Pensions, Economics and Public Policy

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PART FOUR

Pension Plan Characteristics

CHAPTER 10

A Theory of Underfunded Pension Plans

The principal purpose of this chapter is to show that so-called paradoxes posed by observed pension behavior at the firm level may well be explained by rational, profit-maximizing firm behavior after all. In other words, this chapter will show that while puzzles may exist within the constraints of capital market analysis, they may disappear when a broader market perspective is used. To demonstrate this point, the anomaly of underfunded pension funds is examined in closer detail. The results of this exercise demonstrate the plausibility that underfunded pension plans do indeed serve an important function in the firm. Moreover, the results of this chapter rationalize the findings described in Chapter 4 that most underfunding appears to be affiliated with plans covering unionized participants. In this regard, an understanding of the economic function of underfunded pension plans helps to explain the pattern of aggregate funding ratios for the post–World War II period discussed in Chapter 4, and is especially relevant in its explanation of why "target" funding ratios appear to be substantially less than unity.

In this chapter, a theory of pension underfunding is developed. Underfunding creates bondholders out of workers. This is indeed a puzzling phenomenon because workers normally already hold substantial investments in the firm in the form of specific human capital. If they are required to hold firm bonds besides, they must require substantial risk premiums compared to diversified outside lenders. A case is considered where this apparently peculiar bond arrangement might be optimal: when unionized workers as a group can affect firm performance and indeed can ruin the firm's chances of survival. Put differently, once workers are unionized, stockholders in the firm are faced with a classic potential "holdup"[1] problem. If stockholders commit themselves to durable, specialized investment in the firm, unions may be able to expropriate a portion of the return in the form of higher wages. As a result of the threat, efficient investment is not possible. How does the firm write and enforce a contract to solve this problem?

The hypothesis explored below is that firms deliberately underfund their pension plans, despite the tax consequences, as a way of bonding an organized work force. If the union violates the contract, stockholders ultimately abandon the firm. Funding levels are chosen in such a way that at the point of termination, union members suffer large pension losses owing to severely underfunded pensions. By exposing workers to long-term unsecured debt in the form of underfunded pensions, the firm gives unionized workers a stake in the long-term viability of the firm, and therefore permits long-term contracts to occur between unions and stockholders.

The theory turns out to be robust in offering a new and unifying interpretation of many peculiar pension puzzles that were previously unexplained, or explained by a potpourri of ad hoc stories. Perhaps more importantly, however, the theory leads quite naturally to an explanation of the changing character of the pension industry over the last 15 years, including the creation of federal pension insurance in 1974.

UNDERFUNDED PENSIONS AS BONDS

Description of the Underfunding Puzzle

It is useful to begin by restating the problem succinctly. Consider a simple case based on the discussion in Chapter 3 where there is one worker who starts with the firm at age zero, with a years of service to date; the worker and the firm are certain they both will survive until the worker's retirement at age R. At retirement, the defined benefit plan will award the worker a pension with a lump sum equivalent proportional to final salary W_R times years of service times a generosity parameter, say b. Thus, in consideration of a years of service to date, the firm's pension liability is:

$$P_a = baW_Re^{-i(R-a)},$$

where i is the long term interest rate.

[1] *Holdup* is a term of art used in the contracting literature in economics. When two parties enter into a contract where the first party must make an up-front, specialized investment, the second party can take advantage of the situation midstream in the contract; that is, the second party has an opportunity to "hold up" the first party. For a general discussion of this phenomenon, see B. Klein, R. Crawford, and A. Alchian, "Vertical Integration, Appropriable Rents and the Competitive Contracting Process," *Journal of Law and Economics* 21 (October 1978), pp. 297–326.

The amount P_a is the firm's pension liability to date. The liability does not arise because the firm makes the promise, but rather because, in consideration of the promise, the worker implicitly deposits the amount P_a with the firm through lower wages. The pension is not provided gratis; the worker must pay for it. But once the worker makes these "deposits" with the firm, a contract is in effect written: the firm is liable in the amount of these deposits plus interest and is absolved from its obligation only when the payout actually occurs at retirement.

It is important to note that the promised pension benefits are discounted at the pretax rate of interest: this is so because pension plan trusts are tax exempt, and hence the worker expects any implicit contributions to the plan to accumulate at the tax-free rate. If the firm sets aside assets equal to P_a in trust, the pension plan is fully funded and the tax-free accumulation vehicle is used effectively. But if the firm sets aside an amount less than P_a, say FP_a where $F < 1$ is the funding ratio, the unfunded portion of the pension liability is in effect saved outside the trust and its earnings are effectively exposed to the corporate tax. By deliberately underutilizing the tax-free vehicle, the firm sharply increases its tax liabilities. Using a formula described below, it is easy to show that for the case of a 50 percent corporate tax rate, a 10 percent interest rate, and evaluated for an individual 15 years from retirement, the excess tax burden implied by a 50 percent funding policy amounts to over 25 percent of the true economic liability P_a.

Given such high tax penalties attached to underfunding, why is underfunding ever observed? Unless firms are irrational, it *must* be true that underfunding is conveying some offsetting benefit to stockholders to justify what appears to be a puzzling firm tax decision. This chapter seeks to identify a plausible and, it is argued, likely "offset" candidate.

Underfunded Pensions as a Bond

By underfunding its pension plan, the firm makes its employees long-term bondholders in the firm. That is, if workers pay for their pensions (through lower wages) as they accrue real expected pension benefits—that is, if worker "deposits" equal present value pension benefits—then if the firm fails to set aside all these deposits in trust, workers in effect loan moneys to the firm long-term. Such contracts might be optimal if workers have better information about the capabilities of the firm compared to outside lenders. But there is no reason to believe that workers better understand the financial viability of the firm than outside lenders who specialize in such evaluations. Moreover, to the extent that such employee loans to the firm represent substantial portions of their wealth, they would presumably require a higher risk premium than diversified outside lenders. Why would the firm pay such a risk premium to engage in long-term lending arrangements with its employees rather than outside lenders?

A natural explanation is that employees as a group uniquely control some aspect of firm performance. As a group, workers can substantially affect productivity and wage levels in the firm; hence, they can influence the financial viability of the firm over the long run. Outside lenders presumably cannot set conditions that would preclude adverse productivity actions by employees. The firm can arrange its pension rules to discourage poor performance by employees individually.[2] But when workers combine through a union, productivity and wages are more difficult to control.

In a free market, adverse group behavior is presumably difficult to organize, especially if the firm can separate workers at low cost. In the United States, however, federal labor law substantially reduces the cost to workers who wish to organize in the form of unions. Unions may be formed to raise the wage above the competitive level or to reduce employment contract costs to workers. In either case, there exists some union wage at which union and nonunion firms can coexist over the long term.[3] Regardless of the motivation to unionize, once organized, workers clearly represent a potential threat to the long-term viability of a particular firm.

If the firm holds firm-specific assets of sufficient durability, it may be optimal for current employees to extract rents from the firm even if the consequence is the ultimate demise of the firm.[4] Given this threat, stockholders will be reluctant to replenish or expand the firm's capital base, fearing an organized holdup by employees. If specific human capital investment is complementary to stockholder investment in specific durable physical capital in the firm, workers in turn will be unable to embark on job careers that involve substantial amounts of human capital investment. To prevent a degenerating solution, the firm and the union will presumably agree to a contract that bonds the union.

The central idea pursued here is that this bond will quite plausibly take the form of an underfunded pension. If the firm loses its viability as a competitor, employees lose substantial portions of their pensions. Given this bond, stockholders and workers can anticipate a long-term relationship that permits optimal investment patterns in physical and

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[2]See Edward P. Lazear, "Pensions as Severance Pay," Working Paper 854, National Bureau of Economic Research, 1982; and also Chapter 8.

[3]See Edward P. Lazear, "A Competitive Theory of Monopoly Unionism," *American Economic Review* 73 (September 1983), pp. 631–43.

[4]See Carliss Baldwin, "Productivity and Labor Unions: An Application of the Theory of Self-Enforcing Contracts," *Journal of Business* 56 (April 1983), pp. 155–85.

human capital.[5] While other devices might also be used to bond unions, it will be shown that underfunded pensions have several endearing attributes compared to readily apparent alternatives.

Comparison of Underfunded Pensions to Alternative Bonds

While there undoubtedly is a long list of potential bonding devices to deal with union holdup problems, two obvious candidates are considered here.[6] First, to the extent that workers in the firm invest in specific human capital, they will naturally want the firm to remain viable to permit them the opportunity to collect relatively high wages later in their careers. If this specific human-capital bond is insufficient to deter adverse union behavior, the firm could simply artificially tilt this profile to pay even higher wages to older workers relative to younger workers.[7] But the tax losses from deferring compensation through wages instead of pensions are greater than underfunding. Not only do workers forgo the opportunity to save for retirement through a tax-free vehicle (the essential cost of underfunding), they lose the opportunity to spread their taxable income more evenly over life which has important implications in a progressive income tax structure.[8]

In addition, as long as there is a significant lag between a holdup and the ultimate demise of the firm, workers' reliance on the firm's success under this scheme will be strong only for young workers. Older workers have little incentive to refrain from exerting the power inherent in a union if the adverse effects threaten the firm only at the very end of their tenure or after retirement. By forcing workers to accept annuities (as most defined benefit plans do) and then tying the welfare of the firm to the individual's annuity during retirement, workers over all ages retain an incentive to preserve the firm even if firm failure consequent to a holdup occurs after their retirement date.

Second, the firm could establish a stock-bonus defined contribution pension plan. Instead of creating an underfunded defined benefit pen-

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[5]Moreover, union firms are not necessarily at a cost disadvantage to nonunion firms. For example, equilibrium may be found across (union and nonunion) firms in the industry if unions enhance productivity to offset this cost. See Charles Brown and James Medoff, "Trade Unions in the Production Process," *Journal of Political Economy* 86 (June 1978), pp. 355–78. We can think of productivity enhancement occurring as a result of a more efficient worker-firm contract process because of the presence of a single worker agent. Also, see Lazear, "A Competitive Theory of Monopoly Unionism."

[6]For example, as noted above, Baldwin suggests that a firm can reduce its exposure to union exploitation by distorting its production function away from long-term, specialized investment toward shorter-term, more generalized capital. See Baldwin, "Productivity and Labor Unions." For purposes of this paper, it is simply assumed that rearrangement of the production function is either not feasible or prohibitively inefficient.

[7]This idea is developed nicely in Edward P. Lazear, "Why Is There Mandatory Retirement?" *Journal of Political Economy* 87 (December 1979), pp. 1261–84.

[8]See Chapter 2.

sion plan, thereby making workers unsecured long-term debtors, the firm could contribute stock directly to the pension plan, thereby making workers stockholders in the firm.[9] The firm could approximate the function of underfunding by establishing the value of the fund equal to the underfunded portion of its defined benefit plan and requiring workers to convert to annuities at the time of retirement.[10] Stock-bonus plans are on par with underfunded defined benefit plans from a tax perspective.[11] The plan also mimics underfunding in the sense that workers are bonded more heavily as they age (though the bond is rendered valueless at retirement once the pension is converted to an annuity or lump sum). But several problems are evident.

Suppose that the underfunded portion of defined benefit plans were replaced with a supplementary stock bonus plan. In a stock plan, the cost of bankruptcy to workers is the same as in an underfunded pension plan. But consider firm-specific variation unrelated to union activity. This risk is unique to stock bonus plans. Given the importance of the stock value in the workers' pension portfolios and the age at which the risk is faced, firms would presumably be required to pay significant premiums to workers to accept the firm-specific risk.

In addition, the stock values in these plans would typically represent almost 25 percent of the firm's outstanding stock value.[12] Since this stock will carry voting rights, the firm is required to pass these rights to either the pension plan's participants or the pension plan trustee.[13] By making this transaction, the firm in effect awards control of the firm to either the union or the pension plan's trustee.

In the former case, stockholders lose their agent. Workers are awarded the opportunity and the incentive to unravel rules created by existing stockholders to control the union.[14] In the latter case, it is doubtful that

[9]For this scheme to be workable, the firm must structure the pension plan so that lump sum values in each employee's pension account could not be taken by workers upon departure until the normal retirement age in the plan.

[10]If the firm permits lump sum distributions (as most defined contribution plans do), the worker's horizon is substantially shortened, making it an inferior tool to control long-term detrimental behavior of the union. In addition, if a lump sum is offered as an option, workers lose the opportunity to acquire annuities at a fair price, thereby imposing substantial costs on workers.

[11]If the pension plan holds stock, it saves at an interest rate net of the corporate tax; the firm can save outside the plan at the same rate. See discussion of the bonds puzzle in Chapter 9.

[12]Unfunded liabilities and stock value data is available in the Compustat file for 1980. Based on a sample of 1,407 firms, the portion of outstanding stock represented by unfunded pensions was 23 percent.

[13]The Internal Revenue Service virtually requires that firm stock deposited into a pension plan carry its voting rights.

[14]If the union's share of the stock was substantially less than 51 percent, presumably the nonunion stockholders would react to the union through proxy fights which could return power to the nonunion stockholders. The costs inherent in such battles would presumably be nontrivial.

stockholders, especially those now in control, would be willing to award control of the firm to the plan's trustee.[15] Even if large stockholders could agree on awarding firm control to a particular trustee (or group of trustees) in the firm, the Internal Revenue Service could potentially challenge any decision made by the trustee that, in the IRS's view, benefited stockholders at the expense of plan participants.[16]

Perhaps a more workable substitute is a profit sharing plan: workers hold diversified defined contribution accounts but the contributions are proportional to profits. This scheme can impose a substantial bond to the work force except that the bond is highest for new workers and falls to zero for old workers. This could be a problem because older workers (who have shorter horizons) are more likely to favor an attack on the firm (see below). If the profit sharing and stock bonus plan concepts are merged (the account accumulates firm stock at a rate determined by profits), it is easy to show that the bond can be held constant over all ages in the firm, but then all the stock bonus problems described above must again be faced. Some mix of these concepts could well provide a plausible if not perfect bond alternative to underfunding (i.e., contributions to the pension account depend on profits, but the account is also partially invested in the firm's stock).

A MODEL OF UNDERFUNDING

In general, bonding will not be costless. An efficient bond is one that discourages workers from holding up a firm at the lowest cost. Choosing a bond mechanism is a perplexing problem for the firm because the gains from a holdup will generally be different for different workers. If the bond is not set sufficiently high, a majority of workers may favor a holdup. If it is set too high, the bond cost will be excessive. An attractive property of an underfunded pension plan is that its bond value can be set more or less in proportion to the gains from a holdup. This property will become apparent from examination of a very simple model that encompasses the essence of the contract problems discussed above.

Description of the Firm's Problem

Consider a firm in a competitive market. Some portion of the work force finds it desirable to hire an agent to negotiate a contract with the firm. They therefore vote in favor of union representation.

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[15] Indeed, amongst firms that operate stock bonus plans, fewer than 13 percent award full voting rights to the trustee; the rest award primary or full control to employees. The study did not separate plans by union status. See Bankers Trust, Study of Employee Savings and Thrift Plans, 1977.

[16] The IRS has long-enforced rules requiring pension plan decisions to be in the best interest of participants. These rules date to early tax qualification laws.

The firm has two alternative ways to produce an exogenously given rate of output. Both production functions involve two types of labor plus capital, all used in fixed proportions. In particular, L unionized workers and N nonunionized workers are used in either production function. It could produce the same output using either an investment in specialized capital of durability zero in the amount $K(0)$ each period, or an investment in specialized capital in the amount $K(t^*)$which depreciates all at once after t^* periods. Assume for simplicity that the real rate of return is zero and that there is no risk premium; the rental rate on the durable capital is therefore $K(t^*)/t^*$. The use of the durable capital is more efficient than the use of instantaneously depreciable capital: $K(t^*)/t^* < K(0)$.

Consider the firm's problem. It is less costly to produce output using durable (specialized) capital. But if the firm commits itself to the investment, it exposes itself to a holdup problem. That is, following stockholder commitment to durable capital, the union has an incentive to raise its collective wage by some portion of the amount $K(t^*)/t^*$ in each period during the interval $[0,t^*]$.

In the limit, the firm can react to a holdup by taking the costly step of replacing its unionized work force.[17] The firm, however, is clearly exposed to the union up to the cost of replacing its union labor. Suppose the union and firm know that upon the committal of investment in capital $K(t^*)$, stockholders will be liable to a union holdup equal to $\gamma K(t^*)/t^*$ per period during the interval $[0,t^*]$, where $0 < \gamma < 1$. We can think of the labor replacement option as more feasible when unionized workers represent a small portion of the work force and/or are a small input relative to capital;

$$\gamma = f(L/N,\ WL/(K(t^*)/t^*)),\ f'(N) < 0,\ f'(K) < 0, \qquad (10\text{–}1)$$

where W represents the wage rate.

Setting the Optimal Underfund Bond Level

A full treatment to show the effect of underfunding for all unionized workers in the firm is given in Appendix 10–1. For current purposes the problem and solution can be given succinctly for one particular worker in the firm: the worker who will exactly reach retirement when, as a result of a union holdup, the firm fails. In the appendix, it is shown that the level of underfunding that deters this worker can be reasonably expected to deter all workers. Briefly, suppose that if the union holds up a firm, the firm goes broke t^* periods later. Our representative worker

[17] A firm can take this step if, after bargaining in good faith, the firm and union cannot come to an agreement. In this event, the firm can replace a striking work force with a new set of labor.

is also exactly t^* periods from retirement when the holdup occurs. During each of t^* periods, the worker collects a wage premium (from the holdup) equal to δ dollars. Thus, the gain from the holdup is δt^*.

Assets that support the pension promise are diversified and held in trust. Assume that there is no pension insurance (see below); thus upon firm dissolution, pension participants receive the full value of the trust in proportion to their present value pension. If F is the expected funding level, the firm can set the required bond by choosing the funding level F and the present value of the full pension available to our worker at retirement so that the worker's loss of pension benefits $(1-F)P$ exactly equals his gain from a holdup:

$$(1-F)P = \delta t^*. \tag{10–2}$$

Viewed in this way, low funding ratios and high pensions combine to deter workers from trying to extort uneconomic wages from the firm.

The bond will not be posted for free. The bond carries two distinct costs: the tax disadvantage of saving the underfunded portion of the pension outside the tax-exempt pension trust (see below)[18] and the risk premium that workers must receive to offset the additional uncertainty affiliated with an underfunded pension and the potential cost of accepting a nonoptimally large pension plan. If a bond is optimal, it will take the form of an underfunded pension if its cost is lower than alternatives (see above). A necessary condition of equilibrium is that the underfunding bond will be superior to using nondurable, nonspecialized capital.[19]

IMPACT OF INFLATION ON THE EFFICIENCY OF UNDERFUNDING

The model described above is sufficient to provide a basis for evaluating the plausibility of using underfunded pension plans as bonds and for generating testable predictions. But the model is incapable of explaining the dynamics of pensions, and their value as bonds, over the past 20 years. The model is insufficient because it does not incorporate the impact of inflation on the nature of bond equilibrium.

In this section, inflation is introduced into the model. It will be shown that inflation reduces the attractiveness of using underfunded pensions as bonds. This, together with the model already developed,

[18]The firm may not necessarily set the level of funding at F throughout the interval $0,R$. The firm can reduce the cost of the bond by setting the target funding ratio at period 0 at some higher level. That is, the firm can take advantage of the natural interval between the occurrence of the holdup (at period 0) and the date the capital depreciates (at period R). Within constraints set by the Internal Revenue Service, the firm can reduce its rate of contributions over the interval $0,R$.

[19]See Baldwin, "Productivity and Labor Unions."

will lead quite naturally to a theory of federal pension insurance which was instituted in 1974 by the enactment of the Employee Retirement Income Security Act (ERISA). The enactment of this law in turn leads to an explanation of pension developments after 1974. It is understood that in this section, the discussion is predicated on the prevalence of pre-ERISA law; ERISA implications are discussed in the next section.

It is useful to begin by restating the general rule of law that pertains to pensions in failed firms. Upon dissolution of the firm (and therefore the pension plan), trust law and Internal Revenue Service rules require that only *nominal* pension benefits be paid to workers. Thus, *legal* liabilities are limited to *nominal* liabilities. If pension assets exceed legal liabilities, they revert to creditors or stockholders; if assets are less than legal liabilities, only a portion of legal liabilities are paid. If inflation is zero, legal and economic liabilities are not different in any important way. But significant inflation drives a large wedge between legal and economic pension liabilities (see Chapter 3). This wedge creates the possibility of imposing large capital losses on workers even if the firm fails with a fully funded plan (assets = P). Since all assets in excess of legal liabilities revert to the firm then in a period of inflation, the firm can bond the union to some extent without incurring the negative tax implications of underfunding.

To develop those implications, consider the model used above, but introduce inflation. For simplicity, consider a case where overall productivity growth and within-firm real wage growth rates are zero. But we suppose that the wage rate keeps pace with inflation and that the nominal interest rate equals the inflation rate. Recall that in the model, firms do not fail (unless unions cause them to) and workers do not quit, and that the pension formula is assumed to pay benefits in proportion to service and wage levels at retirement.

If the expected inflation rate is i the present value of a pension based on service to date for a worker of age and service level a is

$$P = e^{-i(R-a)} b a W_R,$$

or equivalently, since wages grow with inflation $W_R = W_a e^{i(R-a)}$,

$$P = \mathrm{b}aW_a, \tag{10–3}$$

where W_a is the wage rate at age and service level a and b is the generosity constant in the pension formula. Expression (10–3) shows, not surprisingly, that *economic* liabilities are independent of the rate of inflation. That is to say, recall from Chapter 3 that, as long as pensions are pegged to wage levels at retirement and to inflation beyond retirement, the pension contract is in effect written in real terms. Thus, if b equals .5, a worker with 20 years service to date ($a = 20$), and a \$10,000 annual wage (which is assumed constant over life in real terms), has a pension accrual to date worth \$100,000.

Now consider the firm's *legal* liability. Suppose the firm dissolves the pension plan when the worker is at age and service level a. Legally, the "final" salary in the pension formula is the nominal salary paid at age a, not the salary that would normally prevail at retirement. That is, even though the firm and worker may have an implicit contract that a real pension will be paid at retirement, it nevertheless remains true that, legally, the firm owes workers their pension promises in nominal terms, not real terms. Thus, upon termination of the plan, and using equation (10–3), the firm's legal liability is limited to

$$P^* = e^{-i(R-a)} baW_a,$$

or equivalently,

$$P^* = Pe^{-i(R-a)}, \tag{10–4}$$

where P^* denotes the legal or nominal liability and P denotes the economic or real liability.

If the inflation rate is zero, legal and economic liabilities are the same ($P^* = P$). But if inflation is significant, legal liabilities will be significantly less than economic liabilities. As such, when inflation is positive, a capital loss to workers is imposed by the failure of the firm even though it has a fully funded plan (assets $= P$). The magnitude of this capital loss is found by subtracting equation (10–4) from equation (10–3):

$$P - P^* = P(1 - e^{-i(R-a)}). \tag{10–5}$$

If the worker is 10 years from retirement and the inflation rate is 1 percent, the capital loss described in equation (10–5) is only 10 percent of the economic liability. But if the inflation rate is 5 percent, the capital loss is 40 percent. In the latter case, if the worker described above who expects a \$100,000 (lump sum equivalent) pension is age 55 and 10 years from retirement then this person is legally entitled to only \$60,000 in real terms if the firm terminates the plan immediately.

If pensions are used to bond unions, the "legal" liability concept has a dramatic implication: inflation confers to the firm the use of a free bond. That is, as long as a firm and union do not write themselves out of the standard legal interpretation, the firm can impose a capital loss on workers valued at $P - P^*$ without sacrificing any underfunding costs. It is *as if* inflation automatically confers a legal maximum funding ratio upon firm failure equal to P^*/P. Upon firm dissolution, any assets in excess of P^* revert to the firm.[20]

Recognizing inflation, and recalling that we are describing pre-ERISA law, the bond value of underfunded pensions can now be written as:

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[20] It is also noted that the inflation bond-of-sorts ($P - P^*$) is smallest at the end-point ages 0 and R and is maximized in the middle of the tenure period; thus, the inflation bond value conforms to the same general shape as the underfunding bond. See Appendix 10–1.

$$B = (1 - F)P - (P - P^*) \text{ if } F < P^*/P$$

$$B = 0 \text{ if } F \geq P^*/P,$$

or equivalently, if $B > 0$,

$$B = (1 - F)P - (1 - P^*/P)P, \qquad (10\text{–}6)$$

where the second term in equation (10–6) reflects the free inflation bond-of-sorts. The bond value of underfunding is reduced dollar-for-dollar by the inflation bond. If the inflation rate becomes sufficiently high, the underfunding bond is valueless. For example, if $i = .10$ and $R - a = 10$, then $P^*/P = .367$. That is, upon firm failure, the courts will award 36.7 percent of the real pension to workers; the remaining 63.3 percent is a capital loss. Thus, unless the funding level F is less than 36.7 percent at termination, the bond value of underfunding is zero.

Not only do the benefits from underfunding fall with higher inflation, but the costs also increase. By saving the portion $(1 - F)$ of the pension liability outside the plan, the firm forgoes the tax-free accumulation of the pension vehicle. Ignoring the risk premium components of the underfunding costs (see above), the per dollar cost of underfunding for $R - a$ years is therefore[21]

$$C/(1 - F)P = (1 - \tau)[e^{i\tau(R - a)} - 1] > 0, \qquad (10\text{–}7)$$

where τ is the corporate tax rate. It is apparent from equation (10–7) that the cost per dollar of underfunding the pension plan increases with the inflation rate.

While the model used above is highly simplified, it is possible to estimate the wedge between (legal) pension liabilities P^* and economic liabilities P as a function of nominal interest rates.[22] These calculations were made for long-term interest rates which prevailed from 1950–1983; the results are shown in Table 10–1.

The de facto underfunding ratio brought about by inflation $(1 - P^*/P)$ is shown in column 3 of the table. During the period 1950–1954, a

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[21] That is, in the above example, the cost of paying the economic pension baW in $R - a$ years if underfunding is used is,

$$K(F < 1) = (1 - \tau)baW_a e^{i(R-a)}[Fe^{-i(R-a)} + (1 - F)e^{-i(1-\tau)(R-a)}]. \qquad \text{(i)}$$

The cost if full funding is used is

$$K(F = 1) = (1 - \tau)baW_a e^{i(R-a)}[e^{-i(R-a)}]. \qquad \text{(ii)}$$

Subtracting equation ii from equation i and dividing by $(1 - F)P$, the expression in equation (10–7) in the text is derived.

[22] Calculations of P and P^* using different interest rates is done using algorithms discussed in Chapter 4. As a first order approximation, legal liabilities fall dramatically with higher interest rates. Economic liabilities are more or less indexed and hence are much less sensitive to changes in nominal interest rates.

TABLE 10–1 Impact of Inflation on Efficiency of Underfunding

(1) Period	(2) Long-Term Interest Rate[a]	(3) Inflation Bond $(1 - P^*/P)^b$	(4) Incremental Bond from Underfunding[c] (B)	(5) Tax Cost per Dollar of Underfunding[d] (Annualized)	(6) Cost per Dollar of Incremental Bond[e] (Annualized)
1950–1954	2.8	.18	.42	\$.008	\$.011
1955–1959	3.6	.22	.38	.011	.017
1960–1964	4.4	.24	.36	.014	.023
1965–1969	5.6	.28	.32	.019	.033
1970–1974	7.7	.34	.26	.029	.067
1975–1979	8.7	.36	.24	.035	.087
1980–1983	12.9	.45	.15	.066	.264

[a]Moody's Corporate A bond quotations.

[b]The relation between P and P^* under different interest rate assumptions is found in Chapter 4.

[c]For purposes of the above calculation, the target funding ratio was arbitrarily set equal to 40 percent, leaving 60 percent of the pension underfunded. The incremental bond value of underfunding is given in equation 10–6.

[d]This calculation is given in equation (10–7), except it is divided by $R - a = 20$ years to reflect as annualization of the costs.

[e]Numbers in this column are derived by multiplying the numbers in column 5 by .6 (the assumed underfunding ratio) and dividing by the numbers in column 4.

firm failure would have resulted in an 18 percent reduction in the economic pension. By the late 1960s, interest rates and inflation were higher; firm failure automatically imposed a capital loss on workers equal to 28 percent of their pension; by the early 1970s, 34 percent.

Suppose for the sake of this calculation that the firm wants to expose workers to a 60 percent loss of pension benefits upon firm failure; thus the firm sets the target funding ratio at 40 percent. The level of incremental worker exposure "purchased" by setting underfunding at 60 percent is calculated directly from expression (10–6). In the early 1950s, the inflation bond was 18 percent $(1 - P^*/P = .18)$; thus, the incremental exposure resulting from underfunding the plan by 60 percent was 42 percent (see equation 10–6). During the early 1970s, the inflation rate and the nominal interest rate increased substantially, thereby increasing the value of the inflation bond to 34 percent, leaving the incremental exposure resulting from the same 60 percent underfunding ratio equal to 26 percent.

The cost of maintaining the 60 percent underfund also increased over time. To illustrate, suppose we use the value of $C/(1 - F)P$ in equation (10–7) as a cost index. This index reflects the tax benefits forgone from failing to fully fund the tax-free pension accumulation account; this cost increases sharply with the nominal interest rate (see equation 10–7). Setting the corporate tax equal to 50 percent and setting the average worker's time to retirement $R - a$ to 20 years, the cost per dollar of underfunding is shown in column 5.

During 1950–1954, the nominal interest rate was only 2.8 percent; hence the annualized premium per dollar value of the underfunding is only .8 cents; by 1970–1974, the nominal interest rate was 7.7 percent, which substantially increased the tax cost of underfunding; in fact, the real cost of underfunding increased by a factor of 3.6 to 2.9 cents. Dividing column 5 by column 4 and multiplying by the underfunding ratio $(1 - F)$, or .6, the cost per dollar of the *incremental* exposure caused by underfunding can be calculated. The results show that the cost per dollar of exposure increased substantially over time. During 1950–1954 this cost is calculated to be 1.1 cents; by 1970–1974, the "insurance premium" had increased by a factor of 6.1 to 6.7 cents. Clearly, the economics of inflation was favoring a move away from underfunding.

POTENTIAL BENEFICIARIES OF ERISA

The bond model developed above and the inflationary developments of the late 1960s and early 1970s set the stage for a theory of ERISA. In 1974, Congress enacted ERISA. A central feature of ERISA is the creation of a federally administered insurance scheme. In exchange for a subsidized flat rate premium per participant, ERISA insures all defined benefit plans up to and including the value of the *legal* liabilities. Viewed simply, since ERISA guarantees the legal benefits P^*, the incremental value of underfunding which was being eroded during the 1965–1974 inflationary period was rendered completely valueless in 1974.

It is somewhat of a puzzle why, after more than 40 years of operation virtually free of government regulation, federal pension insurance and its attendant regulations were enacted in 1974. Theories based on increased risks of pension default and optimal temporal insurance schemes are inconsistent with the evidence (see Chapter 11). Moreover, the mandatory nature of the insurance and the absence of a risk-related premium raise suspicions that the insurance is designed to benefit particular pension participants in relatively poorly funded pension plans in dying firms.

The bond theory leads quite naturally to a theory of ERISA. Growing inflation and the prospects for continued high inflation, as reflected in long-term interest rates, must have substantially reduced the demand for underfunding bonds in a prospective sense. Thus, the resistance to ERISA that might normally have been felt by firms during lower inflation years must have waned considerably by the early 1970s. This environment presented an opportunity for some unionized workers to obtain a sizable transfer at the expense of the majority of pension plan participants and taxpayers as a whole.

All prospective beneficiaries share the same pre-ERISA characteristic: the underfunding bond was valuable ($F < P^*/P$). First, consider unionized workers that had *already* held up their firms prior to ERISA and were facing a sizable capital loss upon dissolution; these workers stood to gain the difference between the guaranteed ERISA funding ratio P^*/P and the actual funding ratio F, all times the pension amount P [that is, $((P^*/P) - F)P$]. Second, when ERISA was enacted, say in period t, the model used above suggests that in order to discourage a holdup in the absence of federal insurance, the following relation should hold in all unionized firms:

$$(1 - F)P \geqslant (t^* - t)\gamma K(t^*)/t^*, \tag{10–8}$$

where $t - t^*$ is the remaining life of $K(t^*)$ dollars of capital of durability t^*. Given this relation, a holdup without the insurance is unprofitable. For purposes of calculating worker pensions upon firm failure, ERISA replaces the actual funding ratio F with the guaranteed funding ratio P^*/P. Now consider firms for which the following relation holds:

$$(1 - P^*/P)P << (t^* - t)\gamma K(t^*)/t^*. \tag{10–9}$$

This condition says that, given ERISA insurance, a holdup is profitable to the union. For firms that satisfy conditions in equations (10–8) and (10–9), ERISA will actually precipitate a holdup. These workers will gain an amount up to $[(P^*/P) - F]P$ from the enactment of ERISA.

Finally, consider workers in plans with low funding ratios (predominantly unionized workers in the bond model) for whom condition (10–8) holds, but not condition (10–9); that is, a holdup is unprofitable to the union even with ERISA insurance. If the firm's stock value is sufficiently low, it may be mutually beneficial to stockholders and workers to amend the contract to terminate the plan to obtain a transfer up to the amount $[(P^*/P) - F]P$ from the federal insurance corporation.[23]

As long as ERISA beneficiaries represent a relatively small portion of the pension universe, these transfers, though sizable to the beneficiaries, could be financed with a relatively small tax on remaining pension participants. The current insurance premium is only \$2.60 per participant per year; a request to raise the premium to \$7.00 is now pending. An unknown premium subsidy is being contributed by U.S.

[23]Upon voluntary termination, the firm is liable up to one third of its net worth to the corporation to cover the shortfall $[(P^*/P) - F]P$.

taxpayers as a whole.[24] In short, this theory of ERISA fits neatly into a transfer-type theory of regulation.[25] Some unionized members stand to gain heavily from the insurance but nonbeneficiaries can hardly perceive the tax. Moreover, since the economics of underfunding were changed dramatically by persistently high inflation beginning in the mid-1960s, the insurance does not significantly disrupt the "bond market."

CONCLUSION

Pension plans in the United States have traditionally held assets in their pension plans that are substantially less than their economic pension liabilities, despite the tax advantages of full funding. This is an oft-cited anomaly to the proposition that firms act rationally; seemingly rational firms should take advantage of tax opportunities provided by the federal government. In this chapter, a theory of underfunding was developed. Firms forgo the tax advantages of full funding in exchange for the opportunity to make unionized workers long-term bondholders in the firm. In so doing, the firm reduces the advantage to unions of raising wages or reducing productivity to the point of threatening the long-term viability of the firm.

The bond value of underfunding suffered some erosion because of high inflation beginning in the late 1960s. In 1974, the enactment of ERISA rendered the bond valueless. The theory suggests that the underfunding bond would be replaced by a de facto underfunding bond conferred by inflation and the emergence of profit sharing and stock bonus plans in the union sector. The theory also suggests that unionized pension participants in plans holding valuable underfunding bonds stood to gain significantly from ERISA insurance. A series of statistical analyses will be made in the next chapter which, among other things, will lend strong support to the bond theory of pension underfunding.

It is not possible to say whether this theory or others will ultimately be accepted for an explanation of ERISA, or whether other theories will emerge to explain other apparently anomalous behavior by firms (like eschewing all-bond portfolios—see Chapter 9). But one message is clear: it is certainly plausible that many so-called puzzles in firms may not be puzzles at all. Returning to the themes discussed in the previous chapter—that pensions could exert strong impacts on

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[24] Because of the short history of the insurance, it is difficult to calculate its true cost. But it is widely believed that even the $7 proposed premium is substantially less than the true economic premium.

[25] See Sam Peltzman, "Toward a More General Theory of Regulation," *Journal of Law and Economics*, 19 (August 1976), pp. 211–40.

capital markets—it may be more fruitful to think that if problems exist, their responsibility lies with legal and regulatory constraints, not with firms' inability to choose optimal courses of action, given these constraints.

APPENDIX 10–1
Holdup Gains and Losses among Unionized Workers

In this appendix, the nature of holdup gains and pension losses are considered for workers of different ages in the firm. It is shown that setting a bond to deter the worker who retires on the date of firm failure will, under reasonably general circumstances, suffice to deter all workers in the firm from engaging in a holdup.

Distribution of the Holdup Gain among Union Workers

Taking the potential holdup prize as a given, it is useful to expand the model to permit us to depict how workers of different ages stand to share in this gain. Assume for simplicity that the discount rate for all union workers in the firm is zero, and that all workers start with the firm at age zero and retire at age R. No one quits or dies during the age interval $[0,R]$. If the union holds up the firm, it will do so upon committal of stockholder investment in period zero; consequent firm dissolution will occur t^* periods later when the durable investment is fully depreciated. First, consider the cost of a holdup to a worker. In the absence of a holdup, the wage-service profile for all workers in the firm is described by $W = c + da$, where a refers to age (and service level), W is the wage per period and c and d are constants. Upon firm failures, workers "start over" in another firm characterized by the same wage-service schedule. Thus, for a worker of age a at the point of the holdup (and age $a + t^*$ at the time of firm failure) the wage rate will fall by the amount $-d(1 - \lambda)(a + t^*)$ where:

$$\lambda = 1 \text{ if } a + t^* \geq R; \text{ zero otherwise.}$$

If firm failure occurs after a worker's retirement ($\lambda = 1$) wage loss is zero; otherwise, the worker will suffer this wage loss from age $a + t^*$ until retirement R.

Now consider the worker's gain from the holdup. Assume for simplicity that the holdup wage premium is distributed equally: all workers receive an increase in wage rate equal to δ dollars (thus, after the holdup, $W = a + \delta + da$ and $\delta L = \gamma K(t^*)/t^*$) where L is the number of union workers and $\gamma K(t^*)/t^*$ is the annualized gain from the holdup. Recalling the zero discount date assumption, the present value net gain to a worker aged a when the holdup occurs is therefore

$$G(a) = \delta t^* - \lambda\delta\,[(a + t^*) - R] - (1 - \lambda)d(a + t^*)[R - (a + t^*)]. \tag{10–10}$$

The first term in equation (10–10) is the holdup premium (δ) times the number of periods between the holdup and firm failure (t^*); the second term reduces this benefit for workers who will reach retirement age prior to the point of firm failure, and hence will miss part of the premium period (the sum of the first and second terms is constrained to be weakly positive); and the third term accounts for the wage reduction consequence facing all workers upon firm failure except those that retire during the holdup period. Presumably, a holdup is not feasible unless the holdup gain is positive ($G(a) > 0$) for all or most workers.[28]

Expression (10–10) holds some key qualitative results for the model. It is apparent that the maximum net gain from the holdup is a worker who is exactly at retirement age at the time of firm failure (that is, $a + t^* = R$): this worker gets the entire holdup premium (δt^*)—the second term in equation (10–10) is zero—but pays no opportunity wage cost—the third term is also zero. Workers older than age R at firm failure pay no opportunity cost but they collect the premium for fewer than t^* periods. Younger workers collect the entire premium but must incur "start over" costs. The net gain may not necessarily increase monotonically from age zero to age $R - t^*$ at the point of holdup unless it is assumed that the holdup period exceeds half the worker's normal tenure cycle in the firm, $t^* \geq R/2$; making this assumption, the gain distribution across workers can be neatly summarized as follows:

$$\begin{aligned} G'(a) &> 0 \text{ if } a + t^* < R \\ G'(a) &= 0 \text{ if } a + t^* = R \\ G'(a) &< 0 \text{ if } a + t^* > R \end{aligned} \tag{10–11}$$

This expression says that the gains from holdup are distributed to workers according to a "hill" shape. Evaluated at the point of firm failure, the biggest gainer is the worker at retirement age R; younger and already-retired workers gain progressively less from the holdup. It is important to emphasize that upon firm failure, many of the gainers from the holdup are already retired. Thus, in erecting a bonding device

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[28]For within-retirement-range workers ($\lambda = 1$), the gain from holdup is always positive but the gain diminishes at higher ages in this group because the premium is collected for fewer periods. Younger cohorts ($\lambda = 0$) receive the entire holdup premium (δt^*) but they must pay a price later in the form of moving to the start of a new wage-service profile. Younger workers in this ($\lambda = 0$) group lose less by the post-attack job switch because "starting over" imposes only a small wage penalty *but* the penalty remains for a longer remaining work life. These forces work against each other.

to discourage holdups, care must be taken to ensure that it "reaches" retirees at the time of firm failure. Also, if the bond is efficient, it must be distributed across workers in a way that replicates the essential "hill" shape of the gains.

Demonstration That the Underfunding Bond Replicates the "Hill" Gain Distribution across Workers

We can now consider whether an underfunded pension can be tailored to match the age distribution of the holdup premium. Assume all workers die at age $D > R$. In a world in which holdups do not occur, workers will collect a pension annuity starting at age R. The annuity will equal some constant, say b^a,[27] times years of service times wage at retirement $b^a aW(R)$. Now suppose the firm wishes to protect itself against a holdup. Let it do so by setting the funding ratio less than unity ($F < 1$). If a holdup precipitates a firm failure, workers will collect the portion $1 - F$ of their accrued pensions. At the point of firm failure, still unretired workers aged $a + t^*$ will collect the pension $(1 - F)b^a(a + t^*)W(a + t^*)$ for $D - R$ years; already retired workers aged $a + t^*$ at the point of firm failure will collect the annuity $(1 - F)b^aRW(R)$ for $D - (a + t^*)$ more years. Thus, recalling that discount rates are set to zero, the capital loss imposed by an underfunded pension on a worker who is age a at the point of the holdup (age $a + t^*$ at the point of firm failure) is

$$B(a) = (1 - F)\{(1 - \lambda)b^a(a + t^*)W(a + t^*)(D - R) + \lambda b^a RW(R)[D - (a + t^*)]\}. \qquad (10\text{–}12)$$

It is immediately apparent from equation (10–12) that the value of the bond mimics the distribution of the holdup gain across worker ages: the bond is maximized for individuals of age $R - t^*$ at the point of the holdup, precisely the biggest potential gainers from the holdup (see equation 10–10); moreover, the bond is smaller for older and younger workers:

$$\begin{aligned} B'(a) &> 0 \text{ if } a + t^* < R \\ B'(a) &= 0 \text{ if } a + t^* = R \\ B'(a) &< 0 \text{ if } a + t^* > R. \end{aligned} \qquad (10\text{–}13)$$

Comparing equation (10–13) with equation (10–10), it is apparent that underfunding is tailored to the job of bonding the unionized work

[27] In the text to this chapter, the notation b was used to denote pension generosity, not b^a. In the text, the parameter b referred to the present value pension collected during the entire retirement period; the notation b^a is now used to denote the pension *annuity* amount collected *each* year during retirement. If the interest rate is zero then $b = b^a(D - R)$ where D is the age of death.

force. An underfunded pension can be naturally designed in a way to offset the gains in a proportional sense across worker cohorts; it even assesses an appropriate penalty on workers who are already retired at the point of firm failure but nevertheless participated in the holdup. Other bond alternatives do not share this attribute.[28]

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[28]An enhanced specific human-capital bond (higher value of d in the wage-service profile) has no effect on workers who are older than $R - t^*$ when the holdup occurs. A stock bonus plan (x units of firm stock is given to the worker each period, not redeemable until retirement) sets monotonically higher bond values for workers older than age $R - t^*$. A profit sharing plan (which promises to give y percent of future profits to each worker per period) attaches the highest bond to workers of age zero at the time of holdup, falling monotonically over higher ages. The youngest workers see the largest streams of profits at stake; older workers have already converted past profits-based contributions to a diversified account. A combination of profit sharing and stock bonus plans can generate a bond which is more or less uniform for all workers, regardless of age. If profits are contributed to a plan that holds only firm stock, the declining present value of future firm profits-based contributions is offset by an increasing ownership in the firm's stock.