Estimating the Funding Gap of the Pension Benefit Guaranty Corporation

The Pension Benefit Guaranty Corporation (PBGC), a self-financing government corporation created to insure private defined benefit pension plans, has experienced net losses in all but two years since its creation in 1974.[1] When a pension plan with a large funding deficiency is terminated, the PBGC is obligated to take on a well-defined portion of the net liability of the plan.[2] The cumulative effect of these net liabilities is a stated funding deficiency that stood at $3.8 billion as of the end of fiscal year 1986.[3] Although the stated funding deficiency of the PBGC fully reflects the plan terminations that have already taken place since 1974, it fails to take into account expectations about future terminations or about future premium income. The purpose of this article is to develop and apply a framework for evaluating the effects of expected future income and outflows.

The PBGC's main source of noninvestment income is the collection of insurance premiums from corporations. The chronic funding problems experienced over the years have prompted Congress to raise the premium rates on several occasions and, effective in 1987, to make the rates sensitive to the level of underfunding of each particular plan. These measures have improved the situation somewhat but have fallen short of stemming the rising trend in funding deficiencies.

Because this picture only looks at the past, however, it actually understates the true funding problems of the PBGC. If the corporation were a private pension fund subject to the Employees Retirement Income Security Act (ERISA), it would have to make some provision for the funding of projected future acquisitions of net liabilities.[4] The general principle behind such funding practices is that, even if future outflows are not known with certainty at present, the fund is liable for any future outflows that result from current plan provisions and should fund them as they accrue on the basis of the best available expectations.

In the case of past plan terminations, PBGC accounting adheres to this principle. The assets acquired from terminated plans and their sponsors are earmarked for the payment of future benefits corresponding to those plans. The net liabilities that may be expected to arise from future pension plan terminations, however, are ignored in current financial statements, as are future premium payments. This means that even if Congress were to provide the approximately $4 billion it would take to restore the PBGC to momentary solvency, the burden of future plan terminations could undo the effects of such provisions.

In this article, we estimate the current level of fund-

[1]The accompanying glossary provides definitions of pension terms used in this article.

[2]The PBGC's share is the liability for guaranteed benefits minus the sum of the assets of the plan and 30 percent of the sponsor's equity.

[3]As of the end of fiscal year 1987, the deficiency had declined to $1.5 billion, mainly because of a reversal in the LTV case, which is still being contested. We use the 1986 deficiency because the most recent company data available for use in the empirical part of the article covers this period. The stated deficiency represents the net worth position of the PBGC rather than a cash flow deficit. The PBGC has experienced cash flow deficits in only two of the seven fiscal years from 1980 to 1986. For a brief history and analysis of the PBGC, turn to Appendix A.

[4]A pension plan's "accrued liability" is defined in ERISA as "the excess of the present value...of the projected benefit costs and administrative expenses...over the present value of future contributions for the normal cost" (ERISA, Title I, Subtitle A, Section 3(29)).

ing necessary for the PBGC to provide for future plan terminations. Our estimates suggest that the present value of PBGC liabilities resulting from future terminations is more than $30 billion. Our estimate of the value of future premium payments is only $14 billion, however, resulting in an additional net PBGC liability of nearly $17 billion. This projected shortfall represents a further burden to the PBGC beyond its stated accounting deficiency of $4 billion. While our estimates are sensitive to a variety of assumptions made in the specification of our model and its parameters, we give extensive consideration to the real world behavior of corporations and pension funds in making our assumptions. We incorporate in our model both the actual regulatory restrictions on pension fund activity and the basic characteristics of pension fund assets and liabilities.

If the PBGC were a private insurance company with bottom line motivations, it would be essential that it set its premiums according to such actuarial calculations. Only the public nature of the institution and its presumed access to public revenues make it possible for it to operate without reliance on explicit estimates of future net liabilities.

Glossary of Pension Terms

Accrued pension benefits:
Vested pension benefits plus benefits earned but not yet vested by active employees.

Defined benefit pension plan:
A pension plan in which benefits take the form of a promised annual payment to retirees, usually based on length of service and average salary.

Defined contribution pension plan:
A pension plan in which benefits take the form of periodic contributions to an investment fund dedicated to the worker and transferred to the worker at retirement.

ERISA:
The Employees Retirement Income Security Act of 1974. This legislation established the Pension Benefit Guaranty Corporation and mandated rules for the funding and termination of *defined benefit pension plans.*

Full funding:
The level of *pension plan assets* that just equals the level of *pension plan liabilities.*

Funding ratio:
The ratio of *pension fund assets* to *pension fund liabilities.*

Maximum funding limitation:
The maximum tax-deductible *pension plan contribution* permitted by the IRS and *ERISA*. Essentially, tax-deductible employer contributions may not push *pension plan assets* beyond the *full funding* level.

Minimum funding requirement:
The minimum *pension plan contribution* required under the terms of *ERISA*. It equals the sum of *normal costs* and amortization of any underfunding.

Normal cost:
The present value of pension plan benefits earned by active workers during the year. A component of the *pension contribution* made by the *pension plan sponsor*, it represents the amount that the sponsor would have to contribute to maintain the current level of overfunding or underfunding if all actuarial and market assumptions were met.

Overfunding:
The amount by which *pension plan assets* exceed *pension plan liabilities.*

Pension plan assets:
The market value of all securities held by the pension fund. It equals the current value of all past *pension plan contributions* and investment earnings, net of all past *pension plan benefit payments* and administrative expenses.

Pension plan benefit payments:
Cash payments made to retired workers during the year.

Pension plan contribution:
The cash value of contributions made by the *pension plan sponsor* during the year. It equals the sum of *normal costs* and the amortization of any overfunding or underfunding.

Pension plan liabilities:
The present value of future *pension plan benefit payments* minus the present value of future *normal costs.*

Pension plan participants:
Active workers with both vested and unvested pension benefits, and retirees and former employees with vested pension benefits.

Pension plan sponsor:
The company whose employees and former employees (both retirees and former employees with vested benefits) are covered by the *defined benefit pension plan.*

Underfunding:
The amount by which *pension plan assets* fall short of *pension plan liabilities.*

Vested pension benefits:
Future benefit payments owed to retirees and future benefit payments that are guaranteed to active workers even if they leave the firm.

The PBGC funding problem: definition and methodology

Our primary goal here is to determine the appropriate level of current funding for the PBGC. Since the PBGC is essentially a provider of insurance, we turn for guidance to the methods used by actuaries to value insurance policies and pension funds.[5] These methods provide a framework for modeling the assets and liabilities of the pension funds insured by PBGC and for describing their behavior over time. The evolution of the funding status of these plans, together with the changing financial condition of the firms sponsoring them, determines the size of the net liabilities that will accrue to the PBGC from future plan terminations.

In adopting the research strategy suggested by the actuarial approach to valuing PBGC liabilities, we use tools developed in the field of finance. First, we apply the mathematical tools devised in the theory of contingent claims, since insurance is a special case of such claims.[6] Second, we draw on the theory of business failures in analyzing pension fund terminations. By law, terminations of underfunded pension plans should occur only when the sponsor firm is in grave financial distress. This has been the de facto approach since the PBGC was created, even though it became a legal requirement only recently.

The next few sections present the various portions of the model. The fund and its sponsor firm are modeled as separate but related entities. The value of the PBGC insurance is determined by six variables associated with the fund and its sponsor, and the analysis focuses on the evolution of these variables over time. This evolution is determined by a series of dynamic relationships that describe the growth of firm assets and debt, the number of plan participants, the assets and liabilities of the fund, and the normal cost associated with the fund.[7] These relationships specify that the value of each of these variables in one time period is determined by its own value in the previous time period, as well as by the lagged values of other model variables, by institutional elements such as PBGC premium rules, and by unpredictable random shocks. In each case, assumptions are based on empirical research and on theoretical considerations.

These dynamic relationships are simulated over time by generating values of the random disturbances and "rolling" the equations forward. This process is repeated a large number of times, and averages are taken over all the individual realizations. Simulations are useful in handling complicated dynamics such as those involved in valuing PBGC insurance. They allow for precise and realistic modeling of the various aspects of pension funding and of the relationship between the fund and the sponsor. For example, in our analysis, the sponsor's contribution to the pension plan, as well as the PBGC premium, is charged to the firm in the model, potentially affecting cash flows and the firm's solvency. Although in general not very large, these effects may be central to the issue in some cases, as they were in the solvency problems of LTV and Chrysler.

Pension fund dynamics

The model of PBGC insurance used in the estimates differs from previous models of PBGC insurance in several important respects. In contrast to earlier formulations that make somewhat ad hoc assumptions about funding strategies, this model employs the legal and regulatory restrictions that actually govern pension plan contributions. It takes explicit account of ERISA minimum funding rules and of the PBGC premium rate structure. In addition, the model imbeds funding restrictions imposed by the IRS to limit tax-deductible contributions to overfunded pension funds. These assumptions mean that the modeled behavior of pension funds more closely follows the actual behavior of pension funds under existing law.

We assume that each firm sponsors a single pension fund for all of its workers. This pension fund is financed by contributions from the firm and by the investment return on the fund's assets.

Contributions

The contribution made by the firm to its pension fund during each period is based on minimum and maximum funding guidelines established in ERISA and amended by subsequent legislation. The minimum contribution under the funding requirements consists of the normal cost and a payment to amortize any funding deficiency.

The normal cost component of the contribution represents the present value of pension plan benefits earned by workers during the year. As such, normal costs will vary across firms according to the composition of the work force, the distribution of the length of

[5] A useful mathematical exposition of these actuarial principles is found in Howard E. Winklevoss, *Pension Mathematics* (Homewood, Illinois: Richard D. Irwin, Inc., 1977).

[6] The literature on this topic is extensive. An early (and rudimentary) example of the use of option pricing theory in the context of PBGC insurance is William F. Sharpe, "Corporate Pension Funding Policy," *Journal of Financial Economics*, vol. 3 (1976), pp. 183-94. A more recent example, with a more detailed framework, is Alan J. Marcus, "Corporate Pension Policy and the Value of PBGC Insurance," in Zvi Bodie and others, eds., *Issues in Pension Economics* (Chicago: University of Chicago Press, 1987).

[7] These equations and a mathematical discussion of the model are presented in Appendix B. For a complete analysis of the model, see A. Estrella and B. Hirtle, "The Implicit Liabilities of the Pension Benefit Guaranty Corporation," Federal Reserve Bank of New York Research Paper (forthcoming).

employment of workers at the firm, and the terms of the pension plan. Firms with a high ratio of active workers to retirees will tend to have normal costs that are a larger proportion of pension plan liabilities than firms with a low ratio of active workers to retirees.

The second component of the firm's contribution to its pension fund is the amortization of underfunding. This component is determined by a combination of ERISA funding rules and firm discretion. If the fund is underfunded at the beginning of the year, then the rate at which the firm must amortize this underfunding is determined by a complex set of guidelines imposed under ERISA. For purposes of the model, we assume that the firm amortizes each period's underfunding over a 20-year horizon using the expected rate of return on the pension fund assets as the discount rate.[8] On the other hand, if the firm is overfunded at the beginning of the year, then no amortization payment is required.

The maximum (tax-deductible) contribution is determined by the "full funding limitation" in ERISA, as amended in 1987.[9] The firm cannot contribute on a tax-deductible basis an amount that would push the assets of the plan, including the employer's contribution, beyond the sum of the plan's liabilities plus normal cost. If the normal cost exceeds one half the liabilities, the allowable tax-deductible contribution is further restricted to be less than the excess of 150 percent of liabilities over assets.[10] If the minimum contribution exceeds this full funding limitation, only the full funding amount is required. The firm may choose to make a contribution in excess of the full funding limitation on a non-tax-deductible basis, but our model assumes that firms do not do so. We assume that the sponsor's contribution to the pension fund is the lesser of the minimum funding amount specified in ERISA (assuming a 20-year amortization horizon) and the maximum funding amount specified by the IRS.[11]

Investment returns

The investment return is assumed to consist of two components: an expected return, which is realized with certainty during each period, and a random unexpected return, which varies from period to period and may be positive or negative.

Liabilities

Withdrawals from the fund are made during each period to cover pension plan benefit payments. The relationship between normal costs, pension plan benefit payments, and pension plan liabilities produces the dynamic behavior of liabilities. Normal costs and pension benefit payments are assumed to grow at the same rate per period. This growth reflects an increase in the number of pension plan participants rather than an increase in real benefit provisions over time. Participants are defined as active workers and retirees, and we assume that the number of plan participants grows at the same fixed rate per year as normal costs and pension benefit payments.

Benefit payments can also be expressed as the sum of normal costs and the expected return on the full funding level of pension plan assets (the level of assets that just equals pension plan liabilities). Combining these three relationships implies that pension fund liabilities grow at the same rate as benefit payments and normal costs.

Dynamics of the sponsor firm

This section discusses the dynamics of the sponsor firm and delineates the links between the firm and its pension fund. There are three principal links between the dynamics of the fund and those of the firm: the pension contribution, the PBGC premium, and the plan termination decision.

The pension contribution, which was discussed in the previous section, is modeled explicitly as an expense to the firm. The second link, the PBGC premium, is also modeled as a direct expense of the sponsoring firm. Following legislation adopted in 1987, the PBGC premium varies according to the funding status of each pension fund.[12] The PBGC charges a flat rate of $16 per plan participant. In addition, the PBGC levies an underfunding fee of $6 per $1000 of underfunding per participant. The total premium is capped at $50 per

[8] The 20-year amortization horizon was chosen as a rough average of the amortization horizons specified by the ERISA for underfunding arising from various sources. For instance, underfunding arising from past service credits (increases in benefits of ongoing plans or startup of plans in an underfunded condition) may be amortized over a 30-year horizon, while underfunding arising from actuarial gains and losses (when actual returns deviate from expected returns or when actuarial assumptions are not met) may be amortized over a 10-year horizon. On average, the 20-year assumption is probably on the low side. This would make our estimates of PBGC liabilities conservatively lower.

[9] Omnibus Budget Reconciliation Act of 1987, Subtitle D, Part 1, Section 9301.

[10] The 150 percent of liabilities restriction is additionally binding only if the normal cost exceeds one half the liabilities, a condition that is generally unlikely. Only companies that are growing at exceptionally fast rates would be subject to this further restriction. In the empirical part of the article, the assumed range of normal cost to liability ratios falls in the region in which the 150 percent constraint is nonbinding. Data on actual normal costs for individual firms are not conveniently accessible.

[11] The maximum funding provision is analogous to a requirement to amortize any overfunding. In fact, this amortization is faster for overfunding than for underfunding, especially since the portion of the normal cost that may be used to offset the overfunding is limited to 50 percent of liabilities. This asymmetry has the effect of producing an underfunded status in long-run equilibrium.

[12] Omnibus Budget Reconciliation Act of 1987.

participant. Under these regulations, the total premium cost to the plan sponsor is the premium rate times the number of plan participants.

Based on these pension-related expenses and general considerations, the final set of dynamic relationships used in the model concerns the debt and assets of the sponsoring firm. Firm debt is assumed to grow at a fixed rate per period and is unaffected by pension plan activity. The growth in firm assets is assumed to consist of two components. Like pension fund assets, firm assets have a return consisting of an expected return and a random component that varies across periods. The firm's contribution to its pension fund and the PBGC premium payment are subtracted from firm assets during each period.

Model summary

Six dynamic relationships describing the movement of the model variables over time emerge from the preceding discussion. These relationships are:

(1) Normal cost in year t = normal cost growth factor × normal cost in year t-1

(2) Fund liabilities end of year t = normal cost growth factor × fund liabilities end of year t-1

(3) Fund assets end of year t = fund assets end of year t-1

+ expected plus random rates of return × fund assets end of year t-1

+ pension contributions during year − pension benefit payments during year

(4) Plan participants in year t = plan participant growth factor × plan participants in year t-1

(5) Firm debt end of year t = firm debt growth factor × firm debt end of year t-1

(6) Firm assets end of year t = firm assets end of year t-1

+ expected plus random rates of return × firm assets end of year t-1

− pension contributions during year − PBGC premiums during year.

Plan termination conditions

Now that the basic dynamics for the firm are established, we may proceed to construct the final link between the fund and the firm, the firm failure/pension termination event. Under legislation adopted in 1986, underfunded pension plans may be terminated and PBGC insurance drawn upon only if the sponsoring firm is in a "distress situation."[13] Essentially, the PBGC limits terminations of underfunded plans to firms facing bankruptcy or severe economic distress. For purposes of this model, we assume that underfunded pension plans terminate only when the sponsoring firm enters formal bankruptcy.

The difficulty with this assumption is determining what conditions signal firm bankruptcy. One such condition is the technical insolvency of the firm, when the face value of the firm's debt exceeds the value of the firm's assets.[14] In many cases, however, a firm will declare bankruptcy before it has become technically insolvent. In these instances, the decision to declare bankruptcy may be related to cash-flow difficulties or to the inability to meet a scheduled debt payment. In order to model bankruptcy under these conditions, the simulation model superimposes a criterion of firm failure based on flows. This criterion is developed on the basis of an empirical bankruptcy model using financial statement data.

The basic premise of the empirical model is that flow variables—specifically, the determinants of changes in firm assets—affect the probability that the firm will enter bankruptcy. Firm asset growth may be financed by two sources: retained earnings, which reflect the operating profitability of the firm, and external financing (debt and equity issuance), which reflects balance sheet growth. In order to measure the impact of these two sources of asset growth in predicting bankruptcy probability, we estimate a statistical model using annual data on assets, debt, and retained earnings between 1973 and 1981 for a sample of 174 failed and ongoing firms.[15] Using the results of this estimation, we are able to generate a "critical level" for the change in assets for any given probability of bankruptcy. This critical level represents the change in firm assets necessary to generate the specified bankruptcy probability.

Our PBGC insurance model fixes a target bankruptcy probability P^* and assumes that if the probability of bankruptcy implied by the model simulation equals or exceeds this level, then the firm declares bankruptcy. This target bankruptcy probability is set at 95 percent,

[13] Single Employer Pension Plan Amendments Act of 1986.

[14] This formulation has been adopted in previous studies. For example, see Marcus, "Corporate Pension Policy."

[15] The statistical model chosen is a probit model. The results of this estimation and the data used are discussed fully in Estrella and Hirtle, "Implicit Liabilities."

which is associated with a critical asset-change level, %RV*, of approximately −36 percent. Although the critical level is a function of time-dependent flow variables and varies over time, this value is representative of the magnitude of the one-period change in assets necessary to generate a significant bankruptcy probability.

In the simulation, the procedure to check for firm bankruptcy is to calculate %RV* at the end of each period and to compare it to the actual percent change in firm assets, %RV. Any value of %RV smaller (more negative) than %RV* will produce a predicted probability of failure greater than 95 percent. If the actual change in firm assets is less than or equal to %RV*, then the firm is assumed to be bankrupt.

Data and parameter assumptions

In the case of the PBGC insurance estimates (and probably in general), the selection of data and parameter values is as important to the estimation procedure as the development of the model's equations. Earlier work on PBGC insurance has generally adopted typical parameter values from the literature on options without giving proper consideration to the specific nature of pension fund and corporate assets and liabilities. Since the model is quite sensitive to some of the assumptions, it is worthwhile to invest some time in the selection process.

In order to simulate the PBGC insurance model, it is first necessary to assign initial period values to the variables whose behavior is described by the six dynamic relationships dicussed above. The data needed consist of firm-level information about pension plan assets, liabilities, normal costs, and participants as well as information about firm assets, debt, and equity. These data are derived from information in the COMPUSTAT annual data tapes. The COMPUSTAT tapes contain balance sheet information on approximately 6000 publicly held firms that file reports with the SEC.

To obtain a comprehensive sample, we included all firms reporting complete data on firm assets, retained earnings, long-term and short-term debt, number of employees, and pension plan assets and liabilities for 1985, 1986, or 1987.[16] The final sample consists of 1586 firms from a wide variety of industries. These 1586 firms have aggregate pension fund assets of $437 billion and aggregate pension fund liabilities of $288 billion. Seventy-four of the 100 largest private pension funds in 1987 are represented in the sample. The sample contains nearly 19 million workers, a number which represents approximately two-thirds of the 30 million pension plan participants covered by the PBGC single-employer plan. This number may overstate the coverage of PBGC single-employer plan participants in the sample, however, since all employees of a given firm may not be covered by a PBGC-insured pension plan.[17]

For each of the 1586 firms in the sample, data on firm assets, retained earnings, and debt and pension plan assets and liabilities are taken directly from the COMPUSTAT tapes. Liabilities are reported as both vested and accrued liabilities.[18] The funding requirements imposed by ERISA are written in terms of accrued liabilities, but the benefits guaranteed by the PBGC more closely resemble vested liabilities. Hence, both liability figures are included in the data set. During model simulation, accrued liabilities are used in determining the funding status of a pension plan, and vested liabilities are used in calculating the value of the insurance at termination.

Pension plan assets and liabilities are reported on an aggregate basis for each firm on the COMPUSTAT tapes. That is, firms with multiple pension plans for their employees report only total assets and liabilities summed across all plans at the firm. Since a given firm could have both overfunded and underfunded pension plans, this procedure means that some underfunded plans will go undetected.[19]

[16]The final sample contained 63 firms with information from 1985, 1287 firms with information from 1986, and 236 firms with information from 1987.

[17]For instance, the pension plans of highly-compensated workers are not necessarily insured by the PBGC. In addition, certain workers at the firm could have pension plans covered by the PBGC multi-employer fund. These workers would be primarily production workers covered by certain collective bargaining agreements. Finally, some workers could be enrolled in defined contribution pension plans, which are not insured by the PBGC.

[18]Vested pension liabilities are liabilities arising from vested pension benefits. Vested benefits are benefits owed to retirees and benefits that are guaranteed to active workers even if they leave the firm. Accrued pension liabilities are vested liabilities plus the liabilities corresponding to nonvested but accrued benefits of active employees.

[19]To the degree that underfunded plans are hidden by aggregation at the firm level, the value of the total PBGC insurance liability could be underestimated. Consider a firm with two pension plans, one overfunded by $20 million and one underfunded by $10 million. On an aggregate basis the firm's plans are overfunded by $10 million, and the PBGC insurance would appear to be "out of the money." In fact, however, the underfunded plan might represent a liability for the PBGC, depending upon the net worth of the firm. Assuming that the $20 million of overfunding from the first plan is "returned" to the firm if the plans are terminated, the value of the PBGC's claim against the net worth of the firm is at least $6 million (30 percent of the $20 million of overfunding). If the remaining net worth of the firm is at least $13.3 million (so that the 30 percent claim is worth $4 million), then the $10 million of underfunding from the second pension plan is covered by the 30 percent of net worth claim against the firm and the insurance is out of the money. To the extent that the remaining

The remaining variables necessary for the simulation of the insurance model are not available directly from the COMPUSTAT tapes. The tapes contain neither the normal cost nor the number of pension plan participants. In order to arrive at initial period values for these variables, we make estimates using available information about pension plan liabilities and the number of firm employees. Pension plan normal costs in the initial period are estimated as a share of pension plan liabilities. The number of pension plan participants is similarly calculated as a ratio to the number of employees at the firm. The ratios used in these calculations are taken from simulations performed by Winklevoss of hypothetical "model" pension plans.[20]

Since the relationships between pension plan liabilities and normal costs and the number of pension plan participants and employees will change during the life cycle of a firm, the adjustment ratios are varied according to the growth characteristics of the firm. Firms in the sample are designated as either "stable" or "growing" based on the increase in employment at the firm over the five years before the year of the observation. Firms experiencing rapid employment growth over this period are assigned to the "growing" category while all other firms are designated as "stable." Firms less than five years old at the time of the observation are assumed to be "growing."[21] Growing firms are assumed to have a higher percentage of new workers than stable firms; consequently they will have both a lower ratio of pension plan participants to firm employees and normal costs that are a higher share of pension plan liabilities.[22]

Footnote 19 continued
net worth of the firm is less than $13.3 million, however, the PBGC insurance associated with the underfunded plan will have some value and the aggregation of the two plans will understate the value of the insurance.

[20]Winklevoss, *Pension Mathematics*. The ratios are based on the simulations reported by Winklevoss in Table 4-7.

[21]A cutoff value of 20 percent for the five-year growth in employment is used to determine whether or not a firm is "growing." The 20 percent level was chosen after an analysis of the employment growth rates for the firms in the sample. Of the 1586 firms, 441 (28 percent) had employment growth rates greater than or equal to 20 percent, 858 (54 percent) had growth rates less than 20 percent, and 298 (18 percent) were less than five years old. The median employment growth rate was approximately 10 percent for the sample as a whole, which reflects the rapid economic expansion over the 1982-87 period.

[22]If N is the number of employees at the firm, NC normal cost, P pension plan participants, and L plan liabilities, the calculations are:

Category	N_0/N_{-5}	Calculations
Stable	Less than 20 percent	$NC_0 = .15\ L_0$ $P_0 = 1.427\ N_0$
Growing	More than 20 percent	$NC_0 = .25\ L_0$ $P_0 = 1.103\ N_0$

The remaining information necessary to simulate the PBGC insurance model consists of the expected growth rates associated with the various difference equations and the nature of the random disturbances to firm assets and pension fund assets. In order to make the behavior of the model variables during the simulation as realistic as possible, we derive these parameter values from the behavior of real world proxies for the various model variables. For instance, the basic growth rates characterizing the path of the sponsor firms over time are chosen so that several diagnostic model statistics—including the long-run aggregate funding ratio and the firm failure rate—produce reasonable values.

As part of the attempt to reflect real world behavior in the pension model, asset growth rates are assigned according to the growth categories described earlier. Stable and growing firms are allotted real "base" growth rates of 0 and ½ percent per period, respectively. Pension plan benefits, the number of plan participants, and firm debt are all assumed to grow at this base growth rate. Firm assets grow at the base rate plus the rate of growth of productivity, which is assumed to be 1 percent per period.[23]

The random disturbances to fund assets and firm assets are assumed to be jointly normally distributed with mean zero and standard deviations σ_A and σ_V, respectively. Since economy-wide events could affect firm assets and pension fund assets in similar ways, the disturbances are assumed to be correlated. The random characteristics of the pension fund are based on the performance of a portfolio of common stocks and bonds over the years from 1973 to 1987.[24] The 60/40 mix of stocks and bonds in the portfolio reflects the average relative shares of these securities held by pension funds according to the Federal Reserve Board's Flow of Funds Accounts. An analysis of the behavior of the inflation-adjusted returns on this portfolio suggests that $\sigma_A = .12$ is a reasonable value. In addition, the analysis suggests that the expected real rate of return on pension fund assets should be set to 2.5 percent per year.

We base the value for σ_V on estimates of the unexpected growth of real balance sheet assets of a sample of firms on the COMPUSTAT tapes. A sample consisting of all firms on the COMPUSTAT tapes reporting complete asset and debt data between 1977 and 1987 was collected. For each of the firms in this sample, the unexpected growth in firm assets on a year

[23]Note that the model is expressed completely in real (inflation-adjusted) terms.

[24]The basic returns are obtained from the Ibbotson Associates data base.

over year basis, $VGROW_t$, is calculated as follows:[25]

$$VGROW_t = (V_t - V_{t-1} - (D_t - D_{t-1}))/V_{t-1},$$

where V_t and D_t are the firm's assets and debt, respectively, in year t. The standard deviation of VGROW is calculated for each firm over the 10 observations in the sample. Using these results as a guide, we set the standard deviation of real firm assets, σ_V, to .10.[26] The correlation between the firm's assets and the return on the 60/40 portfolio is set at .25. This value is based on both theoretical and empirical considerations.[27]

To summarize, we assume that pension assets provide a real expected return of 2.5 percent per annum with a standard deviation of 12 percent. The expected value of 2.5 percent serves as the constant discounting rate for future real flows in the model or, more generally, as the constant interest rate. The assumption of a constant interest rate is reasonable in the present context, since we are most interested in present values calculated over the very long run. Although it is possible to experiment with other assumptions about the future course of interest rates and to examine the short-run implications of such scenarios on the PBGC's acquisition of new liabilities, such experiments lie beyond the scope of this article.

The real return on firm assets is either 1 or 1.5 percent, depending on the particular firm's recent growth performance, with a standard deviation of 10 percent. The correlation between the returns on firm assets and pension assets is 0.25. The return on firm assets is essentially a measure of earnings after interest as a proportion of the firm's assets. Thus, for a firm with a debt-to-assets ratio of one half (which is roughly the recent aggregate level in the United States[28]), the return on assets should be about one half of the return on equity. Our assumptions for the expected returns on firm assets (1 or 1.5 percent) and pension assets (2.5 percent) are consistent with the foregoing relationship.

Finally, firm liabilities as well as pension liabilities are assumed to grow at rates of 0 and 0.5 percent for stable and growing firms, respectively.

Model simulation and results

Simulation procedure

The six dynamic relationships describing the behavior of the six variables of the model (firm assets, debt, pension plan assets and liabilities, normal costs, and the number of pension plan participants), together with the plan termination conditions discussed earlier, are the basic elements necessary to evaluate the PBGC insurance. We perform this evaluation by dynamic simulation. After assigning period 0 values for the variables and specifying the nature of the random disturbances, we roll the difference equations forward over a fixed horizon of 100 periods.[29] At the end of each period, the conditions that signal the termination of the pension plan are checked.

When the pension plan is terminated because of technical insolvency or bankruptcy, the PBGC insurance is valued according to the procedure specified by ERISA and subsequent amendments. These procedures require that the PBGC assume the assets and guaranteed liabilities of any underfunded plan upon termination. In return for accepting the net liabilities of the underfunded plan, the PBGC is granted a claim of up to 30 percent of the net worth of the sponsoring firm.[30] This additional claim may not exceed the total amount of plan underfunding. Thus, for firms with overfunded pension plans at termination, the insurance is worth nothing. For firms with underfunded plans, the insurance is valuable only to the extent that the PBGC-guaranteed liabilities exceed the fund's assets plus 30 percent of the net worth of the firm. For plans terminating because of the technical insolvency of the firm, the

[25]Since the parameter σ_V is meant to represent the standard deviation of unexpected firm asset growth and since debt growth is planned for and controlled by the firm, the growth in firm debt, D_t-D_{t-1}, is removed in the asset growth calculation.

[26]The range of values for the standard deviation of VGROW is extensive, probably on account of the limited number of observations per firm. The median standard deviation is .13 and almost half of the observations fall into the range from .05 to .15, leading to the selection of .10 as a representative value.

[27]The lack of information about the market value of a firm's assets makes it difficult to estimate this correlation precisely. However, since the liabilities side of the balance sheet is similar in composition to the fund's assets, we would expect the correlation to be positive. In addition, if the average firm is more volatile than the diversified fund, the correlation should be less than perfect. Test simulations of the model suggest that the results are not very sensitive to changes in the correlation between 0 and 0.5, and we chose the midpoint of this range. Empirically, the median correlation with the firm's capitalization (a somewhat different measure) over the 1978-87 period was 0.11.

[28]Board of Governors of the Federal Reserve System, Flow of Funds Accounts.

[29]Theoretically, the simulation should proceed for an infinite number of periods. Since discounting reduces the present value of liabilities that occur in the distant future, a finite period generally produces a reasonable approximation. The choice of period here is dictated by the size of the discount factor and by practical computer time constraints.

[30]Recent changes in PBGC regulations make the firm liable for 100 percent of the underfunding with respect to guaranteed liabilities in terminated pension plans. However, the part of the PBGC claim exceeding 30 percent of firm net worth has a lower status in bankruptcy court than the portion of the claim falling within 30 percent of net worth. This more-than-30 percent portion has the same status as other unsecured creditors, and it is unclear whether this portion of the PBGC's claim has significant value. For purposes of our model, this part of the claim is assumed to be valueless. To the extent that the assumption is incorrect, our estimate of the value of the PBGC insurance will be reduced.

net worth portion of the PBGC's claim against the firm has no value. Once the net termination liability is determined, its present value is used as the value of the PBGC insurance under the particular sequence of random events.

In order to obtain a precise estimate of the value of the PBGC insurance for each firm, we repeat the entire simulation procedure a significant number of times and calculate an average present value for the insurance.[31]

Results

The basic results of this estimation are presented in Table 1. The aggregate value of the PBGC insurance is calculated at about $31 billion, which is within the general bounds of previous estimates.[32] This is the amount that firms would have to contribute now to prepay fully the PBGC insurance. Under the current premium structure, however, the expected present value of future premium payments is just $14 billion. Thus, the current funding deficiency of the PBGC with respect to future terminations is about $17 billion. Adding this figure to the stated underfunding of $4 billion for past terminations yields a total funding deficiency of $21 billion. Future terminations represent a major burden for the corporation relative to the current accounting obligations.

The new net liabilities of the PBGC are projected in our simulations to accrue at an average rate of $600 million per year and to peak after 15 years at about $2 billion. The precise timing of the liabilities is more difficult to estimate than their present value, which is in essence an average over time. Thus, the results relating to the time pattern of liabilities are of a lower order of certainty than those concerning present values. A couple of summary measures of timing may be useful, however. The liabilities occur over a period whose average length is 29 years and whose (Macaulay) duration is 22 years. These statistics suggest that the problems of the PBGC are long-run, rather than acute, in nature since the burden of the net liabilities incurred by the PBGC falls over a fairly long horizon.

Model diagnostics

To establish the plausibility of the basic results, we compute several additional statistics. Overestimation of the PBGC liabilities could result if either the frequency of terminations or the net liability per termination was overstated. The statistics in Table 2 help to clarify whether either of these problems is encountered in the simulations.

The assumed firm dynamics produce ex post firm failure rates that average 0.9 percent over the course of the simulations. On an annual basis, failure rates run from a low of .2 percent in the 2d year to a high of 1.3 percent in the 25th year (see Figure 1). A higher failure rate implies a greater level of underfunding with respect to the PBGC insurance. The average of the simulated rates is somewhat below the 1.1 percent rate observed over the last four years, a finding which indicates that the estimate of the PBGC's underfunding tends to be conservative in this respect.

The aggregate long-run funding ratio can be used as

[31] Tests suggest that 1,000 repetitions produce statistically stable results.

[32] For instance, Marcus ("Corporate Pension Policy"), operating on a sample of the 100 largest private pension funds in 1982, finds aggregate values ranging between $5.6 billion and $22 billion.

Table 1
Aggregate Simulation Results
Currently Active Firms
Fiscal Year 1986
(In Billions of Dollars)

Future terminations	
Present value of PBGC insurance	30.5
Present value of PBGC premiums	13.7
Underfunding	16.8
Memo:	
Past terminations—PBGC underfunding	3.8
Total PBGC underfunding	20.6
Net new liabilities (annual rate)	
Average	0.6
Maximum (15th year)	1.9
Average life†	29.2 years
Duration‡	21.5 years

†Weighted average time to incurring of net new liability, weighted by amount of net new liability.
‡Weighted average time to incurring of net new liability, weighted by present value of net new liability.

Table 2
Validation Statistics

	Percent
Firm failure rate	
(Equals plan termination rate)	
Average	0.9
Minimum	0.2
Maximum	1.3
Aggregate funding ratio	
(Plan assets/accrued liabilities)	
Initial	122
Long-run (after 100 years)	78

an indication of the relative size of the net liability per termination. Holding the size of the guaranteed liabilities fixed, the higher the funding ratio, the lower the potential cost to the PBGC of assuming the pension plan upon termination. The comparatively low value of 78 percent generated by the simulation results in large part from the tendency of the rules to amortize overfunding more quickly than underfunding. Although this value is lower than levels observed currently in most active pension plans, it is fully consistent with actual amortization rules.

Table 3 contains analysis of the model's sensitivity to parameter values. The results tend to be quite sensitive to the choice of the growth rate of plan benefits (and, in the model, of the firm's debt). The table shows that PBGC underfunding increases by over 20 percent in response to an increase of one percentage point in the growth rate. The two percent growth case leads to a long-run funding ratio that seems low compared to actual experience. On the other hand, the no growth case produces the most favorable results for the PBGC but is unrealistic as a long-run average scenario since it allows for no employment growth over an extended period of time.

Premium structure

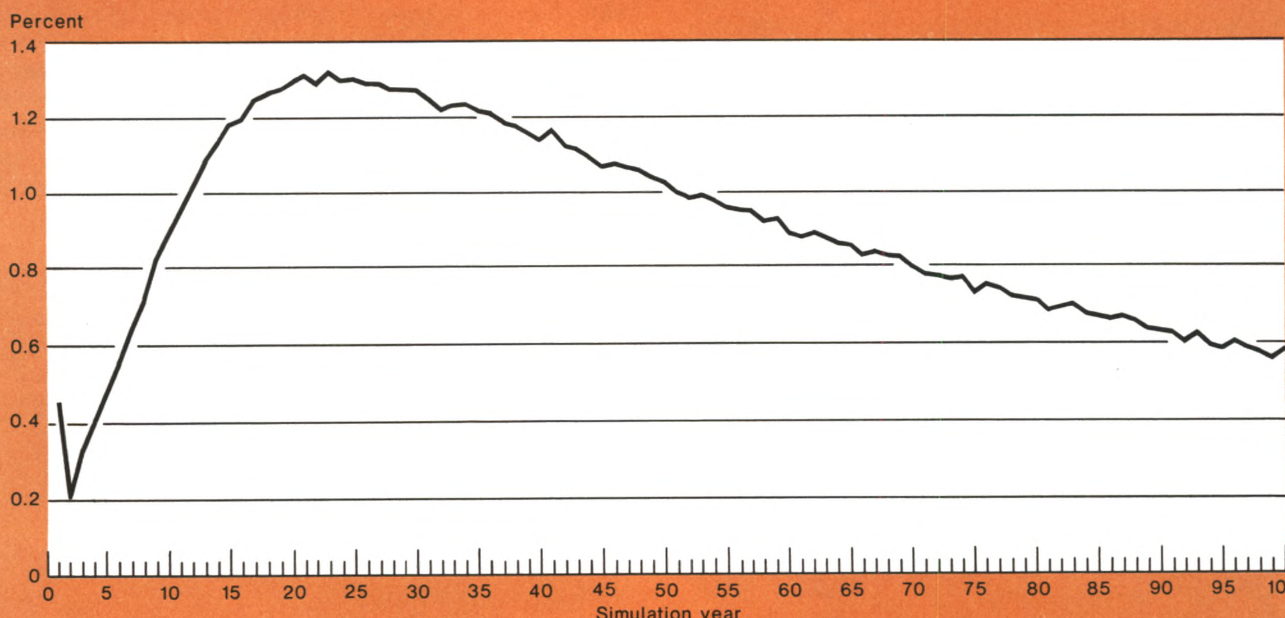
In order to investigate the effects of the latest round of PBGC premium increases, we repeated the base case simulation using the previous flat premium structure of $8.50 per participant per year. The results appear in Table 4. Under the flat premium structure, the present value of future premium payments falls to $5 billion. Given that premiums currently range from $16 to $50, it is not surprising that the present value of the $8.50 constant rate premiums is less than half the $13.7 billion value under the current variable rate regime. Although the value of the insurance is about the same under the two structures, the value of the premiums is higher by about $8 billion when variable rate premiums are imposed, reducing the underfunding by about one third.

The impact of the change in the PBGC premium structure can also be seen by comparing the path of future liabilities implied by our model with the PBGC's own projections as presented in its 1986 annual report. The PBGC estimates are made under the constant premium rate structure and can be contrasted with estimates from our model assuming both constant and variable premium rates.

Figure 1

Annual Failure Rates

Base Case Simulation



To generate its projections, the PBGC report simply extrapolates recent trends in the growth of its assets, liabilities, and operating costs. It provides two sets of estimates, one (Forecast A) based on the trends since the creation of the agency in 1974 and the other (Forecast B) based on the trends over the most recent five-year period. The two sets of estimates are reproduced here in Table 5.

The average year-by-year results of our simulations may be used to produce alternative estimates of the PBGC's net liabilities as they would appear in future annual reports. These liabilities would change from year to year for three basic reasons: they would increase by the interest due on outstanding liabilities as well as by the net new liabilities incurred, and they would decline by the premium income received.

Since our model is estimated in real terms, the results must be adjusted for expected inflation in order to make them comparable to the current-dollar PBGC projections. This may be done by multiplying the resulting estimates by a factor representing the expected cumulative effect of inflation from 1986 to the year of the estimate. The PBGC forecasts assume a discount rate of 7.25 percent. Since our estimates are based on a real discount rate of 2.5 percent, we set the expected inflation rate at a level of 4.75 percent, which is consistent with both of these assumptions.

The PBGC estimates in Table 5 correspond to constant premium rates of $8.50 per employee per year. Hence, estimates from our model using this premium structure also appear in the table. In general, these estimates are close to the lower of the two PBGC projections for the early years and fall between the two projections for the later years.

When estimates based on the new variable-rate premium structure are used, the impact of the change in premiums becomes apparent. Because premiums are currently higher for all firms, the estimated future liabilities are all lower than in the constant premium case. In fact, the liabilities are generally lower than both of the PBGC projections, although they continue to grow significantly over time, more than tripling over the 10-year horizon.

Alternatives for the future

According to our estimates, the funding status of the PBGC is significantly worse than its financial statements would indicate. If liabilities arising from future terminations are taken into account, its total funding

Table 3

Sensitivity Analysis
Liabilities from Future Terminations

	No Growth	Base Case .5 Percent Growth	2 Percent Growth
	In Billions of Dollars		
Present value of PBGC insurance	28.0	30.5	40.3
Present value of PBGC premiums	13.0	13.7	16.9
Underfunding	15.0	16.8	23.4
	Percent		
Average failure rate	0.9	0.9	0.9
Long-run funding ratio	79	78	68

Table 4

Alternative Premium Structures
Base Case Growth (.5 Percent)
(In Billions of Dollars)

	Previous Premium Structure ($8.50 Per Participant Per Year)	Current Premium Structure
Present value of PBGC insurance	30.3	30.5
Present value of PBGC premiums	5.4	13.7
Underfunding	24.9	16.8

Table 5

Year-by-Year Projections of PBGC Reported Liabilities
(In Billions of Dollars)

Year	PBGC Forecast A†	PBGC Forecast B‡	Constant Premiums§	Current Premiums‖
1986	3.8	3.8	3.8	3.8
1987	4.2	4.6	4.0	3.8
1988	4.6	5.5	4.2	3.8
1989	5.2	6.7	4.8	4.0
1990	5.8	7.9	5.5	4.5
1991	6.5	9.4	6.4	5.0
1992	7.4	11.0	7.6	5.8
1993	8.3	12.9	9.2	6.8
1994	9.3	14.9	11.2	8.2
1995	10.5	17.3	13.5	10.0
1996	11.8	19.9	16.4	12.2

†Based on growth trends from 1974 to 1986.
‡Based on growth trends from 1982 to 1986.
§Our estimates, premium rate of $8.50.
‖Our estimates, variable premium rates of $16 to $50.

deficiency is more than five times the value reported. Thus, if the coverage of the insurance is to remain at current levels, additional funding is necessary. Since a deficit has already developed, the problem is particularly pressing.

Who should provide these new funds? When Congress created the PBGC, it intended the corporation to be self-financing. Perhaps the simplest way to resolve the funding problem while adhering to this legislative intent would be to raise the premiums to a level that makes their present value equal to the value of the future insurance provided to the plan participants. This approach is investigated in Table 6 using the results of the simulations. The ratio of the estimated value of the PBGC insurance to that of present value of the premium payments leads to a simple but usable approximation of the premium rate that would solve the current imbalance. The result is not exact in that the greater premiums could affect the financial integrity of the firms and alter the pattern of failures and terminations. In addition, a large increase in premiums could induce some firms to terminate their defined benefit pension plans in order to avoid the additional cost. However, since premiums tend to be small relative to other firm variables, these effects are likely to be of second order.

The simulation of the pre-1987 regime with premiums at a constant rate (Table 4) provides an estimate of the constant premium level that would be required for benefits to match costs. These calculations suggest that a contribution of $48 per employee per year would be necessary. The problem with this type of setup, however, is that it creates disincentives to full funding for sponsors whose plans are substantially underfunded. The variable rate structure was introduced precisely to deal with this kind of moral hazard problem.

An alternative is to retain the current structure that makes contributions dependent on the funding status of the plan—and therefore dependent on the risk to the PBGC—but to raise each of the components of the rate structure by the same proportion. As shown in Table 6, this change would imply premium rates ranging from $36 for fully funded plans to $111 for plans with serious underfunding. This scheme would produce the same present value of premiums as the constant $48, but the burden would be redistributed to reflect the individual risk of the given pension plan.[33]

A different way of dealing with the underfunding problem is related to the negative amortization of overfunding analyzed above. We argued that pension plans tend to be underfunded in the long run because, according to the present rules, overfunding tends to be amortized more quickly than underfunding. Liberalizing the full funding limitation could reduce or eliminate this asymmetry, thus raising the long-run funding level and reducing the PBGC's risk exposure.

The elimination of the full funding limitation would give an incentive to sponsors to contribute more heavily by making additional contributions tax-deductible. Table 7 reports simulation results for a scenario in which firms are always allowed to contribute the normal cost on a tax-deductible basis regardless of the funding status of the plan. The effects are dramatic in that the underfunding is reduced by $16 billion relative to the base case to only $1 billion. A somewhat

[33]This adjustment to the variable rate structure is not unique, in that many combinations will produce the same present value of premiums as the fixed premium system. The adjustment discussed here fixes (at $5667) the maximum per-worker level of underfunding for which the plan sponsor is penalized in the form of a higher PBGC premium. Other systems are possible. In particular, if reducing moral hazard in funding is the goal of the premium structure, a lower "penalty rate" than the $13 imposed by this adjustment could be combined with a higher maximum underfunding level in a way that would maintain the same premium present value.

Table 6
Self-Financing Premium Rates
(Dollars per Participant per Year)

	Actual Premium	Implied Self-Financing Premium
Fixed rate (To end of 1987) (Factor = 30.3/5.4 = 5.61)	8.50	48
Variable rate (1988) (Factor = 30.5/13.7 = 2.23)		
Fixed portion	16	36
Increment†	6	13
Maximum rate	50	111

†Per participant per $1000 of underfunding.

Table 7
No Full Funding Limitation
Base Case Growth
(In Billions of Dollars)

Present value of PBGC insurance	11.7
Present value of PBGC premiums	10.7
Underfunding	1.0
Present value of additional contributions	74.0
Tax revenue loss	25.2
Average failure rate	0.9 percent
Long-run funding ratio	1071 percent

unrealistic feature of these results is that the long-run funding ratio increases to a level of more than 10 to 1. It seems unlikely that such levels would be reached in the aggregate, particularly since such gross overfunding could reasonably be expected to lead to a surge in voluntary plan terminations.[34] Such terminations would both reduce the aggregate funding level and weaken the position of the PBGC by removing the healthiest plans from the pool covered by PBGC insurance. High aggregate funding ratios are observed in this simulation at least in part because the pension model makes no provision for such voluntary terminations.

If the results are so attractive for the PBGC, what are the real costs of such an alternative? Aside from the voluntary terminations issue, one drawback is that tax revenues would be lost by making the additional contributions tax-deductible. In the example, the present value of the tax losses would amount to $25 billion.[35] Since this alternative involves a loss of general revenues, it may be compared to the benefits of providing the additional funding directly from general tax revenues. Bringing the underfunding down to $1 billion through a direct capital infusion would cost taxpayers $16 billion, an amount which is $9 billion less than the cost of eliminating the full funding limitation.

Thus our results suggest that raising the premium rates may be the best current alternative in dealing with the PBGC's funding problems. Relaxing funding limitations appears to be an expensive and ineffective way to keep the PBGC solvent. Even at the exaggerated level reached by the funding ratio when full funding limitations are liberalized, PBGC insurance has significant value and PBGC liabilities exceed assets by $1 billion. Moreover, a provision that bases the individual insurance premiums on the risks involved for the PBGC is the clear choice in handling the moral hazard issue. The present system of making rates dependent on the level of funding is a simple and effective first step. Further progress could be made by taking into account such factors as the riskiness of the fund's portfolio and of the firm's own equity.

In the short run, some stopgap measure may be necessary to prevent cash flow deficiencies resulting from a further deterioration of the PGBC's financial status. Any short-term public funding could be provided in the form of a loan if premium rates are raised to levels that would ultimately suffice to cover the expected liabilities.

Arturo Estrella
Beverly Hirtle

[34]The sponsor of an overfunded pension plan has the option to terminate the plan voluntarily and replace the pension coverage for its workers with annuities. In such terminations, the sponsor is able to recover a large share of the overfunding, since the firm is legally responsible to cover only accrued pension benefits at the time that the plan is terminated. For a more complete discussion of the motives and issues involved in voluntary terminations, see Arturo Estrella, "Corporate Use of Pension Overfunding," this *Quarterly Review*, Spring 1984.

[35]Most of this loss is experienced in the first year, and further losses are incurred for about a dozen years.

Appendix A: Historical Sketch of the PBGC

The PBGC was formed in 1974 under Title IV of the Employee Retirement Income Security Act (ERISA). Established as an independent, self-financing, wholly owned government corporation, the PBGC protects the pension benefits of workers in private defined benefit pension plans.

By year-end 1986, nearly 40 million Americans, or approximately one out of every three workers, were enrolled in pension plans insured by one of the two programs that the PBGC offers. One plan, which is the focus of this paper, covers single employer pension plans; the other covers multi-employer pension plans. Of the 40 million workers enrolled in PBGC plans, 30 million in 110,000 plans were covered by the single employer program in 1986.†

†Pension Benefit Guaranty Corporation, *Annual Report to the Congress*, FY 1986.

In the event that a covered pension plan terminates without sufficient assets to meet liabilities, the PBGC guarantees the enrolled workers' "basic" benefits. Benefits considered basic are all vested retirement benefits, including qualified preretirement survivor annuities and cost of living adjustments (COLAs) that became effective prior to plan termination. These benefits are subject to a maximum payment constraint defined as the lesser of a participant's average monthly earnings during the highest paid consecutive five years or a dollar limit based on the 1974 limit of $750, adjusted proportionally with the Social Security taxable wage base. In 1986, this dollar limit was $1789.77 per month. Although authorized to do so, the PBGC has not insured "nonbasic" benefits such as retiree medical insurance, lump sum payments, and COLAs that became effective after the termination date of the plan.

Appendix A: Historical Sketch of the PBGC *(continued)*

A prerequisite for the PBGC's full guaranty of all basic benefits is that the plan must have been insured for at least five years prior to termination. In addition, any plan amendments that change the basic benefit makeup of a plan must be in effect for at least five years before they are fully insured. Amendments adopted less than five years before plan termination are covered at a rate of 20 percent of the increase per year from the time of the change.

If a plan qualifies for PBGC coverage, the plan's sponsors pay a premium to the corporation in order to participate in the program. This premium is a variable rate equal to a flat rate of $16 per worker per year plus a funding charge of $6 per $1000 of "funding target insufficiency." A funding target insufficiency is defined as the difference between 125 percent of the present value of a plan's vested benefits and the value of the plan's assets. In order to limit a sponsor's costs should a plan be very underfunded, the PBGC imposes a cap of $50 per worker per year. Plans with fewer than 100 workers are exempt from this funding charge and are only subject to the flat rate. The variable rate premium structure was adopted by the PBGC in January 1988. Before this change, plan sponsors were charged a flat rate per participant per year. In 1974, this cost was $1; in 1977, $2.60; and in 1986, $8.50.

Plan sponsors can terminate a plan only under certain circumstances. The Single Employer Pension Plan Amendment Act of 1986 (SEPPAA) details the conditions under which a plan may be terminated. There are three types of terminations: standard, distress, and involuntary. The standard termination occurs when a terminating plan is fully funded or overfunded. In this situation, plan assets must be used to purchase annuity contracts from a licensed insurance company. Any excess assets from an overfunded plan may be recovered by the employer.

The second type of termination is a distress termination. A termination is so designated if a company meets at least one of the four following criteria:

1. It is in bankruptcy liquidation.
2. It is reorganizing under the Bankruptcy Act.
3. It cannot pay its debts and would be unable to continue in business unless the plan terminates.
4. It is experiencing unreasonably burdensome pension costs due solely to a declining work force.

The first two categories are objective. The second two criteria are subjective and require PBGC approval.

The third type of termination is an involuntary termination. In such cases, the PBGC initiates a plan termination if the sponsor is unable to pay benefits when due or to satisfy minimum funding requirements.

In both involuntary and distress terminations, the PBGC assumes ownership of the plan's assets and liabilities. Sponsors are also liable to the PBGC for the full amount of unfunded guaranteed benefits. This liability is separated into two parts. Immediately payable to the PBGC is that portion of the liability equal to the lesser of the value of the unfunded guaranteed benefits or 30 percent of the firm's net worth. The second part is that portion, if any, of unfunded guaranteed benefits in excess of 30 percent of net worth. The PBGC negotiates with the sponsor a package in which this remaining liability is deferred and paid under more commercially favorable circumstances. If an employer is in bankruptcy proceedings, then the first part of the PBGC's claim is given the priority status of a federal tax lien. The second part has the status of an unsecured general creditor. Historically, the PBGC has recovered an average of just 8 cents for every dollar of unfunded guaranteed benefits covered by both claims against plan sponsors.‡

Since its inception in 1974, the PBGC has run deficits in 11 of 13 years as of year-end 1986. By year-end 1986, the accumulated deficit of the PBGC stood at $3.8 billion, an increase of $2.5 billion from year-end 1985.

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‡Pension Benefit Guaranty Corporation, *Promises At Risk* (Washington, D.C., April 1987), p. 18.

Appendix B: The PBGC Insurance Model

This appendix presents the difference equations that compose the PBGC insurance model discussed in the text. The model consists of six equations that describe the dynamic behavior of firm assets and debt, pension plan normal costs and number of participants, and pension fund assets and liabilities. The equations contain the following variables (stock variables are measured at the end of the year):

- A_t = Pension fund assets in year t
- L_t = Pension fund liabilities in year t
- L_t^G = Guaranteed pension fund liabilities in year t
- B_t = Pension fund benefit payments during year t
- C_t = Pension fund contributions during year t
- NC_t = Normal cost portion of pension fund contributions during year t
- m_t = Amortization rate of pension fund overfunding/underfunding during year t
- V_t = Firm assets in year t
- D_t = Firm debt in year t
- P_t = Number of pension plan participants during year t
- π_t = PBGC premium per plan participant during year t.

Given the discussion in the text, the difference equation describing the movement of pension fund assets can be expressed as:

$$A_t = (1 + \alpha_A + z_{A,t})A_{t-1} + C_t - B_t,$$

where α_A is the expected return on pension fund assets (assumed to be constant across time) and $z_{A,t}$ is the random return on fund assets during year t.

The pension fund contribution is the sum of normal costs plus the amortization of any overfunding or underfunding:

$$C_t = NC_t + m_{t-1}(L_{t-1}-A_{t-1}).$$

Under the guidelines established by ERISA, when a pension fund is underfunded, the sponsoring firm must amortize the funding shortage over a period of years. For the purpose of this model, we assume that the amortization horizon is 20 years and that the sponsor uses the expected return on fund assets as the discount rate. These assumptions imply that for underfunded plans,

$$m_t = \alpha_A + \alpha_A/[(1 + \alpha_A)^{20}-1].$$

Sponsors of overfunded plans, on the other hand, are limited by the IRS in the size of the contribution that they may make. Specifically, the firm cannot contribute an amount that will push the assets of the plan beyond the liabilities plus normal costs.† These restrictions imply that:

$$m_t = 1 \qquad \text{if } L_t \leq A_t < L_t + NC_t$$
$$m_t = NC_t/(A_t-L_t) \qquad \text{if } A_t \geq L_t + NC_t.$$

The other component of the pension contribution is the normal cost of the pension plan. We assume that pension benefits and and normal costs grow at the same rate, α_B, per year:

$$B_t = (1 + \alpha_B)B_{t-1}, \text{ and}$$
$$NC_t = (1 + \alpha_B)NC_{t-1}.$$

Benefits may also be expressed as the sum of normal costs plus the expected return on pension fund liabilities:

$$B_t = NC_t + \alpha_A L_{t-1},$$

which leads to the difference equation for pension fund liabilities:

$$L_t = (1 + \alpha_B)L_{t-1}.$$

The sponsor firm's dynamic behavior is described by the movements of firm debt and assets. As noted in the text, firm assets can be expressed as:

$$V_t = (1 + \alpha_V + z_{V,t})V_{t-1} - C_t - \pi_t P_t,$$

where α_V is the expected return on firm assets and $z_{V,t}$ is the random return component. According to ERISA regulations, the PBGC premium is related to the funding status of the pension plan as follows:

$$\pi_t = 16 + \text{MIN}[34,\text{MAX}[0,6(L_t-A_t)/(1000\ P_t)]].$$

The number of pension plan participants is assumed to grow at a constant rate, α_P, per year:

$$P_t = (1 + \alpha_P)P_{t-1}.$$

Finally, firm debt is also assumed to grow at a constant rate, α_D, per year:

$$D_t = (1 + \alpha_D)D_{t-1}.$$

After substitution and simplification, these difference equations may be summarized as follows:

$$(1)\quad NC_t = (1 + \alpha_B)NC_{t-1}$$
$$(2)\quad L_t = (1 + \alpha_B)L_{t-1}$$
$$(3)\quad A_t = (1 + z_{A,t})A_{t-1} + (\alpha_A-m_{t-1})(A_{t-1}-L_{t-1})$$
$$(4)\quad P_t = (1 + \alpha_P)P_{t-1}$$
$$(5)\quad D_t = (1 + \alpha_D)D_{t-1}$$
$$(6)\quad V_t = (1+\alpha_V+z_{V,t})V_{t-1}-NC_t-m_{t-1}(L_{t-1}-A_{t-1})-\pi_t P_t.$$

These equations correspond exactly to those in the text.

When the plan terminates, the value of the PBGC insurance is determined by these six variables. If the pension plan is underfunded at termination, the PBGC assumes the assets and liabilities of the plan and assesses the firm sponsor a fee equal to 30 percent of the net worth of the firm. This fee may not exceed the amount of underfunding, however. Under these rules, the value of the PBGC insurance can be expressed as:

$$\text{PBGC} = \text{MAX}[0,L_t^G-A_t-.3\text{MAX}[0,V_t-D_t]].$$

†This limitation has been tightened by legislation adopted in 1987 that further limits the assets of the fund, including the employer's contribution, to no more than 150 percent of the plan's liabilities. This restriction is binding only if the normal cost exceeds one half of the liabilities. Because of assumptions made in the empirical part of the paper, this constraint is never binding in our model. For a more detailed discussion of this issue, see Estrella and Hirtle, "Implicit Liabilities."