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The Benefits of Hedge Funds in Asset/Liability Management

Case Study for a Dutch Pension Fund

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Introduction

The objective of this document is to show how hedge funds can play a role in the asset/liability management of a Dutch pension fund (PF), taking into account the regulatory framework of the new FTK. Recent market turbulence has drawn attention to the risk management practices of defined benefit pension plans and has increased the focus on asset/liability management. Underfunded pension plans are desperately seeking new asset classes or investment styles that would offer equity-like returns without the associated downside risks. Due to their focus on absolute returns and active risk control, hedge funds may serve as a natural alternative to traditional investments such as stocks and bonds.

Hedge funds are nothing but vehicles that allow investors to gain access to the benefits of highly active investment strategies. Due to their flexible legal structure and strong incentives for manager performance, their organizational form allows for a flexible investment approach using derivatives, short selling and leverage, and investing in illiquid securities. This flexibility is best expressed in the absence of a performance benchmark, such as a market index. The benefits of hedge funds often cited are:

- **Diversification.** Because hedge funds are exposed to different types of risks, they offer risk-return characteristics that are different from (and have low correlation with) traditional investments;
- **Investment skill.** Hedge funds provide access to skilled managers who have the flexibility to exploit their investment skills in an optimal way;
- **Reduction in portfolio volatility.** Diversified portfolios of hedge funds have shown to exhibit low volatility of returns as well as absence of exposure to extreme market events. Combined with low correlations to stocks and bonds, this may further reduce overall portfolio volatility.

The main conclusion of our analysis is that, in light of the objective to reduce the probability of an underfunded pension scheme and to reduce downside risk without compromising expected returns on the portfolio, there is a very clear case to be made for shifting part of the equity allocation of the PF portfolio into a diversified portfolio of hedge funds. The benefits can be measured in terms of:

- A significant decrease in extreme risks in the portfolio;
- A reduction of the expected mismatch between assets and liabilities;
- A lower volatility of the funding ratio.

1. The benefits of hedge funds in asset/liability management

While assessing the impact of adding hedge funds to a traditional portfolio of stocks and bonds (such as the pension fund portfolio), we will focus on *risk reduction*, rather than *return enhancement*. Recent academic research has confirmed that hedge funds' ability to diversify traditional asset portfolios in terms of risk is much more robust than in terms of an increase in expected returns. Following discussions with the pension fund, we defined *the objective is to reduce the probability of an underfunded pension scheme and to reduce downside risk, without compromising expected returns on the portfolio*.

Data description

All calculations and simulations we present throughout this document are performed using the same dataset, which is available upon request. Exhibit 1 below provides some statistics for all the asset classes in

which the PF is currently invested, two HFR fund of fund indices and the PF benchmark portfolio. We used historical data back to the launch date of the HFR Fund of Funds indices (January 1990 to February 2006). All data are publicly available from Bloomberg. The HFR Conservative Fund of Funds Index represents the universe of low volatility multi-strategy funds of funds, which tend to have large allocations to arbitrage strategies. The HFR Fund of Funds Index represents fund of funds with strategy allocations which are more representative of the overall hedge fund universe, including directional strategies such as long/short equity and global macro.

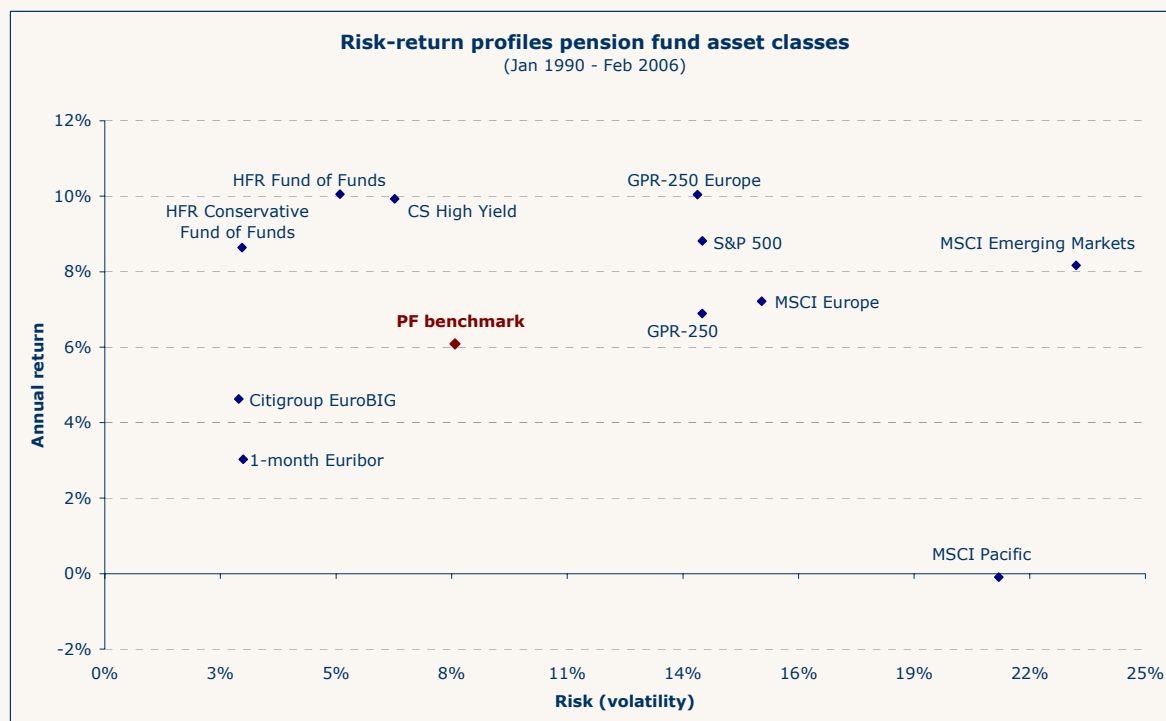
Exhibit 1 Historical statistics of various asset classes

	Pension Fund Benchmark	Hedge Funds		Equities				Bonds		Real Estate
		HFR Conservative Fund of Funds	HFR Fund of Funds	MSCI Europe	S&P 500	MSCI Pacific	MSCI Emerging Markets	Citigroup EuroBIG	CS High Yield	GPR-250 Europe
Annual return	6.09%	8.64%	10.05%	7.22%	8.82%	-0.09%	8.17%	4.63%	9.93%	10.04%
Annual volatility	8.27%	3.24%	5.56%	15.51%	14.11%	21.11%	22.94%	3.16%	6.85%	13.99%
Weight in PF benchmark	100.00%	0.00%	0.00%	38.13%	5.94%	3.56%	2.37%	38.00%	2.00%	10.00%

Source: Bloomberg

Exhibit 2 below provides a visual presentation of the risk-return profiles of the asset classes described above and the PF benchmark portfolio. The horizontal axis plots the risk, as measured by annual standard deviation of returns and the vertical axis plots annual returns.

Exhibit 2 Risk-return profiles of various asset classes

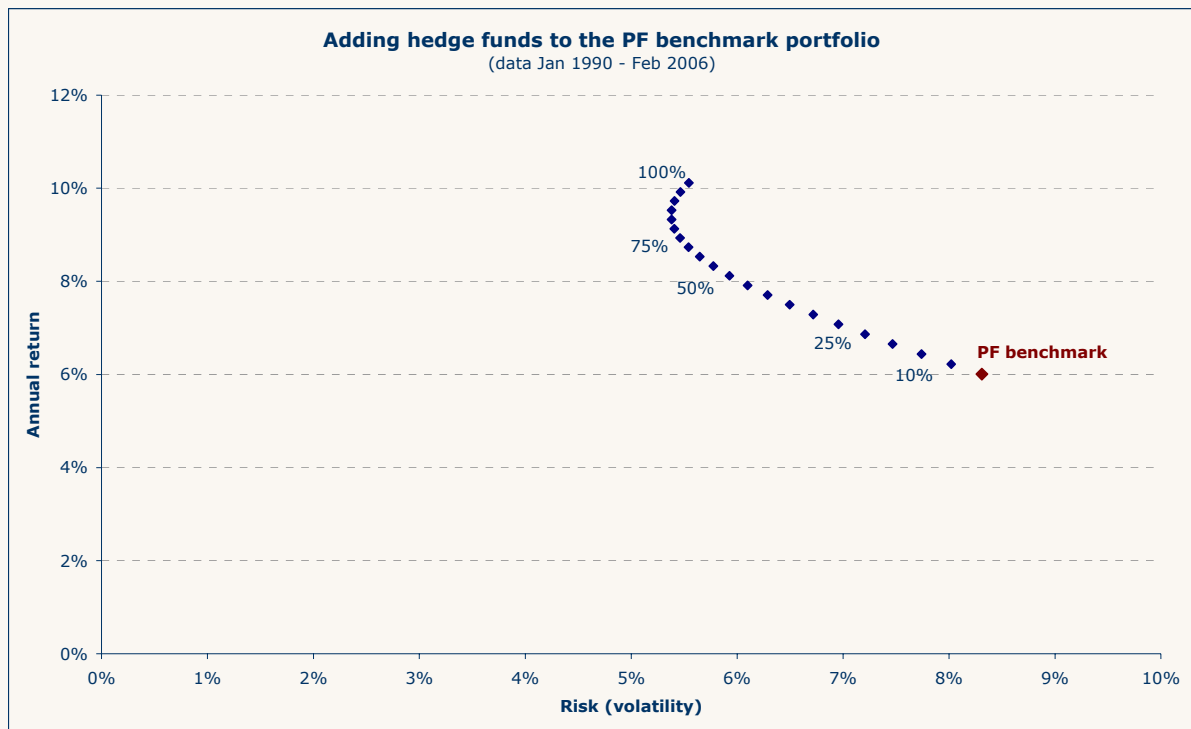


2. Hedge funds as an asset class – historical data

Taking the PF benchmark portfolio as starting point and using the historical data as described above, we can illustrate the consequences of adding hedge funds to this portfolio. In this exercise we view hedge funds as an asset class represented by the HFR Fund of Funds Index, which reflects the performance of funds of hedge funds across all investment strategies. The dotted curve in Exhibit 3 shows the impact on the risk-return profile of the PF benchmark portfolio of adding hedge funds in increments of 5%, while keeping the rest of the portfolio allocations constant on a pro-rata basis. It becomes clear that the addition of hedge funds significantly reduces the return volatility of the portfolio, which we defined to be one of our objectives. The main driver of this positive outcome is the fact that diversified hedge fund portfolios have a lower volatility than most traditional asset classes and also low correlations to these asset classes.

However, there are two caveats to this analysis. First, although we are using a 15-year time period, it is still based on historical data which may be a poor reflection of future returns. Second, risk is defined as the volatility of returns but the PF may be more concerned with *downside* risk, extreme losses and the probability of undershooting a desired funding level or funding ratio (assets divided by liabilities). Third, this analysis assumes that hedge funds are a homogenous group, rather than a set of highly diverse investment strategies. Therefore, we will extend our analysis with simulations, which allows us to make a more meaningful assessment of the actual risk in the PF portfolio, going forward. It also allows us to look at the portfolio in ALM context, i.e. the match between portfolio assets and pension scheme liabilities.

Exhibit 3 The benefits of diversification



3. Hedge fund as an asset class - simulations

Using the same dataset as described in section 1, we have run 10.000 simulations of portfolio returns to get a grip on the risk-return profile of the current portfolio. We use the following assumptions:

- The analysis is limited to passive benchmarks (as described in Exhibit 1), ignoring the potential tracking errors involved. As this would not be very realistic especially for the private equity part of the portfolio we have chosen to approximate this allocation by the Russell 2000 index. In section 4, we will also consider actively managed portfolios of hedge funds as an alternative to the HFR fund of funds indices;
- The liabilities of the PF are assumed to be indexed against consumer price inflation;
- Liabilities are modeled as a portfolio of inflation linked bonds, represented by the JP Morgan Euro Inflation Linked Bond Index with maturities of over 10 years. In its most simple form (i.e. leaving aside changes in the structure and composition of the group of pension beneficiaries), the aggregate indexed pension benefits can be seen as a stream of future cash flows which are discounted at the current risk-free rate and for which the nominal value is indexed with respect to future inflation. In other words, the pension fund liabilities are impacted by two main factors: inflation and interest rates. Therefore, modeling the liabilities with inflation-linked bonds seems reasonable;
- For expected returns of the respective asset classes we have used the ALM assumptions of the PF. Inputs for volatility, skewness, kurtosis of returns and the expected frequency and the size of outliers are based on historical data. Inputs for correlations are calculated with historical returns (see Exhibit 4 below) and are made dynamic in the simulations by assuming correlations of 1 in certain cases of market stress. *This reflects a more conservative stance towards portfolio construction, taking into account the notion that when it is most needed, diversification across asset classes may be much lower than historical data suggest because many asset classes tend to move in tandem for short periods of time.* In managing the risk of portfolios of hedge funds, Theta Capital has very good experiences with this approach.

Exhibit 4 below displays the historical correlations of the various assets with the liabilities of the PF, as represented by inflation-linked bonds and calculated over the period January 1990 to February 2006. Please refer to the appendix for the complete correlation matrix.

Exhibit 4 Correlation of various asset classes with pension fund liabilities

Liabilities	Hedge Funds		Equities					Bonds		Real Estate
	JPM Inflation Linked Bonds	HFR Conservative Fund of Funds	HFR Fund of Funds	MSCI Europe	S&P 500	Russell 2000	MSCI Emerging Markets	MSCI Pacific	Citigroup EuroBIG	CS High Yield
1.00	0.12	0.16	-0.44	-0.38	-0.21	-0.15	0.07	0.82	0.01	0.15

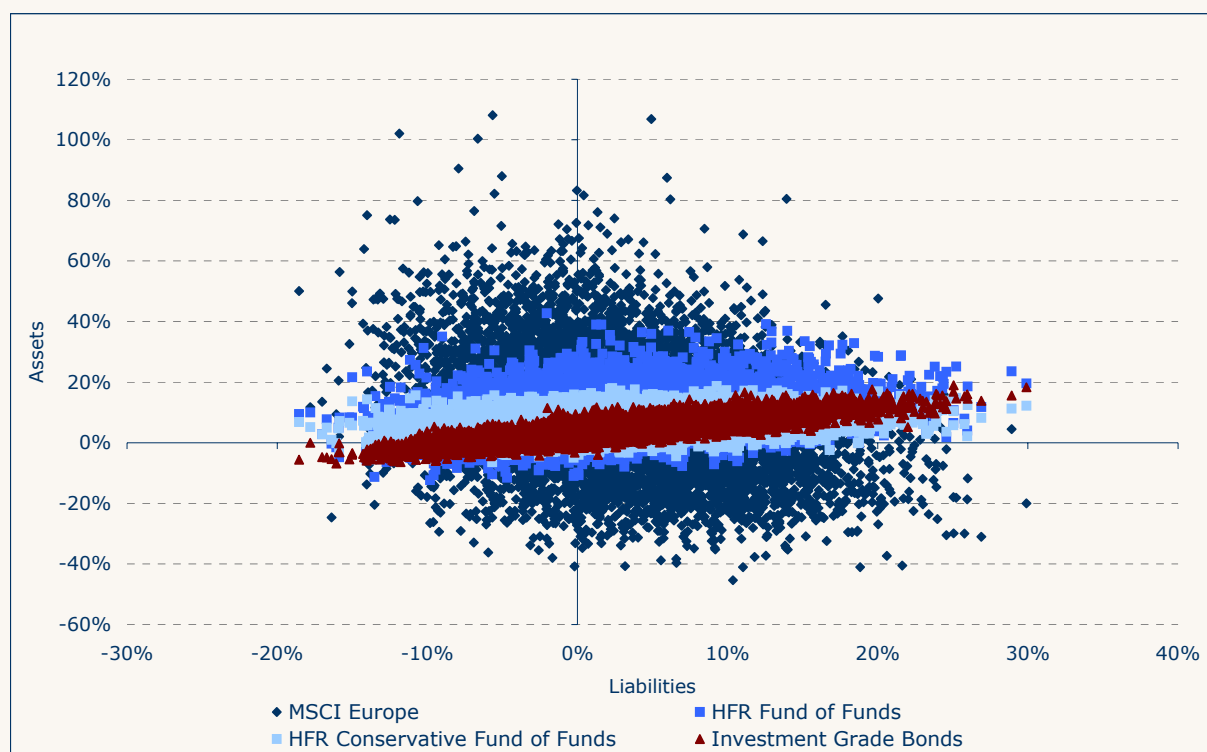
The table shows that, in the context of matching pension fund liabilities, equities are a very poor asset choice since most equity markets have a negative correlation to inflation-linked bonds. In contrast, investment grade bonds (Citigroup EuroBIG) display a very high correlation to liabilities. In between are real estate and diversified hedge fund portfolios (as represented by the HFR indices) with moderate but positive correlations to pension fund liabilities. This suggests that, although expected returns on equities are higher

than those on bonds, it may be more optimal and prudent in an ALM context to increase the allocation to bonds, real estate and hedge funds at the expense of the equity allocation.

The scatter diagram in Exhibit 5 below provides a more visual presentation of how various asset categories relate to pension fund liabilities. Each dot in the diagram is the outcome of one simulated path and represents a combination of the 1-year return on the asset category (vertical axis) and the 1-year return on the liabilities (horizontal axis). Note that in the simulations we have stressed the correlation between the various asset categories by making the conservative assumption that, in times of market stress, many asset classes move in tandem for short periods of time.

It becomes clear that equities are a poor match for liabilities. The dots in the bottom-right corner of the diagram represent a scenario in which pension liabilities grow, while pension assets decline: an allocation to equities shows by far the most outcomes in this negative scenario.

Exhibit 5 Correlation of various asset classes with pension fund liabilities



By contrast, for investment grade bonds and diversified hedge fund portfolios (as represented by the HFR Conservative Fund of Funds and HFR Fund of Funds Index), there are very few outcomes where liabilities grow and assets decline in value. Clearly, these assets are a better match for liabilities and have much less downside risk: the largest loss on a 1-year horizon is -6% for both investment grade bonds and hedge funds, while for equities this is more than -45%.

4. Hedge funds as complementary asset class

In the previous section we have illustrated the benefits of adding hedge funds to the overall portfolio both from an asset only and ALM context. Once it is decided to allocate to hedge funds, the obvious question is: at the expense of which asset class and how large should the allocation be? In this section, we assess a range of available options based on the simulations described above, again both in an asset only and an ALM context.

The asset only context

To illustrate the effect of adding hedge funds to a traditional portfolio we have chosen to work with fairly large allocations. While these large allocations may be viewed as unrealistic and the results may be pronounced, smaller allocations to hedge funds will yield results in the illustrated direction. In these calculations, we use HFR indices to provide an objective representation of the results. Exhibit 6 below shows the portfolio impact of replacing part of the allocation to bonds and equities in the PF portfolio with an allocation to a diversified portfolio of hedge funds (the HFR Conservative Fund of Funds Index and HFR Fund of Funds Index, respectively). The statistical parameters we derive from our simulations are:

- **Annual returns**
- **Annual volatility of returns** (standard deviation)
- **Sharpe ratio:** risk-adjusted return, calculated as excess return over the risk-free rate, divided by the volatility of returns.
- **Annual Value at Risk (95% VaR):** 95% of the time, the portfolio loss in any one year will not be larger than the reported VaR. Modified VaR refers to the same measure, but also takes into account extreme risks by ‘punishing’ any asymmetry in the return distribution;
- **Improvement in risk of extreme loss:** change in VaR, relative to the VaR of the PF Benchmark portfolio

Exhibit 6 Replacing bonds & equities with a diversified hedge fund portfolio (asset-only)

	PF Benchmark	Reduce bond allocation		Reduce equity allocation	
		10% Conservative FoHFs	20% Conservative FoHFs	10% FoHFs	20% FoHFs
Annual return	6.87%	7.03%	7.19%	7.01%	7.16%
Annual volatility	9.68%	9.94%	10.21%	8.44%	7.37%
Sharpe ratio (2%)	0.50	0.51	0.51	0.59	0.70
Modified Value-at-Risk (95%)	9.06%	9.32%	9.61%	6.88%	4.97%
Improvement in risk of extreme loss (VaR)	-	-2.89%	-6.04%	24.07%	45.18%

Source: Theta Capital Management

When we replace part of the allocation to bonds by a conservative portfolio of hedge funds, there is no improvement in limiting the downside risk of the portfolio, but slightly more upside return potential. Intuitively, this makes sense as we are replacing a low volatility asset class with another asset class with slightly higher volatility but also a higher expected return. When we do the same exercise with the equity part of the portfolio, the results are much more pronounced. Exhibit 6 above shows a significant reduction of downside risk when 20% of the equity investments are allocated to diversified hedge fund portfolios: the allocation change would almost halve the probability of extreme loss. At the same time, the expected risk-adjusted return on the new portfolio (as measured by the Sharpe ratio) is considerably higher.

The asset/liability context

In ALM context, we focus on the funding level which is defined as the ratio of pension fund assets to liabilities. An important consideration in our analysis is the solvency test of the new FTK framework, which requires that the assets must be high enough to cover the liabilities in a 1-year horizon with a probability set at 97.5%: this minimum funding level is 105%. We look at both the volatility of the funding level as well as the *shortfall risk*, which is defined as the probability that the funding level falls below the regulatory limit of 105% in any given year. In our simulations (described in section 3), we assume market valuations for both assets and liabilities and a starting funding level of 120%.

It is important to note that the dispersion of expected *funding levels* is much larger than the dispersion of *portfolio asset returns*. This can be explained by the addition of the liability variable which has a relatively high volatility and is far from perfectly correlated to the PF asset portfolio. This illustrates the importance of including pension fund liabilities in the asset allocation decision.

Exhibit 7 Replacing bonds & equities with a diversified hedge fund portfolio (ALM context)

	PF Benchmark	Reduce bond allocation			Reduce equity allocation		
		10% Conservative FoHFs	20% Conservative FoHFs	20% Theta Low Volatility	10% FoHFs	20% FoHFs	20% Theta Medium Volatility
Average funding level	125%	125%	125%	125%	125%	125%	125%
Lowest funding level	85%	84%	83%	85%	89%	92%	93%
Highest funding level	198%	201%	204%	198%	190%	183%	178%
Shortfall risk (funding level < 105%)	6.0%	6.3%	6.8%	6.3%	3.4%	1.7%	1.2%
Improvement in expected shortfall	-	-5%	-13%	-5%	43%	72%	80%
Correlation of assets to liabilities	-0.09	-0.11	-0.12	-0.12	-0.01	0.09	0.15

Source: Theta Capital Management

Similar to the asset-only analysis, we are first allocating 10% and 20% of the bond allocation to a conservative portfolio of hedge funds. Exhibit 7 shows there is no improvement in volatility of the funding level and the risk that the funding level falls below 105% on a one-year horizon. The intuitive explanation for this minimal shift of the distribution is the high correlation between bonds on the asset side and the liabilities. This introduces two (partly) offsetting effects: by reducing the allocation to bonds the volatility of the funding level increases. By then allocating these monies to hedge funds this effect is reversed, partly due to a higher correlation of hedge funds to liabilities, and partly due to the better risk-return profile of a diversified hedge fund portfolio.

In contrast, when we replace part of the equity allocation with a diversified portfolio of hedge funds, there is a significant improvement in shortfall risk: the probability that the funding level falls below 105% on a one-year horizon falls from 6% to just over 1%: an improvement of 80%. The bottom row of Exhibit 7 shows the driver of this outcome: the correlation between portfolio assets and liabilities has turned positive. Intuitively, this makes sense since we are replacing an asset (equities) with a negative correlation to liabilities with another asset (hedge funds) with a positive correlation (see Exhibit 4). In addition, the volatility of the funding level is significantly lower with this allocation.

Regulatory considerations

In light of the objective to reduce the probability of an underfunded pension scheme and to reduce downside risk without compromising expected returns on the portfolio, we conclude there is a very clear case to be made for shifting part of the equity allocation of the PF portfolio into a diversified portfolio of hedge funds. The benefits in an ALM context can be measured in terms of:

- A reduction of the expected mismatch between assets and liabilities;
- A lower volatility of the funding ratio
- A significant decrease in extreme risks in the portfolio.

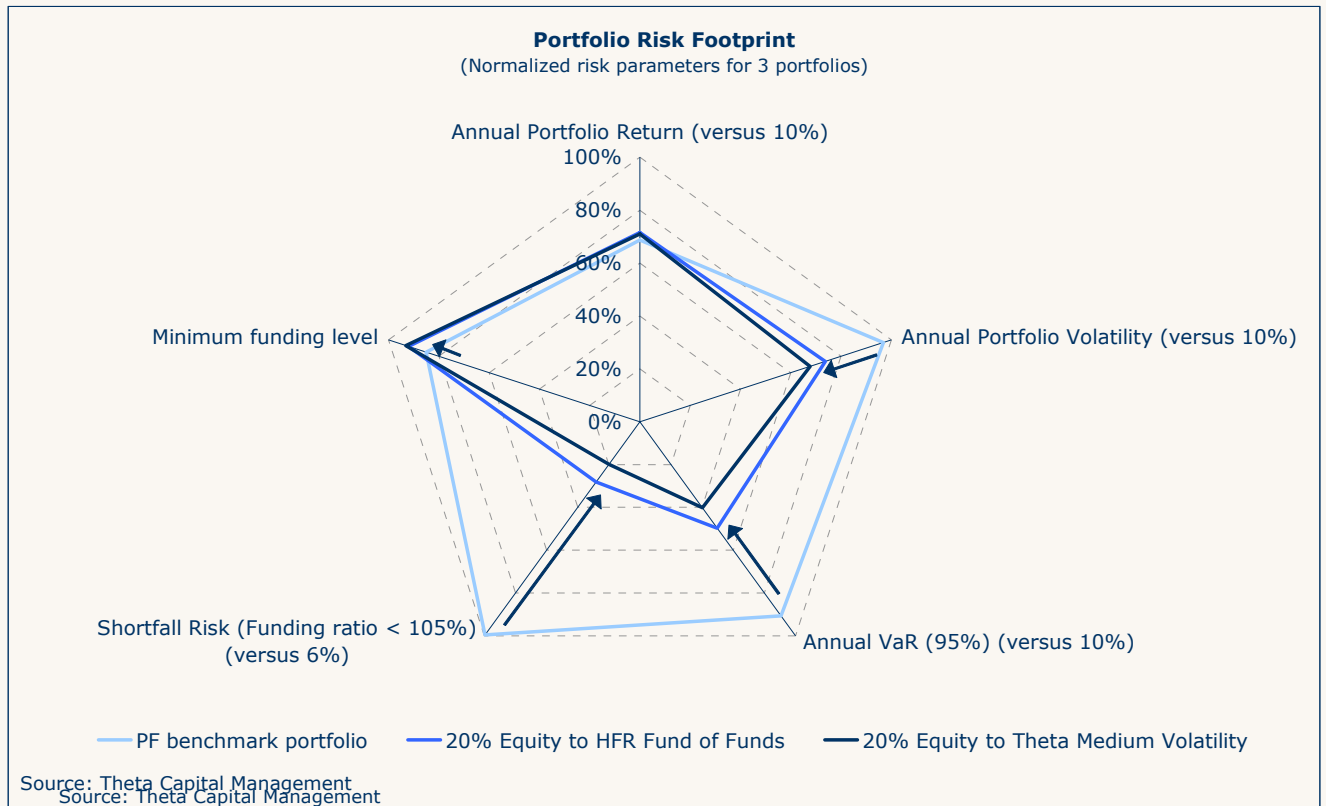
Allocating no more than 20% of the portfolio from equity to a diversified hedge fund portfolio can reduce the risk of undershooting the required funding level (shortfall risk) by as much as 80%. This is particularly relevant in regulatory context, as the FTK regime requires the funding ratio to remain above 105% with a probability set at 97.5%. In other words, *the shortfall risk (the probability of a funding ratio below 105%) may not be higher than 2.5%*. As can be seen from Exhibit 7, this situation can be achieved by shifting 20% of the equity allocation to a diversified portfolio of hedge funds.

Summary

Our analysis may be limited to the extent that we used a simplification for modeling the pension fund liabilities and that we have used passive benchmarks for both traditional asset classes and the hedge funds (HFR fund of funds indices). As for the latter, we can introduce the impact of actively managed portfolios of hedge funds by looking at two diversified hedge fund portfolios managed by Theta Capital: Theta Low Volatility and Theta Medium Volatility. Both portfolios show a consistent outperformance of the HFR Fund of Funds indices. We believe we add value to these passive benchmarks (and we can illustrate our point) with active management based on good manager selection and portfolio construction.

Exhibit 7 shows that allocating to the Theta Low Volatility portfolio instead of the HFR Conservative Fund of Funds Index reduces the shortfall risk marginally. However, when we take the hedge fund allocation out of equities and invest in Theta Medium Volatility portfolio instead of the HFR Fund of Funds Index, the results are much more pronounced: Exhibit 7 shows that this will increase the match between assets and liabilities, as well as further reduce both downside risk and funding level volatility.

The diagram in exhibit 8 below provides a visual summary of the benefits of hedge funds in asset/liability management. Without reducing returns on the PF portfolio, all risk measures display a significant improvement (as illustrated with direction of the arrows) when 20% of portfolio is divested out of equity into a diversified portfolio of hedge funds.

Exhibit 8 Benefits of a diversified hedge fund portfolio in ALM context


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Appendix Historical Correlation Matrix Asset Classes (January 1990 – February 2006)

	Liabilities	Hedge Funds		Equities					Bonds	
	JPM Inflation Linked Bonds	HFR Conservative Fund of Funds	HFR Fund of Funds	MSCI Europe	S&P 500	Russell 2000	MSCI Emerging Markets	MSCI Pacific	Citigroup EuroBIG	CS High Yield
JPM Inflation Linked Bonds	1.00	0.12	0.16	-0.44	-0.38	-0.21	-0.15	0.07	0.82	0.01
HFR Conservative Fund of Funds	0.12	1.00	0.95	0.39	0.45	0.56	0.68	0.60	0.06	0.58
HFR Fund of Funds	-0.01	0.95	1.00	0.24	0.13	0.19	0.18	0.21	-0.05	0.02
MSCI Europe	-0.44	0.39	0.47	1.00	0.90	0.76	0.76	0.52	-0.47	0.39
S&P 500	-0.38	0.45	0.51	0.90	1.00	0.85	0.79	0.55	-0.38	0.49
Russell 2000	-0.21	0.56	0.68	0.76	0.85	1.00	0.80	0.64	-0.32	0.54
MSCI Emerging Markets	-0.15	0.68	0.80	0.76	0.79	0.80	1.00	0.81	-0.22	0.48
MSCI Pacific	0.07	0.60	0.75	0.52	0.55	0.64	0.81	1.00	-0.09	0.38
Citigroup EuroBIG	0.82	0.06	0.03	-0.47	-0.38	-0.32	-0.22	-0.09	1.00	0.08
CS High Yield	0.01	0.58	0.51	0.39	0.49	0.54	0.48	0.38	0.08	1.00
GPR-250 Europe	0.15	0.56	0.61	0.40	0.53	0.54	0.62	0.50	0.15	0.28

Source: Bloomberg, Theta Capital Management