Managerial Risk Preferences, Real Pension Costs, and Long-Run Corporate Pension Fund Investment Policy

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ABSTRACT

This paper presents a new methodology for determining long-run corporate pension fund investment policy for a salary-based defined benefit pension plan. A mean-risk dominance model is developed to choose among the *ex ante* distributions of pension costs. The model identifies the optimum pension portfolio mix that is consistent with the cost objectives of the plan. The optimum mix consists of a minimum investment in stocks, ranging from a low of 40 percent to a high of 100 percent, depending on the risk preferences of the decision agent and corporate pension cost policies. The results are not sensitive to the age structure of the plan population.

What should be the investment policy of a pension plan? This question has become an increasingly important management issue since the cost of pension plans now has a significant impact on shareholders' wealth. Recent surveys of large corporate pension plans indicate that pension costs are approximately 20 percent of pretax profits.[1] Moreover, the real burden has risen over the years and may be expected to grow. For example, average pension costs per employee, for a 40 firm sample of United States companies, increased by 299 percent from 1965 to 1976.[2] The Consumer Price Index, on the other hand,

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[1] See Leo, Bassett, and Kachline [21, p. 221] and Regan [29, p. 48].

[2] Logue [24, p. 50].

grew by only 86 percent for the same period,[3] resulting in a substantial growth in real cost per employee.

The investment policy decision is crucial to planning for pension costs since the higher the pension fund's rate of return, the less money the firm may set aside to fulfill pension obligations. In this regard, the selection of a stock-bond mix has become the most important investment policy decision for pension cost planning.[4]

Traditional models of corporate pension fund investment policy typically use a model of the historical performance of the stock and bond markets to determine the probability of achieving various target rates of return expressed either in nominal [2,6] or real terms [40]. Probability, as a risk measure, implies that the decision maker is indifferent to the size of the adverse experience since each outcome that fails to meet the target is weighted equally. As is discussed in this paper, other and conceptually more appealing risk preference measures have not been explored in the context of pension fund literature.

These traditional models also emphasize primarily the investment side of the problem. However, the pension fund problem is a systems problem involving actuarial assumptions and methods, pension plan provisions, plan participant characteristics, corporate pension cost objectives, and managerial risk preferences, in addition to the investment issues.[5] More recent approaches to the problem emphasize the tax aspects of the problem and uniformly conclude that shareholders will be better off if the pension fund assets are invested 100 percent in bonds [3, 4, 27, 31, 33]. However, conclusions drawn from these approaches lose much of their operational strengths when one observes the lack of an explicit attempt to incorporate risk preferences of the pension fund managers. As a pension fund manager pointed out in his recent discussion:

> Problems of investment policy cannot be decided without references to an analysis of the liabilities of the plan, and cannot be decided without realizing the impact of actuarial assumptions and methods upon what modern portfolio theorists would call *the risk preference of the firm*. On the other hand, problems of actuarial policy cannot be decided without reference to the *investment policies of the fund*, or else serious consequences for the firm can easily result [40, p. 3]. (Emphasis added)

Indeed, financial managers rate the real cost of pensions (pension expense as a percentage of payroll) as a critical financial variable that requires drawing on all the relevant disciplines. Latest discussions on pension fund analysis highlight the simulation approach for long-range planning [12, 19, 38]. However, in analyzing these papers, Sharpe [30] observes that "a clear statement of the objectives of the decision makers involved is lacking" in the

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[4] Private non-insured pension plans, on average, invested more than 90 percent of their assets in stocks and bonds during the period 1959-1978. See [5, p. 448].

[5] The systems approach to the pension fund problem is partially illustrated in a case study by Tepper [34] and to a lesser extent in Winograd [40].

discussion. He also criticizes these papers regarding the manner in which security returns are modeled:

> But all are made as assertions; no supporting evidence is given . . . it seems unreasonable to expect us to accept these assertions until we have been given an opportunity to examine their bases. *One hopes that papers providing at least some details of this important research will be forthcoming* [30, p. 606]. (Emphasis added)

This study provides a direct answer to such calls for more acceptable results via (1) specification of the decision-maker's objectives (risk preferences), and (2) documentation of the process in which all the variables including security returns are modeled [16, 17, 18, 26].

Specifically, this study investigates the choice of a long-run pension portfolio objective for a salary-based defined benefit pension plan. Since future investment returns are uncertain, an *ex ante* distribution of returns exists for each asset mix and a corresponding *ex ante* distribution of pension costs. The problem of portfolio choice, therefore, is a problem of choosing among mutually exclusive pension cost distributions. A mean-risk dominance model is used to choose among these cost distributions, thereby identifying the optimum pension portfolio mix that is consistent with the cost objectives of the plan.

A long-run time horizon is selected due to the deficiencies of short-run analysis. In the short run, once a particular cost pattern is experienced, it generates an associated unfunded liability, thereby necessitating a two-variable choice model. On the other hand, a one-variable model is feasible with a long-run framework since each long-run cost pattern funds the plan to the same extent. Furthermore, these short-run costs and unfunded liabilities cannot be used without modification since a low-cost pattern is associated with a low level of unfunded vested liabilities, and vice versa, when the cost patterns are developed from investment experience gains and losses. This problem arises because the derived variable values are accounting numbers rather than economic values.

The concept of duration provides an operational definition of the long-run horizon. Duration is the average time at which pension payments are made; the average is a weighted average, the time of each payment being given a weight equal to the present value of that payment. Durations of liabilities vary from plan to plan, depending on benefit provisions, the age distribution and mix of plan members, and the actuarial assumptions. However, durations of the order of 18 to 20 years are fairly typical for a final-average defined benefit pension plan.[6] These estimates of duration approximate the number of years until pension liabilities are due and thus represent the average long-run investment horizon for the purpose of benefit funding.

The paper is organized as follows. Section I places the general model in perspective. Section II describes the model pension plan assumptions. Sec-

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[6] Keintz and Stickney [20], Ezra [7, p. 96].

tion III analyzes the results via a series of figures. Section IV presents a summary and concluding remarks.

I. Mean-Risk Model

The literature on decision making describes many models of choice for mutually exclusive distributions. This group includes a variety of (1) parametric models based on means, variances, semivariances, loss probabilities, etc., (2) expected utility models, and (3) stochastic dominance models. Although these models have many similarities, they differ both in implementation requirements and implied decision maker preferences.[7] Fishburn, among others, prefers a mean-risk framework that associates risk with failure to achieve a target objective, since he observed that "decision makers in investment contexts frequently associate risk with failure to attain a target return" [9, p. 123].

The Fishburn framework can be modified as a mean-risk dominance model in which risk is measured by a probabilitiy-weighted function of deviations above a specified pension cost objective, t.[8] For a continuous pension cost function F, risk is defined by the two-parameter function

$$F_\alpha(t) = \int_t^\infty (x-t)^\alpha \, dF(x), \qquad \alpha \geq 0, \; x>t \tag{1}$$

where F(x) is the probability of getting a cost not exceeding x, and the integrals are Lebesgue-Stieltjes intergrals. Fixed values of α and t are used in (1) for all cost distributions in a given situation. The parameter α is a measure of the importance that decision makers attach to cost deviations above the target cost objective.

For a discrete function

$$F_\alpha(t) = \sum_{i=1}^{m} [p_i(x_i-t)^\alpha], \qquad x>t, \; i=1,\ldots,m. \tag{2}$$

where p_i is the probability of the ith observation.

According to the mean-risk dominance model, distribution F dominates distribution G if

Mean (F) $\geq$ Mean (G) and
Risk (F) $\leq$ Risk (G) (3)

with at least one strict inequality. Special cases of (1) and (2) include the probability of failing to meet the cost objective ($\alpha = 0$), risk as given by the expected deviation above target cost ($\alpha = 1$), and the target semivariance measure of risk ($\alpha = 2$).

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[7] A review of these models in an investment context can be found in Fishburn [9].

[8] The Fishburn model is a choice model for mutually exclusive portfolios of *investment returns*. Therefore, risk is defined relative to deviations below a target return. In this study, the Fishburn model is modified to choose among mutually exclusive *cost distributions*. Therefore, risk is defined differently in this context.

Given the cost objective, α is a measure of the decision agents' risk preferences. When $0 < \alpha < 1$, the decision maker exhibits risk-seeking behavior with respect to costs above target.[9] For example, if $\delta > 0$ and costs $x - \delta, x, x + \delta$ are all above t, the 50–50 gamble for $x - \delta$ or $x + \delta$ dominates x when $0 < \alpha < 1$. Thus, $\alpha < 1$ characterizes an individual who is willing to gamble at fair odds in an attempt to minimize the extent to which the costs exceed t. On the other hand, if $\alpha > 1$, x as a known cost will dominate the 50–50 bet for $x - \delta$ or $x + \delta$. When $\alpha = 0$ or 1, the decision maker is neutral with respect to risk.

Determination of α Parameter

The parameter α is a measure of the importance that decision makers attach to cost deviations above the cost objective. If the major concern is failure to meet the target cost without particular regard to the amount, a small value of α is appropriate. A large value of α implies that small deviations above target are relatively harmless when compared to large deviations. As stated above, $\alpha = 1$ is the point that separates risk-averse from risk-seeking behavior with respect to costs above target.

The parameter α can be estimated by working with gambles or distributions with equal means. Thus, using the decision model (3), F is preferred to G whenever $\mu(F) = \mu(G)$ and $F_\alpha(t) < G_\alpha(t)$.

Risk-seeking behavior is characterized by $0 < \alpha < 1$. Letting $d > 0$ be a "significant difference" and given $\alpha \leqslant 1$, the sure-bet for $t+d$ is compared to the gamble that gives $t + 2d$ with probability p and $t - d(2p - 1)/(1 - p)$ with probability $1 - p$, where $p \geqslant 1/2$. The sure-bet has mean $t+d$ and risk d^α; the gamble has mean $t+d$ and risk [10] $p(2d)^\alpha$. If the gamble is preferred to the sure-bet, $p(2d)^\alpha < d^\alpha$, or $\alpha < \log(1/p)/\log 2$. If the sure-bet is preferred to the gamble, $\alpha > \log(1/p)/\log 2$. If p_0 is a value of p at which the two are approximately indifferent, α is approximately $\log(1/p_0)/\log 2$. Risk preference α is inversely related to probability p_0. If the gamble is preferred to the sure-bet for all $p < 1$, $\alpha = 0$.

Given $\alpha > 1$, it is not possible to estimate α more precisely using a sure-bet and a gamble whose mean equals the sure-bet, since the sure-bet will always be preferred to the gamble if (3) reflects preferences. For this case, two two-point gambles are used. The first, denoted by G_1, has probability $p \leqslant 1/4$ for $t + 2d$ and $1 - p$ for t, with $\mu(G_1) = t + 2pd$ and $G_{1\alpha}(t) = p(2d)^\alpha$. The second, denoted G_2, is a $50 - 50$ gamble between $t + d$ and $t - d(1 - 4p)$, with $\mu(G_2) = t + 2pd = \mu(G_1)$ and $G_{2\alpha}(t) = d^\alpha/2$. If G_2 is indifferent to G_1 then $p(2d)^\alpha = d^\alpha/2$. If p^0 is the value of p reflecting approximate indifference, $\alpha \approx \log[1/(2p_0)]/\log 2$. If G_2 if preferred to G_1 for all $p > 0$, $\alpha = \infty$ is indicated.[11]

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[9] Proof is available upon request.

[10] The risk of the gamble is equal to $p(t + 2d - t)^\alpha = p(2d)^\alpha$.

[11] If the value of P_0 that gives indifference depends in a significant way on d, the α-t model may be inappropriate [9, p. 120].

Determination of t Parameter

The cost objective t is specified by the decision maker. Depending on the context and circumstances of the decision maker or the firm, t might be formulated as the plan cost estimated by an actuary, the budgeted plan cost, or a target that reflects general management's attitude towards acceptable performance in the firm.

II. Pension Cost Model

The projected cost of pensions is a function of the pension plan provisions, the plan population characteristics, the level of funding, actuarial assumptions, and the actuarial cost method used. A brief description of the cost model is presented next.[12]

The model pension plan provides retirement benefits only. Other possible benefits (i.e., disability benefits) are not provided. The defined benefit formula is q percent of salary at retirement age for each year of service and is not integrated with social security.[13] All retirements occur at age 65, and the pension plan is noncontributory. Benefits in retirement are not adjusted for inflation.

The plan population is stationary. Retiree participants constitute 13 percent of the active population. The population decremental assumptions are more or less typical of a large corporate plan. Deaths during active service or after retirement are assumed to occur in accordance with the pattern of the 1971 Group Annuity Table for Male Lives. The withdrawal or turnover rates are "ultimate" rates, based on age alone. Salaries are projected through a salary scale that reflects the impact of merit increases, productivity gains, and adjustments for inflation.[14]

The aggregate projected benefit actuarial cost method without supplemental liability is used to calculate pension costs.[15]

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[12] See McKenna [26] for a complete description of the cost model.

[13] The results of the study are independent of q. Each asset mix has a corresponding cost distribution. The optimum portfolio mix is a function of the respective asset mix cost distributions and their relative positions within the feasible cost spectrum. Variations in q produce proportional changes in absolute cost levels and also in the boundaries of the feasible range, but have no effect on the relative positions of the asset mix cost distributions within the new feasible range.

[14] The results reported in this study are based on a stochastic inflation assumption in the salary scale. Using deterministic assumptions equal to expected values does not change the results significantly.

[15] The description of the projected benefit cost method used in this study is consistent with the nomenclature and terminology used by the Pension Research Council [39, p. 108]. This method is commonly used in pension literature [1 and 39]. A number of other costs methods could have been used, each with its own associated level cost. The optimum investment mix, however, is not a function of absolute cost levels, but is determined by relative costs in the distribution of pension costs.

$$C = \frac{\sum^{All} l_{y,x}(PVFB)_{y,x} - (Assets)}{\sum l_x S_x \, {}^{S,T}\ddot{a}_{x:\overline{r-x}|}} \tag{4}$$

where

$100.C$ = annual pension cost as a percentage of payroll;

$\sum^{All}$ = summation over all active and nonactive employees;

$l_{y,x}$ = number of plan members at age x who entered at age y;

$(PVFB)_{y,x}$ = present value of future benefits at age x, for an age-y entrant;

Assets = value of pension fund assets;[16]

l_x = number of active plan participants at age x;

S_x = salary at age x;

${}^{S,T}\ddot{a}_{x:\overline{r-x}|}$ = present value of an employee's future salary from current age x to retirement age r, per unit of salary of age x.

Pension cost (C), is stochastic since it is determined, in part, by the stochastic investment rate (the return on the pension fund investment portfolio). The stochastic investment rates are generated using the Ibbotson and Sinquefield technique [17][17]. The return model utilizes four major types of assets — common stock total returns derived from Standard and Poor's (S and P) Corporate Index, short-term U.S. Treasury bills, long-term U.S. government bonds, and high quality long-term corporate bonds. Inflation is measured by changes in the Consumer Price Index.

Conceptually, the components of return include a real return on a riskless investment, an inflation premium, and compensation for taking risks. The real rate and risk premiums are estimated from historical data. Together they are used to forecast future investment returns, net of inflation. Nominal investment returns are obtained by adding a component for inflation. Expected inflation rates in future years are estimated from the current U.S. government bond yield curve. The uncertainty in inflation forecasts is estimated from historical inflation data and incorporated into nominal return projections.

Simulated probability distributions of the inflation rate are illustrated in Table 1. The kth simulation of the investment rate in year n is represented by

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[16] The value of pension assets is equal to z percent of the present value of future benefits. By definition, the present value of future pension costs is equal to the current unfunded plan liabilities. The degree of current funding (z) will not likely affect the choice portfolio since, if distribution $F(\mu,\rho)$ is preferred to distribution $G(\mu,\rho)$, $[F - C](\mu,\rho)$ is preferred to $[G - C](\mu,\rho)$, where is the level of assets (a constant), F is distribution of present value of future benefits and $[F - C](\mu,\rho)$ is the mean and variance risk measure of the distribution $[F - C]$.

[17] See McKenna [26] for further details. This technique is also used to produce the stochastic inflation component of the salary scale.

Table 1

Illustrated Simulations of the Investment Rate

1st Period	2nd Period	----	Lth Period
$\tilde{R}_{v,n,k}$	$\tilde{R}_{v,n,k}$	----	$\tilde{R}_{v,n,k}$
$R_{v,1,1}$	$R_{v,2,1}$	----	$R_{v,L,1}$
$R_{v,1,2}$	$R_{v,2,2}$	----	$R_{v,L,2}$
$R_{v,1,3}$	$R_{v,2,3}$	----	$R_{v,L,3}$
-	-	----	-
$R_{v,1,T}$	$R_{v,2,T}$	----	$R_{v,L,T}$

$\tilde{R}_{v,n,k}$. One possible sequence of future investment rates is given by the series $R_{v,n,l}$, $n = 1,\ldots,L$.

Corresponding to each pension fund return sequence, is a value for (1) ${}^{S_{\cdot\cdot}T}\ddot{a}_{x:\overline{r-x}|}$ (the present value of future salaries for an individual plan member, per unit of salary at age x),[18] (2) $PVFB_{y,x}$ (the present value of future benefits at age x, for an age-y entrant), and (3) C in equation (4). The annual cost (C) represents the current and future costs necessary to fund the plan over the remaining work life of active employees, based on the long-run investment experience.

T (k=1,...,399) possible sequences of future investment rates and T corresponding pension cost estimates (C) exist. The T values for C constitute the distribution of long-run pension costs.[19]

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[18] The current age (x) of a plan member determines how many periods, from current age to retirement age, are used in the calculation of ${}^{S_{\cdot\cdot}T}\ddot{a}_{x:\overline{r-x}|}$. Thus L (in Table 1) is equal to (r − x) for the model pension plan.

[19] Actual cost experience may be dissimilar to any pattern in the distribution of pension cost. This dissimilarity occurs when the plan investment results differ from that assumed. As a consequence, the funding of the plan may not meet expectations. In particular, if a plan experiences persistent adverse investment based deviations, plan assets will be lower than expected. These investment based losses, by the process of amortization, are offset in future years via higher than expected contributions. In the meantime, however, if the plan terminates, plan assets may not be sufficient to meet plan liabilities because of underfunding.

The expected pension cost, E(c), is measured by the arithmetic mean cost according to:

$$E(c) = \frac{1}{T} \sum_{k=1}^{T} C_k \tag{5}$$

where C_k = pension cost corresponding to the kth simulation and T = number of simulations[20]

The distribution risk, $F_\alpha(t)$, is calculated according to

$$F_\alpha(t) = \frac{1}{T} \sum_{k=1}^{T} (C_k - t)^\alpha \tag{6}$$

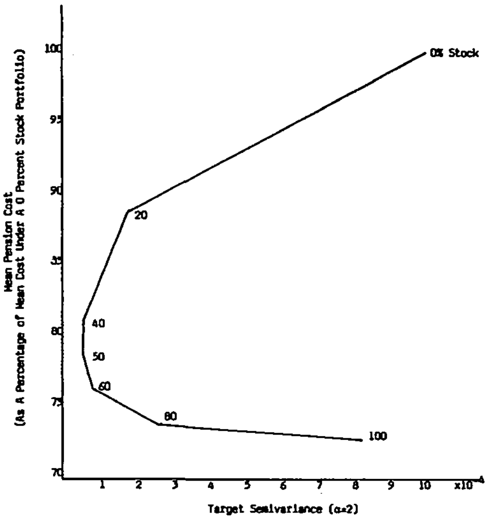
where t is the target pension cost.

III. Results of the Study: An Illustration

Figure 1 shows the relationship between the mean pension cost and risk under the assumption of a high cost objective and target semivariance measure

Figure 1

Mean Risk Relationship[21]
(High Target)



[20] The number of simulations, T, equals 399 [26, p. 198], footnote 11.

[21] The risk of the 50 percent stock portfolio is slightly higher than the risk of the 40 percent stock portfolio. This difference is not noticeable in Figure 1.

of risk ($\alpha = 2$).[22] The portfolio with 40 percent stock dominates portfolios with lesser amounts of stock since its mean cost and risk are lower. The minimum stock content of the optimum portfolio, hereafter referred to as the "optimum minimum stock portfolio," is thus 40 percent. Expanding the stock content of the portfolio beyond 40 percent lowers the expected cost and increases the risk. Thus, the decision maker is faced with a tradeoff between lower expected cost and higher risk, for stock portfolios greater than 40 percent. The tradeoff becomes less and less desirable as additional stock is added. The limiting investment in stock appears to be 80 percent, since beyond that point, the risk increases substantially with an insignificant reduction in expected cost.[23] Although the expected return on the portfolio continues to increase beyond 80 percent, its effect on reducing expected cost is offset by the counter effect of higher variability of returns for portfolios beyond 80 percent stock.[24] The optimum stock portfolio, therefore, lies between 40 and 80 percent. Within these limits the choice portfolio is determined by the decision maker, based on the merits of the tradeoff between cost and risk.

Figure 2 indicates the effect of the target cost objective. The high and low targets represent the extreme ends of the expected cost spectrum for the model pension plan. The high target represents the expected cost for an all bond portfolio and the low target corresponds to the expected cost based on an all stock portfolio. The medium target is approximately the midpoint of the expected cost spectrum. The optimum minimum stock portfolio is higher the lower the target cost. For example, the composition of the optimum portfolio increases from a minimum of 40 percent stock under the high target to a minimum of 60 percent stock under the low target.

The effect of the risk measure is shown in Figures 3, 4, and 5 for α values of 0, ½, 2, and 4.[25] The optimum minimum stock portfolio is inversely related to the degree of risk aversion. For example, the optimum minimum stock portfolio for $\alpha = 0$ and $\alpha = 4$ occurs at approximately 100 percent stock and 50 percent stock respectively for a low target cost (Figure 3). The risk measure has the greatest impact for a low target cost and practically no effect for a high cost target (Figure 5). This change occurs because at the low cost target a significant potential exists for adverse cost experience, whereas with the high

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[22] A realistic target lies in the feasible range bounded by the low and high values of the expected cost spectrum. The low and high values of expected cost correspond to the expected cost under an all stock and an all bond portfolio, respectively.

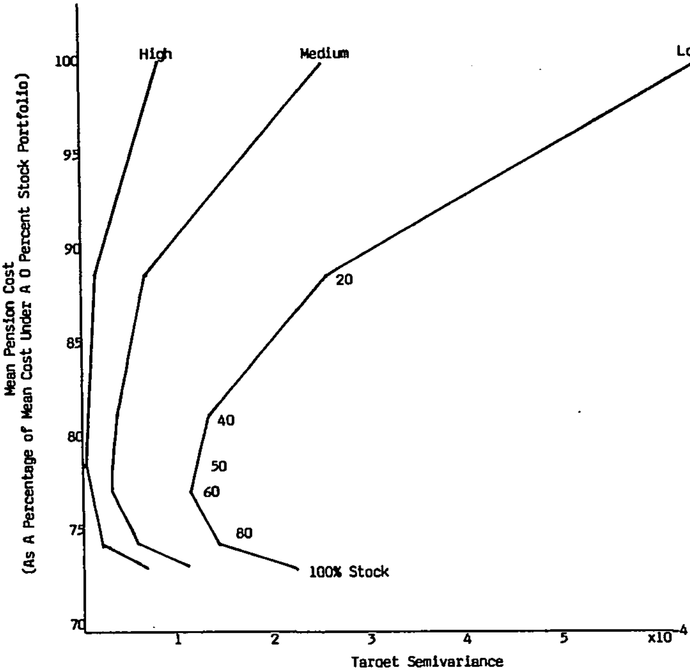
[23] The expected cost is lower, the higher the percentage of stock in the portfolio. However, approximately 98 percent of the total reduction in the expected cost is obtained by an 80 percent stock portfolio.

[24] The mean present value of a life annuity is directly related to the variance of investment return [28].

[25] Fishburn examined published utility functions pertaining to financial decisions [13, 14, 15] and found values of α ranging from less than 1 to greater than 4 for utility in the region that failed the target.

Figure 2

Effect of Target



target, the probability of deviations above target is small. Beyond the minimum stock portfolio, the tradeoff between lower expected cost and higher risk becomes less favorable the higher the degree of risk aversion.

Minimum Stock Portfolio

The optimum portfolio is significantly affected by both the target and the risk measure. If the target is low and $\alpha = 0$, the desirable minimum stock portfolio is 100 percent, that is, an all stock portfolio (Table 2). A low target implies a cost objective at the low end of the expected cost spectrum. When $\alpha = 0$, the risk measure is the probability of exceeding the cost objective. This risk measure is appropriate if the main concern is failure to meet the target without regard to the size of the adverse cost experience.

The other extreme is a high target cost and risk parameter, $\alpha = 4$. The corresponding preferred minimum stock portfolio for this combination is 40 percent. A high target implies a cost objective at the upper end of the expected

Figure 3

Effect of Risk Measure
(Low Target)

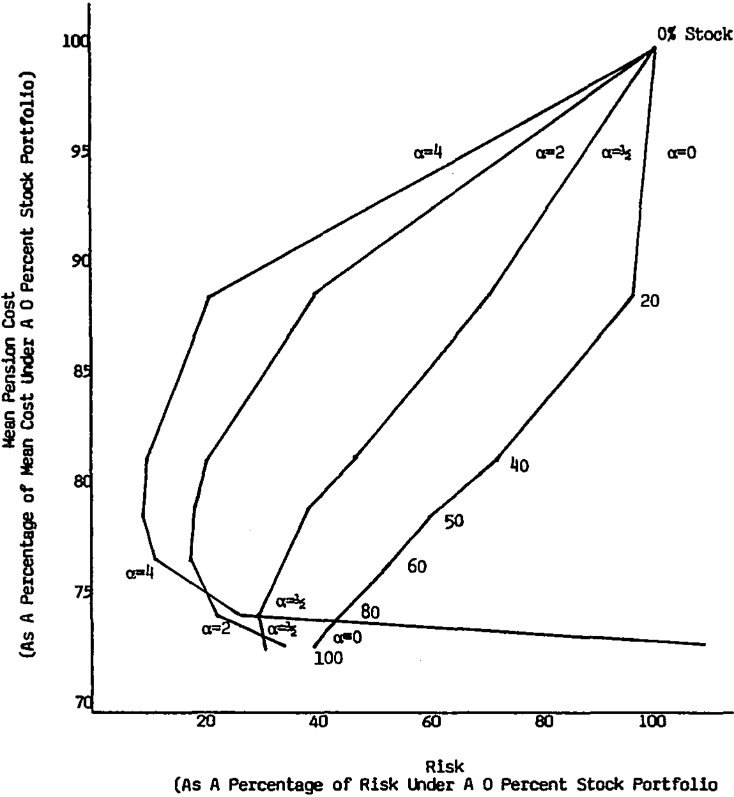
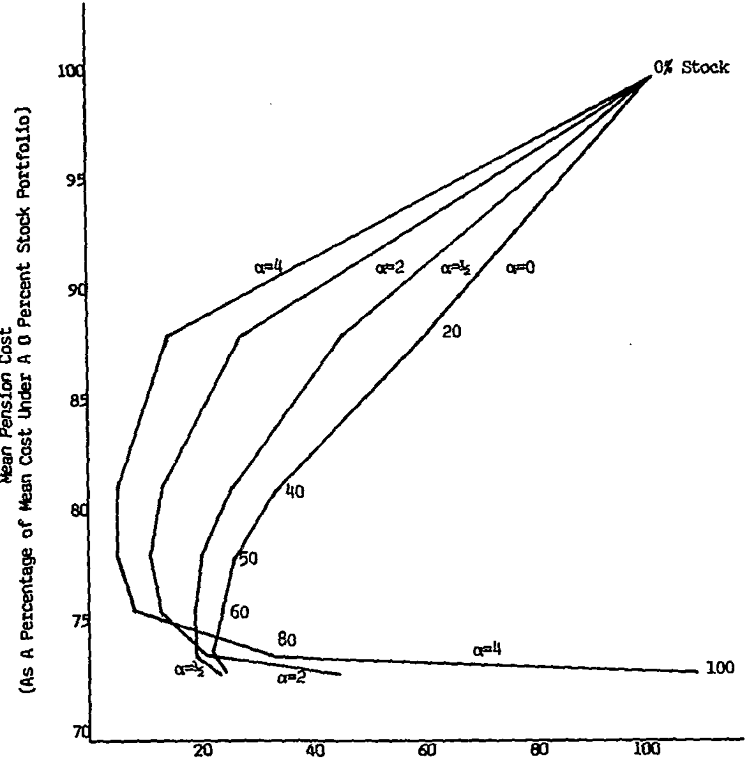


Table 2
Optimum Minimum Stock Portfolio

Target (t)	Risk Measure (α) 0	1/2	1	2	4
Low	100	80	80	60	50
Medium	80	80	60	50	40
High	50	50	50	50	40

Figure 4

Effect of Risk Measure
(Medium Target)

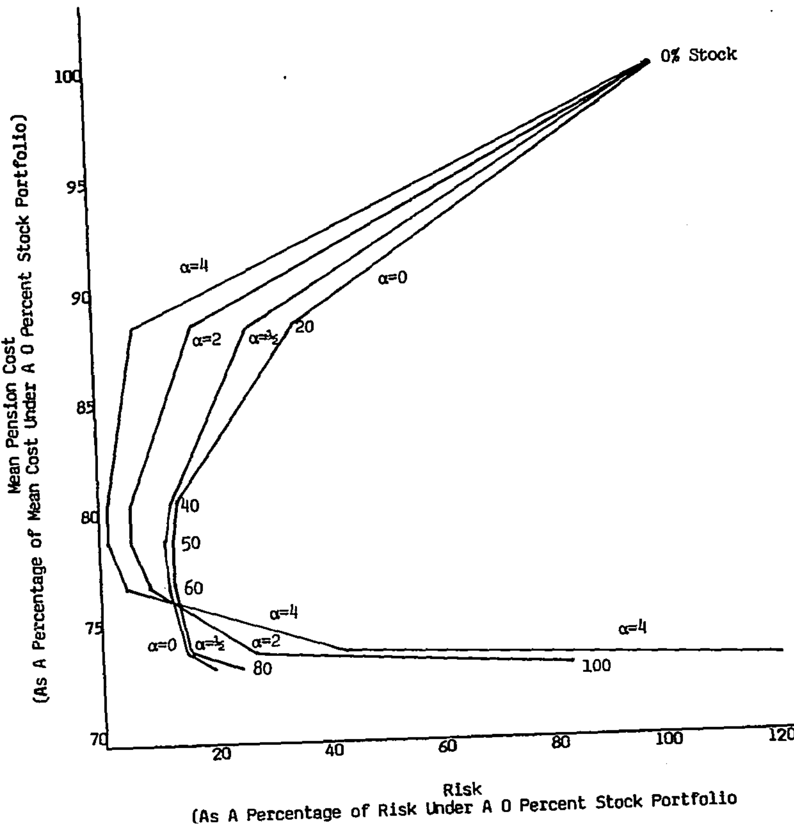


cost spectrum. A risk parameter of $\alpha = 4$ indicates that the decision maker places significantly more weight on large cost deviations as opposed to small deviations above the target.

If the decision maker is risk averse ($\alpha > 1$) with respect to costs above target, the minimum desirable stock portfolio lies between 40 percent and 80 percent. On the other hand, if the decision agent has a preference for risk ($0 < \alpha < 1$), the minimum optimum stock portfolio is at least 60 percent and less

Figure 5

Effect of Risk Measure
(High Target)



than 100 percent. Finally, if the major focus of attention is the probability of exceeding the target cost, the optimum minimum stock portfolio lies between 50 and 100 percent.

Effect of Population Composition

One hypothesis is that the age structure of the beneficiary population may affect the optimum portfolio, with a younger population having a longer investment time horizon and favoring a greater investment in stocks.

This hypothesis is tested by varying the relative proportions of actives and retirees in the plan population. Figure 6 shows results for the actively employed population only, based on a medium-cost target that is representative of the findings. The effect of age structure may be noted by comparing the latter findings with the results in Figure 4, which are based on the combined active and retired populations.

Overall, the effect of age structure is minimal.[26] For example, the minimum optimum stock portfolio remains unchanged regardless of risk preference. Beyond the minimum stock portfolio, the characteristic tradeoff between risk and cost exists. For risk averse individuals the effect of a younger age group is to increase, albeit slightly, the preference for stocks in the region of the tradeoff.[27] The removal of the retired population lengthens the duration of plan liabilities, the longer effective time horizon favoring stocks. The effect, however, is marginal since the duration of the combined active and retired population liabilities is relatively long.[28]

IV. Summary and Conclusions

This paper describes a model for determining long-run corporate pension fund policy for a defined benefit pension plan. The model integrates not only the traditional parts of the problem — the investment side, actuarial techniques, and pension benefits, but also incorporates the decision maker's risk preference and corporate pension cost policy.

The pension fund asset mix decision is formulated as a mean-risk pension cost problem, based on a long-run horizon. The decision model includes two key parameters: (1) the target cost of pensions and (2) the weight given to deviations from the target cost. The target cost is indicative of corporate pension cost policy and represents, for example, the plan cost estimated by an actuary, the budgeted plan cost, or the maximum contribution to an alternative defined contribution plan. The weight factor is a measure of risk. Risk refers to the possibility that the cost experience of the plan is higher than the target level. Deviations above the target cost are weighted, the weight reflecting management's degree of concern relative to cost overruns. As the weight increases, the more important large deviations are as compared to small deviations.

The asset mix decision is illustrated with the classic stock/bond combination problem. The optimum stock/bond mix is a portfolio with at least 40

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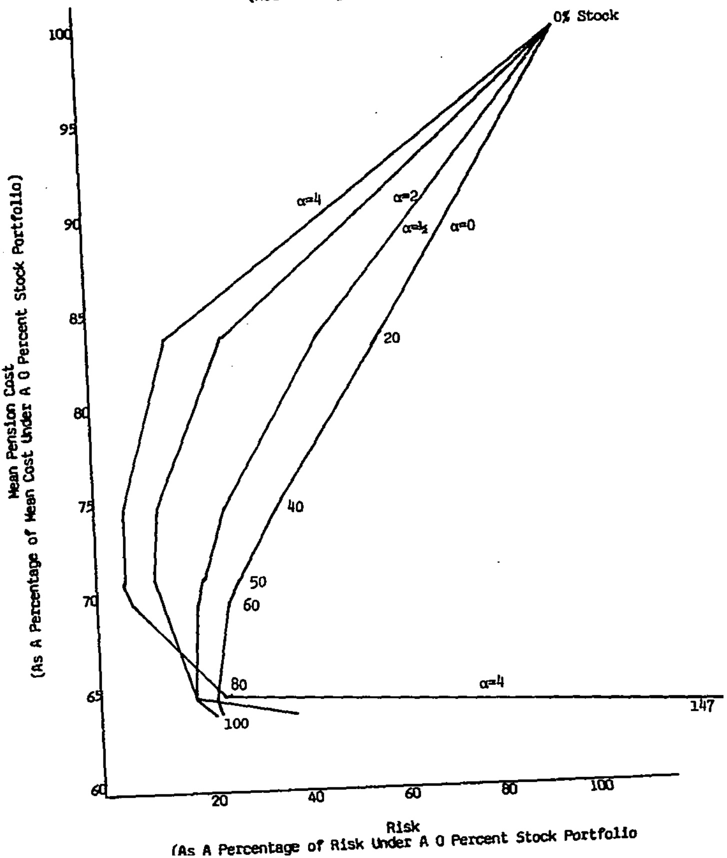
[26] Friedman [11, p. 25] found no statistically significant relationship between the age structure of participants in defined benefit plans and the relative amount of stocks in pension fund portfolios.

[27] In Figure 4, the slope of the curve in the region of the tradeoff, in general, is less steep than the corresponding slope in Figure 6.

[28] The results in Figure 4 are based on a retired population that constitutes 13 percent of the active population. Increasing the relative proportion of retired participants to 28 percent, the stationary population proportion, did not change the major conclusions regarding the effect of age structure.

Figure 6

Effect of Population Composition
(Medium Target)



percent invested in stocks and a maximum of 60 percent in bonds. A higher percentage of stock may be desirable depending on the target cost objective and the risk preferences of the decision maker. For example, 100 percent of assets should be invested in stocks if the goal of management is to maximize the probability of achieving the lowest expected long-run real cost of pensions.[29] In this case, the chance is 39 percent that this low cost target will be

[29] The Bendix Corporation reports a similar conclusion [40, p. 4] using a somewhat different approach.

exceeded in the long run.[30] If the decision maker aims to achieve the lowest expected pension cost and, yet, is concerned about potentially large deviations above this target, a portfolio consisting of between 60 and 80 percent stock would appear appropriate. The results are not sensitive to the age distribution of the beneficiary population.

Implementation of the model requires knowledge of the key parameters: the target cost and the weight given to deviations above the target cost. The target cost is a corporate policy variable. The weight reflects the decision agent's risk preferences. A methodology is provided for determining this weight. The procedure, however, is cumbersome and in some cases a unique solution may not exist.[31] Precise knowledge of the weight, however, is not required in order that the model be useful. For example, if the decision maker is averse to risk, as is often the case, implementation is easier, since part of the choice spectrum is eliminated leaving that which pertains to risk averse behavior only. As a practical matter, it may be sufficient to specify the decision agent's preferences in a qualitative manner such as high, medium, or low risk aversion.

Conventional pension fund models invariably use probability as a measure of risk to arrive at asset mix decisions. This study shows that optimal decisions based on probability, which assumes that the decision agent is indifferent to risk, can be substantially different from optimal decisions based on risk averse behavior. Now, since risk averse behavior is the more generally accepted form of market behavior, the results of this study raise serious questions concerning conventional models based only on probability and the results derived therefrom.

The model and associated results should be viewed as a guide to optimal asset mix decisions. The methodology employs a long-run horizon. Long-run cost overruns involve a permanent loss of wealth to owners. Thus, the framework and analysis are particularly useful where the plan administrator is acting in the best interests of shareholders. Nonetheless, other factors of a short-run nature may also be important. These factors might include, for example, the liquidity needs of the pension plan, intermediate funding goals, unique capital market conditions, and the relationship between a firm's business risk and its pension fund risk. Specifically, the earnings of some firms are more volatile than others. Some firms are able to support a higher level of pension fund risk than others, particularly in the short run. This area needs to be researched.

Finally, the results presented here are directly useful for today's pension managers whose investment mix is primarily stocks and bonds. However, the methodology can be easily extended to an investment mix beyond the simple stock-bond combination. Thus, the model is equally viable when consideration is made for more-than-two asset portfolio mix as a relevant investment opportunity set for a long-run corporate pension policy. Pension policy

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[30] This result is based on extended calculations, not shown here.

[31] See footnote 11.

planners should be able to extend the illustration to any N-asset portfolio mix pension policy. In addition, the systems approach as formulated in this study can be a valuable framework for accommodating multiple, and likely to be conflicting, objectives encountered by pension plans in the portfolio mix selection process.

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