Pensions, Labor, and Individual Choice

Edited by David A. Wise

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Comment  Robert C. Merton

1. Introduction

In a world of full information and perfect markets, where all assets (including human capital) are freely tradable, private pensions provide nothing more than another way for individuals to save. With a full complement of risk-sharing securities available, the worker can fully offset or modify any particular form of payouts prescribed by the pension plan. Hence, the type of pension plan offered would be a matter of indifference to workers. Like the Modigliani-Miller theorem for corporate liabilities, the optimal choice of pension plan would at most be a function of the tax laws and perhaps certain kinds of transactions costs. In such an environment and in the absence of explicit contracts to the contrary, the spot-market view of total employee compensation would obtain where this period's wages plus incremental vested retirement benefits are equal to the worker's current marginal product. For pension plans to have a greater functional significance than that of "just one more security," there must

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1. The saving component is obvious for a defined contribution plan. It also takes place for a defined benefit plan whether or not the firm funds the plan with a pension fund since the (pension) liability issued to the worker in lieu of other cash compensation provides resources to the firm for financing investment just like the issuing of any other liability.

2. This assumes that firms are competitors in the labor market. For a development of the spot market theory with respect to pension liabilities, see Bulow (1982).
be important market imperfections, and the most likely place for these imperfections to occur is in the labor market.

There are, of course, severe impediments to the trading of human capital. The two most prominent explanations for this nontradability are (1) the moral hazard or incentive problem that having once sold off the rights to their earnings, workers will no longer have the incentive to work, and (2) the broad social and legal prohibition of (indentured) slavery whether voluntary or otherwise. The well-known effects of this nontradability are to "force" workers to save more than they might otherwise choose and to cause them to bear much of the risk (both systematic and nonsystematic) of their human capital. In addition to distorting the consumption-saving choice, the nonoptimal risk bearing of the risks of human capital may cause inefficient investment of resources in developing human capital.

In "Insurance Aspects of Pensions," Diamond and Mirrlees explore the possible role of private pensions in insuring the worker against some of the risk associated with his nonmarketable human capital. Their analysis leans heavily on the Harris and Holmstrom (1982) theory of implicit contracts in the labor market. By assuming away the incentive problems associated with the effective sale of human capital, Diamond and Mirrlees focus on contracts that take into account the limitations on workers to bind themselves now to work in the future for less than they could otherwise earn in the absence of such contracts.

As Diamond and Mirrlees themselves note, their model uses a number of assumptions that are wholly unrealistic even by the standards of economic empiricism. Many of these assumptions are constructive in that they merely simplify the analysis without severely distorting the validity of their central conclusions. Others, however, are crucial in reaching their results, and it is on these that I focus this discussion.

As will be shown, the structure of the labor contracts derived by Diamond and Mirrlees (and, for that matter, by Harris and Holmstrom) are isomorphic to various put and call option contracts. Reformulating their findings in this context will help to shed light on the sensitivity of their conclusions to certain of their assumptions. Moreover, the extensive literature on the evaluation of options permits the derivation of comparative statics results that might otherwise not be apparent. The options analogy is developed first in section 2 within the context of the "mobility-threat" model where the equilibrium contract leads to no actual changes in employee by the worker. In section 3, the analogy is extended to the more complex cases of exogenous and endogenous mobility where workers will change employers under the appropriate equilibrium conditions. Section 4 provides a brief summary and overview of the Diamond-Mirrlees model.

2. Optimal Labor Contracts Viewed as Options: Mobility Threats

The model presented in section 11.2 of the Diamond-Mirrlees paper assumes a three-period life for each worker (two work periods and a retirement period) and that workers are risk averse with an additive separable and symmetric utility function for lifetime consumption. It is assumed that firms have full access to a well-functioning capital market and that all securities are priced to yield the same expected return. This "common" expected return is assumed to be zero in real terms, and all contracts (explicit or implicit) are expressed in real terms. In sharp contrast, workers are assumed to have no access to the capital market and own no assets other than their human capital. Thus, workers cannot borrow, and they can only save if the firm (acting as an intermediary) does it for them. In this version of the model it is assumed that a worker's marginal product in period $t$ $(t = 1, 2)$ is the same for all firms (i.e., $m_t = m_i$). (This assumption is relaxed for workers in later sections.) Firms (other than perhaps the worker's current employer) are always willing to pay the worker his marginal product to him, $m_i$, if the employee is willing to move.

To locate and understand the model, consider first the case where there are no restrictions on contracts between the worker and the firm. In this case, the only constraint on the contract is that its present value, $PV$, satisfy

$$PV = m_1 + E(m_2),$$

which is the value to the firm at time 1 of receiving the labor of the worker throughout his work life. Because there is no risk premium paid for risk bearing and workers are risk averse, the optimal (worker utility maximizing) contract provides for the worker to bear no risk. By the assumptions of symmetric utility and a zero interest rate, the optimal contract would pay the worker a first-period wage, $w_1 = PV/3$; a guaranteed second-period wage, $w_2 = PV/3$; and a pension benefit payment, $b = PV/3$. In return, the worker would agree to work for his original employer for his

3. If the state is paternalistic and wants to avoid the free rider problem, it may choose to provide tax incentives to induce saving through pensions together with nonassignment of pension and penalties for early withdrawal to enforce the availability of adequate unencumbered assets for the individual to fund his retirement. Even with no labor market imperfections, these distortions could lead to optimal characteristics for pension plans that minimize the effects of the distortions.

4. Nonsystematic risk is risk that can be eliminated through diversification when there are available adequate risk-sharing financial instruments. Systematic risk is risk that cannot be eliminated by these means and hence is a risk that must be borne by the economy with perfect insurance markets.

5. Thus, a worker may spend real resources to reduce the risk of his human capital by pursuing training that makes him able to undertake a wider variety of jobs. Such diversification of the worker's human capital would not be an optimal allocation if it simply reduces nonsystematic risk.

6. See Nalebuff and Zeckhauser (1981), especially App. 1, for a similar analysis.
entire work life, independently of what his (currently unknown) marginal product, \( m_2 \), turns out to be in period 2. If the worker were permitted to enter into such a binding agreement with his employer, then this unrestricted optimal contract is feasible.

The worker cannot, however, bind himself to work for his current employer in the second period. The employer must, therefore, take into account that the worker will leave in the event that the total compensation offered by a competing firm in the second period plus any transferable component of his pension from his original employer, \( m_1 + b' \), exceeds the total compensation \( 2PV/3 \) provided by the contract with his original employer. Thus, unless the probability that \( m_1 + b' > 2PV/3 \) is zero, the unrestricted optimal contract is not feasible and the worker must bear some risk.

Given this constraint and the condition that \( b' \geq 0 \), Diamond and Mirrlees (eq. [2]) show that the optimal contract calls for a (combined retirement and) second-period compensation given by

\[
W(m_2) = \max(2w_1, m_2) \tag{2}
\]

and a transferable pension \( b' = 0 \).

A call option on a security (or payment) gives its owner the right to buy the security at a specified price \( I \) (the "exercise price") as of a given date. The right to buy also implies the right not to buy. If the owner chooses not to buy, the call option expires, worthless. Thus, the payoff to a call option on its expiration date is given by \( \max(0, X - I) \), where \( X \) is the price of the security on that date. Rewriting (4) as

\[
W(m_2) = 2w_1 + \max(0, m_2 - 2w_1), \tag{2'}
\]

we have that the optimal contract provides for a guaranteed payment of \( 2w_1 \) plus a call option on the worker's second-period marginal product, \( m_2 \), with an exercise price of \( 2w_1 \). If \( C(X, I) \) denotes the market value of a call option on a security with current value \( X \) and exercise price \( I \), then the budget constraint (1) requires that the value of the worker's first-period wage, \( w_1 \), plus second-period guaranteed payment, \( 2w_1 \), plus the call option \( C[E(m_2), 2w_1] \)—equals the present value of his human capital. That is,

\[
3w_1 + C[E(m_2), 2w_1] = PV = m_1 + E(m_2). \tag{3}
\]

Because the payoff to a call option is nonnegative, \( C[E(m_2), 2w_1] \geq 0 \) with equality holding if and only if \( \text{pr}(m_2 > 2w_1) = 0 \). It follows, therefore, that \( w_1 < PV/3 \) unless \( \text{pr}(m_2 > 2m_1 + E(m_2))/3 = 0 \).

8. In the special case assumed by Diamond and Mirrlees of risk-neutral security prices and a zero interest rate, \( X = E(\bar{X}) \) where \( \bar{X} \) is the random variable value of the security at expiration date of the option and \( C(\bar{X}, I) = E(\max(0, \bar{X} - I)). \)
where $P(X, t)$ is the value of a put option with an exercise price of $I$ on a security with current value $X$. Although (6) follows directly from (3) by the parity theorem for option prices, expressing the budget constraint in the form of (6) makes more apparent the result that the first-period wage $w_i$ must always be less than the first-period marginal product $m_i$.

This result underscores how binding the assumed constraint of no borrowing by workers (embedded in the model by requiring $b' \geq 0$) can be in the determination of the optimal feasible contract. Thus, at the extreme where the worker's current marginal product $m_i = 0$, the worker's current wage $w_i = 0$, and moreover he can obtain no insurance for his future earnings. This is so no matter how large is the worker's future expected productivity $E(m_i)$. In a richer model where the worker can influence his current and future marginal products through training or choice of career path, it is readily apparent that the no-borrowing constraint (which is central to the model here) will cause severe distortions of the optimal labor force configuration. That is, with this constraint, workers achieve substantial benefits in terms of both the level of early life consumption and the reduction of risk surrounding later life consumption by choosing a job pattern with relatively high early life marginal product $m$, even at the expense of a large reduction in expected future marginal product, $E(m_i)$.

3. Optimal Labor Contracts Viewed as Options: Exogenous and Endogenous Mobility

In the Harris-Holmstrom type model where the worker's marginal product is the same for all firms, the worker will never change employers in equilibrium and transferable pensions play no role in intermediating the risk of human capital. However, if the worker must change employers for exogenous reasons, or if the worker can have different marginal products at different firms, then the worker may move in equilibrium. Although Diamond and Mirrlees discuss the cases of exogenous and endogenous mobility separately, the discussion here combines these cases in a single model.

As with the mobility-threat analysis, Diamond and Mirrlees derive the optimal contract under the condition that the firm can offer a transferable pension $b'$ if the employee moves and a total compensation floor if the employee stays. If the worker is forced to move ("exogenous mobility") then he receives $m' + b'$. The probability of such a move, $p$, is given exogenously. Otherwise, the worker will move only if his total compensation at the new firm, $m_i + b'$, exceeds that offered by his original employer.

Although not stated explicitly, Diamond and Mirrlees make an important assumption about the structure of the labor market. In the initial period, all firms compete equally to hire the services of the (unattached) worker. In the second-period compensation negotiations, Diamond and Mirrlees assume an asymmetry between the worker's current employer and all other potential employers which gives the worker's current employer an advantage. They postulate those firms which attempt to hire a worker away from his original firm must pay a wage equal to his full marginal product $m_i$ whereas the current employer need only match the total compensation provided to the worker for moving, $m_i + b'$, to induce the worker to stay. Since the transferable pension (if any) $b'$ is a "sunk" cost which the firm will have to pay if the employee moves, the current employer derives a benefit from this monopsony power equal to $(m_2 - m_i)$, which is nonnegative whenever it is optimal for the worker to remain with his original employer.

As in the discussion of the mobility threat case in the previous section, I begin with an analysis of the worker's situation when there are no restrictions on contracts. In the absence of monopsony power, the present value of the worker's human capital is given by

$$W_i = m' + pE(m') + (1 - p)E\{\max (m_2, m_i)\}. \tag{7}$$

As before, the unrestricted optimal contract is riskless to the worker with $w_i = W_i/3$, $w_2 = W_i/3$, and $b = b' = W_i/3$; and in return the original employer receives the worker's marginal product whether he moves or not. Introduction of the Diamond-Mirrlees asymmetry assumption might seem to lower the present value of the worker's human capital to equal $m_i + pE(m') + (1 - p)E(m_i)$. However, because firms are competitive in the initial period, they must pay for this right to "exploit" the worker in the second period. That is, they will pay the worker a "signing bonus" given by

$$W_i = m' + pE(m') + (1 - p)E\{\max (m_2, m_i)\} + (1 - p)E\{\max (0, m_2 - m_i)\}. \tag{8}$$

By inspection of (8), $\max (0, m_2 - m_i)$ is the payoff to a call option on a payment of $m_2 - m_i$ with a zero exercise price, and we denote its price by $C[E(m_2 - m_i), 0]$. (Note: Unlike the "usual case" of a call option on a limited liability instrument, $C[E(m_2 - m_i), 0] > \max [0, E(m_2 - m_i)]$ if the $p\{m_2 > m_i\} > 0$. Hence, even if the expected future marginal product of the worker with his current employer, $E(m_i)$, is less than or equal to his expected future marginal product elsewhere, $E(m_2)$, the signing bonus will be positive.) In the Harris-Holmstrom case, where $m_i = m_i$, there is no value to the firm of obtaining this second-period monopsony power, and hence its assumption has no influence on the analysis of the mobility threat case.

As Diamond and Mirrlees show, when the worker's second-period earnings, $y$ (whether with the current employer or not), can be observed ex
post at the end of the second period, the optimal labor contract calls for a transferable pension given by \( b'(y) = \max (0, 2w_1 - y) \) if the worker moves and a compensation package equal to \( (2w_1, m_2) \) if the worker stays with his original employer. If the worker is not forced to move, this contract leads to the worker's staying with his current employer if and only if \( m_2 \geq m_1 \).

The worker's second- (and retirement) period compensation is given by

\[
W(y) = y + \max (0, 2w_1 - y),
\]

which in terms of structure is the same as the Harris-Holmstrom case (2'). However, in (9), \( y = m' \) if the worker is forced to move and \( y = m_1 \) otherwise. From (9), it would appear that, from the worker's perspective, his second-period compensation does not depend on his second-period marginal product with his original employer, \( m_2 \). This is true in the ex post sense of the uncertainties surrounding \( y \) given the wage floor, \( 2w_1 \). However, the ex ante distributional characteristics of \( m_2 \) do affect \( W(y) \) because they affect the first-period wage and hence the second-period wage floor.

To determine the first-period wage \( w_1 \), equate the value that the firm receives in return for the contract (i.e., the worker's first-period marginal product plus the right to exploit the worker in the second period) to the cost of the contract (i.e., the worker's first-period marginal product plus the insurance provided by the transferable pension and the wage floor). Expressed in terms of the option value equivalent of the contract, we have that

\[
w_1 = m_1 + (1 - p)C[E(m_1 - m_3), 0] - p[E(m'), 2w_1] - (1 - p)E[E(m_2), w_1].
\]

By inspection, the distributional characteristics of \( m_2 \) (and not just its expected value) affect the first-period wage through their influence on the call option price, which reflects the value of the signing bonus.

Comparative statics results along the lines of the previous section can be computed from (10). I do so here only with respect to the effect of a change in \( p \) as the means of providing a few comments on the Diamond and Mirrlees exogenous mobility model presented in their section 11.3. From (10), we have that

\[
sign \left( \frac{dw_1}{dp} \right) = \text{sign} \{P[E(m_1), 2w_1] - P[E(m'), 2w_1] - C[E(m_2 - m_1), 0]\}.
\]

In the case of exogenous mobility alone (i.e., \( m_2 = m_1 \)), the sign of \( dw_1/dp \) depends on the value of a put option on the worker's marginal product when he is forced to move, \( m' \), relative to the value of a put option of identical terms on the worker's marginal product when he can either stay or move, \( m_2 \). Although it is, of course, conceivable for \( m' \) to have a more favorable distribution than \( m_2 \) or \( m_1 \), it would appear to be a rather strained definition of a forced or exogenous move if the worker receives a wage \( m' \) in excess of what he would have earned otherwise. This belief is further reinforced by the model's assumption that among all the firms that might offer the worker a job in the nonforced case, the best offer will be a wage equal to the one available from the worker's current employer. Moreover, if, as Diamond and Mirrlees at one point assume, the exogenous move is the result of a disability, then the case for \( m' < m_2 \) would seem especially compelling.

If one postulates that \( m' < m_2 \), then, the value of the put option insurance on \( m' \) is greater than the value of the corresponding insurance on \( m_1 \). From (11), we have unambiguously that \( dw_1/dp < 0 \). That is, if the probability of ending up in the disadvantaged state of being forced to leave your current employer increases, then the worker must (and is willing to) pay more to insure against the lost income in this state by accepting both a lower first-period wage and a lower floor on guaranteed compensation.

Making this incremental assumption also provides some insight into Diamond and Mirrlees's proposition 1, which provides sufficient conditions for the optimal transferable pension, \( b' \), to be positive. By assuming that \( m_2 < m_1 + (1 - p)E(m_1)/[3/2 - p] \) for all \( m_2 \), they ensure that \( m_2 < 2w_1 \), the equilibrium wage floor. Hence, in the event of no forced move, the put option on \( m_2 \) will always be exercised and the worker receives a guaranteed second-period wage with no uncertainty. If the transferable pension is restricted to be a constant, then the budget constraint is

\[
w_1 = m_1 - pb' - (1 - p)[2w_1 - E(m_1)]
\]

because \( P[E(m_2), 2w_1] = 2w_1 - E(m_1) \) in this case. From (12), if \( b' = 0 \), then \( 2w_1 = m_1 + (1 - p)E(m_1)/[3/2 - p] \), which, by hypothesis, strictly exceeds the maximum possible marginal product to be earned in period 2. Thus, it pays to transfer at least the residual value to a transferable pension, which reduces the risk of lost income when forced to move.

By dispensing with the requirement that \( b' > 0 \) be a constant and positive for all possible \( m' \) and assuming that \( m' < m_2 \), the role for a transferable pension is established without the extreme conditions of proposition 1.

Although Diamond and Mirrlees examine a variety of other cases where various marginal products are or are not observable, I have focused exclusively on the case where the transferable pension can be made a function of the ex post second-period earnings of the worker and the wage floor provided to the worker, if he stays, is a constant. This choice was not arbitrary. This case surely establishes a nontrivial role for private pensions as a means of reducing risk to workers. The derived rules for the transferable pension and wage floor are simple and yet appear to be reasonably robust.
Thus, while the level of the floor and maximum transferable pension depend on the symmetry of the worker's utility function to be a true optimum, they do not depend on the specific form of the worker's utility function, which some of their other derived rules do. Having the transferable pension benefit depend on ex post earnings seems to be a practical possibility. By inspection of income tax returns, the pension-paying firm could verify the later year earnings for computing pension benefits. Although, there is in principle an incentive for the worker to cheat by hiding his income, this possibility would not appear to be serious because it is difficult for workers to avoid declaring wages or benefits reported on W-2 forms. Moreover, to do so would require that the worker cheat on his federal income taxes and thereby expose himself to those penalties as well. The derived plan has the further virtue of not requiring the pension-paying firm to distinguish between involuntary moves (e.g., disability) and voluntary moves.

4. Summary and Conclusion

The Diamond and Mirrlees analysis should stimulate much-needed additional research into the role of pensions when there are significant labor market imperfections. Although their model is almost too simple, many of their assumptions can be relaxed without seriously affecting their conclusions. I applaud their attempt to bring institutional and legal constraints into the discussion of feasible contracts for their model.

Perhaps with a bit of irony, such real world legal constraints may rule out their assumption that the firm can “exploit” its current employees by paying them \( m^* + b^* \) when \( m_2 > m_1 \). If, for example, \( m_2 > m_2' > 2w_1 \), then it is likely that the firm will be hiring new workers in addition to their current labor force. Since by their other assumption firms must pay new workers their full marginal product, it is not clear that it would stand a legal test for the firm to pay “new” workers (who are otherwise the same) more than “old” workers. The sensitivity of their contract schemes to this issue warrants further study.

Diamond and Mirrlees raise the important issue of the firm’s defaulting on its labor contracts. The manifest impact of such a default is that the workers may not be paid the transferable pension and “wage floor” benefits promised in both the explicit and implicit parts of the labor contracts. If workers fully recognize this possibility ex ante, when the contract is negotiated, they will receive compensation for this risk in the form of either a higher first-period wage or larger promised future benefits. Even in this case, however, it is straightforward to show that the workers’ expected utility will fall relative to the case where such defaults are ruled out. If, as would seem reasonable, the fortunes of the firm and the future marginal product of its workers are strongly positively correlated, it is more likely that default will occur in precisely those states where the worker needs the promised benefits. Thus, the utility loss from the possibility of default could be substantial.

There is another—perhaps latent—impact of default that may significantly limit the magnitude and duration of the future promised benefits component of labor contracts. Bankruptcy is, of course, bad for the firm—but it is less bad than if the owners (shareholders) were required to contribute additional sums to the firm in order that it could fulfill its obligations and avoid bankruptcy. As has been shown in the finance literature, it is not the shareholders who lose in a bankruptcy, but the other liability holders who are not paid what they are promised. From this follows the well-known result that if the riskiness of the firm’s assets increases, then there will be a transfer of value from the current nonequity liability holders to the stockholders, and this occurs even if such an increase has no effect on the overall market value of the firm. Thus, the managers of limited liability firms have an incentive to increase the riskiness of their assets (even if there is no compensating higher expected return on the assets). In the Diamond-Mirrlees context, the workers are explicit nonequity liabilityholders of the firm with respect to their vested pension benefits and implicit liabilityholders with respect to the firm’s promise of a floor on future wages. Hence, they face a potential moral hazard problem with respect to the firm not unlike the one that rules out or severely limits the sale of their own human capital.

Since the potential for gain to the stockholders from such a “liability-induced” shift in the risk of the firm’s assets is an increasing function of both the size and the maturity of the nonequity liabilities, the moral hazard problem can be reduced by limiting the magnitude of the liabilities and making them of relatively short duration. For explicit corporate liabilities, the problem is further reduced by the introduction of indenture restrictions that limit the types of investments the firm can make without the liabilityholders’ approval. A relevant example is a corporate pension plan that requires that a specified portion of the firm’s assets be segregated in a pension fund; gives the pension liabilityholders first claim on these assets; and sets guidelines for the types of assets held in the fund. Thus, with the possibility of default, optimal labor contracts will have a smaller proportion of total compensation in the form of promised future benefits than would be predicted by the Diamond-Mirrlees analysis. Moreover, the relative proportion of explicit to implicit contract benefits will also be larger, which suggests that vested and transferable pensions may have an even more important role in improving the risk-bearing opportunities for workers.
If the moral hazard problem surrounding default by the firm can be neglected, then the manifest impact of bankruptcy can be formally integrated into the current Diamond-Mirrlees model by recognizing that the workers, as part of the implicit labor contract, grant a put option to the firm with an exercise price equal to the total promised second-period benefits.

In the case of default on pension benefits, which are a legal liability of the firm, the firm would face actual bankruptcy and the underlying security for the put option would be the firm’s assets. In the (perhaps more interesting) case of default on implicitly contracted wage floors, there would be no formal bankruptcy. While it is not always clear what the underlying security for the put is in this case, I would agree with Diamond and Mirrlees that it is probably the value of the intangible asset called “reputation” lost by the firm when it does not meet its implicit contract obligations. Such an analysis might also explain why some firms when facing hard times choose to employ all their long-term workers part time instead of firing some workers and keeping others full time. In effect, like bondholders in a single debt issue, partial employment permits all workers with defaulted implicit claims to share what amount is available, whereas full employment of some and no employment for others would be the equivalent in a regular bankruptcy of randomly paying some bondholders full face value and others nothing at all. Using the established results from option pricing, one could perhaps identify the type of firms (e.g., by risk characteristics) in which implicit labor contracts with floors are likely to be important.

Finally, I would note that the derived payoff structure to the transferable pension benefit, $b^* = \max(0, 2w_1 - y)$, looks remarkably similar to the structure of a defined benefit private pension plan that is integrated with social security. In effect, the Diamond-Mirrlees pension benefit is equivalent to a defined benefit plan integrated with other private plans instead of social security. Since they derive this structure as the solution of an optimal plan, it may be possible to derive similar normative properties, heretofore unrecognized, for integrated pension plans.

References

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