Does Pension Fund Size Matter for Better Performance?

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Abstract

This paper investigates the influence of pension fund size on pension fund performance. The determinants of pension fund performance are discussed. Using a sample out of a dataset of all Dutch pension funds, different pension fund performance measures in relation to the size are investigated. It is found that there are no significant relationships between the pension fund size and the absolute performance, the relative performance, and the funding ratios. Funding ratios are significantly influenced by pension fund performance, and show a positive relationship. The rest of the performance is influenced other factors like longevity risk and inflation risk.

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Chapter 1: Introduction

The financial position of a lot of people is greatly reflected by pension funds. And in these economic unstable times a lot of pension funds seem to have trouble with maintaining their funding levels. Due to disappointing equity market returns and low interest rates, funding levels of pension funds have dropped fast. Besides, increased live expectancy makes it worse. The expectation is that in 2040 24.3% of the Dutch people is 65 years of age or older. The funding ratios are one of the most important characteristics on which pension funds are judged, and in many European countries there are rules for a certain minimum of the funding ratio. Besides the problems mentioned above, the assets which provide the excess return over the risk free rate tend to be more risky and tend to have a lower premium. The historical estimate of the premium of 4-5% seems to be incorrect and researchers claim that this premium is closer to 3% over the past century (see Capelleveen et al., 2003).

Because of these disappointing returns pension funds had to come up with solutions to raise their funding levels to the appropriate level. In many cases premiums were increased and parts of the risk were transferred from the companies to the participants. Besides pension schemes made a move from final salary to average salary schemes, to reduce costs of retirement security. All this resulted in less generous pension schemes.

Around 2 million people in the Netherlands are in their existence dependent or partly dependent on pension funds, so it is obvious that the performance of pension funds is of great importance for economic prosperity. The income of the people who are retired and worked their whole life for their retirement is dependent on the performance of the pension fund they paid their contribution to.

Bauer et al. (2010) show that there are large differences in sizes of pension funds and there are different ways in how they invest and manage their risk. In the Netherlands there are around 600 different pension funds which differ quite severely in size. Then the question arises:

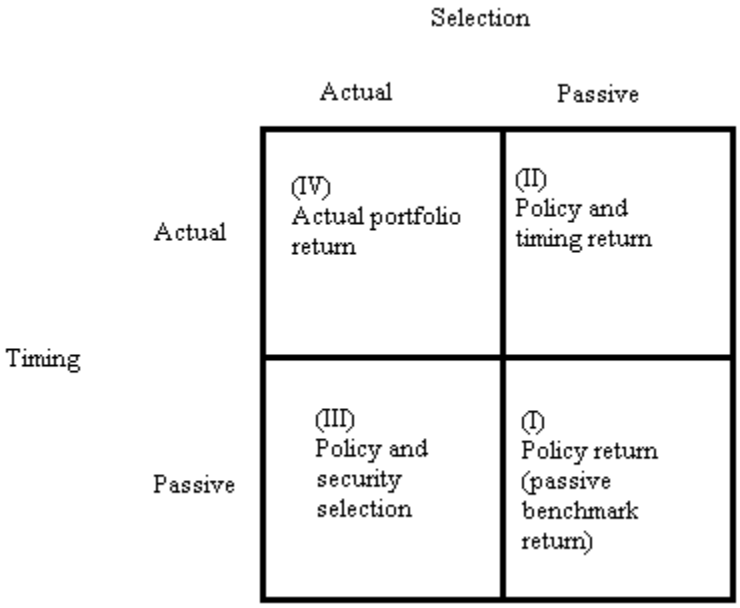
Does the performance of a pension fund depend on the size of the institution?

- What are the determinants of the performance of a pension fund?
- Where do pension funds invest?
- What costs influence pension fund performance?

Chapter 2: Literature review

2.1 What are the determinants of the performance of a pension fund?

A recent study found that more than 80% of corporate pension plans with assets over $2 billion have over 10 managers. And over two-third of corporate pension plans with asset over $50 million have more than one manager. Many funds focus their attention primarily on the selection of these managers and not so much on the contribution of their investments to the portfolio performance. In U.S. pension plans on average 93.6% of the variation in total plan returns is determined by investment decisions – investment policy, market timing and security selection. Brinson et al. (1986) developed a method to attribute the returns to the different factors determining returns. Because of this framework it is possible to see which investment decisions have the greatest impact on the returns and on the volatility of these returns.



One of the most important performance indications of a pension fund is the funding ratio. The funding ratio of a pension fund is the ratio of its assets over its discounted liabilities, since these liabilities lie mainly in the future. When the funding ratio is higher than 1 (or 100%) it means that the pension fund is able to cover all obligated payments. When the funding ratio is below 1 it means that the pension fund is either unable to cover their payments or it is in danger of not being able to do so. Pension funds have to meet certain solvency requirements to stay

financially healthy. These solvency requirements are usually higher than 100% because they take into account a certain amount of risk pension funds are exposed to. In the Netherlands pension funds have to keep up their funding levels at a minimum of 105%. When the funding level drops below 105% the fund has to make a recovery plan with their supervisor to restore the funding level on a short term. In the Netherlands the chance of underfunding is 2.5%, which means that once every 40 years a fund finds itself in a situation of underfunding. The underfunding chance which is strived for is 0.5% (underfunding once every 200 years). But this aspiration is rather impossible because then the funding ratio has to be around 170%. This is occasionally happening, but most of the time it is a one year outlier. There are several ways to improve funding levels of pension funds. For instance pension funds could use retirement pay based on average wages instead of pay-as-you-go or the funds can increase contributions. Unfortunately, these two regulations are at the expense of the working people. So the best way to keep funding levels high is to improve portfolio performance. This is however a great challenge for pension funds' portfolio managers. They have to decide how to allocate assets in order to achieve high returns with risk as low as possible. Asset/liability management (ALM) is always on the minds of pension managers and they use an asset/liability model to find the best investment solution (see Meder (2006)). This model shows that pensions should invest around 50% in real estate, but in reality investments in real estate have been between 4% and 5%. Craft (2005) found that the reason why investment in real estate should be so high according to the model is because real estate provides a diversification benefit with other asset classes, because of its low correlations. The low investment in real estate does not mean pension managers are irrational. The managers try to minimize the variance of the surplus return of the portfolio. Besides, the portfolio allocations are determined by correlations with the changes in the liabilities of the pension, not only by asset returns. The higher the correlations of the asset to the pension liabilities, the higher the received weights.

Asset allocation is one of the main factors that determine pension fund performance. Griffin (1998) found that asset allocation differs quite strongly among different countries. 13 countries where defined-benefit pension funds exceed $25 billion were compared in this study – including the Netherlands. Roughly, there are three main categories in which the asset allocation is divided. The most important distinction is the one between investing in equity or in bonds. Then there is the split in equity allocations between domestic and international, and finally there

is the split in bond allocations between domestic and international. First of all there are quite large differences in the allocation of bonds and equities. For instance two similar countries, like the Netherlands and the United Kingdom, have quite different investments in equities and bonds. In the United Kingdom equity holdings are 76% whereas equity holdings in the Netherlands are 26%. Total bond holdings are 11% in the United Kingdom and 63% in the Netherlands. Both countries have no restrictions on asset allocation and both countries coupled benefits to inflation. Besides, the outperformance of domestic equities over domestic bonds is also quite the same. The cause for the difference in asset allocation lies in the way pension plans are accounted for. In the UK the value of the assets is seen as the price at which the market is prepared to trade the expectations of future cash flowing from investments. So even though the market values change substantially, the actuarial valuation of the assets will not change. In the Netherlands bonds and real estate are held at book value and equities at market value. Liabilities are also treated different. In the UK liabilities are held at an actuarially assessed value; a long term salary growth assumption is used and these payments are discounted at an interest rate which is similar to the interest rate used for assets. In the Netherlands the benefit payments are simply discounted at 4 percent. The accounting standards in the UK decrease the impact of asset allocation on volatility of pension contributions. In the Netherlands the most important source of the volatility of funding levels and contributions comes from equity allocation. Second, there is the split in equity allocations between domestic and international. When an economy is more open there is more international diversification in pension funds' equity portfolios. So countries with high imports plus exports as a percentage of GDP have in general a higher international diversification. The reason for this relationship is that these countries hedge against imported inflation. When the domestic currency devaluates, the costs of imported goods raise which results in a higher price level. This causes higher wages and increasing pension liabilities. Therefore the more open economies have higher international diversification in their equity portfolios. Finally there is the split in bond allocations between domestic and international. However, for equity allocation there is a link with the openness of a economy, this is not the case for bond allocation. A possible reason for this is that a significant part of pension funds' liabilities are fixed cash flows which can be matched with domestic bonds. The rest of the liabilities have a positive link to the inflation of domestic wages. If this part of the liabilities is associated with equity investment, it explains the focus on imported inflation. Therefore international diversification in equity

portfolio increases when international trade increases, whereas international diversification in bond portfolio stays approximately at the same level.

Besides the asset allocation there are more factors influencing the performance of pension funds (see Meder (2006)). The part of the assets that is invested in equity is subject to market risk. Market risk is the day-to-day fluctuations in stock prices, also known as the volatility of the market. The market risk is the systematic risk that influences a large number of assets. Plans with high allocations in equity have high exposure to market risk. A certain political event can affect the assets in the fund's portfolio and it is hard to diversify against this risk. Besides this market risk, pension funds are subject to inflation risk. Pension plans have liabilities that are linked to salary growth and thereby to wage inflation. When pension plans are not hedged against this inflation and the actual inflation differs from the assumed inflation, funding ratios are exposed to inflation risk. Interest risk is also an influence on the funding ratio. Pension funds often have to cope with large differences between duration of assets and liabilities. So changes in interest rate will have different impact on assets and liabilities and thus causing a change in the funding ratio. This risk has more directly impact on bonds than on stocks. Because often funds also invest internationally, pension funds have to cope with currency risk. This risk is exposed to all investments made in foreign countries. Because of this risk, it is possible that the fund makes a loss despite an increase of the value of a foreign asset. This is possible if the foreign currency depreciates in relation to the domestic currency stronger than the value of the asset increases. When not hedged against this risk, it could influence the funding ratio as well.

A risk specific to pension funds is longevity risk. All pension funds have to cope with longevity risk and mortality risk. Defined benefit plans have longevity and mortality risk, whereas defined contribution plans have longevity risk. Longevity risk is the risk that inactive members who receive pension payments live longer than life expectancy. For pension funds longevity risk a very serious and important risk, because there is great uncertainty on longevity projections. This means that with longevity, pension funds' liabilities increase significantly. This is a problem that has to be addressed. To do so, pension actuaries use a mortality table and undertake complex stochastic projections on economic assumptions for asset liabilities. Recently, studies have incorporated mortality improvements by using projection scales with a fixed number of years. Unfortunately mortality is hard to predict and so optimally managing longevity risk is hard as well. This problem can be explained by the fact that longevity risk is a silent risk.

The consequences of longevity are experienced by the pension fund in the long term, whereas the consequences of asset allocation and investment risks have short or medium term impact. Short term solvency contributions could increase by weak investment performance by investment managers. This would also increase medium term pension fund contributions. Beside this silent risk, there is a lack of hedging possibilities against longevity risk. Mortality risk is the risk for active members or inactive members with deferred pensions to die earlier than expected. In contrast to longevity risk, there are hedging possibilities against mortality risk. One of them is the mortality swap or the survivor swap (Blake & Burrows (2001)). A survivor swap is an agreement to exchange future cash flows based on a survivor index. One of the most used survivor swaps is the survivor/longevity bond. This bond allows the hedger to protect against any unanticipated change in mortality until the maturity of the bond. In this case the hedger is a pension fund and an investment bank or a financial intermediary is the issuer of the bond. When the survivor index is lower than anticipated the issuer makes a profit. The future coupons depend on the percentage of the population that is retired on the issue date and who are still alive at the future coupon payment dates. The coupons on the bond decline over time but continue in payment until the last member of this group of the population has died. The hedge is effective when the bond's cash flow provide a close match for the payments of the hedger. Thus, the derivation of the survivor index is very important to the success of the bond. Governments also contribute to mortality risk by promoting health campaigns, and when successful, leading to mortality improvements. Survivor bonds enable pension provision to be a responsibility shared by both the private and the public sector.

2.2 Where do pension funds invest?

There are three main sorts of investments in which pension funds invest; bonds, equities and real estate. In a scheme of Defined Benefit (DB) there is no direct link between the benefits and returns on the investment portfolio. So researchers argued that pension funds should invest in a portfolio that exactly matches the liabilities. This means that the portfolio should consist of 100% long-term index linked bonds (De Jong (2006)). However, there are increasingly more Defined Contribution (DC) schemes and from a investments perspective it is possible that the fund find it optimal to invest in equities. But it is still suggested that pension funds should take a substantial position in bonds. In practice, pension funds invest between 40% and 60% in equities

and real estate. In the US and the UK this percentage is sometimes even more. The remainder is usually invested in medium-term nominal bonds, and a small fraction is invested in index linked bonds. This investment portfolio has a quite different risk-return profile than the liabilities of a pension plan. This results in a higher expected return and thus higher risk. In addition the inflation hedge is rather weak. A lot of pension fund managers have been criticized, arguing that they take too much risk at the expense of the participants in a pension fund who see their benefits becoming threatened. After the recent economic crisis this point is very clear and a lot of pension funds see their funding ratios drop below the required rate.

2.3 What costs influence pension fund performance?

To understand performance of a pension fund it is important to understand what kind of costs pension funds have to deal with. Administrative and investment costs can increase the cost of retirement security significantly (see Bikker & Dreu (2009)). When operating costs of pension fund assets increase by 1%, it will reduce eventual pension benefits with 27%.

The annual administrative costs in the Netherlands lie between 0.1% and 1.2% of pension fund assets. This is quite low compared to other countries. During 1992 and 2004 around 300 smaller Dutch pension funds were shut down and one of the main reasons was the relatively high cost level of pension plans. It was found that during this period the administrative costs depend rather on size of the pension fund and not so much on type of pension fund (the governance structure), management choices and pension plan design. These costs are, like many costs, likely to increase less than proportional due to economies of scale. Bikker & Dreu (2009) found that the average administrative costs in the small class Dutch pension funds where €927 per participant. This amount drastically decreases to €30 per participant in the large class pension funds. The difference is probably even larger because of underreporting of the smallest funds. The average administrative costs as a percentage of total assets follow a similar path, with 1.23% for the smallest fund class and 0.10% for the largest class.

Besides administrative costs pension funds face investment costs. Costs of electronic trading facilities, brokerage fees and wages of managers and portfolio analysts are all investment costs. Just like with administrative costs economies of scale exist with investment costs. There are at least two possible causes for the latter. A larger fund can spread costs over a larger amount

of assets, which results in costs that increase relatively less than the size of the assets. For example the cost of trading facilities, financial research, risk management, wages of asset managers and abiding regulations and accounting requirements increase less than proportional. Second, large pension funds have a better bargaining position.

These economies of scale lead to big differences between small and large funds regarding investment costs as well. The pension fund class with the lowest amount of participants has an average investment cost of €270 per participant and the class with the highest amount of participants has an average investment cost of €13 per participant. The average investment costs as a percentage of total assets decrease from 0.15% for the smallest funds to 0.10% for the largest funds.

Both administrative and investment costs are subject to economies of scale and are strongly dependent on the size of a firm.

Chapter 3: Theoretical framework

The purpose of this research is descriptive. This because the goal is to describe the influence of the size of pension funds on their performance. This research will be a quantitative study. Because the data will be gathered at a single point in time it is also a cross-sectional study. For this research pensionfund.info is consulted, which is a website that provides information about European pension funds and service providers of pension funds. A dataset of the annual reports of nearly 600 Dutch pension funds will provide the data needed for this research. A stratified random sample will be used to divide the dataset into three different segments based on the amount of assets under management (AUM) of the pension fund. This will be the measure of size of the funds. So the pension funds are named as a large (≥ 1000M€), a middle sized (< 1000M€ ≥ 100M€) or a small (< 100M€) fund. The performance will be measured as the yearly returns of the funds.

Out of the dataset for each segment a random sample of 15 funds is drawn, so there will be a total of 45 funds taken into account for this research. Because the results of the last ten years of each fund will be compared it is required that the annual reports go back to the year 2000. Descriptive statistics of the results like means and standard deviations will arise from the dataset. Then the gathered data will be analyzed in the form of correlation matrices and a linear regression model will be used to create a scatter plot of the performance over the fund size.

Finally an analysis based on the information ratio and on the funding ratio will be used to get insight in the relative performance and the solvency requirements of the pension funds.

As mentioned above, descriptive statistics will give a broad overview of the data. Next the data will be analyzed with a regression model to find a relation between the size and the absolute performance of the funds. The following formula will be used to show this relationship,

$$E(R_i) = \alpha_i + \beta_i x$$

Here, $E(R_i)$ is the expected return of the pension fund's portfolio, α_i is a constant, β_i is the slope of the regression analysis, and x is the size of the pension fund in billions of Euros. After the regression analysis a formula should come up with these parameters and it must show whether there is a relationship. Also the results must be checked for validity and significance. Besides a regression for the performance there will be a regression analysis conducted for the volatility of the pension funds.

To measure the performance of a pension fund's portfolio, not only the absolute performance is important, but it is quite relevant to know what the relative performance is of the fund. So besides the absolute rate of return the performance should be compared to a benchmark, for instance the return of pension funds with a similar investment portfolio. There are two often used ratios to measure the relative performance; the Sharpe Ratio (SR) and the Information Ratio (IR). Both ratios are measures of volatility-adjusted performance (Israelsen, (2004)). The main difference between these ratios is the definition of excess return. The Sharpe Ratio compares the return of a portfolio with the risk free rate and the Information Ratio compares the return with a relevant benchmark index. For both cases holds, that the higher the ratio the better. Top quartile managers achieve an Information Ratio of about one-half. For this research it is relevant to know how the pension funds perform compared to each other to find whether size influences the performance. Thus the performance relative to the risk free rate is less relevant. The formula for the Information Ratio is as follows,

$$IR = \frac{E[R - R_b]}{\sigma}$$

Here, R is the portfolio return, R_b is the benchmark return, $E[R - R_b]$ is the expected value of the active return and σ is the standard deviation of the active return (tracking error).

For this research the internal benchmarks of the pension funds will be used. The internal benchmarks are composed by the funds themselves so they reflect similar portfolios. This will lead to an accurate relative performance and therefore to a representative value of the Information Ratio.

Besides the evaluation of the absolute and relative performance, the funding ratios of the pension funds will be analyzed as well. Also for the funding ratios a regression analysis will be conducted to find a relationship between the size of the funds and the funding ratio. The statement made in the literature review that the chance of underfunding in the Netherlands is 2.5% will be compared to the sample used in this thesis. So the funds in the sample will be checked whether they meet the Dutch solvency requirements.

For the regression analysis conducted for the absolute and relative performance and for the funding ratios the correlations between these and the size of the fund must show whether the relation found in the regression is significant. Also the R^2-value must show how much the differences in performance are explained by the size of the pension funds.

Chapter 4: Empirical Results

First the absolute performance of the pension funds' portfolios is analyzed. Second, the performance is compared to the internal benchmarks, the relative performance, of the pension funds' portfolios. Finally the relationship between funding levels and size and the relation between the funding levels and the absolute performance is analyzed.

In figure 1, 2 and 3 the average returns and the average volatilities over the period 2000-2009 of each fund out of the sample size are given per category (small, medium and large). The returns of the small sized funds lie between -2.7% and 4.8% and the volatilities lie between 3.48% and 15.18%. For the medium sized funds these numbers are respectively -1.1% and 4.3%, and 5.06% and 17.77%. Finally for the large sized funds these numbers are respectively 2.1% and 4.8%, and 6.19% and 12.90%. Figure 4 shows an average of the return and volatility per category of fund size. The large funds have the highest return but also the highest amount of volatility. The medium funds have the lowest returns and the small funds have the lowest amount of volatility. Figure 14 shows the logarithmic scatter plot of the AUM against the absolute returns. From the regression analysis of the data the following equation comes up, with fund size as independent variable and the expected return as dependent variable,

$$E(R_i) = 3.088 + 0.007x$$

This formula implicates that for each billion Euros the fund size increases, the expected return increases with 0.007%. This regression is supported by a R^2- value of 0.037. This means that the performance is explained for 3.7% by the size of the fund, which is not enough to support a significant relationship between the fund size and the performance.

In addition to the absolute performance analysis, a relative performance analysis is conducted. As mentioned in the theoretical framework the internal benchmarks are used to calculate the Information Ratios of the pension funds' investment portfolios. Figures 6, 7 and 8 show the IR's of the pension funds of the period from 2000 until 2009 per size category. Unfortunately there were four funds in the sample size which did not report internal benchmarks in their annual reports, so these funds were left out in the analysis of the relative performance. The IR's of the small funds lie between -1.324 and 0.770. For the medium and large funds these ratios are respectively -2.294 and 0.489, and -0.653 and 0.543. Figure 9 shows that the average IR of each category is negative, with the medium funds performing worst and small funds performing best. This implicates that the pension funds underperformed regarding their internal benchmarks. Figure 15 shows the logarithmic scatter plot of the AUM against the IR. From the regression analysis the following equation comes up, with the fund size as independent variable and the IR as dependent variable,

$$E(IR) = -0.1827 + 0.003x$$

The formula implicates that for each billion Euros the fund size increases, the IR increases with 0.3%. This regression is supported by a R^2-value of 0.0403. This means that the IR is explained for 4.03% by the size of the fund, which is not enough to support a significant relationship between the fund size and the IR.

The last performance measure of the funds examined in this paper is the funding ratio. In figure 10, 11 and 12 the average funding ratios of funds can be found for the period 2000-2009. Two funds did not publish their funding ratio in the annual reports so these were left out in the further analysis. The average funding ratios of the small funds lie between 102.6% and 135.9%. For the medium size the ratios lie between 107.9% and 143.1% and for the large funds the ratios lie between 110.8% and 137.6% with one outlier of 185.9%. The pension funds of "VVV" and "Dutch Space" had a funding ratio over the ten year-period below the Dutch solvency rate of 105,

but still above 100. Figure 13 shows the average funding ratio for the three categories. It shows that the three categories have abundantly exceeded the 105%. However those numbers seem quite satisfying, still in 78 out of the 450 total years examined the funding level was below 105, which is not enough to meet the solvency required. The before mentioned chance of underfunding of 2.5% has been exceeded abundantly by 17.3 - 2.5 = 14.8%. This is mainly caused by the credit crisis that started in 2007. Because of this credit crisis almost all pension funds faced underfunding in 2008 and 2009. The funding ratios dropped to an average of respectively 97.8 and 104.3, with an outlier of 68.4. Figure 16 show the logarithmic scatter plot of the AUM against the funding ratio. From the regression analysis the following equation comes up, with the fund size as independent variable and the funding ratio as dependent variable,

$$E(FR) = 123.32 - 0.05x$$

The formula implicates that for each billion Euros the fund size increases, the funding ratio increases with 5%. This regression is supported by a R^2-value of 0.0147. This means that the funding ratio is explained for 1.47% by the size of the fund, which is not enough to support a significant relationship between the fund size and the funding ratio. Figure 5 shows the correlation between the fund size and the performance measures. It is obvious that there are no strong correlations, since all the values are around zero and nowhere near 1 or -1. The funding ratio shows a slightly negative correlation with the fund which also can be seen in the regression equation. Figure 17 shows the scatter plot of the return against the funding level. From the regression analysis the following equation comes up, with the return as independent variable and the funding ratio as dependent variable,

$$E(FR) = 121.35 + 0.5759x$$

This formula implicates that for each percentage point the return increases the funding ratio increases with 0.5759 point. This regression is supported by a R^2-value of 0.1132, which means that the funding ratio is explained for 11.32% by the performance of the investment portfolio. This is also not a very high value, but since Dutch pension funds invest relatively small amounts of their portfolio in equity it is a significant influence. This is the effect of the market risk on the funding levels. The other risks affecting pension fund performance, like longevity risk and inflation risk are risks that have great influence on the performance as well.

Chapter 5: Discussion

It is obvious that in this investigation there is no reason to believe that pension fund size has a significant influence on the performance of pension funds. The empirical results show very low correlations (values around zero) and low R^2-values for the relationships between the size and the performance measures. Bauer (2010) found that in the US the size of pension funds does influence the performance of the funds. In fact, small funds were performing better than large funds and were able to outperform their benchmarks. Liquidity limitations of the larger funds were the main reason found for this, but also the overlap of the tasks of managers in the large funds caused inefficiency. These reasons indicate that small funds perform better, but other researchers (Bikker & Drue (2009) for instance) found reasons that plead for a different opinion. One of the main reasons is that large funds benefit from economies of scale. Economies of scale lead to advantages in administrative costs and investment costs, because large funds can spread these costs over larger amounts of assets. So the administrative and investment costs per participant decrease drastically when funds size increases. These two findings contradict and this is a possible explanation for the lack of significant result in this research.
Besides, the risk variables discussed in the literature review were not included in the technical part of the research. Purely the performance measures of the funds were investigated. It is a possibility that these risk variables have a major impact on the performance of the funds. Finally, the data sample used in this research was small compared to the dataset that Bauer (2010) used. He used a bias-free CEM dataset of a large sample of the US pension funds, whereas in this research a rather small sample of 15 funds per size category is used. Therefore, the results of this research could be different when a larger dataset had been used.

Chapter 6: Conclusion

In this paper the relationship between the size of the pension fund and the performance of a pension fund is investigated. Out of 600 Dutch pension funds a sample of 45 funds is chosen and classified into three different size categories. The performance of the funds is separated into three different performance measures: the absolute performance of the investment portfolio, the relative performance in the form of the Information Ratio and the funds' funding ratios. It turns out there is a positive relationship between the fund size and the absolute performance and

between the fund size and the relative performance. Between the fund size and the funding ratio there is a negative relationship. Despite these relationships it cannot be concluded that the size of a fund influences the performance, because the R^2-values of these relationships were negligibly small – between 1.47% and 4.03%. Also, correlations between the size and the performance variables were close to zero, indicating that there is barely coherence between them. These outcomes indicate that the performance of pension funds is influenced by other variables like market risk. This is examined by the relation between returns and funding ratios, which has a positive relationship, shown by the R^2-value of 11.32%. The rest of the performance is explained by other risk variables like longevity risk, interest risk, etc. Solvency requirements were not met by a large part of the funds in the sample in 2008 and 2009 after the credit crisis started in 2007. In the years before 2007 almost all pension funds met the Dutch solvency requirements. In this research, no significant positive or negative relationship between pension fund size and pension fund performance is found.

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Appendices

Figure 1. This table shows the performance of small sized pension funds (funds with assets under management smaller than €100M). The average return of the fund and the corresponding volatility is shown over the period 2000-2009.

Pension fund	AUM (€)	Average return (%) (2000-2009)	Average volatility (%) (2000-2009)
SDU	1,978,000	3.8	6.91
VUT – ECI	4,253,000	-2.7	15.18
Fondsenbeheer Waterbouw	12,770,376	3.4	13.30
Brandstoffenbedrijf	16,612,908	3.8	6.35
Waterbouw	19,869,993	4.8	3.97
Renolit Nederland	30,427,000	3.2	5.47
Consumentenbond	34,789,730	4.7	7.78
VVV	53,867,000	3.5	5.28
TDF Botlek	56,975,000	4.2	6.15
ECI	57,791,000	2.8	7.01
Draka Holding	77,963,000	2.4	9.10
Solvay Chemie	82,420,000	3.3	7.42
Dutch Space	83,061,000	3.7	3.48
Woningraad	86,142,000	3.7	5.51
GITP	92,904,000	4.4	7.48

Figure 2. This table shows the performance of medium sized pension funds (funds with assets under management smaller than €1000M but over €100M). The average return of the fund and the corresponding volatility is shown over the period 2000-2009.

Pension fund	AUM (€)	Average return (%) (2000-2009)	Average volatility (%) (2000-2009)
Cindu International	124,359,000	2.0	9.25
Lindegas Benelux	157,537,000	2.4	8.97
Verloskundigen	159,284,000	3.6	6.89
CSM Nederland	161,703,000	2.1	8.24
Johnson & Johnson Nederland	166,293,000	1.2	17.77
CSM Suiker	204,497,000	3.8	10.29
Campagne	299,147,000	2.8	7.18
Fonds voor het Kappersbedrijf	334,259,000	4.1	6.40
Alliance	393,572,000	-1.1	14.02
Fonds voor Medewerkers in het Notariaat	579,773,000	2.4	6.31

Ballast Nedam	607,702,000	3.0	7.72
Telegraaf	657,118,000	3.5	8.27
Arcadis Nederland	663,257,000	2.9	10.24
Wolters Kluwer Nederland	686,856,000	4.3	7.67
De Nederlansche Bank	948,564,000	3.1	5.06

Figure 3. This table shows the performance of large sized pension funds (funds with assets under management over €1000M). The average return of the fund and the corresponding volatility is shown over the period 2000-2009.

Pension Fund	AUM (€)	Average return (%) (2000-2009)	Average volatility (%) (2000-2009)
Fysiotherapeuten	1,844,224,000	3.3	7.83
TNO	2,197,474,000	4.1	10.47
IBM Nederland	3,063,796,000	2.1	11.75
Horeca en Catering	3,299,485,000	3.4	10.36
Afwerking- en Glaszetbedrijf	3,603,990,000	4.0	6.19
KLM	4,668,500,000	4.3	12.32
Medische Specialisten	5,206,808,000	3.0	10.48
Hoogovens	5,754,000,000	4.8	8.74
Huisartsen	7,444,884,000	2.1	12.90
Beroepsvervoer over de Weg	7,854,936,000	3.6	9.27
ABN AMRO	9,440,282,000	2.8	7.40
ING	12,342,010,000	3.3	9.31
Philips	13,952,100,000	2.9	8.22
Zorg en Welzijn	96,866,000,000	4.7	12.38
ABP	257,269,000,000	4.4	11.58

Figure 4. This table shows the average return per size category and the corresponding average annualized volatility over the period 2000-2009.

Size	Average return (%) (2000-2009)	Average volatility (%) (2000-2009)
Small	3.3	7.36
Medium	2.7	9.0
Large	3.5	9.9

Figure 5. This table shows the correlations between the fund size and the investigated performance measures.

	Pension Fund Size
Average Return	0.192
Information Ratio	0.201
Funding Ratio	-0.121

Figure 6. This table shows the Information Ratio - which is the relative performance compared to an internal benchmark - of the small sized funds (funds with assets under management smaller than €100M) over the period 2000-2009. N/A means that there was no data available of the internal benchmark of the pension fund.

Pension Fund	AUM (€)	IR (2000-2009)
SDU	1,978,000	N/A
VUT – ECI	4,253,000	N/A
Fondsenbeheer Waterbouw	12,770,376	0.041
Brandstoffenbedrijf	16,612,908	-0.121
Waterbouw	19,869,993	0.609
Renolit Nederland	30,427,000	-1.324
Consumentenbond	34,789,730	0.142
VVV	53,867,000	0.770
TDF Botlek	56,975,000	0.339
ECI	57,791,000	0.143
Draka Holding	77,963,000	-0.038
Solvay Chemie	82,420,000	-0.642
Dutch Space	83,061,000	-0.749
Woningraad	86,142,000	-0.178
GITP	92,904,000	-0.660

Figure 7. This table shows the Information Ratio - which is the relative performance compared to an internal benchmark - of the medium sized funds (funds with assets under management smaller than €1000M but over €100M) over the period 2000-2009. N/A means that there was no data available of the internal benchmark of the pension fund.

Pension fund	AUM (€)	IR (2000-2009)
Cindu International	124,359,000	-0.250
Lindegas Benelux	157,537,000	N/A
Verloskundigen	159,284,000	-0.482
CSM Nederland	161,703,000	0.489
Johnson & Johnson Nederland	166,293,000	-0.076
CSM Suiker	204,497,000	-0.039
Campagne	299,147,000	0.466
Fonds voor het Kappersbedrijf	334,259,000	-0.264
Alliance	393,572,000	-0.542
Fonds voor Medewerkers in het Notariaat	579,773,000	-0.156
Ballast Nedam	607,702,000	-0.283
Telegraaf	657,118,000	N/A
Arcadis Nederland	663,257,000	-2.294
Wolters Kluwer Nederland	686,856,000	0.367
De Nederlansche Bank	948,564,000	0.043

Figure 8. This table shows the Information Ratio - which is the relative performance compared to an internal benchmark - of the large sized funds (funds with assets under management over €1000M) over the period 2000-2009.

Pension Fund	AUM (€)	IR (2000-2009)
Fysiotherapeuten	1,844,224,000	-0.351
TNO	2,197,474,000	0.130
IBM Nederland	3,063,796,000	-0.285
Horeca en Catering	3,299,485,000	-0.138
Afwerking- en Glaszetbedrijf	3,603,990,000	-0.142
KLM	4,668,500,000	0.134
Medische Specialisten	5,206,808,000	-0.474
Hoogovens	5,754,000,000	-0.040
Huisartsen	7,444,884,000	-0.183
Beroepsvervoer over de Weg	7,854,936,000	-0.234
ABN AMRO	9,440,282,000	-0.653
ING	12,342,010,000	-0.249
Philips	13,952,100,000	-0.050
Zorg en Welzijn	96,866,000,000	0.543
ABP	257,269,000,000	0.310

Figure 9. This table shows the average Information Ratio per size category over the period 2000-2009.

Size	Average IR (2000-2009)
Small	-0.034
Medium	-0.141
Large	-0.102

Figure 10. This table shows the funding ratios of the small sized pension funds (funds with assets under management smaller than €100M) over the period 2000-2009. N/A means that there was no data available of the funding ratio of the fund.

Pension Fund	AUM (€)	Funding Ratio
SDU	1,978,000	117.8
VUT – ECI	4,253,000	N/A
Fondsenbeheer Waterbouw	12,770,376	125.7
Brandstoffenbedrijf	16,612,908	177.2
Waterbouw	19,869,993	N/A
Renolit Nederland	30,427,000	115.8
Consumentenbond	34,789,730	107.8
VVV	53,867,000	102.8
TDF Botlek	56,975,000	115.7
ECI	57,791,000	112.3
Draka Holding	77,963,000	120.2
Solvay Chemie	82,420,000	125.5
Dutch Space	83,061,000	102.6
Woningraad	86,142,000	135.9
GITP	92,904,000	105.2

Figure 11. This table shows the funding ratios of the medium sized pension funds (funds with assets under management smaller than €1000M but over €100M) over the period 2000-2009.

Pension fund	AUM (€)	Funding Ratio
Cindu International	124,359,000	125.0
Lindegas Benelux	157,537,000	113.9
Verloskundigen	159,284,000	131.9
CSM Nederland	161,703,000	113.3
Johnson & Johnson Nederland	166,293,000	109.8
CSM Suiker	204,497,000	143.1
Campagne	299,147,000	118.8
Fonds voor het Kappersbedrijf	334,259,000	131.9
Alliance	393,572,000	123.7
Fonds voor Medewerkers in het Notariaat	579,773,000	107.9
Ballast Nedam	607,702,000	108.6
Telegraaf	657,118,000	128.4

Arcadis Nederland	663,257,000	124.8
Wolters Kluwer Nederland	686,856,000	123.6
De Nederlansche Bank	948,564,000	120.6

Figure 12. This table shows the funding ratios of the large sized pension funds (funds with assets under management over €1000M) over the period 2000-2009.

Pension Fund	AUM (€)	Funding Ratio
Fysiotherapeuten	1,844,224,000	185.9
TNO	2,197,474,000	120.9
IBM Nederland	3,063,796,000	131.3
Horeca en Catering	3,299,485,000	119.2
Afwerking- en Glaszetbedrijf	3,603,990,000	126.4
KLM	4,668,500,000	126.4
Medische Specialisten	5,206,808,000	120.0
Hoogovens	5,754,000,000	111.7
Huisartsen	7,444,884,000	137.6
Beroepsvervoer over de Weg	7,854,936,000	115.0
ABN AMRO	9,440,282,000	118.3
ING	12,342,010,000	125.2
Philips	13,952,100,000	124.9
Zorg en Welzijn	96,866,000,000	118.8
ABP	257,269,000,000	110.8

Figure 13. This table shows the average funding ratio per size category over the period 2000-2009.

Size	Average Funding Ratio
Small	120.3
Medium	121.7
Large	126.2

Figure 14. This figure shows the scatter plot of the assets under management against the average return of the pension funds in the period 2000-2009. The x-axis is on a logarithmic scale. Next to the scatter plot the regression analysis and the corresponding R^2-value are shown.

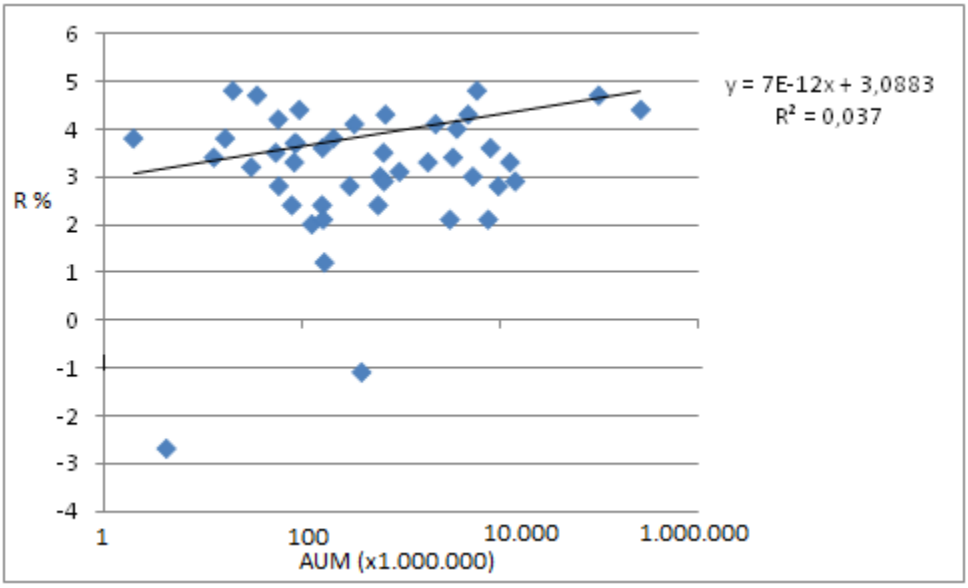


Figure 15. This figure shows the scatter plot of the assets under management against the average IR of the pension funds in the period 2000-2009. The x-axis is on a logarithmic scale. Next to the scatter plot the regression analysis and the corresponding R^2-value are shown.

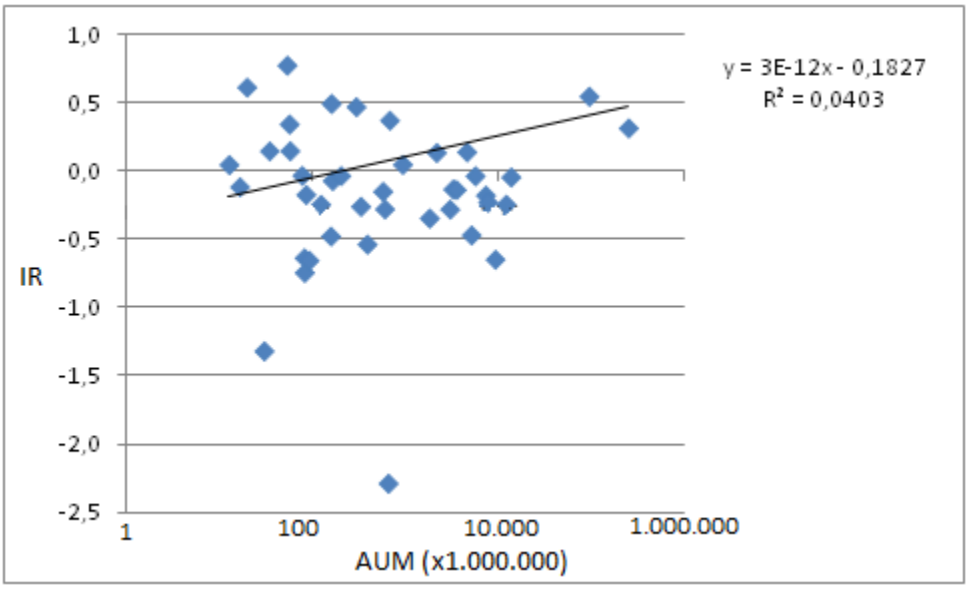


Figure 16. This figure shows the scatter plot of the assets under management against the average funding ratio of the pension funds in the period 2000-2009. The x-axis is on a logarithmic scale. Next to the scatter plot the regression analysis and the corresponding R^2-value are shown.

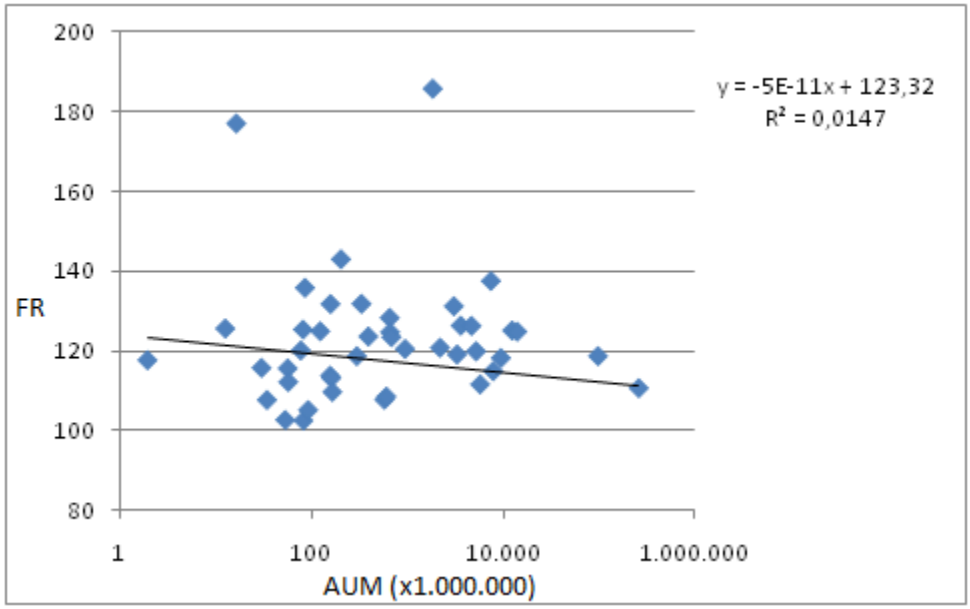


Figure 17. This figure shows the relation between the average return against the funding ratio over the period 2000-2009.

