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Norges Bank Investment Strategy

Strategy Report -
The Norwegian Government Pension Fund - Global

NB NORGES BANK

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Summary

Our report on “Long term market outlook” discussed the future market conditions both in the bond and equity markets, where the Pension Fund is currently invested, and in alternative asset classes, where the Fund may invest in the future. Here we summarise the findings and employ a simulation modelling framework to determine how changes in the investment strategy can be expected to affect the return distribution for the entire portfolio. We are looking both at the expected return and at different measures of risk exposure.

The basic assumptions used in the modelling exercise are presented in section 1 below. We provide numerical details on the macroeconomic scenarios introduced in the Market Report, and specify the covariance matrices that will be assumed in each scenario.

In section 2 we consider the equity/bond ratio in the existing benchmark portfolio, and the regional weightings within the equity and bond benchmarks. This analysis essentially confirms the conclusions from our 2005 Strategy Report.

In section 3 we consider two market segments that are not currently part of the equity or bond benchmark. The small cap segment in the equity markets is the largest segment of listed markets outside the benchmark. We believe that the diversification benefits outweighs the operational burdens and recommend that small cap should now be included in the equity benchmark. The high yield segment of the bond markets is much smaller and heavily biased towards USD issues. But the expected return looks attractive, even taking the risk into account. We thus believe that the Fund should be invested in this segment. Replicating the Lehman High Yield index may on the other hand be a bad idea, because many of the papers in the index are difficult or impossible to buy, and because pricing may not always reflect risk in a reasonable way. We therefore do not recommend including the high yield segment in the bond benchmark.

In section 4 we consider new asset classes. Real estate is the largest asset class where the Fund is currently not invested. We believe that real estate investments will provide attractive diversification benefits in the portfolio and recommend that it be included in the Fund’s investment strategy. The size of the market limits the exposure the Fund can realistically obtain, however. Infrastructure investments have very similar characteristics to real estate, but the market is so far substantially smaller. We are proposing a common allocation to these two asset classes, with a strategic target of 10 percent of the total Fund. This is in line with other large investment funds, but we realise that this target will not be reached in the first few years. The Fund shall need to set up a new investment organisation and gradually build its real estate and infrastructure portfolios.

Private equity is another asset class commonly included in the strategic allocations of large funds. We believe that returns on private equity are highly correlated with returns in the listed equity markets, and that the diversification benefits are limited. Furthermore, we do not find any evidence that an average investor can expect higher returns in the private equity markets. Private equity consequently looks only moderately attractive in the modelling exercise. We still recommend a strategic target of 5 percent of the Fund invested in this asset class. The reason is that returns vary substantially between managers (“leading partners”) and that the differences tend to be persistent. A large investor such as the Pension Fund has a better probability of identifying and getting access to above average quality managers, and will then have a fair possibility of earning an excess return.

1. The basics

1.1. The objective function

The Government Pension Fund Act states that the Fund "shall support central government saving to finance the National Insurance Scheme's expenditure on pensions and long term considerations in the application of petroleum revenues". The proposition to Parliament[1] underscores the need for large financial reserves to meet the future government expenditures as the age structure of the population changes in the next few decades. The share of the population outside the working age cohorts, and thus dependent on pensions or other government programmes, will gradually increase for most of the next fifty years.

These statements do not amount to an objective function. But they indicate that one objective is to have a maximum amount of savings over a very long time horizon. The amount saved at any time will to a large extent depend on the volume of petroleum extraction and the level of petroleum prices on the one hand, and on government spending on the other hand. But the return on investments will become relatively more important as the size of the Fund increases.

The statements quoted above indicate that the Fund is meant for government spending. Since the government budgets are in Norwegian currency, the objective function should at first glance also be in units of Norwegian currency. There has, however, been generally accepted that the returns on the investments are best measured in a basket of foreign currencies, to reflect the Fund's future purchasing power on the world market. The rationale behind that view is that the Fund basically represents a national wealth. On a national level the net effect of spending from the Fund will be an increase in imports of about the same magnitude; thus the imports are implicitly financed by the Fund investments. More intuitively we could say that the purpose of the investments is to maximise the share of (relevant) global supply that can be bought by the Fund in the future.

We shall retain this choice of a basket as the base currency of the Fund, in line with the assumptions set out in our 2005 Strategy Report. The composition of this foreign currency basket was updated in chapter 2 of the Market Report. It is meant to reflect the expected composition of future imports to Norway. Taking both the current composition and expected changes into account, we have chosen a basket that consists of approximately 60 per cent of European currencies, and approximately 20 per cent each of American and Asian currencies.

The Norwegian Parliament has in 2001 approved a spending rule whereby on average four per cent of the Fund may be spent every year. This is meant to correspond to the expected real return on Fund investments, which implies that the expected lifetime of the Fund will be (nearly) infinitely long. The liability side of the Fund may thus be represented by an infinite vector of cash flows.

The investment strategy of the Fund can not be static; it should be updated as new information arrives. Furthermore, even with an infinite projected lifetime for the Fund, finite horizons are relevant for the political viability of the Fund construction. Extended periods of negative returns may endanger the entire savings project. In this Strategy Report we focus on the probability distribution for accumulated return over a 15 year period. The analytical objective is to maximise the expected accumulated return as measured in the currency basket, within

[1] O.t.prp. nr. 2 (2005-2006)

acceptable limits for risk exposure. Year-on-year variations in returns will not be considered important.

Benchmark selection should not overlap with the active management of the Fund. Return variations over short horizons should be the responsibility of the investment management organisation. We believe that our horizon of 15 years is sufficiently long that the relevant information set for selecting the benchmark will be different from the information set that is relevant for active position taking. Our Market Report has been focused on the long term trends in the capital markets.

In this Strategy Report the objective for the investments is thus to maximise the expected accumulated return over the 15 year horizon as measured in the base currency (basket), with an acceptable level of risk.

There is very little guidance in official documents as to how the portfolio risk should be measured. The statement that the Fund shall be buying a share of the global supply of goods might intuitively lead us to a risk minimising strategy which consists of buying a share in the proceeds from global production capital, weighted to reflect the likely future import pattern of Norway. Those proceeds come as remuneration to stockholders and creditors, and the Fund can get a share of the proceeds by holding equity and bonds. But there would be significant elements of capital remuneration where the Fund could not buy its share, such as bank debts and equity in companies that are privately held or held by the government sector. This intuitive approach does not provide a sufficient basis for selecting an investment strategy.

The conventional analytical risk measure is the standard deviation of the return. This is a symmetrical risk measure, and the risk minimising portfolio is the one that minimises the return variation as measured by the standard deviation. But the downside risk may arguably be more relevant than the upside, given the spending rule and the aim to make the Fund permanent. We shall therefore also be looking at shortfall risk measures, such as the probability of negative accumulated real returns over the 15 year period. The risk minimising portfolio will then be the one that minimises either the probability of a shortfall or the probability weighted by the conditional expected value of the shortfall.

1.2. Construction of the benchmark portfolio

The building blocks of the benchmark portfolio consist of a large number of assets, in principle down to the individual securities. For practical analytical reasons the individual securities must be lumped together in sets, which we have chosen to delimit by asset class and region. For transparency reasons we employ the composition of widely used indices to represent these assets. The benchmark asset allocation should then in principle be determined by simultaneous optimisation of the risk and return trade-off over the outcome space spanned by this asset vector.

In practice the analysis has been carried out in steps. In the current approach to benchmark construction the allocation between asset classes is determined first, and then the regional distributions within each class are determined in a second step. The asset allocation within each region thus becomes a function of the regional distributions within each asset class.

There is no direct correspondence between the location where an equity instrument is listed or the currency in which a corporate bond is issued, and the location of the underlying production capital. A large share of global production takes place in multinational companies that are typically listed on one of the major stock exchanges. Corporate borrowings are often made in one of the major currencies rather than in the home currency of the company. Furthermore imports from one country are not necessarily priced in the home currency of that country.

It is difficult to evaluate the importance of these arguments. Most stock markets include the listings of large companies with worldwide production activities, along with local companies that have mainly domestic activities. Our presumption will be that there is a significant positive correlation between where the company is listed and the location of its production activities, and that its location therefore continues to be an important determinant of the currency exposure implicit in holding its stock.

The main deviations from these correspondences are probably the listing of multinational companies at the US and UK exchanges. Listings in these markets will be a weaker indication of true currency exposure than listings in other markets. It would therefore make sense to overweight these stock markets relative to the countries' weightings in the import basket. In the current benchmark that overweight is massive, with 31 and 17 per cent of the equity benchmark in these markets, as compared to 19 and 6 per cent weightings in our projected import basket (section 2 of the Market Report).

On the fixed income side the benchmark is defined in terms of currencies, not in terms of where issuers are domiciled. A relevant question both there and on the equity side concerns the correspondence between the composition of the import basket on the one hand and the currencies in which the imports are effectively priced on the other. Again, the presumption is that there is a high degree of correlation. The main deviations are probably in the commodities markets where prices are normally quoted in one of the major currencies, but these markets are of relatively minor importance in Norway's import basket.

We thus proceed to analyse the benchmark in terms of currency exposure as indicated by the domicile of listed companies on the equity side and by the currency denomination on the fixed income side.

1.3. Potential changes to the benchmark portfolio

The analysis in sections 2 - 4 below will not be based on explicit optimisation procedures. In stead we shall take the current benchmark portfolio as our point of departure. We shall be investigating whether potential changes to that benchmark will improve on the return and risk properties of the portfolio. We concentrate the analysis on those changes that we ex ante believe will be most beneficial.

With regard to the existing asset classes of listed equities and investment grade fixed income, we shall be looking at changes in the regional weightings, as well as changes in the overall asset class weightings. Norges Bank has in a letter of 10 February 2006 recommended that the equity portion should be increased to 50 or 60 per cent of the total portfolio. That recommendation is still being considered by the Ministry of Finance.

In an earlier letter of 22 August 2005 Norges Bank recommended that the regional weightings of the equity benchmark should be changed by increasing the portion invested in Asia/Oceania relative to the investments in the Americas, with a corresponding reduction in the portion invested in America/Africa[2]. Norges Bank also recommended that the portion of the fixed income benchmark invested in Asia/Oceania should be reduced below 10 per cent, with a corresponding increase in the portion invested in Europe. An underlying recommendation was that the total exposure to Asia/Oceania should be left approximately as before.

The recommendations on regional weightings were approved in the Revised National Budget 2006, where Asia/Oceania weighting in the equity benchmark was raised to 15 per cent, whereas the Asia/Oceania weighting in the fixed income benchmark was reduced to 5 per cent. With the total equity portion at 40 per cent of the portfolio, this meant a reduction in the total Asian exposure from 10.6 to 9.0 per cent. On the other hand, if the equity portion were to increase to 50 or 60 per cent, the total Asian exposure would be raised to 10.0 or 11.0 per cent.

In the ensuing portfolio analysis in section 2 we shall be considering changes in the equity portion and in the regional weightings within equities and fixed income. We shall be looking at five regions rather than the three regions currently used in the benchmark. This does not imply that the number of regions specified in the benchmark shall be increased, but we shall get an evaluation of what difference that would have made to return distributions.

In section 3 we ask whether the small cap equity markets or the high yield bond market should be in the benchmark portfolio. Both market segments are permitted within the investment mandate and the question becomes whether it will be advantageous to buy an average market exposure in addition to the selective exposure we get through active bets in these market segments.

The alternative asset classes are considered in section 4. We shall see how private equity, real estate and infrastructure investments will fit into the existing equity and fixed income benchmark. We shall estimate the consequences for the probability distribution of portfolio return, and employ that as a criterion for introducing one or more of these asset classes into the Fund portfolio.

1.4. Simulation modelling

Part of the analysis below will be done within tailor made simulation models for financial market returns. The first version of the model will be employed for the analysis of equity and bond markets in section 2. It consists of simple inter-correlated stochastic price processes for five equity and five fixed income assets. The main deviation from random walk is some modest mean reverting in the equity price processes. The model simulates the market developments over a 15 year period, and produces a probability distribution for returns on each asset and on the portfolio. We shall focus on the distribution for accumulated portfolio returns over the 15 year period, which corresponds to the time horizon we have chosen for our analysis, confer section 1.1 above.

[2] South Africa is the only African country in the benchmark. For practical reasons it is treated as part of the American region.

The model distinguishes between five different regions for equity or fixed income investments, viz. America, Europe ex UK, UK, Asia/Oceania ex Japan and Japan. It also includes the currencies of these five regions, viz. USD, EUR, GBP and JPY. We assume that Asia/Oceania ex Japan is part of the USD bloc, which seems reasonable given the set of countries that are currently included in the benchmark. There are thus 14 different assets in the model. South African investments will be treated as part of the American assets, consistent with the way it is handled in the present benchmark.

Currencies are for technical reasons represented by the exchange rate to NOK. This does not imply that returns are evaluated in the Norwegian currency.

		Base scenario		Deflation		Stagflation	
Mean global inflation rate 2006-21		2.1 %		0.2 %		5.5 %	
		Return	Volatility	Return	Volatility	Return	Volatility
Bonds	America	5.4 %	4 %	3.5 %	4 %	7.4 %	9 %
	Japan	2.9 %	4 %	1.1 %	4 %	4.8 %	9 %
	Asia/Pac ex Japan	5.2 %	5 %	3.3 %	5 %	7.2 %	10 %
	UK	4.7 %	5 %	3.2 %	5 %	7.1 %	10 %
	Europe ex UK	4.2 %	3 %	2.6 %	3 %	6.4 %	8 %
Equities	America	6.6 %	15 %	2.4 %	17 %	5.6 %	17 %
	Japan	4.7 %	20 %	1.4 %	22 %	3.8 %	22 %
	Asia/Pac ex Japan	6.6 %	21 %	2.4 %	23 %	5.6 %	23 %
	UK	7.6 %	16 %	3.1 %	18 %	6.8 %	18 %
	Europe ex UK	5.7 %	18 %	1.6 %	20 %	5.0 %	20 %
Currencies	NOK/USD	0.0 %	10 %	0.0 %	10 %	0.0 %	10 %
	NOK/JPY	0.0 %	12 %	0.0 %	12 %	0.0 %	12 %
	NOK/GBP	0.0 %	8 %	0.0 %	8 %	0.0 %	8 %
	NOK/EUR	0.0 %	5 %	0.0 %	5 %	0.0 %	5 %

Table 1.1: *Nominal returns and volatilities in local currencies assumed for each of the world economy scenarios.*

The expected returns and volatilities of the 14 assets were discussed in the Market Report for one base scenario and two risk scenarios for the world economy. Table 1.1 restates the assumptions employed in nominal terms. Notice that expected returns in bond and equity markets are assumed to differ between regions, as a consequence of different economic situations today and different rates of economic growth within the 15 year horizon. We have not assumed expected compensating changes in the exchange rates, but the uncovered interest rate hypothesis will naturally be applied for testing of robustness. No benchmark change will be recommended if the change is not beneficial even with interest rate parity assumed within the horizon for the analysis.

The return volatilities in the base scenario are listed in tables 1.2 and 1.3. The estimates are approximate historical averages for the latest 20 years. The bond market volatilities are assumed equal in the base and deflation scenarios, but five percentage points higher in the stagflation scenario where the inflation rates are significantly higher. Overall, the bond market volatilities are significantly lower than assumed in last year's Report, when estimates were based on 105 years of history. We now believe that these estimates exaggerated the volatility to be expected in the near future, in particular for the base scenario. The bond volatilities in the table are in line with current estimates from NBIMs RiskManager model.

The equity market volatilities are assumed to be two percentage points higher both in the deflation and stagflation scenarios relative to the base scenario, because of the less favourable environment for stocks in the two risk scenarios. The equity volatilities in the table are somewhat higher than current estimates from NBIMs RiskManager model.

The correlations assumed between bond market returns are also in line with the historical averages in the last 20 years. Table 1.2 reports correlations in the range from 0.4 to 0.7, whereas the correlations between equity market returns in table 1.3 are assumed to be in the range from 0.5 to 0.9. In both asset classes the lowest correlations are found between Japan and the other regions. All these correlations within the equity or within the bond asset class are assumed to be invariant to the economic scenario.

Bond markets	*Volatility*	Correlation to Japan	Correlation to Asia/Pac ex Japan	Correlation to UK	Correlation to Europe ex UK
America	*4 %*	0.4	0.5	0.5	0.6
Japan	*4 %*		0.4	0.4	0.4
Asia/Pac ex Japan	*6 %*			0.5	0.5
UK	*5 %*				0.7
Europe ex UK	*3 %*				

Table 1.2: *Volatility and correlation assumptions for the regional bond markets in the base scenario.*

Equity markets	*Volatility*	Correlation to Japan	Correlation to Asia/Pac ex Japan	Correlation to UK	Correlation to Europe ex UK
America	*15 %*	0.5	0.7	0.9	0.8
Japan	*20 %*		0.5	0.5	0.5
Asia/Pac ex Japan	*21 %*			0.8	0.7
UK	*16 %*				0.8
Europe ex UK	*18 %*				

Table 1.3: *Volatility and correlation assumptions for the regional equity markets in the base scenario.*

Bond vs. equity markets	Correlation to American equities	Correlation to Japanese equities	Correlation to Asia/Pac equities ex Japan	Correlation to UK equities	Correlation to European equities ex UK
America	0.0	-0.1	-0.1	-0.1	-0.2
Japan		0.0	0.0	0.0	0.0
Asia/Pac ex Japan			0.0	0.0	0.0
UK				0.2	0.0
Europe ex UK					0.0

Table 1.4: *Correlation assumptions between regional bond and equity markets in the base scenario.*

The correlation between the two asset classes in table 1.4 are assumed to be very close to zero in the base and deflation scenario, but significantly higher by 0.5 in the stagflation scenario. The latter assumption is based on the experiences from the 1970's.

The present benchmark specifies three regions only. The purpose of doing the analysis with five regions is to see whether there would be any benefit in introducing a more detailed specification in the benchmark. Since this would increase expected rebalancing costs, the benefits will need to be significant before specification of more regions is proposed.

In sections 3 and 4 we shall employ a second simulation model with new market segments or asset classes included. That model will not distinguish between regions, and thus have only one fixed income and one equity asset. But it will otherwise be very similar to the first model. The global expected bond and equity returns, volatilities and correlations will be close to the averages of the regional numbers presented above. The assumptions made about the alternative asset classes will be presented below when relevant.

2. Portfolio analysis of existing asset classes

The Market Report documented the details behind our estimated return expectations and covariance matrix for the listed equities and fixed income investments that are currently in the benchmark. In this section we shall employ the simple portfolio model introduced in section 1.4 to explore the implications of the market assumptions for asset allocation within the two existing asset classes of the Fund.

We set out by considering the present benchmark portfolio, and employ the model to produce a probability distribution for accumulated portfolio return over the 15 year horizon. We compute both the expected annualised return and a couple of risk characteristics. We then go on to consider alternative weightings of the assets and compares the probability distribution produced with the one of the current benchmark. That allows us to judge whether the properties of the probability distribution has been improved. Only significant improvements will justify changing the current benchmark.

2.1. The equity portion

The equity portion in the benchmark is currently 40 per cent, but Norges Bank has recommended an increase to either 50 or 60 per cent. We shall check that the rationale behind that advice remains the same as in last year's Strategy Report. We employ the new regional weightings that have been implemented this year; viz. 50/35/15 for the equity portion and 60/35/5 for the fixed income portion, for Europe, America/Africa and Asia/Oceania, respectively.

Table 2.2 presents the main outputs from these simulations for our base scenario; for scenario details confer table 1.1 above and chapter 1 of the Market Report. We focus on the ratio between the arithmetic mean return per year and the standard deviation of that return, i.e. a kind of marginal Sharpe ratio. An increase in the equity portion from 40 to 50 per cent will increase the arithmetic mean return per year by 29 basis points, and the standard deviation by 118 basis points. The marginal trade-off is thus 0.25. A further increase of the equity portion to 60 per cent will involve a marginal risk-return trade-off of 0.24, and a final step to 70 per cent gives a marginal trade-off of 0.22.

These numbers are marginally less favourable to a higher equity portion than the results that constituted our basis for recommending a higher equity portion. The reason is that we have

now assumed a slightly lower expected equity premium. The global expected equity return implicit in our assumptions is 2.03 per cent above the return on fixed income investments, which is 13 basis points less than assumed last year. This equity premium is definitely on the conservative side when compared to assumptions recently made by other large institutional investors, or by regulators[3].

Equity portion	Annualised expected real return (geometric)	Standard deviation of annualised return	Mean real return per year (arithmetic)	Standard deviation of return per year	Probability of negative accumulated real return
40 %	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
50 %	3.76 %	1.92 %	4.03 %	7.42 %	2.42 %
60 %	3.95 %	2.24 %	4.33 %	8.67 %	3.72 %
70 %	4.11 %	2.58 %	4.61 %	9.98 %	5.25 %

Table 2.2: *Alternative equity portions in the benchmark portfolio in the base scenario: Probability distributions of real return based on 6000 simulations in each case*.

The increase in the equity portion will naturally increase the likelihood of a negative accumulated real return, from 1.2 per cent with 40 per cent equity to 3.7 per cent with 60 per cent equity. This change is largely in line with the estimates obtained last year. But the probability estimates are somewhat lower, because our estimates of return volatilities are now conditional on a stable macroeconomic development and thus lower than the unconditional estimates of last year; see section 3.1 in the Market Report.

Equity portion	1st percentile	1st quartile	Median	3rd quartile	99th percentile
40 %	-0.11 %	2.46 %	3.54 %	4.63 %	7.30 %
50 %	-0.60 %	2.47 %	3.75 %	5.08 %	8.22 %
60 %	-1.15 %	2.43 %	3.96 %	5.50 %	9.21 %
70 %	-1.84 %	2.36 %	4.14 %	5.89 %	10.19 %

Table 2.3: *Alternative equity portions in the benchmark portfolio in the base scenario: The quartiles of the distribution for annualised real returns.*

Table 2.3 focuses on annualised returns, which is the concept that best corresponds to the accumulated returns we have chosen for our objective function. The table reports the quartiles of the probability distribution, and shows small differences between different equity portions for the first quartile. Closer inspection of the probability distributions reveals that there is an approximate 75 per cent probability for obtaining a higher return with a higher equity portion. That probability does not depend much on the level to which the equity portion is increased. This high probability for outperformance in the base scenario is similar to the unconditional probability obtained in the analysis performed last year.

In last year's report we documented the empirical return differences between equity and bond investments over the past 105 years. That analysis is updated in figure 2.1, where the addition of one extra year has of course not changed the conclusions. But we have also updated the

[3] For instance, the relatively strict Dutch regulator allows pension funds to assume an expected equity premium of 3 percent in mature markets and 4 percent in emerging markets.

regional weightings with the changes made earlier this year[4], and that reduces the number of periods where bonds have outperformed equities from eight to six out of the total 92. The six periods are those ending in 1940, 1941, 1943, 2002, 2003 and 2004. The largest outperformance occurred in the period ending in December 2004, when bonds had an annual (nominal) return of 6.9 percent against 4.8 for equities. That corresponds to an accumulated 15 percent outperformance of a benchmark with 40 percent equity relative to 60 percent equity over the 15 year period. In the opposite direction we find the largest outperformance of equities relative to bonds in the period ending in December 1963, when the annualised returns were 17.7 percent for equities and 2.1 percent for bonds.

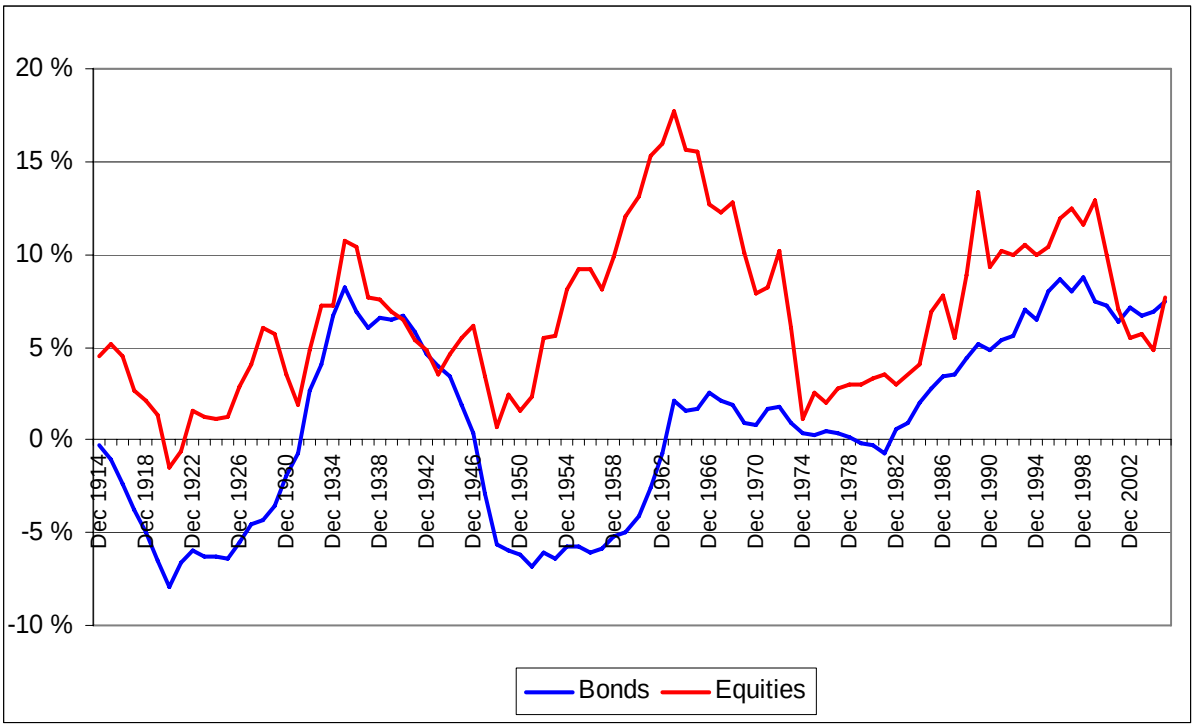

Figure 2.1: *Annualised real return in overlapping 15 year periods for equity and bond portfolios with regional weightings as in the Pension Fund benchmark.*

The new contribution in this report is that we also consider probability distributions conditional on alternative scenarios. The differences from the base scenario are mainly in terms of expected returns. For the stagflation scenario there are also significant changes in the covariance matrix; confer section 3.2 of the Market Report. For both risk scenarios we increase the estimation uncertainty around the point estimates of expected returns.

Table 2.4 reports the quartiles of the probability distributions for annualised real returns in the deflation scenario. In this scenario the expected real bond returns are approximately as in the

[4] The exact weightings employed in the calculations are:

	Bonds	Equities
USA	0.350	0.350
UK	0.100	0.180
GERMANY	0.250	0.160
FRANCE	0.250	0.160
JAPAN	0.050	0.150

base scenario, whereas the expected equity premium is on average very close to zero. This naturally makes an increase in the equity portion to 60 percent look unattractive.

Equity portion	1st percentile	1st quartile	Median	3rd quartile	99th percentile
40 %	-0.76 %	1.97 %	3.10 %	4.23 %	7.01 %
60 %	-2.45 %	1.40 %	2.99 %	4.59 %	8.63 %

Table 2.4: *Alternative equity portions in the benchmark portfolio in the deflation scenario: The quartiles of the distribution for annualised real returns.*

The expected portfolio returns are lower than in the base scenario, but the main point to consider is the effect of a higher equity portion. There is now only a 45 percent probability that a higher equity portion will be profitable and a 55 percent probability that it will not. The probability for a negative accumulated real return increases from 3.1 percent to 9.9 percent.

Table 2.5 similarly reports the quartiles of the probability distributions for annualised real returns in the stagflation scenario. In this scenario the expected real bond returns are about one percentage point lower than in the base scenario, and the expected equity premiums are negative. The correlations between bond and equity markets are significantly higher than in the base or deflation scenarios. It is quite evident that increases in the equity portion will not be a good idea. In this stagflation scenario both the median and the expected portfolio return become lower with a higher equity portion, and the probability that a higher equity portion becomes profitable is only 32 percent. The probability for negative accumulated real returns over the 15 year period increases from 34 to 38 percent when the equity portion is raised to 60 percent.

Equity portion	1st percentile	1st quartile	Median	3rd quartile	99th percentile
40 %	-4.53%	-0.64 %	1.07 %	2.82 %	7.24 %
60 %	-5.51 %	-1.06 %	0.90 %	2.87 %	8.07 %

Table 2.5: *Alternative equity portions in the benchmark portfolio in the stagflation scenario: The quartiles of the distribution for annualised real returns.*

We may consider the two risk scenarios as worst case warnings. But the expected loss from increasing the equity portion from 40 to 60 per cent is even in the unfavourable stagflation scenario only an accumulated loss over 15 years of 0.2 percent. Looking at the 10 percent worst outcomes in this stagflation scenario gives an average accumulated loss of only 7 percent or approximately 0.4 percent per year. This underpins our conclusion from the base scenario that the expected loss from a higher equity portion will be limited even in unfavourable outcomes.

2.2. The regional weighting of the fixed income benchmark

The fixed income benchmark has a regional weighting of 60 percent in Europe, 35 percent in America and 5 percent in Asia/Oceania. In this section we shall search in the neighbourhood of that allocation to see whether other weightings can be expected to improve on the properties of the probability distribution for accumulated return over the 15 year evaluation period. The simulation model has a more detailed specification, with two regions in Europe and two regions in Asia/Oceania. The current market value weightings within the two regions

are in Europe approximately 10 percent in UK and 50 percent in Europe ex UK, and in Asia/Oceania approximately 4 percent in Japan and 1 percent in Asia/Oceania ex Japan.

The simulations are done within the framework of our base scenario with stable economic growth and inflation. The risk scenarios are only used to check the robustness of any recommendations.

We set out by keeping the Europe weighting constant at 60 percent. We then change the weightings of America on the one hand and the two regions of Asia/Oceania on the other, while keeping the relative weighting within Asia/Oceania constant. Similarly, in the next steps we shall be keeping the America or Asia/Oceania weightings constant, while changing the two other weightings. The simulation results from these alternative allocations are compared to the current benchmark allocation in table 2.6 below.

Fixed income regional weightings (UK, Europe, America, Japan, Asia/Oceania	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark 10-50-35-4-1	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
Europe constant					
10-50-40-0-0	3.59 %	1.64 %	3.79 %	6.34 %	1.32 %
10-50-30-8-2	3.50 %	1.59 %	3.69 %	6.15 %	1.25 %
America constant					
11-54-35-0-0	3.56 %	1.61 %	3.75 %	6.25 %	1.27 %
9-46-35-8-2	3.54 %	1.61 %	3.74 %	6.23 %	1.17 %
Asia/Oceania constant					
11-54-30-4-1	3.51 %	1.59 %	3.70 %	6.16 %	1.23 %
9-46-40-4-1	3.58 %	1.63 %	3.78 %	6.32 %	1.25 %

Table 2.6: *Alternative regional weightings of the fixed income benchmark portfolio in the base scenario. Probability distributions of real return based on 6000 simulations in each case*.

None of the alternatives implies a probability distribution that is significantly different from the one that follows from the current regional allocation. The most attractive alternative involves the down weighting of Asian bonds, which is also what we proposed last year. A number of the other alternatives are actually less attractive than the current allocation, and none of them clearly preferable to it.

We also look at changing the internal weightings in Europe and Asia/Oceania away from the market weightings in the current benchmark. As alternatives to 10/50 between UK and Europe ex UK we look 0/60 (no UK bonds) and 20/40 (one third UK bonds). As alternatives to 4/1 between Japan and Asia/Oceania we look at 0/5 (no Japanese bonds) and 5/0 (only Japanese bonds). The simulation results from these alternative allocations are compared to the current benchmark allocation in table 2.7 below.

The most favourable effect on the probability distribution is now clearly obtained by eliminating the Japan weighting in Asia. This will increase the expected returns, slightly reduce the standard deviation and reduce the downside risk as measured by the probability for negative accumulated real return over the entire 15 year period. We notice again that this is

the kind of recommendation that we made in our 2005 analysis. The main reason for the result in the present analysis is naturally the lower expected bond return that we have assumed for Japan. This could easily be counteracted by an appreciation of the Japanese currency, which is the reason that we last year combined this recommendation with an increase in the equity portion in Japan and the rest of Asia/Oceania.

In conclusion, we can see no clear benefit of changing any of the fixed income regional weightings, or of introducing separate weights for UK and Europe ex UK or for Japan and Asia/Oceania ex Japan.

Fixed income regional weightings (UK, Europe, America, Japan, Asia/Oceania	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark 10-50-35-4-1	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
Changes within Europe					
0-60-35-4-1	3.50 %	1.58 %	3.69 %	6.14 %	1.30 %
20-40-35-4-1	3.59 %	1.65 %	3.80 %	6.39 %	1.28 %
Changes within Asia					
10-50-35-5-0	3.54 %	1.61 %	3.73 %	6.24 %	1.27 %
10-50-35-0-5	3.60 %	1.61 %	3.79 %	6.22 %	1.17 %

Table 2.7: *Changed weightings of the fixed income benchmark portfolio within Europe or within Asia in the base scenario.*

2.3. The regional weighting of the equity benchmark

The equity benchmark has a regional weighting of 50 percent in Europe, 35 percent in America and 15 percent in Asia/Oceania. In this section we shall search in the neighbourhood of that allocation to see whether other weightings can be expected to improve on the properties of the probability distribution for accumulated return over the 15 year evaluation period. The simulation model will have a more detailed specification, with two regions in Europe and two regions in Asia/Oceania. The current market value weightings are for Europe approximately 18 percent in UK and 32 percent in Europe ex UK, and for Asia/Oceania approximately 9 percent in Japan and 6 percent in Asia/Oceania ex Japan.

As for the fixed income weightings, the simulations are done within the framework of our main scenario with stable economic growth and inflation. The risk scenarios will only be used to check the robustness of any recommendations.

We set out by keeping the Europe weighting constant at 50 percent. We change the weightings of America on the one hand and the two regions of Asia/Oceania on the other, while keeping the relative weighting within Asia/Oceania constant. Similarly we shall in the next steps be keeping the America or Asia/Oceania weightings constant and changing the two other weightings. The simulation results from these alternative allocations are compared to the current benchmark allocation in table 2.8.

In parallel with our findings for the fixed income benchmark, none of the alternative weightings implies a probability distribution that is significantly different from the one that follows from the current regional allocation. Some of them are clearly less attractive than the current allocation.

The most favourable effect on the probability distribution is now obtained by increasing the weighting in Asia. This will not increase the expected returns, but it will reduce the standard deviation and the downside risk as measured by the probability for negative accumulated real return over the entire 15 year period. We notice that this is the kind of change we also recommended in our 2005 strategy report. The main reason behind this result in the present analysis is the increase in the Asian weighting will bring it closer to the 20 percent weight of Asian currencies in our currency basket, confer section 1.1 above. A lower currency weighting for Asia would have eliminated the benefits of a higher Asia portion in the equity portfolio.

Equity regional weightings (UK, Europe, America, Japan, Asia/Oceania	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark 18-32-35-9-6	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
Europe constant					
18-32-40-6-4	3.54 %	1.63 %	3.74 %	6.31 %	1.33 %
18-32-30-12-8	3.55 %	1.59 %	3.74 %	6.17 %	1.08 %
America constant					
20-35-35-6-4	3.54 %	1.62 %	3.74 %	6.29 %	1.37 %
16-29-35-12-8	3.55 %	1.60 %	3.75 %	6.21 %	1.12 %
Asia/Oceania constant					
20-35-30-9-6	3.55 %	1.60 %	3.74 %	6.21 %	1.18 %
16-29-40-9-6	3.55 %	1.62 %	3.75 %	6.28 %	1.32 %

Table 2.8: *Alternative regional weightings of the equity benchmark portfolio in the base scenario. Probability distributions of real return based on 6000 simulations in each case*.

Equity regional weightings (UK, Europe, America, Japan, Asia/Oceania	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark 18-32-35-9-6	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
Changes within Europe					
10-40-35-9-6	3.49 %	1.60 %	3.68 %	6.21 %	1.32 %
25-25-35-9-6	3.60 %	1.62 %	3.80 %	6.29 %	1.22 %
Changes within Asia					
18-32-35-15-0	3.51 %	1.61 %	3.70 %	6.23 %	1.20 %
18-32-35-0-15	3.60 %	1.64 %	3.80 %	6.35 %	1.28 %

Table 2.9: *Changed weightings of the equity benchmark portfolio within Europe or within Asia in the base scenario.*

We also look at changing the internal weightings in Europe and Asia/Oceania away from the market weightings in the current benchmark. As alternatives to 18/32 between UK and Europe ex UK we look 10/40 (less in the UK) and 25/25 (more in the UK). As alternatives to 9/6 between Japan and Asia/Oceania we look at 15/0 (only Japanese stocks) and 0/15 (no Japanese stocks). The simulation results from these alternative allocations are compared to the current benchmark allocation in table 2.9.

Favourable effects on the probability distribution are now obtained by eliminating the Japan weighting in Asia, and by increasing the UK weighting in Europe. Both of these changes will increase the expected returns, keep the standard deviation the same and reduce the downside risk as measured by the probability for negative accumulated real return over the entire 15 year period. The main reason behind these results in the present analysis is naturally the lower expected equity return that we have assumed for Japan, and the higher return we have assumed for the UK. In Asia the low correlation assumed between Japanese and other Asian equities is also important. We hesitate to make a recommendation based solely on these assumptions.

In conclusion, we can see no clear benefit of changing any of the equity regional weightings, or of introducing separate weights for UK and Europe ex UK or for Japan and Asia/Oceania ex Japan.

3. New market segments for equity or fixed income?

In the Market Report we looked at the question of adding more market segments to the equity and fixed income benchmarks. The small cap and the high yield segments of the equity and fixed income markets, respectively, were discussed in detail. In this Strategy Report we summarize the main findings and present some supplementary results from model simulations.

3.1. Small cap equity markets

The small cap segment is the largest of the candidates to be included in the benchmark, with a market value of more than ten per cent of the mid and large cap segments currently included in the equity benchmark. The basic principle for portfolio construction is that a large fund, in particular when aiming to be a pure financial investor, should diversify its investments as broadly as possible. This is relevant for the small cap segment even if our Market Report only indicated modest diversification benefits for the Pension Fund in terms of reduced volatility. That was mainly due to the limited size of even this market segment, and will be true for any new segment we may consider.

Table 3.1 shows the size of the small cap segment relative to the large and mid cap segments already included in the Pension Fund benchmark. In the countries that are currently part of the benchmark there are in total 4500 small cap stocks in the FTSE Global Index. Their average market value is USD 838 millions, which is far smaller than the average size of large and mid cap companies. There are considerable differences between the developed markets in America and Europe on the one hand and Asia/Oceania and the emerging markets on the other hand. In the latter regions the average size of a small cap company is only USD 300-400 millions. In North America and Europe the corresponding number is USD 1000-1100 millions. The

average small cap companies in these two regions are comparable in size to the average large and mid cap company in New Zealand, which is the smallest developed market in the current benchmark.

	Large/mid cap				Small cap		
Region / Country	Market value (mill USD)	Number of stocks	Mean market value per stock		Market value (mill USD)	Number of stocks	Mean market value per stock
America / Africa							
Brazil	263 746	66	3 996		13 738	30	458
Canada	829 972	62	13 386		229 345	178	1288
Mexico	175 203	31	5 651		6 137	14	438
US	13 023 887	707	18 421		1 952 418	1730	1129
South Africa	229 288	82	2 796		9 589	37	259
Sum all developed	*13 853 859*	*769*	*18 015*		2 181 763	*1908*	*1143*
Sum all emerging	*668 237*	*179*	*3 733*		29 464	*81*	*364*
Sum	*14 522 096*	*948*	*15 318*		2 211 227	*1989*	*1112*
Europe							
Austria	47 357	8	5 919		25 472	18	1415
Belgium	124 017	16	7 751		23 157	32	724
Denmark	84 774	12	7 064		30 997	26	1192
Finland	147 772	11	13 433		41 525	36	1153
France	1 315 239	68	19 341		86 346	88	981
Germany	867 924	49	17 712		76 787	79	972
Greece	77 710	12	6 475		19 713	43	458
Ireland	91 783	8	11 472		23 764	17	1398
Italy	534 116	44	12 139		75 357	91	828
Netherlands	440 091	20	22 004		59 983	46	1304
Portugal	46 220	8	5 777		4 395	8	549
Spain	512 475	33	15 529		44 775	32	1399
Sweden	289 349	30	9 644		58 854	54	1090
Switzerland	823 814	32	25 744		85 616	86	996
UK	2 843 991	133	21 383		374 877	315	1190
Sum	*8 246 632*	*484*	17 038		*1 031 618*	*971*	*1062*
Asia / Oceania							
Australia	675 770	117	5 775		66 994	138	485
Hong Kong	354 786	107	3 315		31 294	109	287
Japan	2 786 834	484	5 757		314 527	854	368
Korea	419 965	99	4 242		56 259	142	396
New Zealand	17 904	15	1 193		2 487	13	191
Singapore	103 235	46	2 244		18 445	56	329
Taiwan	299 331	138	2 169		56 446	249	226
Sum all developed	*3 938 529*	*769*	5 121		*433 747*	*1 170*	*370*
Sum all emerging	*719 296*	*237*	3 035		*112 705*	*391*	*288*
Sum	*4 657 825*	*1 006*	4 630		*546 452*	*1 561*	*350*
Global sum	**27 426 553**	**2 438**	**11 249**		**3 789 297**	**4 521**	**838**

Table 3.1: *Stocks and market values in the large, mid and small cap segments of the FTSE Global Equity Index Series per August 2006.*

The small cap segment has outperformed the large and mid cap segments for extended periods of time, last time during the past 5-6 years. But there has also been extended periods when the small cap segment has underperformed, last time in the 1990's. This record has led analysts to consider small cap characteristics as a priced factor in the equity market. The ex post premium relative to large and mid cap has varied considerably, but on average it has been slightly positive over the years and in the markets for which data are available.

We thus believe that there are small but positive benefits both in terms of diversification and expected return. It should be noted that the pricing of the small cap segment may not be attractive at present (August 2006). But the evidence of excessive pricing is too weak to make it relevant for the question of whether the segment should be included in the benchmark.

There are, however, a couple of other important counter arguments to be considered.

First, the transaction costs are higher for smaller companies. Implementation costs for establishing the new portfolio will be higher than for the large and mid cap segment. The exact costs will depend on market conditions and on the speed of implementation. The estimates of market impact in table 3.2 are based on the StockFactsPRO model.

	Buying small cap				Selling large and mid cap			
Implementation period	Com-missions	Taxes & charges	Impact cost	Total cost	Com-missions	Taxes & charges	Impact cost	Total cost
1 month	5.85	11.97	110.42	**128.23**	5.92	1.21	17.31	**24.43**
3 months	5.85	11.97	49.92	**67.74**	5.92	1.21	6.75	**13.87**
10 months	5.85	11.97	31.50	**49.32**	5.92	1.21	6.03	**13.16**

Table 3.2: *Initial implementation cost estimates (millions USD).*

If the entire small cap portfolio is bought within one month and paid for by selling large and mid cap stocks, the estimated total implementation costs are USD 153 millions. That number can be substantially reduced by stretching the implementation period. With a ten month implementation period the estimated total costs are USD 62 millions. Even that cost could be somewhat reduced by using inflows to the fund for buying the small cap stock rather than selling large and mid cap stocks.

Review	FTSE Global Small Cap Index	FTSE All-World Index	FTSE Global All Cap
March 2006	3.24	0.37	0.98
December 2005	10.67	0.19	1.81
September 2005	6.76	0.82	1.46
June 2005	2.24	0.55	1.07
March 2005	5.52	0.66	1.49
December 2004	23.89	5.01	3.34
September 2004	31.28	1.67	22.43
June 2004	2.12	0.69	1.16
March 2004	4.00	0.65	1.25
December 2003	1.59	0.17	0.73
September 2003	6.00	13.61	1.60

Table 3.3: *Portfolio turnover in the FTSE global equity indices.*

There will also be higher maintenance costs due to more frequent exits from and entries into the small cap benchmark index. The FTSE global small cap index is reviewed quarterly. The turnover figures since inception in September 2003 are reported in the first column of table 3.3. There are large variations over time. The last four quarterly reviews for which data are

available (June 2005 to March 2006) have in total required transactions (buys plus sells) equivalent to 23 percent of total small cap market value. However, this number does not allow for the fact that exits to the mid or large cap segments will not require transactions for the Pension Fund.

Inclusion of the small cap segment means going from a benchmark defined by the FTSE All-World (i.e. large and mid cap) index to a benchmark defined by the FTSE All Cap index. It is therefore more relevant to compare the turnover of these two indices, which are reported in the two last columns of table 3.3. Looking again at the last four quarters, the required indexing transactions increase from 1.93 percent to 5.32 percent of market value. Taking the annual average from all quarterly reviews reported in table 3.3 gives higher numbers for both indexes, but does not significantly affect the difference between them.

Replication of the index also requires a large number of transactions in between the quarterly reviews, mainly because of IPOs and reinvestments of dividends. With the current All-World (i.e. large and mid cap) equity benchmark, these transactions are fully 60 percent of the total replication transactions, making for a total transaction requirement of 4.7 percent of market value. If we apply that same ratio to the small cap segment, the total transaction volume requirement for replicating the All Cap index is 13 percent. A more reasonable assumption may be that transactions due to IPOs and reinvestment of dividends represent the same percentage of total market value in all market segments. With that more conservative assumption the transaction volume required to replicate the All Cap index will be 8.1 per cent of market value as compared to the 4.7 per cent for the All-World Index.

The trading costs can also be expected to be somewhat higher in the small cap than in the large and mid cap segments, but the difference does not on average appear to be very large. Employing the StockFactsPRO model the average trading cost associated with changes in the large and mid cap index is estimated to 46 basis points, whereas trading costs associated with changes in the small cap index is 59 basis points. Together with the estimates of transaction volumes this implies that replication costs for the AllWorld index is approximately 3 basis points, whereas the costs for the AllCap index is between 5 and 8 basis point, depending on what assumption we use for the volume of transactions between the quarterly reviews.

The main source of increased transaction costs is the higher turnover of the index. All investors in the small cap market will to some extent be exposed to higher turnover requirements, and the higher transaction costs will thus at least to some extent be reflected in a higher required gross return. In a fully efficient market this would correspond to a higher equilibrium return.

The second question concerns the limit of five percent maximum ownership in any company imposed by the Ministry of Finance. That is a rule which other large funds do not need to observe. Given market cap weighting between segments, the average ownership of the Pension Fund will not be higher in the small cap segment than in the existing benchmark companies. NBIM presently replicates the equity benchmark by essentially buying all companies included. In the small cap segment there may be good reasons for choosing a different indexing strategy, where only stocks from a representative sample of companies are bought. If the NBIM chooses a sampling strategy the average ownership share would increase above the average in the rest of the equity portfolio, and could limit the room for active management in the small cap segment.

This problem primarily concerns the investments in Europe, where the average ownership in stocks held by the Pension Fund is highest, at present approximately 0.7 per cent. That average would be somewhat diluted if the small cap segment was included, but it will nevertheless increase as the size of the Fund increases in the years ahead. Assume for illustration purposes that the indexing in the small cap segment is done by buying a representative sample comprising one third of the companies in the FTSE index. Average ownership share in these companies would then be close to two per cent and increasing. The room for active management would be limited to three per cent of the stocks in each of these companies, as compared to more than four per cent in the case of full replication. This would of course be an impediment to active management.

There is a trade-off between the degree of sampling in indexing and the room left for active management. More exact replication implies higher indexing costs and larger room for active management. More use of sampling techniques will reduce the indexing costs, but increase the tracking error and reduce the room for active management. This trade-off should be the responsibility of the operational manager (NBIM).

A third question concerns the corporate governance activities towards the small cap companies. The numbers of stocks held by the Pension Fund will more than double or perhaps even triple from today, depending on the indexing strategy chosen. That will not pose a technical problem for NBIM, but it will require more resources to handle the proxy voting, and thus a larger organisation. The costs of the corporate governance activities are still small compared to other management costs. Assume for instance that the addition of small cap companies would require a doubling of the five man-years now employed for corporate governance activities. The initial cost of this would be only in the order of one basis point of the small cap portfolio, and should not in itself constitute an important argument against including the small cap segment in the benchmark for the Pension Fund. But it naturally adds to the operational burden of the management organisation.

As a supplement to these arguments, we have done a model analysis to illustrate how the small cap segment would fit into the benchmark portfolio. For illustrative purposes we assume the equity portion to be 40 %, of which one tenth or 4 % is in the small cap segment. The key assumptions made for small cap equities in the simulation model are listed in table 3.4. For the modelling exercise we assume the same expected return as in the large and mid cap segments, to check whether other factors still make small cap attractive. We assume a significantly higher volatility than in the large and mid cap segments, and the correlations with other equity market are assumed to be 0.7-0.85. There is also a significant and positive correlation with real estate and infrastructure returns. In line with our assumptions for equity in general we assume no correlation with investment grade bond returns.

Expected excess return over existing equity benchmark		0.0 %
Volatility of small cap returns (memo: large/mid cap 15 %)		18 %
Correlation between small cap and	investment grade bonds	0.00
	high yield bonds	0.70
	large and mid cap equities	0.70
	private equity	0.85
	real estate	0.60
	infrastructure	0.60

Table 3.4: *Key assumptions for small cap equities in the simulation model.*

The results are reported in table 3.5, where the model parameters have been calibrated to give approximately the same properties to the current benchmark as in the five region model employed in section 2. We notice that the expected return with small cap included increases by three basis points even if no higher expected return has been assumed, whereas the risk is reduced, whether measured by the standard deviation or the probability of negative accumulated real returns. The increased expected return comes from introducing a higher volatility asset, whereas the reduced total risk exposure is due to the diversification effect obtained by introducing the small cap segment.

Small cap equities	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
Small cap included	3.57 %	1.61 %	3.77 %	6.23 %	1.05 %

Table 3.5: *Small cap equities in the benchmark portfolio in the base scenario: Probability distributions of real return based on 6000 simulations in each case.*

In conclusion we recommend that that the small cap segment should be included in the benchmark portfolio for the Pension Fund. As per August 2006 this means that we recommend introducing approximately 4500 additional companies to the 2500 currently in the benchmark. With these 7000 companies, the equity benchmark will represent 96 percent of the equity markets included in the FTSE index, as compared to 85 percent today. The remaining four percent are in emerging markets that are currently not included in the Fund's equity benchmark.

An alternative to including the entire small cap segment could be to include the developed markets in North America and Europe and exclude the Asia/Pacific and emerging markets small cap segments. The rationale for doing that would be that the average size of the small cap companies in these latter regions is much smaller than in Europe and America, and that the bulk of small cap market value is in Europe and North America. The diversification gain will thus not be much reduced, but the operational burdens could be alleviated.

3.2. High yield fixed income markets

The market for corporate bonds below investment grade had in early 2006 a market value corresponding to approximately four per cent of the current Lehman Global Aggregate benchmark index for the Pension Fund. The market share has been growing rapidly during the last two decades. The market segment is most developed in the US, which constitutes more than 60 per cent of the Lehman Global High Yield Index.

The high yield segment can over time be expected to earn a positive premium over investment grade returns. The expected premium can reasonably be estimated at 1-2 percentage points, when the expected losses from defaults have been deducted. It should be noted that the data basis for the estimate is limited to the last 20 years' experience in the US. Based on the same limited data set, there seems to be diversification benefits within the fixed income portfolio, with a relatively low correlation between high yield and investment grade returns. The

correlation between high yield and equity returns are, however, quite high, and this reduces the benefits for the total portfolio.

Transaction costs are high, with average bid-ask spreads significantly higher than in the investment grade segment. Furthermore, in many cases the issues included in the high yield indexes may be difficult or impossible to buy at all. The Lehman Global High Yield Index is thus not investable in a strict sense.

We have still looked at how the high yield segment would fit into the total benchmark portfolio. The key assumptions made for high yield bonds in the simulation model are listed in table 3.6. We have assumed a 1.4 percentage point higher expected return than in the investment grade segment, and a higher volatility. The correlation with investment grade bonds is assumed to be 0.6, and we also assume high correlation with the equity markets, in particular the small cap and private equity segments where high yield financing is important. There is also a positive correlation assumed with real estate and infrastructure returns.

Expected excess return over existing fixed income benchmark		1.4 %
Volatility of high yield returns (memo: investment grade 4.5 %)		6 %
Correlation between high yield and	investment grade bonds	0.60
	large and mid cap equities	0.60
	small cap equities	0.70
	private equity	0.65
	real estate	0.55
	infrastructure	0.55

Table 3.6: *Key assumptions for high yield bonds in the simulation model.*

The high yield segment will be about four percent of the total fixed income benchmark, and for the simulation exercise we assume that a fixed income portion of 60 percent becomes 57.5 percent investment grade bonds and 2.5 percent high yield bonds. The results are reported in table 3.7. We notice that the expected return with high yield included increases in line with the higher expected return assumed, and that the standard deviation of returns also increases, whereas the probability of negative accumulated real returns may be reduced. The marginal return-risk trade-off is 0.29, which is relatively attractive.

High yield bonds	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
High yield included	3.58 %	1.65 %	3.79 %	6.41 %	1.20 %

Table 3.7: *High yield bonds in the benchmark portfolio in the base scenario: Probability distributions of real return based on 6000 simulations in each case.*

Large funds will typically have a significant allocation to the high yield segment. The fixed income investment programme of the largest US pension fund CalPERS sets a ceiling on high yield investments of 10 per cent of the fixed income portfolio. Similarly, the largest European pension fund ABP has approximately five per cent of its fixed income portfolio invested in the high yield segment. These investment programmes are mandates for active management. We are not aware of funds that employ passive indexing strategies to the high yield segment.

The high yield index weights issues by market cap, which implies that a large debtor will have a higher weighting. In efficient markets the higher risk involved in buying papers issued by a heavily indebted issuer should be reflected in higher yields, and thus represent an opportunity to earn a premium. But pricing may not be efficient, in particular not in the riskiest end of the market where some investors may have motives beyond the return passively earned on the bond investments. There may therefore be a case for avoiding a benchmark where very risky issues have a high weighting.

Another reason for not including the high yield segment in a benchmark portfolio is that risk exposure measured by the tracking error relative to a market weighted index in this segment is likely to be a very poor guide to true exposure. A manager may be discouraged from efforts to avoid bankruptcy situations because he will then incur a tracking error that he avoids by staying passive.

In conclusion, we do not recommend including the high yield segment in the fixed income benchmark of the Pension Fund. One reason is that the high yield indexes are not strictly investable. A second reason is that the market cap weighting may expose the Fund to risks that are not adequately priced in the market, and that indexing may contribute to increased absolute risk exposure.

There is on the other hand a rationale for investing a significant part of the fixed income portfolio in the high yield segment. As a long term investor the Fund should try to collect the illiquidity and risk premiums available. The high yield segment is part of the investment universe, and the manager is free to seek exposure to the market. The benchmark for their investments in the high yield market is effectively the Lehman Global Aggregate of investment grade corporate bonds. We recommend leaving it that way for the time being, with generous upper limits for exposure to the high yield market. Alternatively one could issue a specific high yield mandate, along the lines that will be discussed below for alternative asset classes. This would be similar to the approach chosen by most other large funds.

4. New asset classes

4.1. Real estate and infrastructure

Only very uncertain estimates can be given of the size of the commercial real estate and infrastructure markets. External sources have estimated the value of commercial properties owned by institutional investors in Europe, Asia and North America to be in the range USD 600 - 700 bn, with a rough 80/20 split between unlisted and listed vehicles. The Global Property Research General Index, covering listed real estate stocks in 29 markets had a market value by the end of August 2006 of USD 968 bn.

Estimates of the size of the infrastructure markets are even more uncertain. Listed infrastructure stocks (mainly utilities) as represented by the Macquarie Global Infrastructure Index had a market value of USD 1.8 bn in early 2006. We are not aware of any estimates of the size of unlisted equity investments by institutional investors.

Real estate is a common asset class among large institutional investors. Dutch ABP has 11 % of its net assets in real estate investments by the end of 2005, while Californian CalPERS had

5 % at the same time. In The Government Pension Fund's peer group in the CEM 2005 cost analysis, the average holding of unlisted and listed real estate was 7 %.

Infrastructure investments are still an emerging asset class among institutional investors. Only Australian and Canadian pension funds have so far allocated more than small fractions to infrastructure projects, although the Dutch funds are currently building up exposure.

In the markets with the longest history, unlisted real estate has yielded a return equivalent to bonds plus a margin of 0.5 – 1.5 percentage points. However, these data are from a period with – in the long term – a very high real return on bonds. Market valuations indicate that the historic expected long term risk premium on real estate relative to government bonds on average has been 2 – 2.5 percentage points. Real estate has outperformed equities as well as bonds significantly over the last 10 years, and appears currently to be expensive in relation to other asset classes.

It will be very challenging to accommodate for real estate and infrastructure investments within the current fund governance structure. While there do exist indices for unlisted property in North America, Europe and Australia, they can hardly be used for measuring relative risk and for short term performance comparisons. Thus, alternative performance targets, risk limits and reporting requirements should be established before starting up a real estate and infrastructure program. We return to this in section 4.3 below.

We have looked at how real estate and infrastructure investments would fit into the total benchmark portfolio. The key assumptions made for these asset classes in the simulation model are listed in table 4.1. We have modestly assumed a one percentage point higher expected return than for the fixed income benchmark. The expected return is, however, one percentage point below that assumed for equity. The return estimate does not take the current pricing of the market into account, because the exposures will lie relatively far ahead.

The volatilities of nominal returns in those real estate markets where we have a long history are in the order of 10-15 per cent, confer table 7.7 in the Market Report. The correlations between the main listed real estate markets during the past 20-30 years are around 0.4-0.5. Employing these estimates implies that a global portfolio will have a return volatility of 6-8 per cent. Listed infrastructure has slightly lower return volatilities than listed real estate.

The correlations with fixed income and equity market are assumed to be 0.4-0.6, which is in the high end of the historical estimates. The correlation between real estate and infrastructure returns is not given in the table, but we assume that to be very high, at 0.98.

Expected excess return over the fixed income benchmark		1.0 %
Volatility of real estate returns		7.0 %
Volatility of infrastructure returns		5.0 %
Correlation of real estate and infrastructure returns to	investment grade bonds	0.20
	high yield bonds	0.55
	large and mid cap equities	0.60
	small cap equities	0.60
	private equity	0.60

Table 4.1: *Key assumptions for real estate and infrastructure investments in the simulation model.*

Real estate and infrastructure	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
3.5 % real estate and 1.5 % infrastructure	3.55 %	1.58 %	3.73 %	6.12 %	0.92 %
7.5 % real estate and 2.5 % infrastructure	3.55 %	1.56 %	3.73 %	6.05 %	0.85 %

Table 4.2: *Real estate and infrastructure in the benchmark portfolio in the base scenario: Probability distributions of real return based on 6000 simulations in each case.*

In the simulation exercise we assume that 5 or 10 percent of the total portfolio is invested in real estate and infrastructure, with the major part of that portion in real estate. The rest of the portfolio is assumed to retain a 40/60 split between equities and bonds, which imply that the real estate/infrastructure investments crowd out more bonds than equities. The results are reported in table 4.2. We notice that the expected return does not change much when real estate and infrastructure are included, whereas the volatility of returns is definitely reduced. The probability of negative accumulated real returns is also reduced. The effects on the probability distribution thus look favourable, both with a 5 percent and a 10 percent portion in real estate and infrastructure.

We recommend that real estate and infrastructure investments enter the eligible investment universe of the Government Pension Fund. In order to realise significant diversification benefits, a long term target of 10 % of the fund in real estate and infrastructure should be established. This number is not determined by optimising, but simply by an assessment of how much the Fund can reasonably hope to invest in these markets in a sensible way. A target of 10 percent is ambitious and can probably only be reached many years ahead. An investment program should be started carefully, and it must be based on the preceding establishment of an investment organisation capable of assuming investment responsibility.

4.2. Private equity

To our knowledge no detailed estimate of the size of the institutional private equity market is available. In principle we would like to measure the market value of non-listed companies owned by institutional private equity investors. The most commonly used figures used for describing the size of the market are aggregate numbers of the last years' fundraising and investments by the private equity industry. In the first half of 2006 the private equity industry is estimated to have raised USD 167 bn in new commitments from investors. A similar pace in the second half of 2006 will result in a record year as far as fundraising is concerned. In 2000, before the burst of the "IT-bubble" and the consequent collapse in the IPO-market, close to USD 250 bn was raised globally by private equity funds. The market continues to be dominated by US based funds, responsible for close to 2/3 of the fundraising in first half of 2006.

It is rare to find larger institutional funds not investing in private equity. In the CEM 2005 cost analysis, it is reported that the Government Pension Fund's peer group had invested on

average 6 % of its assets in private equity by the end of 2005. The Dutch fund ABP had approximately 3 % of its assets in private equity at the same time, while the US fund CalPERS had a portfolio equivalent to 5 % of its net assets invested in private equity funds or vehicles.

Performance figures for the private equity investments of US institutional investors since the early 1980's indicate that the average investor has not succeeded in extracting added value from private equity relative to being invested in listed markets. As measured by the chained quarterly return on the Cambridge Associates Private Equity index, buy out investments has on average outperformed S&P500 by 2.6 percentage points annually over the 20 year period from first quarter 1986. However, such comparisons suffer from methodology weaknesses arising from short term valuation uncertainties and sample biases. A number of academic studies report only marginal historic benefits for the average investor relative to public equity investing, and some studies even suggest that the average investor would have been much better off by staying in public markets.

At the same time, there is no disagreement that the best investors in private equity have benefited hugely from their investments. The spread between the upper quartile investor and the median investor in buy out funds raised in the US in non overlapping five year periods from 1986 – 2000 has been in the range 6 – 9 %. Moreover, performance series also show evidence of persistence. Past performance seems to be a good indicator of future performance, or in other words: good performance can at least in part be attributed to skill, not only to luck.

Expected excess return over listed equity		0.0 %
Volatility of private equity returns (memo: listed equity = 15 %)		25 %
Correlation of real estate and infrastructure returns to	investment grade bonds	0.00
	high yield bonds	0.65
	large and mid cap equities	0.80
	small cap equities	0.85
	real estate	0.60
	infrastructure	0.60

Table 4.3: *Key assumptions for private equity investments in the simulation model.*

We have employed the simulation model to look at how private equity investments would fit into the total benchmark portfolio. The key assumptions for the simulation model are listed in table 4.3. We have assumed the same expected return net of investment costs as for equity in general, but a substantially higher volatility at 25 percent. The correlations with other equity market are assumed to be very high, at 0.8-0.85, but in line with the bond/equity correlations assumed above, we assume no correlation with the investment grade bond market.

In the simulation exercise we assume that 2 or 5 percent of the total portfolio is invested in private equity, and that the portion of listed equity is reduced by the same amount. The results are reported in table 4.4. We notice that the expected return with private equity included increases even if no higher expected return is assumed. This is due to the higher volatility of private equity returns. The risk exposure as measured by the standard deviation of returns also increases, whereas the probability of negative accumulated real returns is largely unchanged. The one year risk/return trade-off will in real life not be observable with this asset class, but we still compute it in the model for comparison with other benchmark changes. The marginal ratio is 0.50, which is more attractive than what we find from increases in the equity portion.

Notice also that higher expected return from performance in the first quartile would make the private equity investments far more attractive, with no need to rely on any volatility effect.

Private equity	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
2 % private equity	3.58 %	1.63 %	3.78 %	6.32 %	1.13 %
5 % private equity	3.63 %	1.68 %	3.84 %	6.50 %	1.18 %

Table 4.4: *Private equity in the benchmark portfolio in the base scenario: Probability distributions of real return based on 6000 simulations in each case.*

We recommend that private equity investments should be eligible investments for the Government Pension Fund in the future. The main argument is that the Fund can be a very long term and stable source of private equity capital, and has a scale advantage in building an organisation of necessary quality to be able to extract value from private equity investments. We suggest that up to 5 % of the fund's net assets could be invested in private equity. However, such a target must be for the very long term, and we can only expect it to be reached many years ahead. An investment program should be started carefully, and must depend on the preceding establishment of an investment organisation capable of assuming investment responsibility.

4.3. The investment mandate for alternative asset classes

We have in this chapter been considering investments in alternative asset classes, viz. private equity, real estate and infrastructure investments. These assets are not frequently priced in a market, and the established rules for measuring return and limiting risk exposure for the Pension Fund are not easily applicable. The investments may be very illiquid and in practice locked in for many years. Investments in these asset classes may also make it necessary to accept higher ownership shares in companies and partnerships than is currently permitted in the equity portfolio.

The investment mandate for these asset classes can thus not be in terms of a benchmark with an upper limit to the tracking error. We discuss below some aspects of viable alternative investment mandates for these asset classes.

Return targets

Private equity investments will most likely be through partnerships, whose investments have a lifecycle of seven to ten years for venture funds, and perhaps somewhat shorter for buy-out funds. During this lifetime valuations of the investments will be unreliable and open to subjective judgements. The true return can only be calculated when the partnership has exited from the investments. On a portfolio level there will always be investments that can not be reliably valued. Furthermore, comparisons to returns on the available private equity indices may not be relevant, because no index is even closely replicable. The manager's performance can not be evaluated the same way as in more liquid asset classes.

Cash flows from real estate and infrastructure investments may be more predictable and easier to price, but similar to private equity, valuations of the capital are to a large extent subjective. As for private equity, some alternative form of performance evaluation must be established.

Other large funds will typically manage this kind of investments by defining a hurdle rate for each investment decision. The investment manager will be required to produce a return analysis that documents the expected return on each investment decision. Only if the expected return is higher than the hurdle rate will the investment be made. The quality of this investment analysis will be an important basis for performance evaluation both initially and during the lifetime of the investment.

There are a variety of approaches to setting a hurdle rate. Some funds set an absolute hurdle rate, typically a required rate of real return in the order of 8-10 per cent on private equity and 4-5 per cent for real estate and infrastructure, which will carry much less risk. Other funds define the required premium relative to the return in the listed equity markets, or relative to the return on Treasury securities.

For real estate and infrastructure we know that two Canadian funds (OTPP and CPPIB) employ specific hurdle rates for each project. The hurdles are set by first deciding what proportions of equity-like and bond-like investments are involved in the project. In a second step comparable listed companies and publicly quoted bonds are identified (by a unit that reports directly to the CEO and not to the CIO). The market volatility of the project return is evaluated from the market data of these comparable investments. Once the return volatility has been established the required rate of return follows from a schedule that mimics the normal market risk-return trade-off.

While this latter approach has the attractive property that it seeks to establish the true risk characteristics of each investment, it is operationally complicated. It might therefore not be desirable to employ that approach in the initial phase, but it may be considered at a later stage when the management organisations for alternative investments have been fully established.

For the initial phase it may be preferable to opt for the simpler approach of setting an absolute real return target that must be met by each investment decision. The target can only reflect the average market risk of each asset class and not the risk actually involved in each individual decision. This does introduce a bias towards making more risky investments relatively more attractive for the investment manager, but the importance of that misguiding incentive may be limited in a closely watched initial build-up phase.

Risk limitations

In the more sophisticated (Canadian) approach above, where each real estate and infrastructure project was evaluated relative to comparable listed or publicly quoted investments, tracking error limits could potentially be used in the same way as in the equity and fixed income markets, by simply updating the correspondence to public market investments throughout the lifetime of the investments.

If that approach is not chosen, one may wish to introduce risk limitations in a different way. One obvious first step is to limit the total investments in alternative assets, either by setting an absolute upper limit or by limiting the relative portion to be invested in these assets. One should probably not set a lower limit, which could potentially be in conflict with return targets proposed above.

The investment universe in terms of countries should be the same for the alternative portfolios as for the equity and fixed income investments, since this has been determined by criteria for political and economic stability. As is the case today, the restriction could apply to the location of the main underlying investments when indirect instruments are employed.

Any further limitations could aim at reducing the risk for unacceptable low returns from the alternative investments. That is probably best done by requiring the portfolio to be well diversified across relevant return factors. It will be important not to define very strict limits, which could under certain circumstances force the manager to make very specific investments. Limits are a potential threat to the optimal choice of investments, and should be kept relatively wide. Wide limits could be combined with an ex post evaluation of the actual diversification in the portfolio held by the manager. That naturally implies some additional reporting requirements.

5. The recommendations

We have recommended three major changes in the long term investment strategy of the Pension Fund. Above we have discussed each change in isolation, and we now need to check that the combination of changes will also be beneficial. The new asset allocation recommended is exemplified in table 5.1, where the first column assumes an equity-bond ratio of 40/60 as in the current benchmark. To illustrate the properties of the proposed investments strategies we have assumed that the 10 per cent allocation to real estate and infrastructure are taken in a first step, and that the rest of the Fund is allocated in a 40/60 ratio between equity and fixed income instruments. Private equity is then considered part of the equity allocation. In the second column of table 5.1 we have alternatively assumed that the allocations to the alternative asset classes are combined with a 60 percent allocation to equity. This latter allocation is closest to the asset allocation we typically find at the largest pension funds.

Asset class	**Alternatives combined with 40% equity**	**Alternatives combined with 60% equity**
Large and mid cap stocks	28 %	44 %
Small cap stocks	3 %	5 %
Private equity	5 %	5 %
Sum of equity investments	**36 %**	**54 %**
Investment grade bonds	54 %	36 %
Real estate and infrastructure	10 %	10 %
Sum of stable return assets	**64 %**	**46 %**

Table 5.1: *The recommended strategic asset allocations, conditional on the equity portion.*

The results from the simulation model are reported in table 5.2. Notice that the expected return on small cap and private equity investments have been assumed equal to large and mid cap equity, and that the expected return on real estate has been set to the average of expected equity and investment grade bond returns. Even with these very conservative assumptions, the volatility effect is sufficiently strong to increase the estimated expected return by 21 basis points in the case with 40 percent equity, and by 18 basis points in the case with 60 percent equity. The standard deviation of annualised returns increases by 2 basis points in the first

case and decreases by 6 basis points in the second case. The probability of negative accumulated real return is substantially reduced in both cases.

Current and recommended asset allocation	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	3.54 %	1.61 %	3.74 %	6.24 %	1.23 %
Alternatives with 40% equity	3.75 %	1.63 %	3.95 %	6.32 %	0.68 %
60 % equity, no alternative assets	3.95 %	2.22 %	4.32 %	8.61 %	3.45 %
Alternatives with 60% equity	4.13 %	2.16 %	4.48 %	8.37 %	2.38 %

Table 5.2: *Proposed changes in the benchmark portfolio in the base scenario: Probability distributions of real return based on 6000 simulations in each case.*

Looking at the probability distribution for the one year return, the expected value is estimated to increase by 21 basis points and the volatility by 8 basis points in the case with 40 percent equity. The return-risk trade-off is thus very attractive. With 60 percent listed equity, the addition of alternatives is even more attractive since the 16 basis points increase in expected return comes with a reduction of 24 basis points in volatility.

The above simulations are conditional on our base scenario for the world economy the next 15 years. We have also tried to evaluate the benefits of alternative asset classes in our two risk scenarios. We have, however, very little basis for making assumptions about the expected returns and the covariance matrix under these scenarios. The available data simply do not contain sufficient information. The estimates given below should therefore be treated as very uncertain.

With these reservations, the key assumptions for the deflation scenario are listed in table 5.3. The expected returns of stocks and bonds are lower than in the base scenario, in line with the assumptions made in section 2, and the returns of alternative assets are also generally assumed to be lower. Notice in particular the real estate returns are assumed to fall in tandem with the equity return. The correlations are not listed in the table, but are assumed to be the same as in the base case.

Expected equity premium over bonds		- 0.55 %
Private equity expected excess return over listed equity		0.00 %
Real estate expected excess return over bonds		-0.55 %
Volatility of	investment grade bonds	4.0 %
	large and mid cap equities	16.0 %
	small cap equities	20.0 %
	private equity	25.0 %
	real estate	7.0 %
	infrastructure	5.0 %

Table 5.3: *Key assumptions for alternative investments in the simulation model for the deflation scenario.*

For the simulations reported in table 5.4 the model parameters have been calibrated to provide approximately the same output for the current benchmark portfolio as in the disaggregated version in section 2. We depart from that benchmark and add the alternative assets, employing the parameters in table 5.3. The inclusion of alternative assets is less attractive than in the base scenario, mainly because real estate and infrastructure expected returns are assumed to be low. But an increase in expected annual return of 7 basis points and an increase in volatility of 12 basis points still represent an acceptable risk return trade-off. Starting from a 60 percent equity share, the inclusion looks like an even better deal for the Fund.

Current and recommended asset allocation	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	3.09 %	1.66 %	3.29 %	6.43 %	2.83 %
Alternatives with 40% equity	3.15 %	1.69 %	3.36 %	6.55 %	2.83 %
60 % equity, no alternative assets	2.99 %	2.30 %	3.39 %	8.92 %	9.35 %
Alternatives with 60% equity	3.08 %	2.25 %	3.46 %	8.71 %	8.32 %

Table 5.4: *Proposed changes in the benchmark portfolio in the deflation scenario: Probability distributions of real return based on 6000 simulations in each case.*

A similar analysis for the stagflation scenario is reported in tables 5.5 and 5.6. In this scenario both volatilities and stock-bond correlations are assumed to be higher than in the other scenarios. The alternative asset classes still continue to be attractive. The most important assumption behind that conclusion in the stagflation scenario is that the excess return assumed for real estate and infrastructure investments is well above the expected returns for stocks and bonds. The low volatility of real estate and infrastructure returns also contributes. These important assumptions are based on the fact that the Market Report did not identify differences in real estate returns between high and low inflation environments. But it must be kept in mind that the assumptions are somewhat speculative, and that the simulations reported in tables 5.3 to 5.6 must be interpreted with a high degree of caution.

Expected equity premium over bonds		- 0.90 %
Private equity expected excess return over listed equity		1.00 %
Real estate expected excess return over bonds		1.20 %
Volatility of	investment grade bonds	8.0 %
	large and mid cap equities	18.0 %
	small cap equities	22.0 %
	private equity	27.0 %
	real estate	7.0 %
	infrastructure	5.0 %

Table 5.5: *Key assumptions for alternative investments in the simulation model in the stagflation scenario.*

Current and recommended asset allocation	Annualised real return (geometric average)	Standard deviation of annualised return	Mean real return per year (arithmetic average)	Standard deviation of return per year	Probability of negative accumulated real return
Current benchmark	1.10 %	2.57 %	1.59 %	9.95 %	33.92 %
Alternatives + 40% listed equity	1.40 %	2.53 %	1.88 %	9.80 %	29.42 %
60 % equity, no alternative assets	0.90 %	3.00 %	1.57 %	11.60 %	39.00 %
Alternatives + 60% listed equity	1.23 %	2.81 %	1.82 %	10.87 %	33.41 %

Table 5.6: *Proposed changes in the benchmark portfolio in the stagflation scenario: Probability distributions of real return based on 6000 simulations in each case.*