 percent, and adds value to returns. Hence, it seems evident that CPP's alternative investments does in fact add value by diversifying and following a multi-asset class strategy. The R^2 from our excess calculations increases to 40 percent which indicates an even greater importance when market movements are removed.

The Sharpe ratio for public equities is higher for CPP's policy benchmark than for the fund's actual returns. This means that the fund would do better if they passively followed their public equities policy benchmark. This changes significantly when we include alternative investments, and we find an 8,5 percentage points higher ratio for actual return than policy return, meaning that

CPP has successfully found a better return-risk relationship in the investments they actively pursue. This can explain why the fund in total, as discussed above, is a more efficient portfolio than the policy benchmark.

6.2.1.2.3 Fixed income

Active management adds value to the return within fixed income. Combined with that fact that the R^2 is 45 percent (41 percent in excess calculations), this means that active management adds value to the returns and that this is of importance. For fixed income, the Sharpe ratio is significantly higher for actual returns than for the policy returns. Hence, CPP outperforms their fixed income policy benchmark.

6.2.1.3 Government Pension Investment Fund

6.2.1.3.1 Total fund

For GPIF, active management destroys value for total return. We know that the R^2 is 3 percent (0 percent in excess calculations) for active management in total return with both market weights. This means that even though the ratio indicates that active management destroys value, it seems that it is not important for the fund's return.

The Sharpe ratio for the total return is higher for the policy benchmark returns than for the actual returns, meaning that GPIF is doing slightly worse than their policy benchmark on a risk-adjusted basis. This is the same as for GPFG.

6.2.1.3.2 Public equities

The ratio indicates that active management adds value to the level of return from public equities. The R^2 of active management is 18 percent and the results show that it adds value and that this value is of some importance. Further, the excess calculations show an R^2 of 37 percent which further strengthens the importance.

The Sharpe ratio is significantly higher for the fund's actual return than for its policy benchmark return. This means that the fund does better than their policy benchmark both in absolute terms and on a risk-adjusted basis. This result is of importance, as public equities offers the most homogenous sample, and thus it is most difficult to generate returns above beta in this asset class.

6.2.1.3.3 Fixed income

For fixed income, we see that the active management adds value to the returns. However, similar to the total fund returns, the R^2 of 2 percent shows that it is of low importance. The Sharpe ratio is higher for the fund's actual returns than for the policy benchmark returns.

6.2.2 Market timing and security selection

As mentioned, active management is comprised of both market timing and security selection and we try to identify which of the two that weakens or strengthens active management. Before we can present the results, we again need to clarify our calculations and assumptions.

Equation (9) below is another variation of equation (1) presented earlier and is used in the same manner as equation (7) and (8). In the equation, subscript i again defines what asset class is used. We calculate the conditional return (CR) as the actual return ($R_{a,i}$) from public equities plus fixed income multiplied with their corresponding policy allocation ($W_{p,i}$). This is also done for PAI plus fixed income.

$$Conditional\ Return\ (CR) = \sum_i W_{p,i} * R_{a,i} \qquad (9)$$

Put simply, CR is what the total fund return would have been if the funds followed their given asset allocation policy precisely, but with their active security selection. Dividing CR by TR gives us a ratio judging the performance of the funds' market timing. Dividing PR by CR on the other hand, gives us a ratio for judging the performance of the funds' security selection.

Table 9 below gives the results of our calculations and shows how market timing and security selection separately adds or destroys value. The results from public equities plus fixed income are shown in box 1 and 2, and the results from including alternative investments are in box 3 and 4. Again, green boxes show where the component adds value, and red boxes where it destroys value.

	Equations	GPFG	CPP	GPIF
Market timing (1)	$\frac{CR_{tot}^{eq}}{TR_{tot,gross}}$	1,012	0,947	1,110
Security selection (2)	$\frac{PR_{tot}}{CR_{tot}^{eq}}$	0,947	0,946	0,948
Market timing (3)	$\frac{CR_{tot}^{PAI}}{TR_{tot,gross}}$	1,010	1,001	1,110
Security selection (4)	$\frac{PR_{tot}}{CR_{tot}^{PAI}}$	0,948	0,894	0,948

Table 9: How market timing and security selection contributes to the importance of active management

6.2.2.1 GPFG

From table 9 we see that security selection adds value, while market timing destroys value, which is the case for both variations. The differences between the variations (1 versus 3 and 2 versus 4) are negligible, which is to be expected as GPFG added real estate investments quite recently and the effect is not big enough to see any meaningful difference yet. From the results, we see that security selection adds more value than market timing destroys.

6.2.2.2 CPP

For CPP, the picture is quite similar as for GPFG although we see some small differences. Both market timing and security selection seems to be important factors in the fund's active management in public equities and fixed income. When including alternative investments, the market timing shifts to destroying value but the indicator is so close to 1 that it is not possible to give a definitive assessment. The differences between the variations (1 versus 3 and 2 versus 4) is greater than for GPFG. This is to be excepted as CPP has a lot more alternative investments.

6.2.2.3 GPIF

In the case of GPIF, it is quite clear that market timing destroys value while security selection adds value. We see some small differences between how much value is added and destroyed. There is no difference between the variations as GPIF have no PAI variable.

6.2.3 Discussion

The results presented above show that active management has added value to the level of the returns in total and per asset class for GPFG and CPP. For GPIF, active management has added value per asset class, but not in total. The reason for this must be because of unsuccessful market timing. Hence, the results indicate that two out of three funds are doing well in terms of active management. Sharpe (1991) stated that, in general and on average, market equilibrium removes the possibility for a fund to add value above their policy benchmark. He also postulates that because the market is defined as the aggregate of all investors, the average performance before costs must equal the average performance of the market. Hence, a fund's performance adjusted for costs should underperform relative to the market, on average. Our results seem to indicate that GPFG and CPP produce above average returns, while GPIF produces returns below average. It is important to note that it is not the scope of our thesis to give an answer in light of Sharpe (1991) or of the efficient market hypothesis. Our results do not give a definitive answer regarding the three funds' over or underperformance relative to the market. Rather, they provide an answer of whether the funds are beating their own policy benchmarks, and if each fund's active management adds value to their return.

6.3 Summary

Table 10 below contains a summary of the results from the level of return ratio combined with the corresponding R^2s and Sharpe ratio for all three funds and each asset class.

	GPFG	CPP	GPIF
	Ratio / R-squared / Sharpe	Ratio / R-squared / Sharpe	Ratio / R-squared / Sharpe
Total returns	Positive / Important / Worse	Positive / Some importance / Better	Negative / Low importance / Worse
Public equities	Positive / Some importance / Better	Negative / Low importance / Worse	Positive / Some importance / Better
PAI	Positive / Some importance / Better	Positive / Some importance / Better	N/A
Fixed income	Positive / Low importance / Worse	Positive / Important / Better	Positive / Low importance / Better

Table 10: Summary of results

Positive = Active management adds value in absolute terms

Negative = Active management destroys value in absolute terms

Low importance = R^2 between 0 – 15

Some importance = R^2 between 16 – 30

Important = R^2 of 31 +

Better = Sharpe ratio actual return > Sharpe ratio policy return

Worse = Sharpe ratio actual return < Sharpe ratio policy return

7 Conclusion

Our main results on return decomposition is that market movements on average account for 80 percent of return variance. Further, asset allocation policy and active management both significantly improve the explanatory power of total return variance, with equal importance between the two components. These results are in line with previous literature, and are now also proved for government pension funds. For two out of three funds, active management adds value to the level of return, while for one fund it does not. Below we will give conclusive remarks for each fund, and then present the most efficient portfolio based on our research.

GPFG has a strict governance structure and NBIM's mandate restricts them from deviating a lot from the global market. We confirm this by the high explanatory power of market movements to the fund's total return variance. Although NBIM is subject to limitations to their investment strategy, they have successfully managed to develop a high performing fund. Their active management in total prove to add value to the level of return in excess of their benchmark for each asset class. Separated, market timing contributes negatively, while security selection outweighs this by being more positive. Active management is also important in explaining volatility in total fund returns. However, we argue that the strict asset allocation policy limits the opportunity to explore a broader universe of asset classes and to increase the share of actively managed assets. Hence, the fund lacks the possibility to have an asset allocation policy that seeks diversification effects and reap factor risk premiums. Both of which could increase return within the given level of risk, as discussed in context of the MPT. NBIM states that risk-adjusted return is of severe importance, however we find that the fund has a worse trade-off between risk and return than their policy benchmark. Because their policy benchmark is created to pursue beta returns, it does not improve explained return variance above the market.

The independent management of the CPP forces the CPPIB to limit their own allocation measures, investment strategy and benchmarking. Their mandate is to manage the pension fund assets with a vision of achieving a maximum rate of return without an unnecessary risk of taking losses. CPPIB follows a model where all their active choices are measured against a policy benchmark stating the fund's risk profile. We find that the contribution of their asset allocation policy is of great importance in explaining total fund return variance. This, combined with market movements being less important than for GPFG, indicates that CPPIB is able to manage a portfolio with improved features than the global market. These features are results of their multi-asset class style, creating positive diversification effects, and professional management. Moreover, though explaining less of return variance than asset allocation policy, their active management proves to add value to the level of return, also risk-adjusted. Here, we find that both market timing and security selection contributes positively.

GPIF offers a third governance structure that lies somewhat in between GPFG and CPP. With the Ministry of Health, Labor and Welfare setting instructions on fund objectives and statement of operations, the fund manager is left with less control in terms of their active decisions. When studying GPIF, we discover that the fund, with its significant share of domestic assets, is managed very differently than the global market. Market movements explain less than two thirds of the fund's total return variance. Therefore, asset allocation policy captures the bulk of volatility resulting from market deviation. Even though

GPIF is permitted to deviate from their asset allocation policy and seek excess return, we find that, based on the low importance of active management, they do not. This has been good for GPIF as our results indicate that the small share of active management negatively impacts the level of returns compared to their policy benchmark, and with a worse risk-return relationship. As discussed, security selection contributes positively while market timing outweighs this by being more negative. Hence, GPIF was better off following their passive policy allocation than deviating from it.

Our findings are important for fund managers as they could help determine where to focus the resources. As mentioned, the funds' performance is not directly comparable because of their different mandates and objectives. We are interested in what a fund manager can contribute on top of the market and a given asset allocation policy. We find that CPP adds the most value above their policy benchmark, both in absolute and risk-adjusted terms. The return decomposition also proves that they differ significantly from the market, highlighting the importance of active management versus passive only. Resulting from their independent governance structure and use of several asset classes, we conclude that CPP has the most efficient portfolio.

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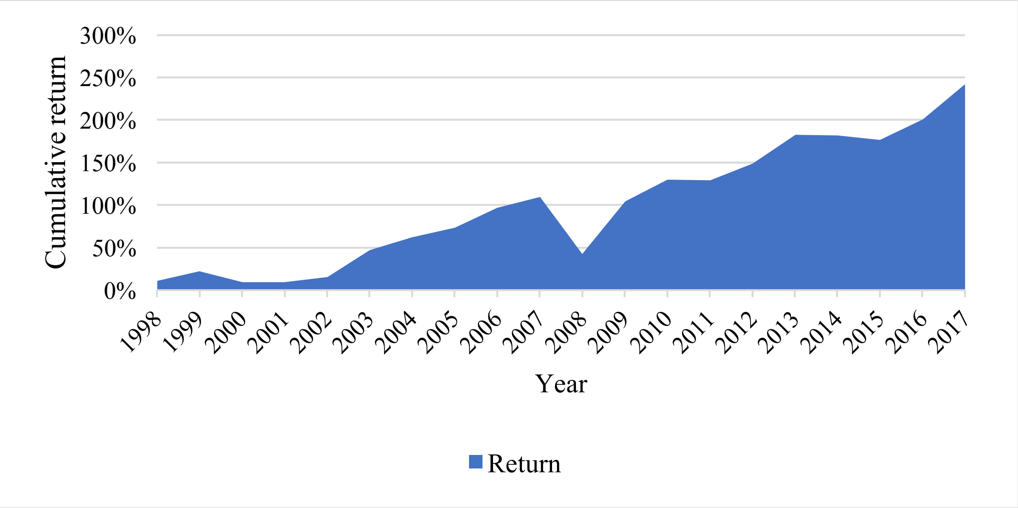
Appendix

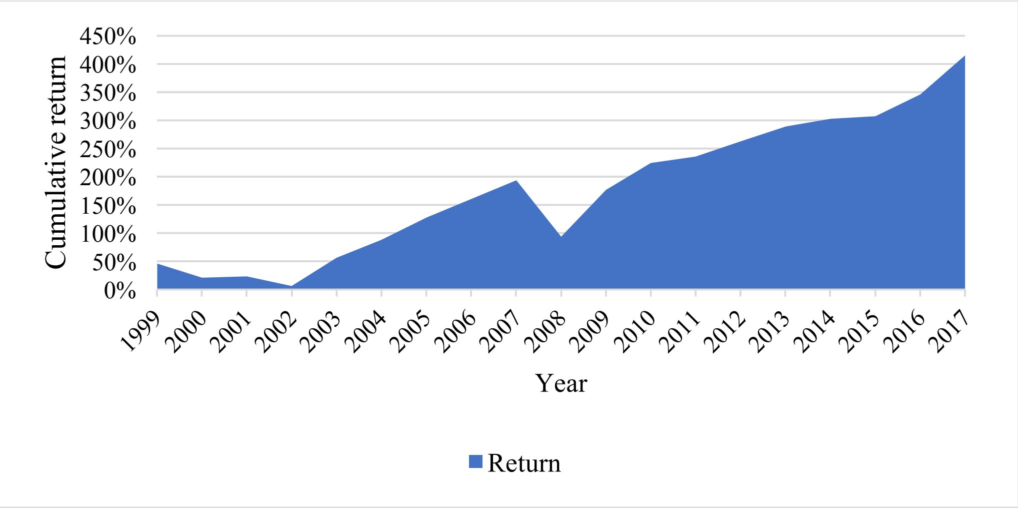
Appendix 1

This shows the cumulative returns for the GPFG, CPP and GPIF.

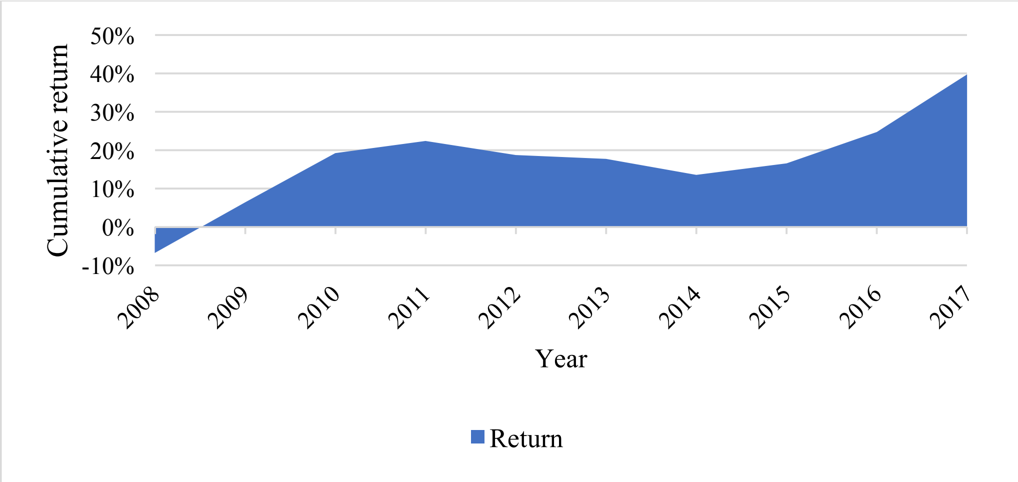
Cumulative returns for GPFG



Cumulative returns for CPP



Cumulative returns for GPIF



Appendix 2

R^2s from split sample, before and after the financial crisis (yearly data)

Data: Yearly, splitted sample		GPFG	CPP	GPIF	Average
Asset: Total fund **Market weights:** 55,5/44,5 **Sample:** Post financial crisis	Market movements	1,00	0,98	0,58	0,85
	Policy allocation	0,54	0,83	0,13	0,50
	Active management	0,83	0,20	0,07	0,37
	Interaction effect	-1,37	-1,01	0,22	-0,72
Asset: Total fund **Market weights:** 64,4/35,6 **Sample:** Pre financial crisis	Market movements	0,88	0,86	N/A	0,87
	Policy allocation	0,28	0,84	N/A	0,56
	Active management	0,05	0,31	N/A	0,18
	Interaction effect	-0,21	-1,01	N/A	-0,61

R^2s from split sample, before and after the financial crisis (quarterly data)

Data: Quarterly, split sample		GPFG	GPIF	Average
Asset: Total fund **Market weights:** 55,5/44,5 **Sample:** Post financial crisis	Market movements	0,98	0,35	0,67
	Policy allocation	0,62	0,06	0,34
	Active management	0,65	0,03	0,34
	Interaction effect	2,25	0,44	1,35
Asset: Total fund **Market weights:** 64,4/35,6 **Sample:** Post financial crisis	Market movements	0,80	N/A	
	Policy allocation	0,12	N/A	
	Active management	0,07	N/A	
	Interaction effect	0,01	N/A	