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7 Pension Funding Decisions, Interest Rate Assumptions, and Share Prices

Martin Feldstein and Randall Mørck

The effect of pension obligations on share prices is of intrinsic interest to anyone concerned with the efficiency of capital markets and the nature of corporate financial decisions. More generally, however, the ability of share prices to reflect unfunded pension obligations is an important link in the effect of private pensions on national saving (Feldstein 1978*a*). If unfunded obligations are not fully reflected in share prices, the equity owners will be induced to increase their consumption incorrectly and national saving will be lower than it would be with correct perceptions.

In this chapter we use a new body of data on corporate pensions to evaluate how unfunded pension liabilities influence the value of corporate equities and to begin an empirical examination of the corporate decision not to fund pension obligations fully. The important and novel feature of the new data is information on the interest rate assumed by each firm in evaluating the present value of its pension obligations.[1] Before such interest rate information became available, it was difficult to interpret and compare differences among firms in the extent of unfunded pension obligations. In a previous study, Feldstein and Seligman (1981) warned that the heterogeneity of interest rate assumptions was the source of a potentially serious problem in measuring the key variable in their study of the effect of unfunded pension liabilities on share prices.[2] The new data make it possible to assess the importance of this source of bias and to examine whether the market takes the differences in interest rate assumptions into account in evaluating pension liabilities.

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To understand the link between national saving and the effect of pension obligations on share prices, it is useful to consider the effect of a firm that obtains lower present wages in exchange for a promise of future pension benefits with the same present value but does not fund the resulting pension obligation. As a result, the firm reports higher earnings and adds the earnings to its capital stock. Over time, the firm's capital stock is increased by an amount equal to its unfunded pension obligation. If shareholders correctly perceive the unfunded obligation, they will recognize that the change in the form of employee compensation has not made the shareholders any wealthier, and their consumption will remain unchanged. The net effect of the pension on national saving will therefore be the difference between the firm's additional retained earnings and the reduction in the employee's direct personal saving that is induced by the promise of retirement benefits.[3] If, however, the share price understates the unfunded pension obligation, shareholders will regard themselves as wealthier, increase their consumption, and thus reduce national saving by a corresponding amount.[4]

The effect of unfunded pension obligations has attracted attention not only because a significant fraction of the pension obligations of some firms is now unfunded but also because alternative legal funding requirements could increase the extent to which pension obligations are not explicitly funded. Current Employee Retirement Income Security Act and tax rules require companies to fund their pension obligations over a period of years and permit a deduction in the calculation of taxable income only for the amount contributed to a fund. An alternative rule would be a "book reserving" system in which a firm would not be obliged to fund its pension obligation but could deduct for tax purposes the present value of a pension obligation that it assumes even if it does not fund that obligation as long as it reports the obligation on its "books" (i.e., balance sheet) and finds an appropriate organization like an insurance company or bank to "guarantee" that pension obligation. The national savings impact of unfunded pensions of this type would depend on the ability of share prices to reflect the accumulating liability and therefore to prevent shareholders from increasing their consumption in response to the apparent but artificial increase in the net assets of the firm.

In considering a firm's pension obligations, it is important to distinguish vested benefits from other types of expected pension payments. The vested benefits are those that will be paid to existing retirees and that would have to be paid to current employees even if they left the firm immediately. In addition to these vested benefits, there are also two other types of benefits that a firm or its shareholders might take into account. First, "unvested accrued pension benefits" refer to the benefits that current employees have earned on the basis of their service with the firm

but which have not yet become vested. Second, firms also look ahead and, on the basis of expected employee turnover and projected wages, estimate the pension benefits that current employees are likely to receive when they retire. Firms may use this very broad concept of benefits based on past and future employment for the purpose of determining the tax-deductible contributions that they can make to their pension fund. Pension assets can therefore exceed both vested pension liabilities and total past service liabilities.

Focusing on the vested pension benefits is important for two reasons. First, vested benefits are the only legal obligation of the firm and have been the principal concern of financial analysts who discuss pension obligations. Moreover, as Bulow (1979, 1982) has explained, the cost to the firm of any nonvested pension benefits can in principle be offset by corresponding reductions in wage payments as those benefits become vested. However, as Feldstein and Seligman (1981) note, it is not clear to what extent such wage adjustments are actually made in practice or taken into account by financial analysts. It is noteworthy, though, that while firms are required to report values for vested benefit obligations and sometimes report values for other past service liabilities, the broader measure of total expected liabilities is not reported.

Most of the estimates presented in this chapter refer to the difference between vested pension liabilities and pension assets. The "unfunded vested pension liability" (UVPL) reported by the firms in our sample is in fact negative for more than two-thirds of the firms in our basic sample (92 of 132 firms reported negative UVPL), implying that their pension fund assets exceed their vested liabilities. Moreover, the aggregate value of pension assets of the firm in our sample exceed the aggregate value of vested pension liabilities. Some analyses using the broader measure of total unfunded accrued pension liabilities (UAPL) will also be reported. For this variable, 62% of the firms in our basic sample reported a negative value.[5]

Those firms with negative unfunded liabilities have accumulated more in pension assets than the present value of the pension benefits they have promised to their employees. If these benefit promises establish an upper limit on the extent to which the pensions depress private saving,[6] the "superfunded" pensions are potential net contributors to national saving. The extent to which superfunded pensions do increase national saving depends on the response of shareholders. To the extent that share prices ignore the value of these excess reserves, the extra corporate pension fund accumulations will not be offset by reduced shareholder saving. Our analysis will generally treat underfunded and superfunded pension liabilities symmetrically by using a single variable to represent the net liability of firms. In section 7.4, however, we will examine this symmetry assumption explicitly.

The first section of the chapter discusses the data that we use and the basic specification of the corporate valuation equations that are estimated in this chapter. In section 7.2 we present the basic estimates of the effect on firms' market values of the net unfunded pension liabilities that the firms report. The third section discusses the importance of the alternative interest rate assumptions used in calculating the present value of liabilities and presents alternative estimates based on the use of a common interest rate for all firms.

The analysis in sections 7.2 and 7.3 estimates linear relations between the market value of the firm and the net unfunded pension liabilities. Section 7.4 considers two generalizations of this basic specification: separate effects of pension assets and of liabilities, and different effects of positive and negative unfunded liabilities. The fifth section provides some evidence on why firms choose different interest rate assumptions for valuing pension liabilities and, more generally, why firms have different unfunded pension liabilities. There is a brief concluding section that summarizes the fundings, comments on the implication for national saving, and indicates some possible directions for future research.

7.1 The Specification and Data

The framework for our analysis is a valuation model that relates the market value of the firm per dollar of its physical capital to several basic determinants of market value including the firm's unfunded pension liability. The basic specification is thus the same as that used in Feldstein and Seligman (1981) and therefore builds on earlier studies of market valuation by Modigliani and Miller (1958), Gordon (1962), Oldfield (1977), Tobin and Brainard (1977), and others.

Under certain strict conditions, the market value (V) of a firm's equity and debt will be equal to the replacement value of its underlying physical assets (A). More generally, however, the marginal and average values of physical assets will not be the same,[7] and even the marginal value of an additional amount of physical capital will differ from one if there are distortionary taxes[8] or if the firm's capital stock is not in equilibrium. Differences among firms in the observed valuation ratio, $q = \text{V/A}$ will reflect perceived differences in the firms' abilities to provide above-average earnings and in the riskiness of their earnings and asset value.

The potential earning ability of a firm depends on such things as market position, patents, know-how, etc. The specification used in the present study represents future earnings by three variables: (1) the current ratio of earnings to physical assets, E/A, where E includes interest payments as well as equity profits;[9] (2) the growth of earnings over the past decade, GROW;[10] and (3) expenditure on research and development as a fraction of the value of the firm's physical assets, RD/A.

The capital asset pricing model implies that the risk of investment in a firm's equity should be measured by the beta coefficient measure of the sensitivity of the firm's share price to the value of the total market portfolio. The beta value for a firm depends on how broadly the "total market portfolio" is defined (equities only; all financial assets; all investment assets including land, gold, etc.) and on the frequency of the observations used for calculating the beta coefficient (daily, monthly, annual, etc.). The present study employs the widely available beta values based on monthly observations and an equity market portfolio that is calculated by Merrill, Lynch, Pierce, Fenner, and Smith.

A second measure of risk included in the current study is the ratio of the net debt to total capital, *DEBT/A*.[11] A higher debt ratio increases the risk of bankruptcy and limits the firm's ability to undertake potentially profitable investment activities.[12]

Because unfunded vested pension liabilities are a form of corporate debt,[13] they should in principle be included with other debts in measuring the market value of the firm (V) and in calculating the net DEBT variable. If the pension liability of the firm were accurately measured,[14] the unfunded vested liability could be added directly to the market value of conventional debt or, equivalently, could be included on the right-hand side of the equation (divided by the replacement value of physical assets) where the expected value of its coefficient would be minus one. More generally, however, the coefficient of the observed unfunded vested pension liability variable, *UVPL/A*, reflects the errors in the measurement of unfunded pension liabilities and the stock market's ability to perceive and reflect the existing liabilities.

The specification of the market valuation equation is thus

$$(1) \qquad \frac{V}{A} = \alpha_0 + \alpha_1 \frac{E}{A} + \alpha_2 \, GROW + \alpha_3 \frac{RD}{A} + \alpha_4 BETA + \alpha_5 \frac{DEBT}{A} + \alpha_6 \frac{UVPL}{A} + \varepsilon,$$

where ε represents a random error. The values of α_1, α_2, and α_3 are expected to be positive, and the values of α_4 and α_6 are expected to be negative. The sign of α_5 (the coefficient of the debt variable) is uncertain. In a strict Modigliani-Miller world, α_5 would be zero. More generally, the increased risks of bankruptcy and the adverse effect of debt on investment opportunities would imply that α_5 is negative. However, if the tax factors discussed by Auerbach (1979) and King (1977) make the value of *V/A* less than one for equity while the value of *V/A* for debt is equal to one, firms with higher ratios of debt to physical assets will have higher values of *V/A* and α_5 may be positive.

As we noted in our introduction, our analysis will examine both the

unfunded vested pension obligations and the broader measure of the total unfunded accrued liabilities ($UAPL/A$).

The specification of equation (1) assumes that the valuation ratio (q) is the same for debt and for equity. If, because of tax or risk factors, a dollar of retained earnings is not worth the same amount as a dollar of capital financed by debt, it would be more appropriate to analyze the effect of pension liabilities on the equity value of the firm (VE). This alternative equity value equation may be written

$$(2) \qquad \frac{VE}{AE} = \beta_0 + \beta_1 \frac{EE}{AE} + \beta_2\, GROWE + \beta_3 \frac{RD}{AE} + \beta_4\, BETA + \beta_5 \frac{DEBT}{AE} + \beta_6 \frac{UVPL}{AE} + \varepsilon,$$

where AE is the "equity value" of the physical assets (i.e., the replacement value of the physical assets minus the value of the net debt and of the preferred shares), EE is the equity earnings of the firm, and $GROWE$ is the 10-year growth of equity earnings. For this purpose, EE is defined as profits after tax plus the equity owners' real gain or loss on net financial assets (i.e., the product of the inflation rate and the firm's net financial debt).

Our analysis is based on data for a sample of large manufacturing firms for 1979. The construction of most of the variables uses the data in the Standard and Poor's Compustat file. Three factors limit the size of the available sample. First, since comparable information on earnings for the decade from 1970 through 1979 must be available, firms that were engaged in significant merger activity had to be eliminated. Second, the interest rate assumed in the pension liability calculation was only available for 1979 for some firms. Third, the information required for inflation adjustment (described below) was not available for all firms. These data requirements and the elimination of a few statistical outliers reduced the sample to 132 firms.

Economists have long recognized that accounting data for assets and earnings can be very misleading in a period of inflation like the 1970s. Beginning with 1976, firms were required to provided information on the replacement value of the firm's capital stock and on the effect of inflation on the value of accounting depreciation and inventory costs. With this information and an estimate of the inflation gain on net financial liabilities, it is possible to estimate an inflation-adjusted measure of accounting profits. This was the procedure found in the earlier Feldstein-Seligman analysis for 1976 and 1977.

Despite the accounting requirement to provide inflation-adjusted information and the widespread recognition of the distortions created by inflation, most financial analysts have continued to focus exclusively on

the traditional accounting measures of assets and income. One important indication of this tendency to disregard the inflation-adjusted data is that by 1979 Standard and Poor's no longer included the inflation-adjusted accounts in its Compustat file.

Because we are concerned with market valuation and the perception of the financial community, we have done our analysis with the conventional accounting data as well as with data adjusted for inflation. Because the inflation-adjusted data are not available in the Compustat file, we have approximated the inflation correction for 1979 by using data for 1980 collected from individual annual reports by Daniel Smith and Lawrence Summers and then deflated to the 1979 level. One of the principal accounting distortions caused by inflation is the misstatement of inventory costs for firms that use first-in-first-out (FIFO) inventory accounting. As a further check on our results, we also present estimates only for those firms that used last-in-first-out (LIFO) as the primary method of inventory evaluation.

We are aware of the difficulty of making valid inferences about the effect of unfunded pension liabilities on the basis of equations like (1) and (2). Any omitted variables will bias the estimated coefficient. If, for example, large unfunded vested liabilities are characteristic of financially weak companies, the estimates of β_b and α_b would reflect this weakness and be biased away from -1. Moreover, firms can to some extent influence the size of their reported liabilities by the interest rate assumption that they choose.

A finding that the coefficient of the pension liability variable is substantially different from -1 must be treated with substantial caution since the difference may reflect statistical bias rather than a failure of the financial market to appraise the extent of a firm's pension obligations. In contrast, a finding that the pension liability variable has a coefficient of approximately -1 would be reassuring support for the view that the financial market correctly assesses pension liabilities since finding the appropriate answer by chance alone, although possible, would be very unlikely.

7.2 Effects of Unfunded Pension Liabilities

In this section we present the basic estimates of the effects on the value of the firm of the net pension liabilities as reported by the firms. The next section discusses the importance of the interest rate assumption used in valuing pension liabilities and their present parameter estimates based on alternative revaluated pension liabilities. The estimates in Section 7.4 examine several general specifications of the relation between pension liabilities and the firm's market value.

Equation (1.1) of table 7.1 reports the estimated coefficients corresponding to the specification of equation (1) in the previous section of this

Table 7.1 **Reported Pension Liabilities and the Market Value of the Firm**

		Total Market Value of Debt and Equity					
		Eq. (1.1)[ac]	Eq. (1.2)[ac]	Eq. (1.3)[ad]	Eq. (1.4)[ad]	Eq. (1.5)[bc]	Eq. (1.6)[bc]
Unfunded vested liability	*UVPL/A*	−1.43 (0.82)	—	−1.72 (0.83)	—	−1.70 (0.60)	—
Unfunded accrued liability	*UAPL/A*	—	−1.42 (0.65)	—	−1.43 (0.65)	—	−1.59 (0.48)
Earnings	*E/A*	2.06 (0.38)	2.09 (0.38)	1.30 (0.34)	1.31 (0.34)	4.98 (0.41)	5.05 (0.40)
Growth	*GROW*	0.15 (0.22)	0.17 (0.22)	0.28 (0.22)	0.28 (0.22)	0.33 (0.16)	0.34 (0.16)
Research	*RD/A*	8.13 (1.02)	8.25 (1.00)	4.31 (1.36)	4.66 (1.35)	5.22 (0.88)	5.33 (0.87)
Beta coefficient	*BETA*	−0.17 (0.08)	−0.17 (0.08)	0.05 (0.09)	0.05 (0.09)	−0.19 (0.08)	−0.18 (0.08)
Leverage	*DEBT/A*	0.20 (0.17)	0.20 (0.17)	0.26 (0.19)	0.25 (0.18)	0.34 (0.14)	0.34 (0.14)
Constant	*C*	0.67 (0.10)	0.68 (0.10)	0.46 (0.11)	0.47 (0.11)	0.41 (0.13)	0.43 (0.13)
Sample size	*N*	132	132	85	85	132	132
$\bar{R}^2$		0.51	0.51	0.28	0.28	0.68	0.68
SSR		13.35	13.18	5.34	5.30	16.05	15.72

Note: See text for definitions. Standard errors are shown in parentheses. Pension liabilities are reported amounts.

[a]Inflation adjusted.

paper. The sample contains all 132 firms and uses inflation-adjusted accounting measures of income and assets. The mean of the dependent variable, the ratio of the firm's market value to the current value of its physical assets, is 0.87.

Before discussing the coefficient of the pension variable, it is useful to comment on the coefficients of the other variables. An increase in the firm's capital income (i.e., the debt and equity earnings, E) per dollar of physical assets increases the market value of those assets. An extra dollar of current earnings adds approximately two dollars to the market value of the firm. The coefficient of *GROW* suggests that a higher rate of past increase of earnings may lead to a higher market value but the coefficient

	Market Value of Corporate Equity					
	Eq. (1.7)[ac]	Eq. (1.8)[ac]	Eq. (1.9)[ad]	Eq. (1.10)[ad]	Eq. (1.11)[bc]	Eq. (1.12)[bc]
UVPL/AE	−1.48	—	−1.73	—	−0.67	—
	(0.84)		(0.80)		(0.69)	
UAPL/AE	—	−1.45	—	−1.41	—	−0.76
		(0.66)		(0.60)		(0.51)
EE/AE	2.14	2.16	1.35	1.34	3.98	3.96
	(0.43)	(0.42)	(0.37)	(0.37)	(0.38)	(0.38)
GROWE	0.15	0.18	0.24	0.26	0.30	0.33
	(0.25)	(0.25)	(0.25)	(0.25)	(0.19)	(0.19)
RD/AE	7.44	7.54	3.59	3.97	4.45	4.32
	(0.95)	(0.93)	(1.26)	(1.25)	(0.95)	(0.94)
BETA	−0.30	−0.29	−0.02	−0.01	−0.42	−0.40
	(0.11)	(0.10)	(0.11)	(0.11)	(0.16)	(0.16)
DEBT/AE	0.00	0.02	0.12	0.13	−0.06	−0.05
	(0.10)	(0.10)	(0.09)	(0.09)	(0.06)	(0.06)
C	0.83	0.84	0.50	0.51	1.13	1.13
		(0.13)	(0.13)	(0.13)	(0.20)	(0.20)
N	132	132	85	85	132	132
$\bar{R}^2$	0.44	0.45	0.23	0.24	0.75	0.76
SSR	23.43	23.12	8.41	8.34	54.61	54.07

[b]Not inflation adjusted.
[c]Inventory method = all.
[d]Inventory method = last in first out.

is smaller than its standard error.[15] Companies that spend more on research and development have significantly greater market value, a relationship that should be interpreted with care since it presumably reflects the market's valuation of the general character of companies that spend more on research rather than a direct effect of research spending on the firm's market value. All three of these effects are similar to the estimates for 1976 and 1977 reported in Feldstein and Seligman (1981).

A greater riskiness of the firm, as measured by its beta coefficient, depresses the firm. This is consistent with the theoretical implications of the capital asset pricing model, although contrary to the insignificant effect found for 1976 and 1977. The weak positive effect of leverage on

the firm's total value is also contrary to the earlier Feldstein-Seligman finding. One possible explanation of this difference is that the sharp increase in inflation (the consumer price index rose 4.8% and 6.8% in 1976 and 1977, but 13.3% in 1979) might have raised the equity value of the firms with greater net debt (Summers 1982).

The coefficient of the unfunded vested liability variable (*UVPL/A*) is −1.43 with a standard error of 0.82. The effect is thus clearly significantly negative and not significantly different from minus one. By coincidence, this coefficient is almost identical to the 1977 value of −1.44 (standard error 0.47) reported by Feldstein and Seligman (1981). The estimate is consistent with the view that the financial market accepts the conventional measure of the net unfunded vested pension liability and reduces the market value of the firm by an equal amount.[16]

Broadening the definition of unfunded liabilities from vested liabilities to accrued liabilities (eq. [1.2]) leaves all of the parameter estimates essentially unchanged. The coefficient of *UAPL/A*, is −1.42 with a standard error of 0.65. The sum of squared residuals (SSR = 13.18) is slightly smaller than the corresponding SSR for the vested pension liability, suggesting that the financial market may give more weight to the broader means of pension liabilities.

One purpose of the inflation adjustment is to correct the understatement of production costs for firms that do not use the LIFO method of inventory accounting. By 1979, the inflation adjustment had become extremely important; for all nonfinancial corporations as a whole, the inflation adjustment was more than 60% of real after-tax profits. As a further check, we therefore estimated the basic equation for the subset of 85 firms that used LIFO as the primary method of inventory accounting. The results, presented in equations (1.3) and (1.4), are essentially the same as for the entire sample.

Although our emphasis is on the estimates using inflation-adjusted data for earnings and assets, we recognize that the financial community continues to rely primarily on conventional accounting data. We have therefore reestimated the basic equations using the conventional accounting figures; the results are shown in equations (1.5) and (1.6).[17] The estimates of the unfunded pension liability variables are essentially unchanged; they are slightly larger than with the inflation-adjusted data, but the difference is less than one standard error. Earnings, earnings growth, and debt appear to have a larger effect on the value of the corporation, and the level of research and development spending has a smaller effect. The unfunded accrued liabilities continue to have slightly greater explanatory power than the unfunded vested liabilities.

The second set of six equations in table 7.1 are based on the equity value of the firm and used the specification of equation (2) in section 7.1.[18]

The coefficients of the four equations estimated with inflation-adjusted data (eq. [1.7]–[1.10]) are essentially identical to the corresponding coefficients based on the market value of debt and equity (eq. [1.1]–[1.4]). This similarity of results with the two specifications was also found for 1976 and 1977 by Feldstein and Seligman (1981). When the conventional accounting data are used without adjustment for inflation (eq. [1.11], [1.12]), the coefficients of the unfunded pension liability variables are reduced substantially to approximately -0.7 and are about equal in size to their standard errors. On the basis of these two coefficients alone, one could not reject the hypothesis that the true parameter is either zero or minus one. Although we regard the instability of the coefficients estimated with conventional accounting data as evidence against relying on such data without inflation adjustment, we recognize that these estimates can also be interpreted as raising some doubt about the conclusion that the coefficient of the pension variable is significantly negative. We shall therefore continue to present estimates in the later sections of the chapter based on the conventional accounting data as well as on the inflation-adjusted data.

7.3 Alternative Interest Rate Assumptions

It has been customary for pension actuaries to assume a low rate of interest in calculating the present value of pension liabilities. Thus the average interest rate assumed by the 132 firms in our sample was only 7.3%, far less than the 12.1% rate on Baa bonds that prevailed at the end of 1979 or the 10.7% average Baa rate for the year 1979 as a whole.[19] Using a low discount rate increases the present value of vested pension benefits and therefore of the unfunded pension liability.

In considering the effect of the interest rate assumption, it is important to distinguish between vested pension liabilities and the total future pension benefits that a firm expects to pay to its current employees and on the basis of which it may legally determine its funding contributions. In estimating the total future pension benefits, the firm must project the employees' future wage growth (as well as the probabilities of death and of employment separation). The typical pension benefit formula relates an individual's retirement benefits to his wage during a year or a few years immediately before retirement. The present value at any time in an employee's career of the benefits that he will be paid during his first year of retirement depends on the difference between the discount rate and the projected rate of growth of wages. Since pension actuaries have generally assumed a low rate of wage growth, the use of a low discount rate may not produce as substantial a bias in their estimates of total future pension liabilities as it might at first appear. The value of benefits to be

paid after retirement, however, depends only on the discount rate, implying that the present value of total future pension benefits is typically overstated.

Vested pension benefits depend only on an employee's previous experience with the firm. Although that experience will entitle the employee to greater future benefits if he stays with the firm,[20] the future annual value of his benefit is fixed if he leaves the firm immediately. Thus, in calculating the present value of vested benefits, the likely future growth of wages is irrelevant. The assumptions of an artificially low interest rate unambiguously raises the value of vested pension liabilities.[21] The same upward bias occurs in the calculations of the present value of unvested benefits based on past service and therefore on the total accrued pension liability.

The 132 companies in our sample assumed interest rates that ranged from 5% to 10.5%. For all but 13 companies, the rate was between 6% and 9%. The assumed interest rates thus differ significantly from each other and from the actual rate of return available on pension fund assets. Since the firms reported pension assets and vested liabilities that are approximately equal in value,[22] a change in the interest rate could have a significant effect on the estimate of unfunded liabilities and therefore potentially on the estimated regression coefficient of this variable in the market value equation.

The effect that changes in the interest rate assumption can have on the present value of vested pension benefits depends on the current distribution of vested benefits among employees and retirees of different ages. Table 7.2 shows the actuarial present value of a dollar a year from age 65 until death evaluated at ages between 45 and 70 for three different interest rates.[23] The closer an employee is to retirement, the nearer in time are his benefits and the less sensitive is their present value to the interest rate assumption. For example, increasing the discount rate from 6% to 8% reduces the value of the pension benefit by 14% at age 65 but 21% at age 60.

Unfortunately, data are not available for each firm on the distribution of vested pension benefits by employee and retiree age. Although the actual distribution will differ among firms, it is clear that most of the "weight" of the typical vested pension distribution is among retirees and older employees in the years just before retirement. This concentration reflects three things. First and most important, the benefits of retirees and older workers are closer in time and therefore subject to less mortality risk and less interest rate discounting. Table 7.2 shows that the present actuarial value of a given benefit is reduced to half or less between the ages of 65 and 55. Moreover, the actuarial present value of a one-dollar annual benefit at age 70 is worth more than the prospect at age 60 of a one dollar benefit from age 65. Second, older workers and retirees have

Table 7.2 **Actuarial Present Value of One Dollar Annual Pension from Age 65**

	Interest Rate		
Age	.06	.08	0.10
70	6.5	5.9	4.3
65	9.0	7.9	6.5
60	6.0	4.9	3.6
55	4.3	3.2	2.2
45	2.2	1.3	0.8

generally accumulated more years of service with a firm and vested benefits are generally proportional to the number and years of service after an initial period. Finally older workers generally have higher earnings and vested benefits are also proportional to earnings.[24]

Bulow (1979) reports that professional actuaries often assume as a rule of thumb that the age distribution of vested benefits is such that the overall present value of vested benefits is inversely proportional to the rate of interest. It is clear from table 7.2 that the actual relation differs by age and that the inverse proportionality rule holds at about age 55 for a comparison of 6 and 8 percent interest rates and at about age 65 for a comparison of 8% and 10% interest rates. Our analysis in this paper uses the inverse proportionality assumption because data for developing a better weighting are not available. While we believe that the resulting estimates of vested pension liabilities are an improvement over using the reported values with varying interest rate assumptions, we caution that the adjustment procedure is only an approximation. It would clearly be desirable to obtain information on the age distribution of vested benefits for all companies in the sample or even for a smaller sample of companies that might be used to develop weights to apply to figures like those of table 7.2.

We have made two different types of interest rate adjustments in recalculating pension benefits. First, we standardized all pension liabilities to the Baa bond rate of 12.1% prevailing at the end of 1979. Since no firm used an interest rate even remotely as high as this, it seems unlikely that the financial market implicitly used such a high rate in evaluating the unfunded pension liabilities. This is confirmed by the estimates presented below that show using such a high discount rate reduces the explanatory power of the market valuation equation and causes the coefficient of the pension liability variables to be small and insignificant.

The second adjustment standardizes all pension liabilities to a discount rate of 7.2%, the average rate used by the 132 firms in the sample. This

has the effect of eliminating the relative overstatements and understatements of pension liabilities that result from the variety of interest rate assumptions while changing very little the estimated liability for firms that use a rate close to the average for the group. It is equivalent to assuming that financial markets adjust the stated pension liabilities for deviations from common practice rather than for deviations from a Baa rate.

Table 7.3 summarizes the effect of different interest rate assumptions on the estimated impact of pension liabilities on the market value of the firm. The estimates are based on the specifications presented in table 7.1 and therefore in equations (1) and (2) of section 7.1. For each equation, table 7.3 presents only the estimated pension liability coefficient and the sum of squared residuals for the corresponding equation.

Consider first the effect of the unfunded vested liability on the total market value of the firm. Using inflation-adjusted data and the reported value of the unfunded vested liability implies a regression coefficient of -1.43 with a standard error of 0.82. This figure was presented in equation (1.1) of table 7.1 and is repeated in the first row of table 7.3 corresponding to the "actual" interest rate.

The present value of vested benefits discounted at the Baa rate is approximated by multiplying each firm's reported liability by the ratio of its actual interest rate to the 1979 year-end Baa rate of 12.1%. With this adjustment, almost all firms had negative unfunded vested liabilities. Pension assets exceed the recalculated vested liabilities by amounts that averaged 8.7% of the replacement value of the firm's physical assets. With these adjusted unfunded vested liabilities, the estimated regression coefficient is only -0.31 with a standard deviation of 0.43. The corresponding sum of squared residuals (13.65) is greater than the sum of squared residuals with the actual interest rate (13.35), however, implying that the Baa rate is a less likely specification of the market-valuations model.

By contrast, adjusting the vested pension liabilities to the common average interest rate of 7.2% provides a substantially better explanation of the data (the sum of squared residuals is only 12.89) and implies a regression coefficient of -0.90 with a standard error of 0.33. This evidence is consistent with the view that the financial markets disregard the differences caused by interest assumptions and evaluate pension liabilities in terms of a common average discount rate. Although we have not done a search over different possible interest rates to find a maximum likelihood estimate of this parameter, it is clear that the assumed average rate of 7.2 is substantially more likely than either the Baa rate or the variety of rates actually used by the individual companies. The regression coefficient of -0.90 with a standard error of 0.33 strongly supports the view that unfunded vested pension obligations, when correctly valued, depress the value of the firm by approximately one dollar for every dollar

Table 7.3 **Estimated Effect of Liabilities with Alternative Interest Assumptions**

Interest Rate	Total Market Value of Debt and Equity				Market Value of Equity			
	Vested Liability		Accrued Liability		Vested Liability		Accrued Liability	
	Coefficient	SSR	Coefficient	SSR	Coefficient	SSR	Coefficient	SSR
	Inflation Adjusted							
Actual	−1.43 (0.82)	13.35	−1.42 (0.65)	13.18	−1.48 (0.84)	23.43	−1.45 (0.66)	23.12
Baa	−0.31 (0.43)	13.62	−0.48 (0.43)	13.53	−0.39 (0.37)	23.81	−0.56 (0.37)	23.60
Average	−0.90 (0.33)	12.89	−0.89 (0.29)	12.73	−0.92 (0.29)	22.27	−0.88 (0.26)	22.02
	Not Inflation Adjusted							
Actual	−1.70 (0.60)	16.05	−1.59 (0.48)	15.72	−0.67 (0.69)	54.61	−0.76 (0.51)	54.07
Baa	0.04 (0.35)	17.09	−0.14 (0.34)	17.07	−0.65 (0.29)	52.87	−0.79 (0.28)	51.81
Average	−0.64 (0.25)	16.26	−0.65 (0.23)	16.04	−0.85 (0.20)	47.88	−0.73 (0.17)	47.99

Note: The coefficient values are the estimated coefficients of the pension liability variable in the specification of equation (1) or (2). Standard errors are shown in parentheses. SSR is sum of squared residuals.

of unfunded obligation or, equivalently, raise the market value of the firm by one dollar for every dollar of pension assets in excess of the vested pension liability.

The results for the total accrued liabilities are very similar. The constant average interest rate has the best explanatory power (with a sum of squared residuals of 12.73) and a coefficient of −0.89. Comparing the sums of squared residuals for total accrued liabilities and vested liabilities suggests that the accrued liability provides a slightly better explanation of the market value of the firm. But the choice between vested and accrued liabilities does not influence the conclusion that the common average interest rate is best and that the effect of net pension liabilities on the market value of the firm is approximately dollar for dollar.

Changing the specification from the total market value of the firm to the market value of equity also has virtually no effect on the estimated coefficients of the unfunded pension liability variables. The specification with the lowest sum of squared residuals again corresponds to the unfunded accrued liability evaluated with the common average rate of return.

When the conventional accounting data are used without inflation adjustment, the estimated coefficients are less stable. For the total market value of the firm, the evidence indicates that the best specification uses the actual interest rate and unfunded accrued liabilities. The coefficient of the pension liability variable is −1.59 with a standard error of 0.48. The Baa rate has a substantially higher residual sum of squares. With the common average interest rate, the coefficient is −0.05 with a standard error of 0.23.

Finally, for the market value of the corporate equity, the best specification corresponds to the common average interest rate. The coefficient of the unfunded vested pension liability is −0.85 with a standard error of 0.20 and therefore quite similar to the estimate with the inflation-adjusted variables. Because the unfunded pension liabilities evaluated at a common average interest rate generally have a better explanatory power than the corresponding reported pension liabilities, we have reestimated the specifications of table 7.1 with these more appropriately measured pension variables. The results are presented in table 7.4. The coefficients of the pension variables estimated for our entire sample of firms have already been discussed in conjunction with table 7.3. For the sample of firms that use LIFO inventory accounting, the unfunded pension liabilities are between −1.54 and −2.03. The coefficients of the other variables are quite similar to their values in table 7.1.

Although we have included five variables that can influence the market value of the firm, it is of course still possible that the unfunded pension liability is correlated with some other omitted variable and that the apparent effort of the unfunded pension liability is really only a reflection

of this omitted variable. In particular, it might be argued that "strong" companies fully fund or overfund their accumulated liabilities while "weaker" companies have large unfunded liabilities. To the extent that this is true and that corporate strength and weakness are not reflected in the other variables, the negative coefficient of the unfunded liability will reflect the corporation's generally weak financial position. Although it is clearly impossible to rule out completely such an "omitted variable" argument, we have tried to test for the importance of such an effect by reestimating the inflation-adjusted equations of table 7.4 with the company's bond rating as an additional variable. The bond rating represents an expert judgment about the long-term financial strength of the company. To incorporate this variable, we use the Moody's bond rating for the longest maturity bond issued in 1979 and scale this rating from a 9 for an Aaa rated bond to 4 for a B rated bond.

For the equations determining the total market value of debt and equity, the coefficient of this variable was small (0.04) and barely larger than its standard error. Including it in the equation actually raised the absolute value of the coefficient of the pension liability variable. For the equation determining the market value of corporate equity, the coefficient of the bond rating variable is slightly larger (about 0.09) and about twice its standard error. Including this variable reduces the coefficient of the unfunded pension liability variable by approximately 0.05. Thus including a general measure of the financial strength of the company does not alter the estimated effect of unfunded pensions.[25]

7.4 Additional Specification

The estimates presented in the previous sections assume that there is a linear relation between the market value of the firm and its unfunded vested pension liabilities. This specification implies that a one-dollar increase in the firm's pension liability has the same effect on the firm's value as a one-dollar decrease in the value of the firm's pension assets. The linear specification also implies that the market responds in the same way to unfunded liabilities that are positive as it does to unfunded liabilities that are negative. The present section presents estimates that relax these constraints.

7.4.1 Separating Assets and Liabilities

The equations in table 7.5 include the value of pension assets per dollar of the firms' physical assets (PA/A or PA/AE) as well as the unfunded pension liability variables. All of the equations are based on inflation-adjusted data and separate estimates are presented using the reported pension liabilities and liabilities adjusted to a common average discount rate.

Table 7.4 **Adjusted Pension Liabilities and the Market Value of the Firm**

		Total Market Value of Debt and Equity					
		Eq. (4.1)[ac]	Eq. (4.2)[ac]	Eq. (4.3)[ad]	Eq. (4.4)[ad]	Eq. (4.5)[bc]	Eq. (4.6)[bd]
Unfunded vested liability	*UVPL/A*	−0.90	—	−1.80	—	−0.64	—
		(0.33)		(0.60)		(0.25)	
Unfunded accrued liability	*UAPL/A*	—	−0.89	—	−1.54	—	−0.65
			(0.29)		(0.50)		(0.23)
Earnings	*E/A*	1.97	1.98	1.25	1.28	4.88	4.90
		(0.38)	(0.37)	(0.33)	(0.33)	(0.41)	(0.41)
Growth	*GROW*	0.06	0.06	0.33	0.33	0.24	0.24
		(0.21)	(0.21)	(0.21)	(0.21)	(0.16)	(0.16)
Research	*RD/A*	7.75	7.75	3.96	4.36	5.35	5.36
		(1.02)	(1.01)	(1.33)	(1.31)	(0.89)	(0.88)
Beta coefficient	*BETA*	−0.20	−0.20	0.06	0.07	−0.23	−0.22
		(0.08)	(0.08)	(0.09)	(0.09)	(0.08)	(0.08)
Leverage	*DEBT/AE*	0.22	0.22	0.29	0.29	0.37	0.38
		(0.17)	(0.17)	(0.18)	(0.18)	(0.15)	(0.15)
Constant	*C*	0.66	0.67	0.45	0.46	0.42	0.42
		(0.10)	(0.10)	(0.10)	(0.10)	(0.13)	(0.13)
Sample size	*N*	132	132	85	85	132	132
$\bar{R}^2$		0.52	0.53	0.32	0.32	0.67	0.68
SSR		12.89	12.73	5.05	5.03	16.26	16.04

Note: See text for definitions. Standard errors are shown in parentheses. Pension liabilities adjusted to a common average interest.

[a]Inflation adjusted.

The coefficients in equation (5.1) are representative of all of the equations for total market value of debt and equity in this table. The estimated parameter values for the nonpension variables are very similar to the corresponding figures in equation (1.1) of table 7.1, which had the same specification without the separate pension assets variable. The coefficient of unfunded vested pension liabilities is now slightly lower (−1.14 with a standard error of 0.82), while the coefficient of the pension assets variable is −0.55 with a standard error of 0.28.

Including the pension asset variable is equivalent to estimating separate coefficients for vested pension liabilities and pension assets. The coefficient of *UVPL/A* measures the effect of increases in vested pension liabilities (−$1.14 of market value per dollar of vested pension liability),

	Market Value of Corporate Equity					
	Eq. (4.7)[ac]	Eq. (4.8)[ac]	Eq. (4.9)[ad]	Eq. (4.10)[ad]	Eq. (4.11)[bd]	Eq. (4.12)[bd]
UVPL/AE	−0.92	—	−2.03	—	−0.85	—
	(0.29)		(0.54)		(0.20)	
UAPL/AE	—	−0.88	—	−1.61	—	−0.73
		(0.26)		(0.44)		(0.17)
EE/AE	2.21	2.21	1.30	1.30	4.07	4.02
	(0.41)	(0.41)	(0.36)	(0.36)	(0.36)	(0.36)
GROWE	0.03	0.05	0.35	0.36	0.28	0.29
	(0.24)	(0.23)	(0.24)	(0.24)	(0.18)	(0.18)
RD/AE	6.88	6.90	3.04	3.54	3.75	3.75
	(0.95)	(0.94)	(1.21)	(1.20)	(0.87)	(0.87)
BETA	−0.31	−0.31	0.02	0.03	−0.39	−0.38
	(0.10)	(0.10)	(0.11)	(0.11)	(0.14)	(0.15)
DEBT/AE	−0.03	−0.02	0.14	0.14	−0.05	−0.04
	(0.09)	(0.09)	(0.08)	(0.08)	(0.05)	(0.05)
C	0.81	0.82	0.48	0.49	1.02	1.04
	(0.13)	(0.13)	(0.13)	(0.13)	(0.19)	(0.19)
N	132	132	85	85	132	132
$\bar{R}^2$	0.47	0.47	0.31	0.31	0.78	0.78
SSR	22.27	22.02	7.58	7.60	47.88	47.99

[b]Not inflation adjusted.
[c]Inventory method = all.
[d]Inventory method = last in first out.

while the difference between the coefficients of *PA/A* and of *UVPL/A* measures the effect of increases in pension assets (i.e., −0.55 + 1.14 = $0.59 of market value per dollar of pension assets). This coefficient of pension assets has a larger standard error (0.91), implying that when pension assets and pension liabilities are included as separate variables neither can be estimated with any precision.[26]

Using the liability variables adjusted to a common average interest rate (eq. [5.3] and [5.4]) permits much more precise parameter estimates. The implied coefficient of vested pension liabilities is −0.91 with a standard error of 0.32, while the implied coefficient of pension assets is 0.29 with a standard error of 0.42. This implies that liabilities have a substantial negative effect on the market value of the firm that is not significantly

Table 7.5 **Adjusted Pension Liabilities and Assets on the Market Value of the Firm**

		Total Market Value of Debt and Equity					Market Value of Corporate Equity			
		Eq. (5.1)[a]	Eq. (5.2)[a]	Eq. (5.3)[b]	Eq. (5.4)[b]		Eq. (5.5)[a]	Eq. (5.6)[a]	Eq. (5.7)[b]	Eq. (5.8)[b]
Unfunded vested liabilities	*UVPL/A*	−1.14 (0.82)	—	−0.91 (0.32)	—	*UVPL/AE*	−1.26 (0.85)	—	−0.91 (0.29)	—
Unfunded Accrued liabilities	*UAPL/A*	—	−1.02 (0.70)	—	−0.83 (0.29)	*UAPL/AE*	—	−1.18 (0.73)	—	−0.83 (0.26)
Pension Assets	*PA/A*	−0.55 (0.28)	−0.46 (0.29)	−0.62 (0.27)	−0.54 (0.27)	*PA/AE*	−0.32 (0.22)	−0.20 (0.24)	−0.36 (0.20)	−0.28 (0.21)
Earnings	*E/A*	2.16 (0.38)	2.16 (0.38)	2.09 (0.37)	2.09 (0.37)	*EE/AE*	2.14 (0.42)	2.16 (0.42)	2.22 (0.41)	2.21 (0.41)
Growth	*GROW*	0.19 (0.22)	0.19 (0.22)	0.12 (0.21)	0.12 (0.21)	*GROWE*	0.21 (0.25)	0.20 (0.25)	0.11 (0.23)	0.11 (0.24)

Research	*RD/A*	8.46	8.53	8.02	8.04	*RD/AE*	7.66	7.70	7.08	7.10
		(1.02)	(1.01)	(1.01)	(1.00)		(0.96)	(0.95)	(0.95)	(0.95)
Beta		−0.17	−0.17	−0.19	−0.19		−0.30	−0.29	−0.30	−0.30
coefficient	*BETA*	(0.08)	(0.08)	(0.07)	(0.07)	*BETA*	(0.10)	(0.10)	(0.10)	(0.10)
Leverage	*DEBT/A*	0.21	0.20	0.24	0.24	*DEBT/AE*	0.06	0.05	0.04	0.03
		(0.17)	(0.17)	(0.16)	(0.16)		(0.10)	(0.10)	(0.10)	(0.10)
Constant	*C*	0.72	0.73	0.73	0.72	*C*	0.87	0.87	0.86	0.86
		(0.10)	(0.10)	(0.10)	(0.10)		(0.13)	(0.13)	(0.13)	(0.13)
Sample size	*N*	132	132	132	132	*N*	132	132	132	132
$\bar{R}^2$		0.52	0.52	0.54	0.54	$\bar{R}^2$	0.45	0.45	0.47	0.47
SSR		12.94	12.92	12.35	12.33	SSR	23.05	22.98	21.74	21.70

Note: See text for definitions. Standard errors are shown in parentheses. All amounts are inflation adjusted.

[a]Actual interest rate.

[b]Average interest rate.

different from minus one, while assets have a much smaller effect that may not differ from zero. One possible reason for this asymmetry is that the financial market may regard large pension assets as an indication that the firm projects large pension liabilities that will have to be paid on the basis of future employment service.[27]

The estimates based on the market value of corporate equity imply that pension assets have a greater effect that is not significantly different from the effect of pension liabilities. In equation (5.5), for example, the implied effect of pension assets is \$0.94 of market value per dollar of pension assets. With the more precisely estimated coefficients corresponding to a common average discount rate, the implied coefficient of pension liabilities is -0.91 (with a standard error of 0.29), while the implied coefficient of pension assets is 0.55 with a standard error of 0.36. The difference between those two coefficients is marginally significant; the corresponding t-statistic is 1.8 and therefore significant at the 7% level.

Taken at face value, the coefficients in table 7.5 generally imply that each dollar increase in a firm's pension liabilities reduces the firm's market value by about one dollar while each dollar increase in pension assets increases in value by less than one dollar. If this is correct, it provides at least a short-run reason for firms not to fully fund or overfund their pensions. It also implies that, to the extent that firms make pension promises that reduce the savings of employees, the market perceives the extra liability and therefore has the information to adjust other personal saving. At the same time, the lower coefficient of the pension assets variable implies that the market does not accurately reflect the extent of asset accumulation in the pension fund. The net effect of this is that an increase in a funded vested liability reduces the market value of the firm and induces additional saving.

7.4.2 Positive and Negative Net Liabilities

A different but related issue is raised by the fact that pension assets exceed liabilities for the majority of the firms in our sample. Does the market respond differently to "unfunded" pension liabilities that are positive and to the unfunded liabilities that are negative and therefore represent an additional net asset of the firm? To answer this question, we have divided each unfunded pension liability variable into two variables—for example, *PUVPL/A* is *UVPL/A* if this is a positive amount (implying that liabilities exceed assets) and *NUVPL/A* if *UVPL/A* is a negative amount (implying that assets exceed liabilities.)

Table 7.6 presents the estimated coefficients of the positive and negative pension liability variables. These coefficients are based on the same basic specification used in tables 7.1 and 7.4. The pension liabilities are

Table 7.6 **Effects of Positive and Negative Net Pension Liabilities on the Market Value of the Firm**

	Coefficient of Liability Variables If Net Liability Is:		*t*-Statistics for Equality of Coefficients (Probability)	Sum of Squared Residuals
	Positive	Negative		
Total market value of debt and equity				
Net vested liability	−2.25	−0.52	1.55	12.64
	(0.93)	(0.40)	(0.12)	
Net accrued liability	−1.87	−0.45	1.59	12.48
	(0.69)	(0.40)	(0.11)	
Market value of corporate equity				
Net vested liability	−2.54	−0.51	1.96	21.60
	(0.88)	(0.36)	(0.05)	
Net accrued liability	−1.89	−0.45	1.77	21.47
	(0.63)	(0.35)	(0.08)	

Note: Coefficients are from specifications like eq. (1) and (2) in the text but with unfunded pension liability split into positive and negative variable firms; see text for full description. All equations are based on inflation adjusted data and on pension liabilities adjusted to a common average discount rate.

adjusted to a common average discount rate and all of the data are adjusted for inflation.

All four parameter estimates show a much larger negative coefficient for the firms with actual unfunded liabilities (the "positive" liability coefficients) than for the firms in which assets exceed liabilities. In each case, the pension coefficient for the firms in which assets exceed liabilities is approximately -0.5 with a standard error of about 0.4. These coefficients are therefore not significantly different from either zero or minus one. In contrast, the pension coefficient for the firms in which liabilities exceed assets is approximately minus two with a standard error of about 0.8. These coefficients are all significantly different from zero and again not significantly different from minus one.

An explicit test of the equality of the two pension coefficients in each equation indicates that equality cannot be rejected at the 10% probability level in the equations relating to the total market value of the firm but can be rejected at the 5% and 8% probability levels in the equation for the market value of corporate equity.

How should these estimates be interpreted? One possible interpretation is that, because of the large standard errors, there is no need to distinguish between the two types of firms or to revise the conclusion that an extra dollar of unfunded vested pension liability reduces the market value of the firm by approximately one dollar. An alternative "statistical" explanation is that the equation is misspecified and omits additional variables that are observed by participants in the financial markets and are correlated with the size of pension liabilities. Thus, although the financial market may correctly reduce or increase a company's market value by one dollar for each dollar of positive or negative unfunded vested pension liability, our estimated coefficient instead reflects the impact of the additional omitted variables.

It is, however, also possible that the observed difference between the "positive" and "negative" coefficients are more than statistical artifact and do reflect the way that the financial market responds differently to these two types of firms. Since a firm that fails to fund fully its vested or past service liability incurs a higher corporate tax than would otherwise be necessary, a firm's failure to fund these liabilities may be an indication to the financial market that the firm is in a financially weak position or is not well managed. This could account for coefficients of the unfunded liability variables that are absolutely greater than one. This argument would, however, suggest a symmetrically favorable effect on a firm's market value if its pension liabilities are substantially overfunded and therefore an equally large negative coefficient for firms with negative unfunded liabilities. One reason why this is not observed is that, as we noted earlier in this section, the financial market may regard large pension assets as an indication that the firm has correspondingly large future

pension benefits that are not yet vested or based on past service but that can be reasonably anticipated for the future. We can think of no way to test this two-part explanation.

7.5 Why Firms Choose Different Interest Assumptions

As we noted in section 7.3, the choice of the discount rate has a very powerful effect on the value of vested and other accrued pension liabilities. Because these benefits are based only on employees' past service, future wage rates and turnover rates are irrelevant. As a rough approximation, the value of unfunded pension liabilities varies in inverse proportion to the assumed interest rate.

The tax law provides a strong reason for companies to assume a low interest rate. By increasing the value of its pension liability, the firm can justify accumulating more pension assets. For any given stream of anticipated benefits, the accumulation of more pension assets is equivalent to reducing the real cost of those pensions. The reduced cost reflects the fact that the earnings in the pension fund are untaxed while earnings on assets held by the corporation are taxed and the interest rate that the corporation pays on its own debt is deductible from taxable income.

If the tax benefits of early funding were the only influence on the choice of an interest rate assumption, firms would choose the lowest permissible interest rate. But a low interest rate assumption also has its disadvantages. Firms may wish to avoid making the large annual funding payments that would result from a low interest assumption and may not wish to report that they have large unfunded pension liabilities. To the extent that this is true, they will prefer a higher interest assumption.

A large unfunded liability requires a firm to increase the annual contribution to its pension fund. This directly reduces the firm's reported earnings. A firm may fear that this in turn will have an adverse effect on the market price of the firm's stock because portfolio investors do not correctly perceive the reason for the lower reported earnings. Moreover, a firm that has limited access to credit or that faces a rising marginal cost of funds may prefer to postpone funding. To the extent that a firm can fund as much as it wants at a moderate or high interest rate, it will have no incentive to use a lower interest rate.

A large unfunded liability may also be regarded by corporate management as undesirable in itself. It would not be unreasonable for them to fear that such a liability would depress the equity value of the firm and increase its cost of debt. If financial investors are unable to take the firm's choice of interest rate into account in interpreting its reputed liability, the firm may be able to raise its value by selecting a high interest rate that causes pension liabilities to be understated.

Firms that have large vested pension liabilities when calculated at some

standard rate will have more incentive to reduce their apparent liability by selecting a high interest rate. Even more likely, firms that have large unfunded liabilities (when valued at a standard interest rate) will have an incentive to choose a high interest rate and virtually nothing to gain by choosing a low rate. Conversely, firms in which pension assets exceed liability (when valued at a standard rate) will have no reason to disguise the size of their promised liability and every reason to increase the size of that liability in order to increase the rate of tax-deductible funding.

The evidence that we have examined indicates that firms do systematically choose their interest rate assumption in the way that this analysis suggests. Table 7.7 presents estimates of the way in which the choice of interest rate is influenced by the firm's pension liability (adjusted to the common average discount rate to permit comparability) and by other variables that measure the firm's financial condition.

Equation (7.1) shows that firms with large vested pension liabilities tend to choose high interest rate assumptions. The assumed interest rate is related even more strongly to the firm's unfunded vested pension liability, a fact shown in equation (7.2). Firms with higher ratios of net debt to assets may be more reluctant to increase the size of their pension fund and therefore may prefer a higher assumed interest rate. The coefficient of *DEBT/A* in equation (3) is positive but just barely larger than its standard error.

Equations (7.4) and (7.5) indicate that the choice of the interest rate assumption can also be explained by reference to the total accrued pension liabilities, although that variable has somewhat weaker explanatory power than the vested liability. Equations (7.6) and (7.7) indicate that firms with better bond ratings choose higher interest rates.[28] Again the coefficient of this variable is only slightly larger than its standard error and may be due to chance. If it is not due to chance, the positive relation between bond rating and the choice of interest assumptions suggests that the causation is actually from the interest rate assumption to the bond rating. Thus, a firm with a given "true" value of *UVPL/A* that chooses a high interest rate assumption will appear to have a smaller pension liability. This in turn makes the firm appear financially sound if the rating agency does not take its interest rate assumption into account.

The last three equations are based on data that have not been adjusted for inflation. Those results are quite similar to the corresponding equations with inflation-adjusted data.

It is clear from the estimates presented in table 7.7 that firms do engage in strategic attempts to reduce their reported unfunded vested pension liabilities when the benefits from doing so may outweigh the tax advantages of early funding.

Table 7.7 **Factors Affecting the Interest Rate Assumed in Calculating Reported Pension Liabilities**

Equation	Inflation Adjusted	*VPL/A*	*UVPL/A*	*UAPL/A*	*Debt/A*	Bond Rating	Constant	*N*	$\bar{R}^2$	SSR
(7.1)	Yes	1.88					6.95	132	0.05	128.32
		(0.70)					(0.14)			
(7.2)	Yes		11.58				7.20	132	0.25	100.61
			(1.73)				(0.08)			
(7.3)	Yes		10.99		0.48		7.10	132	0.25	99.70
			(1.81)		(0.44)		(0.12)			
(7.4)	Yes			8.88			7.07	132	0.20	107.80
				(1.54)			(0.08)			
(7.5)	Yes			8.26	0.69		6.97	132	0.21	105.87
				(1.58)	(0.45)		(0.12)			
(7.6)	Yes		10.63			0.09	6.62	98	0.22	100.69
			(1.99)			(0.07)	(0.12)			
(7.7)	Yes		10.56		0.28	0.11	6.41	98	0.21	75.34
			(2.06)		(0.68)	(0.09)	(0.74)			
(7.8)	Yes		7.66				7.20	132	0.27	98.04
			(1.09)				(0.08)			
(7.9)	No		7.13		0.46		7.06	132	0.28	96.49
			(1.14)		(0.32)		(0.12)			
(7.10)	No		6.89		0.41	0.13	6.21	98	0.23	73.03
			(1.26)		(0.52)	(0.09)	(0.74)			

Note: The dependent variable in all equations in the interest rate chosen by the firm for calculating the pension liability that it reports. The pension liability variables are all based on the common average rate.

7.6 Conclusion

The purpose of the current study has been to assess the extent to which the market value of firms reflects accurately their unfunded pension obligations. Although there are substantial problems in measuring pension liabilities and in specifying an appropriate framework for estimating their effect on market values, the results presented in this chapter can be said to be generally consistent with the view that the market value of firms reflects a conventional measure of unfunded pension obligations or net pension assets.

The value of vested pension liabilities depends critically on the interest rate that firms use to discount future benefit obligations. The 132 large manufacturing firms in the sample used a wide range of interest rates from 5.0% to 10.5% in evaluating their 1979 pension liabilities. The choice of interest rate appears to reflect the deliberate policy by which firms with substantial benefit obligations relative to existing pension assets try to reduce the reputed present value of their obligation. Similarly, firms in which pension assets are large relative to benefit obligations tend to choose low interest rate assumptions in order to increase the tax advantages of early funding.

The financial market appears to "see through" this manipulation of pension liabilities and sets market values that are related more closely to a pension obligation evaluated at a common standard interest rate than to the pension obligations as reported by the firms. Although an appropriate interest rate for evaluating pension obligations would be the long-term interest rate prevailing in 1979, our evidence indicates that market values of firms are related much more closely to pension liabilities evaluated at the average rate used by all of the firms in our sample (7.2%) than to the pension liabilities implied by the Baa rate (12.1%).

The majority of firms in the sample have pension assets that exceed the value of pension liabilities. There is some evidence in our estimates that the market gives more weight to pension liabilities than to pension assets and responds more to variations in the excess of liabilities over assets than to the excess of assets over liabilities. Although we offer some tentative explanations of these asymmetries, we are aware that they might also be an indication of a misspecification of the basic equations.

More research with additional data could help to resolve some of the remaining problems. Using cross-section data on a panel of firms for several years would permit eliminating firm-specific effects that may bias the estimated effect of the pension liabilities. With data for several years, it might also be possible to modify the measurement of earnings to include information on pension contributions and the changes in vested pension liabilities. It would certainly be very useful to obtain data on the age distribution of vested benefit obligations in order to improve the adjustment of total vested obligations to a common rate of interest.

If the two basic findings of this study—that the market appears to see through the "pension veil" and that the market value of the firm reflects pension obligations evaluated at an interest rate that is far below the market rate—are correct, they have important implications for the relation of pensions to national saving. First, pension liabilities are evaluated at an interest rate that is too low; the present value of those liabilities is overstated. Thus, share prices are depressed by larger pension obligations and shareholders have an increased incentive to save. Second, if pension assets are correctly perceived by the financial market, the extent of pension funding will not influence aggregate private saving. Moreover, to the extent that the evidence of Section 7.4 implies that the market gives too little value to pension assets, an increase in pension assets will not reduce other private saving by an offsetting amount. The overstatement of pension liabilities and the possible understatement of pension assets thus suggests that the expanding size of the private pension system may increase total saving by companies and their shareholders.[29]

Notes

1. These interest rates are reported by firms in their annual reports and were tabulated in Kotlikoff and Smith (1983).

2. The same problem also affects the share prices studies of Oldfield (1977) and Gersovitz (1980), as well as any other study that uses the reported values of pension liabilities.

3. In the extreme case in which employees reduce direct personal saving by one dollar for every dollar of present value of promised pension benefits, the introduction of the pension would have no effect on total saving.

4. In the special case referred to in note 3, the provision of a private pension could actually reduce national saving.

5. When the pension liabilities are reevaluated using the market interest rate instead of the lower values assumed by the companies in their calculations, significantly higher fractions of the companies have assets that excced their liabilities. Using the Baa bond rate prevailing at the end of the sample year suggests that virtually all firms in the sample had pension assets in excess of both vested and past service liabilities.

6. This need not be true if employees reduce their own saving to offset the benefits that they anticipate on the basis of their expected future employment experience and not just the benefit rights that they have already accumulated.

7. Hayashi (1982) shows the conditions under which the marginal and average value of capital are equal.

8. King (1977), Auerbach (1979), and Feldstein and Green (1979) discuss the effect of taxes on the market valuc of marginal additions to the capital stock.

9. It would in principle be desirable to adjust E by adding to it the difference between the firm's pension contribution and the increase in vested benefits during the year. Such an adjustment would be unlikely to have a substantial effect since completely omitting E or *GROW* or both does not change the implied effect of *UVPL/A*.

10. This variable is defined in the same way as it was in Feldstein and Seligman (1981): the difference between average earnings in the most recent 5 years and average earnings in the previous 5 years divided by the 1979 value of physical assets in the final years of this 10-year period.

11. Net debt is defined as total financial liabilities minus financial assets. Short-term assets and liabilities are included at book value, but long-term liabilities are revalued by assuming that they have a remaining maturity of 10 years and pay a 9% coupon rate but are valued to have the 1979 year-end yield to maturity of about 12%. For many firms in our sample net debt is actually negative; financial assets including cash and accounts receivable exceed financial liabilities.

12. See Myers (1977) and Gordon and Malkiel (1981).

13. If the unfunded liability is negative, it actually represents a financial asset or "negative debt."

14. See section 1 of Feldstein and Seligman (1981) for a discussion of the problems of pension liability measurement and the inadequacies of the reported estimates. Note in particular that unfunded liabilities are tax deductible when funded or paid. Similarly, until liabilities are paid, the relevant interest rate is a net of tax rate.

15. The measures of earnings and earnings growth should be adjusted by adding the pension expenses and subtracting the increase in accrued pension liability. This correction is not possible with the data available for a single year. It is reassuring therefore that the estimated effect of unfunded vested pension liabilities is not affected by completely omitting both E and $GROW$ from the equation.

16. There are so many problems of measurement that we are reluctant to give a stronger interpretation. Nevertheless, while coefficients not significantly different from minus one could occur by chance in the current and previous study, we regard that as unlikely.

17. The mean of the dependent variable is 1.30, substantially higher than the inflation-adjusted value.

18. The dependent variable is VE/AE where VE is the market value of the firm's stock and AE is the difference between the value of property, plant, equipment, and inventories and the firm's net debt. The mean of this variable is 0.82 when the data are adjusted for inflation and 1.54 when they are not.

19. Despite the tax advantage of investing pension funds exclusively in debt instruments (Black 1980*a*; Tepper 1981), most pensions invest in both debt and equity and, considering the greater risk of equity as a method of funding nominal liabilities, expect to earn an even higher nominal return on equity. It might, however, be argued that the appropriate rate for discounting future liabilities is a risk-free rate, with any extra return going to shareholders as compensation for assuming the portfolio risk while guaranteeing the benefits. But even a 10-year United States Treasury bond had a 1979 year-end yield of 10.4%.

20. A typical defined-benefit pension plan makes retirement benefits proportional to the product of the final year's (or years') earnings and the number of years of employment with the firm.

21. The low interest rate assumption is advantageous to the firm because it permits the firm to make greater tax-deductible pension contributions. We return to this in section 7.5.

22. The mean absolute value of unfunded vested pension liabilities as a percentage of pension assets was only 6.56%; for total accrued pension liabilities, the corresponding figure was 7.02%.

23. The actuarial present value was calculated using the 1978 age-specific death rates for white males that are presented in the 1980 *Statistical Abstract of the United States*.

24. This may be offset to the extent that retirees had lower nominal earnings before retirement than employees currently have.

25. Jeremy Bulow has told us that he has sought to establish a relation between unfunded pension liabilities and the rate of return on equity over the previous decade (as a measure of the "quality" of the firm) but found none.

26. It is, however, possible to say that the difference between the coefficients of the liability and asset variables is statistically significant.

27. Recall that a firm can accumulate pension assets only to the extent that it can satisfy the Internal Revenue Service that these assets are a reasonable provision against future

pension liabilities. Note also that this explanation assumes that the value of such liabilities will not be offset by lower wages in the future. Stewart Myers has pointed out to us that, when separate coefficients are estimated for pension assets and liabilities, it is not possible to distinguish among different assumed constant discount rates. The superiority of a common rate over varying individual assumptions remains.

28. Recall that the bond rating variable scores Moody's Aaa bonds as 9 and decreases the score linearly with lower bond ratings.

29. Any conclusion about the overall effect of pensions on saving depends also on the response of employees to promised pension benefits. It is of course possible that employees may substitute promised pension benefits for direct saving. If the interest rate that they would anticipate on their own direct saving is less than the interest rate earned by the pension fund, total saving could decline. Alternatively, the higher potential yield on pension saving might induce employees to increase planned retirement consumption by enough to raise the level of current saving despite the higher interest rate. The problem is closely related to the discussion in Feldstein (1978*b*).

Comment

Stewart C. Myers

Professors Feldstein and Mørck have written a worthwhile extension of the previous Feldstein-Seligman paper (1981) on pension funding and share prices. The previous paper's chief result stands: that investors see through over- or underfunding of firms' pension liabilities. I am comfortable with this result because it is consistent with the widely held view that capital markets are information efficient. However, as one person's truth is another's econometric difficulty, I have tried to cast a critical eye on the paper.

Feldstein and Mørck's tests require a valuation model fitted to a cross section of firms. Cross-sectional tests have fallen out of favor in financial research. However, in this case the alternative time-series test would require observing the stock market's reaction to *changes* in a firm's pension funding policy. Because these changes are usually not discrete, easily identified events, like a merger or earnings announcement, time-series tests seem impractical.

Of course, Feldstein and Mørck do not need a completely satisfactory valuation model. They just need to control for profitability, risk, growth, and other factors that affect value, especially variables that might be correlated with pension funding policy. Here the refinements and elaborations could go on forever.[1] However, they have tested enough combinations and definitions of control variables to quiet all but one of my doubts.

I still worry about a "weak firm effect." If highly profitable firms overfund, or poor performers underfund, the causality of Feldstein and

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Mørck's equations is reversed. For example, poor performance would cause low stock prices *and* underfunded pensions.

Casual observation suggests that weak firms underfund. Moreover, there are at least three a priori reasons to expect them to do so: (1) The tax advantages of funding are typically less for poorly performing firms, which are more likely to have tax loss carryforwards or to face a low marginal tax rate. (2) Debt covenants are typically written in terms of accounting earnings. A firm under financial pressure may try to loosen the covenants by cutting back pension funding. (3) Managers manage earnings by choice of accounting technique. They can smooth earnings through pension funding decisions. (Feldstein and Mørck find that firms also manage their reported pension liabilities by choice of the rate used to discount vested future benefits.)

Feldstein and Mørck of course recognize the weak firm effect and introduce the firm's bond rating as proxy for it. The book earnings, risk, and growth variables should also help. However, if the weak firm effect is important, it will be difficult to find any manageable set of variables that will control for it in a single-equation, cross-sectional model. Thus, a still more elaborate version of the Feldstein-Mørck chapter would probably not settle the issue. We really need a careful study of the pension funding decision, as distinct from its effects.

Section 7.3 of the chapter explores the effects of adjusting for arbitrary differences in firms' actuarial interest rate assumptions. The results seem to indicate that investors see through these differences and evaluate pension liabilities at a common rate. We learn very little about *what* common rate is used, however.

This point deserves further explanation. The adjustment to a common rate affects only vested pension liabilities (*VPL*). Pension assets are reported at market value. Suppose unfunded vested liabilities (*UVPL*) are calculated at a common Baa rate (12.1%). The calculation is

$$UVPL(\text{Baa}) = VPL\left(\frac{\text{actuarial rate}}{12.1}\right) - PA,$$

where *PA* indicates pension assets.

Using the *average* actuarial rate (7.2%),

$$UVPL(\text{average}) = VPL\left(\frac{\text{actuarial rate}}{7.2}\right) - PA$$

$$= VPL(\text{Baa})\left(\frac{12.1}{7.2}\right) - PA.$$

Thus, the only effect of substituting the average for the Baa rate is to multiply *VPL*(Baa) by a constant. The better fit and more sensible coefficients obtained using the average rather than the Baa rate must therefore reflect a greater relative weight on pension liabilities versus

assets. This suggests entering assets and liabilities as separate variables. It does not suggest that investors disregard current interest rates in assessing a firm's pension liabilities.

Feldstein and Mørck do examine pension assets and liabilities separately in section 7.4 of their chapter. The results seem to confirm that the market deducts more from market value for pension liabilities than it adds for assets. If the difference is real, it poses a puzzle: If investors value pension liabilities correctly, which requires a difficult adjustment for differences in actuarial interest rates, why can they not value assets, which require no adjustment?

The work of Black (1980*b*) and Tepper (1981) suggests a possible explanation. They showed that tax-paying, value-maximizing firms ought to invest their pension fund in taxable bonds, offset by borrowing on the corporate account. Investing any significant fraction in stocks as most firms do, appears suboptimal. Could the low weight given to pension assets reflect a penalty for inferior portfolio strategies?

I would summarize my reactions to Feldstein and Mørck's chapter as follows. Like most good research, it settles some questions and opens up new ones. It confirms that investors recognize unfunded pension liabilities. In fact, it is by far the most thorough and intelligent study of this issue. The most important open question is not whether investors take pension assets and liabilities into account, but how they do so. The different coefficients for pension assets and liabilities suggest the market may value them on assumptions different than Feldstein and Mørck's.

The only issue that might undercut the chapter's main qualitative conclusions is the "weak firm effect"—the possibility that low market value leads to pension underfunding, not vice versa. This possibility will be hard to address without a better understanding of the pension funding decision, not just the capital markets' reaction to it.

Note

1. For example, common-stock betas should not be used to explain the valuation of the firm as a whole. We know that financial leverage affects stock betas.

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