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Spinoff/Terminations and the Value of Pension Insurance

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ABSTRACT

This paper derives the value of Pension Benefit Guarantee Corporation (PBGC) pension insurance under two scenarios of interest. The first allows for voluntary plan termination, which appears to be legal under current statutes. In the second scenario, termination is prohibited unless the firm is bankrupt. Empirical estimates of PBGC liabilities are calculated. These show that prospective PBGC liabilities greatly exceed current reserves for plan terminations, that even under a bankruptcy-only termination rule, PBGC liabilities still would be quite sensitive to discretionary funding policy, and that the increasingly common practice of pension spinoff/terminations, substantially increases the present value of the PBGC's contingent liabilities.

THE PENSION BENEFIT GUARANTEE CORPORATION (PBGC) was established by the Employee Retirement Income Security Act of 1974 (ERISA) to guarantee the benefits of workers who belong to defined benefit pension plans. If a pension plan is terminated with insufficient assets to pay guaranteed benefits, the PBGC assumes responsibility for those benefits. The PBGC can take some comfort from the fact that most large pension plans are currently overfunded. Surplus plan assets provide a cushion for adverse investment experience that reduces the value of PBGC contingent liabilities. Recently, however, terminations of overfunded plans have become more common [7]. These spinoff/terminations typically allow firms to split their pension plans into two parts, one for active employees and one for retirees, to place all surplus assets into the retiree plan, and then to terminate that plan, thereby recapturing the entire surplus. The PBGC is left insuring a continuing plan that has been stripped of surplus assets. The current value of PBGC contingent liabilities obviously increases under spinoff/terminations.

One approach to valuing PBGC liabilities is provided by the options pricing framework. Several authors [3], [4], [5], [6], [9], [11], [12], [17], and [19]) already have used option pricing methodology to study the valuation of PBGC insurance. The provisions of ERISA allow firms to transfer their pension liabilities to the PBGC in return for pension fund assets plus 30 percent of the market value of the firm's net worth. Thus, viewing PBGC insurance as a put option, the pension liabilities play the role of the exercise price while the fund assets plus 30 percent of net worth play the role of the underlying asset or stock price.

However, while the analogy between put options and the option to terminate a pension plan appears straightforward, the correspondence between the two is not at all clear with respect to the effective time to maturity of the pension put.

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In practice, virtually all terminations of *underfunded* pension plans occur as a byproduct of corporate bankruptcy. The lack of voluntary terminations suggests that there may be hidden impediments to termination. In one widely cited case, the PBGC brought suit to block the voluntary termination and reorganization of the underfunded pension plan of AlloyTek. The case was ultimately settled out of court in 1981, with the PBGC assuming the underfunded plan and AlloyTek agreeing not to establish a new defined benefit plan. Instead, the firm was allowed to establish a defined contribution plan that did not require PBGC insurance (Munell [6]).

This paper presents two models of the pension insurance program. In the first model, the underfunded pension plan is terminated only when that action is value maximizing for the firm. This scenario is motivated by the opportunity for profitable termination that ERISA, taken literally, seems to offer firms. The point of departure for this model is the AlloyTek case, the resolution of which suggests that a firm can terminate an underfunded pension plan with minimum explicit cost once, but only once. A one-time-only termination provision makes the pension put formally identical to an infinite maturity American option, which expires only upon exercise. In a second model, a pension plan terminates only at the occurrence of corporate bankruptcy. The motivation for this approach is two-fold. First, it is consistent with the empirical fact that virtually no underfunded-but-solvent firms exercise the pension put. Second, it is consistent with proposals for pension-insurance reform that would disallow termination of underfunded plans by solvent firms.

The next section presents a model of pension insurance. The value of PBGC liabilities are derived for each scenario. Section II presents empirical estimates of the value of PBGC insurance for a sample of Fortune 100 firms. The results of this section indicate that the pension put has significant value for several firms, and that spinoff/terminations can significantly increase PBGC liabilities. Section III concludes.

I. A Model of Pension Insurance

A. Valuation of PBGC Pension Liabilities: Voluntary Termination

For simplicity, I will assume that all accrued benefits are vested and fully insured by the PBGC. In fact, guaranteed benefits typically account for between 90 and 95 percent of vested benefits, while approximately 80 percent of accrued benefits are vested [1].

Following Bulow [4], let A denote the value of accrued benefits, F denote the value of assets in the pension fund and $0.3E$ denote the firm liability beyond assets in the pension fund, i.e., 30 percent of net worth. F and E are measured as market values, while A is the present value of accrued benefits calculated by discounting at the riskless nominal interest rate. The benefits will be paid with certainty, either by the firm or the PBGC.

At a termination, if the plan is sufficiently funded ($F + 0.3E \geq A$), the firm gains F and transfers assets of value A to the PBGC. Otherwise, the firm is liable only up to the amount $F + 0.3E$. The net proceeds to the firm at termination therefore equal

$$F - \min(A, F + 0.3E) \tag{1}$$

or equivalently,

$$F - A + \max[A - (F + 0.3E), 0]. \tag{2}$$

Expression (2) highlights the nature of the firm's put option. Its net pension liability is $F - A$; however, at the termination date, it can transfer its liability of A to the PBGC in return for only $F + 0.3E$.

There is no explicit maturity date associated with the insurance plan. In this sense, it is isomorphic to an American put option with infinite maturity and exercise price A. Just as the put can be exercised only once, the firm can voluntarily terminate just one underfunded defined-benefit plan.

For convenience, use S to denote the sum $F + 0.3E$. I will assume that S follows the diffusion process

$$dS = (C_S + \alpha_S)S\,dt + \sigma_S S\,dz_S \tag{3}$$

where α_S is a standard drift term attributable to the normal rate of return on the pension fund assets, F, and the firm equity, E, and where C_S is the rate (as a fraction of S) of firm contributions into the pension fund *net* of payments to retirees.[1] C_S need not be constant; solutions are presented below in which it is a function of the funding status of the plan. C_S will be positive if firm funding for accruing benefits exceeds payouts from the pension fund for current retirees.

We now model the dynamics for A. As a base case, consider a situation in which none of the firm's employees have yet retired and in which no further pension benefits will accrue. If the interest rate, r, were constant, then the present value of accrued benefits, A, which is the exercise price of the pension put, would increase at the constant proportional rate r.

When long-term interest rates are stochastic, then so will be the present value of accrued benefits. Denote by α_A the expected rate of return on a bond with a payoff stream identical to that of accrued benefits. This will also be the expected growth rate in the present value of already accrued benefits. If interest rates were nonstochastic then α_A would equal r.

Demographics also affect the evolution of A. Accrued benefits increase when current workers increase their length of employment and decrease when plan participants die or are paid benefits. Denoting the *net* growth rate in accrued benefits attributable to demographic factors as C_A, the total growth rate in A would be $C_A + \alpha_A$. The evolution of A can then be summarized by the process

$$dA = (C_A + \alpha_A)A\,dt + \sigma_A A\,dz_A. \tag{4}$$

The stochastic component of (4) is due to uncertainty regarding long-term interest rates and the future pattern of additional net accruals. I will denote the correlation coefficient between dz_A and dz_S as ρ.

Following Merton [15], and letting $P(A, S)$ denote the value of the pension

[1] For analytic simplicity, I will treat σ_S as a constant. This treatment is not strictly correct when the ratio of F to E is not constant.

put, one can show that P must satisfy the partial differential equation:

$$\tfrac{1}{2}P_{AA}A^2\sigma_A^2 + \tfrac{1}{2}P_{SS}S^2\sigma_S^2 + P_{AS}AS\sigma_A\sigma_S\rho - rP + (r + C_A)AP_A + (r + C_S)SP_S = 0 \quad (5)$$

where subscripts on P denote partial derivatives, and r denotes the rate of return on instantaneously riskless bonds. Equation (5) lacks a term involving calendar time because the put is of infinite maturity.

The boundary conditions for P are: (a) at a point of exercise of the put (i.e., termination of the plan), $P = A - S$; (b) the limit of P as S approaches infinity is zero; (c) the limit of P as A approaches zero is zero; and (d) the rule for voluntary termination is chosen to maximize the value of the pension-insurance put option.

For general specifications for C_A and C_S, (5) must be solved numerically (see Section I.C). When C_A and C_S are constant, (5) has an analytic solution that has the general form (McDonald and Siegel [14]):

$$P(A, S) = (1 - K)A(S/A)^{\varepsilon}K^{-\varepsilon} \quad (6)$$

where K is the ratio of S/A at which the option is exercised. Equation (6) will satisfy p.d.e. (5) for

$$\varepsilon = -\left[\left(\frac{C_S - C_A}{\sigma^2} - \frac{1}{2}\right)^2 - 2\,\frac{C_A}{\sigma^2}\right]^{1/2} + \left(\frac{1}{2} - \frac{C_S - C_A}{\sigma^2}\right)$$

$$\sigma^2 = \sigma_A^2 + \sigma_S^2 - 2\rho\sigma_A\sigma_S.$$

Choosing K to maximize the value of the option results in the condition

$$K^* = \frac{\varepsilon}{\varepsilon - 1}. \quad (7)$$

Equation (7) gives the condition for voluntary termination of the pension plan. Feasibility and second order conditions require that $\varepsilon < 0$, which implies $0 < K^* < 1$ so that the put will be exercised only for $S < A$, i.e., if fund assets plus 30 percent of net worth fall below accrued benefits. Parameters that result in nonnegative values for ε would imply that the option would never be exercised.[2]

B. Comparative Statics for the Closed-Form Solution

Although the closed-form solution places an unrealistic restriction on the firm's pension-funding policy, it offers the opportunity to examine analytically some properties of the valuation equation. It is possible to show analytically for the special case presented in Equation (6) that the value of the termination option increases with C_A and decreases with C_S. Conversely, the ratio of S/A at which it is optimal to terminate falls with C_A and increases with C_S. The intuition for these results is straightforward: when the gap between the growth rates of

[2] The insurance policy could have infinite value in this case. For example, for large C_A and $C_S = 0$, the option would provide a claim on a payoff growing faster than the rate of interest. The value would be infinite although the option would never be exercised. Obviously, one would not observe values of (constant) C_A and C_S leading to these singular cases.

accrued benefits and the assets backing those benefits ($S = F + 0.3E$) increases, the expected profits from a future exercise of the put option increase and the value of waiting to exercise correspondingly increases. These results are illustrated in Table I, in which optimal ratios for pension termination, $K^* = (S/A)^*$, and the values of the pension put, $P(A, S)$, are presented for various combinations of C_A and C_S and for a variance rate of $\sigma^2 = 0.05$. Recall that the certainty equivalent drifts in A and S are $r + C_A$ and $r + C_S$, respectively. Therefore, the parameters presented in Table I correspond to combinations of sustained growth rates in the value of the assets and liabilities of the fund ranging from −0.03 to +0.03.

The values of PBGC obligations presented in the second panel of Table I are calculated assuming that $A = S = 1.0$. Therefore, these entries may be interpreted as the value of the pension insurance as a fraction of accrued benefits when the pension put is exactly at the money, i.e., when the total assets backing the pension fund obligations equal the present value of those obligations. The table demonstrates that the termination put can be valuable. As a base case, the zero drift configuration of C_A and C_S gives a pension put value of 28 percent of the value of accrued liabilities. The table also can be used to examine the effects of equal changes in C_S and C_A. Reading down the diagonals from top left to bottom right demonstrates that the optimal voluntary termination ratio decreases for larger (algebraic) values of these growth rates. The value of the pension put correspondingly increases. These results derive from the effect of scale on the

Table I

Termination Ratios and Option Values ($\sigma^2 = 0.05$, $S_0/A_0 = 1$, real interest rate = 0.04)

	$r + C_A$						
$r + C_S$	−0.03	−0.02	−0.01	0	+0.01	+0.02	+0.03
	Optimal Exercise Ratio, $K = (S/A)^*$						
−0.03	0.55	0.50	0.44	0.37	0.29	0.20	0.10
−0.02	0.59	0.53	0.47	0.39	0.31	0.22	0.11
−0.01	0.61	0.56	0.50	0.43	0.34	0.24	0.13
0.0	0.64	0.59	0.53	0.46	0.38	0.27	0.14
0.01	0.67	0.62	0.57	0.50	0.41	0.30	0.17
0.02	0.69	0.65	0.60	0.50	0.46	0.34	0.20
0.03	0.72	0.68	0.64	0.58	0.50	0.39	0.23
	Put Value						
−0.03	0.214	0.250	0.296	0.355	0.433	0.538	0.693
−0.02	0.196	0.230	0.273	0.330	0.406	0.512	0.671
−0.01	0.179	0.210	0.250	0.304	0.378	0.483	0.646
0	0.163	0.191	0.227	0.277	0.347	0.450	0.617
0.01	0.148	0.173	0.205	0.250	0.315	0.414	0.582
0.02	0.135	0.156	0.184	0.224	0.282	0.375	0.541
0.03	0.123	0.141	0.165	0.199	0.250	0.333	0.491

* Denotes optimality of ratio.

termination decision. If a pension fund is increasing in size (large positive C_A, C_S), then the dollar gain from a termination for any given *ratio* of S/A is larger. If the fund is growing, it pays to wait to terminate, and the ratio S/A must be smaller to induce early termination. Thus, one should expect termination decisions to be more frequent in declining industries in which pension funds are shrinking.

C. Discretionary Funding: Voluntary Termination

The analytic solution studied in Sections B and C imposes passive behavior on the firm in that pension funding always equals a fixed fraction of current assets, S. In fact, one would expect firms to adjust funding as financial circumstances change. Suppose that funding behavior can be described by the following specification:

$$C_S = c_0 + c_1[\ln(A/S)]. \tag{8}$$

For $c_1 = 0$, funding is independent of the current status of the pension plan; this is the passive rule. For $c_1 < 0$, the firm follows an exploitative strategy: if the plan becomes underfunded ($A > S$), then C_S falls, contributions to the plan are reduced, and the value of the pension insurance is increased. Conversely, if the plan is overfunded, then PBGC insurance is less valuable, and funding increases to exploit the tax benefit of further contributions (see Black [2] and Tepper [18]). Finally, for $c_1 > 0$, the firm exhibits "socially responsible" behavior. Its contribution rate varies inversely with the funding level.

Figure 1 presents numerical solutions[3] to Equation (5) using parameters $c_0 = -r$ and $c_1 = -0.1$, 0, and 0.1. The figure demonstrates that the value of pension-insurance is most variable for the exploitative strategy.

[3] For the numerical solutions, a maximum time-to-termination of 75 years was assumed. Because the option is no longer of perpetual maturity, the term P_t must be added to the left-hand side of Equations (5) and (9).

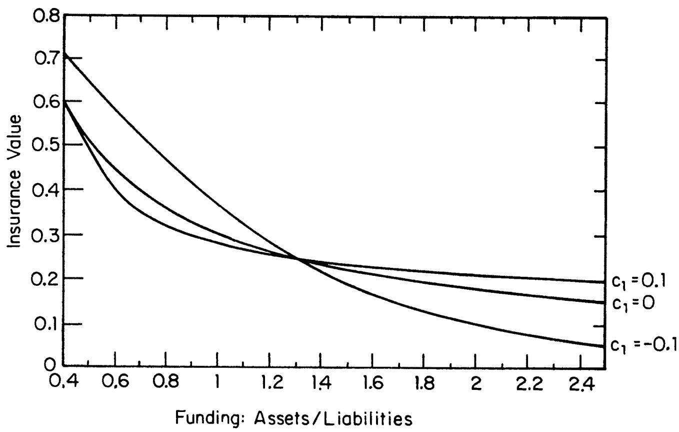

Figure 1. Pension-Insurance Value as a Function of Plan Liabilities (voluntary termination scenario)

D. PBGC Liabilities with Termination Only at Bankruptcy

If the pension plan terminates only when the firm bankrupts, the special put option conveyed by the current pension insurance system is lost. The value of the PBGC liability will depend on the specific conditions that set off a bankruptcy. I will assume for simplicity that bankruptcy is declared when the value of the firm, V, falls below the present value of the debt obligations of the firm, where that value is computed under the assumption that the obligations will be fully met.

Denote by D the present value of debt obligations computed by discounting at the riskless-in-terms-of-default interest rate and let $v = V/D$. Then insolvency occurs at the first occurrence of $v \leq 1$. At that moment, the PBGC inherits a net liability of $A - F$, where F denotes the value of the funds in the pension plan. The PBGC's claim to 30 percent of firm net worth is irrelevant in this instance, since at bankruptcy, equity has no value.

The dynamics for debt, pension funds and firm value are taken to be:

$$dD = \alpha_D D\, dt + \sigma_D D\, dz_D$$

$$dF = (\alpha_F + C_F)F\, dt + \sigma_F F\, dz_F$$

$$dV = \alpha_V V\, dt + \sigma_V V\, dz_V$$

where C_F denotes the rate of contributions to the pension fund as a fraction of F. The covariances between the instantaneous rates of return on the variables will be denoted by σ_{DF}, σ_{DV}, and so on.

Letting $P(v, F, A)$ be the value of the PBGC liabilities, one can show that P must satisfy the p.d.e.

$$\tfrac{1}{2}(P_{vv}\sigma_v^2 v^2 + P_{FF}\sigma_F^2 F^2 + P_{AA}\sigma_A^2 A^2) + P_{vF}\sigma_{vF} vF + P_{vA}\sigma_{vA} vA + P_{FA}\sigma_{FA} FA + P_v rv + P_F(C_F + r)F + P_A(C_A + r)A - rP = 0 \quad (9)$$

subject to the boundary conditions (a) $P = A - F$ when $v = 1$; (b) the limit of P as v approaches infinity is zero; and (c) the limit of P as A and F approach zero is zero.

These boundary conditions embody the assumption that if a firm with an overfunded plan goes bankrupt, then the PBGC simply inherits the plan together with its surplus. Given this rule, the present value of the PBGC's net liability can be negative. This assumption is likely to be irrelevant in practice, however, since it is unlikely that a firm with discretionary funding would ever reach bankruptcy with an overfunded pension plan.

For the special case in which C_F and C_A are constant, the solution to this equation is

$$P = Av^{-\phi} - Fv^{-\theta}$$

where

$$\theta = \frac{K}{M} + \left[\left(\frac{K}{M}\right)^2 - \frac{2C_F}{M}\right]^{1/2}$$

$$\phi = \frac{L}{M} + \left[\left(\frac{L}{M}\right)^2 - \frac{2C_A}{M}\right]^{1/2}$$

$$K = -\frac{1}{2}\sigma_V^2 + \frac{1}{2}\sigma_D^2 - \sigma_{DF} + \sigma_{VF}$$

$$L = -\frac{1}{2}\sigma_V^2 + \frac{1}{2}\sigma_D^2 - \sigma_{DA} + \sigma_{VA}$$

$$M = \sigma_V^2 + \sigma_D^2 - 2\sigma_{DV} = \sigma_v^2$$

and where the solution is valid for parameters which result in positive values for θ and ϕ.

To examine discretionary funding policy in the bankruptcy-only termination model, consider the following specification for funding behavior:

$$C_F = c_0 - c_1(D/V). \tag{10}$$

For $c_1 > 0$, funding declines with the firm's debt ratio (and associated probability of bankruptcy) to a minimum possible level of $c_0 - c_1$. Although debt ratios are not perfect measures of firm financial status, especially in interindustry comparisons, this specification does capture the stylized notion that as a firm approaches bankruptcy, its pension funding will decrease, and in fact can become negative. Although negative contributions are, strictly speaking, disallowed by ERISA, de facto negative funding is realized when the pension plan purchases equity or debt of the firm.

Figure 2 displays numerical solutions for the value of PBGC insurance as a function of the debt ratio, D/V, for a fully funded plan for three values of c_1.[4] c_0 is set at a level so that at $D/V = 0$, the ratio of plan assets to liabilities would increase at a rate of 2 percent per year ($c_0 = -r + 0.02$). As D/V increases, the funding rate falls, and eventually the ratio of assets to liabilities will decrease over time.

For extreme values of the debt ratio, the present value of PBGC liabilities equals zero. Because the plan is fully funded, the PBGC faces no liability even if the firm bankrupts. At the other extreme, as the debt ratio approaches zero, PBGC liabilities fall to zero because the probability of bankruptcy vanishes. For middle-range values of the debt ratio, however, PBGC liabilities can be quite large. If the firm reaches a debt ratio of 0.6, for example, there is a significant chance of bankruptcy, and until bankruptcy is reached, the firm has the opportunity to drain the pension plan.

[4] The variance rates used to solve (9) are as follows: A—0.01; F—0.04; S—0.04; D—0.01; V—0.04. Correlations are: S, A—0.1; D, A—0.8; V, A—0.1; D, F—0.1; V, F—0.5, V, D—0.2. These values are meant to be reasonable guesses only. The low variance rates on A and D and high correlation between the two reflect their similar natures as nominal liabilities. The variance rates on firm value and fund assets compare to a historical value for the S & P 500 of approximately 0.05 annually. The variance rate for V is derived by unlevering the S & P 500 variance using a debt-to-value ratio of ⅓ and then by doubling that variance to account for the lack of diversification of a single stock relative to the index. The variance rate on fund assets is set slightly below that on the S & P 500: the fund is probably less diversified than the index but this effect is offset by bonds held in the fund.

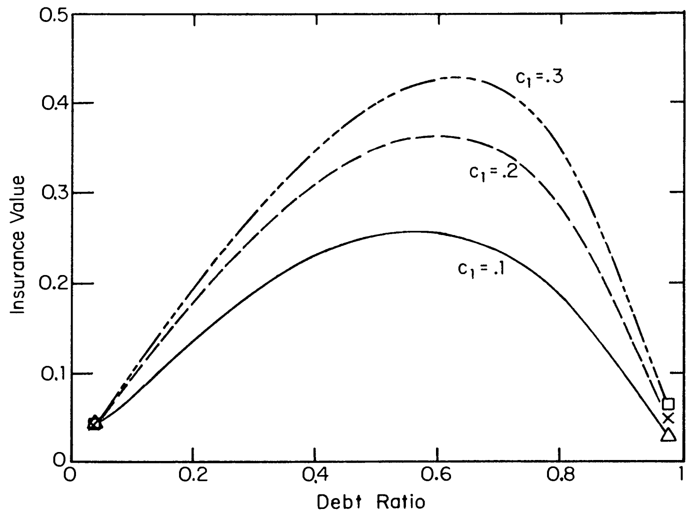

Figure 2. Pension-Insurance Value as a Fraction of Plan Liabilities (fully funded plan, bankruptcy-only termination)

Figure 2 shows that the PBGC's liability can be a significant fraction of vested benefits, even for fully funded plans. Using the conservative assumption that $c_1 = 0.1$, the value of pension insurance still can rise to more than 20 percent of benefits. Further, the disparity in insurance values between the $c_1 = 0.1$ and $c_1 = 0.3$ curves shows that the values of pension insurance can be quite sensitive to firm funding policy, even without the option for firms to voluntarily terminate plans.

II. Empirical Estimates

Estimates of the value of PBGC insurance were calculated for both the voluntary and bankruptcy-only termination models. For each model, three scenarios were considered, corresponding to different plan-funding strategies. Values in the voluntary termination model were calculated for $c_0 = -r$ and for $c_1 = -0.1$ (exploitative strategy), 0 (passive strategy), and 0.1 (socially responsible strategy) [see Equation (8)]. Values in the bankruptcy-only termination model were calculated for coefficients on the debt ratio equal to 0.1, 0.2, and 0.3, and for $c_0 = r + 0.02$ [see Equation (10)]. The (real) interest rate in all of the calculations was set at 0.04.

A. Data

Pensions and Investment Age (July 11, 1983) reports pension fund statistics derived from the 1982 annual reports of the Fortune 100 companies. The survey includes pension fund assets, vested benefits, and the assumed interest rate used to derive the present value of vested benefits. The survey expresses pension fund assets as market values. The market value of vested benefits can be approximated by multiplying reported benefits by the ratio of the plan's assumed interest rate to the actual long-term market interest rate for 1982 which was 12.76 percent.

Table II
Insurance Value Summary Statistics

A. Voluntary Termination Model	$c_1 = -0.1$		$c_1 = 0$		$c_1 = 0.1$	
	Actual Funding	No Surplus	Actual Funding	No Surplus	Actual Funding	No Surplus
1. Frequency Distribution: Insurance Value as a Fraction of Vested Benefits						
0–0.01	51	41	4	4	3	3
0.01–0.025	13	4	8	7	1	1
0.025–0.05	5	7	10	7	0	0
0.05–0.075	7	9	17	12	2	1
0.075–0.10	2	3	11	10	4	5
0.10–0.15	4	10	22	14	26	24
0.15–0.25	2	8	13	28	49	51
0.25+	3	5	2	5	2	2
2. Summary Statistics						
Maximum value	0.338	0.338	0.288	0.288	0.270	0.264
Mean value	0.033	0.065	0.095	0.119	0.153	0.165
Median value	0.003	0.019	0.082	0.121	0.156	0.171
Weighted averaged[a]	0.084	0.126	0.145	0.169	0.187	0.198
Total value ($ billion)	6.7	10.0	11.5	13.4	14.8	15.7

Table II—*Continued*

B. Bankruptcy-Only Model	$c_1 = 0.10$		$c_1 = 0.20$		$c_1 = 0.30$	
	Actual Funding	No Surplus	Actual Funding	No Surplus	Actual Funding	No Surplus
1. Frequency Distribution: Insurance Value as a Fraction of Vested Benefits						
−0.6–0	16	0	7	0	5	0
0–0.1	51	25	26	22	22	20
0.1–0.2	18	29	31	12	17	10
0.2–0.3	1	32	21	33	32	17
0.3–0.4	1	1	1	19	9	34
0.4–0.5	0	0	1	1	2	5
0.5+	0	0	0	0	0	1
2. Summary Statistics						
Maximum value	0.306	0.357	0.401	0.469	0.459	0.557
Mean value	0.003	0.161	0.115	0.217	0.169	0.249
Median value	0.044	0.193	0.155	0.257	0.199	0.283
Weighted average[a]	0.070	0.155	0.155	0.208	0.196	0.233
Total value ($ billion)	5.6	12.3	12.3	16.5	15.5	18.5

[a] Weights, value of vested benefits.

This adjustment assumes that pension benefit payout streams have time paths similar to perpetuities. Total firm value can be approximated as the market value of equity plus book value of long-term debt at year end 1982. The remaining inputs required to estimate the value of PBGC insurance are the variance and covariance rates of the underlying securities. Footnote 4 contains these values.

B. Results

Summary statistics covering pension-insurance values for 87 firms are presented in Table II.[5] PBGC insurance values are expressed as a fraction of total vested benefits. Values are calculated under actual funding levels and under a spinoff/termination scenario in which the pension plan surplus, if positive, is set equal to zero. Table II reveals that PBGC liabilities can be extremely sensitive to firm funding policy. Using actual funding levels, Panel A shows that total liabilities for the exploitative strategy ($c_1 = -0.1$) are less than one-half the value for the socially responsible strategy ($c_1 = 0.1$) in the voluntary-termination model. This result reflects the overfunded status of most plans in 1982: the exploitative strategy for overfunded plans entailed the largest contribution rate into the pension fund, and thus resulted in the smallest insurance values.

Although Panel A indicates that many firms derive little value from pension insurance, some "problem firms" derive considerable value from the pension insurance. These tend to be the larger firms: the weighted averages of the insurance values are greater than the means.

The total value of PBGC liabilities for the 87 firms is extremely large, ranging from \$6.7 billion to \$14.8 billion for the three cases considered in Panel A that use actual funding levels. These values compare with PBGC reserves for insured future benefits of only \$1.14 billion (PBGC *Annual Report*, fiscal year 1982). Therefore, if the option to terminate voluntarily is to be taken seriously, the PBGC reserve calculations are wildly optimistic. Keep in mind that the total insurance values presented in Panel A are summed only over the 87 firms in the sample. PBGC liabilities for all insured firms must be significantly greater. The insurance values for individual firms also differ from the traditional measure of underfunding ($A - F - 0.3E$) by wide margins, and highlight the pitfalls of ignoring the option component of pension insurance in assessing PBGC liabilities. Even ignoring the firm's contingent liability of $0.3E$, the total underfunding of all the underfunded plans in the sample is only \$0.48 billion, which is a small fraction of the values derived from the voluntary termination model. As expected, spinoff/terminations tend to increase PBGC liabilities. This can be seen from the entries in Panel A in which surplus is set equal to zero. The effect of terminations on pension value is sensitive to discretionary funding rules: when additional funding rates increase with current funding shortfalls, the termination has the least effect on insurance value.

Panel B of Table II presents summary statistics for the bankruptcy-only termination model. These results are similar to those presented in Panel A. Even greater sensitivity to spinoff/terminations and the firm's funding behavior is

[5] Thirteen observations were lost because of missing data. For firm-specific estimates, see Marcus [13].

evidenced. Interestingly, the values for total dollar liabilities of the PBGC are similar in the two models, despite the disparities in assumed funding behavior and plan-termination conditions.

III. Conclusions

This paper derives the value of PBGC pension insurance liabilities under two scenarios of interest. The first allows for voluntary plan termination, which appears to be legal under current statutes. The second is a termination only-at-bankruptcy rule, that has been suggested as a reform to current law. Empirical estimates of PBGC liabilities are derived. These show that total liabilities far exceed current reserves for plan termination and that liabilities are quite sensitive to plan funding policy and potential spinoff/terminations.

The empirical results support several conclusions. First, the ability of firms to voluntarily terminate pension plans is a potentially important option, the value of which can be substantially underestimated by the simple measure $\max(0, A - S)$. Second, even without the ability to voluntarily terminate underfunded plans, discretionary pension-funding policy can lead to equally large PBGC liabilities. Even fully funded plans can impose contingent liabilities with present value more than 25 percent of vested benefits. Thus, spinoff/terminations, which effectively allow firms to recapture the surplus assets in a pension plan, impose significant costs on the PBGC in the sense that the present value of PBGC liabilities increases substantially as surplus assets are siphoned out of funds. Moreover, these liabilities are extremely sensitive to small changes in ongoing funding policy. While the exact numbers derived in this paper might not be accurate estimates of PBGC liabilities, the *sensitivity* of PBGC liabilities to funding policy that is documented in this paper *is*, in fact, likely to be true of the actual pension-insurance program. Thus, reform of the PBGC rate structure will require attention to firm funding policies as well as funding levels.

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DISCUSSION

LARRY MERVILLE*: This paper attempts to value the insurance provided by the Pension Benefit Guarantee Corporation (PBGC) under Title IV of ERISA (1974). The author's approach is to use an option pricing framework to develop two put option valuation models. After an introductory overview of the issues and problem, the author presents two put models in Section I of the paper: (1) One model under the assumption of voluntary termination by the firm and (2) a second model assuming bankruptcy (involuntary termination) on the part of the firm. Section II of the paper contains some empirical estimates for the value of PBGC insurance using the models from part one plus some actual pension data from a survey reported in *Pensions and Investment Age* (July 11, 1983). The author concludes that the actual value of PBGC insurance to a company is fairly represented by the value of the put option and is bounded by the two put option values developed under the voluntary and bankruptcy scenarios of Section I. He also concludes that simply taking the difference between the actuarially determined value of the accrued benefits (A) and the value of assets in the pension fund plus 30 percent of equity ($F + 0.3E$) is a very low estimate of the real value of PBGC insurance to major U.S. corporations.

On balance the paper is well presented, technically correct, and tackles a difficult valuation problem. It attempts to place the decisions available to the firm with respect to a defined benefit pension program under ERISA in a value maximizing framework. However, there are at least three major assumptions made in the paper which effectively limits its importance and generality:

A. In the referenced Amoroso [1] study of 1982, it turns out that only 72 percent of all pension benefits were both guaranteed *and* vested. The percentage of firms offering vested defined benefit plans today must be

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