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JEL classification: G11, G23, G28

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The impact of new capital requirements on the portfolio decisions of Finnish pension institutions

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Abstract

This paper examines the potential impact of new capital requirements on asset allocations of Finnish pension institutions. We describe the new requirements and consider portfolio construction to minimize regulatory capital, given the investor's preferred level of expected return. Results identify portfolio transactions that enhance expected return without increasing capital needs. Regulation calls for portfolio diversification and prudence in management, but this paper shows that market participants can exploit inconsistencies in regulation. Possible future consequences include capital outflows from the pension system and an unintended decrease in pre-funding of old-age pensions.

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1 Introduction

Capital requirements in the Finnish statutory private sector pension scheme (TyEL) define the amount of capital a pension institution must have in excess of its actuarial reserve, defined as the present value of pension and possible other liabilities. Requirements aim to secure the financial viability of pension institutions, and are built upon a solvency margin that has been formulated to approximate the capital amount for which the bankruptcy probability in one year equals 2.5 percent. The solvency margin has practical relevance for pension institutions as it affects the monetary resources a sponsor must commit to pension arrangements, a pension institution's ability to compete through contribution rebates, and the level of scrutiny from regulating authorities. Pension managers therefore have incentives to identify and exploit inconsistencies in capital requirements, an act referred to as regulatory arbitrage. This paper focuses on possible impacts of new capital requirements on asset allocations in Finnish pension portfolios. We present the requirements and identify portfolio transactions that increase expected return without increasing the solvency margin.

Swinkels (2004) analyzes new capital requirements for Dutch pension funds. He concludes that the accumulation of a solvency buffer for risky investments 'poses a non-negligible cost for the average Dutch corporate sponsoring a defined-benefit pension plan', and that this might induce some firms to hold less risky investments that require a lower buffer. Alestalo and Puttonen (2006) examine factors that affect the strategic asset allocation of Finnish pension funds. Using regression analysis, they find that a portion of the dispersion in asset allocations between funds is explained by differences in liability structures, but another part remains unexplained. They suggest that factors affecting portfolio structure could include regulation, historical developments, mean-variance optimization instead of asset liability modeling, sponsor's preferences or even irrationality. They conclude that examining these factors would be a fruitful topic for further research. Hilli et al. (2007) present a stochastic programming model for asset and liability management of a Finnish pension company. The unique features of the model stem from the statutory regulation of which solvency requirements form a central part. In their model, the objective function includes a penalty parameter for breaching solvency constraints. This makes solvency considerations an important driver of optimization results.

Tuomikoski (1998, 2000) and Ranne (2000) present a general discussion of capital requirements in the TyEL scheme and requirements that were applied prior to year-end 2006. Ranne, Kivisaari and Mannonen (2000) describe the connection between a common return requirement for TyEL institutions and old capital requirements. Heikkilä (2004) uses simulation techniques to analyze how tracking error relative to the average portfolio of competitors affects the solvency of an

institution. Hilli (2007) employs simulation techniques to analyze the impact of a new broad based pension reform on the projected paths for system wide actuarial reserves, solvency and pension contributions. No previous paper seems to make an attempt to analyze regulation driven pension portfolio investments in Finland.

With this paper we hope to contribute in a positive spirit to the ongoing discussion of pension system design. We acknowledge that the TyEL pension scheme actually is quite innovative compared with many others and that there are no easy asset and liability management solutions in a system that fundamentally is about 75 percent under funded. We further acknowledge the social aspect of the pension system and the fact that one should be careful when implementing financial theories on an area that is part of the Finnish social welfare system. On the other hand, we do believe in interdisciplinary research. In addition to academic model developers, our results ought to interest pension institutions that want to minimize unwelcome effects of regulations, as well as secure a competitive advantage over competitors. Asset managers may be interested in offering financial products that make use of relatively under penalized risk factors. From authorities' perspective, regulatory arbitrage undermines the effectiveness of regulations and gives motivation to continually improve them.

The paper is structured as follows. Section 2 describes capital requirements. Section 3 formulates the portfolio optimization problem. Section 4 discusses results and Section 5 concludes.

2 Capital requirements

Section 2.1 presents the solvency margin, which gives the capital requirement based on return and risk characteristics of assets. Section 2.2 explains the groups into which assets must be categorized before the solvency margin can be calculated, and gives a short overview of coverage requirements designed to avoid large concentrations of investment risks.

2.1 Solvency margin

Solvency is defined as a pension institution's ability to withstand risks in the pension insurance business. An indicator of an institution's solvency is its surplus, defined as the difference between the market value of assets and relevant actuarial reserve. Solvency position is calculated as surplus divided by solvency margin. Solvency margin is calculated as a percentage (p) of the actuarial reserve.

The formula for p is¹

$$p = \max \left[0.05, \left(-(\sum_i \beta_i m_i - t) + a \sqrt{\sum_{i,j} \beta_i \beta_j s_i s_j r_{ij} + \lambda^2 S^2} \right) / 100 \right] \quad (1)$$

where β_i and β_j are portfolio weights for asset groups i and j , m_i is the expected rate of return for asset group i , t is a technical interest rate, a is a constant, s_i and s_j are the standard deviations of the rates of return for asset groups i and j , r_{ij} denotes the correlation coefficient between the returns of asset groups i and j , and $\lambda^2 S^2$ is a “tracking error term” as explained below. Means and standard deviations are expressed in annual terms and returns are assumed normally distributed².

The most important thing to note about the solvency margin is that it is dependent on portfolio structure. The general idea is that riskier portfolios carry a higher margin, but a closer look at (1) reveals that pension funds are penalized for holding assets with low expected returns, high standard deviation of returns or low diversification benefits. Formula (1) can be seen as a mean-variance approach to risk management. Term $(\sum_i \beta_i m_i - t)$ gives the expected value of portfolio return in excess of the technical interest rate t , which in this formulation approximates reserve growth. The second term, $a \sqrt{\sum_{i,j} \beta_i \beta_j s_i s_j r_{ij} + \lambda^2 S^2}$, defines the distance from portfolio mean return, and is linked to the volatility component of the normal distribution. Coefficient a has been set to 1.96 to reflect a 2.5 percent probability of ruin. The mean of the distribution is expressed in term of excess return, but the volatility component is not. It considers only asset return volatility and not the volatility of excess returns.³ All estimates in (1) except t are time invariant. This implies that an increase in the technical interest rate increases the solvency margin of all pension institutions even though asset allocations would remain unchanged⁴.

Product $\lambda^2 S^2$ requires many words. The statutory occupational pension system in Finland is of the defined-benefit type, which means that retirees are promised a certain pension based on a benefit formula. Pensions are mainly financed by current employers and employees following the pay-as-you-go principle, but part is financed by savings. The system is based on partial pre-funding, meaning that a portion of the pension contributions that are deducted from workers’ salaries and employers’ profits are used to collect a reserve for the future. This actuarial reserve is compounded through time according to certain retrospective actuarial rules. The technical interest rate is a central element of actuarial rules as it partially defines how much of each year’s portfolio returns are transferred into reserves. The technical interest rate therefore considerably affects reserve growth and the co-movement between assets and reserves. It is generally considered a minimum rate of return on

assets, a view confirmed by formula (1). The rate is common for all institutions and is determined in advance of the period in which it is applied. The technical interest rate for the following period equals $[0.2 \times (1 - \lambda)]$ times current average surplus in the TyEL scheme. Average surplus is calculated as a weighted average of surpluses in individual institutions. The maximum weight of a single institution is 15 percent.

Another part of reserve growth reflects the average performance of a predefined group of common stocks. The weight of the stock performance component is defined by λ and is set to 0.02 in year 2007. It will be linearly increased to 0.1 within a time span of five years. Growth in actuarial reserves depends partly on the performance of common stocks through λ , making them a more attractive investment from an asset and liability management perspective. Furthermore, when calculating the solvency margin, one deducts λ from the portfolio weight of common stocks.

The stock portfolio of an individual institution probably deviates from average, and the standard deviation of the differential return between the holdings and the system average has been defined to equal S . S has been set to 0.045. Product $\lambda^2 S^2$ in (1) penalizes without reason portfolios that mimic the average stock holdings of the system. These portfolios have zero differential stock return volatility and (1) results in an unfairly high solvency margin. The opposite is true for portfolios with high differential stock returns. Although somewhat unfair, the approach has at least one beneficial property: it reduces incentives to copy the stock holdings of competitors and thereby reduces systematic risks in the pension system as a whole. If capital requirements penalize an institution according to a 4.5 percent tracking error on the stock component, why incur the costs of research and trading related to copy-cat behavior?

The main principle is to direct investments so that the solvency position is at least 1.5 times the solvency margin. That way it is possible to run operations quite freely without intervention by regulating authorities. If the solvency position systematically exceeds a level four times the solvency margin, pension managers can opt between returning permanent excesses to sponsors, decreasing pension contributions or modifying portfolio structure to increase the margin and thereby the upper bound on solvency position. A high solvency position is desirable since it allows contribution rebates and makes the institution a compelling, lower cost partner in pension arrangements. Because solvency position is defined as surplus divided by solvency margin and actuarial rules are close to identical between institutions, high solvency positions are achieved through successful investments or cash infusions. Alternatively, it can be achieved through portfolio changes that decrease the solvency margin. It is the latter aspect that interests us.

2.2 Asset groups

To calculate the solvency margin, one must group assets according to their return and risk characteristics. Main groups include short term fixed income, long term fixed income, real estate, stocks, and other investments. Each group is further divided for a total of 20 sub-groups and predefined values for their expected mean returns, standard deviations and correlation coefficients have been set in the law decree and form part of the mathematical formula in (1). Table 1 outlines the sub-groups, their expected means and standard deviations of returns. Table 2 reports the correlation matrix. For asset classes like stocks, the standard deviation parameter s is substantially higher than for fixed income assets. To obtain the mean or standard deviation for an asset group, one calculates a weighted average of sub-group values. Using these averages together with the correlation matrix in Table 2 and formula (1) gives the solvency margin.

A feature in the grouping is the split between investments made in member countries of the European Economic Area (EEA) or the Organization for Economic Cooperation and Development (OECD), and investments made elsewhere. The purpose is to treat investments within EEA and OECD as safer than investments made outside these regions, due to their relatively developed legislature and financial markets, and relatively stable political and economic environments. Another feature is the split between fixed income investments with and without currency risks. Domestic currency denominated fixed income investments are grouped in I or II, whereas foreign currency denominated fixed income investments are grouped in V. Currency movements are considered a major risk in fixed income investments, and therefore different groups apply for domestic and foreign currency debt instruments. A similar currency split has been thought unnecessary for real estate (Group III) and equity investments (Group IV). Instead currency risks are directly included in the estimates of means, standard deviations and correlation coefficients (Government proposal 79/2006, 6§).

Additional coverage rules have been designed to force portfolio diversification. All assets, valued at market value, are eligible as coverage for the actuarial reserve, but the guiding principles are those of general portfolio diversification and prudence in management. Authorities have set upper bounds on the relative portion of certain asset groups. Restrictions include upper bounds on the portfolio weights of investments outside EEA and OECD (20 percent), positions that incur currency risks (20 percent), unlisted securities (15 percent), and uncollateralized debt holdings or investments in a single corporation (5 percent).

Table 1

Asset groups of solvency margin formula (1)

This table reports asset groups and sub-groups defined by TyEL solvency requirements. The first column of the table reports the number and shorthand of the main asset groups, the second column reports the sub-group number, column 3 gives a short description of the sub-groups, column 4 reports the expected value of annual returns per sub-group, and the last column reports the expected annual standard deviation of sub-group returns.

Group	Sub-group	Description	Return	Volatility
I	I/1	Issuer within EEA/ OECD and with a right to collect taxes. Collateralized loans to sponsor.	3.0 %	0.8 %
	I/2	Issuer is supervised insurance company or bank within EEA/ OECD.	3.5 %	1.5 %
	I/3	Issuer is publicly listed company within EEA/ OECD.	4.0 %	2.5 %
	I/4	Other short-term receivables.	3.5 %	3.0 %
II	II/1	Premium loans and investment loans	4.5 %	2.0 %
	II/2	Issuer within EEA/ OECD and with a right to collect taxes.	5.0 %	5.0 %
	II/3	Issuer outside EEA/ OECD and with a right to collect taxes.	6.0 %	6.0 %
	II/4	Issuer is supervised insurance company, bank, publicly listed company within EEA/ OECD.	6.0 %	6.0 %
	II/5	Other long-term receivables.	7.0 %	9.0 %
III	III/1	Residential real estate within EEA/ OECD.	6.0 %	7.0 %
	III/2	Business, hotel or industrial real estate within EEA/ OECD.	7.0 %	10.0 %
	III/3	Other real estate within EEA/ OECD.	7.0 %	11.0 %
	III/4	Real estate outside EEA/ OECD.	8.5 %	15.0 %
IV	IV/1	Within EEA/ OECD publicly listed shares	8.0 %	18.0 %
	IV/2	Shares of corporations located within EEA/ OECD.	10.0 %	24.0 %
	IV/3	Other shares.	11.0 %	28.0 %
V	V/1	Foreign currency denominated short term fixed income and currency investments.	4.0 %	4.5 %
	V/2	Foreign currency denominated long term fixed income and currency investments.	6.5 %	7.5 %
	V/3	Metals, energy, other raw materials and commodities, land.	8.0 %	20.0 %
	V/4	Other investments.	12.0 %	34.0 %

Table 2

Correlation matrix of solvency margin formula (1)

This table reports correlation coefficients between annual returns of groups I to V as defined in TyEL solvency requirements.

	I	II	III	IV	V
I EUR denominated short-term fixed income	1.0				
II EUR denominated long-term fixed income	0.3	1.0			
III Real Estate	0.0	0.0	1.0		
IV Stocks	0.0	0.0	0.4	1.0	
V Other	0.2	0.2	0.0	0.0	1.0

3 Optimizing the solvency position

This section presents the optimization problem of minimizing the solvency margin of a portfolio at alternative levels of expected return. As previously stated, this is a relevant exercise due to several reasons. The solvency margin affects the capital amount a business must commit to pension arrangements, and the capital is thus excluded from use for profitable business opportunities possibly present elsewhere. From the perspective of pension institutions, solvency considerations affect their ability to compete through lower pension contributions, and may additionally have an impact on costs related to regulatory reporting and compliance. A pension fund manager therefore has incentives to exploit inconsistencies in capital requirements, and authorities should work to prevent such regulatory arbitrage from occurring. The most straightforward way to identify possible inconsistencies is through a quantitative search for combinations of assets that minimize the solvency margin at desired levels of expected return, taking relevant constraints into account. The optimization problem becomes

$$\text{Minimize } p \tag{2}$$

subject to a target return, denoted c ,

$$\sum_i \beta_i m_i = c,$$

a budget constraining the sum of weights to $1 - \lambda$ ⁵

$$\sum_i \beta_i = 1 - \lambda,$$

a constraint that excludes short sales

$$\beta_i \geq 0,$$

a 20 percent upper bound on investments outside EEA and OECD

$$\beta_{I/4} + \beta_{II/3} + \beta_{II/5} + \beta_{III/4} + \beta_{IV/3} + \beta_V \leq 0.2,$$

a 20 percent upper bound on currency risk

$$\beta_{III/4} + \beta_{IV/3} + \beta_{V/1} + \beta_{V/2} \leq 0.2,$$

a 15 percent upper bound on investments in unlisted securities

$$\beta_{IV/2} \leq 0.15.$$

We impose upper bounds only on sub-groups for which it is difficult to avoid relevant risks without extra economic or administrative cost⁶. As an example, currency exposure is possible through EEA and OECD listed common stocks, but we do not include sub-group IV/1 in the currency constraint because currency risk can be avoided at will.

The mathematical formulation in (2) is connected to Markowitz' (1952) mean-variance-framework. Markowitz considered portfolio construction to minimize expected portfolio risk, given the investor's preferred level of expected return. He defined risk as the variance of portfolio return about the mean. Our endeavor to find efficient portfolios has a similar goal, to optimize the tradeoff between risk and return, but the technical formulation of the solvency framework makes implementation more complicated than wished for. As Markowitz and van Dijk (2006) explain, it is not equivalent to optimize in mean-variance-space as opposed to mean-shortfall-space (or mean-VaR-space), which is a more accurate characterization of the problem we are dealing with. Mean-shortfall efficient portfolios are usually a subset of mean-variance efficient portfolios.

A further complication arises due to the minimum solvency margin of 5 percent, and the averaging of sub-group parameter values to get group level parameters. Pre-defined parameters allow for several portfolios with solvency margins below 5 percent if the minimum is not imposed on solutions. No unique solution to the optimization problem can thus be found for a 5 percent solvency margin. The process of averaging sub-group means and standard deviations to derive corresponding values at group level introduces two layers of portfolio weights and the possibility of multiple solutions at given levels of expected return.

To avoid problems introduced by the minimum solvency margin, we first solve for optimal portfolios as if no minimum exists. This results in several portfolios with theoretical solvency margins below 5 percent, and others with a higher margin. Then we impose the minimum on all solutions with too low a margin.

This leaves the problem of multiple solutions at higher levels of solvency margins. We proceed as follows. The iteration to estimate optimal portfolios starts with initializing the parameter vector for sub-group weights. To ensure convergence towards the true minimum of the objective function these starting values need to be chosen carefully. For the first optimization at low levels of risk we use knowledge of parameter values and formula (1). We set a 90 percent weight to sub-group I/1. This group represents high quality short term fixed income instruments and has the lowest volatility parameter of all sub-groups. We further set the weight of group V/1 (common stocks) at 10 percent since this fraction should go largely unpenalized in solvency calculations. Solvency parameter values indicate that the portfolio has an expected return of 3.5 percent and a theoretical solvency margin of 5.0 percent (disregarding the minimum constraint). Using a Newton search algorithm, we minimize the solvency margin subject to relevant constraints and a target return of 3.5 percent. The purpose of this is to find the portfolio with an overall theoretical minimum solvency margin⁷. After the first initialization, the estimated weight vector of the previous estimation is taken as the new starting values for the subsequent estimation. We then solve problem (2) at different levels of target return, thus spanning the efficient frontier in mean-solvency margin-space

4 Results

This section implements the optimization methodology of section 3 to illustrate the optimal trade-off between expected portfolio return and solvency margin. We use Table 1 and 2 as input to our optimization and solve problem (2), thus finding the portfolios that least tie up the sponsor's capital for desired levels of expected return. The results of this section show asset groups that dominate portfolios when solvency considerations dictate decisions. This is the case for institutions with low surpluses, but partially may also guide decision-making in better-capitalized competitors.

Table 3 reports optimization results. Certain sub-groups are favored against others. For expected returns of 5 to 8 percent, sub-groups II/1, II/4, III/2, IV/2, IV/3, and V/2 dominate portfolios. Examples from each sub-group include premium loans to sponsors (II/1), EEA/ OECD investment grade corporate bonds (II/4), commercial real estate (III/2), EEA/ OECD private equity (IV/2), emerging market equity (IV/3), and foreign currency denominated emerging market bonds (V/2). Note that domestic currency denominated government bonds and EEA/ OECD listed equities are excluded from optimal portfolios. At higher levels of expected return, commercial real estate (III/2), EEA/ OECD listed equity (IV/1), EEA/ OECD private equity (IV/2), and other investments (V/4) dominate portfolios.

Table 3

Optimization results

The table presents optimization results for problem (2). The first column numbers the portfolio, the second reports expected portfolio mean return and the third column reports the solvency margin. Rest of columns contains sub-group portfolio weights.

Portfolio	Expected mean return, %	Solvency margin, %	Portfolio weights, %																							
			I/1	I/2	I/3	I/4	I/1	II/2	II/3	II/4	II/5	III/1	III/2	III/3	III/4	IV/1	IV/2	IV/3	V/1	V/2	V/3	V/4				
1	4.0	5.0	56.7	0.0	0.0	0.0	0.0	31.9	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	3.3	0.0	2.5	0.0	0.0	
2	4.5	5.0	52.5	0.0	0.0	0.0	0.0	30.1	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	10.3	0.0	2.4	0.0	0.0	
3	5.0	5.0	8.8	23.7	0.0	0.0	0.0	45.8	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	4.2	0.0	0.0	
4	5.5	5.3	0.0	0.0	9.0	0.0	0.0	61.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	11.0	0.0	8.5	0.0	0.0	
5	6.0	6.4	0.0	0.0	0.0	0.0	0.0	50.8	0.0	0.0	9.3	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0	7.0	5.6	0.0	14.4	0.0	0.0
6	6.5	7.6	0.0	0.0	0.0	0.0	0.0	22.1	0.0	0.0	27.2	0.0	0.0	0.0	16.6	0.0	0.0	0.0	0.0	0.0	14.0	0.1	0.0	19.9	0.0	0.0
7	7.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.3	0.0	0.0	0.0	21.7	0.0	0.0	0.0	0.0	0.0	15.0	1.1	0.0	18.3	0.0	0.6
8	7.5	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.1	0.0	0.0	0.0	26.8	0.0	0.0	0.0	0.0	0.0	4.1	13.2	0.0	0.0	0.0	6.8
9	8.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.5	0.0	0.0	0.0	28.5	0.0	0.0	0.0	0.0	0.0	15.0	8.5	0.0	0.0	0.0	11.5
10	8.5	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0	0.0	45.4	0.0	0.0	0.0	0.0	0.0	13.2	15.0	1.7	0.0	0.0	18.3
11	9.0	24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	55.0	15.0	0.0	0.0	0.0	20.0
Average TyEL portfolio	6.7	13.3	1.4	3.1	0.0	0.0	0.0	2.3	22.8	0.0	19.7	0.0	0.0	0.0	3.8	7.6	0.0	0.0	0.0	0.0	32.1	2.6	4.6	0.0	0.0	0.0
Minimum margin	6.7	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.1	0.0	0.0	0.0	23.2	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	19.7	0.0	0.3
Maximum return	8.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.6	0.0	0.0	0.0	31.4	0.0	0.0	0.0	0.0	0.0	15.0	8.1	0.0	0.0	0.0	11.9

A central ambition in the solvency reform was to increase the average expected rate of return on pension assets. If successful, the strategy would result in larger future pension funds than can be obtained with current portfolios. Reform therefore aimed at increasing the possibilities to invest in assets with higher relative levels of expected returns (and risk), such as common stocks instead of bonds. Based on our results, authorities have indeed succeeded in expanding these opportunities: it almost seems that combining the riskiest sub-groups results in the lowest solvency margins for different expected rates of return.

As an example, a pension institution with a low surplus at 8 percent of the actuarial reserve, would need to invest in a portfolio with an approximate 5 percent solvency margin to maintain a solvency position above 1.5 ($8 / 5 = 1.6$). Using Table 1, a 5.3 percent solvency margin can be obtained by investing 9 percent in corporate notes, 61 percent in premium loans to the sponsor, 10.5 percent in real estate, 11 percent in emerging market equities, and 8.5 percent in foreign currency denominated emerging market bonds.

Perhaps somewhat unexpectedly, there exist preferences for unlisted over listed securities, emerging market equities over developed world equities, and foreign currency bonds over domestic bonds. It is the constraints of problem (2) that prohibit the riskiest assets from taking control of the portfolio. Even when constrained, they can be combined in ways that result in attractive tradeoffs between expected return and solvency margin.

The last three rows of Table 3 further illustrate. The first portfolio, denoted “Average TyEL portfolio”, is an approximation of the average portfolio in the TyEL pension scheme as of December 31, 2006 (see www.tela.fi). It consisted of 5 percent short term fixed income, 45 percent long term fixed income, 11 percent real estate, and 39 percent stocks. Using regulatory estimates it has a 6.7 percent annual expected return with 8.5 percent annual volatility, and a 13.3 percent solvency margin. The second portfolio, denoted “Minimum margin”, shows that the same expected return can be obtained by investing in corporate bonds (48 percent), commercial real estate (23 percent), private equity (9 percent) and emerging market debt (20 percent). The solvency margin for this portfolio is only 8.6 percent. The portfolio that we have denoted “Maximum return” maximizes return given a 13.3 percent solvency margin. Expected return and volatility increase by 130 and 60 basis points respectively, but the solvency margin does not change. The portfolio includes assets that can be considered relatively risky: corporate bonds (31 percent), commercial real estate (34 percent), private equity (15 percent), emerging market stocks (4 percent), and other investments (16 percent).

Someone might argue that reported portfolios do not fulfill requirements of sufficient portfolio diversification and prudent management. Furthermore, the portfolio weight for premium loans to sponsors is not a free decision variable because sponsors have the right, but not the obligation to

borrow part of their paid pension contributions. Despite these possible caveats, we argue that pension managers attempting to enhance expected return while simultaneously managing the solvency margin will find it attractive to increase investments in some combination of the sub-groups presented in our results.

Results confirm that reform has accomplished its task of giving more leeway to pension managers in their investment activities. Accomplishment of creating incentives for better risk management practices is still an open question. For example, the inclusion of (deterministic) asset return volatility in the solvency formula is not without problems. As Amenc et al. (2006) point out, the use of volatility as a measure of risk leads to possible aberrations such as long-short equity strategies requiring less capital than conservative long-only strategies, and an absence of consideration for dynamic asset allocation strategies⁸, especially ones performed inside a financial product such as a mutual fund. Also, our observations indicate that the calibration of the solvency model may give incentives for opportunistic regulatory arbitrage. This raises concern with regard to future capital allocation decisions in the Finnish pension system. In a competitive environment, incentives for contribution rebates are high. The attraction of changing portfolio structure and releasing part of capital for use in the sponsor's business operations will loom significant. A possible outflow of assets from the pension system contradicts the generally accepted goal of increasing pension pre-funding in preparation for higher pension expenditure in coming decades. This may be avoided by recalibrating the parameters of the solvency model (expected returns, volatilities and correlations) to avoid grossly under penalized risk factors.

5 Concluding remarks

This paper examines the capital requirements of pension institutions acting under the Employees' Pension Act in Finland (TyEL). We present the requirements and perform portfolio optimization to examine asset choice within the regulatory setup. Our results show that regulation favors certain, quite risky types of investments, such as corporate bonds, real estate, private equity, emerging market stocks and bonds.

Despite the fact that reform aims at increasing the return and risk profile of pension assets, we are surprised by the extent to which one can construct risky portfolios with relatively low solvency buffers. Due to the fact that capital requirements play a central role in the competitive positioning of pension institutions, we express our concern over the possibilities to exploit inconsistencies in regulation, which in turn could lead to unintended capital outflows from the pension system.

Notes

¹ See 'Laki eläkelaitoksen vakavaraisuusrajan laskemisesta ja vastuuvelan kattamisesta (1114/2006)', www.finlex.fi

² Finance theory usually assumes that annual, once per year compounded, returns are log-normally distributed, and the logarithm of one plus the annual rate of return (continuous return) is normally distributed. Assuming normally distributed annual returns (once per year compounded) is equivalent to assuming normally distributed asset prices. Such an approach assigns a positive probability to negative asset prices, which is not realistic for limited liability securities. We follow this approach, however, due to the way that regulation defines the solvency margin formula and its parameters.

³ This is a fundamental change compared to the previous formula in use until December 31, 2006. The previous formula considered returns in excess of the technical interest rate for both the mean and the standard deviation of the return distribution and correlation coefficients were indeed very different from current values. Current approach can be defended in case of a deterministic technical interest rate, but this is a false assumption because the technical interest rate can change during a year. We have no credible explanation to why the principle of the formula has been changed in this way.

⁴ Historically, the technical interest rate has varied between 4 and 10 percent.

⁵ Recall from section 2 that we must deduct λ from the weight of Group IV, which represents common stocks. We set λ equal to 0.1 in the optimization.

⁶ Pension funds and foundations are reluctant to use derivatives due to heavy administrative burden in form of regulatory reporting.

⁷ Several alternative approaches were tested with none giving better results than the one selected.

⁸ For examples of dynamic portfolio and asset liability management approaches, see e.g. Samuelson (1969), Hakansson (1971), Perold and Sharpe (1988), Ziemba and Mulvey (Eds., 1998), Hilli et al. (2007), Zenios and Ziemba (Eds., 2006).

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