

CHAPTER 4  
RESEARCH RESULTS

## Chapter 4

### 4.1 Introduction

This section organizes the findings of the study and presents the research results. First, this section will describe the actual returns of the Malaysian EPF.

### 4.2 Marked to Market Malaysian Employees Provident Fund Return

R. Thillainatham suggested that the EPF portfolio should marked-to-market, if necessary over a three years time frame. It should benchmark and evaluate the performance of its portfolio in relation to the performance of the market and not in relation to an absolute target return that is not related to how the market has performed. Thus, the KLSE index, MXFEJ Index, MGS and JP Morgan Global Aggregate Bond Index are used to calculate the return for the Malaysian EPF. Table 4.1 shows the comparison EPF dividend rate and the marked-to-market EPF return for 1997 until 2008.

**Table 4.1:**

#### **Comparison EPF Dividend rate and Mark-to-Market Return**

<i>Year</i>	<i>Dividend Rate (EPF)</i>	<i>Mark-to-market EPF Return</i>
1997	6.70%	-2.80%
1998	6.70%	7.21%
1999	6.84%	8.72%
2000	6.00%	1.99%
2001	5.00%	4.59%
2002	4.25%	3.40%
2003	4.50%	7.89%
2004	4.75%	6.62%
2005	5.00%	2.93%
2006	5.15%	6.56%
2007	5.80%	9.84%
2008	4.50%	-5.80%

As can be seen from Table 1, obviously there are differences between the EPF's return and the dividend declared. By using the EPF's actual return, we proceed by finding the return, risk and risk-adjusted return for the EPF portfolio.

### 4.3 Alternative Asset Allocation and Correlation for Employees Provident Fund

During the first stage, the quarterly data was gathered and analysed, considering each of the alternative assets in isolation. Quarterly return, standard deviation of the return and risk-adjusted returns for all assets were generated in the study. Table 4.2 provides a summary of the investment return for various assets.

**Table 4.2:**  
**Asset Return for Assets, 1997 to 2008**

Year	Assets						
	Domestic Equity	Foreign Equity	Private Equity	Commodity	Hedge Fund	MGS	Fixed Income
1997	-51.98%	-45.48%	38.82%	65.23%	22.38%	6.74%	9.58%
1998	-1.40%	-7.39%	10.99%	5.11%	-0.18%	7.92%	10.04%
1999	38.59%	59.40%	46.72%	-46.00%	17.17%	6.12%	-1.05%
2000	-16.33%	-37.88%	-13.92%	-38.94%	10.84%	5.04%	9.00%
2001	2.42%	-4.18%	-6.29%	57.47%	5.93%	3.94%	6.79%
2002	-7.15%	-11.05%	-7.37%	49.67%	2.06%	3.54%	9.25%
2003	22.84%	40.77%	27.54%	5.63%	14.46%	3.42%	3.49%
2004	14.29%	14.24%	23.08%	-22.25%	8.33%	4.05%	5.37%
2005	-0.84%	17.86%	31.93%	0.36%	8.84%	3.67%	3.48%
2006	21.83%	28.47%	28.28%	42.40%	12.96%	4.07%	2.01%
2007	31.82%	33.37%	12.39%	55.25%	17.88%	3.55%	4.20%
2008	-39.33%	-51.96%	-17.05%	-47.50%	-16.17%	4.06%	7.25%

According to Table 4.2, domestic equity and foreign equity return are relatively weak from 1997 to 2000. This is because of the Asian Financial Crisis, which began in July 1997 and had a significant macro-level effect, including a sharp

reduction in the value of currencies, stock markets, and other asset prices of several Asian countries. In 1997, nominal US dollar GDP per capital fell 19% in Malaysia, 42.3% in Indonesia, 21.2% in Thailand, 18.5% in South Korea and 12.5% in the Philippines. In contrast, alternative assets such as private equity, commodity and hedge funds achieved an impressive return in 1997. MGS and fixed income provided a stable return each year.

However, domestic equity, foreign equity and private equity performed well in 2003 and continuously delivered a positive return in the following years until 2007. Table 4.2 shows that 2003 and 2004 were a period of rapid growth for domestic equity and foreign equity. Commodities have very high volatility and the commodities boom caused a rise in many physical commodity prices from 2000 onwards with spectacular returns in 2006 and 2007. However, it dropped dramatically in 2008. Hedge Funds provided a relatively good return except for 2008. The contrast between returns in 2008 and previous years is probably due to the Global Financial Crisis in 2007 and 2008. It was the most serious financial crisis since the Great Depression and caused worldwide economic meltdown. Therefore, this study categorized 1997 to 2000 as a Bear Market, 2001 to 2004 as a Bull Market and 2005 to 2008 as a Fluctuating Market.

Table 4.3 also shows the assets return and total risk (standard deviation) of all the assets over these sub-periods – bear market, bull market and fluctuating market. The results indicate that riskier assets are not necessary in bringing a higher return. Although the domestic and foreign equity indexes had a large

standard deviation they did not carry the highest return. Private equity and hedge funds had relatively high returns but smaller standard deviations. As shown, the results indicate a fairly consistent relationship between risk and return for these two assets during these three sub-periods. The commodities had a high degree of risk but volatile return over the 12 years under review. However, the long-term results reflected that commodities experienced higher returns and lower risk than common stocks. It is not surprising that MGS and fixed income had low returns (refer to Table 4.2) and the smallest standard deviation, because fixed income has the smallest volatility, it is almost risk-free assets.

**Table 4.3:**

**Asset Return, Total Risk and Systematic Risk for Assets, 1997 to 2008**

Description	Assets						
	Domestic Equity	Foreign Equity	Private Equity	Commodity	Hedge Fund	MGS	Fixed Income
<i>Jan 1997- Dec 2000</i>							
Asset Return	-45.10%	-50.00%	94.59%	-42.73%	58.67%	28.40%	30.05%
Standard Deviation	28.61%	21.52%	6.21%	16.66%	6.03%	0.29%	1.66%
<i>Jan 2001- Dec 2004</i>							
Asset Return	33.52%	37.06%	36.28%	93.57%	34.05%	15.81%	27.21%
Standard Deviation	7.99%	13.73%	5.80%	13.32%	1.67%	0.07%	1.59%
<i>Jan 2005- Dec 2008</i>							
Asset Return	-3.38%	-2.99%	57.80%	16.47%	21.49%	16.26%	17.98%
Standard Deviation	8.96%	12.14%	6.84%	16.62%	4.74%	0.10%	1.91%

In addition, Table 4.3 implies that commodities acts as a diversifier in the EPF portfolio. It provides a negative correlation with domestic equity and gives better returns when the market performance is falling, or a bear market. In a bull market, commodities somehow outperformed the stock market. While the stock market was still recovering during 2005 to 2008, commodities achieved

a better return. Hence, adding commodity exposure can help diversify a portfolio of stocks and increase returns.

The correlations between these asset classes from January 1997 to December 2008 were computed and can be found in Table 4.4. As can be seen from the table, domestic equity and foreign equity are highly correlated (0.8293). Also, MGS and fixed income have a low correlation with other assets over the given data period, especially fixed income with negative correlation.

It is apparent that there are relatively low correlations between alternative assets (hedge fund and commodity) and traditional pension fund assets (domestic equity and foreign equity), which are the same as suggested by previous studies, such as Schneeweis, Groot and Dwinkels. Also, commodities show almost zero correlation with domestic and foreign equity. Private equity is less positively correlated with domestic equity, foreign equity, MGS and fixed income. Because alternative assets have a correlation of less than one, this indicates that a diversified EPF portfolio combining these assets will gain diversification benefits and reduce the risk of the portfolio.

**Table 4.4:**

**Correlation Matrix Jan 1997 to Dec 2008**

	Domestic Equity	Foreign Equity	Private Equity	Commodity	Hedge Fund	MGS	Fixed Income
Domestic Equity	1.0000	0.8293	0.3765	-0.0346	0.1086	-0.1360	-0.3396
Foreign Equity	0.8293	1.0000	0.4793	0.0502	0.0859	-0.1825	-0.4428
Private Equity	0.3765	0.4793	1.0000	0.2632	0.5966	0.2326	-0.4396
Commodity	-0.0346	0.0502	0.2632	1.0000	0.2963	-0.0144	0.0651
Hedge Fund	0.1086	0.0859	0.5966	0.2963	1.0000	0.1510	-0.3353
MGS	-0.1360	-0.1825	0.2326	-0.0144	0.1510	1.0000	0.0896
Fixed Income	-0.3396	-0.4428	-0.4396	0.0651	-0.3353	0.0896	1.0000

#### **4.4 Performance Comparison with Alternative Asset Allocation under the Constraints of the EPF Investment Rules and Regulations**

As this study is testing how investment in private equity, real assets and hedge funds affects pension fund performance, all three alternative assets were combined together and categorized as alternative investment. The alternative assets were inserted into a mean-variance optimizer to calculate the optimal weightage of each individual asset. This step was repeated for the traditional assets.

In order to build an alternative pension fund portfolio that complies with the EPF rules and regulations, this study started by calculating the optimal weightage based on the following restrictions:

- a.) At least 70% is to be invested in MGS.
- b.) Investment in domestic equities cannot exceed 25%.

These constraints are set during portfolio optimization, whereby the larger portion of investment will go to MGS and fixed income.

As mentioned in the earlier chapter, the research period was divided into three sub-periods, the investment returns for these three sub-periods were then compared beginning with 5 percent alternative target allocation and ending with 30 percent alternative target allocation, by adding 5 percent increments. The mean investment return and the standard deviation are shown in the results table for each sub-period. Results also show the differences between the sub-period's means, and the p-value of the t-test to determine if the mean returns for the two groups of every alternative target

allocation are significantly different. Appendix A shows the asset allocation in various alternative target allocations from year January 1997 to December 2008.

#### 4.4.1 Return

Starting with a zero alternative target allocation, first, a comparison was made of the investment returns for the three sub-periods with 5 percent alternative target allocation. Table 4.5a shows the results of this first comparison. Although the mean return of investing in alternative assets is higher for the period of 1997 to 2000 and 2005 to 2008, the p-value shows that none of these differences are significant.

**Table 4.5a:**

#### **Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 5%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 5%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.016852	0.0062270	-0.0069385	0.515
2001 to 2004	16	0.013880	0.0173101	16	0.012279	0.0056052	0.0016009	0.677
2005 to 2008	16	0.008101	0.0186212	16	0.010771	0.0063416	-0.0026702	0.513

The target allocation was then increased to 10 percent. The results in Table 4.5b until Table 4.5f show that pension funds with alternative assets have nominally higher returns than those without alternative assets for 1997 to 2000 and 2005 to 2008, however, there is no evidence of significant differences in the investment return between pension funds without alternative assets and with alternative target allocations of 5 to 30 percent during the period under review. However, although the return is increasing by adding alternative assets into the portfolio it implies that adding 30 percent alternative assets is not sufficient to change the returns in a statistically significant way.



**Table 4.5b:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 10%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 10%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.018004	0.0078588	-0.0080905	0.422
2001 to 2004	16	0.013880	0.0173101	16	0.012586	0.0061324	0.0012941	0.719
2005 to 2008	16	0.008101	0.0186212	16	0.011508	0.0067003	-0.0034066	0.337

**Table 4.5c:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 15%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 15%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.019597	0.0096120	-0.0096840	0.345
2001 to 2004	16	0.013880	0.0173101	16	0.012972	0.0070760	0.0009080	0.802
2005 to 2008	16	0.008101	0.0186212	16	0.012346	0.0080067	-0.0042453	0.209

**Table 4.5d:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 20%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 20%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.021165	0.0120624	-0.0112513	0.268
2001 to 2004	16	0.013880	0.0173101	16	0.013687	0.0089158	0.0001930	0.957
2005 to 2008	16	0.008101	0.0186212	16	0.013513	0.0106040	-0.0054116	0.108

**Table 4.5e:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 25%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 25%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.022224	0.0146100	-0.0123107	0.227
2001 to 2004	16	0.013880	0.0173101	16	0.013771	0.0106946	0.0001095	0.977
2005 to 2008	16	0.008101	0.0186212	16	0.013939	0.0131036	-0.0058381	0.085

**Table 4.5f:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 30%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 30%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.024202	0.0166134	-0.0142882	0.198
2001 to 2004	16	0.013880	0.0173101	16	0.013947	0.0113642	-0.0000674	0.987
2005 to 2008	16	0.008101	0.0186212	16	0.014651	0.0142730	-0.0065494	0.073

#### 4.4.2 Risk

Risk is an important component in measuring the performance of pension funds. Although there are numerous potential measures of risk, this study looks at the risk aspect by comparing the standard deviation of investment returns over the research period, which is from 1997 through 2008. It is because this measure is somewhat intuitive, it is correct and widely recognized and has been used in most of the theoretical asset pricing models. Table 4.6a to Table 4.6f show the results of these comparisons across every percentage of alternative allocation, from zero percent to 30 percent. Consistently, across the different alternative target allocation, the results show significantly lower standard deviations in investment returns for pensions targeting alternative assets. This result indicates that under the constraints of the EPF restrictions, adopting an alternative investment of as little as 5 percent is sufficient to significantly reduce the portfolio risk. Results also significantly show that standard deviation is increasing while adding more alternative assets to the portfolio.

**Table 4.6a:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 5%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 5%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.005542	0.0016283	0.0355834	0.000
2001 to 2004	16	0.016531	0.0060677	16	0.005060	0.0020883	0.0114715	0.000
2005 to 2008	16	0.014411	0.0063782	16	0.006521	0.0016820	0.0078902	0.000

**Table 4.6b:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 10%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 10%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.007312	0.0030677	0.0338129	0.000
2001 to 2004	16	0.016531	0.0060677	16	0.004539	0.0028016	0.0119920	0.000
2005 to 2008	16	0.014411	0.0063782	16	0.006246	0.0021113	0.0081650	0.000

**Table 4.6c:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 15%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 15%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.008303	0.0044003	0.0328222	0.000
2001 to 2004	16	0.016531	0.0060677	16	0.004392	0.0032955	0.0121396	0.000
2005 to 2008	16	0.014411	0.0063782	16	0.006448	0.0025366	0.0079631	0.000

**Table 4.6d:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 20%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 20%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.010221	0.0054795	0.0309036	0.000
2001 to 2004	16	0.016531	0.0060677	16	0.005220	0.0036942	0.0113111	0.000
2005 to 2008	16	0.014411	0.0063782	16	0.006966	0.0030909	0.0074445	0.000

**Table 4.6e:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 25%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 25%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.012407	0.0065354	0.0287183	0.000
2001 to 2004	16	0.016531	0.0060677	16	0.006230	0.0038865	0.0103016	0.000
2005 to 2008	16	0.014411	0.0063782	16	0.008185	0.0037134	0.0062259	0.000

**Table 4.6f:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 30%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 30%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.013663	0.0072104	0.0274619	0.000
2001 to 2004	16	0.016531	0.0060677	16	0.006532	0.0036093	0.0099997	0.000
2005 to 2008	16	0.014411	0.0063782	16	0.008740	0.0037638	0.0056711	0.001

### 4.4.3 Sharpe Ratio

Risk plays an important role in measuring performance; do risk and return offset each other? To investigate how much risk premium return earned per unit of total risk, this study used the Sharpe Ratio to examine the risk-adjusted return. The Sharpe ratio of various alternative target allocations was tested by using 3-months bond as the risk-free benchmark. Starting with 5 percent alternative target allocation, Table 6.0 suggests that the performance of 5 percent alternative investment over period 1997 to 2000 has a significant increase.

**Table 4.7a:**

**Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 5%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 5%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.867319	2.3016114	-2.0415938	0.002
2001 to 2004	16	0.383894	1.1657029	16	0.678869	1.0074822	-0.2949750	0.328
2005 to 2008	16	0.071128	1.2313522	16	0.308044	0.9935388	-0.2369153	0.384

The results from Table 4.7a through Table 4.7f provide evidence that increments in alternative target allocation will gain higher pension fund's risk-adjusted return for years 1997 to 2000, and 2005 and 2008. Table 4.7e shows that there is not significantly increase the portfolio return when alternative target allocation is 25 percent. This is due to outlier point for standard deviation in 1998, it is extremely low and distant from the rest of the other data, Therefore, it has dramatically increased the risk-adjusted return for that particular period. However, there is no evidence of increment in risk-adjusted return in the period 2001 to 2004. As the results in Table 4.7e indicate, the pension funds with alternative assets investment do not have significantly

higher returns at any time horizons. By adding alternative assets, it provides downside protection. Nevertheless, results do not show that increments in alternative target allocations will significantly increase the risk-adjusted return.

**Table 4.7b:**

**Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 10%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 10%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.799931	2.3341198	-1.9742063	<b>0.002</b>
2001 to 2004	16	0.383894	1.1657029	16	0.733544	1.1110516	-0.3496500	0.214
2005 to 2008	16	0.071128	1.2313522	16	0.538788	1.0871085	-0.4676591	<b>0.031</b>

**Table 4.7c:**

**Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 15%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 15%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.837475	5.7794970	-3.0117500	<b>0.043</b>
2001 to 2004	16	0.383894	1.1657029	16	0.544819	1.4865925	-0.1609250	0.683
2005 to 2008	16	0.071128	1.2313522	16	0.707400	1.4001441	-0.6362716	<b>0.015</b>

**Table 4.7d:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 20%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 20%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.217731	3.5157188	-2.3920063	<b>0.010</b>
2001 to 2004	16	0.383894	1.1657029	16	0.697125	1.3337426	-0.3132313	0.331
2005 to 2008	16	0.071128	1.2313522	16	1.125150	2.0036720	-1.0540216	<b>0.009</b>

**Table 4.7e:**

**Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 25%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 25%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	3.003650	7.0636032	-3.1779250	0.079
2001 to 2004	16	0.383894	1.1657029	16	0.391994	1.3804733	-0.0081000	0.979
2005 to 2008	16	0.071128	1.2313522	16	1.564500	3.5748534	-1.4933716	0.061

**Table 4.7f:**

**Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 30%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 30%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.095900	2.8066195	-2.2701750	0.007
2001 to 2004	16	0.383894	1.1657029	16	0.476981	1.3573644	-0.0930875	0.797
2005 to 2008	16	0.071128	1.2313522	16	1.139169	1.9003031	-1.0680403	0.006

#### **4.5 Performance Comparison with Alternative Asset Allocation without the Constraints of the EPF Investment Rules and Regulations**

Alternative assets in pension funds are widely considered by European countries and more recently by Asian countries, as it is believed they can outperform the traditional pension funds. Looking at the standard deviation and Sharpe Ratio tables under the constraints of the EPF rules and regulations as shown above, investing in alternative assets will reduce the portfolio risk and achieve outsized gains for certain periods. Nevertheless, to test the extent of the impressive effects of alternative assets, this study also compares the investment's return and risk for pension funds involving alternative assets and investment and pension funds without alternative assets, based on the model without the constraints of the EPF rules and regulations.

##### **4.5.1 Return**

Similar to the earlier method, the alternative assets were inserted into a mean-variance optimizer to calculate the optimal weightage of each individual asset, with the asset allocation shown in Appendix B. Then the study computes the return, risk and Sharpe Ratio. First, the investment returns for

the three sub-periods with 5 percent alternative target allocation were compared. Table 4.8a shows the results of this first comparison.

**Table 4.8a:**

**Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 5%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 5%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.011611	0.0414912	-0.0016973	0.049
2001 to 2004	16	0.013880	0.0173101	16	0.014082	0.0172411	-0.0002019	0.692
2005 to 2008	16	0.008101	0.0186212	16	0.008942	0.0193518	-0.0008408	0.225

As the table shows, pension funds with 5 percent alternative asset allocations have significantly higher returns in a bear market, as well as higher returns in a bull market and fluctuating market, though not significantly.

**Table 4.8b:**

**Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 10%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 10%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.013300	0.0404712	-0.0033870	0.048
2001 to 2004	16	0.013880	0.0173101	16	0.014281	0.0174003	-0.0004006	0.694
2005 to 2008	16	0.008101	0.0186212	16	0.009776	0.0204009	-0.0016747	0.226

Table 4.8b shows the return comparisons between a zero alternative asset allocation and an alternative asset allocation of 10 percent. Comparing the mean returns of these two groups, the results show that the pension fund with the larger alternative asset allocation had significantly higher returns for the period 1997 to 2000. Pension funds with a higher alternative asset target had higher returns from year 2001 to 2008, however, the differences are not statistically significant.

**Table 4.8c:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 15%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 15%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.014983	0.0396759	-0.0050695	0.048
2001 to 2004	16	0.013880	0.0173101	16	0.014476	0.0177806	-0.0005962	0.696
2005 to 2008	16	0.008101	0.0186212	16	0.010603	0.0217207	-0.0025018	0.227

In continuing to increase the alternative asset allocations for every sub-period, respectively, Table 4.8c until Table 4.8t show that the overall results remain the same. When the alternative asset target increases to 15 percent or more, the mean return differences remain significant only for the bear market, which is from 1997 through 2000. For the following years, although increments of return remain constant, the differences are not statistically significant.

Overall the results reflect that pension funds that allocated at least 5 percent of their assets to alternative assets enjoyed larger and significant returns when the market is falling. There is no significant difference in the investment return during bull markets and fluctuating markets, although pension funds with alternative assets had nominally higher returns than those without alternative assets.

**Table 4.8d:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 20%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 20%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.016658	0.0391130	-0.0067449	0.048
2001 to 2004	16	0.013880	0.0173101	16	0.014669	0.0183672	-0.0007886	0.698
2005 to 2008	16	0.008101	0.0186212	16	0.011423	0.0232636	-0.0033223	0.229



**Table 4.8e:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 25%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 25%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.018327	0.0387864	-0.0084132	0.047
2001 to 2004	16	0.013880	0.0173101	16	0.014858	0.0191405	-0.0009779	0.700
2005 to 2008	16	0.008101	0.0186212	16	0.012237	0.0249867	-0.0041361	0.230

**Table 4.8f:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 30%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 30%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.019988	0.0386965	-0.0100747	0.047
2001 to 2004	16	0.013880	0.0173101	16	0.015044	0.0200780	-0.0011641	0.702
2005 to 2008	16	0.008101	0.0186212	16	0.013045	0.0268541	-0.0049435	0.231

**Table 4.8g:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 35%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 35%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.021643	0.0388392	-0.0117295	0.046
2001 to 2004	16	0.013880	0.0173101	16	0.015227	0.0211572	-0.0013472	0.704
2005 to 2008	16	0.008101	0.0186212	16	0.013846	0.0288366	-0.0057444	0.233

**Table 4.8h:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 40%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 40%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.023291	0.0392067	-0.0133777	0.046
2001 to 2004	16	0.013880	0.0173101	16	0.015407	0.0223569	-0.0015271	0.706
2005 to 2008	16	0.008101	0.0186212	16	0.014640	0.0309110	-0.0065389	0.234

**Table 4.8i:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 45%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 45%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.024933	0.0397878	-0.0150195	0.046
2001 to 2004	16	0.013880	0.0173101	16	0.015584	0.0236582	-0.0017040	0.709
2005 to 2008	16	0.008101	0.0186212	16	0.015428	0.0330589	-0.0073271	0.236

**Table 4.8j:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 50%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 50%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.026568	0.0405686	-0.0166549	0.045
2001 to 2004	16	0.013880	0.0173101	16	0.015758	0.0250446	-0.0018777	0.711
2005 to 2008	16	0.008101	0.0186212	16	0.016210	0.0352662	-0.0081091	0.237

**Table 4.8k:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 55%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 55%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.028197	0.0415335	-0.0182841	0.045
2001 to 2004	16	0.013880	0.0173101	16	0.015928	0.0265023	-0.0020483	0.713
2005 to 2008	16	0.008101	0.0186212	16	0.016986	0.0375214	-0.0088849	0.238

**Table 4.8l:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 60%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 60%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.029821	0.0426656	-0.0199073	0.045
2001 to 2004	16	0.013880	0.0173101	16	0.016096	0.0280196	-0.0022158	0.715
2005 to 2008	16	0.008101	0.0186212	16	0.017756	0.0398157	-0.0096547	0.240

**Table 4.8m:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 65%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 65%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.031438	0.0439482	-0.0215245	0.044
2001 to 2004	16	0.013880	0.0173101	16	0.016260	0.0295869	-0.0023802	0.717
2005 to 2008	16	0.008101	0.0186212	16	0.018520	0.0421421	-0.0104184	0.241

**Table 4.8n:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 70%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 70%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.033049	0.0453650	-0.0231359	0.044
2001 to 2004	16	0.013880	0.0173101	16	0.016422	0.0311963	-0.0025415	0.719
2005 to 2008	16	0.008101	0.0186212	16	0.019277	0.0444949	-0.0111762	0.243

**Table 4.8o:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 75%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 75%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.034655	0.0469002	-0.0247415	0.044
2001 to 2004	16	0.013880	0.0173101	16	0.016580	0.0328412	-0.0026997	0.721
2005 to 2008	16	0.008101	0.0186212	16	0.020029	0.0468695	-0.0119281	0.244

**Table 4.8p:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 80%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 80%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.036255	0.0485396	-0.0263414	0.043
2001 to 2004	16	0.013880	0.0173101	16	0.016735	0.0345162	-0.0028548	0.723
2005 to 2008	16	0.008101	0.0186212	16	0.020775	0.0492623	-0.0126742	0.245

**Table 4.8q:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 85%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 85%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.037849	0.0502700	-0.0279358	0.043
2001 to 2004	16	0.013880	0.0173101	16	0.016887	0.0362168	-0.0030069	0.725
2005 to 2008	16	0.008101	0.0186212	16	0.021516	0.0516703	-0.0134145	0.247

**Table 4.8r:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 90%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 90%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.039438	0.0520795	-0.0295248	0.043
2001 to 2004	16	0.013880	0.0173101	16	0.017036	0.0379391	-0.0031558	0.728
2005 to 2008	16	0.008101	0.0186212	16	0.022250	0.0540910	-0.0141492	0.248

**Table 4.8s:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 95%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 95%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.041022	0.0539577	-0.0311084	0.042
2001 to 2004	16	0.013880	0.0173101	16	0.017182	0.0396802	-0.0033016	0.730
2005 to 2008	16	0.008101	0.0186212	16	0.022979	0.0565223	-0.0148782	0.249

**Table 4.t:****Mean Investment Return Comparison, 1997 to 2008 Alternative Target = 100%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 100%			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.042600	0.0558952	-0.0326867	0.042
2001 to 2004	16	0.013880	0.0173101	16	0.017324	0.0414374	-0.0034443	0.732
2005 to 2008	16	0.008101	0.0186212	16	0.023703	0.0589625	-0.0156016	0.251

**4.5.2 Risk**

Table 4.9a until Table 4.9t show the results of comparisons across the twenty sets of alternative target allocations, from 5 percent to 100 percent. Consistently across the different alternative allocations, results show significantly lower standard deviation and higher investment returns for alternative target allocations of 5 percent, 10 percent and 15 percent during the bear and bull market. The greater the alternative target allocation, the lower the standard deviation. Investment returns for the continuous alternative target allocation are significantly increased although the standard deviation is not significantly reduced between 1997 and 2000. This indicates that in the bear and bull market, allocating a maximum of 15 percent alternative assets will significantly reduce portfolio risk. Table 4.9m indicates that alternative target allocation at 65 percent or more than 65 percent will significantly increase the risk of the portfolio during bull markets.

However, starting from 35 percent onwards, the results indicate significantly higher standard deviations from year 2005 to 2008, which is a fluctuating market. Thus, according to these common measures of portfolio risk, portfolio investing in alternative assets with higher target allocation is riskier than

portfolios that allocate less alternative assets when the stock market is fluctuating.

**Table 4.9a:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 5%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 5%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.040076	0.0169756	0.0010488	0.032
2001 to 2004	16	0.016531	0.0060677	16	0.015873	0.0058593	0.0006581	0.025
2005 to 2008	16	0.014411	0.0063782	16	0.014163	0.0066242	0.0002476	0.332

**Table 4.9b:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 10%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 10%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.039133	0.0164706	0.0019918	0.039
2001 to 2004	16	0.016531	0.0060677	16	0.015304	0.0058527	0.0012272	0.034
2005 to 2008	16	0.014411	0.0063782	16	0.014069	0.0069225	0.0003415	0.464

**Table 4.9c:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 15%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 15%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.038305	0.0161247	0.0028202	0.048
2001 to 2004	16	0.016531	0.0060677	16	0.014826	0.0060264	0.0017048	0.044
2005 to 2008	16	0.014411	0.0063782	16	0.014207	0.0070964	0.7240792	0.724

**Table 4.9d:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 20%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 20%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.037604	0.0159253	0.0035215	0.059
2001 to 2004	16	0.016531	0.0060677	16	0.014463	0.0063270	0.0020679	0.059
2005 to 2008	16	0.014411	0.0063782	16	0.014577	0.0071343	-0.0001666	0.792

**Table 4.9e:**

**Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 25%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 25%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.037042	0.0158532	0.0040828	0.074
2001 to 2004	16	0.016531	0.0060677	16	0.014269	0.0066297	0.0022619	0.080
2005 to 2008	16	0.014411	0.0063782	16	0.015088	0.0072058	-0.0006769	0.359

**Table 4.9f:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 30%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 30%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.036629	0.0158963	0.0044962	0.094
2001 to 2004	16	0.016531	0.0060677	16	0.014365	0.0066752	0.0021664	0.117
2005 to 2008	16	0.014411	0.0063782	16	0.015690	0.0073842	-0.0012794	0.160

**Table 4.9g:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 35%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 35%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.036364	0.0160552	0.0047612	0.120
2001 to 2004	16	0.016531	0.0060677	16	0.014751	0.0064490	0.0017805	0.198
2005 to 2008	16	0.014411	0.0063782	16	0.016369	0.0076723	-0.0019578	0.082

**Table 4.9h:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 40%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 40%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.036244	0.0163334	0.0048814	0.154
2001 to 2004	16	0.016531	0.0060677	16	0.015326	0.0061313	0.0012051	0.371
2005 to 2008	16	0.014411	0.0063782	16	0.017118	0.0080467	-0.0027067	0.046

**Table 4.9i:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 45%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 45%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.036264	0.0167297	0.0048608	0.196
2001 to 2004	16	0.016531	0.0060677	16	0.016036	0.0058044	0.0004948	0.706
2005 to 2008	16	0.014411	0.0063782	16	0.017934	0.0084798	-0.0035232	<b>0.027</b>

**Table 4.9j:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 50%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 50%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.036421	0.0172381	0.0047043	0.249
2001 to 2004	16	0.016531	0.0060677	16	0.016851	0.0055049	-0.0003202	0.803
2005 to 2008	16	0.014411	0.0063782	16	0.018812	0.0089546	-0.0044011	<b>0.017</b>

**Table 4.9k:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 55%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 55%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.036707	0.0178511	0.0044180	0.313
2001 to 2004	16	0.016531	0.0060677	16	0.017750	0.0052577	-0.0012188	0.344
2005 to 2008	16	0.014411	0.0063782	16	0.019741	0.0094664	-0.0053304	<b>0.011</b>

**Table 4.9l:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 60%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 60%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.037115	0.0185620	0.0040095	0.391
2001 to 2004	16	0.016531	0.0060677	16	0.018716	0.0050840	-0.0021845	0.098
2005 to 2008	16	0.014411	0.0063782	16	0.020711	0.0100148	-0.0063007	<b>0.007</b>

**Table 4.9m:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 65%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 65%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.037637	0.0193644	0.0034881	0.482
2001 to 2004	16	0.016531	0.0060677	16	0.019735	0.0050008	-0.0032040	<b>0.021</b>
2005 to 2008	16	0.014411	0.0063782	16	0.021714	0.0105987	-0.0073034	<b>0.005</b>

**Table 4.9n:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 70%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 70%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.038262	0.0202503	0.0028627	0.586
2001 to 2004	16	0.016531	0.0060677	16	0.020798	0.0050188	-0.0042672	<b>0.004</b>
2005 to 2008	16	0.014411	0.0063782	16	0.022743	0.0112153	-0.0083321	<b>0.004</b>

**Table 4.9o:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 75%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 75%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.038985	0.0212076	0.0021401	0.699
2001 to 2004	16	0.016531	0.0060677	16	0.021897	0.0051400	-0.0053661	<b>0.001</b>
2005 to 2008	16	0.014411	0.0063782	16	0.023792	0.0118615	-0.0093816	<b>0.003</b>

**Table 4.9p:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 80%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 80%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.039803	0.0222146	0.0013217	0.821
2001 to 2004	16	0.016531	0.0060677	16	0.023026	0.0053590	-0.0064945	<b>0.000</b>
2005 to 2008	16	0.014411	0.0063782	16	0.024859	0.0125345	-0.0104478	<b>0.002</b>

**Table 4.9q:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 85%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 85%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.040728	0.0232305	0.0003972	0.948
2001 to 2004	16	0.016531	0.0060677	16	0.024179	0.0056646	-0.0076475	<b>0.000</b>
2005 to 2008	16	0.014411	0.0063782	16	0.025938	0.0132313	-0.0115273	<b>0.002</b>

**Table 4.9r:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 90%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 90%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.041781	0.0241960	-0.0006557	0.918
2001 to 2004	16	0.016531	0.0060677	16	0.025352	0.0060432	-0.0088212	<b>0.000</b>
2005 to 2008	16	0.014411	0.0063782	16	0.027028	0.0139496	-0.0126172	<b>0.001</b>

**Table 4.9s:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 95%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 95%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.042968	0.0250856	-0.0018426	0.781
2001 to 2004	16	0.016531	0.0060677	16	0.026544	0.0064813	-0.0100124	<b>0.000</b>
2005 to 2008	16	0.014411	0.0063782	16	0.028126	0.0146870	-0.0137154	<b>0.001</b>

**Table 4.9t:****Comparison of Standard Deviation, 1997 to 2008 Alternative Target = 100%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 100%			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.044276	0.0259066	-0.0031510	0.646
2001 to 2004	16	0.016531	0.0060677	16	0.027750	0.0069668	-0.0112185	<b>0.000</b>
2005 to 2008	16	0.014411	0.0063782	16	0.029231	0.0154416	-0.0148200	<b>0.001</b>



### **4.5.3 Sharpe Ratio**

Looking at the comparison of the Sharpe Ratio in Table 4.10a to Table 4.10t, the outcome is very similar to the earlier findings. For years 1997 to 2000, there are statistically significant higher risk-adjusted returns for pension funds with any alternative target allocations. The higher the alternative allocation, the higher the risk-adjusted return. As the tables show consistently across the different alternative target allocations for 2001 to 2004, the pension fund with alternative assets had nominally lower returns than those without alternative assets, and the p-value shows that none of these differences are significant. Pension funds allocating at least 35 percent of the portfolio to alternative assets for 2005 to 2008 show a significantly higher Sharpe Ratio. Increasing the target allocation to 75 percent, as shown in Table 4.10p, still shows a significantly higher Sharpe Ratio. Starting from an alternative target allocation of 80 percent onwards, the Sharpe Ratio is significantly remaining no increment compared to the zero alternative allocation.

According to the tables, adding alternative assets to pension funds during a bear market will definitely increase the risk-adjusted return for the pension fund portfolio. The risk-adjusted return shows no significant changes in a bull market. However, the optimal range for alternative allocation is 35 to 75 percent for a fluctuating market.

**Table 4.10a:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 5%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 5%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	-0.106925	1.0258925	-0.0673500	<b>0.012</b>
2001 to 2004	16	0.383894	1.1657029	16	0.395269	1.2512368	-0.0113750	0.721
2005 to 2008	16	0.071128	1.2313522	16	0.143225	1.3238452	-0.0720966	0.435

**Table 4.10b:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 10%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 10%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	-0.030806	0.9913608	-0.1434688	<b>0.013</b>
2001 to 2004	16	0.383894	1.1657029	16	0.391338	1.3507743	-0.0074438	0.912
2005 to 2008	16	0.071128	1.2313522	16	0.157325	1.6245239	-0.0861966	0.715

**Table 4.10c:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 15%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 15%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.057644	0.9537514	-0.2319188	<b>0.015</b>
2001 to 2004	16	0.383894	1.1657029	16	0.360719	1.4748913	0.0231750	0.834
2005 to 2008	16	0.071128	1.2313522	16	0.203456	1.9201630	-0.1323278	0.702

**Table 4.10d:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 20%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 20%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.160875	0.9269710	-0.3351500	<b>0.020</b>
2001 to 2004	16	0.383894	1.1657029	16	0.279606	1.6652776	0.1042875	0.559
2005 to 2008	16	0.071128	1.2313522	16	0.369875	1.8581406	-0.2987466	0.377

**Table 4.10e:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 25%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 25%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.274738	0.9383744	-0.4490125	<b>0.025</b>
2001 to 2004	16	0.383894	1.1657029	16	0.128325	1.9794059	0.2555688	0.374
2005 to 2008	16	0.071128	1.2313522	16	0.544000	1.7783014	-0.4728716	0.154

**Table 4.10f:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 30%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 30%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.387769	0.9951018	-0.5620438	<b>0.028</b>
2001 to 2004	16	0.383894	1.1657029	16	0.121581	1.8703508	0.2623125	0.346
2005 to 2008	16	0.071128	1.2313522	16	0.701456	1.7610109	-0.6303278	0.070

**Table 4.10g:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 35%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 35%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.491725	1.0717365	-0.6660000	<b>0.026</b>
2001 to 2004	16	0.383894	1.1657029	16	0.197356	1.6572778	0.1865375	0.466
2005 to 2008	16	0.071128	1.2313522	16	0.845094	1.7911789	-0.7739653	<b>0.041</b>

**Table 4.10h:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 40%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 40%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.587488	1.1495278	-0.7617625	<b>0.023</b>
2001 to 2004	16	0.383894	1.1657029	16	0.231913	1.5685903	0.1519813	0.560
2005 to 2008	16	0.071128	1.2313522	16	0.972244	1.8477698	-0.9011153	<b>0.030</b>

**Table 4.10i:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 45%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 45%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.680250	1.2284533	-0.8545250	<b>0.018</b>
2001 to 2004	16	0.383894	1.1657029	16	0.243625	1.5129282	0.1402688	0.600
2005 to 2008	16	0.071128	1.2313522	16	1.076906	1.9138879	-1.0057778	<b>0.028</b>

**Table 4.10j:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 50%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 50%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.775363	1.3173826	-0.9496375	<b>0.015</b>
2001 to 2004	16	0.383894	1.1657029	16	0.244231	1.4720541	0.1396625	0.611
2005 to 2008	16	0.071128	1.2313522	16	1.160150	1.9928708	-1.0890216	<b>0.030</b>

**Table 4.10k:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 55%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 55%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.877956	1.4295110	-1.0522313	0.012
2001 to 2004	16	0.383894	1.1657029	16	0.239831	1.4415643	0.1440625	0.611
2005 to 2008	16	0.071128	1.2313522	16	1.229688	2.0954878	-1.1585591	0.034

**Table 4.10l:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 60%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 60%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	0.994181	1.5840677	-1.1684563	0.011
2001 to 2004	16	0.383894	1.1657029	16	0.233450	1.4195291	0.1504438	0.606
2005 to 2008	16	0.071128	1.2313522	16	1.290206	2.2148870	-1.2190778	0.041

**Table 4.10m:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 65%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 65%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.132988	1.8113755	-1.3072625	0.011
2001 to 2004	16	0.383894	1.1657029	16	0.226463	1.4044482	0.1574313	0.599
2005 to 2008	16	0.071128	1.2313522	16	1.341231	2.3304692	-1.2701028	0.046

**Table 4.10n:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 70%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 70%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.308863	2.1626933	-1.4831375	0.013
2001 to 2004	16	0.383894	1.1657029	16	0.219488	1.3950409	0.1644063	0.594
2005 to 2008	16	0.071128	1.2313522	16	1.381019	2.4238254	-1.3098903	0.051

**Table 4.10o:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 75%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 75%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.545675	2.7240205	-1.7199500	0.019
2001 to 2004	16	0.383894	1.1657029	16	0.212738	1.3901908	0.1711563	0.588
2005 to 2008	16	0.071128	1.2313522	16	1.409300	2.4867853	-1.3381716	0.054

**Table 4.10p:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 80%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 80%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.872906	3.6005279	-2.0471813	<b>0.031</b>
2001 to 2004	16	0.383894	1.1657029	16	0.206250	1.3889736	0.1776438	0.584
2005 to 2008	16	0.071128	1.2313522	16	1.427631	2.5208224	-1.3565028	0.056

**Table 4.10q:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 85%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 85%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.250138	4.6246161	-2.4244125	<b>0.045</b>
2001 to 2004	16	0.383894	1.1657029	16	0.200025	1.3906826	0.1838688	0.579
2005 to 2008	16	0.071128	1.2313522	16	1.438506	2.5324445	-1.3673778	0.057

**Table 4.10r:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 90%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 90%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.415019	4.7871558	-2.5892938	<b>0.041</b>
2001 to 2004	16	0.383894	1.1657029	16	0.193950	1.3947256	0.1899438	0.575
2005 to 2008	16	0.071128	1.2313522	16	1.444400	2.5290965	-1.3732716	0.058

**Table 4.10s:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 95%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 95%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.338881	4.1012246	-2.5131563	<b>0.026</b>
2001 to 2004	16	0.383894	1.1657029	16	0.188019	1.4006758	0.1958750	0.571
2005 to 2008	16	0.071128	1.2313522	16	1.447306	2.5169283	-1.3761778	0.058

**Table 4.10t:****Comparison of Sharpe Ratio, 1997 to 2008 Alternative Target = 100%**

Return Period	Alternative Target Allocation = 0%			Alternative Target Allocation = 100%			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	2.240838	3.5768880	-2.4151125	<b>0.019</b>
2001 to 2004	16	0.383894	1.1657029	16	0.182181	1.4081266	0.2017125	0.567
2005 to 2008	16	0.071128	1.2313522	16	1.448613	2.5004241	-1.3774841	0.057

#### **4.6 Performance of Optimal Portfolio**

The above results reflect whether the EPF rules and regulations affect alternative investment returns, investment risk and risk-adjusted returns. It would be meaningful to create an optimal portfolio that encompasses the best combination among all the traditional and alternative assets, diversified across different assets, which is a similar concept to the Yale Model. The purpose is to establish the highest return for each given level of risk or minimum risk for each level of return. According to the mean-variance optimizer, during a bear market the optimal portfolio should be 71 percent invested in MGS and fixed income, 4 percent in domestic and foreign equity and 25 percent in alternative assets. During the bull market, 27 percent should be invested in MGS and fixed income, 1 percent in domestic and 72 percent in alternative assets. Lastly, 53 percent should be invested in MGS and fixed income, 3 percent in equity and 44 percent in alternative assets when the market is fluctuating, refer Appendix C.

Based on the mentioned allocation, Table 4.11 shows the results of the investment return comparison between the existing pension plan (EPF) and the optimal portfolio. The mean return of the optimal portfolio is nominally higher for every sub-period reviewed, but the result of the p-value only shows significant from 2005 through 2008. As presented in Table 4.12, the pension fund based on the optimal investment concept may significantly reduce the investment risk for the period 1997 to 2000. Indeed, similar to the previous findings, Table 4.13 indicates that risk-adjusted returns for pension plans based on the optimal portfolio in bear and fluctuating markets are significantly

increased. For 2001 to 2004, it is not significantly proven that a pension plan based on the optimal portfolio will reduce the risk-adjusted return.

From the above analysis, this study shows that the optimal portfolio will significantly increase the risk-adjusted return when the market is on the downside, thereby reducing the portfolio risk. However, alternative investments will slightly increase the portfolio risk when the market is up. When the market is fluctuating, the optimal portfolio will significantly improve the return and Sharpe Ratio of the portfolio.

**Table 4.11:**

**Mean Investment Return Comparison, EPF Portfolio & Optimal Portfolio**

Return Period	EPF Portfolio			Modified Yale Model			Mean Diff.	p-value
	N	Mean	SD	N	Mean	SD		
1997 to 2000	16	0.009913	0.0427258	16	0.022737	0.0176066	-0.0128241	0.172
2001 to 2004	16	0.013880	0.0173101	16	0.024524	0.0291975	-0.0106436	0.078
2005 to 2008	16	0.008386	0.0180535	16	0.018135	0.0259629	-0.0097496	<b>0.048</b>

**Table 4.12:**

**Comparison of Standard Deviation, EPF Portfolio & Optimal Portfolio**

Return Period	EPF Portfolio			Modified Yale Model			Mean Diff.	p-value
	N	Mean STD	SD	N	Mean STD	SD		
1997 to 2000	16	0.041125	0.0176524	16	0.016038	0.0064229	0.0250875	<b>0.000</b>
2001 to 2004	16	0.016531	0.0060677	16	0.029094	0.0097320	-0.0125625	<b>0.000</b>
2005 to 2008	16	0.014411	0.0063782	16	0.015519	0.0063155	-0.0011079	0.437

**Table 4.13:**

**Comparison of Sharpe Ratio, EPF Portfolio & Optimal Portfolio**

Return Period	EPF Portfolio			Modified Yale Model			Mean Diff.	p-value
	N	Mean RAR	SD	N	Mean RAR	SD		
1997 to 2000	16	-0.174275	1.0560686	16	1.241338	1.9019684	-1.4156125	<b>0.003</b>
2001 to 2004	16	0.383894	1.1657029	16	0.673000	1.0072399	-0.2891063	0.249
2005 to 2008	16	0.071128	1.2313522	16	1.066188	1.9959834	-0.9950591	<b>0.012</b>

#### **4.7 Summary**

Based on the results, three alternative investment assets – private equity, commodity and hedge fund – were found to influence the performance of the EPF. These included return, risk and risk-adjusted return during different types of market style. Moreover, the results were generated under two conditions – with the EPF rules and regulations and without the EPF rules and regulations.

Chapter 5 will cover the conclusion and recommendations of this study.