The Economics of Pension Insurance

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CHAPTER 2

Insuring a Defined Benefit Contract

Before issues surrounding federal pension insurance can be addressed, it first is necessary to understand the contract that is the subject of insurance: the defined benefit pension. This chapter will discuss the implications of this contract for the development of sound insurance principles, including those related to the nature of the insurance contract and to asset allocation. The degree of protection offered workers who are covered by the insurance is also studied. These principles lay the groundwork for evaluating the federal pension insurance program administered by the Pension Benefit Guaranty Corporation (PBGC).

THE DEFINED BENEFIT CONTRACT

A *defined benefit pension* is a promise by a firm[1] to pay workers an annuity at retirement age. Usually the benefit is proportional to years of service and to some measure of final pay (e.g., the average of the highest three annual salaries).[2] Some pensions offer flat benefits (pensions dependent on years of service, not salary), but the economic implications of flat benefit plans do not differ from so-called final pay formulas. This is because flat benefits usually are increased on a regular basis in relation to wage growth. Hence the discussion can be restricted to a stylized final pay plan without sacrificing our ability to generalize from the results.

[1]Technically, the promise is made by the pension plan. The firm, in turn, is held responsible for satisfying the minimum funding laws.

[2]A good summary of different types of defined benefit plan formulas is U.S. Department of Labor, 1983. A sample of actual formulas can be found in Banker's Trust, 1980. Full citations are found in book Appendix F.

Defined benefit plans are not the same as defined contribution plans. In the latter, the firm contributes a portion of the wage package each period to a separate account for each worker. After a short vesting period (usually five but not more than seven years), the account belongs to the workers, even if they leave the firm. The account accumulates interest and dividends until retirement. The annuity that can be purchased depends on the value of the account at retirement; benefit levels are not guaranteed, only contributions are.

Federal pension insurance covers only defined benefit plans. Thus, from this point onward unless otherwise specified, references to pensions mean defined benefit varieties.

Pension Formula

For analytical ease, suppose the worker's age is set to zero when he starts work in the firm. Then his age and service are always the same; denote this variable by a. The expressions are also simplified if we assume a lump sum is paid at retirement instead of an annuity. In a final pay formula, a worker's pension at age of retirement is denoted by the following benefit formula:

$$P_R = bRW_R \tag{2-1}$$

where

P_R = lump-sum pension at retirement age R
W_R = worker's wage during the last year of work
b = measure of generosity in the pension plan

Recall that age in the formula starts at zero at the time the worker begins employment with the firm. If the worker starts with the firm at age 35 and retires at 65, the value of R is 30. The worker gets a benefit based on 30 years of service, proportionate to his final wage, W_R. If W_R is $20,000, and b equals .15,[3] the value of this worker's pension is 30 × $20,000 × .15 = $90,000.

We now want to determine the value of this promised pension—not at the age of retirement, but at the worker's *current* age, a. At his current age, the worker does not have R years of service; he has a years of service. But the promised pension is still indexed to final wage at retirement, W_R, not current wage. For illustration, assume the chances of death or quitting the firm (or the firm failing) prior to retirement are zero. Thus, the value of the pension to the worker of age (and service level) a is

[3]This amount reflects the average generosity of private pension plans. A distribution of these parameters is found in McCarthy, 1985.

$$P_a = baW_R e^{-i(R-a)} \qquad (2\text{–}2)$$

where

i = long-term rate of interest.

The formula in Equation (2–2) is the same as Equation (2–1) except the formula reflects a years of service, not R, and the value of the pension is discounted to current age, not retirement age. The interest rate incorporates a real interest component (roughly 2 percent) plus some reflection of expected inflation (if the interest rate is 8 percent, expected inflation might be in the range of 6 percent). It is convenient to rewrite Equation (2–2) in terms of *current* wage, not wage at retirement:

$$P_a = baW_a e^{(g-i)(R-a)} \qquad (2\text{–}3)$$

where

g = rate of expected wage growth

For simplicity, I can reasonably assume that expected wage growth is roughly the same as the interest rate. That is, wages are expected to grow at the expected rate of inflation (in the above example, 6 percent), plus some factor that reflects growing seniority in the firm plus overall productivity growth in the economy [which, taken together, are in the range 2 percent—see Ippolito (1986)]. With this simplification ($g = i$), Equation (2–3) becomes

$$P_a = baW_a \qquad (2\text{–}4)$$

Equation (2–4) says that the value of the pension promise is proportional to current service and current wage. Thus, if current wage is $20,000 and current service is 10 years (and recall that $b = .15$), the value of a pension promise that is indexed to final wage is $20,000 × 10 × .15 = $30,000.

Who Pays for the Pension?

In the example above, it can be reasonably inferred that the $30,000 pension value is not a gift from the firm. Over the worker's 10 years of service, this amounts to roughly a $2,700 contribution per year of service in real terms ($2,709 per year accumulated at a continuously compounded 2 percent real interest rate over 10 years equals $30,000). This amounts to almost 15 percent of the wage. If this firm gave 15 percent "extra" to workers, it would not be able to compete with firms who paid the same wage but offered no pension. In equilibrium in our example, it must be true that the no-pension firm pays a cash wage of roughly $23,000, and the pension firm pays approximately $20,000 plus a pension worth roughly $3,000. Total compensation in each firm is approximately the same.

The issue of who pays for a pension, and how much, has been the subject of much study. This evidence shows that workers pay for pensions through lower cash wages (e.g., Ehrenberg, 1980; Schiller and Weiss, 1980b; and Smith, 1981) and that they pay for pensions as if they expect to receive them at retirement, that is, as if their pensions will be indexed to their final wage (Ippolito, 1985; Clark and McDermed, 1986; and Mitchell and Pozzenbon, 1986). If workers expect and pay (through lower cash wages) for the value of the pension depicted in Equation (2–4), then, in our example, the worker earning $20,000 with 10 years of service views his $30,000 pension value as an asset, just as he would view the equity value of his house. Like the investment in his house, however, his pension wealth is not a risk-free asset.

PENSION CAPITAL LOSSES

Losses upon Quitting

If everything goes as planned, the worker will receive his $30,000 value at retirement (plus the equivalent of all future service accruals plus interest). But if events are different than expected, he may absorb capital losses on his pension wealth. To develop this notion it is useful to consider the consequences of the worker quitting the firm. Later the same concept will be applied to the major event of concern to this book: failure of the firm and termination of the pension.

What happens if the worker just described quits the firm after five years of service? With inconsequential exceptions, the law requires all workers to vest after five years, and thus the first tendency may be to think that the worker who quits loses nothing. But this is not correct. On quitting the firm, a vested worker loses much (and in many cases, most) of his pension wealth. The reason is that the firm is not required to pay workers a pension indexed to final wage, unless the worker actually stays until retirement. If the worker quits early, the firm is legally required to pay a pension at retirement age R, but the pension value is indexed to the wage at the time the worker leaves the firm, not the wage that would have prevailed had he stayed until retirement.

Intuitively, the reason the pension loses value on quitting is that the pension accumulated to date is eroded in real terms due to inflation during the period between current age and retirement age (and because the worker forgoes any real interest accumulation on his pension savings as well). If the vested worker in our example leaves after 10 years, his pension value is calculated as $30,000, but he will literally receive this $30,000 lump sum at retirement age R, not $30,000 indexed to wage growth.

TABLE 2–1 Capital Losses from Quitting

Interest Rate	*Age at Time of Quit* 30	40	50
2%	39.3%	25.9%	9.5%
5	71.3	52.7	22.1
10	91.8	77.6	39.3

NOTE: This table assumes retirement with full benefits occurs at age 55. Numbers expressed as a percent of ongoing liabilities at the time the worker quits the firm. See Equation (2–6).

If time to retirement age is 20 years (retirement age is 55, and age at the time he quits is 35), then the present value of $30,000 received 20 years from now, discounted at 8 percent, is $6,054. If the worker stays until age 55, his pension based on his first 10 years of service has a present value of $30,000. Thus, on quitting the firm, the worker absorbs a capital loss equal to $23,946 ($30,000 − $6,054), or 80 percent of his pension wealth.

In general, this loss can be represented by reconsidering Equation (2–3). The pension value on quitting is represented by setting the rate of wage growth to zero. Doing this, we can rewrite Equation (2–3) in the special case of quitting the firm:

$$P_a{}^* = baW_ae^{-i(R-a)} \qquad (2\text{–}5)$$

If the worker in our example quits, the value of $P_a{}^*$ in Equation (2–5) is $6,054. If he stays, his pension value is P_a as given by Equation (2–4), or $30,000.

In general, the *capital pension loss* from quitting is the difference between the ongoing and termination-value pensions, P_a and $P_a{}^*$. Expressed as a percent of his pension wealth, P_a, we have

$$CL_a = (P_a - P_a{}^*)/P_a = [1 - e^{-i(R-a)}] \qquad (2\text{–}6)$$

The solutions to Equation (2–6) for various interest rates and ages of quits (assuming a retirement age R of 55) are shown in Table 2–1. It is apparent from the table that even though workers get their vested benefits on quitting, they can lose large portions of their accumulated wealth. If the interest rate is 5 percent, a 40-year-old worker with 15 years of service loses half his accumulated pension value. At a 10 percent interest rate, he loses more than three fourths of his benefits.[4]

[4]In view of the large cost of quitting a pension firm, it is not surprising that a large body of literature shows that workers covered by pensions quit less frequently than those not covered by pensions (e.g., Bartel and Borjas, 1977; Mitchell, 1982; Schiller and Weiss, 1980a). This is not necessarily undesirable: long-term employment may enhance productivity in the firm. Presumably one advantage of defined benefit pensions is that they give firms the opportunity to provide incentives for workers not to quit the firm.

The calculations in the table demonstrate an important principle for pension insurance: *Even though termination-value pensions are insured, the loss of an ongoing plan is costly to workers.* This feature will come into play as a coinsurance feature later on, and it will be critical to an understanding of the debate surrounding so-called follow-on plans.

Losses upon Plan Termination

Quit costs are important for this book because they exactly describe the capital losses imposed on workers when their pension plan is terminated. On termination, the firm owes workers nominal benefits, not benefits indexed to wages at retirement age. If a termination occurs without sufficient assets in the pension plan to pay legal benefits, then the Pension Benefit Guaranty Corporation pays only the *nominal*, or *legal*, pension benefit.

Related Issues: Coinsurance and Follow-On Plans

The issue of *coinsurance* is demonstrated in Table 2–1. Suppose a pension plan is terminated with no assets (and the net worth of the sponsor is zero). Thus, federal insurance must cover the entire legal pension value. If the interest rate is 10 percent, the age-40 worker absorbs 77.6 percent of his pension losses; the PBGC picks up the remaining 22.4 percent. The age-50 worker loses 39.3 percent of his pension; the PBGC picks up 60.7 percent of its value. In other words, given the large pension losses absorbed by workers on termination, workers are essentially brought in as coinsurers. In general, workers will not prefer to see pension plans terminated. This preference gives the insurance company a major ally in the battle against moral hazard.

The basic presumption behind the coinsurance notion is that a firm will be reluctant to terminate its pension plan and thereby impose large losses on workers. If workers believe the firm could continue as a viable entity without a pension termination, then these workers and the labor market as a whole will be distrustful of the firm in the future. This distrust translates into a risk premium the firm will be required to pay workers that will not be required of competing firms. Presumably this explains why healthy firms terminating pension plans to obtain reversions almost always structure the transaction to offset all capital losses.[5]

When firms are truly in financial difficulty, however, it is assumed that workers will be willing to participate in the firm's revival, which may require them to accept at least temporary reductions in compensa-

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[5]See Hay-Huggins Company, 1986.

tion to secure their jobs. The coinsurance feature rides off this implied contract—that pension plan termination is an unavoidable solution to a serious market problem and thus is less likely to reflect a firm's taking advantage of the insurance carrier.

This coinsurance is destroyed if, subsequent to the insurable event—say, termination in Chapter 11 of the Bankruptcy Code (Chapter 11 permits reorganization and continuation of the firm as an ongoing entity)—the firm is permitted to set workers' losses to zero. If the firm were able to restructure a *follow-on* plan after reorganization in a way that eliminated worker losses from termination, the insurer essentially would lose its coinsurer.

One way worker losses can be eliminated is to reestablish a new plan following termination that is identical to the old plan. On termination, the PBGC promises to pay the worker the value of the pension equal to P_a^* in Equation (2–5). But suppose that after the termination, the firm sets up a new plan that is exactly like the old plan and awards past service credit. That is, the firm promises to pay the amount on retirement:

$$P_R = bRW_R \tag{2-7}$$

To prevent double payments for the first a years of service (the value P_a^* is already being paid by the insurance company), the firm *offsets* the value P_R by the amount of the insurance guarantee, P_a^*. In this way, the firm and workers obtain the insurance payments without requiring workers to absorb any coinsurance loss.

This description of plan *reestablishment* is exactly what is done in most terminations for reversion.[6] That is, healthy plans can terminate, pay off legal liabilities, and take back any excess assets beyond this amount in the pension plan. So as not to impose losses on workers, they reestablish the old plan with past service credit and offset the plan by the amount given to workers on termination.

When healthy firms engage in reestablishment, the transaction merely reflects a rearrangement of assets from the pension trust to elsewhere in the firm. When a firm does this following a termination that involves an insurance claim, it eliminates all worker incentives against terminations and thus increases the potential for moral hazard problems.

Age Distribution of Coinsurers

Before leaving this issue, it is important to recognize that all workers in the firm do not share alike in the coinsurance. This can be important because if some pension plans have age distributions concentrated

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[6]A study of terminations for reversion is found in Hay-Huggins Company, 1986. Also see Ippolito, 1986.

among those who absorb only small losses on termination, the coinsurance feature is diluted.

To illustrate, it is important to go beyond the capital losses depicted in Table 2–1. In that table, workers at older ages lose a smaller portion of their pension wealth. What the table does not reflect is the larger absolute level of pension wealth that characterizes older workers. A better way to show the amount of coinsurance across ages is to calculate capital losses from termination as a percent of wage:

$$(P_a - P_a^*)/W_a = ba[1 - e^{-i(R - a)}] \qquad (2–8)$$

The values from this equation are shown in Table 2–2 for interest rates equal to 2, 5, and 10 percent. It is apparent that workers far from retirement and those close to retirement lose less from termination than those in the middle of the age-service distribution. For example, when the interest rate is 5 percent, those workers between the ages of 35 and 45, with 10 to 20 years of service, absorb pension losses between 95 and 118 percent of their annual wage. Those aged 30 with 5 years of service or age 54 with 29 years of service lose the equivalent of 53 and 21 percent, respectively, of their annual wage. Clearly, the value of coinsurance depends on the age and service distributions in the firm.

The capital loss calculations shown in Tables 2–1 and 2–2 implicitly assume that postretirement inflation adjustments are zero. By using an example where a lump sum is paid at retirement, I have assumed away this issue. Thus, a 55-year-old worker eligible for full benefits in my example would be indifferent to a termination, assuming he would normally retire at age 55.

For most plans, the pension is paid in the form of an annuity. Most pension plans, especially large plans, also periodically enhance service benefits to reflect inflation erosion during retirement. Allen, Clark, and Sumner (1983) have shown that these adjustments accounted for at least one half of the inflation rate during the 1970s. For example,

TABLE 2–2 Pension Losses from Termination, by Age

		Interest Rate		
Age	*Tenure*	*2 Percent*	*5 Percent*	*10 Percent*
25	0	0.00%	0.00%	0.00%
30	5	.29	.53	.68
35	10	.49	.95	1.29
40	15	.58	1.19	1.74
45	20	.54	1.18	1.90
50	25	.36	.83	1.47
54	29	.09	.21	.41
55	30	0.00	0.00	0.00

NOTE: Numbers express pension losses as a percent of salary at the time of the termination. The illustration assumes a worker started the job at age 25 and retires with full benefits at age 55. The lump-sum pension equals 15 percent times years of service times wage. See Equation (2–8).

suppose the inflation rate is 5 percent and the real interest rate is zero. If the plan is ongoing, suppose it will periodically increase benefits for retirees on average 2.5 percent per year. If the retiree dies with certainty at age 80 and the interest rate is 5 percent, the present value of a pension annuity that starts out at $5,000 per year is worth $92,948 at age 55. If the plan is terminated when the worker is age 55, the federal insurer will not award inflation adjustments, and hence the annuity is discounted at the full 5 percent. This yields a value of $71,350 at age 55.

Thus, in general, even workers close to retirement have some stake in plan terminations. As long as they expect to lose some inflation adjustments during retirement, termination will be a costly event. Of course, firms most likely to terminate may be the least likely to award any postretirement adjustments even absent termination. If so, older workers are effectively lost from the coinsurance pool.

These calculations suggest that once a pension plan becomes dominated by older workers and retirees (which might be expected in dying firms), the value of coinsurance is diminished. One way for the insurer to retain coinsurance even in this case is to guarantee something less than 100 percent of nominal pensions to retirees. In fact, in a world in which expected inflation becomes very low, the latter solution is the *only* way to retain a coinsurance feature.

ROLE OF THE INTEREST RATE

If interest rates are high, the insurance carrier can earn higher nominal returns from investing in long-term bonds, which lowers the cost of paying off fixed pension obligations. From the workers' perspective, because long-term nominal interest rates primarily reflect market expectations of future inflation rates, high interest rates imply substantial erosion of their real benefits if they leave the firm or if the firm terminates the pension plan. Thus, when the insurance carrier views the cost of a termination as "low," workers tend to view the cost as "high" (and vice versa when interest rates are low).

Levels of Claims

The discussion above hints at the large role played by long-term nominal interest rates in the cost of insuring termination-value pensions. This point is made forcibly in Table 2–3. The table depicts a 40-year-old worker with 15 years of service in a plan that pays a lump-sum pension at retirement equal to 15 percent per year of service multiplied by final wage. The funding ratio in the plan is zero.

Columns 2 and 3 in the table show the shares of pension losses on termination to the worker and insurer. [See Equation (2–6).] When the

TABLE 2–3 Role of Interest Rate in Pension Insurance

Interest Rate	Claim as Portion of Current Wage* (1)	Percent Real Pension: Paid by Insurer† (2)	Percent Real Pension: Percent Not Covered‡ (3)
2%	1.66	74.1%	25.9%
5	1.06	47.3	52.7
10	.50	22.4	77.6

NOTE: Example assumes pension has one participant aged 40 with 15 years of service; retirement with full benefits at age 55; pension generosity is 15 percent [b = .15 in Equation (2–1)]. The funding ratio in the plan is assumed to be zero.

* Solution to Equation (2–5) divided by the wage level W_s.

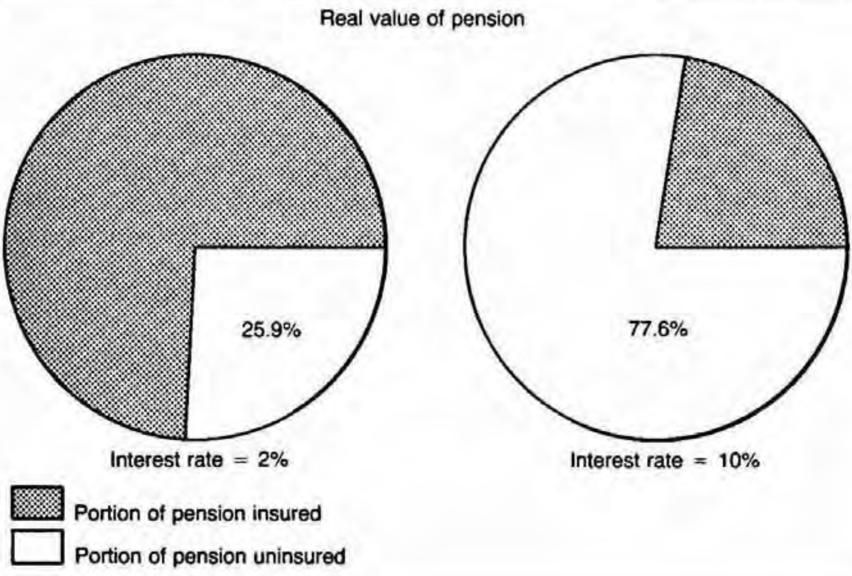
† 100 percent minus worker's share of loss in column 3.

‡ Solution to Equation (2–6).

interest rate is 10 percent, the worker absorbs 77.6 percent of the pension losses from termination, and the insurer pays the remaining 22.4 percent. If the interest rate is 2 percent, however, the shares essentially are reversed: the individual pays only 25.9 percent of the loss, and the insurer pays 74.1 percent (see Figure 2–1).

The claims implications of these share distributions are shown in column 1 in Table 2–3. At a 10 percent interest rate, the insurer faces a

FIGURE 2–1 Insured and Uninsured Losses on Termination



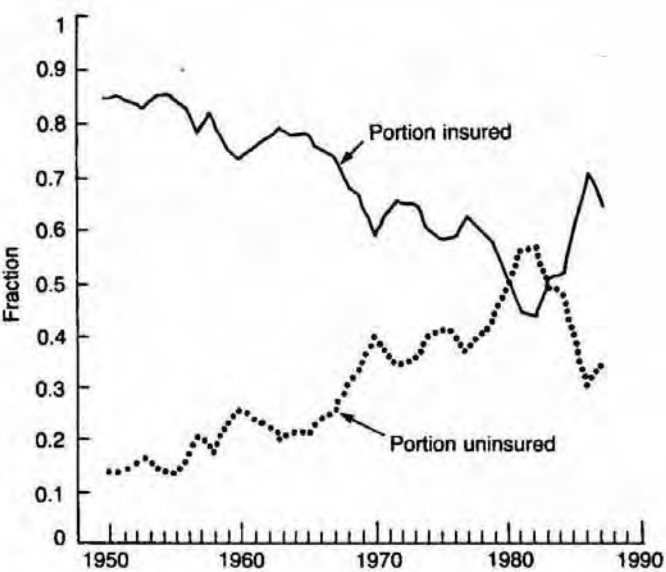
claim equal to 50 percent of this worker's wage on termination of the pension plan; at a 2 percent interest rate, the value of this claim increases more than threefold, to 1.66 times current wage. If the worker's wage is $10,000, the insurer's obligation increases from $5,000 to $16,600, depending on whether the interest rate is 10 percent or 2 percent.

In general, the sensitivity of claims to interest rates depends on the age and service distributions in the plan. But, in general, the numbers in Table 2–3 make it clear that any rational premium scheme to cover such claims must take current interest rates into account. The numbers in the table, however, do not tell the whole story.

Reconsider the distribution of losses between the insurer and the insured. When the interest rate is 10 percent, the worker has a 77.6 percent stake in the loss; at 2 percent, he has only a 25.9 percent stake. Because the coinsurance amount falls with lower interest rates, there is more potential for moral hazard problems. Put another way, when interest rates are lower, employers can impose a larger portion of the burden of termination on the PBGC (as opposed to on workers), and thus more terminations are expected. This factor tends to aggravate the cycle of higher claims likely to occur when interest rates fall.

Figure 2–2 gives some idea of the variation in the coinsurance shares if the PBGC insurance policy had been in effect in 1950. The

FIGURE 2–2 Coinsurance, 1950–1987



numbers in the figure are based on the ratio of termination to ongoing liabilities for the entire defined benefit pension system; thus, the numbers depict the portion of pension value that would have been preserved if the "typical" pension terminated during each period. The coinsurance share is also denoted.

Over the entire period depicted, the portion of pension wealth guaranteed would have decreased substantially. There also has been great variation in these shares during the ERISA period. The illustration makes it clear that if interest rates revert to levels that prevailed in the 1950s, the cost of providing PBGC insurance would escalate dramatically.

Investment Implications: The Principle of Immunization

Interest rate volatility can introduce large uncertainties into the value of pension liabilities at termination. It is possible, however, to offset much of this risk by choosing appropriate investments on the asset side. Choosing assets that offset liability risk is known as *portfolio immunization*. This complex topic would take us far beyond the scope of this book, and thus only the essence of the idea is presented here.[7]

To make this illustration, suppose a plan sponsor wishes to eliminate the risk that it will not be able to pay its pension liabilities in the event of a termination. Consider the same example used above (only one worker, who is age 40 and has 15 years of service). Assume the sponsor's obligation is to provide a lump sum at the time of termination. The pension obligation of the firm on termination of the pension is given by Equation (2–5). This obligation is rewritten here:

$$P_a^* = baW_a e^{-i(R-a)} \qquad (2\text{–}9)$$

where

a = current age (and service)
R = retirement age, when the lump-sum equivalent must be given to the worker

Now suppose the plan sponsor contributes an amount to the pension plan equal to $A = P_a^*$, so that the pension plan is fully funded in a termination sense. And suppose the firm wants to insure against having the funding ratio fall below 100 percent. First, consider a strategy that will not work. Suppose the firm buys all Treasury bills. This portfolio certainly does not eliminate volatility. If long-term interest rates fall from 10 percent to 2 percent in the next instant,

[7]A good introduction to the notion of immunization is found in Lebowitz, 1986a, 1986b.

termination liabilities in Equation (2–9) increase by over 200 percent (see Table 2–3). Because the value of T-bills is virtually unaffected by changes in interest rate, asset values do not change. In this case, a large difference would arise between insured liabilities and assets backing the insurance.

Suppose, instead, that the pension plan buys either a noncallable, zero-coupon bond or a "stripped" bond with a maturity equal to $R - a$ years.[8] These bonds guarantee a stated rate of interest for the entire investment period. The firm purchases bonds equal in value to termination liabilities:

$$B(i, R - a) = P_a^* \tag{2–10}$$

where

$B(i, R - a)$ = amount of the bond investment that pays the interest, i, payable in $R - a$ years

If the interest rate changes from i to zero a moment after the bond is purchased, the funding ratio will remain 100 percent. This is because when the interest rate falls to zero, the liability value increases by the factor $e^{i(R - a)}$. But the value of assets must increase by the same factor; that is, if the interest rate falls to zero, the market value of a bond B paying an interest rate i over $R - a$ years increases by the factor $e^{i(R - a)}$.

Consider a 40-year-old worker with 15 years of service. Retirement normally occurs at age 55. If his wage is $10,000 and the interest rate equals 10 percent (recall that $b = .15$), his pension wealth on termination is 50 percent of his wage, or $5,000 (see Table 2–3). Assume a $5,000 noncallable, zero-coupon bond that pays 10 percent per annum is purchased. If the interest rate falls to zero in the next instant, the termination pension wealth increases to $22,500.[9] But the market value of the bond also increases to $22,500. That is, if the interest rate decreases from 10 percent to zero percent, a noncallable, zero-coupon bond yielding a continuously compounded interest rate equal to 10 percent will appreciate by the entire amount of interest over the 15-year life of the bond: $22,500 = $5,000 accumulated over 15 years at a 10 percent interest rate.

This example illustrates the principle of immunization: assets are matched against liabilities. Real increases in termination benefit obligations are offset by real increases in matched asset values.

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[8]A zero-coupon bond pays no interest during the period it is outstanding. All interest is accumulated at the stated rate of interest on the bond. A "stripped" bond is one where all coupons have been clipped from the bond and sold; proceeds represent an implicit constant rate of interest over the period the bond is held. In both these cases, there is no interest rate risk: The rate of interest stated on the bond is guaranteed over its life.

[9]This is equivalent to the pension formula of 15 percent per year times 15 years of service times current wage ($10,000) with no discount.

The insurer can apply the same principle. First, it can protect itself from changes in liability values for any obligations it purchases by exactly matching a bond portfolio against liabilities. Second, the insurance company can invest all premiums (minus administrative expenses) into a "matched" asset pool, where the maturity of the portfolio is based on the age/service distribution of the insured plans. If this matching is followed over several periods, terminated obligations will tend to be offset by matched asset pools.

MARKET FOR INSURANCE

The discussion of the principles of pensions and insurance raises several interesting questions. The most important is whether a market would develop without government involvement to insure against pension losses, and, if so, whether it necessarily would insure termination-value pensions.

Insurance for Termination-Value Pensions

Consider the second issue first. One attraction of providing insurance against termination-value liabilities is that through careful management of a bond portfolio, the liabilities can be immunized. The agent guaranteeing payment (the pension plan or the insurer) and the insureds both know in advance that the promise to pay can be made credibly because insured promises are backed by an appropriately selected matched portfolio.

The problems with insurance against termination-value pensions are apparent in Table 2–3. From the workers' perspective, the amount of protection against loss of pension wealth varies greatly with the interest rate. From the insurer's perspective, the amount of coinsurance, and therefore the potential for moral hazard problems, also varies greatly with the interest rate. These problems are addressed by an insurance contract written for ongoing benefits.

Insurance against Ongoing-Value Pensions

The question arises whether insurance for ongoing benefits requires the insurance carrier to abandon the notion of portfolio immunization. The answer is no. It is also possible to choose assets that largely offset the risk of insuring against ongoing-value pensions. In this case, however, assets must be chosen so that their values are not affected substantially by unanticipated inflation.

Cost of ongoing versus termination insurance. Consider the example above. A 40-year-old worker with 15 years' service has a current annual wage of $10,000. The pension generosity parameter is

15 percent ($b = .15$). Using Equation (2–4), which assumes wage growth will approximate the interest rate, the ongoing value of this pension is $22,500:

$$P_a = .15 \times 15 \text{ years} \times \$10{,}000 = \$22{,}500 \qquad (2\text{–}11)$$

A termination pension is worth much less than an ongoing pension. For example, if the nominal interest rate is 10 percent and retirement occurs in 15 years, the termination value of the pension is worth only $5,000:

$$P_a^* = .15 \times 15 \text{ years} \times \$10{,}000 \times .223 = \$5{,}020 \qquad (2\text{–}12)$$

where

.223 = discount factor representing the present value of one dollar payable at age 55 discounted to age 40 using a 10 percent interest rate

This discount factor is what distinguishes termination from ongoing liabilities. It is omitted from the ongoing calculation in Equation (2–11) because wage growth exactly offsets the discount effect.[10]

Cost of an actual ongoing contract. A real insurance contract, however, does not necessarily cover the full value of the ongoing pension. First, instead of insuring a pension indexed to wages, the contract may insure pensions indexed to prices (prices generally increase at a rate 1 to 2 percent lower than wages—see book Appendix A, Table A–1). Second, a coinsurance factor may be used guaranteeing some portion of the real value of the pension.

The value of the insured pension could be written in the following general terms:

$$P_a' = I\, baW_a e^{(k - i)(R - a)} \qquad (2\text{–}13)$$

where

I = portion of the pension insured
k = the inflation rate

Because the interest rate equals the inflation rate plus a real interest rate component (that is, $k - i = -r$, where r is the real interest rate), Equation (2–13) can be written as:

$$P_a' = I\, baW_a e^{-r(R - a)} \qquad (2\text{–}14)$$

In the above example, the value of b is .15, current wage is $10,000 per year, and time to retirement is 15 years ($R - a = 15$). If the

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[10] In my model, I assume the expected wage growth rate equals the interest rate. If this is not the case, the wage growth and discounting effects would not be exactly offsetting. Qualitatively, however, the results would be the same as those depicted by the simpler model demonstrated above.

insurance pays 67.7 percent of this amount (I = .677) and the real interest rate is 2 percent (r = .02), the amount of the insured pension P_a' equals approximately \$11,300:

$$P_a' = .677 \times .15 \times 15 \text{ years} \times \$10{,}000 \times .74 = \$11{,}272 \quad (2\text{–}15)$$

where

.74 = present value of \$1 discounted 15 years at 2 percent

Comparing the insured amount in Equation (2–15) with ongoing benefits in Equation (2–11), it is apparent that the "real" pension insurance contract in this example protects roughly half of the ongoing value of the pension (\$22,500). Put another way, the coinsurance factor is 50 percent.

The advantage of a contract stated in real terms is that the value of the insurance is not affected by changes in unexpected inflation, and therefore: (a) the coinsurance factor (in this case, 50 percent) is stable; (b) the insureds know exactly the real value of their pension guarantee long before they attain retirement age; and (c) the insurer does not need to reassess the real price for the insurance each period, as the long-term interest rate changes.

Immunizing a Real Pension Insurance Contract

Can this contract be immunized or hedged on the asset side? The answer is yes. The insurer can match its liabilities (P_a') against a 100 percent short-term T-bill portfolio. Over a long period of time, T-bills are expected to yield a small, risk-free real rate of interest (r) plus the rate of inflation. To be conservative, the insurer could write the contract assuming r equals zero and offer a "bonus" at retirement in the event r is positive over time.

In this type of portfolio, assets grow with inflation (plus r) and indexed pensions also grow with inflation. The covariance between changes in asset and liability values is expected to be positive and large. Federal government-issued indexed bonds would be even better candidates for a real pension liability match because they are long term and explicitly pay a real interest rate plus the inflation rate.[11] In this case, no hedge on the real interest rate needs to be incorporated in prices.

Examples of immunization strategies are shown in Table 2–4 for

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[11]Unlike some countries like England and Israel, the United States does not issue indexed bonds. Some such bonds are available through private issuers. For example, the Fidelity Fund offers instruments indexed to the CPI plus a real rate in the vicinity of 3 percent. Maturities, however, are limited to 10 years. I am indebted to Zvi Bodie for alerting me to the existence of these securities.

TABLE 2–4 Immunization Strategies

		Value in 15 Years*		
Insurance Contract	*Current Value*	$i = 0$	$i = .1$	$i = .2$
Termination-value liability (evaluated at $i = .10$)	$ 5,020	$22,500	$22,500	$ 22,500
Noncallable, zero-coupon, 20-year bond, $i = .10$	5,020	22,500	22,500	22,500
Real-value liability (67% of price-indexed pension)	11,300	11,300	50,643	226,966
T-bills (assumed to pay inflation rate)	11,300	11,300	50,643	226,966

Assumptions: Worker has 15 years of service, is 15 years from retirement, has a salary of $10,000, and a lump-sum pension that pays 15 percent of wage ($b = .15$). See text.

* It is assumed that the *actual* interest rate becomes effective the day after the insurance contract is signed, is equal for short- and long-term bonds, and is constant over the entire period. It is also assumed that expected and actual real wage growth and the real interest rate are zero.

both the termination and real insurance contracts discussed in the example above. Consider the termination-value contract. Suppose the insurer locks into a noncallable, zero-coupon bond of the same maturity as the liability (15 years, in the example). If the bond pays the same interest rate used to discount the pension (10 percent), assets will be sufficient to pay the nominal benefit on the date it becomes payable. In the example, a bond valued at $5,020 will pay off the stated liability regardless of subsequent changes in interest rates.

In the case of a real-value pension, as long as T-bills do not pay negative real interest rates, they will accumulate sufficient funds to pay off price-indexed pensions.[12] Table 2–4 assumes that T-bills pay a zero real rate of interest (thus, the interest rate is the inflation rate). If the interest (inflation) rate suddenly falls to zero, liabilities *and* assets retain their value of $11,300 in 15 years. If the interest (inflation) rate increases from 10 to 20 percent, the value of assets *and* liabilities will both grow to $226,966 in year 15.

Why Any Insurance?

Technically, either termination-value or real-value pensions can be insured in a free market. The question is whether a market in pension insurance *would* develop. That is, why would not all pension plan

[12]To protect itself against the possibility of negative real returns, the insurer could write the contract to index pensions to the T-bill rate or to the inflation rate, whichever is lower.

sponsors self-insure? Why would not all firms merely invest an amount in matched bonds sufficient to cover liabilities in the event of plan termination?

In the event the firm continues in operation, it will face pension obligations substantially higher than those payable on termination [compare the value of ongoing benefits (P_a) in Equation (2–4) with either termination benefits ($P_a{}^*$) in Equation (2–5) or insured real benefits ($P_a{}'$) in Equation (2–14)]. The firm could match these liabilities by investing in either long-term bonds in the case of termination-value insurance or T-bills (or indexed bonds if available) in the case of real-value insurance. Additional liabilities could be funded with securities that will more likely keep pace with obligations indexed to wages (stock, real estate, etc.).

One reason might be *information* problems. Without regulation, it is difficult for workers to monitor the firm's actions and, in particular, to know that assets are held in a separate trust and properly matched against termination liabilities. This is not a problem in many large firms with valued reputations; but in many smaller firms, it is less clear that sufficient trust exists for workers to accept a pension promise without at least some guarantee from a third party. In these cases, by requiring an insurance contract, workers in essence hire an agent whose self-interest will act to guarantee that at least the insured portion of a pension will be paid. That is, the insurance firm will attach conditions to the contract to ensure that a fully funded trust matches either termination-value or some portion of real-value pension liabilities, whichever is promised in the contract. A third-party insurer makes defined benefit pension plans more feasible in some firms. In this case, the insurer acts as a *quality-assurer:* it guarantees the "quality" of the insured portion of the pension.

Another answer is related to *leverage*. Suppose workers prefer a larger pension and are willing to gamble with more volatile securities, say, 100 percent growth stocks. But they want some guaranteed pension if the firm must terminate the pension (say, because the firm encounters financial difficulties). Suppose 1 plan in 100 will terminate per year at random, regardless of funding levels in the plan; and suppose, because of market volatility, funding ratios in all plans are either 50 percent or 150 percent in any given year. In this example, only one all-bond portfolio is needed to insure nominal benefits for the single termination expected every two years. Without an insurer, *all* plans must hold the amount $P_a{}^*$ in bonds to offer the same insurance protection. With an insurer, all firms can invest in riskier but higher-return stocks and still protect workers against termination.

A special case occurs when the firm underfunds its plan. In effect, the plan is holding its assets in the plan sponsor's stock. If many firms underfund in this way, the same leverage argument holds.

When these firms combine to find insurance, the insurable event is the confluence of two events: the plan becomes underfunded *and* the firm encounters severe financial difficulties. In the case discussed above where firms maintain underfunding, the first condition always prevails. When firms have a target funding ratio of 100 percent but are invested in a diversified portfolio, underfunding occurs when the market value of securities falls markedly. When this happens *and* some firms fail, an insurable event occurs.

This kind of insurance is akin to life insurance, where "death" is the failure of the firm. In life insurance, accidental insurance can be purchased on a term basis, but death from health problems must be sold on a term/renewal basis. Otherwise, the insurer could drop insureds as soon as, say, cancer is diagnosed. Because most firms fail slowly, we could think of these contracts as renewable, term contracts. Some agreement can be made in advance about the amount of insurance paid at the time of the insurable event.

Though there is some reason to believe in the possibility of a market for pension insurance, at least one serious problem could prevent its development. In reality, markets generally do not rise and fall in predictable patterns. In the above example, assets may fall by 50 percent and remain there for several years. Moreover, when investment returns are low, the evidence suggests that firms terminate plans in "clusters" because of the burden that higher contribution levels (to offset reduced asset values) placed on them (Ippolito, 1986). The occasional years in which large amounts of underfunding develop, and lots of terminations occur, generate "bunching" of claims over time, or catastrophic risk.

Catastrophic risk poses solvency problems for insurance firms. If large claims are taken after the first year of operation, the insurance company may be unable to honor its promises (unless it can find events to insure that are negatively correlated with pension losses). The problem is especially severe if the size of the insured plan population is skewed. If a few large plans randomly terminate soon after the insurance begins, the insurance company can easily be overwhelmed. This is a rationale for participation of an industry group or government in some type of reinsurance scheme.

CONCLUSION

The discussion in this chapter laid the groundwork for understanding why a demand for pension insurance might exist; how these insurance contracts might look; and why a private market might not arise to meet this demand. The starting point is understanding the nature of the pension promise between the firm and its workers. Workers in effect give up a portion of cash wages in exchange for a promised pension at retirement. This pension is essentially indexed to final wages at retirement (and, in effect, at least partially indexed to prices during retirement). If the firm survives, the workers will receive the value of the "ongoing" pension.

Insurance contracts could be written to protect termination-value or real-value pensions. The contract, however, must guarantee something less than ongoing pensions so that workers are included as coinsureds. The carrier must hold a portfolio that immunizes the value of the guarantee; this immunization could involve an all-bond portfolio or an all-T-bill portfolio, depending on the nature of the guarantee. Real-value contracts are more stable because all parties know in advance the real value of the guaranteed pension, the real price of the insurance, and the amount of coinsurance.

Insurance firms can play two roles in a pension market. First, they can act as *quality-assurers*, ensuring that firms not entirely "trustworthy" can credibly promise to pay termination-value or partially guaranteed real-value pensions. The self-preservation interests of the insurers guarantee that they will act as agents for workers in protecting at least insured benefits.

Second, insurance firms could permit *leverage* by firms and workers who want a riskier but higher expected pension amount but also desire some minimum insurable pension in the event the firm fails. In this case, instead of all insureds holding a requisite bond or T-bill portfolio that guarantees at least a partial pension to workers, the insurer holds a much smaller bond or T-bill portfolio that actually will be used by the few insureds who need it.

One problem with private insurers offering pension insurance is the expected bunching of claims over time. Funding levels tend to fluctuate together for all insureds, and pension plan terminations tend to occur in clusters. Nonrandomness in claims makes it difficult for the private sector to offer credible insurance. This will be the starting point for the next chapter, which adopts this rationale for public insurance and begins the process of deriving insurance principles that would exist in a private insurance market.