

NBER WORKING PAPER SERIES

PENSION FUNDS AND FINANCIAL INNOVATION

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Working Paper No. 3101

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 1989

This paper was prepared under Department of Labor Contract Number J-9-P-8-0097 and with support from the Federal Reserve Bank of Boston. I am grateful to Robert C. Merton, Leslie E. Papke, and Robert A. Taggart, Jr. for many helpful suggestions. This paper is part of NBER's research program in Financial Markets and Monetary Economics. Any opinions expressed are those of the author not those of the National Bureau of Economic Research.

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ABSTRACT

Pension funds have played a critical role in the evolution of the markets for debt and equity securities and their derivatives in the U.S. over the last 15 years. The new securities and markets can largely be explained as responses to the investment demands of pension funds in an environment of increased interest rate volatility and tighter regulation.

Defined benefit pension plans offer annuities that have a guaranteed floor specified by the benefit formula. In order to minimize the cost to the sponsor of providing this guarantee, there is a strong incentive to invest an amount equal to the present value of the accumulated benefit obligation in fixed-income securities with a matching duration. The pursuit of duration matching and related immunization strategies by pension funds has contributed to the emergence and rapid growth of markets for zero coupon bonds, GIC's, CMO's, options, and financial futures contracts. Recent changes in accounting rules (FAS 87) and tax law (OBRA) are likely to reinforce the use of immunization strategies.

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August 1989

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PENSION FUNDS AND FINANCIAL INNOVATION

"It is by no means clear that the demand and supply for financial assets by opaque institutions simply reflect retail forces. In the prevailing equilibrium models of securities markets, demand comes from the individuals solving portfolio optimization problems. However, when we take account of the intervening contractual relations under which opaque institutions operate, it seems heroic to think that they mirror these forces."

Stephen A. Ross, "Institutional Markets, Financial Marketing, and Financial Innovation," The Journal of Finance, July 1989.

1. Introduction.

In the past 15 years, starting in 1974, we have seen an unprecedented wave of financial innovation in the U.S. capital markets. The main areas of innovation have been the securitization and repackaging of debt and the emergence of derivative securities markets. The purpose of this paper is to show how some of these developments can be explained by the nature of the benefits guaranteed by defined benefit pension plans and the investment strategies they employ to hedge their liabilities.

In 1988 assets of pension plans amounted to almost \$2.5 trillion, representing the largest single pool of investable funds. It is not surprising, therefore, that the investment policy of pension funds has had a profound effect on the direction and rate of innovation in the capital markets.

Perhaps the most striking development has been the emergence of new securities and markets designed to provide long-duration

dollar-denominated cash flows. Examples are the markets for zero coupon bonds, Collateralized Mortgage Obligations (CMO's), and Guaranteed Investment Contracts (GIC's).¹

From the perspective of household lifetime utility maximization it is hard to see why there would be much of a demand for such securities. Economic theory would suggest that households want securities that hedge against the main sources of risk to their future stream of consumption. A long-term nominal bond has little value as a hedge against the risks faced by households because it is so vulnerable to inflation risk.

This paper traces the demand for long-duration dollar-denominated debt to the nature of the benefits guaranteed by defined benefit pension plans and to the immunization strategies they employ to hedge their liabilities. It also explains the emergence of options and financial futures markets along similar lines. It then explores several possible explanations for the failure of pension plans to provide automatic protection against inflation risk. The analysis focusses on corporate pension plans, but most of it applies as well to state and local government defined benefit plans.

¹See Smith and Taggart [1989] for a discussion of the major innovations in the fixed-income area.

2. Pension Funds as Financial Intermediaries

This paper takes the view that the primary economic function of a pension plan is to provide retirement income security to plan beneficiaries and that the investment behavior of the pension fund can best be understood from that perspective.² This is the conventional view of pensions expressed by most pension professionals, and it is codified in the law that regulates private pension plans in the U.S..³

We start by thinking of an employer-sponsored pension plan as a savings scheme for the provision of retirement income. Through a combination of employer and employee contributions part of the employee's total compensation during the working years is deferred until retirement. This savings scheme can and often does have several insurance features designed to protect the employee against economic insecurity in retirement.

The major sources of retirement income risk that a risk-averse employee would like to insure against are:

1. Replacement rate inadequacy- This is the possibility that the retiree will not have enough income to maintain the same standard of living after retiring as during the preretirement years.

²For an elaboration of this view see Bodie [1989a].

³The Employee Retirement Income Security Act (ERISA) of 1974 mandates that private pension plans be operated for the exclusive benefit of the participants and their beneficiaries. Subsequent amendments to ERISA have not altered this basic approach. The leading text book on private pensions, McGill and Grubbs [1989], seems to adopt this perspective as well.

2. Longevity- the risk that the retiree will outlive the amount saved for the provision of retirement income.
3. Social Security cuts- the risk that the benefits provided by the Social Security retirement system will be cut before the individual reaches retirement age.
4. Investment risk- the possibility that the amount saved for retirement will be inadequate because the assets in which they were invested performed poorly.
5. Inflation risk- the risk that inflation will erode the purchasing power of retirement savings.

We can think of a corporation's pension fund as a financial intermediary designed to provide insurance against some of these risks. There are two basic types of pension plan: defined contribution and defined benefit. In the case of a defined contribution plan the fund is owned entirely by the plan beneficiaries, the corporation's employees. In the case of a defined benefit plan, the corporate sponsor guarantees the liabilities of the pension fund and, in effect, shares ownership with the employees. A defined benefit pension fund is essentially an insurance company subsidiary of the sponsoring corporation.

The sharing rules for defined benefit plans are very complex, and mostly they are implicit. The funding and investment policies for a defined benefit plan depend on these sharing rules, on the tax advantages offered by IRS regulations, and on the laws governing pension plans.

2.1 Defined Benefit and Defined Contribution Plans

Let us first distinguish more fully between the two basic types of pension plan: defined contribution (DC) and defined benefit (DB). The DC arrangement is conceptually the simpler of the two.

Under a DC plan, each employee has an account into which the employer and the employee (in a contributory plan) make regular contributions. Benefit levels depend on the total contributions and investment earnings of the accumulation in the account.

Contributions usually are specified as a predetermined fraction of earnings, although that fraction need not be constant over the course of a career. Contributions from both parties are tax-deductible, and investment income accrues tax-free.⁴ At retirement, the employee receives either a lump sum or an annuity whose size depends on the accumulated value of the funds in the retirement account.

Often the employee has some choice about how to invest the funds in the account. In principle, contributions may be invested in any security, although in practice most plans limit investment options to various bond, stock, and money market funds. The employee bears all the investment risk; the retirement account is by definition fully funded, and the firm

⁴Employee contributions are tax-deductible only if the DC plan is structured so as to meet certain restrictions imposed by the IRS.

has no obligation beyond making its periodic contribution.

For defined contribution plans investment policy is not much different than it is for an individual deciding how to invest the money in an IRA. The guiding principle is efficient diversification, that is, achieving the maximum expected return for any given level of risk exposure. The special feature is the fact that investment earnings are not taxed as long as the money is held in the pension fund. This consideration should cause the investor to tilt the asset mix of the pension fund towards the least tax-advantaged securities such as corporate bonds.

In a DB plan, the employee's pension benefit entitlement is determined by a formula that takes into account years of service for the employer and usually wages or salary. In a typical DB plan, the employee might receive retirement income equal to 1% of final salary times the number of years of service. Thus, an employee retiring after 40 years of service with a final salary of \$30,000 per year would receive a retirement benefit of 40% of \$30,000, or \$12,000 per year.

The annuity promised to the employee is the employer's liability. The Pension Benefit Guarantee Corporation (PBGC), an agency of the U.S. government, guarantees the pension benefits promised under defined benefit plans up to certain limits. Plan sponsors pay insurance premiums that depend on the number of employees covered by the plan and on how well funded it is.

Large corporations usually offer a defined benefit plan as their primary pension plan and supplement it with voluntary

defined contribution plans (called savings or profit-sharing plans). To encourage participation the sponsor often makes matching contributions to these supplementary DC plans, and the employee decides how to allocate the money. When a DC plan is the primary pension plan, however, the employee often is not required to make any contributions, and the employer usually makes the asset allocation decisions.

In a DB plan the assets serve as collateral for the firm's pension liabilities. Traditionally, pension funds have been viewed as separate from the corporation. Funding and asset allocation decisions are supposed to be made in the best interests of the beneficiaries, regardless of the financial condition of the sponsoring corporation.

3. The Nature of the DB Pension Promise

The nature of the insurance provided under a defined benefit plan varies with the specific type of plan and benefit formula. As stated in the previous section, in plans for salaried employees the benefits tend to be salary-related, a proportion of either average final pay or career average pay, and the benefits actually paid often exceed those specified by the formula.

The pensions offered under these plans are best viewed as participating annuities that offer a guaranteed minimum nominal benefit determined by the plan's benefit formula. This guaranteed benefit is enriched from time to time at the discretion of management based on the financial condition of the

plan sponsor, the increase in the living costs of retirees, and the performance of the fund's assets.

The evidence in support of this contention is that many plans have given ad hoc voluntary benefit increases to plan participants in the past.⁵ While these increases have been viewed by many as evidence of implicit cost-of-living indexation they are very different from a formal COLA (cost-of-living adjustment). We will come back to this distinction shortly.

The recent ruling by the Financial Accounting Standards Board (FAS 87) regarding the reporting of corporate DB pension obligations has recognized two different measures: the accumulated benefit obligation (ABO) and the projected benefit obligation (PBO). The ABO is treated as the primary measure. If pension assets fall short of the ABO, the unfunded liability must be reported on the corporate balance sheet. The PBO is reported only in the footnotes to the corporation's annual report.

There is considerable controversy among investment professionals about which of these (if either) should be seen as the true pension liability to be hedged through pension fund investment policy. Several experts on pension investment policy have stated that the PBO and the ABO should both be hedged by corporate sponsors of defined benefit pension plans.⁶ While they

⁵See Clark, Allen, and Sumner [1983] for a discussion of these ad hoc increases.

⁶For example, see Black [1989], Arnott and Bernstein [1988], and Ambechtsheer [1987].

agree that the ABO is the correct measure of the termination value of the sponsor's pension obligation, they think that the PBO is the correct measure of its "going concern" value.

We can clarify the issues involved by considering the following numerical example. Suppose the plan pays a benefit equal to 1% of final salary per year of service. To keep the mathematics simple we will make some additional assumptions that will not affect the qualitative results we are interested in.

Plan participants enter the plan at age 25, retire at age 65, and live until age 85. There is immediate vesting, no early retirement option, and no employee turnover. These assumptions allow us to ignore the actuarial adjustments necessary to account for mortality risk and turnover.

We assume that the typical employee's salary increases at the rate of inflation. This implies no change in real wages over an employee's career and allows us to avoid the complications arising from any divergence between nominal wage growth and inflation. Finally, we assume that the interest rate appropriate for discounting nominal annuities is 9% per year (the riskless real rate of 3% per year plus an expected rate of inflation of 5% per year plus a risk premium of 1% per year).

3.1 The Accumulated Benefit Obligation (ABO)

Figure 1 and the second column of Table 1 show the profile of the present value of new benefits earned (as a proportion of salary) in each year. This is the amount the sponsor would have

to contribute to the pension fund in order to eventually provide the benefit earned in that year.

Figure 2 and the second column of Table 2 show the value of the employee's accrued benefits (as a proportion of salary) at the end of each year. It represents the amount of money that the employee would be entitled to if the plan were terminated or if the employee left at that time. In other words, it is the ABO.

The profile in Figure 1 is "backloaded," that is, the present value of new pension benefits earned is a much larger proportion of salary in the later years than in the earlier years. Table 1 shows that even in the tenth year of employment the present value of the new benefit earned is only .98% of salary and the cumulative value of all benefits earned up to that time is less than 6.88% of annual salary. Most benefits are earned in the last ten years of employment.

This backloading is due to two factors: the time value of money and inflation. The older the worker, the closer the date of retirement, and therefore the higher the present value of an additional dollar of pension benefits.

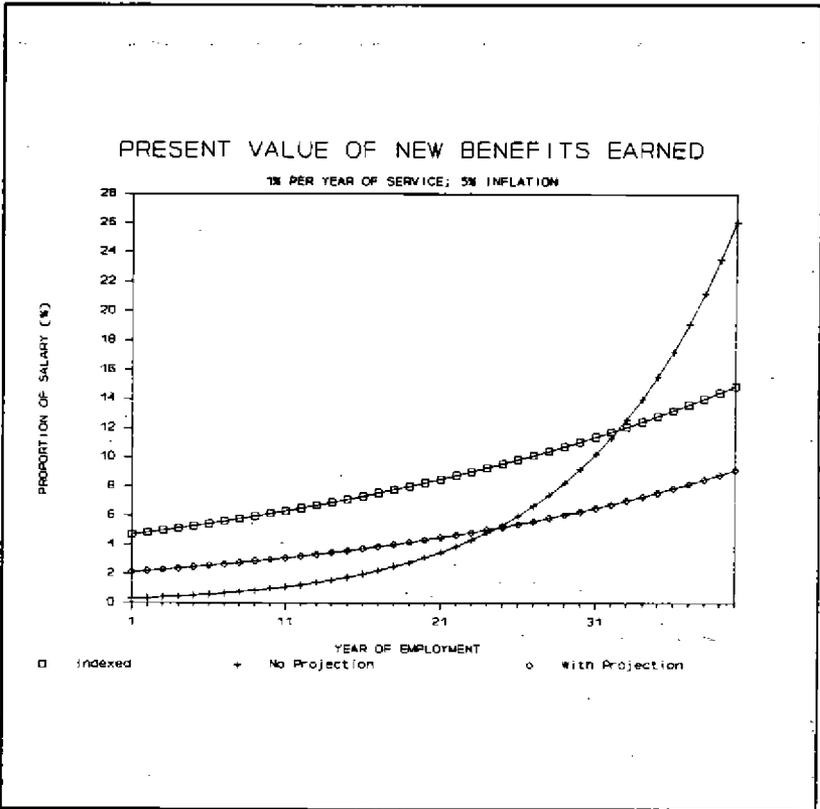


Figure 1

Figure 1 Present Value of New Benefits Earned as a Proportion of Salary

Assumptions: The plan pays a benefit equal to 1% of final salary per year of service. Plan participants enter the plan at age 25, retire at age 65, and live until age 85. The employee's salary grows at the rate of inflation, which is 5% per year. The interest rate used for discounting nominal annuities is 9% per year.

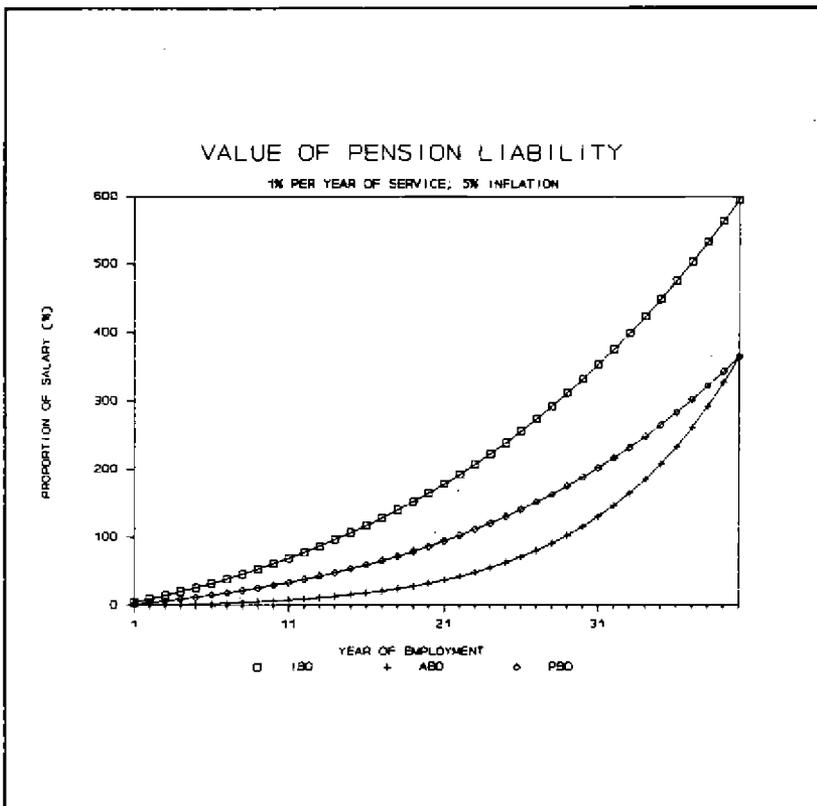


Figure 2

Figure 2. Cumulative Value of Benefits Earned as a Proportion of Salary

Assumptions: The plan pays a benefit equal to 1% of final salary per year of service. Plan participants enter the plan at age 25, retire at age 65, and live until age 85. The employee's salary grows at the rate of inflation. The riskless real rate of interest is 3% per year, and the nominal rate used for discounting nominal annuities is 9% per year.

Table 1. Present Value of New Benefits Earned as a Proportion of Salary

Year of Employment	Without Salary Projection	With Salary Projection	Fully Indexed Pension
1	.32%	2.12%	4.70%
10	.98	2.97	6.13
20	3.10	4.32	8.24
30	9.18	6.28	11.07
40	26.08	9.13	14.88
Steady State	6.40	4.82	8.86

Assumptions: The plan pays a benefit equal to 1% of final salary per year of service. Plan participants enter the plan at age 25, retire at age 65, and live till age 85. The employee's salary grows at the rate of inflation. The riskless real rate of interest is 3% per year, and the nominal rate used for discounting nominal annuities is 9% per year. The steady state values assume an equal age distribution of plan participants (age range from 25 to 85).

Table 2. Cumulative Value of Benefits Earned as a Proportion of Salary

Year of Employment	ABO	PBO	IBO
1	.32%	2.12%	4.70%
10	6.88	29.74	61.29
20	32.58	86.43	164.75
30	115.68	188.43	332.11
40	365.14	365.14	595.10
Steady State	128.33	155.84	247.66

Assumptions: Same as for Table 1.

Inflation increases backloading for two reasons. First, it increases the nominal rate of interest, thus accentuating the time value of money factor already mentioned. Second, given the benefit formula and our assumption that salary increases at the rate of inflation, inflation creates an indexation component in the benefit earned each year. With each year of continued employment, the present value of the benefit earned increases both because the number of years of service increases and because the nominal salary base increases.

Because it is critical in understanding the distinction between the ABO and the PBO, let us illustrate this "wage indexation" effect in detail. Suppose that you just turned 26 years old and have received a salary of \$30,000. You have therefore accrued a deferred pension annuity of \$300 per year for 20 years starting 39 years from now when you retire. The present value of this deferred annuity is \$95. This is the ABO.

If you work for another year, assuming inflation of 5%, you will receive a salary of \$31,500. The pension annuity that you are now entitled to is 2% of \$31,500, or \$630 per year starting 38 years from now. Thus the promised pension annuity has increased by \$330. By working for an additional year you have earned an additional percentage point of salary for the additional year of service (\$315), and you have earned an additional \$15 by increasing the salary base for computing your pension benefit. Had you not worked the additional year you would have been entitled to only \$300 per year at retirement.

Thus, you have earned the \$15 indexation increment to your pension benefit through continued employment.

That this indexation increment to the pension benefit can only be achieved through continued employment is well understood by plan participants facing the retirement decision. They will often delay the date of retirement if they anticipate inflation in the immediate future, in order to raise the salary base for computing their pension benefit.

3.2 The Projected Benefit Obligation (PBO)

By contrast, if the pension benefit were automatically indexed for inflation up to the age of retirement, then regardless of what happens in the future your projected pension benefit after one year of service is $\$300 \times 1.05^{40}$ or \$2,112 per year. The present value of this deferred annuity is \$669. This is the PBO.

Note that at retirement the ABO and the PBO have the same value.⁷ They differ only in how much the sponsor is assumed to owe the worker before retirement. The PBO would be the correct

⁷Note that if a plan sponsor makes contributions to the pension fund each year equal to the amounts in the third column of Table 1 (corresponding to the PBO), then by the time the employee reaches retirement the amount accumulated in the fund will equal the amount necessary to pay the pension benefits (at the assumed interest rate). The projected benefit method is therefore an acceptable actuarial funding and costing method. (Winklevoss 1977). FAS 87 requires corporations to use this method to report pension costs in their income statements. When used to determine contributions it results in overfunding relative to the ABO approach.

number to use if benefits were tied to some index of prices or wages up to the age of retirement independently of whether the employee stays with the employer. Because private plans do not offer such automatic indexation, it is a mistake to use the PBO as the measure of what the sponsor has guaranteed.

3.3 The Indexed Benefit Obligation (IBO)

The indexed benefit obligation or IBO is the present value of the pension liability assuming indexation for inflation both before and after retirement. Figures 1 and 2 and Tables 1 and 2 show that inflation indexation makes an enormous difference to the value of pension benefits. Without indexation, at retirement a plan participant would have benefits with a lump-sum equivalent value of 3.65 times final salary. With indexation it would be 5.95 times final salary, an increase of 63%.

Many economists argue that the IBO is the most appropriate measure of a sponsor's pension obligation.⁶ They claim that although there is no formal COLA, there is an implicit contract between employer and employees that, in effect, guarantees the real value of the pension benefits to workers who stay with the firm. As evidence these economists have argued that workers behave as if they believed that their pension benefit is indexed.

I do not find this argument persuasive. After all, workers

⁶See, for example, Cohn and Modigliani [1985] or Ippolito [1986]. These economists think that belief in long-term implicit contracts between employer and employee imply this result.

can be systematically mistaken about the value of their pension benefits. Studies have shown, for example, that 75% of Americans think that Medicare provides long-term care insurance for the disabled elderly. It does not. These citizens are simply mistaken. Indeed, I will argue in the next section that one of the main reasons that employers do not offer automatic inflation indexation is that workers are subject to a kind of money illusion regarding their income replacement ratio in retirement.

I agree with those who think that there is usually an implicit long-term contract between employees and employers who offer DB plans. I also agree that the pension plan plays a part in this implicit contract and that the pension liability therefore exceeds the ABO. The evidence to support this view is: (1) employers make ad hoc benefit increases for retired employees, and (2) employees are not usually fired just before they become entitled to big increases in the value of their accrued benefits due to early retirement options. It does not follow, however, that the IBO or the PBO is the correct measure of the sponsor's pension liability or that they should be hedged through the fund's investment policy.

What then is the nature of the implicit pension liability? As I said earlier in this paper, I think that the DB pensions offered to salaried employees are best viewed as participating annuities that offer a guaranteed minimum nominal benefit determined by the plan's benefit formula. This benefit is enriched from time to time at the discretion of management based

on the financial condition of the plan sponsor, the increase in the living costs of retirees, and the performance of the fund's assets.

The implicit pension obligation is a very complex contingent claim, both in the economic and legal sense. It seems clear that if the sponsoring corporation does not do well financially, then employees cannot expect to get anything more than the ABO. There is mounting evidence that corporations facing severe financial difficulties, either because of low profitability or because they are under threat of hostile takeover, will raid their overfunded pension plans and give employees only the legal minimum (that is, the ABO).⁹

On the other hand, if the corporation does well financially, and if retired employees face inflation, then there is evidence that the corporation will help them out with ad hoc benefit increases. It is for this reason that I have referred to this type of pension benefit as a participating annuity with a guaranteed floor.

⁹See, for example, VanDerhei (1989), Petersen (1989), and Pontiff, Shleifer, and Weisbach (1989).

4. Why Pension Plans Do Not Provide Inflation Insurance

Why aren't pension plans designed to offer automatic indexation for inflation? One reason frequently cited in the past was that plan sponsors had no way to hedge the risk through an appropriate investment strategy.¹⁰

While it is true that in the past there have been no financial instruments offering a risk-free real rate of return in the U.S., had there been a demand for them by pension funds there is little doubt that they would have come into existence. Indeed, recently several financial institutions have introduced financial instruments linked to the CPI. Their success or failure will put the "lack of inflation hedge" explanation to the test in the next several years.¹¹

Another explanation is that people already have enough inflation insurance. Most notably Social Security retirement benefits are indexed to wages during the preretirement years and to the CPI after retirement. Furthermore much personal saving takes the form of investment in residential real estate, which while not riskless, is probably hedged against inflation risk.¹²

Pension planners seem convinced that plan participants are not willing to pay for inflation insurance through salary

¹⁰This explanation, however, raises the question of why integrated DB plans insure against Social Security risk even though they have no apparent way of hedging that risk through an appropriate investment strategy.

¹¹See Bodie [1988].

¹² See Martin Feldstein [1983] and Lawrence Summers [1983].

reduction whether explicitly or implicitly. The way these pension professionals see it, offering inflation insurance under a DB plan with no offsetting reductions in the benefit formula would increase pension costs for younger employees. This is precisely the group that is least likely to place much value on pension benefits in general and on inflation insurance in particular. For young people, retirement income (such a long way away) is so heavily discounted that variations in inflation rates may have only second-order effects on saving for retirement now.

Finally, there is money illusion. In economies where the rate of inflation is not too high, people mistakenly treat nominal values as if they were real. Even professional financial planners often fall into the trap of treating nominal annuities as if they were real for retirement planning purposes.

A rule of thumb used by many financial planners and benefits specialists to judge the adequacy of retirement income is the following: add expected Social Security benefits and expected pension benefits and compare their sum to preretirement income. If this so-called "replacement ratio" is greater than 80% you will have adequate retirement income and do not need to supplement it with other retirement saving.

This approach ignores the effect of post-retirement inflation on pension benefits, and therefore can lead to inadequate saving for retirement. For example, imagine that you are 45 years old, and you work for a firm that has a defined benefit pension plan that offers you a benefit equal to 1.5% of

final pay times the number of years of service. Your salary is now \$50,000 per year, and you do not expect it to grow in real terms.

By the time you retire you will have worked for the company 40 years, and your pension benefit will therefore be 60% of your final salary or \$30,000 per year. You expect Social Security to provide a benefit of \$10,000 per year, so your expected combined retirement income is \$40,000 and your replacement ratio 80%.

Now suppose inflation is 5% per year. At that rate prices double roughly every 14 years. Your Social Security benefit has a COLA (cost of living adjustment), so it will increase in tandem with inflation. But your pension benefit does not. The \$30,000 of pension income which may have been adequate when you retired will have half of its original purchasing power when you are half way through retirement. If you are fortunate enough to live 28 years past the retirement age, your pension benefit will be worth only one quarter of its original value.

The situation I have just described is the norm rather than the exception. Very few retirement planning professionals currently pay more than lip service to the problem of post-retirement inflation. They routinely ignore it in calculations of income replacement ratios.

This replacement ratio fallacy may lead employees to mistakenly think that a defined benefit plan with a final average pay formula offers them more inflation protection than it really does. What incentive does an employer have to incur the costs of

offering inflation protection to employees who are already behaving as though they had it? By raising the issue, the employer might alert the employees to a previously unnoticed inadequacy in their benefits package and cause discontent.

5. Who Owns the Pension Surplus?

If a corporate pension fund has an ABO that exceeds the market value of its assets, FAS 87 requires that the corporate sponsor recognize the unfunded liability on its corporate balance sheet. If, however, the pension assets exceed the ABO, the corporate sponsor cannot include the surplus on its balance sheet.

This asymmetric accounting treatment expresses a widely held view among pension professionals that as guarantor of the accrued pension benefits, the sponsoring corporation is liable for pension asset shortfalls but does not have a clear right to the entire surplus in case of pension overfunding. Recent court rulings in cases of terminations of overfunded plans have left unclear how much of the surplus belongs to the plan sponsor, but it is clearly less than 100%.¹³

There is one way that the corporation's shareholders can get the entire pension fund surplus, but it takes time. This is by

¹³Early papers on pension finance by Sharpe [1976] and Treynor [1977] assumed that the pension trust was essentially an asset of the sponsoring corporation. Bulow and Scholes [1983], however, argue convincingly that the corporation's shareholders and the plan beneficiaries actually share ownership.

reducing the level of funding in the future. Thus while the corporation may own less than 100% of the pension fund surplus in the short run, in the long run it can take it all.

The implicit contract that we discussed in the previous section can be viewed as a form of employee ownership share in the pension fund surplus.

6. The Corporate Pension Guarantee and Funding and Investment Strategies.

The asymmetry between the treatment of pension deficits and surpluses creates an incentive for pension plan sponsors to pursue an investment policy of immunizing their pension liabilities. We can clarify the issues with a simple example.

Imagine a corporation that has a defined benefit pension plan. The only liability on the pension fund balance sheet is the ABO (B). The situation is displayed in Table 3. These balance sheets differ from conventional accounting ones in that we have explicitly included the corporate sponsor's guarantee of the ABO (G) as both an asset of the pension fund and a liability of the corporation.

The pension fund net worth (S) is the difference between its total assets - investments plus corporate pension guarantee (I+G) - and the ABO. The corporation owns a proportion, ϕ , of the pension fund net worth; the remainder (1- ϕ) belongs to the employees. The shareholders' equity in the corporation (E) is the difference between total corporate assets (conventional plus

the corporation's share of the pension fund surplus, $A + \phi S$) and corporate debt (conventional plus the guarantee of the ABO, $D + G$).

Let us consider several cases differing with respect to the funding status of the pension plan. First consider the case of a completely unfunded pension plan (that is, $I = 0$, $G = B$, and $S = 0$). In this case the pension fund's investments are zero, and the only pension fund asset is the corporate guarantee, which is equal in value to the ABO. The pension fund net worth is zero. This case is illustrated in Table 4.

What is the effect of funding? That depends on the source of the funds and what they are invested in. Let us assume that the corporation borrows on corporate account to fund the plan and invests the money in the bonds issued by other corporations. This leaves the corporation's total debt, as conventionally measured, unchanged.

Table 3. Sample Corporation Balance Sheets

a. Corporate Balance Sheet

<u>Assets</u>		<u>Liabilities and Owners' Equity</u>	
Conventional Assets	A	Conventional Debt	D
Corporate share of pension fund net worth	φS	Corporate guarantee of ABO	G
		Shareholders Equity	E

b. Pension Fund Balance Sheet

<u>Assets</u>		<u>Liabilities and Net Worth</u>	
Investments	I	Accumulated benefits	B
Corporate guarantee of ABO	G	Net Worth	S

Table 4. Case of Unfunded Pension Plan

a. Corporate Balance Sheet

<u>Assets</u>		<u>Liabilities and Owners' Equity</u>	
Conventional Assets	A	Conventional Debt	D
Corporate share of pension fund surplus	0	Corporate guarantee of ABO	B
		Shareholders Equity	E

b. Pension Fund Balance Sheet

<u>Assets</u>		<u>Liabilities and Net Worth</u>	
Investments	0	Accumulated benefits	B
Corporate guarantee of ABO	G	Net Worth	0

In the absence of tax effects, G should go down and D and I should each go up by the amount of funding. S will be zero as long as I is less than or equal to B. Therefore funding the plan and investing in bonds will have no effect on shareholder wealth regardless of the size of the ownership share of employees in the pension fund surplus. This leads to the following proposition regarding pension funding:

Proposition I: Ignoring taxes and assuming that the money is invested in assets that match the pension liability, funding the pension plan will not affect the value of shareholders' equity.

Of course, overfunding the plan will result in a positive pension surplus ($S > 0$). If the employees have some claim to the pension surplus ($\phi < 1$), then shareholder wealth will decline as the degree of funding increases.

What is the effect of altering the pension fund asset mix? Let us assume that the plan is exactly fully funded ($I = B$). Then G and S are zero only if the fund invests 100% in bonds whose cash flows are matched to the pension liabilities. If there is a mismatching of pension investments with the ABO, then the corporate pension guarantee will have some value, and the market value of the pension fund net worth will be positive. The riskier the pension fund investment portfolio, the higher will be the values of G and S.

If the corporation owns the entire pension fund surplus ($\phi = 1$), the pension fund asset mix will not affect the market value of corporate shareholders' equity. This is because G is a corporate liability, and all of S is a corporate asset. From a shareholder wealth perspective the corporate pension guarantee cancels out.¹⁴

Proposition II: In the absence of corporate income taxes and assuming the corporation owns the entire pension fund net worth, the pension fund asset mix does not affect the value of shareholders' equity.

If, however, the firm's shareholders own less than 100% of the pension fund net worth, then an increase in the riskiness of the pension assets may reduce the market value of shareholders' equity.

The corporate guarantee of the ABO (G) is in effect a put option on the investments of the pension fund with an exercise price equal to the present value of the ABO. To see this, imagine that the plan is terminated. Formally, the payoff structure at the date of termination is: $\text{Max}(0, B - I)$.

Just as the corporate pension guarantee is analogous to a put option, the pension fund net worth (S) is analogous to a call option. Its payoff structure at the date of termination is:

¹⁴See Sharpe [1976] and Treynor [1977] for a discussion of this special case.

Max (0, I - B). From the pension fund balance sheet we know that the net worth is always identically equal to:

$$S = I + G - B$$

In the literature on options this is known as the put-call parity relationship.

A well-known result in the theory of option pricing is that if the volatility of the underlying security's price increases, then the put and the corresponding call option will both increase in value by the same amount. In the case of a defined benefit pension fund the values of G and S increase with the volatility of the difference between the ABO and the pension fund's investments.

6.1 Immunization and Duration Matching

One way to minimize this cost to the corporation's shareholders is to immunize the pension liability through an investment strategy of duration matching. For example, suppose we can characterize the firm's pension liability as a perpetual annuity. Suppose further that the term structure of interest rates is flat.

The duration of this liability is $(1+y)/y$ years, where y is the level of interest rates. By investing in a bond or other fixed income securities with this same duration, the corporation can insure that the value of its pension assets will always equal the value of the pension liability. A simple way to do this would be to invest in zero coupon bonds with a maturity of

$(1+y)/y$ years. As y changes and as the bonds in the pension fund portfolio mature, management has to continuously readjust the portfolio to maintain a duration equal to $(1+y)/y$.

The pursuit of duration matching strategies by pension funds has created a demand for fixed income instruments with a guaranteed duration. The innovations of the past 10 years like zero coupon bonds, CMO's, interest rate swaps, and interest rate futures contracts can be viewed, at least in part, as the market response to this demand. They are all ways of eliminating duration uncertainty from traditional bonds and mortgages.

6.2 Pension Overfunding and Contingent Immunization

If the corporation's management wants to maximize shareholder wealth, why should they choose to fund the pension plan and why should they invest in anything but securities that exactly hedge the ABO liability? There are at least four reasons why firms fund their defined benefit pension plans.

First, there are minimum standards imposed by law. The purpose of these standards is to insure the promised pension benefits against the risk of default by the corporate sponsor and to protect the government (and therefore the taxpayer) from abuse of the insurance provided by the government. Recent changes in the law have made the insurance premium charged by the PBGC a function of the degree of underfunding and eliminated the possibility of voluntary termination of an underfunded pension

plan.¹⁵

Second, there are big tax incentives for plan sponsors to fund their DB plans. Black [1980] and Tepper [1981] have shown that the tax advantage derived from a defined benefit pension plan stems from the ability of the sponsor to earn the pretax interest rate on pension investments. In order to maximize the value of this tax shelter it is therefore necessary to invest entirely in assets offering the highest pretax interest rate. Because under the IRS code in the U.S. dividends from investments in common and preferred stock are taxed at a much lower rate than interest on bonds, corporate pension funds should invest entirely in taxable bonds and other fixed income investments. Recent changes in the tax laws have reduced the ability of pension plans to overfund, but sponsors are still allowed to make additional tax-qualified contributions as long as pension assets are less than 150% of the ABO.¹⁶

Third, funding its pension plan provides the sponsoring corporation with financial "slack" that can be used in case of possible financial difficulties the firm may face in the future.¹⁷ Because the law still allows plan sponsors facing financial distress to draw upon excess pension assets by reduced

¹⁵See Utgoff [1988].

¹⁶The relevant law is the Omnibus Budget Reconciliation Act (OBRA) of 1987.

¹⁷See Bodie et al [1987] for a more complete discussion of the financial slack motive for funding a pension plan.

funding or, in the extreme case, voluntary plan termination, the pension fund can effectively serve as a tax-sheltered contingency fund for the corporation.

Finally, PBGC insurance covers only a portion of the promised benefits for the highly compensated plan participants. Funding provides a cushion of safety for this group, which includes top corporate management.¹⁸

If the pension fund is overfunded, then a 100% fixed income portfolio is no longer required to minimize the cost of the corporate pension guarantee. Management can invest surplus pension assets in equities provided it reduces the proportion so invested when the market value of pension assets comes close to the value of the ABO. Such an investment strategy is known as portfolio insurance or contingent immunization.

The pursuit by pension funds of portfolio insurance strategies has created a market for index options and futures contracts. The implementation of these strategies is feasible without these derivative securities, but their existence makes implementation less costly and less disruptive to the activities of portfolio managers.¹⁹

7. Pension Fund Investment Policy in Practice.

¹⁸See Light and Perold [1987] for a more complete discussion of this point.

¹⁹Leland and Rubinstein (1988) have described how the emergence of a market for stock index futures made their ideas for portfolio insurance commercially viable.

How do corporate pension funds actually invest their money? The stylized facts are that there is no significant difference between DB and DC plans in the overall asset mix. Regardless of plan type there is a clear tendency to invest between 40 to 60% of assets in equities and the remainder in fixed income securities.²⁰

If the only goal guiding corporate pension policy is shareholder wealth maximization then it is hard to understand why the pension fund would invest in equities at all. A policy of 100% bonds would both maximize the tax advantage of funding the pension plan and minimize the cost of guaranteeing the defined benefits.

This suggests that there are other reasons why pension funds invest a large fraction of their money in equities. Among the possibilities are:

- .. Corporate management views the pension plan as a trust for the employees and manages fund assets as if it were a defined contribution plan with a guaranteed floor specified by the benefit formula. In doing so, it balances the goal of shareholder wealth maximization against the goal of employee welfare maximization.
- . Management has a mistaken view of the nature of the guaranteed benefit and thinks that the best way to hedge it is with a portfolio that contains a large proportion in

²⁰See Greenwich Research Associates [1988].

equities.

Management believes that through superior market timing and security selection it is possible to create value in excess of management fees and expenses. This is usually stated as reducing pension costs through superior investment performance.

Many executives in nonfinancial corporations are used to creating value in excess of cost in their businesses. They assume that it can also be done in the area of portfolio management. Of course, if that is true then one must ask why they do not do it on corporate account rather than in the pension fund. That way they could have their tax shelter "cake" and eat it too.

In other words, many executives do not believe in the Efficient Markets Hypothesis (EMH). Note, however, that there is a growing trend particularly among large pension plans to engage in indexing of both the fixed income and equity portfolios. This is evidence that the sponsors of these plans believe that even if there are opportunities to beat the market, the fees of those portfolio managers who can do it consume any surplus earned.

While all three explanations have an element of truth to them, I believe that the first is the most important one. Management views the pension fund as a trust for the employees and is trying to manage the assets so as to maximize employee welfare subject to the constraint that the cost of providing the benefit guarantee is minimal.

Such a policy could lead an overfunded pension plan to invest in equities. But it would also dictate that a firm should reduce the proportion of its portfolio invested in equities if the degree of overfunding falls. In other words, it should pursue a policy of portfolio insurance or contingent immunization.

Recent trends in pension asset allocation are broadly consistent with this explanation. Some pension funds pursue portfolio insurance strategies openly, often using stock index futures. Others accomplish a similar result through stop-loss orders and similar trading techniques in the stocks themselves.

The widespread practice of writing covered call options can also be interpreted as evidence that pension funds want to convert some of their investment in corporate equities into debt. By writing a call option on an appropriate stock market index, a pension fund can effectively transform a portfolio of stocks into a portfolio of corporate bonds maturing at the expiration date of the option.²¹

Berkowitz and Logue (1986) found that the average risk-adjusted performance of ERISA plans from 1968 to 1983 was lower than returns experienced by other diversified portfolios in U.S. financial markets. This could be interpreted as evidence that they pursue contingent immunization strategies. Under this interpretation the difference in their average return is in

²¹See the appendix for a more complete explanation of how this transformation is accomplished.

effect the insurance premium. Berkowitz and Logue also found that there was more reallocation between stocks, bonds and cash equivalents in DB pension plans than in the control group. This too can be interpreted as evidence of portfolio insurance practices.

In cross-sectional studies of pension asset allocation we would expect to find that the proportion of fund assets invested in equities would be positively related to plan overfunding. Friedman (1983) found no significant correlation between the allocation of defined benefit plan assets and the funding status of the plan. Bodie et al (1987) confirmed this finding. In both of these studies, however, the unit of observation was the corporation rather than individual plans. Since many corporations have several plans, some of which are overfunded (usually the ones for salaried employees) and some underfunded, it could be that the effect we are looking for is obscured at the level of the firm.

Recent changes in accounting rules (FAS 87) and tax law are likely to reinforce the strategy of immunization. As a result of FAS 87 corporate officers concerned with the adverse impact of an unfunded ABO on the corporate balance sheet will have a greater incentive than before to hedge against interest rate risk.

Two of the provisions of the Omnibus Budget Reconciliation Act of 1987 (OBRA) are relevant. The first is the strengthening of the claim of the PBGC on corporate assets for underfunded pension plans. This will eliminate some of the incentive for

such corporations to take risks with the assets in the pension plan and therefore increase the proportion invested in fixed income securities.

The second relevant provision of OBRA is the imposition of strict funding limits on pension plans. If pension plans gradually become less overfunded, the cost of providing benefit guarantees will become more sensitive to the proportion they invest in equities. They will therefore have an incentive to invest more in fixed income securities.

8. Financial Innovation as a Response to the Investment Demands of Pension Funds

Most of the innovations in the fixed income securities markets since the early 1970's have been in response to an underlying increase in the level and volatility of interest rates and the desire to hedge against the risks created thereby.²² These interest rate developments were triggered largely by the inflationary trend that began in the late 1960's.

Figure 1 shows the history of the 10 year moving average inflation rate and the interest rate on 10 year Treasury bonds from 1958 to 1988. If we interpret the moving average of past inflation rates as a proxy for the expected rate of inflation, we can explain the trend in long-term interest rates almost entirely on the basis of the trend in expected inflation.

²²See Smith and Taggart (1989).

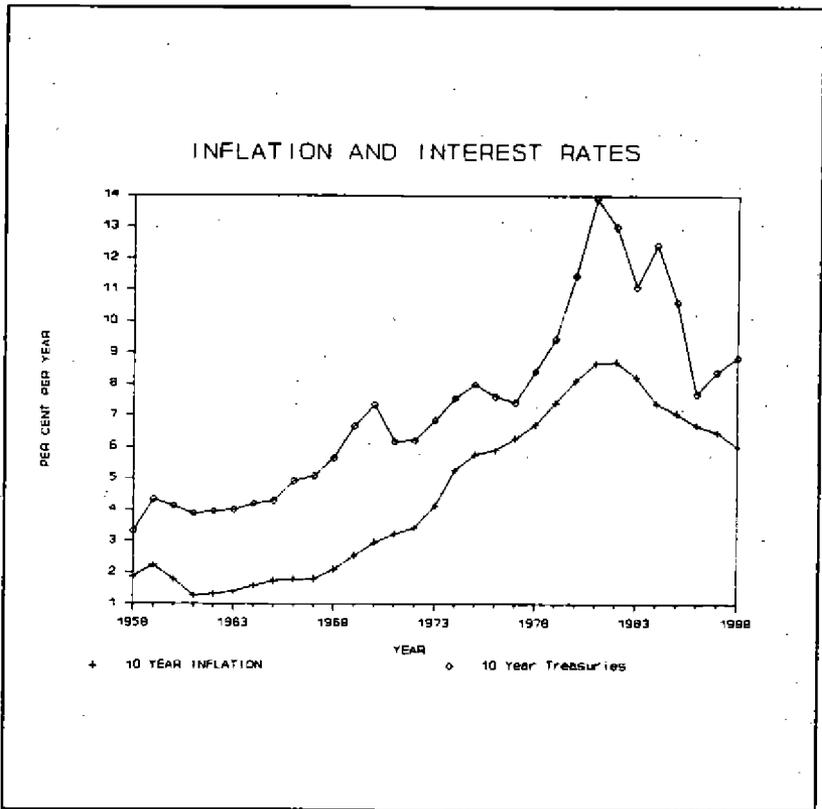


Figure 3

Figure 3. Inflation and Interest Rates: 1958-1988

Notes: The inflation rate is a 10 year moving average of the annual change in the CPI-U.

Source: For the 10 year Treasury bond interest rate - Economic Report of the President 1989, Table B-71.
 For the rate of inflation - Bureau of Labor Statistics.

The initial response to the high and unpredictable interest rates of the early 1970's was the emergence of an active market for floating rate debt as both borrowers and lenders shied away from long-term commitments at fixed rates. Smith and Taggart (1989) point to Citicorp's \$850 million issue in 1974 as the key development in this area. Many bond market analysts were predicting a permanent shortening of the maturity structure of fixed rate debt and a complete transition to floating rate corporate debt and adjustable rate mortgages. The last thing they imagined was a surge in the exact opposite direction.

But then came ERISA. In 1974 Congress passed the Employee Retirement Income Security Act and in one bold stroke transformed the structure of institutional demand for fixed income securities. The critical features of ERISA for the capital markets were its codification of the legal status of corporate defined benefit pension obligations and its imposition of minimum funding requirements. The new age of bond immunization and duration matching began.

The demand for long duration fixed-income securities was not new. Life insurance companies always had an investment demand for long-term fixed-income securities to hedge their whole-life and annuity products. But consumer demand for these products went into eclipse in the 1970's because of the inflationary bulge and resulting high interest rates. Sales of new policies fell sharply, and loans to policy-holders at contractual interest rates as low as 4% per year were siphoning funds away at a

frightening pace.

Eventually, the environment of inflation and interest rate uncertainty of the 1970's led the insurance industry to innovate in the retail market of the 1980's. They designed universal life and variable life insurance policies offering interest rates that were both higher and more adjustable than those embodied in traditional whole-life policies. Joining forces with mutual funds, the life insurance industry also started offering insured savings plans that allowed a broader spectrum of investment instruments, including money market funds and common stocks. Thus retail demand in the insurance market has led to a shortening of the maturity structure of life insurance company investments.

The new demand for long-duration fixed income securities has come primarily from pension funds. Life insurance companies have played an important role in this market both by directly assuming pension fund liabilities and by providing guaranteed investment contracts (GIC's) to pension funds. GIC's are essentially zero coupon bonds issued by insurance companies, who hedge the liability by investing in fixed income securities. Insurance companies thus have become an additional layer of financial intermediation. Their demand for long-duration debt securities is ultimately derived from the demand by pension funds.

While the immunization strategies of pension funds have spurred innovation in the fixed income securities markets, pension fund contingent immunization and portfolio insurance

strategies have created a market for options and financial futures contracts. The implementation of these strategies is feasible without these derivative securities, but their existence makes implementation less costly and less disruptive to the activities of portfolio managers.

Pension fund involvement in writing covered call options has also been an important factor contributing to the growth of stock options markets. As explained before, buying stocks and writing call options on them is similar to investing in fixed-income securities. Pension funds that write call options on stocks or stock indexes are in effect converting some of their investment in equities into short-term fixed-income investments.

9. Future Innovations.

As people rely more and more on pensions and private savings to provide their retirement income, there will surely be an increasing demand on the financial system to provide suitable products. The existing array of life annuities offered by life insurance companies and pension plans has one major shortcoming: the lack of protection against inflation.²³

Until recently there was no simple way for investors to completely hedge inflation risk in the U.S. capital market.²⁴

²³See Bodie [1989b and 1989c].

²⁴See Bodie [1988]

Recently, however, several financial institutions have issued securities linked to the U.S. consumer price level. The new securities were issued first by the Franklin Savings Association of Ottawa, Kansas, in January 1988 in two different forms.

The first is certificates of deposit, called Inflation-Plus CDs, insured by the Federal Savings and Loan Insurance Corporation (FSLIC), and paying an interest rate tied to the Bureau of Labor Statistics Consumer Price Index (CPI). Interest is paid monthly and is equal to a stated real rate plus the proportional increase in the CPI during the previous month. As of this writing (May 1989), the real rate ranges from 3% per year for a one-year maturity CD to 3.2% per year for a ten-year maturity.

The second form is twenty-year noncallable collateralized bonds, called Real Yield Securities or REALs. These offer a floating coupon rate of 3% per year plus the previous year's proportional change in the CPI, adjusted and payable quarterly. A recent issue of similar bonds includes a put option.

Two other financial institutions have recently followed the lead of Franklin Savings.²⁵ If the trend continues, we have reached a milestone in the history of this country's financial markets. For years prominent economists at all points of the

²⁵In August 1988 Anchor Savings Bank became the second U.S. institution to issue REALs, and in September 1988 JHM Acceptance Corporation issued modified index-linked bonds subject to a nominal interest rate cap of 14% per annum. The investment banking firm of Morgan Stanley and Company is the underwriter and market maker for REALs.

ideological spectrum have argued that the U.S. Treasury should issue such securities, and scholars have speculated why private markets for them have not hitherto developed.²⁶ The current innovative environment in the U.S. financial markets appears to finally have put an end to this speculation by producing private indexed bonds in several forms.

From the perspective of this paper what is interesting about these developments is that savings institutions have undertaken to offer this insurance against inflation risk without having a way of completely hedging that risk through their investment policy. The owners of these institutions are bearing the inflation risk through their own capital.

This is a viable situation for small amounts of inflation insurance. Should the demand grow, however, it seems clear that the additional supply of price-indexed securities would have to come from the nonfinancial sector.

One promising source of CPI-linked investments for an inflation insurance intermediary is CPI-linked home mortgages. The U.S. Department of Housing and Urban Development (HUD) is about to certify a variety of price-level-adjusted mortgages (PLAMs) for Federal Housing Administration approval (FHA). There is reason to believe that once FHA mortgage insurance is available and the tax status of PLAMs is clarified, they could account for a significant portion of new lending in the home

²⁶See, for example, the analysis in Fischer (1986).

mortgage market.²⁷

Nonfinancial businesses have shown some willingness to issue debt securities that are indexed to the prices of their output. A financial intermediary could pool such bonds in order to synthesize an investment that hedges annuities indexed to broader price indexes.²⁸

With a large market for price-indexed securities and their derivatives, pension plan sponsors and other financial institutions could then offer annuities with inflation insurance features. Sponsors who already offer their employees several investment options for their supplementary savings plans can simply expand the set of alternatives to include CPI-linked securities.

Merton [1983] has proposed a more radical innovation. Instead of indexing retirement annuities to the cost-of-living, he suggests indexing them to aggregate per capita consumption. His proposal is based on a model of lifetime household optimizing behavior that suggests that such consumption-indexed annuities might enhance welfare considerably. Merton envisions a major role for the government in making this type of product possible. In view of the innovative atmosphere in the U.S. financial markets in recent years, however, it is conceivable that the private sector can manage it without help from the government.

²⁷See Modigliani and Lessard [1975] for a discussion of these mortgage designs.

²⁸See Blinder [1976].

10. Summary and Conclusions

Pension funds have played a critical role in the evolution of the markets for debt and equity securities and their derivatives in the U.S. over the last 15 years. The new securities and markets can largely be explained as responses to the investment demands of pension funds in an environment of increased interest rate volatility and tighter regulation.

Defined benefit pension plans offer annuities that have a guaranteed floor specified by the benefit formula. In order to minimize the cost to the sponsor of providing this guarantee, there is a strong incentive to invest an amount equal to the present value of the accumulated benefit obligation in fixed-income securities with a matching duration. The pursuit of duration matching and related immunization strategies by pension funds has contributed to the emergence and rapid growth of markets for zero coupon bonds, GIC's, CMO's, options, and financial futures contracts. Recent changes in accounting rules (FAS 87) and tax law (OBRA) are likely to reinforce the use of immunization strategies.

One way to predict financial innovations is to forecast the future hedging demands of pension funds and other institutions catering to the retirement income needs of our aging population. If inflation risk becomes a major concern, then it is likely that financial intermediaries like pension funds and life insurance companies will respond by providing annuities that offer better inflation-protection.

Appendix: Using Derivative Securities to Convert Equity into Debt.

The purpose of this appendix is to show how derivative securities like forward contracts and options can be used to convert a portfolio of common stocks into a bond. To keep the exposition simple we will assume the portfolio is a single stock that pays no dividends, and we will assume that options on the stock are of the European type and therefore can only be exercised at expiration.

Suppose you are holding a share of XYZ stock with a current price of S . Now consider a forward contract on the stock with a forward price of X payable T years from now. Because the contract commits you to hand over the stock T years from now in exchange for X dollars, you can convert the stock into a zero coupon bond maturing in T years by selling such a forward contract. In other words, a combination of the stock plus a short position in the forward contract is equivalent to a zero coupon bond.

Instead of selling a forward contract, suppose you sell a call option with an exercise price of X . The call option is similar to the forward contract in that if T years from now the stock price exceeds X , you will have to hand over the stock in exchange for X dollars. The call option differs from the forward contract in that if at the expiration date the stock price is less than X , the option will not be exercised and you will be left with the stock.

The combination of the XYZ stock and a short position in the call option is therefore similar to a zero coupon XYZ bond with default risk. The analogy with default risk is that if XYZ Corporation were to default on its debt, then its unsecured bondholders would become stockholders. If the exercise price, X , is far below the current stock price, S , then the call option is very likely to be exercised. In our analogy, this would correspond to the default risk on the bond being very low.

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