

NOTES AND COMMUNICATIONS

Duration, Systematic Risk, and Employee Valuation of Default-Free Pension Claims: Comment

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A Misdirected Focus on Pre-Retirement Pension Value

The compensating differential model of labor contracts holds that employees pay for their pension claims by foregoing other compensation such as cash wages. Thus, the valuation of pension claims from employees' perspective is fundamental to measuring the appropriate compensating differential for defined benefit pension plans. Employee valuation of defined benefit pensions claims can be affected by two sources of risk: default risk¹ and interest rate risk. In an article in this journal, Nader (1990) argues that the interest rate risk associated with pension claims is significant, and therefore a risk premium must be added to the risk free rate when discounting pension claims for valuation purposes. This article also focuses on the interest rate risk of pension claims, but my conclusions differ considerably from Nader's.

The key to Nader's analysis is the assumption that employees have short (one-year) horizons, but pension claims are long-term bonds. Intuitively, an investor with a short horizon must liquidate long-term bonds before they mature. Consequently, a short-term investor suffers a capital loss if interest rates increase, because the price at which the bonds can be sold decreases when interest rates rise.

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¹ There is the possibility that the sponsoring firm can default on its pension promise. However, most U.S. defined benefit plans are currently well funded (see Pension Benefit Guarantee Corporation [PBGC], 1989). Moreover, because pension promises in the United States are guaranteed up to a limit by the PBGC, default risk is minimal for most employees. Higher paid employees, however, may have pension claims that exceed the PBGC's guaranteed limit. In addition, when an underfunded defined benefit plan is terminated, pension benefits are based on employees' salaries preceding termination, not salaries preceding retirement. Ippolito (1989) shows that when salaries are expected to increase, the termination of an underfunded plan can impose significant losses on employees.

Although Nader's analysis of the consequences of interest rate changes on pre-retirement valuation of pension benefits is correct, the focus on pre-retirement valuation is misdirected. The focus should be on the consequences of interest rate changes for the value of pension benefits at retirement. In other words, the horizon assumption in Nader's analysis is, in general, not appropriate.

Two arguments support this view. First, the fact that employees accept pension claims as part of their compensation suggests that employees are concerned with consumption during retirement. Thus, employees are most likely to be concerned about the value of their pension during retirement, not at periods prior to retirement. In addition, fluctuations in the value of pensions prior to retirement are likely to be of little concern to employees, as long as the value at retirement is constant.

Second, pension claims cannot be sold, and it is difficult (and illegal) to borrow using pension claims as collateral. Therefore, even if employees have short horizons, fluctuations in the value of pension claims prior to retirement will not normally affect pre-retirement consumption opportunities. The illiquidity of pensions prior to retirement further suggests that, holding the value of pension benefits at retirement constant, employees are likely to be indifferent to changes in the value of pension claims prior to retirement.

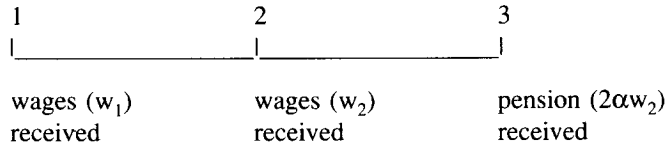
The argument that employees are concerned with the retirement value of their pension does not imply that interest rate changes are irrelevant. Instead, it suggests that the focus should be on how interest rate changes alter the retirement value of pension benefits. Such an analysis is undertaken in the next section. The link between interest rate changes and the retirement value of pension benefits exists because pension benefits typically are based on an average salary immediately preceding retirement, and interest rate changes can alter employees' salaries.

A Model of Pension Benefit Valuation

A two-period (three-date) model is used in which labor contracts are negotiated at the beginning of the periods (dates 1 and 2), and the employee retires at the end of the second period (date 3). Employee compensation takes two forms: cash wages and a defined benefit pension plan with pension benefits equal to α times service times final salary. Wages negotiated in the first contract, w_1 , are received at time 1; wages negotiated in the second contract are received at time 2. Lump sum pension benefits are received at time 3. Initially, it is assumed that all quantities are denominated in real dollars. Figure 1 illustrates the sequence of events. Pension promises have no default risk, and employees remain with the firm until retirement. Thus, the service component of the benefit formula is necessarily equal to two.

The only source of risk in the model is the risk that interest rates can change after labor contracts are negotiated. As is typical in analyzing interest rate risk, a flat term structure is assumed, where r is the default-free real interest rate prevailing at time 1. This rate is known when first period contracts are

Figure 1
Sequence of Events



negotiated, but the rate at time 2 is not known until second period contracts are negotiated (date 2). The second period interest rate is written as $(r+\Delta)$, where Δ is a random variable equal to the change from the first period rate. The expectation of the second period rate given information as of time 1 is r ; that is, $E_1(r+\Delta) = r$.

Let $V_t(B_1)$ equal the value at time t of pension benefits accrued during the first period. In general, the time path of the value of pension benefits accrued during the first period is described by the following equations (explained below):

$$\begin{aligned} V_1(B_1) &= \alpha E(w_2) e^{-2r}, \\ V_2(B_1) &= \alpha w_2 e^{-r-\Delta}, \text{ and} \\ V_3(B_1) &= \alpha w_2. \end{aligned}$$

Since pension benefits are based on a final salary that may be unknown during the first period, the value of pension benefits as of time 1 depends on the expectation of wages at time 2. These expected benefits are discounted at the rate r . At time 2, w_2 becomes known, so the actual wage appears in the valuation expression at time 2. The discount rate at time 2 depends on the realization of Δ . Whereas Nader (1990) focuses on the consequences of interest rate changes for $V_2(B_1)$, this analysis is primarily concerned with $V_3(B_1)$.

Since pension benefits depend on final salary, the value of benefits depends on how wages are set at time 2. The following models show that wages at time 2 depend on the assumption made concerning the labor market. In addition, it is shown that under most assumptions, changes in interest rates at time 2 affect wages at time 2, which in turn affect the face value of pension benefits.² Thus, interest rate changes alter the value of pension benefits at time 3 because of their impact on final salary, w_2 .

Long-Term Contracts that Fix Future Wages

A long-term contract negotiated at time 1 sets wages for both the first and the second period. The expected present value of compensation equals the value of marginal product in each period. The value of marginal product in the first period is v , and the value of marginal product in the second period is ve^g ,

² Nader (1990) does not analyze how wages change with interest rates.

where g is the growth rate. Initially, it is assumed that the time profile of the value of marginal product is known at time 1. In other words, the value of the marginal product in each period is certain and does not depend on interest rates.

The long-term contract sets w_1 and w_2 to satisfy the following equations:

$$\begin{aligned} v &= w_1 + \alpha w_2 e^{-2r}, \text{ and} \\ v e^g &= w_2 + \alpha w_2 e^{-r} \end{aligned} \quad (1)$$

Since the second period wage is fixed at time 1, the face value of pension benefits is known as soon as the long-term contract is set. Nevertheless, the value at time 2 of pension benefits accrued in the first period depends on whether interest rates change. In particular, $V_2(B_1) = \alpha w_2 e^{-r+\Delta}$, where w_2 satisfies equation (1). The value at time 2 is inversely related to the realization of Δ . In other words, an increase in interest rates at time 2 will decrease the value at time 2 of the pension benefits accrued during the first period.³ However, the pension benefit at retirement—the quantity of concern to employees—is αw_2 , independent of the change in rates at time 2.

Given assumptions concerning the values of v , g , r , α , and Δ , if interest rates do not change, then the value of pension benefits accrued during the first period will steadily increase. Under the long-term contract model, an increase in rates at time 2 will decrease the value of pension benefits at time 2. The higher interest rate will then cause benefits to increase at a higher rate, so that at time 3 the value of benefits when interest rates change is the same as when they do not change (see Table 1).

Spot Model of the Labor Market

If the labor market is characterized by a spot model, then the present value of compensation equals the value of employees' marginal product for each period. In this model, the second-period wage is not known until the interest rate at time 2 is known, because the present value of pension benefits accrued in the second period depends on the interest rate during that period. The wage in the first and second period therefore satisfy the following equations:

$$\begin{aligned} v &= w_1 + \alpha E_1(w_2) e^{-2r}, \text{ and} \\ v e^g &= w_2 + \alpha w_2 e^{-r-\Delta}. \end{aligned}$$

The second equation can be used to solve for the second-period wage conditional on the second period's interest rate:

$$w_2 = v e^g / [1 + \alpha e^{-r-\Delta}].$$

This relation implies that, *ceteris paribus*, if interest rates increase (i.e., $\Delta > 0$), the wage in period 2 also increases relative to its value if the interest rate had not changed. Intuitively, higher interest rates cause the present value of pension benefits accrued in period 2 to decrease, implying a larger compensating

³ This change in value is the focus of Nader's (1990) analysis.

Table 1
Present Value of Pension Benefits Accrued at Time 1

Assumptions:				
Initial Real Rate	$r = 10$ percent			
Value of Marginal Product at Time 1	$v = \$1,000$			
Growth Rate of Value of Marginal Product	$g = 1$			
Generosity Parameter of Benefit Formula	$\alpha = 0.25$			
Notation:				
Present Value at Time t of Pension Benefits				
Accrued at Time 1	$PV_t(B_1)$			
Change in Real Rate at Time 2	Δ			
Change in Growth Rate of Value of Marginal				
Product for Per Unit Change in Real Rates	β			
	Increase in Real Rates ($\Delta = 5$ percent)			
No Change in Real Rates	Long-Term Contract Model	Spot Model		
		$\beta = 0$	$\beta = 1$	
$PV_1(B_1)$	168.35	168.35	168.35	168.35
$PV_2(B_1)$	185.19	177.13	178.57	187.50
$PV_3(B_1)$	203.70	203.70	205.36	215.63

differential in wages. The higher second-period wage also increases the face value of pension benefits since the pension is based on final salary.

In this model, the value at time 2 of pension benefits accrued during the first period is affected by the increase in interest rates for two reasons: (1) the discount rate for valuation purposes increases, and (2) the second period wage rate—on which pension benefits are based—increases. The second effect is what makes this model different from the long-term contract model. The consequence of this difference is that when real rates increase, the value at time 2 of pension benefits accrued at time 1 does not decrease as much as it does in the long-term contract model. As a result, real pension benefits are higher at retirement than in the long-term contract model (column 3 versus column 2 of Table 1) and higher than the case when interest rates do not change (column 3 versus column 1 in Table 1). Thus, in a spot model, employees' consumption opportunities at retirement are better when real rates increase.

What If the Value of Marginal Product Varies with the Real Rate?

The analysis to this point assumes that the value of marginal product does not vary with real interest rates, an assumption that is now relaxed. Suppose for simplicity that a change in real rates equal to Δ is associated with a change in

the growth rate of the value of marginal product of labor from g to $(g + \beta\Delta)$.⁴ In this case, wages in the second period will equal

$$w_2 = ve^{g+\beta\Delta}/[1 + \alpha e^{-r-\Delta}].$$

Thus, if real rates increase and $\beta > 0$ (implying the value of marginal product increases), then the second period wage is higher relative to the case when the value of marginal product is independent of real rates. As shown in the last column of Table 1, the higher second-period wage causes the value of pension benefits to be higher at retirement than when the value of marginal product is independent of the interest rate.

On the other hand, if $\beta < 0$, implying the value of marginal product decreases as real rates increase, then the second period wage will fall relative to the case when the value of marginal product is independent of interest rates. The lower second-period wage implies that when interest rates increase, the value of pension benefits is lower than when the value of marginal product is independent of interest rates. If β is negative and of a sufficient magnitude, then an increase in real rates could actually lower the value of pension benefits at time 3 relative to the case when interest rates do not change. Thus, unlike the other scenarios considered so far, this case implies that an increase in real interest rates will decrease the value of retirement benefits.

Analysis of Changes in Expected Inflation and Nominal Rates

Although the previous analysis only considers changes in real rates, it is altered little by introducing changes in nominal interest rates due to changes in expected inflation. Assume all quantities previously defined are nominal. A reasonable assumption is that an increase in expected inflation causes a similar increase in the nominal value of marginal product. In other words, the growth rate g changes by the same amount as the change in the expected inflation rate Δ . The value of marginal product at time 2 is therefore $ve^{g+\Delta}$. This assumption implies that, for contracts negotiated at time 2, the present value of real compensation is invariant to a change in expected inflation.

To analyze the impact of an increase in expected inflation on the real retirement value of pension benefits accrued in the first period, consider first the spot labor market model. An increase in expected inflation has two effects. First, higher expected inflation increases the final salary which increases the face value of nominal pension benefits. In particular, the nominal pension benefit is $\alpha w_2 = \alpha ve^{g+\Delta}/[1+\alpha e^{-r-\Delta}]$. Second, the expected purchasing power of pension benefits is decreased because of the higher expected inflation.

⁴ To determine the sign of β theoretically would require doing a comparative static analysis of a general equilibrium model that incorporates the labor and capital markets and a product market. Even if such a model were constructed, the sign of β may depend on which exogenous variable is shocked. In addition, it is likely that the nature of the production function (i.e., the substitutability between capital and labor) would in part determine the sign of β . Such an analysis is beyond the scope of this paper.

Therefore, when the nominal benefit is discounted by $e^{-\Delta}$, the real value of retirement benefits is $V_3(B_1) = \alpha ve^g/[1+\alpha e^{-r-\Delta}]$. This is the same value that was derived for the spot model when the value of marginal product was independent of the real rate. Thus, an increase in expected inflation increases the real value of pension benefits at retirement. The intuition is that an increase in expected inflation increases the nominal salary, which increases the value of pension benefits accrued in prior periods. Ex post, the total compensation received for period 1's labor services exceeds the value of marginal product of those services.

In the long-term contract model, the first effect of an increase in expected inflation discussed above would not take place. In particular, final salary would not increase with an increase in expected inflation. Consequently, the nominal pension benefit would not change. The increase in expected inflation, however, would decrease the real expected retirement value of pension benefits. Thus, higher interest rates due to an increase in expected inflation decrease retirement consumption opportunities when long-term contracts set final salary in advance.

Will New Contracts Compensate for Losses on Previously Accrued Benefits?

In the spot model of the labor market, contracts are forward looking in the sense that the present value of compensation equals the value of marginal product in the coming period. Events that happened in the past are irrelevant to new contracts. This characteristic is important because it implies that changes in the value of pension benefits accrued in the past are irrelevant to new labor contracts. An increase in interest rates at time 2 (i.e., $\Delta > 0$) reduces the value (as of time 2) of pension benefits accrued in the first period, but this is irrelevant to the labor contract agreed upon at time 2 because the new contract is only concerned with compensating future labor services.

The spot model does not necessarily characterize actual labor markets.⁵ Consequently, following an increase in interest rates, employees may bargain for higher compensation because the pension benefits they accrued in the first period appear to have decreased in value.⁶ However, such a bargaining position is unlikely to be effective, because changes in the value of pensions prior to retirement are unlikely to reduce either pre-retirement consumption opportunities (as argued in the introduction) or post-retirement consumption opportunities (as the analysis above suggests).

⁵ For example, Allen, Clark, and Sumner (1986) present evidence that, despite the absence of an explicit contractual obligation, firms often compensate retired employees for the erosion in the real value of pension benefits due to unexpected inflation.

⁶ This seems to be what Nader (1990) has in mind for why employees have short horizons. He states, "Employees may be viewed as engaging in periodic valuations of their pension claims for the purpose of determining the compensating differentials (concessions) they should factor into their next wage settlement."

Conclusion

In most of the scenarios considered here, the real value at retirement of pension benefits varies directly with interest rates. The reason for the positive relation is that final salary is likely to be positively related to interest rates, and pension benefits are based on final salary. Because interest rates are negatively correlated with the market return (see Nader, 1990), pension benefits are likely to be negatively related to the market return. Thus, contrary to the conclusion reached by Nader (1990), in most of scenarios considered here, pension benefits are likely to have negative systematic risk.

Two scenarios, however, were identified in which retirement value of pension benefits is negatively related to interest rates. One scenario is when the value of marginal product is negatively related to real rates and the labor market is characterized by a spot market. The second scenario is when a long-term contract sets final salary in advance and nominal interest rates increase due to an increase in expected inflation. Although the end result in these scenarios is consistent with that obtained by Nader (1990), the reasoning is much different.⁷

⁷ Nader suggests that positive systematic interest rate risk of pension claims may account for the empirical evidence in Smith (1981) indicating that employees demand a premium on their pension promises. Although the point estimates reported by Smith (1981) are greater than minus one, suggesting that a discount exists, the coefficient estimates are not significantly different from minus one. Nevertheless, to the extent that a discount does exist, it is unlikely that Nader's analysis explains the phenomenon. This article indicates that interest rate risk is the source of the premium only if one of the two scenarios identified above hold. Most of the scenarios considered in this article, however, are inconsistent with interest rate risk being the source of the risk premium.

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