Optimal Asset Allocation of Assets in an Open Pension Plan

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Abstract

Given the generally long term nature of pension plans, the behaviour of the market plays a crucial role in making a pension plan able to meet its obligations. Regardless of the market performance, the structure of the benefits remains the same, unless they are negotiated to be at a different level.

In this paper, we studied primarily the impact of market performance on a pension plan's ability to meet its obligations. We studied the period from 1974 to 2010 and included asset allocation strategies that varied from allocating 25% to 100% weight assigned to equity portfolios. The goals were to determine which type of asset allocation system is the most efficient across all time horizons.

Our results show that it is not necessary to have an overly aggressive posture to equities. Indeed, as assets become more exposed to equities, the efficiency of a portfolio (as measured by Sharpe ratio) declines. We found that an exposure to equity in the range of 35%-50% is sufficient to meet most pension obligations, provided that the plans are fully funded at the outset.

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Keywords: Sharpe Ratio, Risk Aversion, Asset Allocation

1. Introduction

Pension plan management is a complex undertaking. There are many variables that can impact the performance of the funds, and thus its ability to meet its current and future obligations to its constituents. Among the more important variables that can impact the ability of a pension plan to deliver its promise are: 1) the initial funding levels of the plan, 2) the average salary level of the organisations, 3) the number of participants in the plan, 4) the average age of the participants, 5) the asset allocation utilised by the plan, and 6) the status of the plan as either a) ongoing, b) closed, or c) frozen. While each of the above variables can have a significant impact by itself, the main theme of this report is focused on the asset allocation strategy utilised by pension plans and its impact on both the ability of the plan to meet its obligations as well as the risk profile as a result of various asset allocation strategies.

2. Literature Review

Since pensions are defined benefits, the risk of managing assets within a pension plan falls squarely on the pension plan provider and or the financial institution that is managing the plan. Just like in portfolio theory, the two most important factors in a pension plan being viable are contributions and growth of these assets. In this paper, we are not focused on the contributions as much as we are on the asset allocation systems that result in a viable pension plan.

McFarland and Stoner (2010) reported that in aggregate, the pension plan asset allocation was as follows: 44.5% in equity; 39.4% in bonds; 3.2% in real estate; 5.5% in private equity; 4% in cash; 4.9% in hedge funds; and 3% in others. McFarland and Stoner also report that the range of allocation in equities was from roughly 28% to 44%.

Portfolio theory would suggest that the optimal asset allocation should be based upon individual investor's risk aversion. This tradeoff between risk and return is well defined in portfolio theory (Merton, 1969;Stiglitz, 1980). Based on Merton and Stiglitz theory, it is well accepted that the weight allocated to risky asset (equities in case of two security portfolio) should be defined by:

$$W^* = (R-r)/A\sigma^2$$

where, W* is the optimal weight in equities; R is the rate of return on equities; r is the risk free rate of return;

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A is a measure of risk aversion and σ^2 is the variance in the returns. Of course, it is difficult for plans, if not impossible, to determine the risk aversion as a whole for the entire plan, so we do not see this model being utilised in any pension plan that we have come across. Now, pension plans can potentially become reckless as they face pressures of redemption, and this can affect the way plans allocate assets. But in their study, Weller and Wenger (2009) did not find any evidence that would indicate that pension plans engaged in any imprudent behavior. A tangential conclusion that can be drawn from this finding is that asset allocations, whatever they were, did not change drastically in response to changes in market conditions.

In a related article, Wade (2010) studied the asset allocation in lifecycle funds versus a fixed allocation strategy and concluded that both strategies were effective though strategies with fixed allocation seemed to result in better overall outcome. Schleef and Eisinger (2007) found that there are only four target date funds (dynamic asset allocation mode) that had equal chance to outperform a 70% equity and 30% fixed income asset allocation outcome.

Asset allocation in plans can also be affected by regulations as well as age of the workforce. For example, Eli and Shlomo (1998) find that assets allocations were influenced by (over the period of 1988-1994) SFAS No. 87. Their findings suggest that businesses also allocate assets in a fashion so as to avoid additional minimal funding liability. Although, they find that both equities and fixed income were used by managers, they offer no specific and concrete conclusion to an optimal asset allocation puzzle. Age also influences asset allocation. Bikker *et al.* (2012) use life cycle approach to model asset allocations in pension plans. We would expect a negative relationship between the ages of participants and equity exposure. The results of the study, done on Dutch plans, found that for every one year increase in age of participants, the exposure to equity reduced by 0.5%.

One of the issues helpful in this regard is the availability of information on data that could be utilised in order to study the impact of varied allocations on plan viabilities. Thornton (2012) provides some of the resources to be used in like studies. He also notes that even though pension professionals may provide information to states and municipalities, it is usually the state and local government officials that make the final decisions.

But the central question that we address in this paper is one of most efficient asset allocations that are most efficient in terms of risk-return as well as keeping a plan well-funded? The question of optimal asset allocation has been studied many times in the literature. For example, Yang and Huang (2009) model an asset allocation system based upon minimizing the variance of asset minus liabilities. In their model, they also model longevity risk using a stochastic model so as to account for changing mortality risk in U.K. Results from simulations of their model show that longevity risk can be minimized by either increasing contribution rate or resorting to a more aggressive asset allocation. Giacinto *et al.* (2011) also models the optimal allocation for a pension fund with a minimum guarantee by maximising the expected utility function. Pension plan allocations can be influenced by other factors such as taxes. Frank (2002) found that corporate tax rates had a significant influence on the fixed income allocation of pension plans.

Unfortunately, this study and others, while theoretically robust, are based on simulations that assume historical behaviour of the market. While it is true that each pension plan and plan manager must make assumptions regarding the future behaviour of the markets, what is troubling is that even the most sophisticated of models will fail to minimise the impact of asset minus liability variance if the markets deviate from expectations for any significant period.

Our paper differs from existing efforts in one significant way. We don't theorize the optimal asset allocation. We actually determine what has worked in the past, across many turbulent times. The work in this paper is therefore evidence based. At the end of the day, the foremost objective of any pension plan is to stay solvent (meaning assets > liabilities). Of course this can be attempted to be achieved in many ways: conservative to aggressive allocation and or by adjusting contribution rates and or by adopting a more dynamic asset allocation methodology.

3. Plan of Study

This paper studies the performance of pension plans under different market conditions and under varied asset allocation decisions. The primary purpose of the investigation is to determine if pension plans are viable under stresses of financial market performance as well as to determine what, if any, asset allocation can be determined

Table 1: Descriptive Statistics for S&P 500 for 1974-2010 Period

	1974-2010	*1974-1994*	*1980-2000*	*1985-2005*	*1990-2010*
Geometric mean	10.49%	12.76%	17.14%	13.39%	8.88%
Std. Deviation	17.8%	15.48%	13.53%	16.14%	18.58%

Table 2: Descriptive Statistics for Fixed Income Portfolio I for 1974-2010 Period

	1974-2010	*1974-1994*	*1980-2000*	*1985-2005*	*1990-2010*
Geometric mean	8.15%	9.70%	10.54%	8.94%	7.34%
Std. Deviation	6.90%	7.92%	7.83%	6.35%	5.21%

to be most efficient. We chose 1974 as the starting point of our study because this is the period during which the U.S. economy was experiencing very low growth and high inflation rates, which were fed by a brewing oil crisis. Also, 1974 marked the passage of the Employee Retirement Income Security Act of 1974 (ERISA), which provided, for the first time, a broad framework of rules for pension plans. This period would last until the mid-1980s. It was during the middle 1980s that tighter controls over the monetary policy by the Federal Reserve were able to reign in the higher inflation rates. This led to a prolonged period of declining interest rates. We reflect this phenomenon by studying the period from 1980-2000. We also studied two additional periods that included two recessions (2001 and 2007-2009), which, of course, are viewed as the harshest since the Great Depression of the 1930s.

The second part of the paper examines if there exists an optimum asset allocation when it comes to managing pension assets. To study whether such an allocation exists, we created three primary and predetermined allocation strategies. These were 25% weight to equity (represented by S&P 500 index); 50% allocated to both S&P 500 and Barclay's fixed income index (FI); 65% in equity and 35% in FI. In this paper we study the open plan which is open to new participants and is of an indefinite time period in nature. Applying the asset allocation to all the plans and across all economic spectrums, we hope to find a solution from which future pension fund managers could learn and implement.

4. Data

We used the S&P 500 as a benchmark index for equities and Barclay's total composite bond index for the fixed income component. Both data streams had a starting period in 1974 and the last stream of data was for 2010. The S&P data were collected from the Bloomberg database while the FI data were obtained from Barclay's. The fixed income data was a composite FI index which included U.S. treasury, U.S. treasury medium term and U.S treasury long term bond data. The data obtained had returns on a monthly basis from January 1, 1973 to December 31, 2010. Table 1shows the descriptive statistics for the S&P 500, while Table 2 summarizes the FI performance.

Studying the results from Table 1, the S&P 500 geometric mean is close to its historical average of 10.49% with a standard deviation of 17.8%.

Results of FI portfolio show what has historically been known- that both return and risk of a FI portfolio is much less than same variables for the S&P 500. The liabilities were discounted using Moody's AA Corporate rate, the rate often used as a benchmark when determining liabilities for the purposes of accounting for U.S. private pensions. The Moody's data as well as the S&P 500 data wereprovided by Nyhart while Barclay's provided the bond index data.

5. Description of the Model in the Study

In this study, we explored the open plan model.The most basic model of a pension plan is one that is fully funded at the outset, and is ongoing. Table 3 details the assumptions upon which the model was constructed. The basis for the ongoing plan is that there is a static population in the plan, meaning the demographic profile is constant for the duration of the study. In addition, the pace of actives withdrawing matches the mortality of retirees. Finally, another assumption made was that the company would be able to have positive cash flows to fund any level of shortfall.

Table 3: Assumptions Made for the Basic Ongoing Plan

Initial Liability	*Initial Funding Level*	*Service Cost*	*Average Salary*	*Active Participants*	*Basic Payroll*	*Retiree Percent*	*Retiree Percentage Payout*	*Retiree Death Decrement*
$10M	100%	3.5%	$20K	300	$6.4M	30%	14%	1.8%

We also assumed annual benefits increment equal to the long-term average inflation rate of 3.5%. In the plan, it is assumed that 30% of liabilities are attributed to retirees whose annual payouts start out at 14% of the retirement liabilities. The liabilities are measured at the Moody's AA Corporate rate at the beginning of the year, and the duration in the ongoing scenario is assumed to be 14. Liabilities are rolled forward each year adjusting for payouts made and incoming contributions – both of which are weighted to be mid-year cash flows. Annual contributions follow the basic Pension Protection Act funding rules where there is a normal cost component for annual benefit accruals and a 7-year amortization payment for any shortfall. For this model, the full normal cost is always contributed unless the plan is at least 110% funded, in which case the contribution is then one-half of the normal cost. If the plan is at least 120% funded, the contribution is assumed to be zero for that particular year. Our assumption of mortality is based upon a representative rate in the 1994 U.S. group annuity mortality table for the retiree group in the model. Since we had indicated in our proposal that we would make use of data and information on pension plans from Nyhart's pension data, we based our retiree percent of 30% as well as retiree percentage payout of 14% on similar pension plans from Nyhart's data base. For pension plans of this size ($10M), these were common traits for the retiree and retiree percent payments. Further notes on use of assumptions used in modeling the basic and other plans are listed in Appendix A. Appendix B shows the Moody's rates that were used in this study (from 1974-2010). For this model, we use asset allocations that started at a very conservative 25% attributed to equity while 75% was attributed to the fixed income portion. We then gradually raise the equity portion to 50%, 65%, and then 100%. Finally, we also perform a sub-set analysis of 10 years for this model to see what would happen when the pension plan is launched over a period of sustained economic weakness.

6. Discussion of Results

6.1. Asset and liability growth rates

For this model, we utilised the following four periods: 1974-1994; 1980-2000; 1985-2005; and 1990-2010. The tables and results below will discuss four asset allocation models as well as an allocation of 100% equity over a smaller sub-period of 2000-2010. Tables4-A1 through E2 show the findings from using the various asset allocation systems, from 25% in equity to 100% in equity.

Tables 4-A1 and A2 show the results of allocating a 25% weighting to equity through all the four sub-periods, with the remaining weight in the FI index. The effective growth rate was computed by taking each sub-period's initial amount of assets, in this case $10M (because the plan was assumed to be fully funded) and adding any contributions to the asset base and then subtracting the benefits paid. Appendix A shows the actual formula for determining the asset amount at the end of any specific period. Results show that growth of assets was in a very reasonable range of approximately 7%. Even at this rate of effective growth, the minimum level of funding was at 78%, and that was during the 1985-2005 sub-period. Also note the percent funded figures. These numbers are averages of percent funded, which is computed by dividing the assets by liabilities for a specific period, over an entire twenty year period. For example, for the 1974-1994 periods the average level of funding was 190%. This implies that the average of assets over liabilities was 190%. The results also show the maximum level of funding achieved during any of these periods. The maximum level of funding was noted at 270%, and that was for the 1974-1994 period. It is also of interest to note that the maximum level of funding never dropped below 120%, which is good.

We also note the rate of growth of liabilities, and these results show a wide range of growth rates. The range of liability growth rates ranges from a low of 3.37% in the 1974-1994 periods while the highest rate of growth was noted as 8.37%, and that was in the 1985-2005 sub-period. Of the four sub-periods in our study, we noted that in two of the sub-periods, namely 1974-1994 and 1980-2000, the rate of growth of assets exceeded the rate of growth of liabilities. However, in the remaining two sub-periods, the rate of growth of liabilities exceeded the growth rate of assets. It is also worth noting that the average funding level of the plan was in a comfortable

Table 4-A1: Findings From 25% Equity Allocation

Sub-Periods	*Effective Asset Growth Rate*	*Effective Liability Growth Rate*	*Average of (A- L) Difference*	*Percent Funded*	*Std. Dev. of Funding Levels*	*Max Funding Percentage*	*Minimum Funding Percentage*
1974-1994	7.06%	3.37%	$9,325,948	190%	56%	270%	100%
1980-2000	7.43%	6.08%	$1,941,528	116%	21%	171%	88%
1985-2005	7.74%	8.37%	-$992,824	96%	10%	122%	78%
1990-2010	6.69%	7.25%	-$427,751	100%	10%	127%	86%

Table 4-A2: Findings From 25% Equity Allocation

Sub-Periods	*# Periods A<L*	*Total Cash Contributions*	*Total Benefits Paid*	*Avg (A-C)/L*	*Percent Funded @ End*	*Portfolio Return*	*Std. Dev. Portfolio*	*Sharpe Ratio*
1974-1994	0	$1,028,000	$15,173,000	189%	160%	10.44%	8.61%	0.79
1980-2000	4	$10,420,000	$28,549,000	113%	129%	11.9%	7.59%	1.09
1985-2005	15	$21,547,000	$34,956,000	91%	89%	10%	7.15%	0.88
1990-2010	11	$21,542,000	$26,280,000	95%	90%	7.88%	6.45%	0.65

range of more than 96% funded (in fact, the 96% was the lowest average funding level), reaching as high as 190% in the 1974-1994 period.

6.1.1. Periods where assets < liabilities

We computed the total number of periods where assets are less than liabilities for each sub-period. The results show that for a 25% asset allocation, the highest number of years in which the assets were smaller than liabilities were in the 1985-2005 period, where this number was 15 (out of the 20 total years in the period). During the 1990-2010 exhibited 11 years out of a total of 20 where liabilities exceeded assets. The most efficient period was 1974-1994, where assets were greater than liabilities in each of the twenty years. If we sum all the years where assets < liabilities, we obtain a sum of 30 years out of a cumulative 80 years. This puts the ratio of A < L to total years at 37.5%. If the manager of a pension plan could invest in such a way so as to have no periods where liabilities exceed assets, it would make for a close to an ideal scenario.

6.1.2. (Assets - Contributions)/Liabilities

If we take away the contributions from the total asset base, we are left with assets minus the benefits paid, and it is this number that is more meaningful as a gauge of risk. Higher this ratio, more viable the plan. We can see that this ratio ranges from a high of 190% to a low of 91%. A 91% funding level is not all that bad, when all is said and done. Therefore, it would seem that even a conservative allocation of 25% to equity is somewhat functional.

6.1.3. Sharpe ratio

Perhaps the most efficient way of risk testing is to make use of the Sharpe ratio. The Sharpe ratio is computed as follows: (return – risk free rate)/Std. deviation. The risk free rate was defined by the 10-year Treasury bond yield, and this is the rate we used in our study. For the 25% weight to equity, we see that the Sharpe ratio ranges from a low of 0.65 to a high of 1.09. To determine how efficient this investment profile is, we will wait to discuss results from other allocations.

6.2. Discussion on 50% allocation

The results of imposing a 50% equity weighting to assets are depicted in Tables IV-B1 and B2. The difference of (A-L) was not negative in any of the four sub-periods. However, because higher equity weight puts more risk on the overall portfolio, we noted that the amount for minimum level of funding was generally better for the 25% equity weighting. This greater risk is also evident by looking at the standard deviation of the funding, which is higher in each of the four sub-periods. Clearly, there is a price to pay for higher allocation to equity.

Table 4-B1: Findings From 50% Equity Allocation

Sub-Periods	Effective Asset Growth Rate	Effective Liability Growth Rate	Average of (A-L) Difference	Percent Funded	Std. Dev. of Funding Levels	Max Funding Percentage	Minimum Funding Percentage
1974-1994	8.12%	3.37%	$11,745,036	210%	70%	290%	99%
1980-2000	8.80%	6.08%	$4,560,437	126%	23%	178%	95%
1985-2005	8.19%	8.37%	$1,895,695	104%	17%	153%	80%
1990-2010	6.57%	7.25%	$419,002	104%	16%	149%	82%

Table 4-B2: Findings From 50% Equity Allocation

Sub-Periods	# Periods A<L	Total Cash Contributions	Total Benefits Paid	Avg (A-C)/L	Percent Funded @ End	Portfolio Return	Std. Dev. Portfolio	Sharpe Ratio
1974-1994	1	$1,169,000	$15,173,000	209%	199%	11.38%	10.37%	0.74
1980-2000	1	$5,672,000	$28,549,000	125%	166%	13.68%	8.76%	1.14
1985-2005	13	$15,201,000	$34,956,000	101%	97%	11.31%	9.56%	0.80
1990-2010	10	$18,625,000	$26,280,000	100%	88%	8.66%	9.97%	0.50

We also noted that the total number of periods where assets were less than liabilities was 25 years from a possible 80 years. This gives a better percent ranking at 31.25% as compared to 37.25% in the 25% allocation. Even when they are superior, after some point, it becomes meaningless to look at plans and decipher the difference between say 200% funded from one that is 190% funded. As far as we are concerned, this turned out to be not a very meaningful statistic. The overall portfolio performance was higher under the 50% weighting, but so was the standard deviation.

6.3. Discussion on 65% allocation

Tables 4-C1 and C2 depict the results from imposing a 65% weighting to equities. As for the 50% allocation, the results in the effective rate category are superior. There was only one sub-period where the assets rate of growth

Table 4-C1: Findings From 65% Equity Allocation

Sub-Periods	Effective Asset Growth Rate	Effective Liability Growth Rate	Average of (A-L) Difference	Percent Funded	Std. Dev. of Funding Levels	Max Funding Percentage	Minimum Funding Percentage
1974-1994	8.67%	3.37%	$13,132,608	221%	79%	308%	94%
1980-2000	9.80%	6.08%	$6,623,615	133%	26%	199%	99%
1985-2005	8.67%	8.37%	$4,258,379	111%	24%	178%	81%
1990-2010	6.55%	7.25%	$1,461,214	108%	22%	170%	79%

Table 4-C2: Findings From 65% Equity Allocation

Sub-Periods	# Periods A<L	Total Cash Contributions	Total Benefits Paid	Avg (A-C)/L	Percent Funded @ End	Portfolio Return	Std. Dev. Portfolio	Sharpe Ratio
1974-1994	1	$1,239,000	$15,173,000	220%	223%	11.95%	11.70%	0.70
1980-2000	1	$4,018,000	$28,549,000	133%	199%	14.70%	10.00%	1.10
1985-2005	7	$13,058,000	$34,956,000	108%	106%	12.10%	11.40%	0.74
1990-2010	9	$17,162,000	$26,280,000	105%	88%	9.12%	12.40%	0.44

was smaller than the rate for liability. But because of the higher weighting to equity, the standard deviation of the funding levels is higher, indicating the higher volatility in the levels of funding. The total number of years where A < L, was 18 out of 80 years. This puts the percentage at 22.5%, which is much improved from the 37.5% in the 25% equity weighting. Finally, the portfolio returns and standard deviation numbers are all higher, as expected, but the same could not be said for the Sharpe ratio, which continues to favor the 25% allocation model.

6.4. Discussion on 100% Allocation

The results of 100% allocation are shown in Tables 4-D1 and D2. As expected, the assets generally exceed liabilities and do so in a more meaningful way. Also, the number of years where the assets < liabilities is also reduced to a mere 11 out of a possible 80 years. That puts this percentage at only 13.75%, which is far superior to any other equity model.

6.5. Discussion on 2000-2010 Period

If a pension plan were started during this period, and even if it were fully funded, what would be the impact of heavy equity weighting? This is a question that we examined and we report these results in Tables 4-E1 and E2.

It is clear from looking at these panels that the pension plan was under water no matter what the weighting. Further, these outcomes become worse with heavier weighting towards equity. For example, all measures (rate on assets, average of A-L, funded standard deviation, and others) are meaningfully worse off. Most of all, the Sharpe ratio is actually negative. The message from this analysis is therefore that while a more aggressive stance would be tolerable under a "normal" economic period, it would be downright suicidal under a negative economic scenario. Since it is difficult to forecast a recession, as it was in the 2001 and 2007, it is best to avoid a very heavy weight to equities. Therefore, it would seem that an equity weighting between 25% and 50% is sufficient to deliver the results under most economic circumstances. In fact, it is a 25% weighting to equity when a portfolio of a pension plan is most efficient, based on this analysis.

7. Conclusions

The results of this study have allowed us to draw a few concrete conclusions. One, it is not necessary to adopt a very aggressive equity posture when it comes to managing plan assets. Our findings have shown that a range of 36%-50% weight in equity can provide ample return to allow a plan to meet its obligations, as long as service costs are funded each year. We should emphasize that if a plan is run like a typical corporate plan, where

Table 4-D1: Findings from 100% Equity Allocation

Sub-Periods	*Effective Asset Growth rate*	*Effective liability growth rate*	*Average of (A- L) difference*	*Percent Funded*	*Std. dev of funding levels*	*Max funding Percentage*	*Minimum funding Percentage*
1974-1994	9.86%	3.37%	$ 16,562,561	248%	103%	381%	84%
1980-2000	12.29%	6.08%	$ 12,926,678	156%	46%	312%	100%
1985-2005	9.67%	8.37%	$ 10,965,502	131%	44%	260%	73%
1990-2010	6.43%	7.25%	$ 4,595,918	121%	38%	232%	71%

Table 4-D2: Findings from 100% Equity Allocation

Sub-Periods	*# Periods A<L*	*Total cash contri-butions*	*Total benefits paid*	*Avg (A-C)/L*	*Percent funded @ end*	*Portfolio return*	*Std. dev Portfolio*	*Sharpe ratio*
1974-1994	2	$1,515,000	$ 15,173,000	247%	338%	13%	16%	0.62
1980-2000	0	$1,080,000	$ 28,549,000	155%	312%	14%	14%	0.99
1985-2005	3	$8,280,000	$ 34,956,000	129%	127%	17%	16%	0.63
1990-2010	6	$14,977,000	$ 26,280,000	118%	86%	10%	19%	0.35

Table 4-E1: Findings from 2000-2010 Period

Asset Allocation	Effective Asset Growth Rate	Effective Liability Growth Rate	Average of (A- L) Difference	Percent Funded	Std. Dev. of Funding Levels	Max Funding Percentage	Minimum Funding Percentage
25% equity	8.44%	9.94%	-$2,356,268	88%	6.18%	100%	81%
50% equity	7.92%	9.94%	-$3,122,746	84%	8.48%	100%	71%
65% equity	7.53%	9.94%	-$3,593,497	81%	10.20%	100%	64%
100% equity	6.40%	9.94%	-$4,709,998	75%	14.34%	100%	51%

Table 4-E2: Findings from 2000-2010 Period

Sub-Periods	# Periods A<L	Total Cash Contributions	Total Benefits Paid	Avg (A-C)/L	Percent Funded @ End	Portfolio Return	Std. Dev. Portfolio	Sharpe Ratio
25% equity	10	$15,271,000	$9,795,000	80%	87%	5.40%	4.10%	0.41
50% equity	10	$16,702,000	$9,795,000	75%	83%	4.40%	9.90%	0.07
65% equity	10	$ 17,580,000	$9,795,000	72%	80%	3.80%	12.00%	0.01
100% equity	10	$19,663,000	$9,795,000	65%	72%	2.50%	19.30%	-0.06

service costs are not being continuously funded, the plan most likely runs the risk of being severely underfunded, which might necessitate higher equity allocations and the accompanying inefficiencies mentioned before. We would clearly advise any manager not to assign a 100% weight to equities because as shown in the analysis, this kind of weighting can produce disastrous results under the strain of a severe economic downturn. The risk that is associated with such a weighting is difficult to justify.

Making investment decisions simply based upon one factor is not wise. As a result, even though a 25% weighting towards equity produced the most efficient investment performance (as measured by Sharpe ratio), we found that other measures of investment performance should be taken into account. We would recommend that asset managers look at not only the Sharpe ratio, overall standard deviation of the plan, and the plan funding levels, but also focus on the total number of years that a plan's assets might be less than plan liabilities. The risk is that based on cumulative number of years where a plan's assets < liabilities, a manager might be tempted to allocate a 100% weight to equity, though we caution in the strongest possible terms that such a weighting be avoided. Again, the reason being that a manager must look at the overall riskiness of the plan rather than years "under water" scenario.

Appendix A: Calculations

Asset computations:

Ending period assets = Beginning period assets*(1+r) + Contributions*(1+sqrt(1+r)) – benefits paid*(1+sqrt(1+r))

Where r = periodic rate of return on a specific portfolio

Liability Methodology and Assumptions

Initial liabilities set at $10 Million in base year (1974)

Liability amounts divided into two groupings with percentages: Actives / Term Vested (70%), Retired (30%) with static population (for ongoing plan) and no new actives (for closed and frozen plans)

Actives: Base year payroll – $6.4 Million (from 320 active count and average salary $20,000)

Service Cost – 3.5% of payroll (to approximate actuarial cost due to the annual benefit accruals from a 1% final average pay plan)

Payrolls increase using the US CPI-W Multiplier

Retirees: Base year annual payouts set at 14% of retiree liabilities

Subsequent annual payouts of 14% of retiree liabilities are normalized for changes in interest rates

Mortality assumption – 2.5% annually, represented rate based on 1994 US GAM blend table for the retiree group as a whole

Liabilities: Changes in liabilities beyond base year are valued at the Moody's AA Corporate rate

Duration – 14 (for ongoing plan); 12 (for closed and frozen plans)

Annual liability valuations employ a roll-forward method with retiree payouts weighted to be at mid-year

Liabilities adjusted annually for changes in the Moody's AA Corporate rate using the assumed duration

Contribution Methodology and Assumptions

Annual contributions follow a methodology similar to the current Pension Protection Act rules:

Service Cost plus a 7-year amortization payment of any shortfall

Amortization interest rate is the current year's Moody's AA Corporate rate

Years with funding percentage below 100% - Service Cost + 7-yr amortization payment

Years with funding percentage at least 100% but below 110% - Service Cost

Years with funding percentage at least 110% but below 120% - One-half of Service Cost

Years with funding percentage at least 120% - no contribution

Service Cost for frozen plan is $0

Appendix B: Historical Rates for Liabilities

Moody's AA		*US CPI-W**	
1974	7.92%	1973	6.20%
1975	9.20%	1974	10.96%
1976	9.25%	1975	9.07%
1977	8.24%	1976	5.73%
1978	8.40%	1977	6.47%
1979	9.33%	1978	7.72%
1980	11.15%	1979	11.43%
1981	13.78%	1980	13.41%
1982	15.00%	1981	10.25%
1983	12.44%	1982	6.02%
1984	12.76%	1983	2.99%
1985	12.50%	1984	3.51%
1986	10.63%	1985	3.48%
1987	9.02%	1986	1.59%
1988	10.33%	1987	3.59%
1989	9.81%	1988	4.00%
1990	9.11%	1989	4.79%
1991	9.39%	1990	5.22%
1992	8.61%	1991	4.11%
1993	8.24%	1992	2.90%
1994	7.12%	1993	2.82%
1995	8.62%	1994	2.46%
1996	6.99%	1995	2.88%
1997	7.41%	1996	2.87%
1998	6.99%	1997	2.27%
1999	6.65%	1998	1.33%
2000	7.78%	1999	2.19%
2001	7.48%	2000	3.49%
2002	7.19%	2001	2.72%
2003	6.63%	2002	1.38%
2004	6.02%	2003	2.22%
2005	5.69%	2004	2.61%
2006	5.50%	2005	3.52%
2007	5.58%	2006	3.19%
2008	5.91%	2007	2.88%
2009	5.80%	2008	4.09%
2010	5.44%	2009	-0.67%

* The prior year US CPI-W is used in the roll-forward process due to using prior year compensations for a typical beginning of year actuarial valuation, i.e., 1974 Valuation is based on 1973 compensations.

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