Mutual fund performance in the Swedish premium system

Beyond the mean-variance framework

Rasmus Håkansson

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Supervisor: Thomas Fischer

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Abstract

This paper presents an evaluation of the Swedish pension system, using performance measures that accounts for higher moments of the distribution. The aim of this study is to analyze the relationship between the classical Sharpe ratio and more sophisticated measures, while specifically focusing on the outcome of the default fund in the system. These additional measure consists of the ASSR which accounts for relative skewness preference and the GR which is based on the Gini coefficient as the method for measuring risk. This is accomplished by calculating various ratios for all funds with a PPM history dating back to at least 2010 and dividing them into subcategories in order to get a more accurate representation of fund performance within a certain category. The default fund is then benchmarked against its own category and against all other equity funds in the sample. Correlation between measures is determined by firstly assigning ranks to each performance measure and secondly calculating the rank correlation using Spearman's rho. For the data set used in this study, the results show that the default fund meets its explicit goal of achieving a long term return at least as good as the average of all PPM-funds, given its level of risk. The highest rank correlation is seen between the SR and the ASSR while the lowest correlation is seen between the SR and the GR, a result which fits perfectly in line with what we would expect in theory.

Contents

1 Introduction

1.1 Background

Ensuring effective management of a nation's pension funds is an increasingly important task for most of the countries in the West. This is also true for Sweden whom faces the demographic challenges associated with an aging population. After deliberations between all larger parties, the Swedish pension system was reformed in 1999 and government officials decided to increase the individual autonomy in the system with regards to portfolio choice and introduced the PPM-system. However, an expansion of the system also calls for comprehensive transparent information given to investors in order to increase the likelihood of agents making well informed decisions. This brings us on to the need for theoretically sound and coherent methods for measuring and evaluating portfolio performance.

Modern portfolio theory has been largely influenced by Markowitz (1952) mean-variance framework and later extensions of this model resulted in the widely used CAPM model, proposed by Sharpe (1964), Lintner (1965) and Mossin (1966). The original model takes the form of a utility optimization problem where the investor attempts to strike the perfect balance between expected return and risk as measured by the variance in returns. One of the most commonly used measures for measuring portfolio performance, the Sharpe ratio, is directly derived from Markowitz's model. It is based on the underlying assumption of normality in return distribution or that the investors exhibit preferences which can be represented by a quadratic utility function. Therefore, it is only valid when either of these restrictive assumptions hold and this is largely the main criticism of the model. Empirical studies show that returns generally deviate from normality (Agarwal and Naik 2004; Brooks and Kat 2002) and the assumption of quadratic utility is called into question since this implies that investors do not differentiate between upside risk and downside risk. As a consequence of the simplifying assumptions, the Sharpe ratio can sometimes lead the analyst astray with unwarranted conclusions and apparent paradoxes (Hodges 1998). The limitations of the Sharpe ratio has therefore led researches to exploring alternative methods of measuring performance which allows for deviations from the normal distribution albeit remaining its consistency with expected utility theory. Some of the suggestions include the semi-variance (Markowitz 1959), Gini's mean difference (Yitzhaki 1982, 1983) and ratios adjusted for higher moments in the distribution (Hodges 1998; Zakamouline and Koekebakker 2009).

These measures are generally not brought to the public's attention and investors within the PPM-system mainly rely on the Sharpe ratio as a decision rule for choosing among a vast amount of funds. Therefore, I thought it would be interesting to explore some of these more sophisticated measures and see how well they connect with the standard Sharpe ratio. Given the fact that a great number of people passively have chosen to remain in the state default fund I also thought it would be interesting to see how well it stacks up to the other funds in the system.

1.2 Thesis objective and contribution

The objective of this study is to evaluate the funds in the PPM-system using both classical and more sophisticated methods of measuring performance and to determine how well the ranking is preserved between these measures. This relationship is examined using a rank correlation matrix where the correlation between different measures is determined by the observed shifts seen in the ranks assigned.

Furthermore, it aims to provide a comprehensive analysis regarding the outcome of the default option relative to the other funds in the PPM-system. This paper intends to make two major contributions to the existing literature. Firstly, it aims to evaluate the funds in the Swedish pension system, thereby increasing the amount of information available to investors. Secondly, it builds on the vast number of studies exploring performance measures that account for higher moments in the distribution.

1.3 Outline

The rest of the paper is organized as follows. In section **2**, a general summary of the Swedish PPM-system is presented. The implications related to configuration of the pension system and its effects on measuring fund performance is also presented in this section. Section **3** offers some insights to previous research and examines related papers with regards to the methodology. Section **4** contains the theoretical background for the thesis. Section **5** offers an overview of the performance measures I intend to use in the analysis coupled with a statistical background regarding higher moments of the distribution since this is a prerequisite for understanding the more advanced performance measures. Section **6** describes the data set and explains the methodolgy employed in this paper, coupled with a brief examination of statistical issues related to the sample selection process.. Section **7** presents the empirical results and the analysis. The last section is dedicated to conclusions drawn from the analysis and suggestions for future research.

2 A brief overview of the Swedish pension system

The Swedish pension system is comprised of three main parts and is commonly illustrated as a pyramid. The three parts are the private pension, the occupational pension and the state pension. The private pension consists of any personal savings put away for retirement and is depicted at the top of the pyramid in the figure below. The occupational pension is provided for you by your employer and neither of these two top parts are compulsory. The state pension is the foundation of this system, governed by the national pension authority. This overview will focus on the Swedish state pension. For more information regarding the other parts please follow the link: www.pensionsmyndigheten.se/forsta-din-pension/sa-fungerar-pensionen/pensionens-alla-delar

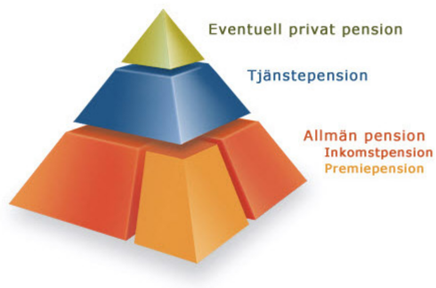

Figure 1: Pension pyramid

Each year, 18.5 % of an employee's salary is set aside for the Swedish state pension. 16 % out of the 18% is reserved for the income pension, while 2.5 % can be allocated freely within what is known as the PPM-system. In this system, an individual can choose among a vast number of funds with the restriction of simultaneously holding a portfolio containing a maximum of 5 funds. There are no major transaction costs for buying and selling funds, except for a small administrative fee equal to the running costs of managing the system. For 2016, this cost was equal to around 0.07% for an average sized account. Furthermore, investors within the system receive large discounts on fund fees, approximately equal to 2/3 of the original fee and PPM-savers therefore enjoy an additional 15 % return, on average. Technically, the discount is given by the PPM-funds to the pension authority and later distributed to savers according to the holdings of each individual's the previous year. The size of the discount is determined by the total amount invested in a fund. The pension authority receives a greater discount with a higher proportion of all saver's capital invested in a particular fund. Prior to 2015 there were no restrictions regarding how high these fees could be after the discount but now there is a ceiling of 0.89% for equity funds, 0.62% for balanced funds and 0.42% for bond funds. If you refrain from choosing any of these funds, your savings will be automatically placed in the Swedish state owned alternative, AP7 Såfa. For the interested reader, a more detailed description regarding the structure and investment strategies of the AP7 is given in appendix in section **9**.

3 Previous studies

In this section previous research is discussed related to the research question and the methodology employed in this paper. I will begin by providing a review of previous studies followed by a review of similar research articles with regards to methodology and performance measuring for mutual funds

3.0.1 Evaluation of the PPM-system

Although the Swedish pension system has stirred up a lot of controversy in recent years, the literature on the topic consists of only one study where the performance of funds within the PPM-system is examined. In this study, Jakobson and Lundgren (2009) attempts to evaluate the performance of AP7 (named Premiesparfonden at the time) relative to the other funds in the system. This is accomplished both through mean-variance analysis and CAPM-analysis with modifications to the original model to account for utility losses associated with varying degrees of risk aversion. The AP7 turns out to be one of the most efficient funds and the authors conclude that there are strong reasons to believe that investors actually are better off sticking to the default alternative. However, although the research question is similar to mine there are substantial differences when it comes sample selection and the overall approach.

3.0.2 Measuring performance

With regards to methodology this thesis is closely linked to a study from Zakamouline and Koekebakker (2009) where different hedge fund categories are evaluated based on performance measures accounting for higher moments in the return distribution. The implications of using the Sharpe ratio as a decision rule when distributions are non-normal, or when investors have preferences for skewness are examined in this paper. The authors develop an adjusted Sharpe ratio where the skewness of the distributions is taken into account based on approximations of investor's relative preferences for skewness and this measure is directly applied in the analysis for this thesis.

This paper also draws inspiration from Yitzhaki (1982) paper on bridging the gap between models based on the concept of stochastic dominance (SD) and models based on the mean variance framework. Stochastic dominance approaches to portfolio selection usually results in more coherent results but it is much more complicated to model in practice. Therefore, the author develops a performance measure which aims to strike a balance between applicability and consistency with SD based on a measure of risk called Gini's mean difference. A simple overview of the performance measures employed in this paper is also found in a survey by Caporin et al. (2014)

4 Theoretical background

This section serves as a introduction to the most important theories within financial economics for which this thesis is founded upon. I will begin by examining the mean-variance framework and the concept of stochastic dominance before moving on to the characteristics of utility functions commonly used in finance. It is paramount to have a basic understanding of these functions since the models for portfolio evaluation used in this thesis is based on risk averse individuals maximizing their utility by choosing the optimal portfolio.

4.1 Mean-variance framework

In a seminal paper from 1952 on portfolio selection, Markowitz (1952) laid the foundation for how modern portfolio theory is structured today. The framework is especially relevant to this thesis since it provides a simple way of ranking fund performance and the methodology employed in this paper can be seen as extensions of this original model. The model can be thought of as a quadratic utility maximization problem where variance represents the risk of the assets and the mean represents expected returns. The idea behind the model is that a rational investor should aim to maximize his utility by maximizing expected return of a portfolio, given a certain level of risk. The relationship between return and risk for different assets is usually depicted in a mean-variance diagram with risk on the horizontal axis and expected returns on the vertical axis. By varying the weights of different assets in this mean-variance space we can find the portfolio with the overall lowest variance by solving the following optimization problem:

$$\text{Min} \quad \sigma_p^2 = X_A^2\sigma_A^2 + X_B^2\sigma_B^2 + 2X_AX_B\sigma_{AB} \qquad \text{s.t} \sum_{i=1}^{n} \tag{1}$$

where the expression for variance is a simplification of the general minimization problem when only two assets are available. All portfolios which lie above this minimum variance portfolio form the efficient frontier and these portfolios are unique in the sense that they provide the highest expected return given a certain level of risk. Portfolios and assets located under the efficient frontier are therefore inferior alternatives since it is possible to achieve higher expected returns without increasing the risk. By combining the optimal portfolio on the efficient frontier with the risk free asset we find the Capital Allocation Line (CAL). The optimal portfolio is tangent to the CAL with the steepest angle possible in the mean-variance space:

$$CAL = \text{Max} \quad \frac{E(r_p) - r_f}{\sigma_p} \tag{2}$$

The model is depicted below where the concepts of efficient frontier and the CAL are illustrated:

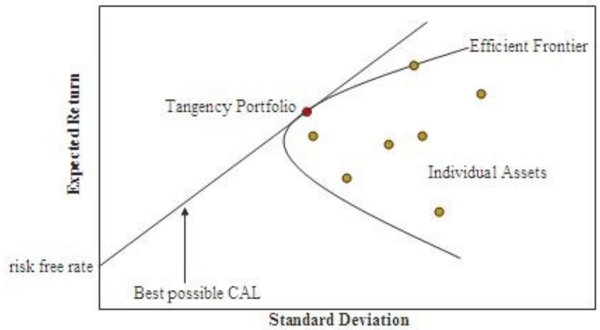

Figure 2: Mean-variance diagram

4.1.1 Criticism of the mean-variance framework

Although the model has been a major influence in the development of finance theory, it is a highly simplified model which only holds true under certain restrictive assumptions. Critics argue that the notion of a portfolio that can be adequately represented by its mean and variance leads to a problem known as estimation risk. This problem arises when estimated parameters are treated as if they were true, although the underlying distributions of asset returns generally are not known (Bawa et al. 1979). Accounting for estimation risk can lead to entirely different choices for the optimal portfolio since the parameters are incredibly sensitive to even slight variations in expected returns. In an empirical study from Ceria and Stubbs (2006), the consequences for ignoring estimation risk are demonstrated. Portfolios constructed using a robust estimation of expected returns consistently outperform classical optimization in the study, possibly due to the fact that assets with positive estimation errors typically are over weighted. Correlation between true expected portfolio returns and expected returns implied by portfolio alphas is therefore smaller in the classical case and the investor may sometimes be better off holding onto a sub optimal portfolio, instead of changing portfolios based on classical optimization. Criticism of the mean-variance framework can also be extended to the Sharpe ratio which is directly derived from this model. Apparent paradoxes and problems related to this performance measure is examined in greater detail in section 5.2

As previously stated, ranking based on the mean variance framework does not always end in satisfactory results. As a response to the limitations of the model, other models have been proposed whereas one of the more influential ones is based on the concept of stochastic dominance

4.2 Stochastic dominance

The intuition behind stochastic dominance and its proposed solution to the drawbacks of Markowitz models can be easily grasped through a simple example, as illustrated by Danthine and Donaldson (2015). Consider an investor whom faces the decision of choosing between two risky prospects:

Table 1: FSD stochastic dominance

Payoffs	**10**	**100**	**2000**
Pr(X_1)	0.4	0.6	0
Pr(X_2)	0.4	0.4	0.2
		E(X_1) = 64	$\sigma_{X_1} = 44$
		E(X_2) = 444	$\sigma_{X_2} = 779$

Note that it is not possible to rank the prospects in this case using mean-variance analysis since X_2 has the greater mean but X_1 has the smaller variance. Despite this fact it is clear that X_2 actually is the superior alternative. In terms of payoffs it at least matches investment 1 and has a positive probability of exceeding it. By plotting the investments respective cumulative probability density functions we see that the first investment lies below and to the right of the first investment. This is indicative of first order stochastic dominance which holds true if:

$$F_1(x) \leq F_2(x) \text{for all x in the interval [a,b]} \tag{3}$$

where $F(x)$ is the cumulative probability density function for investment 1 and 2 respectively. The theorem states that the area beneath the CDF-curve must be smaller for all payoffs if investment 1 first order stochastically dominates investment 2. However, FSD stochastic dominance is an extremely strong condition and ranking based solely on this concept generally leads to incomplete rankings. In this case one can resort to a less restrictive condition, second order stochastic dominance (SSD), which explicitly compares CDF:s of different prospects. We say that investment 1 SSD investment 2 if the following condition is fulfilled:

$$\int_{-\infty}^{x} [F_2(t) - F_1(t)]dt \geq 0 \text{for any x} \tag{4}$$

The different forms of stochastic dominance are illustrated in a picture below where the CDF:s for two different assets are mapped out and compared:

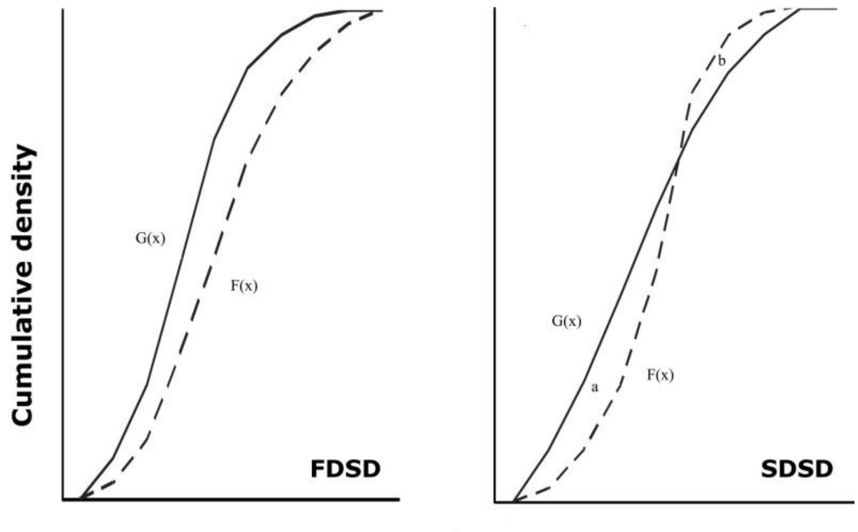

Figure 3: Stochastic dominance

4.3 Risk aversion and utility functions in finance

One important assumption in expected utility theory is that agents are risk averse and want to be compensated for the risks they are taking. Although the assumption of risk aversion is reasonable in finance, a more difficult task lies in determining the degree of that risk aversion and how it changes with increases or decreases in wealth. Based on the underlying utility function we can derive the degree of absolute- and relative risk aversion, using a measure famously proposed by Pratt (1964) and Arrow (1965):

$$R_A(w) = -\frac{U``(w)}{U`(w)} \tag{5}$$

$$R_R(w) = -\frac{U``(w)}{U`(w)}w \tag{6}$$

where w denotes initial wealth, $U``$ and $U`$ represents the first and second derivative of the utility function and R is the level of risk aversion. Investors are split up into different groups depending on how the function for risk aversion behaves over increases in total (or relative) wealth. The utility functions commonly used in finance can all be categorized as different forms of Hypebolic Absolute Risk Aversion. HARA utility is given by:

$$U(w) = \frac{\rho}{1-\rho}\Big(\frac{\lambda w}{\rho} + \theta\Big)^{1-\rho} \tag{7}$$

Where λ is a measure for absolute risk aversion, ρ denotes relative risk aversion and θ is a constant. When $\rho = -1$ the expression simplifies to the quadratic utility form implied by the mean-variance framework. Quadratic utility functions exhibit Increasing Absolute Risk Aversion (IARA) which is a controversial assumption for portfolio selection since this implies that agents will decrease the total dollar amount invested in a risky asset as their wealth increases. Constant Relative Risk Aversion (CRRA) is obtained when $\theta = 0$ and $\rho > 0$ and the equation converges to Constant Absolute Risk Aversion (CARA) when $\Theta = 1$ and $\rho \Rightarrow \infty$.

The HARA possesses some interesting properties making it especially suitable for finance purposes. As shown by Cass and Stiglitz (1964), the two-fund separation theorem holds if all investor share the same HARA function. The implication is that all investors will choose the same combination of the risk free asset and the market portfolio, regardless of how rich they are, which ties in to the assumption behind modern portfolio theory where investors have homogeneous expectations and access to the same information. Zakamouline and Koekebakker (2009) prove that for HARA utility, preference for higher moments in the distribution is given by:

$$b_n = \frac{\Pi_{k=1}^{n-2}(\rho + k)}{\rho} \tag{8}$$

where b_3 is the investor's relative preference for the nth moment of the distribution and ρ denotes relative risk aversion. Since investors represented by a quadratic utility function have no preferences for moments higher than the second it is clear that $b_3 = 0$. For $n = 3$ we note that relative skewness preference is given by:

$$b_3 = \frac{\rho + 1}{\rho} \tag{9}$$

When we let $\rho \to \infty$ the investor (CARA) exhibits rather small preferences for skewness and as ρ gets closer to 0 (CRRA) the investor greatly appreciates positive skewness and greatly dislikes negative skewness. The implications of HARA utility with regards to skewness preference will be important when introducing the adjusted Sharpe ratio (ASSR) in section 5.3.

5 Overview of performance measures

This section provides a theoretical overview of the performance measures used in this thesis. The statistical properties of return distribution is firstly examined in order to increase the understanding and intuition behind some of these measures. This is followed by an overview of the most commonly used performance measure, the Sharpe ratio, before moving on to more sophisticated measures which can be seen as extensions or modifications of the original Sharpe ratio.

5.1 Higher moments of distribution

One main disadvantage of the Mean-Variance framework is the assumption that assets can be fully described by its mean and variance. The framework is therefore only valid when returns are normally distributed returns or when the investor have no preferences for higher moments of distribution. Intuitively investors should care about the mean and standard deviation but they should also care about other relevant aspects of the distribution, such as the prevalence of fat tails and the skewness of the distribution. Therefore, it is important to go through the implications of higher moments as it relates to portfolio choice.

5.1.1 Skewness

Skewness is a measure which describes the asymmetry of the distribution around its mean and is more commonly known as the third moment. For a normal distribution the skewness is zero since it is perfectly symmetrical and it is mathematically defines as:

$$E\{(Y-\mu)^3\} \tag{10}$$

In portfolio theory it is argued that an investor should favour assets with positive skewness since returns far above the mean are more likely than returns far below the mean (source). The situation is displayed below for a positively skewed distribution. (see Bodie et al. 2011)

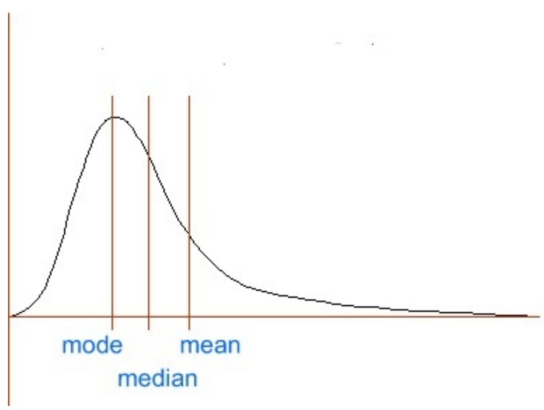

Figure 4: Positive skewness

As we can tell from this picture the distribution is drawn to the right since the tail is considerably longer at that end. This indicates that there is some possibility of drawing a very large number from the random variable, although most observations will be smaller compared to a normal variable which share the same mean and variance.

5.1.2 Kurtosis

Kurtosis on the other hand measures the "tailedness" of the distribution and is also known as the forth moment. Kurtosis is equal to 3 for any univariate normal distribution and it is common to subtract three to arrive at what is known as excess kurtosis. Mathematically kurtosis is defined as (see Bodie et al. 2011):

$$E\{(Y-\mu)^4\} \tag{11}$$

Below is a picture for a distribution with fatter tails than that of the normal distribution:

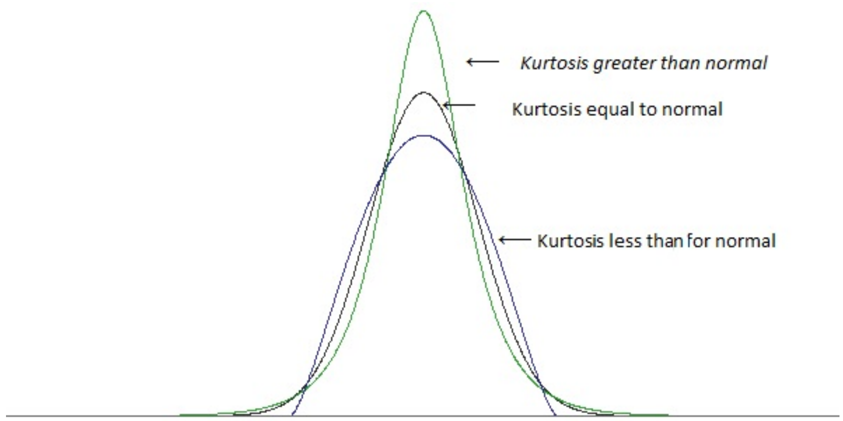

Figure 5: Kurtosis

From this picture we see that the distribution with the greatest kurtosis has a higher peak and the tails are considerably longer which is indicative of a distribution with high kurtosis.

5.2 Sharpe ratio

The Sharpe ratio is one of the most well-known performance measures in finance and has since its introduction in 1966 served as a way of ranking different portfolios. It is entirely based on the mean-variance framework and can be interpreted as a measure for calculating expected excess return per unit of risk. More specifically, it is defined as:

$$\frac{E[R_p]-R_f}{\sigma_p} \tag{12}$$

One benefit of the Sharpe ratio is the simplicity of it, but this is also one of its main disadvantages. As shown by Goetzmann et al. 2007 the Sharpe ratio is prone to manipulation which can be achieved by levering or delevering the portfolio accordingly based on past returns. A simple example from (source) will serve as a demonstration for how the Sharpe ratio might be manipulated in practice:

Consider a hedge fund manager that in the past experienced a higher than expected mean excess return of x_h for the time period γ, resulting in a higher than anticipated Sharpe ratio S_h. By delevering the portfolio for the future time period $1 - \gamma$ thereby achieving a lower mean excess return $x_f < x_h$ the fund manager can now lower the overall standard deviation, $\sigma_f < \sigma_h$ in the portfolio. This will cause past performance to weigh more heavily which will maximize the resulting Sharpe ratio. The same strategy in reverse can be applied for the time period $1 - \gamma$ if past returns are poor for the fund.

As shown by Hodges 1998, ranking funds based on the Sharpe ratio when the distributions of returns are non normal can also lead to apparent paradoxes. This problem is highlighted by looking at two return distributions:

Table 2: Sharpe paradox

X_1	-25	-15	-5	5	15	25	35		
X_2	-25	-15	-5	5	15	25	45		
Pr(X)	0.01	0.04	0.25	0.4	0.25	0.04	0.01		
μ_1	**5**			σ_1	**10**			Sharpe$_{X_1}$	**0.5**
μ_2	**5.1**			σ_2	**10.34**			Sharpe$_{X_2}$	**0.493**

From this table we clearly see that X_2 is the superior distribution for any rational investor under the reasonable assumption of non-satiation. The returns are equally good for all states except for the worst one where X_2 delivers larger returns. However, despite this fact the Sharpe ratio is still greater for X_2 and using the Sharpe ratio as a decision rule would lead to a mistake in this case. The greater returns does not make up for the increased upside risk which followed as a result of the greater returns and so the overall Sharpe ratio is greater for X_1. This is also a perfect example of first order stochastic dominance, previously discussed in section 1.

5.3 Adjusted for Skewness Sharpe Ratio

The criticism regarding higher moments previously discussed can be extended to the Sharpe ratio since it is directly derived from the Mean-Variance framework and subject to the same problems. As shown by Goetzmann et al. 2007 the Sharpe ratio can be easily manipulated, mainly by selling the upside return and creating a distribution with a negative skewness. Several attempts have been made to create a Sharpe ratio that accounts for more than just the mean and standard deviation. One of the suggestions is the Adjusted for Skewness Sharpe Ratio (ASSR), developed by Zakamouline and Koekebakker 2009. The intution behind the ASSR is that investors should value positive skewness and the ASSR therefore increases when skewness is postive and decreases when skewness is negative. When the distribution is normal, or when the investor have no preferences for skewness the ASSR simplifies to the standard Sharpe ratio. The ASSR is defined as:

$$ASSR = SR\sqrt{1 + b_3\frac{Skew}{3}SR} \tag{13}$$

ASSR can also be interpreted as the standard Sharpe ratio times an adjustment factor:

$$SAF = \sqrt{1 + b_3 \frac{Skew}{3} SR} \tag{14}$$

From equation 14 it is clear that the SAF is dependent on three factors:

1. The relative preference factor b_3, determined by the underlying utility function.
2. The skewness of the distribution. Higher skewness raises the adjustment factor.
3. The size of the Sharpe ratio. A higher Sharpe ratio results in a higher SAF.

For certain asset distributions it might not be possible to define the ASSR based on the definition in equation 13. This problem might arise when the SAF turns out to be a negative number, which can be a result of negatively skewed returns coupled with either a high b_3, a high Sharpe ratio or a combination of all the factors which determine the SAF.

5.4 Gini mean difference

The Gini coeffient was first introduced in 1912 and is primarily used in the economic field of measuring income and wealth distribution. It is derived from what is known as the Lorentz curve, where the wealth belonging to certain percentiles of a nation's citizens is mapped against the wealth of the nation as a whole. In this sense the Gini coefficient is a statistical measure of dispersion used to represent the equality or inequality in wealth distribution seen in the Lorentz curve (see Cowell 2011). The application for a performance measure based on the Gini coefficient for financial purposes was first suggested by Yitzhaki 1982 and relates to its consistency with second order stochastic dominance (SSD). Ranking based on SSD is a popular method for evaluating risky prospects since it is consistent with utility maximization for risk averse individuals. As opposed to the mean-variance framework, GMD does not require normality of returns or quadratic utility preferences, thereby making it applicable for all probability distributions and for all utility functions that exhibit risk aversion (see Ji et al. 2017). Following Yitzhaki 1982 Two necessary conditions must be fulfilled in order for portfolio F to be preferred over portfolio G:

$$a) \qquad \mu_F \geq \mu_G \tag{15}$$

$$b) \qquad \mu_F - \Gamma_F \geq \mu_G - \Gamma_G \tag{16}$$

where μ is the mean and Γ is the Gini's mean difference defined as (see Saghir et al. 2012):

$$GMD = \frac{2 \sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j|}{n(n-1)} \tag{17}$$

In turn, the Gini coefficient is defined mathematically as half of the relative mean absolute difference between any two observations:

$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j|}{2 \sum_{i=1}^{n} \sum_{j=1}^{n} x_j} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j|}{2 \sum_{i=1}^{n} x_i} \tag{18}$$

where the numerator denotes the absolute difference and the denominator denotes the arithmetic mean. The Gini coefficient ranges from 0 to 1, depending on the ”equality” or ”inequality” of the distribution where 0 represents perfect equality and 1 represents perfect inequality. For portfolio applications the Gini coefficient can be thought of as a measure of risk. In a survey of performance measures by Caporin et al. (2014), the resulting Gini ratio is defined as:

$$Yi_p = \frac{[E(r_p) - r_f]}{G_p} \tag{19}$$

The Gini ratio is a performance measure similar to the Sharpe ratio in the sense that they both are normalized measures where expected return is bench marked to total risk using a statistical measure of dispersion. As previously mentioned, the benefits of the Gini ratio are its applicability varying utility functions and probability distribution and the fact that it does not rely on restrictive assumptions.

6 Thesis data and methodology

This section examines the data sample and describes the overall approach to the thesis with regards to methodology. A brief discussion covering survivorship bias is also presented in this section.

6.1 Thesis data

All data for individual funds are retrieved directly from the Swedish pension authority. The data consists of daily closing NAV-courses, quoted in the Swedish krona, not adjusted for dividends or discounts applicable to pension savers. Since all NAV-courses are quoted in the Swedish crona, funds investing in foreign assets are subject to the currency effects that follows from changes in exchange rates Dividends are collected separately from the pension authority along with data on fees for which the average yearly discounts applicable to each fund are derived. The 3-month Swedish treasury bill is used as a proxy for the risk free rate and is collected from SCB (the Statistical Central Bureau).

6.2 Sample selection

All funds categorized as a PPM-fund as of the end of 2016 are included in the sample, conditional on a PPM-history dating back to at least 2010. As of July

2017 a pension saver can choose among 838 funds but only 455 funds survived the sample selection process. This results in about 800 000 total observations over the time period 2010-2016. The rational behind choosing the specific time period is based on two main reasons. Firstly, the only study remotely similar to this one (Jakobson and Lundgren 2009) was conducted in 2009 and in a sense I am finishing where they left off. Secondly, the default fund had a reorganization in 2009 and it is therefore interesting to solely analyze the performance under this new umbrella.

Since the number of funds in the sample is rather large, they are split into different categories later in the analysis based on the type of assets traded (equity or fixed income instruments) and the "geographic" location of the fund. Some funds in the sample are categorized as pension funds or "generation funds" where the number of years left to retirement generally determines how much of the total portfolio is invested in equities. The mixed funds can be further split up based on the ratio of equities to bonds invested:

1. Careful fund with 1/3 invested in equities
2. Balanced fund with approximately 1/2 invested in equities
3. Aggressive fund with 2/3 invested in equities

As a start, I will include all pension funds in the mix funds category. The largest category in the sample is the fixed income category which constitutes around 15% of the total sample, followed by the mixed funds which make up around 13%. However, all the remaining funds can be included in a much broader category consisting of equity funds and by submerging all of these categories into one makes it the largest category by far, making up 72% of the total sample.

6.3 Survivorship bias

Considering the fact that only funds that survived the time period is included in the sample, the results may be suffering from a phenomena known as survivorship bias. Survivorship bias in the context of mutual fund refers to the overestimation of performance that follows from only including surviving funds in a data sample. Generally, the predominant reason for shutting down a fund, or merging it into other funds, is poor past performance and this bias must be taken into consideration when evaluating funds. The extent of this bias varies greatly in empirical studies. In a study Rohleder et al. 2010 done on the US market, the differences between unbiased and biased estimates, measured by Jensen's alpha is around 157 basis points for an average fund. When benchmarked against a passive index this is the difference between outperforming or underperforming the index on a risk adjusted basis.

6.4 Generating returns and statistics

The process of calculating returns for mutual funds is similar to how returns are calulated for individual assets. For mutual funds, returns are based on changes in the Net Asset Value (NAV) which is given by:

$$NAV = \frac{Assets - Liabilities}{\text{Number of outstanding shares}} \tag{20}$$

Liabilities include all costs related to managing the fund such as salaries to employees, utilities and other operational expenses. In this sense, investors do not pay for the costs explicitly through a bill but rather through the reduced value of the portfolio (Bodie et al. 2011). As a way to increase transparency, mutual funds usually quote the Total Expense Ratio which is the ratio of total costs to total assets:

$$TER = \frac{\text{Total costs}}{\text{Total assets}} \tag{21}$$

If an investor knows the market value of the fund it is also possible to calculate total expenses by multiplying the TER with total assets.

The rate of return is in turn measured as the increase or decrease in NAV plus dividends or income distributions of capital gains, expressed as a fraction of the NAV at the start of the holding period:

$$\text{Rate of return} = \frac{NAV_1 - NAV_0 + d_1}{NAV_0} \tag{22}$$

where d_1 are income and capital gain distributions incurred during period 1.

Logarithmic returns are calculated for all funds in the sample in excel using the formula:

$$R_{i,t} = \frac{ln(NAV_t)}{ln(NAV_{t-1})} \tag{23}$$

where NAV_t is the net asset value of fund i at time t. The rational for choosing logarithmic returns is primarily based on its interesting property with regards to compounding effects.. Logarithmic returns are compounded and so the sum of all daily returns is equal to the logarithmic return over that time period and this relationship does not hold for simple arithmetic returns. Excess returns are found by subtracting the 3-month treasury bill, using the following formula for quoting the risk free rate at a daily basis:

$$rf_d = \left[(1 + r_t)^{(1/365)}\right] - 1 \tag{24}$$

After each year, the dividends and average discounts for each fund is added back to the yearly returns. The yearly discount is calculated as the average of the discount at the beginning of the year and the discount at the end of the year, derived from differences in PPM-fees and TER-fees:

$$d_{i,t} = \frac{(TER_t - PPM_t) - (TER_{t-1} - PPM_{t-1})}{2} \tag{25}$$

where TER is the Total Expense Ratio and PPM is the fee applicable for pension savers after the discount. The excess returns are then annualized by dividing the total return by the number of years in the time period.

Next, summary statistics over the 7-year period are calculated using STATA in order to retrieve estimations for the standard deviation, skewness and kurtosis of each fund. The Gini coefficient is also calculated in STATA using a syntax which allows for separate estimates for different funds in a sample. Standard deviation is then annualized based on the 7-year estimation period of daily deviations. Annualized standard deviation is given by :

$$\sigma_{annual} = \sigma_{daily} * \sqrt{T} \tag{26}$$

where T represents the amount of trading days in a year, approximately equal to 250 for the sample at hand.

6.5 Calculating performance measures

6.5.1 Sharpe ratio

Sharpe ratios for all funds are calculated based on the annualized standard deviation and the yearly logarithmic excess returns after adding back discounts and dividends:

$$SR_i = \frac{\left[r_i + D_i + d_i\right] - r_f}{\sigma_{i,y}} \tag{27}$$

where r_i is the observed cumulative logarithmic return, D_i represents dividends and d_i the discounts related to fund i. After computing Sharpe ratios, a rank is assigned to each fund in the sample based on the outcome of the measure. The fund with the highest Sharpe ratio receives a rank of 1, the fund with the second highest score will receive a rank of 2 and so on.

6.5.2 Adjusted for Skewness Sharpe Ratio

The ASSR is calculated for all funds using equation 13 based on the yearly Sharpe ratios previously estimated. When computing the ASSR one must determine an underlying utility function consistent with expected utility theory. Furthermore, the chosen utility function directly determines the preference for skewness, b_3, and so we must find theoretically sound functions which assigns appropriate values to that factor as well. In this thesis, CRRA utility will be implictly assumed for reasons outlined by Goetzmann et al. 2007.

The next step is to find a reasonable approximation for the relative risk aversion and the estimates for this factor seem to be vary across studies. However I will follow the example of Zakamouline and Koekebakker 2009 and set $\rho = 30$, based on arguments originally made by Mehra and Prescott 1985. From equation 9 we see that this results in b_3 approximately equal to one. The ASSR then becomes:

$$ASSR = SR\sqrt{1 + 1\frac{Skew}{3}SR} \tag{28}$$

Somewhat of a paradox can be found in the relationship between higher preferences for skewness and relative risk aversion for investors exhibiting CRRA utility. For risk tolerant investors, the relative preference for skewness is higher compared to more risk averse investors which implies that risk averse investors care less about negative skewness. For example, using a relative risk coefficient equal to 30, which I intend to do, will result in a lower preference for skewness compared to a less risk averse agent with a relative risk coefficient of 2. However, the main reason for including the ASSR is to examine how portfolio selection changes for agents exhibiting skewness preference and so the validity of the underlying utility function is of secondary importance.

6.5.3 Gini ratio

The Gini coefficient found in equation (18) is computed for all funds in STATA using a syntax which allows for separate estimates for groups within the sample. The Yitzhaki Gini ratio is then calculated using the very same observed returns as for the Sharpe ratio:

$$GR_i = \frac{R_i - r_f}{G_{p,i}} \tag{29}$$

where R_i now is the observed logarithmic return after adjusting for dividends and discounts. Once again, a rank is now assigned to each fund based on the score from this performance measure.

6.6 Measuring rank correlation

After assigning a rank for each fund for all 3 performance measure, a rank correlation matrix is created in order to determine how well the ranking is preserved between measures. This is accomplished through calculating Spearman's rho, a measure of correlation which assesses the relationship between two variables using a monotonic function. Spearman's rho is typically used to determine the correlation between two variables when the exact cardinal numbers are irrelevant, but the ordinal ranking between them is important. Therefore, it is perfectly applicable for the variables in this thesis since the overall ranking of funds is the main interest. Spearman's rho is mathematically defined as the Pearson's rho correlation coefficient, only for ranked variables instead of cardinal ones:

$$\rho = \frac{cov(x_i, x_j)}{\sigma_{xi}\sigma_{xj}} \tag{30}$$

where x_i and x_j are ranked variables.

7 Results and analysis

The results in this section are based on daily data from 2010-2016 for all 455 funds in the sample. In the analysis I will distinguish between fixed income funds and equity funds since the two categories are substantially different from each other when it comes to returns and return distribution. It should be noted that the SR is quoted for the entire time period, as opposed to the annualized

Sharpe ratio used in the calculation of the ASSR. This consistent inconsistency, although confusing, have no bearing on the results since the Sharpe ratio itself is a monotonic function and so the ranking is preserved regardless of how we chose to express it. In other words, the interesting part is the interchanging of ranks and not the exact numerical differences between measures. For exact annualized Sharpe ratios, see section 9 With that said, let us move on to the overview of the analysis:

1. Summary statistics are presented for the first four moments of the return distribution for all equity funds. The purpose of examining the statistics is to get a better feel for the data and to discover patterns which may be of interest. A mean-variance diagram alongside a mean-gini diagram is also included in this section based on the statistics.

2. The outcomes of different performance measures for the subcategories in the equity sample are analyzed. Each category is assigned a specific number based on the outcome with the purpose of analyzing how the rank changes between measures. Additionally, the top 5 performing funds for the 3 performance measures are highlighted in tables.

3. The AP7 is benchmarked against the rest of the equity funds in order to determine how well its performing within the PPM-system.

4. A brief analysis of the fixed income funds where the funds are split up into different groups

7.1 Summary statistics

Table 3: Excess returns

Percentiles	**Excess return**	**Smallest value**
1%	-0.0427	-0.0695
5%	-0.0040	-0.0674
10%	0.0204	-0.0445
25%	0.0534	-0.0427
50%	0.0824	
Mean	0.0788	**Largest value**
75%	0.1097	0.1731
90%	0.1365	0.1741
95%	0.1480	0.1778
99%	0.1731	0.1885

The table above displays percentiles for the highest and lowest scoring funds based on the yearly excess returns of the equity sample. From the table it is clear that the difference between the best performing fund and the worst performing fund is rather substantial for the time period. The best performing fund achieves an excess mean return of 18.85% while the worst performing fund displays a negative excess mean return of -0.0695% The median return is lower than the mean return which is indicative of a negatively skewed distribution and so the distribution appear to be skewed to the left.

Table 4: Standard deviation

Percentiles	**SD**	**Smallest value**
1%	0.036	0.032
5%	0.080	0.034
10%	0.109	0.035
25%	0.147	0.036
50%	0.170	
Mean	0.167	**Largest value**
75%	0.190	0.284
90%	0.213	0.303
95%	0.237	0.304
99%	0.284	0.307

Table 4 shows the annualized standard deviation with percentiles for the highest and lowest scoring equity funds. Once again we see a great disparity in the equity sample with values ranging from $0.032 - 0.307$.

Table 5: Skewness

Percentiles	Skewness	Smallest value
1%	-3.517	-5.612
5%	-0.995	-5.002
10%	-0.760	-4.263
25%	-0.606	-3.517
50%	-0.459	
Mean	-0.525	**Largest value**
75%	-0.317	0.416
90%	-0.196	0.468
95%	-0.095	0.488
99%	0.416	0.625

Table 5 display the percentiles for skewness and there are a few things worth noting about this table. Firstly, the mean skewness of funds is negative and equal to -0.525 over the time period. This result fits perfectly in line with the extensive empirical evidence of negatively skewed returns in portfolios and in market aggregate returns (Albuquerque 2012; Farias et al. 2009). The finding adds to the validity for including the ASSR, and in extension the GR, since these performance measure accounts for the negative skewness found in the data. This is a statistical property that the traditional mean-variance framework would not have been able to capture.

Table 6: Kurtosis

Percentiles	Kurtosis	Smallest value
1%	4.651	4.292
5%	5.118	4.508
10%	5.403	4.539
25%	6.031	4.651
50%	7.173	
Mean	8.569	**Largest value**
75%	8.840	47.765
90%	10.948	57.332
95%	15.848	75.170
99%	47.765	82.472

Table 6 shows the percentiles for kurtosis in the equity sample and we see that all funds in the sample exhibit a higher kurtosis than that expected from returns drawn from a normal distribution. The fund with the thinnest tails in the sample has a kurtosis of 4.29 and the fund with the fattest tail has a kurtosis of 82.47. Given the high values of kurtosis across the board it is safe to say that the prevalence of fat tails is extremely prominent in the equity sample. Diving deeper into the data we see that the 5 funds with the highest kurtosis all are categorized as mixed funds with a low proportion of total capital invested in equities. Below is a table with summary statistics for these 5 funds:

Table 7: Highest kurtosis

Mixed fund category	Fund name	Mean	Std	Skew	Kurt
Pension: -10	Nordea Generationfund	0.042	0.035	-5.612	82.472
Pension: -10	SPP Generation 40	0.048	0.047	-5.002	75.170
Careful	Skandia Smart Careful	0.034	0.032	-4.263	57.332
Pension: -10	Swedbank Robur Transfer 60	0.042	0.034	-3.517	47.765
Pension: -10	E. Öhman J:or Fonder AB	0.043	0.051	-2.625	30.121

We note that all funds in the table have a relatively low standard deviation and would belong to the 5% percentile seen in Table 4. Despite this fact, the combination of negative skewness and high kurtosis gives rise to some concerns from a risk management stand point. The high kurtosis implies that tail events far from the mean are more likely to occur compared to a normal distribution. Fat tails coupled with negative skewness further implies that extreme values on the left tail are more likely to occur. These are not desirable characteristics from an investors point of view. However, it is worth noting that these funds all have a low average yearly return and so large relative deviations from the mean might be considered tail events, although the absolute deviations might be small compared to a high risk equity fund. Furthermore, some agents might actually prefer negative skewness if it increases the likelihood of stable returns. Although this assumption goes against most of the literature on the subject, there are certain cases where a investors favour negative skewness (Brockett and Kahane 1992). In a paper on loss aversion and negatively skewed portfolios from Krawczyk 2015, it is argued that pension savers with little time left to retirement might fit this profile. With negative skewness, the mean lies below the median and so more observations will lie above the mean relative to a distribution with the same mean but positive skewness. Given that the mean is actually a positive number this might be a desirable trait for a risk averse pension saver whom care more about stable returns than the occasional extreme return.

Furthermore, we know from experiments in behavioral economics that agents sometimes behave in ways inconsistent with expected utility theory. This is especially true when agents are faced with making decisions involving losses (Angner 2016). The notion that the utility function behave differently in the domain of losses compared to the domain of gains is one of the underlying principles in prospect theory, originally developed by Kahneman and Tversky 1979 as a response to the inconsistencies seen in expected utility theory. However, this is not a primary interest since an investor can create portfolios which reflect such preferences within the PPM-system by choosing different funds with varying levels of risk. For the passive investor in the AP7 Såfa fund this reallocation of risk occurs automatically as you age.

7.2 Scatter plot diagrams

In the figure below, equity funds are mapped out in the mean-variance space with standard deviation on the horizontal axis and excess yearly mean return on the vertical axis. This is also done using the gini coefficient as the measure of risk on the horizontal axis. 4.1

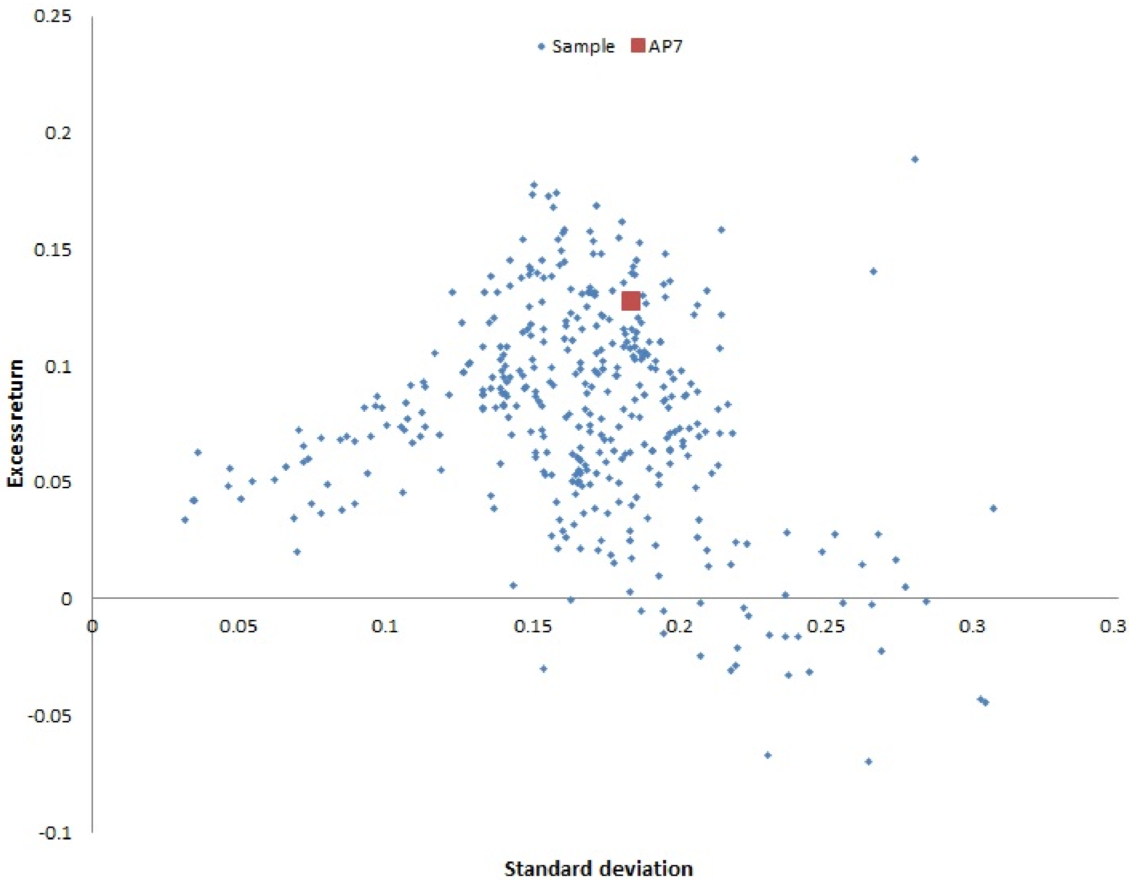

Figure 6: Mean-variance diagram

From the figure we see a scattered pattern where a large number of funds appear inferior alternatives and outperformed by other funds in the same risk category. The AP7 seem to be placing somewhere in the diagram. Interestingly enough, a majority of the worst performing funds in terms of excess return also display a higher level of risk in terms of variance. However, further analysis is needed in order to get a more detailed overview.

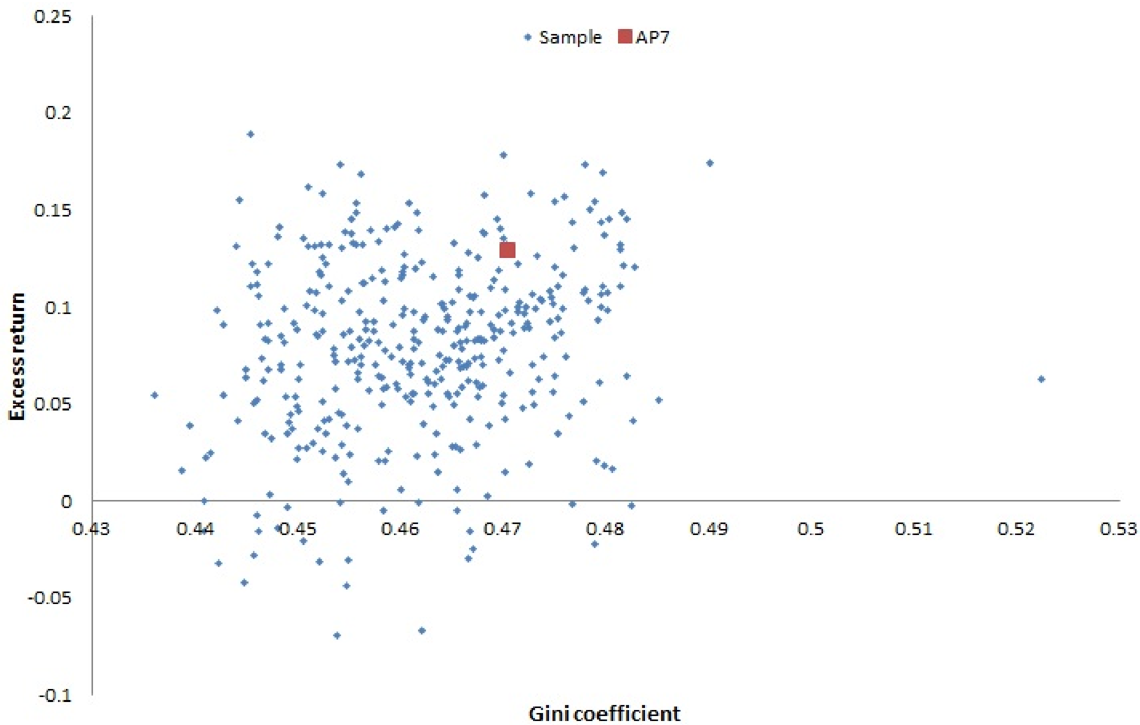

Figure 7: Mean-gini diagram

The figure above displays an even less dense pattern and the average absolute deviation in the risk scale as measured by differences in the Gini coefficient appears to be smaller compared to the standard mean-variance diagram. Once again, the AP7 places somewhere in the middle given its level of risk. The counterintuitive relationship between low excess returns and high levels of risk for certain funds seem to be eradicated from this diagram.

7.3 Evaluating performance of fund categories

In this section I will analyze the performance of the different fund categories. The different categories and their respective proportion of the total equity sample is illustrated below:

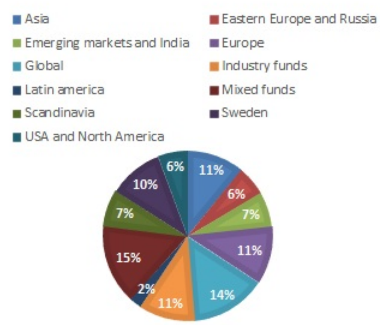

Figure 8: Fund distribution

From figure 8 we see that the different categories are relatively similar with regards to size. The smallest group by far is Latin America which makes up around 2% of the total sample. The largest subcategory is the mixed category with 59 funds followed by the global category with 56 funds.

Table 8: Statistics and performances of different subcategories in the equity sample. The number in the parenthesis denotes the subcategories respective ranks for the performance measures.

Category	**Skew**	**Kurt**	**SR**	**GR**	**ASSR**
Asia	-0.353	7.613	2.51 (8)	1.027 (7)	0.349 (8)
Eastern Europa and Russia	-0.509	10.846	0.442 (10)	0.157 (10)	0.061 (10)
Emerging markets and India	-0.374	6.566	1.413 (9)	0.578 (9)	0.198 (9)
Europa	-0.681	9.986	3.063 (7)	1.134 (6)	0.407 (7)
Global	-0.459	7.424	4.656 (3)	1.438 (4)	0.623 (3)
Industry funds	-0.396	7.192	4.261 (4)	1.518 (3)	0.572 (4)
Latin America	-0.153	5.492	0 (11)	0 (11)	0 (11)
Mixed funds	-0.852	12.670	4.960 (2)	0.972 (8)	0.569 (5)
Scandinavia	-0.462	6.936	3.73 (5)	1.382 (5)	0.502 (6)
Sweden	-0.577	7.425	3.247 (6)	1.768 (2)	0.628 (2)
USA and North America	-0.439	7.717	5.435 (1)	2.056 (1)	0.724 (1)

From the table above it is clear that USA and North America dominate all other categories over the sample period, regardless of what performance measure is being used. However, it should be noted that the higher returns can be partly explained by the strengthening of the US exchange rate seen over the time period. For instance, at the end of 2008 the USD/SEK was around 6.6 and increased to around 8.6 at the end of 2016 (**OFX**). With that said, it is difficult to pin down exactly how much that currency effect has contributed to the overall performance for the US category.

Latin America receives the worst rating for all performance measures, although the average values for skewness and kurtosis are the lowest. The fact that all funds in this category display average negative returns, might be related to overall poor performance in the market portfolio for these funds but in the absence of a CAPM-analysis this argument cannot be proven.

Moving on to the rank correlation in Table 8, shifts occur for most of the categories across all performance measures, although major changes are seen only for the Mixed category and the Swedish category. An interesting result can be found in the interchanging of ranks observed between the Global category and the Industry funds. The Global category receives a higher SR (3) compared to Industry funds (4) but for the GR we see that the ranking is reversed. By examining the values for skewness and kurtosis this shift seems reasonable since the Industry funds exhibit higher kurtosis and lower skewness compared to the Global category. Moving on to the ASSR, the ranking is reversed once again. This surprising result is explained by the size of the SAF which in this case was not great enough to make up for the higher original SR.

The ranking is entirely preserved for the best performing category (USA) and the worst performing categories (Latin America and Russia).

Table 9: Rank correlation for all 386 equity funds

	SR	GR	ASSR
SR	1	0.794245	0.935917
GR	0.794245	1	0.851271
ASSR	0.935917	0.851271	1

The rank correlation matrix above gives a more detailed description regarding the correlation between measures for all 386 funds in the equity sample. The correlation coefficient in the diagonal of the matrix is equal to 1 since a variables correlation with itself by definition equals 1. The non-perfect correlation between SR and the other measures implies that some weight is given to the higher moments of the distribution in the calculation for the GR and ASSR. The lowest correlation in Table 9 is seen between the SR and the GR. This is a natural result since these measures are based on entirely different premises with regards to defining risk. The GR uses the Gini coefficient as the statistical measure of dispersion which takes more relevant factors of the distribution into account compared to the variance used in the SR. Furthermore, both the SR and the GR share the same numerator and so the low rank correlation seen between these measures can be entirely explained by the difference in how risk is measured in the denominator.

Lastly, the highest correlation in the matrix is seen between the SR and the ASSR. Bearing in mind that the SR is directly included into the calculation of the ASSR coupled with the relatively conservative approximation of the skewness preference factor $\bar{3}$, this result is quite unsurprising and coherent with the rest of the correlation matrix.

7.4 Determining the performance of the AP7

In this section, the performance of the AP7 is benchmarked to the other equity funds in order to get an idea of how well the passive investor is doing in the Swedish PPM-system. I will begin by comparing AP7 to other funds within its global category, before moving on to the overall placing in the equtiy sample. Although outcomes for all performance measures will be explored in this section, the bulk of the analysis will revolve around GR based on three primary reasons:

1. The AP7 has never been evaluated based on the GR or any other similar performance measure in the literature to the best of my knowledge
2. It is a more sophisticated measure relative to the standard Sharpe ratio and contains less simplifying assumptions compared to the ASSR.
3. A deeper analysis with tables for all performance measures would take up a lot of space which might detract from overall reading experience

7.4.1 AP7 and the global category

Table 10: Gini ratio

Fund name	**Mean**	**Std**	**Skew**	**Kurt**	**GR**	**SR**	**ASSR**
Lannebo vision	0.154	0.147	-0.596	8.705	2.254	1.052 (1)	0.936 (2)
Seligson & Co Global Top 25	0.138	0.136	-0.226	5.681	2.128	1.017 (2)	0.977 (1)
AP7 equity	0.128	0.183	-0.607	8.285	1.821	0.667 (4)	0.621 (4)
Average_G	0.094	0.146	-0.459	7.424	1.438	0.582	0.626

Table 10 displays all funds that outperformed the AP7 in terms of GR coupled with the the average result from the global category, denoted by $Average_G$ in the table. The AP7 gets a top placing for this performance measure, finishing at 4th place. The fact that the AP7 receives such a high score for the GR can be treated as a testimonial for the success of current investment strategies, given the goal of achieving above average returns in the long run. The result is not only impressive due to the fact that there are 56 funds within this category, but also since the data might be suffering from survivorship bias and it is plausible that only the best performing funds are included in the sample. Furthermore, the discounted average PPM-fees for AP7 are the lowest in the category indicating that the managers achieved the high ranking in spite of a small budget relative to the size of the fund.

The rank correlation is considerably lower in Table 10 compared to Table 8 and the ranks appear to be jumping around seemingly uncorrelated. This could be a consequence of selection bias from selecting only the top 4 funds. It follows from the selection process that these funds are closely related, especially considering the fact that they are in the same category, and so smaller adjustments might have a greater impact in this table.

If the funds are traditionally evaluated based on Sharpe ratios the AP7 gets less appraisal for its performance. It finishes somewhere above the middle in the Global category, with 18 funds outperforming it in terms of sheer SR. Moving on to the ASSR, the ranking is similar to the SR although the AP7 slides down a few placings, finishing at 26th place in the global category. From the statistics in Table 10 we see that the AP7 has a lower than average skewness and it is therefore reasonable to assume that this partly explains the lower placing of the ASSR. However, given AP7:s primary goal of achieving a long term return at least as good as the average of all funds, these placings are satisfactory.

7.4.2 Evaluating the AP7 relative to all other funds

This section contains an analysis regarding the overall placing of the AP7 compared to all other funds in the equity sample. However, drawing definitive conclusions from such a general analysis is not appropriate since funds in widely different categories have varying market portfolios and therefore it is difficult to accurately measure portfolio performance. For example, the performance of a fund focusing on the Swedish small cap cannot be directly compared to a global industry fund specializing in biotechnology. In the absence of a CAPM analysis one should proceed with caution when analyzing funds with such dissimilar characteristics.

Since the AP7 is beaten by a large number of funds when benchmarked against all of the equity funds, tables for outperforming funds will not be included in this section. With that said, tables will be included in the appendix 9 for the interested reader although the overall result will be analyzed below.

For the Gini ratio, the AP7 finishes on 60th place out of the 386 equity funds. This is also the highest overall placing out of the 3 performance measures for the AP7. Based on the ASSR, the AP7 slides down to 111th place which can be explained by the lower than average skewness previously discussed in the previous section. When compared to all equity funds, the AP7 still exhibits a lower than average skewness and it has the 350th lowest skewness overall. The AP7 finishes on place 113 for the standard Sharpe ratio. Once again, when the goals of the default fund is taken into consideration, the placing for all performance measures is acceptable over the time period.

In order to explore some of the characteristics of high achieving equity funds, a table is presented below with results for the top 5 funds for each of the three performance measures:

Table 11: Add caption

Fund name	Skew	Kurt	GR	ASSR	SR
Top 5 GR					
UBS (Lux) Equity Fund - Biotech (USD)	-0.169	4.508	**2.962**	0.659	4.704
Skandia Time Global	-0.611	10.980	**2.659**	0.976	7.768
Länsförsäkringar Fastighetsfond	-0.536	7.091	**2.648**	1.047	8.250
Morgan Stanley Investment Funds US Advantage Fund	-0.480	8.416	**2.574**	0.971	7.462
Öhman Sweden Micro Cap	-0.995	9.662	**2.535**	0.906	8.065
Top 5 ASSR					
Länsförsäkringar Fastighetsfond	-0.480	8.416	2.648	**1.047**	8.250
Seligson & Co Global Top 25 Pharmaceuticals	-0.204	5.899	2.232	**0.983**	7.134
Seligson & Co Global Top 25 Brands	-0.226	5.681	2.128	**0.977**	7.116
Skandia Time Global	-0.611	10.980	2.659	**0.976**	7.768
Morgan Stanley Investment Funds US Advantage Fund	-0.002	8.862	2.574	**0.971**	7.462
Top 5 SR					
Swedbank Robur Transfer 50	-3.517	47.765	0.625	0.000	**8.536**
Nordea Generationsfond Senior	-5.612	82.472	0.631	0.000	**8.467**
Danske Invest Horisont Försiktig	-1.882	20.559	0.824	0.600	**8.285**
Länsförsäkringar Fastighetsfond	-0.536	7.091	2.648	1.047	**8.250**
Öhman Sweden Micro Cap	-0.995	9.662	2.535	0.906	**8.065**

From this table we see that one fund remain in the top 5 regardless of what performance measure is being used, namely Länsförsäkringar Fastighetsfond (Swedish real estate fund). The higher placing for the ASSR can be directly derived from analyzing the top 5 funds with regards to the SR. Länsförsäkringar has a considerably lower kurtosis and higher skewness compared to the three funds that places higher for this measure. The higher kurtosis also provides an explanation as to why none of these 3 funds made it to the top 5 for the ASSR, or the GR for that matter. The negative skewness coupled with the higher SR resulted in a SAF so great that the ASSR could not even be defined for the top 2 funds. Another interesting part of Table 11 is the surprising result seen for UBS(Lux) which finishes first for the GR while simultaneously having the lowest SR of all the funds in the table. Diving deeper into the data we see that this might be a consequence of the penalizing of upside risk that can occur for the SR since UBS (Lux) display the highest excess return out of all the funds in the sample. This is achieved while having relatively low values for kurtosis and relatively high values for skewness. The top placing for the GR might relate to its consistency with stochastic dominance discussed in section 5.4 and in this case it is possible that we are witnessing a Sharpe ratio paradox.

7.5 Brief analysis of fixed income- and money market funds

In this section the data for the remaining funds in the fixed income category is analyzed. Firstly, a mean-variance diagram is presented followed by summary statistics for the sample. Secondly, the funds are divided into different subcategories and performance measures are calculated for these categories.

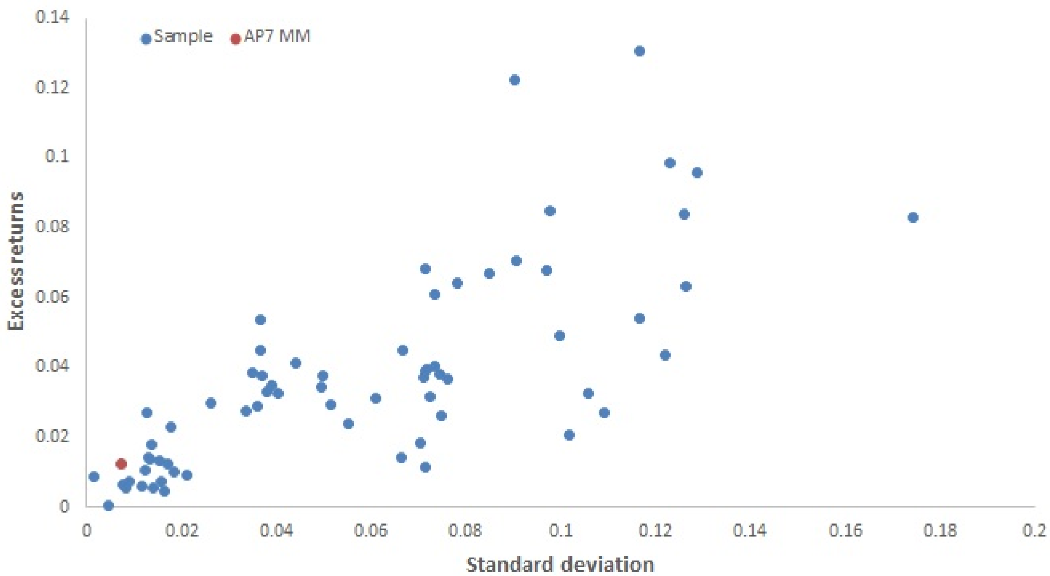

Figure 9: Mean-variance diagram

In figure 9 we see a more dense pattern where the trade-off between risk and return seem more prominent compared to the mean-variance diagram displayed in section 7.2. The AP7 money market fund, which is used in conjunction with the AP7 equity fund to create different risk profiles, is also illustrated in this figure.

7.5.1 Summary statistics

Table 12: Summary statistics for fixed income funds

Variable	Mean	Min	Max
Mean	0.0374	0.0004	0.1306
Standard deviation	0.0575	0.0014	0.1742
Skewness	-9.977	-34.704	0.97
Kurtosis	287.317	3.984	1290.521

In this table there are substantial differences between the worst and the best performing fund in terms of excess return. The fund with the lowest return achieves an average yearly return over the 3-month Swedish treasury bill of 0.004%, a reasonable result considering the fact that the sample contains Swedish money market funds with an average duration in investments of less than 1 year. There are also large differences with regards to standard deviation in the sample and some of the fixed income funds have a risk level approximately equal to some of the equity funds. The mean skewness is highly negative and the mean kurtosis is extremely large. Below is a figure for different subcategories in the sample of fixed income funds which might provide a more detailed picture regarding the return distribution.

Table 13: Add caption

Category	**Mean**	**SD**	**Skew**	**Kurt**	**SR**	**GR**
Europe bonds	0.045	0.071	-1.631	55.123	4.989(3)	0.095(3)
Emerging market bonds	0.081	0.117	0.013	4.379	4.754(5)	0.181(1)
Global bonds	0.051	0.101	0.001	5.230	3.548(6)	0.114(2)
Other bonds	0.041	0.070	-7.790	205.438	4.864(4)	0.085(4)
Sweden money market	0.009	0.012	-25.450	759.966	7.333(1)	0.015(6)
Sweden bonds	0.035	0.048	-11.481	300.261	6.143(2)	0.072(5)

In Table 13 the statistics and outcomes for the Sharpe ratio and the Gini ratio are presented for all fixed income funds. The reason for excluding the ASSR is related to the high negative skewness seen in the majority funds which makes it impossible to define the ASSR since the SAF becomes a negative number. Overall, the values for kurtosis are very large and we see that the GR is considerably smaller compared to the subcategories in the equity sample, except for Latin America for which all measures were negative. The higher Sharpe ratios assigned to the Swedish categories seem to be related to the low standard deviation more so than the mean excess returns. A interesting part of this table is the negative rank correlation seen in the Swedish categories. When only looking at the Sharpe ratio these categories appear to be among the most efficent. However, when the extreme values for higher moments are taken into consideration in the GR and the ASSR the Swedish categories now end up placing last.

Table 14: Rank correlation

	SR	**GR**
SR	1	0.167691
GR	0.167691	1

From Table 14 it is clear that the rank correlation between the SR and the GR is considerably lower for the fixed income funds relative to the equity funds. This is not a surprising result considering the extreme values for the higher moments seen in Table 13 which once again justify the need for more sophisticated performance measures.

8 Summary

The goal of this study was to evaluate the Swedish pension system through various performance measures and to investigate whether or not the default fund is an attractive alternative for the passive investor. The limitations of the mean-variance framework seem to theoretically justify the need for more sophisticated measures which accounts for higher moments in the distribution. The empirical analysis further adds to the validity for including such measures given the fact that the sample deviated significantly from the characteristics implied by the normal distribution. This was seen in the average negative skewness for both equity- and fixed income funds but also in the values for kurtosis which were high across the board.

The rank correlation matrix offered some insights regarding how well the ranking was preserved between the different performance measures. The matrix indicated that ranking was well preserved between the ASSR and the SR and the lowest correlation was seen between the GR and the SR. This result is consistent with what we would expect in theory since the ASSR is directly derived from the SR and the GR is based on an entirely different method of calculating risk.

When analyzing the default fund we saw that it received a high placing and outperformed most funds within its own global category for the GR. For the SR and the ASSR the placing is more modest and it finishes somewhere in the middle within its category. When benchmarked against the entire sample of equity funds, the AP7 still finished in the top half across all performance measures, with the best placing seen for the GR where it finished on 60th place. Given the long term goal of achieving at least a good of a return as the average fund in the system this is still a fine result, especially considering the low TER relative to other comparable funds. It is also reassuring for the passive investor that the highest placing was seen in the GR and the ASSR since this implies that investment managers at the AP7 presumably do not use strategies aimed towards manipulating Sharpe ratios. However, it is worth mentioning the economic context that the AP7 has operated in over the estimation period and its potential effect on observed performance.

However, it should be noted that the results from the empirical analysis is highly dependent on the time period for which the returns are measured and it is problematic to draw definite conclusions regarding the performance of a certain fund. Based on how the sample was selected, the results may also suffer from survivorship bias.

8.1 Suggestions for future research and limitations

Like previously stated, the results in this study are highly dependent on the time period for which the returns are measured. By analyzing the PPM-funds over a longer period of time, one could potentially achieve more reliable estimations of fund performance and thereby get a more accurate representation of the system. It would also be interesting to see how well the AP7 performs in worse economic conditions, bearing in mind that the fund usually is levered quite aggressively.

Another main limitation of this study relates to the absence of an analysis where the funds are benchmarked against their respective market portfolios. Further research should therefore be conducted where market risk, and not only idiosynchratic risk, is included in the analysis. This could be accomplished through CAPM-analysis where each fund is assigned a market portfolio based on the subcategories laid out in this thesis.

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9 Appendix

9.1 AP7 Såfa

9.1.1 Background

AP7 Såfa is the Swedish state owned alternative within the PPM-system and the default option if no other funds are chosen by the saver. It replaced the previous fund "Premiesparfonden" in 2009 following a reorganization primarily aimed towards adjusting the risk level so that older pension savers with less time to retirement had lower risk profiles. The timing from a "marketing perspective" was pretty good as well considering Premiesparfonden's negative returns of -35% in 2008 following the financial crisis. Premiesparfonden had its worst year in 2008 and fell under the PPM-index which might be perceived problematic since one of the primary goals of the fund is to be at least as good as the average of all funds.

Såfa is categorized as a mixed fund comprised of one part equity fund and one part fixed income fund, also managed by the Swedish pension investment authority AP-fonderna. The split between the two is determined by a formula based on time left until retirement. All pension savers below the age of 55 have the entirety of their capital invested in the AP7 equity fund. The share in the equity fund starts to decrease from that point onward while the share in the fixed income fund increases, reaching a split of 1/3 equity and 2/3 fixed income for pension savers aged 75 and above.

9.1.2 AP7 Equity fund

The Equity fund is a global fund that primarily invests in stocks and stock related instruments. The goal is to provide its investors with a highly diversified portfolio by spreading risk across different industries and regions. The fund is managed through a mostly passive investment strategy where the composition of individual stocks reflects the global market index MSCI. However, an active strategy is implemented on some selected markets through a zero-cost portfolio which is focused on generating alphas. This is achieved by going long in projected winning stock and short in projected losing stocks. On average, 97% of the portfolio consists of public equity while 3% is invested in funds specializing in private equity. Risk and return is further enhanced through derivative instruments with a leverage ratio ranging between $100 - 150\%$ for the equity fund as a whole, although it is usually hovering around 135% under normal circumstances. (AP7, 2017)
Below is a chart illustrating in what sectors the fund currently holds its positions.

The fund is subject to short term exchange rate fluctuations due to the fund

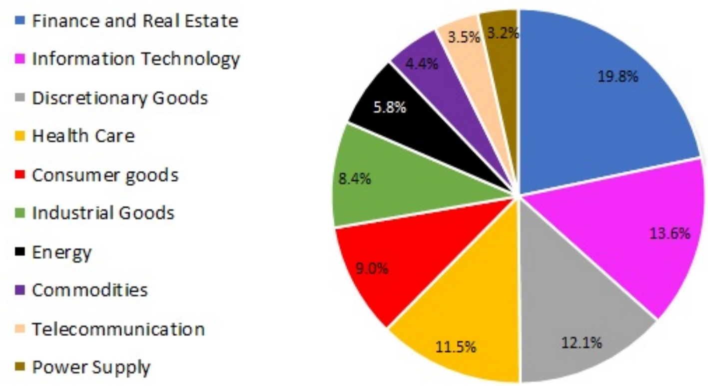

Figure 10: Industry distribution

being denominated in the Swedish krona while 99% of the portfolio consists of foreign equity. Despite this fact fund managers chose not to hedge for currency fluctuations; a decision justified by two primary arguments. Firstly, given the long term investment horizon ranging over several decades it is incredibly difficult to make accurate predictions of where the krona might lie relative to other currencies in the distant future. Secondly, pension savers already have a high exposure to the Swedish krona (between 50 and 90%) since the larger part of the state pension; the income pension, also is denominated in the Swedish krona. An exception to the rule of a high krona exposure is found in the derivative contracts used for achieving leverage which are exclusively bought in USD. Since nearly all trade in that market is made using USD, it is a more cost-effective strategy and a more liquid strategy. (AP7, 2017)

9.2 AP7 fixed income

The AP7 fixed income fund is a low risk fund, solely managed by employees at AP7 and aims to provide its investors with a long term return at least as good as the return for a relevant Swedish bond index. The investment strategy, apart from only investing in interest related instruments, is based on three guidelines:

1. Low credit risk in the asset
2. An average duration in the fund's total investment of at most 3 years
3. The majority of assets should be denominated in the Swedish krona

The investment strategy is also anchored on three requirements which must be fulfilled long term:

1. 10% of all capital may be placed in other funds
2. 30% of all capital may be placed in an account at a credit agency
3. 10% of all capital may be placed in asset exhibiting currency risk

The fund uses relatively advanced methods for valuating risk in the portfolio and is currently using a Monte Carlo simulation model for estimating Value at Risk (VaR)at the 99% confidence interval. The resulting estimate is then bench marked against a relevant Swedish bond index. (AP7, 2017)

9.3 Funds that outperform the AP7

Table 15: Based on GR

Fund name	Skew	Kurt	SR	GR	ASSR
UBS (Lux) Equity Fund - Biotech (USD)	-0.169	4.508	0.672	2.962	0.659
Skandia Time Global	-0.611	10.980	1.110	2.659	0.976
Länsförsäkringar Fastighetsfond	-0.536	7.091	1.179	2.648	1.047
Morgan Stanley Investment Funds US Advantage Fund	-0.480	8.416	1.066	2.574	0.971
Öhman Sweden Micro Cap	-0.995	9.662	1.152	2.535	0.906
DNB Teknologi	-0.262	5.118	0.894	2.505	0.859
Didner & Gerge Småbolag	-0.624	8.248	1.098	2.486	0.965
Handelsbanken Svenska Småbolagsfond	-0.760	8.167	0.982	2.463	0.851
F&C Portfolios Fund - US Smaller Companies A	-0.290	6.392	0.738	2.447	0.711
Pictet Digital	-0.188	4.651	0.862	2.437	0.839
Evli Sverige Småbolag	-0.736	7.804	0.927	2.356	0.815
BlackRock Global Funds - World Healthscience Fund	-0.319	6.002	0.899	2.355	0.855
Spiltan Aktiefond Småland	-0.893	9.270	0.982	2.341	0.826
Aberdeen Global - Japanese Smaller Companies Fund	-0.622	11.470	0.818	2.320	0.745
Lannebo Småbolag	-0.675	7.697	0.978	2.306	0.864
Swedbank Robur Småbolagsfond Sverige	-0.821	8.700	0.972	2.272	0.833
Odin Sverige	-0.429	6.592	0.853	2.272	0.800
Lannebo Vision	-0.596	8.705	1.052	2.254	0.936
Delphi Nordic	-0.478	6.516	0.758	2.247	0.710
Seligson & Co Global Top 25 Pharmaceuticals	-0.204	5.899	1.019	2.232	0.983
Pictet Biotech	-0.193	4.653	0.528	2.196	0.519
Öhman Småbolagsfond A	-0.833	8.806	0.935	2.190	0.805
Axa Rosenberg US Equity Alpha Fund	-0.345	6.108	0.772	2.166	0.737
Skandia USA	-0.732	10.632	0.947	2.165	0.830
SEB Nordamerikafond	-0.559	9.704	0.944	2.151	0.857
AMF Aktiefond Småbolag	-0.828	7.981	0.865	2.151	0.755
Morgan Stanley Investment Funds US Growth Fund	-0.562	8.392	0.758	2.130	0.703
Seligson & Co Global Top 25 Brands	-0.226	5.681	1.017	2.128	0.977
PineBridge American Equity Fund	-0.307	5.929	0.751	2.125	0.721
Pictet Security	-0.230	5.716	0.748	2.121	0.727
Öhman Etisk Index USA	-0.336	5.079	0.895	2.118	0.849
SPP Aktiefond USA	-0.698	11.056	0.936	2.113	0.828
Skandia Småbolag Sverige	-0.752	8.544	0.900	2.110	0.792
Spiltan Aktiefond Sverige	-0.611	7.848	0.781	2.108	0.716
Fondita Nordic Micro Cap Placeringsfond	-0.668	7.728	0.958	2.098	0.850
Catella Småbolagsfond SEK Allmän klass	-0.780	9.000	0.899	2.093	0.787
UBS (Lux) Equity Sicav - USA Growth B	-0.301	5.159	0.691	2.092	0.667
Handelsbanken Läkemedelsfond	-0.439	9.399	0.922	2.084	0.857
Länsförsäkringar USA Aktiv	-1.334	17.447	0.884	2.070	0.689
UBS (Lux) Equity Fund - Health Care (USD)	-0.206	5.043	0.765	2.061	0.745
SEB Läkemedelsfond	-0.446	8.923	0.942	2.059	0.874
Franklin U.S. Opportunities Fund	-0.355	5.782	0.631	2.044	0.607
BlackRock Global Funds - US Flexible Equity Fund	-0.456	7.254	0.785	2.040	0.737
Swedbank Robur Technology	-0.605	8.909	0.775	2.037	0.712
BlackRock Global Funds - US Small & MidCap Opportunities Fund	-0.437	6.164	0.747	2.036	0.705
BlackRock Global Funds - US Basic Value Fund	-0.393	6.613	0.774	2.031	0.734
Pictet Health	-0.274	5.713	0.782	2.024	0.753
Swedbank Robur Realinvest	-0.741	8.575	1.073	2.021	0.920
Aberdeen Global - North American Equity Fund	0.286	9.988	0.766	2.017	0.794
NN (L) Information Technology	-0.177	6.167	0.694	2.008	0.679
Öhman Global Growth	-0.430	5.462	0.944	2.005	0.878
F&C Portfolios Fund - European Small Cap A	-1.556	21.837	0.812	1.996	0.618
Didner & Gerge Aktiefond	-0.489	7.389	0.693	1.992	0.653
Spiltan Aktiefond Stabil	-0.528	6.524	0.955	1.960	0.871
BL - Equities America	-0.369	6.134	0.740	1.935	0.706
UBS (Lux) Equity Fund- USA Multi Strategy (USD) P-acc	-0.333	5.562	0.672	1.930	0.646
Credit Suisse (Lux) USA Value Equity Fund	-0.276	5.317	0.570	1.912	0.554
AMF Aktiefond Nordamerika	-0.686	10.760	0.832	1.911	0.749

Table 16: Based on ASSR

Fund name	Skew	Kurt	SR	GR	ASSR
Danske Invest SICAV - Global Corporate Bonds	-0.002	8.862	1.742	0.840	1.741
Länsförsäkringar Fastighetsfond	-0.536	7.091	1.179	2.648	1.047
Seligson & Co Global Top 25 Pharmaceuticals	-0.204	5.899	1.019	2.232	0.983
Seligson & Co Global Top 25 Brands	-0.226	5.681	1.017	2.128	0.977
Skandia Time Global	-0.611	10.980	1.110	2.659	0.976
Morgan Stanley Investment Funds US Advantage Fund	-0.480	8.416	1.066	2.574	0.971
Didner & Gerge Småbolag	-0.624	8.248	1.098	2.486	0.965
Lannebo Vision	-0.596	8.705	1.052	2.254	0.936
First State Global Listed Infrastructure Fund	-0.135	5.241	0.943	1.813	0.923
Swedbank Robur Realinvest	-0.741	8.575	1.073	2.021	0.920
Danske Invest Horisont Balanserad	-0.600	6.595	1.028	1.089	0.916
Öhman Sweden Micro Cap	-0.995	9.662	1.152	2.535	0.906
Öhman Global Growth	-0.430	5.462	0.944	2.005	0.878
SEB Läkemedelsfond	-0.446	8.923	0.942	2.059	0.874
Spiltan Aktiefond Stabil	-0.528	6.524	0.955	1.960	0.871
Lannebo Småbolag	-0.675	7.697	0.978	2.306	0.864
Nordea Småbolagsfond Norden	-0.712	8.855	0.983	1.911	0.861
DNB Teknologi	-0.262	5.118	0.894	2.505	0.859
Handelsbanken Läkemedelsfond	-0.439	9.399	0.922	2.084	0.857
SEB Nordamerikafond	-0.559	9.704	0.944	2.151	0.857
BlackRock Global Funds - World Healthscience Fund	-0.319	6.002	0.899	2.355	0.855
Handelsbanken Svenska Småbolagsfond	-0.760	8.167	0.982	2.463	0.851
ValueInvest LUX Global	-0.362	6.168	0.900	1.650	0.850
Fondita Nordic Micro Cap Placeringsfond	-0.668	7.728	0.958	2.098	0.850
Öhman Etisk Index USA	-0.336	5.079	0.895	2.118	0.849
Pictet Digital	-0.188	4.651	0.862	2.437	0.839
Swedbank Robur Småbolagsfond Sverige	-0.821	8.700	0.972	2.272	0.833
Skandia USA	-0.732	10.632	0.947	2.165	0.830
SPP Aktiefond USA	-0.698	11.056	0.936	2.113	0.828
Spiltan Aktiefond Småland	-0.893	9.270	0.982	2.341	0.826
Öhman Hjärt-Lungfond	-0.393	5.241	0.875	1.766	0.824
Öhman Global Hållbar	-0.460	5.488	0.878	1.830	0.817
Evli Sverige Småbolag	-0.736	7.804	0.927	2.356	0.815
Öhman Småbolagsfond A	-0.833	8.806	0.935	2.190	0.805
Odin Sverige	-0.429	6.592	0.853	2.272	0.800
KPA Etisk Blandfond 2	-0.671	7.926	0.888	1.231	0.795
BL - Global Equities	-0.382	5.708	0.840	1.425	0.794
Aberdeen Global - North American Equity Fund	0.286	9.988	0.766	2.017	0.794
Sparinvest SICAV - Procedo	-0.327	5.621	0.830	1.283	0.792
Skandia Småbolag Sverige	-0.752	8.544	0.900	2.110	0.792
Swedbank Robur Medica	-0.399	8.233	0.840	1.875	0.792
Catella Småbolagsfond SEK Allmän klass	-0.780	9.000	0.899	2.093	0.787
BlackRock Global Funds - Global Allocation Fund	-0.192	5.179	0.800	1.423	0.780
Swedbank Robur Transfer 60	-0.954	11.216	0.929	0.741	0.780
Länsförsäkringar Trygghetsfond	-0.650	6.505	0.865	0.872	0.780
SEB Världenfond	-0.839	11.106	0.899	1.300	0.778
Aberdeen Global - Technology Equity Fund	-0.299	6.031	0.787	1.849	0.755
AMF Aktiefond Småbolag	-0.828	7.981	0.865	2.151	0.755
SEB Generationsfond 50-tal	-0.908	10.714	0.880	1.032	0.754
Pictet Health	-0.274	5.713	0.782	2.024	0.753
AMF Aktiefond Nordamerika	-0.686	10.760	0.832	1.911	0.749
Aberdeen Global - Japanese Smaller Companies Fund	-0.622	11.470	0.818	2.320	0.745
UBS (Lux) Equity Fund - Health Care (USD)	-0.206	5.043	0.765	2.061	0.745
Lannebo Mixfond	-0.396	6.658	0.787	1.255	0.745
Stewart Investors Worldwide Leaders Fund	-0.214	6.512	0.764	1.660	0.743
Carnegie Strategifond	-0.695	8.448	0.825	1.359	0.742
FIM Brands	-0.377	5.386	0.780	1.751	0.741
Nordea Generationsfond 40-tal	-0.722	7.182	0.826	0.740	0.739
Axa Rosenberg US Equity Alpha Fund	-0.345	6.108	0.772	2.166	0.737
BlackRock Global Funds - US Flexible Equity Fund	-0.456	7.254	0.785	2.040	0.737
BL - Global 75	-0.189	5.563	0.754	1.059	0.736
BlackRock Global Funds - US Basic Value Fund	-0.393	6.613	0.774	2.031	0.734
First State Global Property Securities Fund	-0.209	6.966	0.752	1.789	0.732
SEB Aktiesparfond	-0.704	10.774	0.814	1.615	0.732
Länsförsäkringar Pension 2015	-0.657	7.514	0.805	1.026	0.730
Danske Invest Global Index	-0.476	5.790	0.778	1.628	0.729
Pictet Security	-0.230	5.716	0.748	2.121	0.727
PineBridge American Equity Fund	-0.307	5.929	0.751	2.125	0.721
Fondita 2000+ Placeringsfond	-0.590	6.550	0.779	1.761	0.717
Spiltan Aktiefond Sverige	-0.611	7.848	0.781	2.108	0.716
SPP Generation 50-tal	-0.757	9.282	0.801	1.065	0.715
SEB Generationsfond 70-tal	-0.673	10.889	0.788	1.529	0.715
Skandia Smart Balanserad	-0.848	10.214	0.814	0.914	0.714
Swedbank Robur Technology	-0.605	8.909	0.775	2.037	0.712
F&C Portfolios Fund - US Smaller Companies A	-0.290	6.392	0.738	2.447	0.711
Danske Invest Horisont Aktie	-0.569	7.093	0.769	1.447	0.711
Delphi Nordic	-0.478	6.516	0.758	2.247	0.710
SEB Generationsfond 60-tal	-0.717	11.261	0.787	1.521	0.709
BL - Equities Dividend	-0.349	6.912	0.741	1.140	0.709
Delphi Global	-0.341	6.381	0.738	1.804	0.706
BL - Equities America	-0.369	6.134	0.740	1.935	0.706
BlackRock Global Funds - US Small & MidCap Opportunities Fund	-0.437	6.164	0.747	2.036	0.705
Morgan Stanley Investment Funds US Growth Fund	-0.562	8.392	0.758	2.130	0.703
Danske Invest SRI Global	-0.487	5.876	0.748	1.571	0.701
Swedbank Robur Transfer 70	-0.372	6.314	0.732	1.041	0.698
Handelsbanken Nordiska Småbolagsfond	-0.617	8.009	0.757	1.907	0.695
Pictet Water	-0.293	6.104	0.718	1.735	0.693
BL - Equities Horizon	-0.233	5.258	0.709	1.224	0.689
Länsförsäkringar USA Aktiv	-1.334	17.447	0.884	2.070	0.689
East Capital Baltikum	-0.343	8.278	0.716	1.148	0.686
Sparinvest SICAV - Equitas	-0.588	6.363	0.739	1.570	0.683
SEB Generationsfond 80-tal - Lux ack	-.8089162	8.736	0.766	1.471	0.682
NN (L) Information Technology	-0.177	6.167	0.694	2.008	0.679
Danske Invest SICAV - Global Stockpicking	-0.259	5.912	0.700	1.547	0.679
SEB Dynamisk Aktiefond	-0.760	12.587	0.754	1.725	0.679
C WorldWide Medical	-0.571	10.395	0.728	1.746	0.675
AMF Aktiefond Världen	0.625	7.331	0.634	1.475	0.675
F&C Portfolios Fund - F&C Responsible Global Equity	-0.445	5.910	0.710	1.551	0.672
Länsförsäkringar Pension 2010	-1.182	13.221	0.809	0.879	0.668
UBS (Lux) Equity Sicav - USA Growth B	-0.301	5.159	0.691	2.092	0.667
SEB Teknologifond	-0.678	9.479	0.728	1.817	0.665
Carnegie Sverigefond	-0.487	6.908	0.702	1.806	0.661
UBS (Lux) Equity Fund - Biotech (USD)	-0.169	4.508	0.672	2.962	0.659
SPP Generation 60-tal	-0.660	10.039	0.718	1.326	0.659
AMF Balansfond	-1.448	15.442	0.860	1.258	0.658
BlackRock Global Funds - Global SmallCap Fund	-0.457	5.839	0.693	1.709	0.655
Didner & Gerge Aktiefond	-0.489	7.389	0.693	1.992	0.653

Table 17: Based on $ASSR_2$

Pictet Global Megatrend Selection	-0.306	5.472	0.676	1.739	0.652
Länsförsäkringar Global Aktiv	-0.408	7.490	0.684	1.578	0.651
BlackRock Global Funds - Technology Fund	-0.579	6.339	0.699	1.910	0.650
AP7 Aktiefond	-0.607	8.285	0.700	1.910	0.649

Table 18: Based on SR

Fund name	**Skew**	**Kurt**	**SR**	**GR**	**ASSR**
Danske Invest SICAV - Global Corporate Bonds	-0.002	8.862	1.742	0.840	1.741
Swedbank Robur Transfer 50	-3.517	47.765	1.219	0.625	0.000
Nordea Generationsfond Senior	-5.612	82.472	1.210	0.631	0.000
Danske Invest Horisont Försiktig	-1.882	20.559	1.184	0.824	0.600
Länsförsäkringar Fastighetsfond	-0.536	7.091	1.179	2.648	1.047
Öhman Sweden Micro Cap	-0.995	9.662	1.152	2.535	0.906
Skandia Time Global	-0.611	10.980	1.110	2.659	0.976
Didner & Gerge Småbolag	-0.624	8.248	1.098	2.486	0.965
Skandia Smart Försiktig	-4.263	57.332	1.079	0.515	0.000
Swedbank Robur Realinvest	-0.741	8.575	1.073	2.021	0.920
Morgan Stanley Investment Funds US Advantage Fund	-0.480	8.416	1.066	2.574	0.971
Lannebo Vision	-0.596	8.705	1.052	2.254	0.936
SPP Generation 40-tal	-5.002	75.170	1.040	0.731	0.000
Danske Invest Horisont Balanserad	-0.600	6.595	1.028	1.089	0.916
Seligson & Co Global Top 25 Pharmaceuticals	-0.204	5.899	1.019	2.232	0.983
Seligson & Co Global Top 25 Brands	-0.226	5.681	1.017	2.128	0.977
Nordea Småbolagsfond Norden	-0.712	8.855	0.983	1.911	0.861
Spiltan Aktiefond Småland	-0.893	9.270	0.982	2.341	0.826
Handelsbanken Svenska Småbolagsfond	-0.760	8.167	0.982	2.463	0.851
Lannebo Småbolag	-0.675	7.697	0.978	2.306	0.864
Swedbank Robur Småbolagsfond Sverige	-0.821	8.700	0.972	2.272	0.833
Fondita Nordic Micro Cap Placeringsfond	-0.668	7.728	0.958	2.098	0.850
Spiltan Aktiefond Stabil	-0.528	6.524	0.955	1.960	0.871
Skandia USA	-0.732	10.632	0.947	2.165	0.830
Öhman Global Growth	-0.430	5.462	0.944	2.005	0.878
SEB Nordamerikafond	-0.559	9.704	0.944	2.151	0.857
First State Global Listed Infrastructure Fund	-0.135	5.241	0.943	1.813	0.923
SEB Läkemedelsfond	-0.446	8.923	0.942	2.059	0.874
SPP Aktiefond USA	-0.698	11.056	0.936	2.113	0.828
Öhman Småbolagsfond A	-0.833	8.806	0.935	2.190	0.805
Swedbank Robur Transfer 60	-0.954	11.216	0.929	0.741	0.780
Evli Sverige Småbolag	-0.736	7.804	0.927	2.356	0.815
Handelsbanken Läkemedelsfond	-0.439	9.399	0.922	2.084	0.857
Swedbank Robur Mixfond Pension	-1.816	24.258	0.909	0.976	0.610
ValueInvest LUX Global	-0.362	6.168	0.900	1.650	0.850
Skandia Småbolag Sverige	-0.752	8.544	0.900	2.110	0.792
Catella Småbolagsfond SEK Allmän klass	-0.780	9.000	0.899	2.093	0.787
BlackRock Global Funds - World Healthscience Fund	-0.319	6.002	0.899	2.355	0.855
SEB Världenfond	-0.839	11.106	0.899	1.300	0.778
Öhman Etisk Index USA	-0.336	5.079	0.895	2.118	0.849
DNB Teknologi	-0.262	5.118	0.894	2.505	0.859
KPA Etisk Blandfond 2	-0.671	7.926	0.888	1.231	0.795
Länsförsäkringar USA Aktiv	-1.334	17.447	0.884	2.070	0.689
SEB Generationsfond 50-tal	-0.908	10.714	0.880	1.032	0.754
Öhman Global Hållbar	-0.460	5.488	0.878	1.830	0.817
Öhman Hjärt-Lungfond	-0.393	5.241	0.875	1.766	0.824
AMF Aktiefond Småbolag	-0.828	7.981	0.865	2.151	0.755
Länsförsäkringar Trygghetsfond	-0.650	6.505	0.865	0.872	0.780
Pictet Digital	-0.188	4.651	0.862	2.437	0.839
AMF Balansfond	-1.448	15.442	0.860	1.258	0.658
Lärarfond 59+	-2.625	30.121	0.854	0.635	0.429
Odin Sverige	-0.429	6.592	0.853	2.272	0.800
BL - Global Equities	-0.382	5.708	0.840	1.425	0.794
Swedbank Robur Medica	-0.399	8.233	0.840	1.875	0.792
AMF Aktiefond Nordamerika	-0.686	10.760	0.832	1.911	0.749
Sparinvest SICAV - Procedo	-0.327	5.621	0.830	1.283	0.792
Nordea Generationsfond 40-tal	-0.722	7.182	0.826	0.740	0.739
Carnegie Strategifond	-0.695	8.448	0.825	1.359	0.742
Aberdeen Global - Japanese Smaller Companies Fund	-0.622	11.470	0.818	2.320	0.745
Skandia Smart Balanserad	-0.848	10.214	0.814	0.914	0.714
SEB Aktiesparfond	-0.704	10.774	0.814	1.615	0.732
F&C Portfolios Fund - European Small Cap A	-1.556	21.837	0.812	1.996	0.618
Länsförsäkringar Pension 2010	-1.182	13.221	0.809	0.879	0.668
Länsförsäkringar Pension 2015	-0.657	7.514	0.805	1.026	0.730
SPP Generation 50-tal	-0.757	9.282	0.801	1.065	0.715
BlackRock Global Funds - Global Allocation Fund	-0.192	5.179	0.800	1.423	0.780
SEB Generationsfond 70-tal	-0.673	10.889	0.788	1.529	0.715
Aberdeen Global - Technology Equity Fund	-0.299	6.031	0.787	1.849	0.755
SEB Generationsfond 60-tal	-0.717	11.261	0.787	1.521	0.709
Lannebo Mixfond	-0.396	6.658	0.787	1.255	0.745
BlackRock Global Funds - US Flexible Equity Fund	-0.456	7.254	0.785	2.040	0.737
Pictet Health	-0.274	5.713	0.782	2.024	0.753
Spiltan Aktiefond Sverige	-0.611	7.848	0.781	2.108	0.716
FIM Brands	-0.377	5.386	0.780	1.751	0.741
Fondita 2000+ Placeringsfond	-0.590	6.550	0.779	1.761	0.717
Danske Invest Global Index	-0.476	5.790	0.778	1.628	0.729
Swedbank Robur Technology	-0.605	8.909	0.775	2.037	0.712
BlackRock Global Funds - US Basic Value Fund	-0.393	6.613	0.774	2.031	0.734
Axa Rosenberg US Equity Alpha Fund	-0.345	6.108	0.772	2.166	0.737
Danske Invest Horisont Aktie	-0.569	7.093	0.769	1.447	0.711
Aberdeen Global - North American Equity Fund	0.286	9.988	0.766	2.017	0.794
SEB Generationsfond 80-tal - Lux ack	-.8089162	8.736	0.766	1.471	0.682
UBS (Lux) Equity Fund - Health Care (USD)	-0.206	5.043	0.765	2.061	0.745
Stewart Investors Worldwide Leaders Fund	-0.214	6.512	0.764	1.660	0.743
Morgan Stanley Investment Funds US Growth Fund	-0.562	8.392	0.758	2.130	0.703
Delphi Nordic	-0.478	6.516	0.758	2.247	0.710
Handelsbanken Nordiska Småbolagsfond	-0.617	8.009	0.757	1.907	0.695
SEB Dynamisk Aktiefond	-0.760	12.587	0.754	1.725	0.679
BL - Global 75	-0.189	5.563	0.754	1.059	0.736
First State Global Property Securities Fund	-0.209	6.966	0.752	1.789	0.732
SEB Europafond Småbolag	-1.496	20.151	0.751	1.856	0.594
PineBridge American Equity Fund	-0.307	5.929	0.751	2.125	0.721
Pictet Security	-0.230	5.716	0.748	2.121	0.727
Danske Invest SRI Global	-0.487	5.876	0.748	1.571	0.701
BlackRock Global Funds - US Small & MidCap Opportunities Fund	-0.437	6.164	0.747	2.036	0.705
BL - Equities Dividend	-0.349	6.912	0.741	1.140	0.709
BL - Equities America	-0.369	6.134	0.740	1.935	0.706
Sparinvest SICAV - Equitas	-0.588	6.363	0.739	1.570	0.683
F&C Portfolios Fund - US Smaller Companies A	-0.290	6.392	0.738	2.447	0.711
Delphi Global	-0.341	6.381	0.738	1.804	0.706
Swedbank Robur Transfer 70	-0.372	6.314	0.732	1.041	0.698
SEB Teknologifond	-0.678	9.479	0.728	1.817	0.665
C WorldWide Medical	-0.571	10.395	0.728	1.746	0.675
Pictet Water	-0.293	6.104	0.718	1.735	0.693
SPP Generation 60-tal	-0.660	10.039	0.718	1.326	0.659
East Capital Baltikum	-0.343	8.278	0.716	1.148	0.686
F&C Portfolios Fund - F&C Responsible Global Equity	-0.445	5.910	0.710	1.551	0.672

Table 19: Based on SR_2

BL - Equities Horizon	-0.233	5.258	0.709	1.224	0.689
Carnegie Sverigefond	-0.487	6.908	0.702	1.806	0.661
Lärarfond 45-58 år	-0.814	9.229	0.701	1.107	0.631
Danske Invest SICAV - Global Stockpicking	-0.259	5.912	0.700	1.547	0.679
AP7 Aktiefond	-0.607	8.285	0.700	1.910	0.649