Determining the Technical Interest Rate in the Finnish Employment Pension Scheme

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Summary

In the Finnish statutory employment pension scheme all the pension institutions have a common technical interest rate for the pension reserves. This interest rate is determined for each year, and it may also be changed during the year. In all cases, the interest rate is decided in advance before the period in which it is applied and before the actual investment results are known for certain. The law prescribes that both the security of the pensions and the obtainable investment yield must be taken into account when the technical interest rate is determined.

This paper describes the method that was developed by the Interest Rate Working Group in the year 1998. The maximum obtainable investment yield is estimated using the Markowitz efficient frontier model, which gives the optimal mean values of the investment yield associated with different standard deviations. The standard deviations are then connected with the level of the solvency margin by specifying the risk of falling to a statutory solvency limit. The result is the expected value of the obtainable investment yield as a function of the level of the solvency margin. The interest rate is then calculated by including terms that take into account the growth rate of the reserves and the short term level of the yields.

The method does not produce the technical interest rate directly but rather gives a basis to assist in determining the proper level of the interest rate.

1 Introduction

The technical reserves in the Finnish statutory pension insurance (TEL) are calculated using a discount rate of 3%. In addition, there is a higher interest rate, the technical interest rate whose value is calculated for each year (or sometimes even more often). As of the year 2000, the investment income corresponding to the difference between the technical interest rate and the discount rate is used for increasing the technical reserves at the end of the year. Taken together, the investment income corresponding to the technical interest rate is transferred to the reserves yearly.

The Finnish TEL pension law prescribes that the technical interest rate must be determined so that both the security of the pensions and the obtainable investment yield are taken into account. To clarify the meaning of this, a working group was established in 1998 to propose the rules used for determining the value of the technical interest rate. The Interest Rate Working Group was chaired by Hillevi Mannonen, and the other members were Lasse Heiniö, Esko Kivisaari, Tom Liljeström, Antero Ranne and Leena Väänänen, representing pension insurance companies and the Ministry of Social Affairs and Health.

To estimate the obtainable investment yield, the group used the efficient frontier model. The idea stems from the work of Markowitz, who developed a method to maximise the return of the investments for a given level of risk. The risk is represented by the standard deviation of the investment return. For an insurance company the investment risk that can be taken depends on the level of the company's solvency margin. For this purpose the group developed a method to connect the level of the solvency margin to the standard deviation of the investment return.

For a given solvency margin, it is straightforward to estimate the maximum acceptable standard deviation of the investment return, if the probability of ruin is fixed (at least if the returns are assumed to be normally distributed). The ruin is here defined as the solvency margin falling to or below the zero level. Instead of the zero level, the working group decided to use a limit used in the statutory solvency requirements. Choosing the acceptable standard deviation is then complicated by the fact that the solvency requirements for a Finnish pension company are dependent on the distribution of the investment portfolio. However, the solution can be found by utilising the optimal investment distributions produced by the Markowitz model.

2 The technical interest rate

The TEL scheme forms part of the statutory pension system of Finland. The system covers the majority of the wage earners in the private sector, approximately one half of the total workforce. The TEL system is run by six pension insurance companies and about 50 pension funds and foundations. They are called by the general term pension institutions.

All the pension institutions use the same technical interest rate. Its yearly level is confirmed by the Ministry of Social Affairs and Health, based on the common application of all the pension companies. If necessary, its level can be changed also during the year. The technical interest rate has been 5.25% as of 1 July 1999.

The investment income corresponding to the difference between the technical interest rate and the 3% discount rate was used in 1997-1999 to increase the solvency margin of the pension institutions. The purpose was to enable the institutions to make more risky investments and so to be able to get better returns in the long run. After this period, the interest difference is transferred to the technical reserves. The higher the interest rate is on average, the faster is the growth of the reserves in the future.

The TEL scheme is a partially funded system, where about 25-30% of the pension expenditure is paid from the reserves and the rest is financed as a pay-as-you-go system. The total amount of the pensions is prescribed by law and it is not affected by the size of the funded part of the pensions. This means that high interest rates do not lead to higher pensions, but the funded part is increased and, as a consequence, the total pension premiums will be lower. Therefore, in order to reduce the rise of the future pension costs, the level of the technical interest rate should not be set unnecessarily low.

3 The solvency requirements

The mechanism of the solvency requirements of Finnish pension institutions is described in Tuomikoski (2000). Therefore, only some main features are treated here.

The basis of the requirements is the solvency border, which is calculated dependent on the investment distribution of the company. The solvency border approximates the level of the solvency margin on which the probability of ruin in one year is 2.5%. Formerly, in 1997-1999, the border was calculated by a linear formula of the form

$$s = \sum_i \beta_i d_i ,$$

where s is the solvency border divided by the technical reserves, β_i is the proportion of the investment category i in the portfolio and the d_i:s are coefficients. This was, however, considered to be too inaccurate, and at the end of 1999 this was replaced by a non-linear formula

$$s = c\left(-b\sum_i \beta_i m_i + a\sqrt{\sum_{i,j} \beta_i \beta_j s_i s_j r_{ij}}\right).$$

Here a, b and c are coefficients and the m_i:s are related to the means and the s_i:s to the standard deviations of the different investment returns and the r_{ij}:s to their correlation coefficients. The exact form of the solvency border formula is, however, not essential in the sequel. It is only important to note that the result is dependent on the investment distributions so that the more risky is the portfolio, the higher is the solvency border.

Using the solvency border, various other limits and zones for the solvency margin are defined. One of these is the target zone. The lower limit of the target zone is two times the solvency border and the upper limit is four times the solvency border. A pension company is supposed to direct it investments so that its solvency margin is usually in the target zone.

4 Calculating the efficient frontier

The Markowitz efficient frontier model gives the optimal mean values of the investment yield associated with different standard deviations. A description of the theory can be found e.g. in Haugen (1993) or Luenberger (2000).

The Markowitz model is based on the means μ_i, the standard deviations σ_i and the correlation coefficients ρ_{ij} of the investment returns. If the proportion invested in category i is x_i, the mean and standard deviation of the portfolio are

$$\mu = \sum_i \mu_i x_i$$

$$\sigma = \sqrt{\sum_{i,j} \rho_{ij}\sigma_i \sigma_j x_i x_j}$$

The problem is to find the portfolio with the highest mean return μ corresponding to a given risk σ. The efficient frontier is the set of values (σ,μ) that correspond to the solutions of the optimisation problem.

Generally, the solution can include some negative values x_i. These cannot, however, be accepted for the TEL institutions for which selling short is not allowed. The working group decided to adopt some even stricter minimum or maximum values for the proportions of different investment categories.

The investment categories used by the Interest Rate Working Group were premium loans, other loans, market money, bonds, shares and property. The means, the standard deviations and the correlation coefficients of the returns of these investment categories have to be estimated for the model. The newest values used by the working group are presented in Tables 1 and 2.

	Mean %	Standard deviation %
Premium loans	5.0	2.0
Other loans	5.1	2.0
Market money	3.6	2.0
Bonds	5.0	4.0
Shares	10.3	21.5
Property	7.0	12.0

Table 1. Means and standard deviations of the investment returns

Premium loans	1	0.8	0.6	0.4	0.0	0.0
Other loans	0.8	1	0.6	0.4	0.0	0.0
Market money	0.6	0.6	1	0.1	-0.1	-0.1
Bonds	0.4	0.4	0.1	1	0.2	-0.1
Shares	0.0	0.0	-0.1	0.2	1	0.3
Property	0.0	0.0	-0.1	-0.1	0.3	1

Table 2. Correlation coefficients of the investment returns

It should be noted that the estimated parameter values are not derived solely from the statistical data. The investment environment is changing, e.g. because of the adoption of the euro currency, and the parameters have been adjusted so that they should rather reflect the future than the past. Also, the parameter values are not meant to represent the investment returns in the short term but they are meant to describe the average returns in the long run - maybe for the next 5-10 years of even longer.

	Minimum	Maximum
Premium loans	10%	10%
Other loans	0%	5%
Market money	2.5%	100%
Bonds	0%	100%
Shares	0%	30%
Property	0%	30%

Table 3. Minimum and maximum values of the investment categories %

The minimum and maximum values selected by the group are shown in Table 3. The proportion of the premium loans was set at the constant value of 10%, which is nearly the average for the TEL companies. Because the policyholder has a right to borrow back part of the paid premiums, the proportion of the premium loans in the portfolio does not depend on the decision of the company and, therefore, it was not defined as a free variable in the optimisation. The demand for the other loans to customers was estimated to be at most 5% of the total portfolio. On the other hand, the minimum value of 2.5% of market money (or cash) was considered to be necessary for liquidity. The proportion for shares and property was restricted below 30%, which was regarded to represent the maximum reasonable level of risk for the companies considering their current solvency margins. The effect of this is mainly to restrict the efficient frontier to the region where nearly all pension institutions now are.

The efficient frontier calculated using these assumptions is shown in Figure 1. The corresponding allocation of the investments is in Figure 2.

5 Connecting the efficient frontier and the solvency margin

In the previous chapter, the risk was represented by the standard deviation of the investment return. To apply the results in practice, it was necessary to connect the risk with the level of the company's solvency margin.

For defining this connection, the working group selected as the starting point the system of statutory solvency limits described in chapter 3. As the requirements are based on the idea that a company should most of the time be in the target zone, it is natural that the chosen risk level should also fulfil this condition. The group defined the risk level as the position of the solvency margin that is one standard deviation of investment returns above the lower limit of the target zone. Thus the probability of dropping from this position to the lower limit is approximately 16%, if the returns are assumed to be normally distributed. This probability is, however, only a rough estimate, e.g. for the reasons that the returns have not exactly a normal distribution, and the limits of the target zone will also usually change at the same time as the solvency margin comes down. A more accurate value for the probability of dropping to the lower limit could be estimated, for example, by multidimensional methods, but the question is not essential for the purpose of this paper and, therefore, will not be addressed here.

To complete the definition, the lower limit of the target zone must also be connected with the standard deviation of the investment return. This can be done by assuming that the company's investments are optimal, i.e. that it is on the efficient frontier. Then each value of the standard deviation is connected with a unique investment allocation, as is shown in Figure 2. This investment distribution can be used to calculate the value

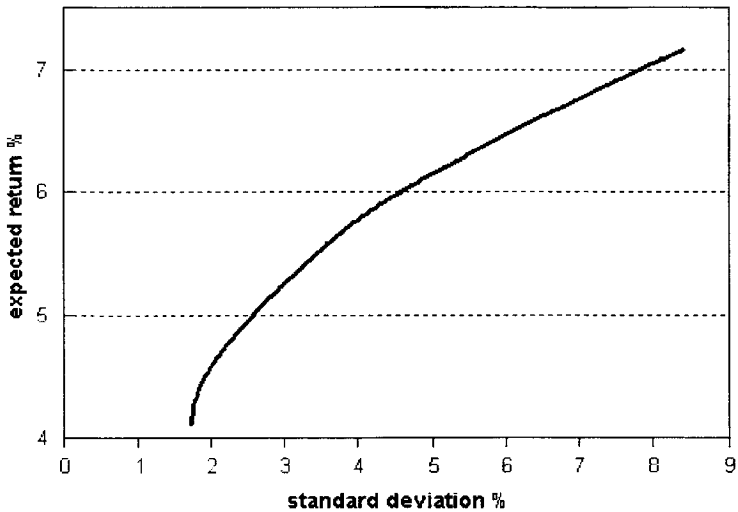

Figure 1. Efficient frontier

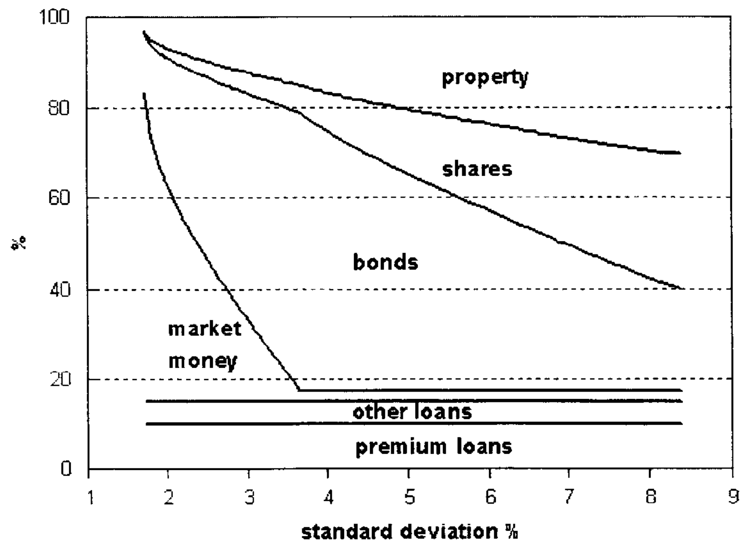

Figure 2. Asset allocations corresponding to the efficient frontier

of the solvency border using the formula presented in chapter 3. Finally, the lower limit of the target zone is twice the solvency border.

To sum up, for each standard deviation σ there is a unique expected return $\mu(\sigma)$and a unique investment allocation $x_i(\sigma)$ corresponding to a point on the efficient frontier. The investment allocation is further connected to a level of solvency border $s(\sigma)$ expressed as per cent of the reserves. The solvency position $p(\sigma)$ corresponding to the risk level σ is defined by the formula

$$p(\sigma) = 2\,s(\sigma) + \sigma.$$

The function $p(\sigma)$ is illustrated in Figure 3.

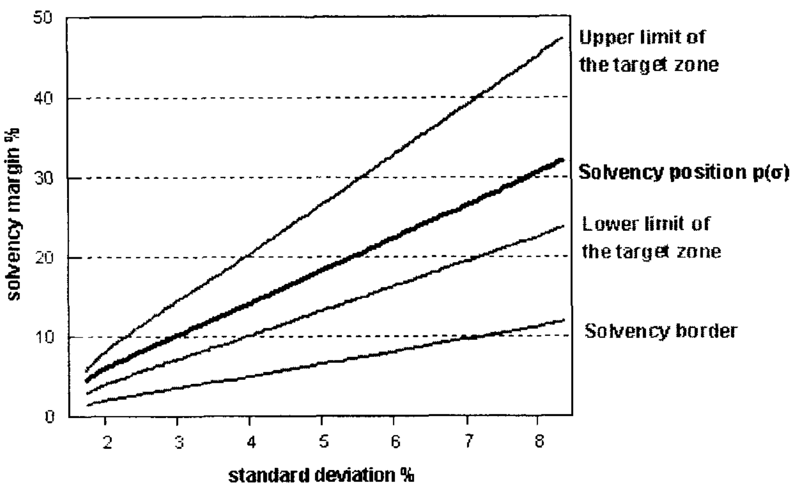

Figure 3. The solvency position as a function of the standard deviation of the investment return. The solvency margin is expressed as per cent of the reserves.

It can be seen that the solvency position $p(\sigma)$ is a strictly increasing function of σ. This is to be expected, since the more risky is the investment portfolio, the greater is the solvency margin that the company must have, if the solvency risk is held fixed. This means that there is an inverse function $\sigma(p)$, which gives the standard deviation when the solvency position is given. This standard deviation is further connected with a unique value $\mu(\sigma)$ of the expected return. The combined function that gives the expected return corresponding to a solvency position, is denoted by $m(p)$:

$$m(p) = \mu(\sigma(p)).$$

The function $m(p)$ is shown in Figure 4. The figure contains also the positions of the pension companies and foundations and the average values for two groups of pension funds corresponding to August 1999. In the figure the solvency positions of the pension institutions are their actual positions, and the expected returns are the theoretical returns based on their actual investment portfolios and the assumptions in Tables 1 and 2. There is further one pension foundation and one group of pension funds which are not shown in the figure because their solvency positions are quite large.

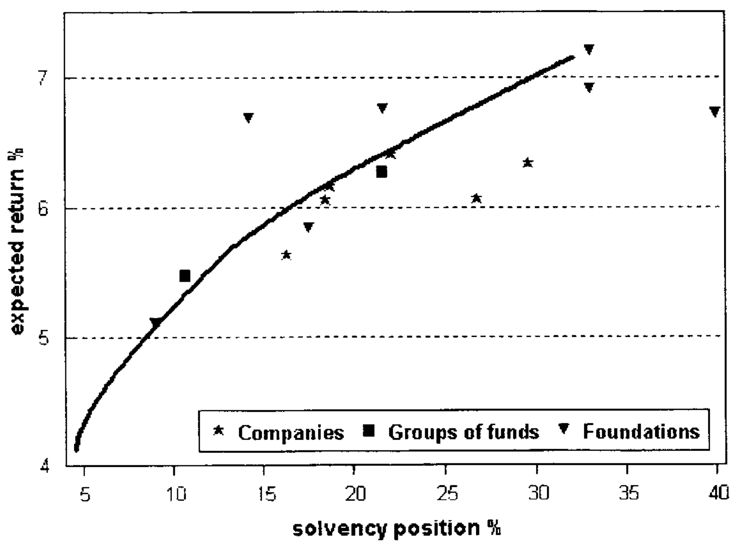

Figure 4. Expected return as a function of the solvency position for optimal investment portfolios. On the line the solvency position is defined as one standard deviation above the lower limit of the target zone. The pension institutions have the actual solvency positions and theoretical expected returns based on their investment portfolios in August 1999.

The figure shows, calculated by the method developed in the working group, the maximal expected return that can be obtained in a given solvency position, based on the chosen assumptions. The institutions are shown mostly in order to illustrate the distribution of their solvency positions. Whether the institutions are situated above or below the line in the figure does not signify the strength or weakness of their investment strategy. This is because the line is calculated based on long term assumptions, but the position of the institutions depends on the situation at one point of time and can change quickly due to random factors. Also, their actual investment return may be different from the theoretical value shown in the figure.

6 Calculating the technical interest rate

Figure 4 shows one problem in defining the technical interest rate common to all pension institutions: the distribution of the solvency of the institutions is quite wide. However, the method requires that a single value of p is selected in order to calculate the expected return $m(p)$. The working group decided not to define any fixed rule in which way the value is chosen. Instead, the group agreed on some general guidelines according to which the selection should be made near the average position. In no case should the selection be made based on the position of the institutions that have the smallest level of solvency margin.

To advance further towards the value of the technical interest rate, a margin depending on the growth rate of the technical reserves is next deducted. It is estimated that for the next 10-15 years the growth of the reserves in the TEL pension system will be faster than the average level of the investment returns. This means that if the technical interest rate is set at the level of the expected total returns, the solvency margin will gradually decrease in proportion to the reserves. To maintain the average level of solvency, a margin should be deducted when the technical interest rate is determined. The amount of this margin was estimated to be 0.1-0.5 percentage points depending on the solvency position.

In addition, the law requires that the security of the pensions should be taken into account in the interest rate level. The working group estimated that this could be achieved be deducting a further 0.2-0.3 percentage points from the technical interest rate. The surplus this deduction would produce in the investment income would be returned as bonuses to the policyholders as reductions of the premiums.

Combined, these two deductions are denoted by the symbol δ, and it's average level for the next few years is estimated to be about 0.5 percentage points.

There is another term in the calculations for the technical interest rate whose purpose is to take into account the short term level of the investment returns. The expected return level $m(p)$ is based on the long term assumptions presented in chapter 4. However, when the short term returns are expected to deviate from these assumptions, the difference can be taken into account by a correction term, which is denoted by τ. Because of the near impossibility of forecasting the change in the values of shares and property with any accuracy for the following year, the term τ is normally calculated based only on the income from interest (bonds, loans and market money).

There is a further correction term ε that the working group proposed for exceptional situations. For instance, during a serious depression it could be necessary to lower the technical interest rate from the level produced by the calculations described above, in order to enable the institutions to get over a period of exceptionally bad investment returns. Conversely, in particularly favourable times the interest rate could be revised upwards. These corrections are meant to be made only for reasons that affect all the pension institutions simultaneously. In particular, the interest rate should not be lowered to save just one pension institution that has got into difficulties, perhaps due to too risky an investment strategy.

Collecting all the terms described above into a formula, the technical interest rate $j(TEL)$ is (preliminarily) calculated by

$$j(TEL) = m(p) - \delta \pm \tau \pm \varepsilon$$

where the terms are

$m(p)$	the optimal expected return in solvency position p (calculated by the method of chapter 5)
δ	margin due both to the growth of the reserves and to the security of pensions
τ	forecast for the deviation of the short term investment returns from the long term assumptions
ε	correction term for exceptional situations.

The value produced by the formula is not used directly as the technical interest rate. Rather, it forms only the basis to assist in the decision process. It can show the direction in which the interest rate should be changed. The decision to make a change, however, is made based on various additional considerations. For instance, it has not been held reasonable to make small changes in the interest rate every year but rather to keep the level fixed as long as it is not too far from the level indicated by the formula.

The method developed by the Interest Rate Working Group has been applied in practice a couple of times. The experience has shown that it has been useful and has given a more concrete basis to the yearly discussions about the proper value of the technical interest rate.

References

Haugen, R. (1993), Modern Investment Theory, 3rd edition, Prentice Hall, New Jersey

Luenberger, D. (1998), Investment Science, Oxford University Press, New York

Tuomikoski, J. (2000), Financial Solidity of Pension Insurance Companies and Pension Funds within the Finnish Employment Pension System, Transactions of the 10th AFIR Colloquium, Tromsø.