Asset allocation in Finnish pension funds

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Abstract

This paper empirically examines the strategic asset allocation and the asset/liability issues in the Finnish defined benefit pension funds. The results indicate that there is a relationship between the liability structure and the asset allocation. While pension funds with younger participants have more equity exposure, more mature pension funds have more fixed income investments.

Wide dispersion in asset allocations is also found between the funds. One fund holds its entire portfolio in fixed income securities, whereas other funds have none or only few fixed income holdings. Equity investments also vary dramatically, ranging from 0 % to over 70 % of the asset allocation. The same applies to investments in a sponsor, real estate investment, and money market investments. A portion of these different asset allocations is explained by the liability structure, but another part remains unexplained. The other variables affecting strategic asset allocation of a pension fund are not obvious, but they could include factors such as regulatory environment, historical reasons, mean-variance optimization instead of ALM, sponsor's own preferences or pension fund's irrationality. Analyzing these factors would be a fruitful topic for further research. Additionally, international comparisons would be a fruitful topic for further investigation.

1 Introduction

Although asset and liability management (ALM) is a central issue in the pension fund management, empirical research within this topic appears to be fairly limited. Previous studies have either concentrated on presenting ALM theories and the optimal asset allocations for pension funds without any empirical research, or they

have only described the pension funds' asset allocations without the use of a theoretical framework.

This study represents an attempt to partially bridge the gap between literature and practice. This is the first time that asset allocation and asset/liability issues of Finnish pension funds have been comprehensively studied.

This study concentrates on long-term strategic portfolio asset allocation, and investigates if the structure of pension liabilities is reflected in the investment horizon of a pension fund. In particular, the aim of this paper is to (1) determine and analyze variables that affect the pension fund's strategic asset allocation, and (2) examine if pension funds with different pension liability structures have different strategic asset allocations. As a consequence, this study addresses the question:

Do pension funds with younger participants have longer investment horizons, and thus, hold riskier investments in their portfolios than pension funds with more mature policy holders?

Asset and liability management in pension funds

According to Chernoff (2003a), a pension fund cannot just maximize its returns by using the traditional efficient frontier method. The correct way is to match pension assets against pension liabilities, and he simplifies: 'match the assets and the liabilities and go to bed'. Ito (1995) argues that the aim of pension fund asset management is to provide funding for the pension liabilities, but a pension fund sponsor has also a secondary goal that is the achievement of an 'earnings spread' (i.e. the positive gap between assets and liabilities). As this earnings spread can reduce the requirement for future contributions.

Peskin (1997) examines defined benefit funds under the asset and liability management, and states that this framework is substantially different from asset return maximization. The study implies that an appropriate asset and liability management reduces risk and saves a considerable amount of sponsors' money. He finds that savings can be more than 20% of future contributions.

In order to meet the long-term future obligation, Chernoff (2003b) suggests that pension funds should return to basic ALM practises. Ryan and Fabozzi (2002) also suggest that pension fund managers should avoid severe underperformances and asset/liability mismatches every year, in order to follow an appropriate ALM.

The popularity of ALM in pension funds seems to have risen in recent years. The Society of Actuaries (2003) provides a useful definition:

ALM is the practice of managing a business decisions and actions taken with respect to assets and liabilities are coordinated. ALM can be defined as an ongoing process of formulating, implementing, monitoring and revising strategies related to assets and liabilities to achieve organizations financial objectives, given the organizations' risk tolerances and other constraints. ALM is relevant to, and critical for, sound management of the finances of any organization that invests to meet its future cash flow needs and capital requirements.

Most obviously, ALM should be the cornerstone of any pension institution's investment policy. Feinberg (2002) reports that many pension funds are now conducting more asset/liability studies, mainly due to the deterioration of their funded status. She has interviewed many pension fund managers to learn the reason for the

recent increase in the popularity of the asset/liability studies. The demand for these asset/liability studies has occurred for various reasons, including: market conditions; switching from defined benefit funds to defined contribution funds, additional contributions, increased liabilities due to the baby boomers retirement, and changes in the future benefits structure.

Finnish pension funds have been previously studied, for example by Puttonen and Torstila (2003), in a risk management survey of Finnish corporate pension funds. The results of the survey reveal that risk management issues are generally well covered in pension funds, but there is, nevertheless, much to improve. Pension fund managers see asset/liability mismatch as one of the greatest challenges facing pension funds.

The choice between asset classes

Campbell and Viceira (2002) provide extensive theoretical analysis on strategic asset allocation. They provide an approach different from the static mean–variance analysis, as they recognize that many investors seek to finance a stream of consumption over their lifetime. The book shows that long-term inflation-indexed bonds are riskless assets for long-term investors and that stocks can be safer assets for long-term investors than for short-term investors. A long-term investor may be willing to hold higher proportion of stocks and inflation-linked bonds, and less cash, than a short-term investor.

Campbell and Viceira (2002: 7) note that empirical work on long-term portfolio choice has lagged far behind existing theoretical literature. Perhaps for this reason, there has been very slow diffusion of understanding from academic literature to institutional investors, asset managers, financial planners, and households.

Many surveys on pension fund asset allocation have been carried out in the US market. Papke (1991) reports some interesting data on the asset allocations of US private pension funds, both for defined benefit and defined contribution plans. The main findings for the defined benefits plans are that larger single employer plans hold about 60 % in fixed income securities and 20 % in equities; and smaller single employers invest 50 % and 20 %, respectively.

Healey and Rozenov (2004) studied the 200 largest defined benefit pension funds in the United States. They found that equity allocation increased its share from 48 % in 1991 to 57 % in 2001. They also reported that funds were increasingly allocating to alternative investments, real estate, enhanced indexed equities, and bonds.

Blake *et al.* (1998) report asset allocation and performance of more than 300 UK pension funds. They find that the allocation practices of funds have remained rather steady from 1986 to 1994. Notable observation is the high allocation to equities (78 %) with only 14 % in fixed income. However, the Blake *et al.* (1998) study concentrates on performance rather than asset allocation. Therefore, it remains somewhat unclear why UK pension funds invest so much more in equities than their US counterparts.

The debate over an optimal asset allocation for a pension fund has two extreme views. One view states that bonds are the only way to match assets with liabilities, while the contradicting view recommends equity exposures. In this section, the

main potential asset classes of a pension fund are presented, including: fixed income, equity, real estate, and investing in a sponsor. Equity and fixed income are generally the biggest investment classes in pension funds.

Fixed income

Bodie *et al.* (1999) argue that a pension fund, with a financially sound sponsor corporation, should not invest in equities at all. A fully funded pension fund should only invest in *fixed income assets* and, thus, minimize the additional contributions. However, it is found that pension funds generally invest around 40% to 60% of their portfolio in equities. Bodie *et al.* (1999) find three reasons for these equity investments. First, a sponsor sees the defined benefit fund more like the defined contribution fund: a sponsor may believe that a successful strategy may lead to extra benefits and tries to maximize benefits paid to employees. Second, a sponsor believes in market timing and security selection ability. Third, a sponsor in financial distress may have an incentive to invest in riskier assets, as there is the federal pension insurance.[1]

According to Blake (2001), fixed income investments are encouraged by regulators simply because the discount rate used in pension liability calculation by actuaries and accountants is based on bond yields. This means that in order to avoid the short-term mismatch between assets and liabilities, pension fund asset allocation should be more heavily weighted towards bonds.

In the US, pension funds have a special tax treatment and this gives them the incentive to create an asset mix with a large spread between pre-tax and after-tax returns. Therefore, tax reasons drive pension funds to invest more in bonds than in equities (Bodie *et al.*, 1999). For a fully funded healthy pension fund, Bodie (1988) recommends investments only in taxable fixed income securities. In Finland, pension funds do not have any special tax treatment with respect to fixed income securities.

Equity

Black (1989) studies the role of *equities* in the portfolio of a pension fund. Stocks are used to achieve higher expected returns, and, therefore, meet the pension obligation in the future, while helping to lower expected pension costs. Black acknowledges that some managers think about bonds as the only answer to hedge their pension liabilities. However, stocks also should be viewed as a hedge against a potential increase in pension liabilities. Stocks particularly hedge against the risk of salary inflation, which causes an increase in liabilities. Black states that stock prices and the expected rate of inflation move in tandem. This is called an 'economic' view of liabilities.

Black (1989) divides pension liability into two categories: a narrow view and a broad view. Both of these liability types act like a security. The narrow liability is defined as a present value of all vested benefits for current employees. Hence, it is

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[1] In the US, Pension Benefit Guaranty Corporation (PBGC) insures all the vested benefits of participants in defined benefits plans. In Finland, all the pension funds are collectively liable in the case of insolvency of any pension fund.

only tied to past and current, while not including the future. However, the narrow liability is only a snapshot of the current work force, and, hence, the narrow liability is changing all of the time. Hedging for the type of narrow liability is mainly performed using interest rate hedging methods and, therefore, the narrow view suggests investing in bonds to hedge the liabilities.

According to Black, the broad liability is the present value of all benefits to be paid, and therefore it is always greater than the narrow liability. The broad liability is the narrow liability plus salary increases, benefits to be accrued, changes in the benefits and additions to the workforce. In most cases, the broad view suggests investing in stocks is superior. Also Chun *et al.* (2000) argue that a growing company typically should have more equity investments, and less bonds or real-estate investments, due to the higher expected rate of return of equity.

Peskin (1997) argues that a pension fund's equity exposure is critical to the future contribution cost. The equity exposure varies between pension funds, and the optimal equity exposure to each a fund is found by using the following factors:

- Noise in liabilities. If a pension fund's liabilities do not act like bonds (i.e. the relationship between bonds and liabilities is volatile) and liabilities have a lot of noise, then a fund should have greater equity exposure.
- Weight attached to surplus value. Extraordinary equity returns generate more surpluses.
- Funded status of plan. The extreme funds, both poorly funded and well funded, should have larger equity exposures. Poorly funded funds need the upside of equity investment and well-funded funds have large buffers to protect future contributions from downside risk.
- Growth in workforce. A growing fund, with active liabilities growing faster than retired liabilities, should have more equity exposure.

In Finland, the possibility to invest in equities is a fairly new phenomenon, starting in the mid 1990s. Nowadays, equity investments are allowed, but the amount of equity is tied to the coverage and solvency margin regulations. Due to these regulations, pension funds have to analyze carefully their equity exposure.

Real estate

Hudson-Wilson *et al.* (2003) give several reasons why every investor should consider *real estate* as a part of their portfolio. When their reasoning is applied to the pension fund world, real estate seems to be an essential part of a pension fund's portfolio. Pension funds are usually risk-sensitive investors: they have great concern for capital preservation, a moderate actuarial target rate of return, and they have known liabilities.[2] Also, the hedge against inflation is important to defined benefit pension funds because their future benefit payments happen in real terms.[3] In addition,

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[2] For highly risk-tolerant investors, real estate should play no role in their portfolios. Hence, extremely overfunded pension funds or extremely underfunded pension funds, which are risk-tolerant, should not include real estate into their portfolios at all (Hudson-Wilson *et al.*, 2003).
[3] One might also choose to argue the opposite. In the short term, increased inflation would increase nominal interest rates, which would put pressure on real estate markets.

pension funds have a heavy demand for cash and some liquidity requirements in order to satisfy the liability stream. These reasons seem to suggest that pension funds should invest in real estate (Hudson-Wilson *et al.*, 2003).

Chun *et al.* (2000) studied the pension plan real estate investment within an asset/liability framework. In the US, pension funds seem to hold a low proportion of real estate in their portfolios, and the study finds that real estate investment is more limited than one would expect on the mean–variance basis.[4] The main result of the study is that real estate is not highly correlated with pension plan liabilities and that the main role of real estate is to hedge against the risk of inflation.

Finnish pension funds have traditionally held a substantial amount of real estate in their portfolios. Many pension funds hold real estate in order to completely lease those real estate investments for the use of a sponsor.

Sponsor company

Pension funds have the possibility to invest in their *sponsor company* or in companies associated with the sponsor company. These investments have two advantages: first, a sponsor company gets financing at a lower price than market rates; and, second, in the case of a defined contribution fund, this system builds up long-term incentives for the company's employees (Besley and Prat, 2003).

The collapse of Enron has resulted in a public debate regarding the rationale behind investing in company's own stock. The Enron case showed that employees carry the risk of these investments. Meulbroek (2002) studies company stock investments in defined contribution pension plans. Some of her ideas can be applied to defined benefit plans as well. Meulbroek states that investing in the sponsor's stock is inefficient for all stakeholders, because the pension fund carries a firm-specific risk, which could be diversified away. Also Even and Macpherson (2004) state that investing pension assets in a single stock (i.e. sponsor) is contrary to basic diversification and, therefore, a pension fund that holds sponsor's stock can provide the same rate of return as diversified portfolio but it is increasing the risk borne by its members.

Direct investments in a sponsor are mainly done in the form of loans or equity investments. A specific feature of Finnish pension funds is that an employer has the right to borrow funds that are not needed to pay pension benefits. These loans are called TEL[5] loans, and a sponsor needs to provide collateral for the TEL loan and pay interest.[6] According to TELA (2004),[7] the amount of TEL loans has diminished significantly since the beginning of 1990s. This is due to the increased possibilities to invest in other securities. At the time, the governments increased debt levels and this led pension funds to switch from TEL loans to government bonds.

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[4] The mean–variance return of a pension fund's portfolio can be substantially improved by including real estate into the portfolio. The existing literature reports that real estate investment should cover around 20–30 % of the total investment portfolio of a pension fund (Chun *et al.*, 2000).

[5] Employee's Pension Act in Finland. TEL pensions belong to the earnings-related pension scheme.

[6] Only corporate pension funds give TEL loans. TEL loans do not belong to the investment scheme of industry-wide pension funds.

[7] The Finnish Pension Alliance (TELA).

Optimal investment policy of a pension fund

Stux (1995) divides pension fund portfolio management using two steps. First, a pension fund needs to decide which broad asset classes to invest in. Typically, the asset classes include fixed income, equities, real estate, money market instruments, venture capital, and private investments. This step is called strategic asset allocation and it is the most important part of a pension fund's asset management, as the strategic asset allocation decisions heavily affect the performance of a pension fund. The second step includes the actual implementation of the chosen strategic asset allocation by choosing internal or external fund managers, and putting in practice the particular investment strategies and security selection process. This step is also important, but has less influence on pension fund's overall performance.

The liability structure of a pension fund defines how much risk the fund can take. The risk can be divided into two categories: the risk of long-term shortfall and the risk of near-term shortfall. One solution is to increase the near-term shortfall risk, and leverage existing assets to gain higher long-term returns. This is called *a short-term versus long-term dilemma*. If the assets are growing fast enough, they will not fall below liabilities in the long-term. However, the likelihood of a shortfall increases in short term, as the asset/liability relation is volatile. Another solution is to secure short-term needs, but that risks long-term return.

A traditional view suggests that pension funds should only invest in a well-diversified fixed income portfolio, which can be duration matched with the liability stream. Investment in bonds is also suggested, due to the tax advantages in some countries. Equity exposures are mainly for the higher expected rate of return on equity investments. This upside potential is especially needed in funds with younger participants, a growing workforce, and when salary inflation is expected.

Real estate investments are considered to be an essential part of a diversified investment portfolio, and, therefore, pension funds also include real estate in their portfolio. Real estate is also considered to be a good hedge against the risk of inflation. Investments in a sponsor seem to make very little sense in terms of finance theory, due to their non-diversifying nature.

The optimal asset allocation for a pension fund depends on many factors. These factors include, for example, the regulatory environment, the view of the pension liability, the funded status of a pension fund, and the sponsor's interests. Due to the diversity of these factors and complexity of the issue, it is difficult to provide a definitive set of allocation rules for pension funds.

2 Data

The Finnish pension system can be divided into three pillars, where the first pillar is statutory, and the second and third are voluntary pensions, either employer specific or individual specific. Both the second and third pillars are fairly small in Finland compared with, for example, other European countries.[8] The first pillar is further

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[8] In 2000, voluntary and individual funded pensions represented only 4.4 % of all pension benefits, while contributions were 5.6 % of total contribution.

split into the national pension scheme, and into the income-related pension scheme. The income-related scheme is a defined benefit system, and it can be further divided into private and public segments: the private segment provides pensions to employees in the private sector, and public segment acts in the public sector. The biggest private sector's sub-system is a statutory TEL scheme, having 1.2 million people insured at the end of 2002. The pension funds providing TEL pensions are called B-pension funds.

The Finnish earnings-related pension system has some rather unique features: it is statutory by law but largely privately run. Funding is based on individual pension rights but is collective in the sense that individual pension benefits do not depend on the existence or yield of funds. Funds only affect the level and timing of contributions.[9] The received benefits are based on the number of gainful employment years, the age-specific accrual rate, and the 'pensionable wage', which is based on the gross wage net of employees' pension contributions.

In 2005, employees' pension contribution amounted to 4.6% of wages. The employer collects the employees' pension contributions from their pay. Correspondingly, employers' contributions must be sufficient to cover the annual change in the pension liability, the costs arising from pensions, and the pension foundation's other expenses.

The empirical part of this study is conducted using data on the Finnish B-pension funds (both corporate and industry wide). Thus, the focus is on the pension funds of the income-related defined benefit TEL scheme. Benefits of the income-related scheme are a function of the number of years of employment, age-weighted accrual rate, and the wage. The scheme consists of all pensions that have accrued from each employment contract and from self-employment. Almost all the work for pay or other forms of remuneration has to be insured through a pension provider.

The private sector scheme is managed by private pension institutions: insurance companies, corporate pension funds, industry-wide pension funds, and other statutory pension providers. According to Puttonen and Torstila (2003), smaller companies often organize the earnings-related pension of their employees through larger insurance companies, whereas larger companies usually have their own pension funds in Finland.

According to the Pension Foundation Act, pension funds only perform insurance and pension operations. A pension fund does not aim to make profit. However, if a pension fund is performing well (i.e. it is successful in its investment activities) it reduces the required contribution rate from its sponsor.

The goal of pension fund's investment strategy is to invest the pension fund's assets profitably and securely, but also to ensure the pension fund's liquidity. The Pension Foundation Act requires every pension fund to have a written investment policy that is approved by the pension fund board. Therefore, the board of the pension fund is responsible for the pension fund's investment policy and actions.

[9] Normally annuities and/or embedded interest rate guarantees play a significant role in ALM in pension funds. That is not, however, the case in the Finnish system.

Both the solvency margin rules and the coverage rules limit the investment operations of a pension fund, and its investments need to be planned in order to fulfill these rules. The solvency margin should be within the target area or at least above the minimum requirements. The coverage rules determine the maximum proportional investments in any asset class.

The data used in this study are collected from two main sources: the Finnish Centre for Pensions and the Insurance Supervisory Authority. Both of these institutions collect pension data from pension institutions. The collected data are used either to inspect pension funds (i.e. internal use) or for published statistics (i.e. public data).

The empirical data consist of Finnish B-pension funds (i.e. both B-pension funds and B-divisions of AB-pension funds) from the end of year 2002. At the end of 2002, there were 44 B-pension funds in Finland, of which 36 were corporate pension funds and eight were industry-wide pension funds. The data used in this paper include all 44 B-pension funds, and the empirical research is, thus, based on the whole population in 2002. We treat corporate pension funds and industry-wide pension funds together due to their similar nature.

We focus on the earnings-related pension scheme which is statutory. All employers pay a certain pension contribution for all employees. This means that all employees are members of the pension fund and the risk does not exist that an employer would not pay any contribution, for example, for young employees.

For every pension fund, age structure data, solvency margin data, and asset allocation information are collected. The first data set, containing age structure information, is not publicly available, and it is gathered for the purpose of this study from the Finnish Centre for Pensions. The second data set, collected from the Insurance Supervisory Authority, contains public balance sheet information of solvency margins and asset allocations. However, the asset allocation information obtained from balance sheet is not comprehensive, and the amount of pure equity investments is not available.[10] Because of this problem, supplementary information of asset allocation is needed, and the third data set is collected from the Insurance Supervisory Authority. The third data set contains pure asset allocation information in market values. These data are not publicly available, and the Insurance Supervisory Authority collects the data for internal use only in order to calculate the solvency margins.

3 Empirical results

Descriptive statistics

The data consist of 44 pension funds at the end of 2002. The main parameters of pension fund used in this study are asset allocation figures, liability structure information, and solvency margin limits. The liability structure of each pension fund is studied with an age structure of employers in the sponsoring company as a proxy.

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[10] The balance sheet item 'shares' includes direct equity investments, and all the holdings of mutual fund shares. These mutual funds can have investments in all kind of securities (e.g. bonds, money market instruments). Therefore, this item does not describe well the actual equity exposure. The problem does not exist for the third data set.

Table 1. *Descriptive statistics for pension funds' proportional asset allocation*

This table presents the descriptive statistics for 44 Finnish pension funds' proportional asset allocations. The assets are divided into five groups including (1) Equity (both direct equity investments and equity investments in a sponsor), (2) fixed income (both direct fixed income investments and fixed income investments in a sponsor), (3) money market, (4) real estate, and (5) other. All of the asset classes are calculated as a percentage of a pension fund's total portfolio. For all of these asset classes, mean, standard deviation, minimum, maximum, percentiles for 5th, 25th, 50th, 75th, and 95th, and number of funds investing in the asset class are presented. All the figures are presented in percentages except the number of funds. The figures are from the end of year 2002.

	Mean, %	Stdv, %	Min, %	Max, %	Percentile, %					
					5th	25th	50th	75th	95th	N
Fixed income (Direct)	*33.8*	*19.7*	*0.0*	*78.9*	*1.2*	*20.3*	*32.1*	*49.7*	*67.3*	*42*
Fixed income (Sponsor)	*10.4*	*22.0*	*0.0*	*88.1*	*0.0*	*0.0*	*0.0*	*10.7*	*64.9*	*18*
Fixed income (Total)	44.2	22.4	0.0	100.0	10.3	28.4	43.0	60.9	82.8	43
Equity (Direct)	*19.2*	*13.4*	*0.0*	*71.0*	*1.9*	*11.4*	*15.2*	*25.6*	*37.5*	*43*
Equity (Sponsor)	*1.0*	*3.0*	*0.0*	*16.7*	*0.0*	*0.0*	*0.0*	*0.0*	*6.3*	*10*
Equity (Total)	20.2	14.3	0.0	71.0	1.9	11.4	16.5	27.6	38.0	43
Money market	18.8	16.3	0.0	67.6	0.0	6.5	13.1	29.3	46.4	41
Real estate	13.3	13.4	0.0	47.6	0.0	0.0	10.4	21.6	35.7	32
Other	3.6	5.6	0.0	26.5	0.0	0.0	0.8	5.2	13.1	28

The investment portfolio of a pension fund is here divided into five asset classes: long-term fixed income securities, equity, short-term money market instruments, real estate, and other investments. *Fixed income* consists of bonds and long-term debt instruments, either invested directly or through mutual funds. *Equity* investments include both direct equity investments as well as investments in equity mutual funds. *Money market* includes short-term debt instruments. *Real estate* investments include only direct real estate investments, and not loans to real estate companies.[11] The category *other* is usually very small and includes investments that cannot be classified into the first four groups. *Other* could include private equity and hedge funds.

Table 1 includes descriptive statistics on corporate and industry-wide pension funds together: the total value-weighted asset allocation of 44 B-pension funds at the end of 2002. The total investment of pension funds amounts to €6.4 billion and is composed as follows: fixed income securities are the most popular investments accounting for €2.6 billion (40% of the total investments). Equity investments come next with €1.5 billion (24%). Real estate amounts to €1.1 billion (18%) and short-term money market investments to €0.9 billion (14%). Investments in a sponsor total €0.6 billion (9%). Other investments amount to 0.2 billion (4%). Investments in a sponsor can be broken down into equity investments, amounting to €0.2 billion

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[11] Another way is to calculate both *direct real estate investments* and *loans to pension fund's real estate companies* together. This calculation illustrates better pension fund's actual real estate exposure.

Table 2. *International comparison of pension fund asset allocations*

This table presents comparative statistics of proportional asset allocations and old age dependency. Finnish data are from the current study and other countries figures are from UBS Global Asset Management (2004). Old age dependency rate is population aged over 65/population in working age (15–64) expressed as a percentage. Finnish figures are from 2002, while most of the other countries' figures are from 2003.

|	Equities	Fixed income	Cash/money market	Real estate	Old age dependency % 2000	Old age dependency % 2030
Finland	20	44	19	13	25	45
Netherlands	43	40	4	5	20	40
Australia	53	22	6	12	18	32
Sweden	37	55	2	6	27	46
Japan	44	45	5	1	25	52
UK	67	15	3	6	24	40
US	62	34	1	1	19	33

(3% of total investment portfolios and 12% of total equity investments) and into fixed income investments totaling €0.4 billion (6% of total investment portfolios and 15% of total fixed income investments).

The striking feature in asset allocations is the wide dispersion among pension funds. For example, equity exposures vary from 0 to 71%, money market exposures from 0 to 68%, real estate exposures from 0 to 48%, and fixed income exposures from 0 to 100%. This dispersion can be only explained by factors such as regulatory environment, historical reasons, mean-variance optimization instead of ALM, sponsor's own preferences, or the pension fund's irrationality.

Papke (1991) reports asset allocation figures separately for single employer and multi-employer defined benefit funds. Single employer funds can be compared with Finnish corporate pension funds, and multi-employer funds with Finnish industry-wide funds. According to Papke, the US single employer funds hold 50% in fixed income, and 23% in equity, in comparison with Finnish corporate pension funds which hold percentages of 45% and 21% respectively. For multi-employer funds, percentages in the US are 63% and 19%, while in Finland they are 40% and 18% respectively.

According to Papke, the real estate investments are close to zero in both single employer and multi-employer US pension funds. This is very different from Finland, where pension funds eagerly invest in real estate. The corporate pension funds hold 10% of their portfolio in real estate compared with 0.8% in the US single employer funds. The difference is even larger in industry-wide pension funds, where Finnish funds have real estate holdings of 29%. The US multi-employer funds have real estate holdings of only 0.7% of their portfolio.

Table 2 provides comparison of pension fund asset allocations in different countries. The table also reports old age dependency rates for 2000 and projected
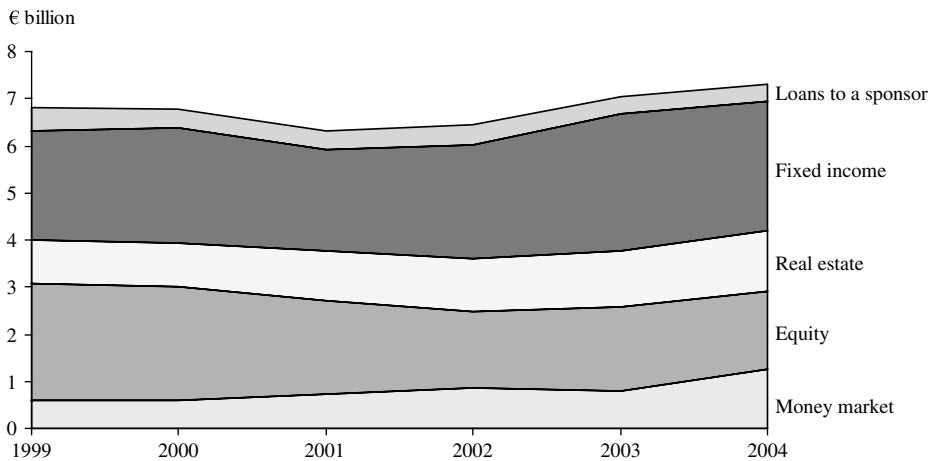
This figure represents the development of the investment portfolios of the Finnish pension funds. Both corporate pension funds and industry-wide pension funds are included. The investment portfolio is divided into five asset classes: (1) Money market instruments, (2), equity, (3) real estate, (4) bonds and loans, and (5) loans to a sponsor, including both TEL loans and other loans (TELA, 2004).

Figure 1. Investment portfolio of pension funds in 1999–2004

figures for 2030. In the US, UK, and Australia, pension funds have had larger equity weightings. Interestingly, the old age dependency rate in these three countries is not projected to be greater in 2030 than in other countries – rather the opposite. Pension funds in Finland, Sweden, and Japan have relatively small equity weightings, even though these countries project a major increase in old age dependency rates. Finnish pension funds hold a much larger cash position than their international counterparts. Real estate exposures are clearly largest in Finland and Australia.

The development of the Finnish pension funds' asset allocations is illustrated in Figure 1, in which both corporate and industry-wide pension funds are included. In 1Q 2004, investment portfolios of pension funds totaled €7.3 billion. Fixed income securities are the most important investment class of the pension funds, and the equity investments come next. The amount of equity exposure in each year is somewhat dependent on the market environment, but its proportion has still been rather stable over the period observed. The loans to a sponsor and real estate investments have remained fairly stable in recent years as well.

We examine a cross-section of pension funds at the end of 2002. Our findings should not represent a sample bias. First, we employ all Finnish pension funds, i.e. our sample is the same as the population of pension funds in Finland. This is possible because we do not employ a survey but have gathered the data from official (though not public) sources. Second, Figure 1 shows that average allocations in the Finnish pension funds have been stable in recent years. This makes us believe that tactical asset allocations are not driving the results.

The liability structure of pension funds is examined by the age structure. As the whole age structure of pension fund's beneficiaries is not available, employees working in the sponsoring company at the end of 2002 are used as a proxy. Average

Table 3. *Liability structures of pension funds*

This table reports the descriptive statistics for 44 Finnish pension funds' liability structures, which is studied by the employees working in a sponsor company at the end of 2002. Variables include average age, median age, and number of employees in a pension fund. For all the variables mean, standard deviation, minimum, maximum, and percentiles for 25th, 50th and 75th are presented. All figures are presented in years, except the number of employees. Source: The Finnish Centre for Pensions (ETK).

					Percentile		
	Mean	Stdv	Min	Max	25th	50th	75th
Average Age	42.6	3.5	33.4	51.8	41.0	43.3	45.2
Median Age	43.0	4.3	32.6	53.2	40.5	43.8	46.3
Number of employees	3,660	5,196	70	23,832	454	1,506	4,491

age of employees, median age of employees, and number of employees are presented, and Table 3 reports descriptive statistics for these parameters at the end of year 2002. The average age varies radically between pension funds, with the minimum average age being 33.4 years and maximum being 51.8 years. The pension funds differ significantly also in size, as the number of employees working in a sponsor company varies from 70 to 5196.

Hypotheses testing

The variables used in the correlation and regression analyses are as follows:

$Fix\%_i$	Proportional fixed income investment in ith pension fund;
$Equity\%_i$	Proportional equity investment in ith pension fund;
Age_i	Average age of employees in a sponsor company of ith pension fund;
$Solvency\%_i$	Solvency margin divided by the lower target limit in ith pension fund;
D_i	Dummy variable, which receives value 1 if the solvency margin is over the lower target limit in ith pension fund.

The average age of employees (Age_i) is used as a proxy for the liability structure of a pension funds.[12] The results of the correlation analyses for different variables are presented in Table 4. The Pearson correlation coefficients illustrate a significant positive relation between the average age and the proportional fixed income investments, as well as a significant negative correlation between the average age and the proportional equity investment. These findings are in line with the hypotheses.

Table 5 reports the regression results. There is a statistically significant positive relation between the proportional fixed income investment and the average age (significant at the 5% level). One year's increase in the average age increases the

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[12] As the arithmetic average stresses the extreme values, a control variable of *median age* of employees is also used. All the correlations and regressions are computed also for this control variable, in order to verify the results. All the results with the median age variable are in line with the results of the average age variable, and these results are not presented here.

Table 4. *Correlation between variables*

This table reports the correlation results between different variables, including ave-rage age of employees (Age) proportional fixed income investment (Fix%), proportional equity investment (Equity%), Solvency margin divided by lower target limit (Solvency%) and dummy variable, which receives value 1 when solvency margin is over lower target limit (D). Correlation analysis is performed for the total population consisting of 44 Finnish pension funds at the end of 2002.

	Fix%	*Equity%*	*Solvency%*	*D*
Age	0.355	−0.415	0.026	0.224
	(0.009)***	(0.003) ***	(0.432)	(0.072)*
Fix%		−0.501	−0.005	0.281
		(0.000)***	(0.486)	(0.032)**
Equity%			0.296	−0.350
			(0.026)**	(0.010)**
Solvency%				0.444
				(0.001)***

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

Table 5. *Proportional fixed income and equity investment against average age*

This table reports regression results of the proportional fixed income investment (Fix%) against the average age of employees (Age), and the proportional equity investment (Equity%) against the average age of employees (Age). Intercept, variable coefficient, F statistics, R^2 value, and adjusted R^2 value are reported.

$Fix\%_i = a + b\ Age_i + e_i$			$Equity\%_i = a + b\ Age_i + e_i$		
Intercept	−0.528	(0.189)	Intercept	0.925	(0.001)***
Age	0.0227	(0.018)**	Age	−0.0170	(0.005)***
F	6.064**		F	8.716***	
R^2	0.126		R^2	0.172	
Adjusted R^2	0.105		Adjusted R^2	0.152	

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

proportion of fixed income investment by 2.3%. The relation between the proportional equity investment and the average age is negative, and it is statistically significant at the 1% level. One year's increase in the average age decreases the proportion of equity investment by 1.7%. These statistically significant relations are in line with both hypotheses. For all regressions, residual analyses show that normality and homoscedasticity assumptions about the error terms hold.[13]

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[13] We also explored other terms in the regressions. Using natural logarithm of age results in similar results (Adjusted R^2 in regressions are 0.105 and 0.175). We did not test quadratic regression because the correlation between age and age^2 is as high as 0.99.

Appendices 1 and 2 show the plots of both equity investments and fixed income investments with respective pension fund average ages. One may notice that there is one extreme observation in which the average age of a fund is 52 years and the proportion of fixed income is only 10 %. This is a very small fund, which also has only 2 % invested in equities. Removing this outlier from the sample would increase the R^2 in the fixed income regression from 12.6 % to 23.4 %.

The Finnish regulations limit the investment opportunities of the pension funds by the coverage and solvency margin rules. The coverage rules set maximum limits to some asset classes (e.g. equity, real estate, investment in sponsor), but these limits do not affect the results of the OLS regressions. However, the solvency margin rules force pension funds to observe the risk level of asset allocation, although all the coverage rules were followed. The minimum requirement and target limits for a solvency margin depend on the risk level of the investment portfolio: A pension fund holding a riskier portfolio has higher solvency margin limits. These limitations will be taken into account next.

In the solvency margin calculations, the asset classes are divided into seven risk categories, and the risk level of the total portfolio is calculated based on these categories. In the categorization, equity investments clearly belong to the riskier category than fixed income investments, and equity exposure increases the solvency margin limits. Thus, the solvency margin regulations limit the amount that a pension fund can invest in equities. Not all fixed income securities belong to the same risk category, but, for the sake of simplicity, fixed income is regarded in this study as investments with no limitations.

Due to the limitations of equity investments, the second hypothesis of proportional equity investment is further developed and a new solvency-variable is added to the regression. As the solvency margin of a pension fund decreases close to the minimum requirement or even the lower target limit, the pension fund has to be careful with its investments and particularly watch the equity investments. The aim of this new solvency variable is to take into account the fact that not all funds can invest in equities due to the solvency margin regulations, although the liability structure would suggest it.

The new multiple regression model is formed as the proportional equity investment against both the average age variable and the solvency margin variable (*Solvency %$_i$*). *Solvency %$_i$* is defined as solvency margin divided by the lower target limit in ith pension fund. The results of multiple regression with the solvency margin variable are reported in Table 6.

The resulting F-statistics indicate that the coefficients are statistically significant, and the adjusted R^2 of the model improves. The age variable is statistically significant, as it was in the single regression. The statistically significant positive coefficient of the *Solvency %$_i$* variable is in line with the hypotheses, meaning that a pension fund with weaker (better) solvency holds less (more) equity in its portfolio.

We find a relationship between the liability structure and the asset allocation. However, the age structure and the solvency margin measures only explain one quarter of the proportion of equity investments with the adjusted R^2 in the regression being 23 %. This means that there obviously are other variables that affect the

Table 6. *Proportional equity investment against average age and solvency margin measures*

This table reports regression for proportional equity investment (Equity %) both against the average age of employees (Age) and against Solvency %. Solvency % is defined as solvency margin/lower target limit. Intercept, variable coefficients, F statistics, R^2 value, and adjusted R^2 value are reported.

$Equity\%_i = a + b\ Age_i + c\ Solvency\%_i + e_i$		
Intercept	0.863	(0.001)***
Age	-0.0173	(0.003)***
Solvency %	0.0634	(0.027)**
F	7.428***	
R^2	0.266	
Adjusted R^2	0.230	

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

strategic asset allocation of a pension fund. This already became evident in the descriptive statistics where the wide dispersion among pension fund allocations was reported. Finding and analyzing these factors and their effect could be a potential topic for further research.

4 Conclusions

Our findings indicate that the liability structure of a pension fund affects its asset allocation. The correlation and regression analyses provide evidence that there is a relation between age structures and the strategic asset allocations of pension funds. The average age of employees seems to better explain the proportional equity investment than the proportional fixed income investment. When the solvency variable is added to the proportional equity investment – model, the coefficient of determination improves.

The strategic allocation cannot be entirely explained by the age structure, however. One reason for that is the fact that the data from year 2002 is only a snapshot in time, so no lead–lag comparison to other years is made. Additionally, the coefficient of determination could certainly be enhanced by using more specific measures of the liability structure. Another important factor affecting the strategic allocation is the nature of the Finnish pension system, which is a mix of pay-as-you-go and pre-funded systems.

The results indicate that the allocations of Finnish pension funds are highly dispersed. One fund holds its entire portfolio in fixed income securities, whereas other funds have none, or only a minute portion of fixed income holdings. Also equity investments vary a lot, ranging from 0 % to over 70 % of the asset allocation. The same applies to investments in a sponsor, real estate investment, and money market investments, which all fluctuate dramatically between the funds. A portion of these

different asset allocations is explained by the liability structure, but another part remains unexplained.

Other variables affecting the strategic asset allocation of a pension fund are not obvious, but they could include factors such as, regulatory environment, historical reasons, mean-variance optimization instead of ALM, sponsor's own preferences, or individual pension fund irrationality. Identifying and analyzing these factors and their effect on a pension fund's strategic asset allocation could be a topic for further research. Additionally, international comparisons would be a fruitful topic for further investigation.

If the Finnish pension institutions aim to meet their pension obligation in the future, the debate and discussion should be more sharply focused on the development of a comprehensive asset and liability management in pension institutions. The discussion could lead to a modification in Finnish regulations that will support an appropriate asset and liability management system. This would mean a shift from regulators' current one-year inspection period to a longer-term focus. This issue is particularly important now as the Finnish population, like many Western nations, is rapidly aging.

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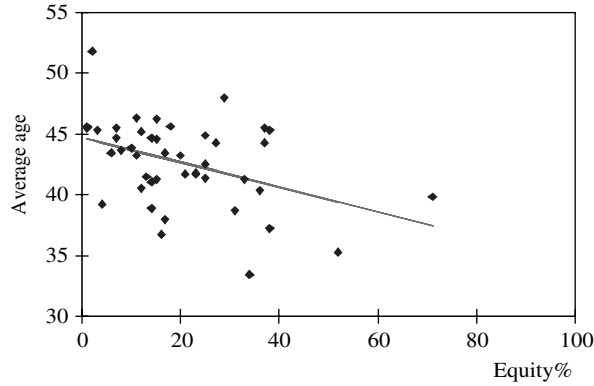
Appendix 1. The proportion of equity investments
and the average age of pension funds.
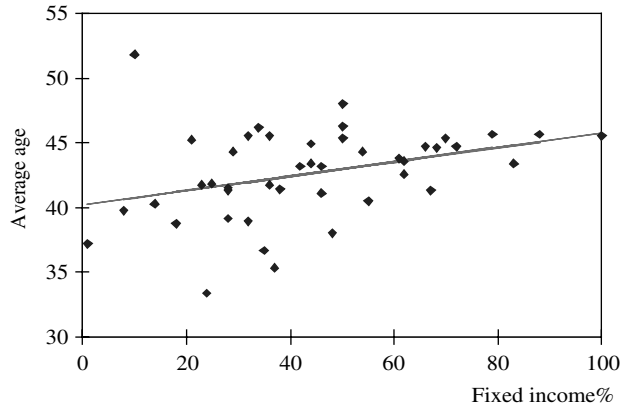
Appendix 2. The proportion of fixed income investments
and the average age of pension funds.