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OVERFUNDED PENSION PLANS, EARLY TERMINATION, AND ASSET ALLOCATION STRATEGIES: AN OPTION THEORETIC APPROACH

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INTRODUCTION

The objective of this paper is to explain the reluctance of pension fund sponsors to terminate overfunded defined benefit pension plans (hereafter, pension plans). The paper extends the "pension put" option-theoretic approach of Sharpe [1976] and Bicksler and Chen [1985] to a "pension call" model to describe a general phenomenon of the unwillingness to terminate overfunded plans by their sponsors.

Recently, Turner and Beller [1989] estimate that by 1987 aggregate pension assets were 125.7% of aggregate pension liabilities. This indicates that pension funds are overfunded. In addition, Alderson and Chen [1986], Haw, Ruland, and Hamdallah [1987], VanDerhei [1987], and Mitchell and Mulherin [1989] provide evidence that the terminations of overfunded pension plans can, indeed, produce positive statistically significant abnormal returns. Nonetheless, only 0.7% of all plans had been terminated as of 1987-accounting for a mere 9% of the excess plan assets (Mitchell and Mulherin [1989 p.43]). A question that naturally arises, then, is, "Why haven't more sponsors terminated their overfunded plans?" Some research has been done in this area with the focus on factors such as implicit labor agreements (Ippolito and Turner [1987]), tax abuse (Ippolito [1986]), financial distress (Mittelstaedt [1989] and Thomas [1989]), and efficient market (Ippolito and James [1992]). This paper offers an alternative explanation that does not base on neither external factors nor on termination costs. Instead, our "pension call" option-theoretic approach shows that it is economically sub-optimal to divest overfunded portfolios of risky assets. Besides, our model also provides implications on the allocation strategies of pension plans.

This paper is organized as follows. Section II analyzes the "pension call" option model and summarizes the general implications of the model. Section III discusses the asset allocation decisions and section IV concludes the paper.

THE MULTIPLE PERIOD PENSION CALL OPTION MODEL

A pension put (as in Sharpe [1976]) is the value of the sponsor's right to abandon an underfunded pension plan. If a sponsor exercise the pension put option (i.e., abandon the underfunded pension plan), it leaves the responsibility of the shortfall to the beneficiaries or to the PBGC (Pension Benefit Guaranty Corporation). Following the general argument in Sharpe [1976], in order to preserve the value of the pension put, the sponsor would not be motivated to terminate an underfunded plan. Therefore, the value to the sponsor of early termination of a defined benefit plan is similar to the exercise value of a call option on the pension asset portfolio (hereafter, the "pension call"). The exercise price of the pension call option is equal to the vested benefit at the time plan termination is considered.

To investigate possible early termination, we analyze the pension call in a simple multi-period discrete-time framework. This introduces a major departure from Sharpe [1976] and Bicksler and Chen [1985]'s approach. Our

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multi-period extension of Sharpe's basic framework is more realistic because the pension call is essentially an American option.

The essential questions surrounding the pension call are: (i) the right of the sponsor to transfer plan assets in excess of the amount required for funding from the plan to the sponsor; and (ii) the incentives to do so. Herein we focus on the latter. The following assumptions function to define the nature of the plan and its two alternative funding strategies and to state the market conditions commonly presumed to exist in such analyses.

Market Assumptions:

M1 Transactions costs and taxes are zero.
M2 All agents are non-satiated.
M3 Markets are cleared at discrete points in time over the time interval [0,T]. 0 and T are, respectively, the initiation and the natural termination date of the plan. Each trading interval is of equal length, and which is equal to Δt.
M4 A known risk free rate of return, r, is constant over time. All agents may lend or borrow an unlimited amount of money at this rate.
M5 The bond market is complete. The price at t_1 of a default-free zero-coupon bond which pays one dollar at t_2 is equal to $B(t_1, t_2)$ ($t_1, t_2 \in [0,T]$). Where $B(t_1, t_2)$ is equal to $(1 + r)^{t_1 - t_2}$.
M6 There exists a risky asset (hereafter, the stock) which does not have any payout over [0,T]. Or,
M7 The distribution of the rate of returns of the risky asset is independent of the level of payout which may occur over [0,T].

Plan Assumptions:

P1 The beneficiary of the defined benefit plan is entitled to receive V_T dollars at time T.[1] T is the natural termination date of the plan.
P2 Upon early termination of the plan at time t ($t \in [0,T]$), the beneficiary is entitled to receive the present value of V_T at time t. Under M4 and M5, the beneficiary is entitled to $V_T B(t,T)$ dollars if the plan is terminated at time t.
P3 The sponsor makes a one time contribution to the plan at time 0.

Under ERISA (Employee Retirement Income Security Act), the PBGC has a priority claim (equivalent to a tax lien) on up to 30% of a company's net asset value and a non-priority claim on all other assets upon the termination of the firm's defined benefit plan.[2] Therefore, as in Bicksler and Chen [1985], the PBGC's pension claim against the firm at any time t is equal to $\text{Min}[A_t, V_t]$; where $A_t = PA_t + NAV_t \times A_t$ is the value at time t of the "augmented" pension assets, which is equal to the value of pension portfolio, PA_t, plus 30% of the net asset value of the firm, NAV_t. Given that the firm has limited liability, NAV_t must be non-negative. V_t is the pension liability (or the vested benefit) at t. Note that $V_t = V_T B(t,T)$; $t \in [0,T]$. The above minimum function is equivalent to $V_t - \text{Max}[V_t - A_t, 0]$. The second term is the exercise value of an American put option (the so-called pension put) on A_t. The put can be exercised at any time over [0,T]. Moreover, the exercise price of the put is equal to V_t at any time t ($t \in [0,T]$).

For the firm, the value in terminating the plan at time t is equal to $\text{Max}[PA_t - V_t, 0]$; and which is equal to the exercise value of an American call option written on PA_t. The call can be exercised at any time over [0,T]. The exercise price of the call option is also equal to V_t. Where $V_t = V_T B(t,T)$; $t \in [0,T]$. To the benefit of the firm, the call may only be exercised if the value of the pension asset exceeds that of the pension liability. Note that the value of the pension asset instead of the value of the augmented pension asset is of concern here, because it is not reasonable to terminate a plan when only the value of the firm asset rises. Furthermore, for any given amount contribution to the pension asset, the firm can maximize the value of its pension call by investing the amount solely on the risky asset.[3] Therefore, in the following discussions, until otherwise noted, the pension asset portfolio composes only of the risky asset.

There are at least two alternatives from the exercise of the pension call to lock in the benefit for the firm when V_t is less than PA_t.

Alternative A (Exercising The Call Without Terminating The Plan):

(1) Selling the pension asset for A_t,
(2) Purchasing V_t / B(t,T) unit of B(t,T). This costs a total of V_t dollars,
(3) Keeping the difference, $PA_t - V_t$ for the firm itself, and
(4) Redeeming the zero-coupon bond portfolio for V_T dollars at T which will be exactly enough to meet the promised pension payment.

or,

Alternative B (Exercising The Call By Early Termination):

(1) Selling the pension asset for PA_t,
(2) Terminating the pension plan and paying off the employees with V_t, which is equal to the vested benefit at t,
(3) Keeping the difference $PA_t - V_t$ for the company itself.

Alternative B has equal value to alternative A if the fund can be terminated at no cost to the firm. However, if it is costly in terminating the plan, then alternative A may be superior. Furthermore, alternative B would be much more expensive if the firm elects to re-establish a pension fund after the termination of the old one. Furthermore, alternative A also provides the firm with a market timing option. The option allows the firm to later on sell off the bond portfolio (in this case, at fully predictable price) to re-participate in the equity market. Therefore, for just locking in the value from an overfunded plan, alternative A should be preferable. However, next, we show that even alternative A is not optimal.

Proposition 1: Under market assumptions M1 to M6, the American pension call option will not be exercised prior to expiration at T. (Note that the exercise price of the call is increasing at a constant rate r, which is similar to a stream of dividend payout).

Proof: See appendix.

Note that proposition 1 is independent of the sponsor's risk and liquidity preferences. Furthermore, the validity of the proposition does not require the existence of a market for pension calls. For example, due to the surge in the price of the risky asset, the pension call is deep in the money at time t. The sponsor may want to immediately lock in the excess value for fear that the call will be out of the money when the bull market retreat; or, due to liquidity reason, the sponsor needs cash that could be obtained by exercising the pension call. Note that from the above discussion, the exercise value of the option is equal to $PA_t - V_T B(t,T)$. Then the sponsor may consider the following strategy:

(1) Shorting the risky asset in the market up to an amount which is equal to the value of the pension portfolio,
(2) Purchasing $V_T B(t,T)$ / B(t, t + Δt) unit of the one-period bond B(t, t + Δt). (which is equal to $V_T B(t + \Delta t,T)$; since $B(t + \Delta t,T) = B(t,T)$) This costs a total of $V_T B(t,T)$ dollars, and
(3) Keeping the pension call alive.

The above strategy produces a cash inflow at t which is exactly equal to that could be obtained from exercising the pension call. At t + Δt, the value of the short stock and long bond portfolio is equal to $V_T B(t+\Delta t) - PA_{t+\Delta t}$; while the exercise value of the pension call is equal to $\text{Max}[PA_{t+\Delta t} - V_{t+\Delta t}, 0]$. If the value of the long-bond portfolio is less than the (negative) value of the short-stock position, then exercise the pension call and use the proceed to cover the deficit.

On the other hand, if the pension call is out of the money (i.e., the value of the pension asset is less than the pension liability), then the short-stock long-bond portfolio is in the money. In this case, the sponsor has a valuable option. First, if absolutely necessary, the funding deficiency can be covered exactly by the value of the short-stock long-bond portfolio. Second, the sponsor may use the net proceed from the stock-bond portfolio to expand the

pension asset portfolio. Finally, it may use the proceed from the stock-bond portfolio and leave the pension call as it is. Given this option, the value of the above non-exercise strategy must be non-negative.

Therefore, under the assumption that the risky asset has zero payout before the call expires, the American pension call will not be exercised early even though the exercise price of the option is strictly increasing over time. Now, we want to show that the assumption on payout can be relaxed.

Proposition 2: Assume that the risky asset in the pension portfolio has positive payout before the call expires. (M6 is violated). Then, the call will not be exercised if the payout do not affect the distribution of the rate of return of the underlying asset (M7).

Proof: See appendix.

Propositions 1 and 2 hence show that exercising the pension call is not optimal even if the call is in-the-money (or, the value of the pension asset exceeds the value of the pension liability). Since early termination of the pension plan implies early exercise of the pension call, the propositions hence imply that early termination of the pension plan is not optimal for the sponsor, given the above assumptions.

Since the American call will not be exercised early, it is reduced to an European call option. Accordingly, option pricing models for valuing European call options can be applied directly to value this pension call. For example, the Black-Scholes [1973] option pricing model can be used. In general, it can be seen easily that the value of the pension call is positively related to the risk-free interest rate, the value of the pension asset, the time to expiration, and the volatility of the value of the pension asset, and is negatively related to the future defined benefits.

Termination of the plan can also be accomplished by the firm through exercising the pension put. Rational exercise of the pension put implies that the value of the augmented pension asset is less than the pension liability. When this happens, the sponsor has at least the following two alternatives.

Alternative 1:

(1) Initiating plan termination,
(2) Liquidating the augmented pension asset for A_t,
(3) Paying off the PBGC with the entire sales proceed

or,

Alternative 2:

(1) Terminating the defined benefit plan,
(2) Establish a defined contribution plan with the amount of augmented pension asset.

Given these two alternatives, we state the following proposition:

Proposition 3: The sponsor will not voluntarily exercise the pension put when it is in the money.

Proof: See appendix.

We can summarize the findings from the model as follows:

(1) It is not optimal for the firm to exercise the pension call (i.e., the value of early pension termination of a pension plan which is the difference between pension asset and pension liability) before it expires.
(2) If the pension call has to be exercised, then it can be accomplished by substituting a riskless bond portfolio for the risky pension asset portfolio. This may help the firm to avoid the costs associated with plan termination.

(3) It is not beneficial for the firm to exercise the pension put even when it is deep in the money. The firm does not obtain any benefit from doing so and the pension call will be eliminated if the put is exercised.
(4) It is clearly not optimal to exercise the pension call when it is out of the money. For example, it is clearly not to the advantage of the firm to establish a dedicated bond portfolio if the plan is underfunded. The firm never get enough money to pay off the defined benefit.
(5) For the underfunded plan, the only rational asset allocation strategy is to maximize the riskiness of the pension asset.

IMPLICATION ON ASSET ALLOCATION DECISIONS

According to Sharpe's argument, the sponsor of a defined benefit plan should invest the pension asset entire in stocks (the most risky asset when compared to fixed-income securities) to maximize the value of the pension put. However, Black [1980] and Tepper [1981] argue that the pension assets should be exclusively bonds in order to maximize the tax benefits to the sponsor. In essence, the tax benefits argument is that, both bond and stock returns are tax-exempt to the pension. Since bond income is generally taxable to firms while stock income enjoys a preference, then stock income must be slightly lower to compensate for this difference. Pensions, being non-taxable, are able to benefit from investing in the less sheltered bond income.

Together these arguments suggest that the distribution of pension assets observed in practice should be relatively U-shaped. Plans choosing to avoid taxes being at the all bonds end of a hypothetical spectrum and plans choosing to maximize the net gains to the sponsor from embedded options should reside at the all equity end of the spectrum. In fact, this is not what is observed.

Bodie et. al. [1985] find out that in 1980 almost no plans held all equities and roughly 10% of plans held all fixed income securities. The debt/equity distribution of the remainder of the plans represented a bell-shaped curve with a peak at 45% fixed income and 55% equity.

According to our model, when a plan is overfunded, early exercise becomes a possibility. Given the termination costs and the tax benefits of bonds, early exercise of the pension call implies the adoption of an all-bond pension portfolio. However, we have shown that early exercise is sub-optimal in a world without tax. Therefore, our result produces another factor that trades off the tax benefits of an all-bond pension portfolio. Once an overfunding situations exists, plan termination is one way for the sponsor to exercise the pension call, capture the excess value in the fund and convert it to cash. But plan termination is not the only way for the sponsor to achieve this. It may function to facilitate other sponsor motives. Consider the sponsor's own account. If the market acts as though the balance sheet of sponsor and plan are one, then the exchange of bonds for stock may constitute a reduction of riskiness of sponsor-issued financial assets. As the cost of funds falls from the reduced risks, the value of the pension call is traded off against the reduced capital costs. Presumably, such a trade-off will continue until some marginal equalization of costs and benefits occurs. Thus, we concur with Black that tax benefits exist, but they do not exist to the exclusion of other considerations of opposite sign. Hence, the finding of Bodie et. al. is consistent with our model.

CONCLUSION

This paper studies the rationality on the part of the sponsor of a defined benefit pension plan in terminating the plan when the pension liability is below the value of the pension asset portfolio. We show that the benefit accruing to the sponsor from terminating the plan is similar to the exercise value of an American call option (the pension call). In general, the call would not be exercised when it is out of the money. Moreover, we show the conditions under which the pension call would not be exercised early even when it is in the money. Early exercise of the call can be accomplished by early termination of the pension plan or merely by substitution of riskless bonds for stocks in the pension asset portfolio. The analysis hence show that early termination is sub-optimal in a world without taxes. Subject to various termination costs, asset substitution seems to be superior to plan termination in extracting value from an overfunded pension plan. In a world with taxes, we conjecture that early exercise of the pension call may be warranted. In order to obtain the tax benefit, the call should be exercised partly or totally via asset

substitution. Therefore, we conclude that the sponsor would not terminate its defined benefit plan unless it is absolutely necessary—for example, when the firm is facing bankruptcy.

We also find that, if early exercise of a pension call is justified when it is in the money, then the existence of tax benefit would imply full investment of the pension asset in riskless bonds. This increases the likelihood that we would observe pension portfolios solely devoted to bond investments. Our argument reduces the attractiveness of early exercise, which therefore reduces the chance that pension portfolios are skewed towards fixed-income securities.

ENDNOTES

1. The amount of benefit receivable at time T can be a lump sum or the present value of the stream of future retirement benefit payments. See also footnote number 3 in Sharpe [1976].

2. Note that the following analysis is independent of the true percentage of company's net asset value in the augmented pension asset portfolio.

3. See Sharpe [1976].

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APPENDIX

Proof Of Proposition 1:

Let C(t,T) denote the value at time t of the above (American) pension call option which will expire at T. The exercise price of the option is equal to $V_TB(t,T)$; $t \in [0,T]$, and which is strictly increasing over time. Even though under M6 the risky pension portfolio has zero payout, the increasing exercise price is equivalent to a leakage of the underlying asset.[1] This may trigger an early exercise of the call. However, we show that the call will not be exercised early.

The exercise value of the call at t is equal to $Max[PA_t - V_TB(t,T),0]$. If the call is not exercised at t, then consider exercising it at the next point in time $t + \Delta t$. The exercise price at $t + \Delta t$ will however increase to $V_TB(t + \Delta t,T)$. From Theorem 1 in Merton [1973], the value of exercising the call at $t + \Delta t$ is no-less-than $Max[PA_t - V_TB(t,t + \Delta t)B(t + \Delta t,T),0]$, which is equal to $Max[PA_t - V_TB(t,T),0]$. Therefore, it pays to wait until the next point in time in exercising the call. Then, by straightforward inductions, the call should never be exercised before T. **Q.E.D.**

Proof Of Proposition 2:

Consider a particular point in time t($t \in [0,T]$). The payout from the asset is equal to a fraction λ of the value of the asset at t. Hence, the dollar amount of the payout is equal to $\lambda(PA_t)$.[2] Then consider the following strategy:

1. Holding the risky asset and receiving the payout,
2. Using the received amount $\lambda(PA_t)$ to purchase the risky asset at its ex-payout price. Presumably, the ex-payout price of the asset is equal to $(1-\lambda)$ of its pre-payout value.

Then for each unit of the pre-payout risky asset, the above strategy will result in $(1-\lambda)^{-1}$ unit of the ex-payout asset. Given the assumption that the distribution of the rate of return of the risky asset is independent of the payout, the call is fully payout protected. (Theorem 11, Merton [1973]). This means that the value of the call is independent of the payout and the leakage will not trigger an early exercise of the call. Applying the above strategy for any payout which may occur at any time before time T, the American pension call will not be exercised early in anticipation of any leakage. **Q.E.D.**

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1. The leakage is zero with respect to the increasing exercise price if the pension portfolio is a straight bond portfolio. However, in this case, the call option does not exist.
2. Note that this is true because it is assumed that the pension portfolio is fully invested in the risky asset.

APPENDIX
(CONT'D)

Proof Of Proposition 3:

Under both alternatives, the firm will eliminate the "underfunded" pension plan and free itself from the future obligations associated with the defined benefit plan. Note that we have a different definition for underfunding here. However, given the non-negativity of NAV_t, underfunding in this sense (i.e., $A_t < V_t$) implies underfunding in the conventional sense (i.e., $PA_t < V_t$). Exercising of the pension put simultaneously triggers the exercising of the pension call. However, it is clearly not rational to exercise the pension call because the value of the pension asset is below that of the pension liability. Hence, the sponsor will not voluntarily exercise the pension put before it matures. Therefore, it is to the benefit of the firm to keep the pension put alive even when it is in the money. **Q.E.D.**