Pension Fund Investment: Which Factors Determine the Investment Policy of Dutch Pension Funds?

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This paper investigates which factors determine the strategic risk exposure of Dutch pension funds. In contrast to previous research, the complete spectrum of risky assets is included, resulting in a model that accounts for a pension fund's investment in equity, private equity, hedge funds, commodities and various other types of risky alternative assets. The main findings include evidence of the use of lifecycle investment theory in Dutch pension funds, as well as a relationship between pension funds size, generosity and plan type to the degree of strategic risk exposure. Contrary to previous research, no relationship is observed between a plan's funding ratio and its strategic asset allocation.

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1. INTRODUCTION

Although we don't enjoy thinking about it, someday we will all be old. Given the inevitability of old age, it would be wise to prepare ourselves for it. Most of us do this is by contributing to a pension plan. But what happens to the money that goes into these pension plans? The obvious answer to this question is that it is invested. But how is it invested and why is it invested this way? These are the questions this paper will seek to answer for Dutch pension funds. To be more specific, this paper will investigate the *strategic* asset allocation of Dutch pension plans, also referred to as investment policy. Strategic asset allocation refers to the distribution policy of funds over various asset classes, which is usually determined by an Asset Liability Management (ALM) study. This may differ from the actual distribution, due to market-timing efforts or imperfect rebalancing. Why is it important to investigate pension fund investment policy? Recent economic and demographic developments have pulled into question the sustainability of the Dutch pension facilities (Frijns, Nijssen, & Scholtens, 2010; Goudswaard, Nijman, Schnabel, & Beetsma, 2010). To ensure that current and future generations may also enjoy a financially sound retirement, every aspect of the current pension facilities must be closely scrutinised, including the pension fund investment process.

Given that "nominal defined-benefit pension liabilities can be hedged by investing in the replicating portfolio of fixed income securities" (Bikker, Broeders, & De Dreu, 2010, p. 54), it is curious that most pension funds still invest a large portion of their funds in risky assets. Most likely, they are trying to achieve a surplus in assets, to reduce future contribution or apply indexation to their liabilities (as compensation for inflation). However, pension funds cannot just maximise the return on their assets using mean-variance optimisation. They must, at all times (and by Dutch law), take into account their liabilities. Thus, they have to seek a balance between generating return and securing their ability to meet their obligations. But it appears this balance varies greatly among Dutch pension funds. For example, there are funds that invest up to 60% of their assets in risk-bearing securities such as equity, while others may invest as little as 10% in risk-bearing securities. Clearly there are elements that influence a pension fund's investment decision, and encourage them to take more or less risk.

Previous research has provided some insight into what may influence risk exposure, such as: liability structure (Alestalo & Puttonen, 2006), funding ratio (Bikker et al., 2010), pension fund size (Bikker, Broeders, Hollanders, & Ponds, 2012a) and market conditions (Bikker et al., 2010). However, the focus has always been on the strategic equity exposure of pension funds. This paper takes a different approach than the current literature by paying more attention to the overall risk taken by pension funds. This means taking into account a larger array of risky assets. Risk taking will be measured by the percentage of investments allocated to risky assets such as: equity, private equity, hedge funds, hybrid securities and high yield bonds. In addition, tests will also be carried out using only equity as the independent variable, to make comparisons to previous work.

The purpose of this paper is to extend previous work by Bikker et al. (2012a) on Dutch pension fund investment behaviour. In addition, it aims to contribute to the academic understanding of pension fund investment policy. The paper will proceed as follows: section 2 contains an extensive review of the literature on pension fund investment policy and provides the basis for the hypothesis development; section 3 presents the data that was used; section 4 elaborates on the methodology; section 5 and 6 present the results and introduce some robustness checks; and sections 7 and 8 will conclude with a discussion about the limitations of this research and its implications for others.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Four elements are important to understand pension fund investment behaviour. First of all, a distinction must be made between the active components of the investment process and the passive components. The difference between these components is usually responsible for the discrepancy between strategic and actual asset allocation. Second, it is important to understand that the design of strategic asset allocation is based on the risk-profile a pension fund chooses to adopt. This discussion lies at the heart of this research, since long-term performance of pension funds is strongly dictated by its strategic asset allocation and the corresponding risk profile. Third, to understand pension fund strategic portfolios and the method used in this research, it is necessary to elaborate on the characteristics of the asset classes at a pension fund's disposal and their implications for pension fund portfolios. Finally, it is necessary to have some knowledge of the regulatory and institutional environment that pension funds operate (in this case the Dutch environment) and how this may affect their investment policy. The following sections will discuss each of these elements in detail, and how they may relate to investment policy.

2.1 Pension fund investment process

Brinson, Hood and Beebower (1986) were the first to decompose the investment process of pension funds. They realised that the effort that was put into the selection of management could only be justified if these managers contributed significantly to performance. Using a conceptually simple model, they divided the investment process into three different attributes: investment policy, market timing and security selection (Brinson et al., 1986), where investment policy is the process of strategic asset allocation, while market timing and security selection are part of active portfolio management and are often referred to as tactical asset allocation.

Brinson and his colleagues managed to create quite a stir when they concluded from their studies that "[strategic] asset allocation policy […] is the overwhelmingly dominant contributor to total return" (Brinson, Singer, & Beebower, 1991), indicating that portfolio managers didn't really add any value. However, as Ibbotson and Kaplan (Ibbotson & Kaplan, 2000) pointed out, it really depends on how the question is formulated. If ones looks at the performance of funds *over time*, then it is indeed the policy that drives performance, but if one looks at the difference in performance *among funds*, only 35% of the variation is explained by differences in policy. Likewise, Xiong et al. (Xiong, Ibbotson, Idzorek, & Chen, 2010) found that "…within a peer group, asset allocation policy return in excess of market return and active portfolio management are equally important" (p. 28).

Pension fund policy design is considered to be the most interesting part of the investment process, since it better captures the trade-offs that pension funds make when balancing return and risk. Where the aim of tactical asset allocation is solely to generate additional return through ad hoc decisions, strategic asset allocation involves the careful ex ante

designation of weights to various asset classes based on a fund's risk preferences (elaboration follows in section 2.2) and its asset liability management study. The rest of this paper will focus on strategic allocation. Actual asset allocation will merely be used to test the robustness of the results.

2.2 Pension fund risk profile

Perhaps the most important aspect of the pension fund investment process is the risk profile it adopts. This risk profile reflects the risk/return preferences of a fund's stakeholders, which are: the beneficiaries and the sponsors (de Dreu & Bikker, 2012). However, these stakeholders do not always have the same preferences. Also, preferences might change or even be ignored depending on the state of the fund and its ability to cater to the needs of its stakeholders.

Starting with the beneficiaries, it is theorised that risk preference should change over time, in accordance with lifecycle theory (described here). Taking into account that individuals have labour income that varies over the course of their life, optimal investment strategy should consider the risk-return characteristics of (current and future) labour income, also referred to as human capital. As individuals age, human capital diminishes and becomes less flexible, turning a previously large low-risk asset into a small high-risk asset. Investing in assets with less risk should then offset this movement. Assuming that pension funds apply this rationale when determining their strategic asset allocation, this paper's first hypothesis is that there is a negative relationship between the average age of participants of Dutch pension plans and strategic risk exposure (H1). Evidence for a negative relationship between age and strategic equity exposure has already been observed in Swiss, Finnish and Dutch pension plans (see: Gerber & Weber (2007), Alestalo & Puttonen (2006) and Bikker et al. (2012a)).

The interest of sponsors can also play a strong role in determining risk preferences of pension funds, especially in the case of defined benefit (DB) plans. With DB plans, the investment risk is entirely born by the plan sponsor, whose contributions depend on the outcome of a fund's investments. When the fund performs poorly, the sponsor may have to make additional contribution payments. However, as higher returns may lead to lower future contributions, plan sponsors may also be inclined to take more risk. Indeed previous research (An, Huang, & Zhang, 2013) has demonstrated that sponsors may sometimes prefer to increase a pension fund's risk profile, particularly in countries that have some form of pension benefit insurance such as the Pension Benefit Guarantee Corporation in the U.S. Contrary to DB plans, defined contribution (DC) plans shift the risk entirely to a plan's participants by making the sponsor's contributions fixed and the benefits dependent on the investment outcome. Since the plan participants are mainly concerned with securing their pension, and the sponsor has nothing to gain through higher expected returns, there is less incentive to increase risk. It is therefore hypothesized that DB plans will, on average, invest more in risky assets than DC plans (H2).

In addition to stakeholder preferences, a strong determinant of pension fund risk profile is its state of solvency. Previous research (Alestalo & Puttonen, 2006; An et al., 2013; Bikker et al., 2012a; Rauh, 2008) has found a positive relationship between funding ratio and strategic equity exposure, indicating that funds with higher buffers are more risk tolerant, while funds with lower solvency ratios tend to invest more in safe assets. The only exception appears to be DB plans in the U.S. This is most likely explained by their use of expected portfolio returns in discounting liabilities, as pointed out by Andonov, Bauer & Cremers (2012). This paper will also include funding ratio in its analysis, adopting the hypothesis that it is positively related to strategic risk exposure (H3).

Similar to the previous argument, a positive relationship has also been observed between the level of risk and the wealth of individual plan members. Similar to the behaviour of private individuals who invest more in risky assets as they become wealthier, pension funds of wealthier participants also take more risk (Bikker, Broeders, Hollanders, & Ponds, 2012b). Thus the hypothesis is that pension plans with higher assets per participant take, on average, more risk than those who invest on behalf of poorer individuals (H4).

Finally, previous research has found evidence for a positive relationship between pension fund size and risk taking (Bikker et al., 2012a). This is usually attributed to a higher degree of professionalism, associated with larger funds. Dreu & Bikker (2012) observe a strong relationship between investor sophistication and size, and investor sophistication and risk-taking (even when controlling for size). Another explanation could be economies of scale: as pension funds become larger the marginal costs of expertise decrease, encouraging the employment of managers specialising in equities or alternative assets. Based on these arguments it is hypothesized that larger pension funds invest, on average, more in risky assets than smaller pension funds. (H5)

2.3 Pension fund asset classes

When designing asset allocation policy, pension funds have a variety of asset classes at their disposal. However, there is much debate about the suitability of each asset class. There are some who argue that pension funds should only invest in fixed-income securities, allowing them to match their assets to their liabilities (Bodie, 2001), while others argue that pension funds should attempt to add value by earning a spread between their assets and their liabilities (Alestalo & Puttonen, 2006). This section will discuss the characteristics of the most common asset classes found in Dutch pension fund portfolios: equity, fixed-income securities, real estate, private equity, hedge funds and commodities.

2.3.1 Equity

Generally viewed as a high-risk / high-return asset class, the suitability of equity as an investment vehicle for pension funds is up for debate. A strong argument against equity is the risk mismatch that results from equity exposure. This mismatched risk must be absorbed by one of the fund's stakeholders, e.g. one generation may thrive at the expense of another. On the other hand, one could argue that a fund's assets and liabilities are never perfectly matched, due to the changing nature of liabilities as a result of increasing wages and inflation. Equity could then serve as a hedge, due to the positive long-term correlation between stock returns and wages and inflation (Lucas & Zeldes, 2006). In addition, if indexation is conditional on funding ratio, like is often the case in Dutch pension funds, the optimal portfolio is likely to contain equity due to its higher expected return.

Another argument in favour of equity relates to the long-term performance of this asset class. Some authors argue that the risk of equity diminishes over time due to the long-term mean reversion of its returns: the annualised standard deviation halves over a 25-year horizon (Campbell & Viceira, 2002;

Hoevenaars, Molenaar, Schotman, & Steenkamp, 2008). Given the long-term investment horizon of pension funds, this should make equity a more attractive asset class. However, this argument is controversial, since the cost of insuring against returns below the risk free rate does not decrease with time (Bodie, 2001).

2.3.2 Fixed-income securities

Fixed-income securities are investments that provide a return in the form of fixed periodic payments and the eventual return of principal at maturity. Examples include corporate or sovereign bonds. The attractiveness of fixed-income securities in asset-liability management (ALM) comes from the possibility to replicate the liability portfolio, which, without indexation, is basically a fixed series of expenses with a discount rate that runs in tandem with bond yields. Another argument has to do with the aforementioned risk mismatch resulting from investing in more risky assets. In order to ensure equitable distribution, pension funds have to hedge this risk. In a perfect market the cost of this protection would match the additional returns, resulting in the same return as an all-bonds strategy. Thus "a pension fund cannot add value by changing the asset mix, assets held in an all bonds strategy are equal in value to those in an all-equity strategy" (Bikker et al., 2012a, p. 4). Finally, "pension funds invest on behalf of the risk bearing stakeholders. In a perfect market, a pension fund can do nothing that individual stakeholders cannot do directly themselves. The best strategy is [therefore] an all bond strategy with no mismatch risk at all" (Bikker et al., 2012a, p. 4).

2.3.3 Real estate

After stocks and bonds, real estate is one of the most popular asset classes for pension funds. The asset class is attractive due to its long-term nature. In addition, "investments in real estate are less volatile, offer a stable cash flows, and serve well for portfolio diversification purposes" (Gerber & Weber, 2007, p. 322). Yet Brounen, Prade and Verbeek (2010) find that pension fund holdings of real estate are substantially less than would be suggested by mean-variance optimisation. They observe that inflation and interest rate hedging capabilities of real estate are poor. After accounting for poor hedging in their model, the projected allocations come closer to the reported ones. Overall, the conclusion is that "real estate offers no addition advantage beyond its diversification potential and its attractive risk-reward characteristics" (Brounen et al., 2010, p. 801).

2.3.4 Private equity

In addition to the three common asset classes mentioned above, pension funds have a variety of alternative investment classes at their disposal, one of which is private equity: equity that is not traded publicly. Bond, Hwang, Mitchell and Satchell (2007) in their analysis of return data of British private equity trusts from 1990 to 2006, find that private equity is the best performing asset class (compared to all other classes mentioned here) over the period. However, private equity returns also showed the highest degree of volatility, in addition to being strongly correlated to hedge funds and equities. The latter implies that private equity serves as a poor source of diversification.

2.3.5 Hedge funds

Although hedge funds as an asset class can be hard to define, it is possible to characterize hedge funds in general by a number of features. "These features include a largely unregulated organisational structure, flexible investment strategies, relatively sophisticated investors, substantial managerial investment and strong managerial incentive" (Ackermann, McEnally, & Ravenscraft, 1999, p. 834). Analysis of historic performance of hedge funds provides mixed results. According to Malkiel and Saha (2005), hedge funds can easily manipulate returns data causing returns calculated from hedge fund databases to be biased upwards. This is confirmed by others, e.g. (Bing, 2000). After correcting for these biases, they find that hedge funds have lower returns than commonly supposed. In addition, "the cross-sectional variation and the range of individual hedge fund returns are far greater than they are for traditional asset classes" (p. 87). This poor performance is confirmed by several authors (e.g. Dichev & Yu (2011), Ackermann et al. (1999)).

2.3.6 Commodities

Commodities refer to financial contracts of which the value is determined by the price of a certain commodity, like crude oil. Commodities form an attractive asset class for pension funds due to their inflation risk hedging properties (Bodie, 1983). The positive correlation between commodity prices and inflation is intuitive and has been confirmed in a number of empirical studies over certain periods of time (Bodie & Rosansky, 1980; Büyükşahin, Haigh, & Robe, 2009; Erb & Harvey, 2006; Geman & Kharoubi, 2008; G. B. Gorton, Hayashi, & Rouwenhorst, 2012). In addition, commodities are thought to have little correlation with stocks and bonds, which make them a good diversification opportunity (Hoevenaars et al., 2008). However, it appears that the "growing presence of index funds in commodities markets integrates the commodity markets with the stock and bond markets (Silvennoinen & Thorp, 2013; Tang & Xiong, 2010). This diminished the diversification opportunity and makes the asset class less attractive. Commodity prices are also inherently more volatile than bond prices (G. Gorton & Rouwenhorst, 2004), making them a more risky investment.

2.4 The Dutch pension landscape

In addition to the theory presented above, it is necessary to give some consideration to the conditions in which Dutch pension funds operate, and the effect that these condition might have on the relationship described above. Like in many other countries, the Dutch pension system consists out of three pillars. The first pillar is made up out of a state administrated pay-as-you-go (PAYG) fund that provides basic retirement income to all citizens of the Netherlands. Pension rights are built up for each year an individual resides in the Netherlands, regardless of whether the individual is employed or not. Benefits are defined and linked to minimum wage. The second pillar consists out of an occupation-linked plan. The most common plan type in the Netherlands is a defined benefit plan, however, in recent years, there has been a tendency to shift to defined contribution or hybrid plans. The third pillar comprises tax-deferred personal savings, which individuals undertake on their own initiative.

A unique aspect of the Dutch pension fund system is the combination of a state-run pay-as-you-go plan with funded occupational plans in the second pillar. The first pillar implies that younger generations exchange part of their human capital for a claim on the human capital of future generations. This form of intergenerational risk sharing may enforce the preference of younger people to invest in equity (Heeringa, 2008). Therefore, Dutch pension funds are likely to invest less conservatively compared to other countries.

Concerning Dutch pension fund regulation, in 2007 a rather influential piece of legislation was passed by the Dutch government, called the nFTK, or the new financial review

framework. This legislation imposed a number of new requirements on pension funds, not the least of which the requirement to maintain certain buffers when investing in risky assets. Dutch pension funds are required to hold reserves such that the probability of becoming underfunded within one year is less than 97,5%. This means that a fund must become more solvent before it can invest in risky assets. Clearly this should enforce the relationship between funding ratio and risk exposure. It is also likely to lower the overall risk profile of pension funds. In fact, it has been argued that legislation has caused the relationship between pension fund characteristics and investment behaviour to collapse entirely. In 2010, two reports commissioned by the Dutch bureau for economic policy analysis (Frijns et al., 2010; Goudswaard et al., 2010) concluded that pension funds were no longer investing in a way that was in the best interest of its beneficiaries, but in such fashion that is satisfied the regulatory requirements. This, of course, makes the outcome of this study all the more relevant.

3. METHODOLOGY

In contrast to previous work on pension fund asset allocation, this paper will use a collection of asset classes as its independent variable. Merely looking at equity allocation does not capture the full picture, since it does not account for other risk-bearing investments. It makes more sense to include all risky assets since some pension funds may allocate a relatively low percentage towards equity and subsequently invest more heavily in alternative assets. These funds would then qualify as funds with very low risk, while in reality the level of risk may be just as high or higher than funds with higher percentages of equity allocation.

To test the relationship between the variables mentioned in section 2 and strategic risk exposure (*SRE*), a multivariate regression model will be used similar to that used by Bikker et al. (2012a). However, some limitations are imposed by a lack of data; mainly the absence of age figures. This issue is resolved by approximating average age by taking the ratio of active to retired pension plan participants, where a high ratio represents a pension fund with relatively young participants and a low ratio represents a fund with relatively old participants. Notice that this will result in a positive coefficient if the relationship between age and risk exposure is negative.

In addition, a time lag has been added to the variables *funding ratio*, *size* and *personal wealth*. Instead of using the values at the end of the year, the values at the start of the year will be used. Given that the strategic portfolio is adjusted at the start of the year, it makes more sense to use information that is available at the start than to use information from the end of the year (as is done by Bikker et al in their principle model). Finally, a different measure will be used for size. Instead of the total number of participants, the total amount of assets will be used, since it is a fund's assets that determine the advantage it can take from economies of scale. The resulting model reads as follows:

$$\begin{aligned} SRE_{i(t)} = \ & \alpha + \beta\ dependency\ ratio_{i(t-1)} \\ & + \gamma\ log\ (size)_{i(t-1)} + \delta\ fratio_{i(t-1)} \\ & + \omega\ log\ (personal\ wealth)_{i(t-1)} \\ & + \varphi DB_i + \theta\ OPF_i + \vartheta BPRF_i + \mu_i \end{aligned}$$

where i represents the pension fund and *dependency ratio* represents the aforementioned ratio between active and retired pension plan participants. *Size* is measured as the natural log (to reduce possible heteroskedasticity) of a pension fund's total assets. *Fratio* is the ratio between a fund's assets and its liabilities at the start of the year, measured in percentages. *Personal wealth* is a measure of the generosity of the plan, expressed as the total assets divided by the total number of participants. The model includes three dummy variables: *DB, OPF* and *BPRF*. The first dummy variable *DB* stands for defined benefit and reflects any difference in investment behaviour between defined benefit plans and either defined contribution or hybrid plans. The second dummy variable *OPF* stands for corporate pension plans, while the third stand for industry-wide pension plans. These dummy variables reflect any difference in investment behaviour between different types of pension funds. Finally μ denotes the error term.

The regression model will be tested using plain vanilla OLS, as well as weighted least squares. Unweighted regression attached equal value to each observation of a pension fund, regardless of whether it has ten participants or 2 million. In contrast, weighted regression attributes similar importance to each participant, weighting pension funds proportionate to their size. This is expected to yield results that are more in line with economic reality. However, since the largest two pension funds in our sample make up 50% of the participants, these observations will be dropped from the weighted regression to overcome a strong bias. Bikker et al. also tested for a non-linear relationship between age and risk exposure, however found no significant result. This paper will refrain from the non-linear model due to the unavailability of multiple age variables.

4. DATA

The dataset used for this analysis was retrieved from the annual reports of 110 Dutch pension funds for the years 2011 and 2012, provided by the Dutch pension fund federation. Not all funds provided an annual report for each year, leaving a sample of 181 cases. Of these 181 cases, one pension fund (2 cases) with assets worth over one million euros per participant was excluded. Such funds are typically meant to serve a small number of company board members and are not representative for the population that is of interest to this study. For the same reason two cases of abnormal funding ratios (500% and 800%) were removed, as well as two cases with a very high dependency ratio (>250), leaving a sample size of 175. The descriptive statistics of the sample are listed below. The far right column lists the means weighted by the number of participants but excludes the two largest pension funds (4 cases) to overcome a strong bias. These weights will also be used in the weighted regression (elaboration follows in section 4).

Comparing the sample to data from 2007 used by Bikker et al., the effects of the financial crisis become very apparent. First of all, Bikker et al. report an average funding ratio of 139.4%, with a median of 135.4%. This is significantly higher than the average funding ratio in this sample. Second, the strategic equity exposure is, on average, 3% higher in the sample of Bikker et al., demonstrating that pension funds have become more risk averse. It is likely that this is, at least in part, also the result of the nFTK, which was introduced in 2007. Other differences that should be noted are that the sample of Bikker et al. was larger (378 pension funds over 1 year) and contained far smaller pension funds (averages size: 42,300 participants). Comparing the sample to the Finnish and Swiss data confirms that Dutch pension funds do indeed invest more aggressively, supporting the idea that the first pillar of the Dutch pension system encourages a higher risk exposure.

Table 1. Descriptive statistics of 175 annual reports

Variable (measurement)	Mean	Median	Other percentiles		Weighted mean[a]
			10	90	
Age (dependency ratio)	2.20	1.46	0.52	4.63	3.00
Strategic equity exposure (% of total investments)	30.06	30.00	17.14	41.90	28.02
Actual equity exposure (% of total investments)	28.70	28.98	16.48	40.00	26.92
Strategic risk exposure (% of total investments)	36.64	37,50	21.30	49.42	36.27
Actual risk exposure (% of total investments)	35.34	34.32	21.33	48.66	33.66
Total number of participants (in thousands)	164.78	23.91	4.51	549.12	619.32
Share of active participants (in %)	32.96	31.16	17.03	51.10	27.52
Share of retirees (in %)	24.48	21.86	8.61	47.27	15.99
Share of dormant (in %)	42.56	40.98	20.10	66.21	56.50
Funding ratio (in %)	103.07	102.30	91.93	115.55	100.92
Total assets (in € million)	8,813.70	1,535.56	671.78	14,908.37	16,146.39
Defined benefit schemes (in %)	74.29	-	-	-	-
Defined contribution schemes (in %)	5.71	-	-	-	-
Collective defined contribution schemes (%)	20.00	-	-	-	-

[a] Weighted by the number of participants per pension fund, as used in the weighted regression analysis.

5. RESULTS

Table 2 presents the Pearson correlation results between the different variables in the regression model. Already there is some indication that there is a relationship between the variable *SRE* and *dependency ratio*, *size* and *personal wealth.* Other significant and possibly meaningful relationships include a positive correlation between *funding ratio* and *personal wealth*, however partly induced by the extraneous variable OPF (corporate pension plan), after controlling for OPF, the correlation is 0.14 (p=0.064), and a negative correlation between OPF and size is observed. However, these relationships are not of interest to this study.

Table 3 reports the estimation results of the regression model. The coefficient for the age variable, dependency ratio, is significant at a 1% level and equals 1.10 (when unweighted; left-hand column). This means that an increase in the ratio of active participants to retired participants, which represents a decrease in average age, coincides with an increase in strategic risk exposure. The right-hand column of the table shows the results of the weighted regression. The increase in adjusted R^2 from 0.12 (unweighted) to 0.25 (weighted) demonstrates that the variation in equity exposure is better explained by large pension funds than by small ones. Also, the age coefficient has become both larger (3.04) and more significant (t-value = 6.70). It appears that the investment behaviour of larger pension funds is based more strongly on lifecycle investment theory than that of smaller pension funds. This is also confirmed when splitting the data up into two halves (one above the median and one below). Applying the (unweighted) model to the 'small half' yields an adjusted R^2 of 0.1, while the 'large half' produces an adjusted R^2 of 0.2. These findings all agree with the findings of Bikker et al.

Table 2. Pearson correlation matrix

	SRE	Dependency ratio	Fratio (t-1)	Size (t-1)	Log personal wealth (t-1)	DB	OPF	BRPF
SRE		0.14*	0.09	0.18**	0.20***	0.12	0.04	0.04
		(0.07)	(0.24)	(0.02)	(0.01)	(0.11)	(0.60)	(0.63)
Dependency ratio (age)			-0.03	-0.06	-0.32***	0.16**	-0.12	0.00
			(0.65)	(0.44)	(0.00)	(0.04)	(0.12)	(0.98)
Funding ratio (t-1)				0.13	0.24***	-0.08	0.23***	-0.14
				(0.09)	(0.00)	(0.32)	(0.002)	(0.06)
Log size (t-1)					0.00	0.12	-0.26***	-0.05
					(0.96)	(0.10)	(0.001)	(0.49)
Log personal wealth (t-1)						-0.29**	0.53***	0.34
						(0.00)	(0.00)	(0.00)
DB							-3.3***	-0.09
							(0.00)	(0.26)
OPF								-0.32***
								(0.00)
BRPF								

P-values are represented in parentheses. Significances are marked so that * denotes 10% level, ** 5% level, and *** 1% level.

Table 3. Strategic risk exposure

	Unweighted		SQRT weighting		Full weighting	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Dependency ratio (age)	1.10***	3.09	1.83***	4.75	3.04***	6.70
Log size (t-1)	1.20*	1.87	1.18*	1.91	1.97***	2.80
Funding ratio (t-1)	0.00	0.01	-0.11	-1.20	-0.22**	-2.24
Log personal wealth (t-1)	4.01***	3.14	5.93***	4.87	7.76***	5.56
Dummy defined benefit plans	3.40*	1.80	3.36	1.44	3.56*	1.06
Dummy corporate pension plans	-1.91	-0.72	-4.43	-1.63	-6.17*	-1.76
Dummy industry-wide pension plans	-3.91	-0.98	-6.50	-1.41	-7.12	-1.19
Constant	-37.46**	-2.29	-47.81***	-2.67	-75.55***	-3.36
Adjusted R	0.11		0.16		0.25	
F	4.13***		5.67***		9.06***	
Number of observations	175		171		171	

Significances are marked so that * denotes 10% level, ** 5% level, and *** 1% level.

Looking at the other independent variables, we see that personal wealth is a strong contributor to strategic equity exposure. There also appears to be some evidence that size influences the degree of risk taking, however the effect appears to be less robust than the findings of Bikker et al. (t-value 2.80 vs. 4.45 weighted). Also in line with Bikker et al.'s findings, there is no significant evidence that there is any difference in the investment behaviour between corporate and professional pension plans, while there is at least some evidence that DB plans take more risk than DC or hybrid plans.

Finally, the analysis produced some results that disagree with the findings of Bikker et al. There appears to be little evidence that higher funding ratios encourage smaller funds to take on more risk and some minor evidence to the contrary for larger funds. As the weighted regression shows, it appears that larger funds invest slightly less in risky assets the more solvent they become. This could be explained by the fact that many pension plans were underfunded in 2011 and 2012. Because Dutch pension funds are required to hold buffers before they can invest in risky assets, it is possible that the overall tendency was to reduce the holdings of risky assets regardless of funding ratio. However, it remains to be seen if these result pass the robustness checks in the next section.

6. ROBUSTNESS CHECK

To be able to compare this work to the work of others, as well as to check whether the results are somewhat robust, a number of adjustments are made to the model in terms of variables used. The unweighted results of these alternative models are also presented here.

The first two columns in table 3 represent the traditional model using strategic and actual equity as its dependent variable, end of the year data on funding ratio, size and personal wealth, and number of participants as a measure for size. From the results it is clear that age and personal wealth appear to be the strongest determinants of equity allocation, as they are of overall pension fund risk taking. Plan type also appears to be significantly related to the actual risk exposure, adding to the evidence from the original analysis.

Table 4. Alternative specifications as a robustness test

	Strategic equity allocation		Actual risk exposure		Strategic fixed income allocation	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Dependency ratio (age)	1.42***	4.25	1.13***	3.32	-0.84	-2.11**
Log of total number of participants	0.15	0.25	0.94	1.51	-1.53	-2.12**
Funding ratio	-0.12	-1.51	-0.02	-0.23	-0.13	-1.45
Log of personal wealth	3.62***	3.10	4.97***	4.14	-5.66	-4.07***
Dummy defined benefit plans	2.39	1.35	5.17***	2.84	-3.58	-1.69*
Dummy corporate pension plans	-0.30	-0.12	-1.84	-0.72	5.60	1.89*
Dummy industry-wide pension plans	-4.91	-1.35	-4.05	-1.09	5.31	1.23
Constant	-4.38	-0.28	-33.41**	-2.07	148.9	7.97***
Adjusted R	0.11		0.13		0.12	
F	4.05***		4.80***		4.40***	
Number of observations	175		175		175	

Significances are marked so that * denotes 10% level, ** 5% level, and *** 1% level.

The final column represents purely a robustness check, using strategic fixed income allocation as a dependent variable. As expected, all signs are flipped (except funding ratio which shows insignificant results). Dependency ratio is negatively related to a pension fund's strategic fixed income investments, meaning that an increase in the average age of pension fund participants results in a higher allocation towards fixed income investments and vice-versa. Like with equity allocation, this model also become stronger when it is applied to actual fixed income allocation, indicating a strong relationship between the model and the actual behaviour of pension funds.

7. CONCLUSION

This paper sought out to discover which factors determine the investment policy of Dutch pension funds. The first hypothesis was that age was negatively related to strategic risk exposure, as suggested by lifecycle theory. The results provide strong evidence that this relationship is indeed negative, confirming the hypothesis and supporting the findings of previous authors. The second hypothesis concerned the impact of the type of pension plan on its strategic risk exposure. Theory suggests that DB pension plans are more likely to adopt risk than DC or hybrid plans. In contrast to previous research, some evidence is found in support of this hypothesis, particularly in the actual allocation of pension funds. A possible explanation for this is that DB plans allow portfolio managers a higher degree of discretion, under encouragement of the plan sponsor. The third hypothesis this paper set out to investigate was the proposition that pension funds with higher funding ratios are more likely to invest in risk assets than pension funds with poorer states of solvency. No evidence was found for this relationship. By contrast, strong evidence was found for a positive relationship between personal wealth, measured as the amount of assets per participants, and strategic risk exposure. It appears pension funds do indeed take into account the generosity of their plan and the wealth of its members, as suggested by this paper's fourth hypothesis. Finally, minor evidence is found for the hypothesis that larger pension funds take more risk than smaller ones. However, it must be noted that the sample used in this research consisted out of relatively large pension funds in comparison to the data of other researchers, making it more difficult to identify statistically significant differences.

8. LIMITATIONS AND DISCUSSION

Contrary to the believes of some, this paper clearly demonstrates that Dutch pension funds still attempt to invest in the best interest of their beneficiaries, by taking into account their age and other characteristics. It is however clear that the investment behaviour has become somewhat more conservative since the time Bikker et al. researched this topic. This might also explain this paper's findings concerning the relationship between solvency and risk taking. Where other authors (Alestalo & Puttonen, 2006; Bikker et al., 2012a; Gerber & Weber, 2007) find a significantly positive relationship, this research finds a mildly negative one at best. This may indicate that this relationship is broken, and that there is too much pressure on pension funds to restore funding ratios. Alternatively, one may question the measurement value of funding ratio. Since the measurement only accounts for nominal liabilities, it does not truly reflect the state of solvency. However, it should be noted that a severe limitation to this research is that it only covers a very limited timeframe (two years) and a rather small data set (<200 observations). Additional empirical research is required to confirm the findings of this paper.

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