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INSURANCE AND LABOR MARKET CONTRACTING: AN ANALYSIS OF THE CAPITAL MARKET ASSUMPTION

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ABSTRACT

In recent years a large literature has developed which investigates the role of insurance in labor market contracting. Papers in this literature typically assume that workers are completely restricted from borrowing. We argue, and to some extent demonstrate, that in many environments capital market imperfections do not lead to a no borrowing result, but rather to a capital market assumption which is intermediate between the no borrowing assumption and the perfect capital market assumption. We then consider some of the ramifications this intermediate capital market assumption has on the type of insurance that firms provide through the labor market contract.

I. Introduction

Since the work of Azariadis (1975) and Baily (1974), it has been widely recognized that part of the role of labor market contracting is for firms to provide insurance to workers. For example, in the initial papers cited, firms provided workers a constant wage and in this way insured workers against random fluctuations in output. More recent developments have shown that there are insurance aspects of labor market contracts in an even wider set of circumstances. Harris and Holmstrom (1982) demonstrate how the labor market contract can insure workers against the uncertainty they face concerning their own ability, while Weiss (1984) concentrates on insurance in a world where output grows stochastically. The present paper considers the insurance/labor contracting literature, and in particular is concerned with the proper way to model the capital market in this literature.

The standard capital market assumption in this literature is that workers have no access to capital markets. This was the approach taken in the initial articles of Azariadis and Baily, and few subsequent articles have strayed from it. In the type of environment analyzed by both Azariadis and Baily, this assumption seems quite reasonable. The logic is as follows. Both Azariadis and Baily assume a high degree of specificity between workers and firms and that firms are risk neutral. The specificity assumption means that workers are tied to the initial employer. Combining this with the assumption that firms are risk neutral results in workers being completely insured through the labor market contract. Hence, any type of capital market imperfection would result in exactly the same labor market contract as the one derived by Azariadis and Baily, and thus their analyses suffered no loss of generality because of the simplifying assumption that workers have no access to capital markets.

For some of the more recent papers in the insurance/labor contracting literature, however, the assumption that workers have no access to capital markets seems less reasonable. Consider, for example, the papers of Freeman (1977), Harris and Holmstrom (1982), Waldman (1984), and Weiss (1984). These papers consider environments where, as a worker ages, firms accumulate information concerning the expected productivity of the worker in subsequent periods. Further, the specificity between workers and firms is assumed to be low so that the long-term contracts offered to young workers are constrained by the future wage offers the worker may receive from other employers. Each of these papers found that, when workers have no access to capital markets, the labor market contract which results only partially insures workers against the uncertainty they face concerning their own future productivity.

Given this description, it is clear that the assumption that workers have no access to capital markets is not as well justified in the above described models as in the Azariadis and Baily settings. That is, workers are only receiving partial insurance through the labor market contract, and therefore the extent of the capital market imperfection may very well have an effect on the form of the labor market contract offered.

The above discussion suggests that in this more recent literature one might want to move away from the strong assumption that workers have no access to capital markets. This is what we attempt to do in this paper, but note that in doing so we will not move to the other extreme assumption that workers face perfect capital markets.[1] To understand the problems with either extreme assumption, consider again the models of Freeman, Harris and Holmstrom, and Weiss.[2] In each paper it was found that, if workers have no access to capital markets, then sufficiently positive information concerning a worker's future productivity will result in the worker's wage being increased just enough to stop the worker from being bid away by another firm. If any other type of information is received, however, there is no change in the wage. To us this seems counter to the idea that a major role of the labor market contract is the provision of insurance to workers. It is as if workers faced a lottery, and the firm provided the following prizes. If a worker wins the lottery, then the firm promises to increase his wage. If, however, a worker loses the lottery, then the firm's promise is only to not cut the worker's wage. If any, this is a very weak type of insurance.

On the other hand, in this set of papers a perfect capital market assumption will also not yield a result which seems a particularly plausible description of reality. Under that assumption everyone gets a wage increase, but the problem is that everyone gets the same wage increase. In real world settings more positive information usually leads to larger wage increases (see Weiss for the perfect capital market assumption analysis).[3]

Our first goal is thus to demonstrate that if workers are allowed access to capital markets, but not perfect capital markets, then there will be incomplete insurance, however, it will now be of a much more plausible type. It is still the case that if sufficiently positive information is received concerning a worker's future productivity, then the worker's wage is increased just enough to stop the worker from being bid away by another firm. If another type of information is received, however, there will now be a wage increase, although one smaller than the increases provided when very positive information is received. That is, under an intermediate capital market assumption, the insurance takes the form of a wage increase even for the case where the worker loses the lottery.

The demonstration that altering the capital market assumption has significant effects, in turn, suggests that more attention should be paid to how the capital market assumption is modeled. Previous papers in this literature have modeled the capital market without ever explicitly modeling the third party sources of funds from whom workers might borrow. As indicated earlier, we feel such an approach can easily yield misleading results because there is no guarantee that the capital market assumption employed will be the appropriate one for the environment being analyzed. Our second goal is thus to explicitly model these third party sources of funds, and in this way "derive" the appropriate assumption concerning the capital market.[4]

The outline for the paper is as follows. Section II presents and analyzes a simplified version of the model contained in Harris and Holmstrom (1982). As suggested earlier, the analysis demonstrates that if workers are allowed access to capital markets, although not perfect capital markets, then there is a major effect on the resultant labor market contract which corresponds to a much more intuitive outcome as regards the type of insurance provided. Section III presents some further analysis which suggests how the intermediate capital market assumption employed in Section II can be justified by an explicit modeling of the third party sources of funds from whom workers might borrow. Section IV is concerned with the idea that the theory in this paper provides an alternative explanation for the recent empirical finding that workers receive wage increases even in the absence of productivity increases (see Medoff and Abraham 1980). In particular, the explanation presented in this paper is contrasted with previous explanations for the empirical finding, and tests which might help discriminate between the alternative theories are then presented. Section V presents some concluding remarks.

II. Model and Analysis

To begin we state the assumptions that constitute our model.

Assumptions

1) Within the economy there is only one good produced and the price of this good is normalized to one.

2) Workers live for two periods, and in each period labor supply is perfectly inelastic and fixed at one unit for each worker.

3) Workers display no disutility for effort. However, each worker has associated with him or her a value for a variable which will be called ability, and which will be denoted by A.

4) A worker's output at a firm simply equals the value of his ability.

5) Previous to his first period of employment a worker's ability is unknown both to the worker and to all the firms in the economy. However, a worker's output in every period is public information, which in turn yields that after a single period of employment a worker's ability becomes public knowledge.

6) Each worker's value for A is a draw from a random variable which equals A^H with probability p, and equals A^L with probability $(1-p)$, where $A^H > A^L$.

7) A worker's preferences over the consumption stream (c_1, c_2) are given by

$$U(c_1, c_2) = \mu(c_1) + \beta\mu(c_2),$$

where $\mu' > 0$, $\mu'' < 0$, and $\beta < 1$. This simply states that workers are risk averse with a discount factor equal to β.

8) Firms are risk neutral, where a firm's valuation over the profit stream (c_1, c_2) is given by

$$\Pi(c_1, c_2) = c_1 + \beta c_2.$$

9) In agreeing to a contract a worker cannot irrevocably bind himself to a firm.

10) A worker can change firms after his first period of employment without incurring any costs. However, for expositional simplicity it is assumed that, given equal wage offers prior to his second period of employment, a worker will choose to remain with his first period employer.

11) There is free entry.

Before proceeding to analyze the model, it is necessary to stipulate a contracting environment. It is assumed that firms offer young workers long-term or implicit contracts which specify three wage rates, denoted W_1, W_2^L and W_2^H. These contracts bind the firm in the following ways. First, the firm is obligated to pay a worker accepting the contract the wage W_1 during the worker's first period of employment. Second, the firm is restricted from firing such a worker after the worker's first period of employment. Third, if the worker is revealed to be of low (high) ability, then the firm is obligated to offer the worker the wage $W_2^L(W_2^H)$. Finally, the contract must also satisfy the restriction on wages, $W_2^j \geq A^j$ for $j = L,H$. This restriction guarantees that second period wages are high enough to stop the worker from being bid away by another firm.[5]

We first analyze our model under the assumption that workers can lend any amount they choose at an interest rate equal to $(1-\beta)/\beta$, but that they are completely restricted from borrowing. Under this capital market assumption equilibrium is characterized by the wages and consumption levels which solve the following maximization problem. Note, below $c_2^L(c_2^H)$ denotes the second period consumption of a worker who is revealed to be of low (high) ability.

$$(1) \qquad \max_{\substack{W_1, W_2^L, W_2^H \\ c_1, c_2^L, c_2^H}} \mu(c_1) + \beta[p\mu(c_2^H) + (1-p)\mu(c_2^L)]$$

$$\text{s.t. } p[A^H - W_1 + \beta(A^H - W_2^H)] + (1-p)[A^L - W_1 + \beta(A^L - W_2^L)] \geq 0$$

$$W_2^j \geq A^j \quad \text{for} \quad j = L,H$$

$$(1/\beta)\ (W_1 - c_1) + W_2^j - c_2^j \geq 0 \quad \text{for} \quad j = L,H$$

$$c_1 \leq W_1$$

Equation (1) is explained as follows. The objective function simply states that the equilibrium contract will maximize a worker's discounted expected lifetime utility. The first constraint ensures that the discounted expected profits for the firm offering the contract are non-negative. The second constraint is simply our earlier mentioned restriction on wages which guarantees that, after his first period of employment, a worker accepting the contract is not bid away by another firm. The third constraint states that the consumption stream can never exceed what is affordable given the wage stream. The fourth constraint rules out borrowing. The following proposition characterizes the solution to (1). Note, to keep the exposition from becoming bogged down in detail, we have relegated all proofs to an Appendix.

Proposition 1: When workers are completely restricted from borrowing, then

i) $A^L < W_1 = W_2^L < W_2^H = A^H$

ii) $c_1 = W_1$, $c_2^L = W_2^L$, $c_2^H = W_2^H$.

The results in Proposition 1 are consistent with the analyses of Freeman (1977), Harris and Holmstrom (1982), and Weiss (1984). If a worker is revealed to be of high ability, then he receives a raise just sufficient to stop the worker from being bid away by another firm. If, however, he is revealed to be of low ability, then his subsequent wage is equal to what he received in the previous period.

We now analyze the model under a perfect capital market assumption. Specifically, workers are allowed to lend and borrow any amount they choose at an interest rate equal to $(1-\beta)/\beta$. Under this capital market assumption equilibrium is characterized by the same maximization problem as previously, except now the last constraint no longer applies. The following proposition characterizes the solution to this new maximization problem.[6]

Proposition 2: When workers have access to a perfect capital market, then

i) $W_1 < W_2^L = W_2^H > A^H$

ii) $c_1 > W_1,\ c_2^L < W_2^L,\ c_2^H < W_2^H$

iii) $c_1 = c_2^L = c_2^H$.

Proposition 2 tells us that, when workers face a perfect capital market, then the outcome is a first best result. That is, workers face no risk because the second period wage received is independent of the ability revealed, while borrowing allows workers to smooth out their consumption stream. This full insurance result is consistent with Weiss' previous analysis of a perfect capital market assumption.

Propositions 1 and 2 illustrate the claim we made in the Introduction. That is, given either no access to capital markets or perfect capital markets, the resulting contract does not seem particularly plausible. In the one case, a very weak form of insurance is observed, while in the other workers revealed to be of low ability receive the same raises as those revealed to be of high ability. For these reasons, we now consider an intermediate capital market assumption. This intermediate assumption is intended to first reflect the observation that workers face a higher interest rate when they borrow than when they lend, and second, reflect the observation that there is frequently a maximum amount which workers can borrow. Formally, we assume that workers face the interest rate $((1-\beta)/\beta) + I(c_1-W_1)$ if $c_1 - W_1 \leq X^*$, $0 < X^* \leq \infty$, and cannot borrow an amount greater than X^*. Further, it is assumed that $I(.)$ is twice continuously differentiable over the interval $(-\infty, X^*)$, and satisfies the following restrictions: $I(X) = 0$ for all $X \leq 0$ and $I'(X) > 0$ for all $0 < X < X^*$. Under this capital market assumption equilibrium is characterized by the following maximization problem.

$$\max_{\substack{W_1, W_2^L, W_2^H \\ c_1, c_2^L, c_2^H}} \mu(c_1) + \beta[p\mu(c_2^H) + (1-p)\mu(c_2^L)] \tag{2}$$

$$\text{s.t. } p[A^H - W_1 + \beta(A^H - W_2^H)] + (1-p)[A^L - W_1 + \beta(A^L - W_2^L)] \geq 0$$

$$W_2^j \geq A^j \quad \text{for } j = L,H$$

$$[(1/\beta) + I(c_1 - W_1)](W_1 - c_1) + W_2^j - c_2^j \geq 0 \quad \text{for } j = L,H$$

$$c_1 - W_1 \leq X^*$$

Proposition 3: The solution to (2) is characterized by,

i) $W_1 < W_2^L < W_2^H = A^H$

ii) $c_1 > W_1$, $c_2^L < W_2^L$, $c_2^H < W_2^H$

iii) $c_1 = c_2^L < c_2^H$.

Proposition 3 tells us that under our intermediate capital market assumption there is incomplete insurance, but it is of a much more plausible type than what occurs when workers have no access to capital markets. Specifically, it is still the case that if a worker is revealed to be of high ability, then he receives a raise just sufficient to stop the worker from being bid away by another firm. However, if he is revealed to be of low ability, he now receives a wage increase, but one smaller than the increase received by those revealed to be of high ability. That is, the insurance takes the form of a wage increase even for the case where the worker loses the lottery.

The intuition behind these results is as follows. Suppose the worker has no access to capital markets. This immediately translates into a fixed level of utility in period 2 when the worker is revealed to be of high ability. This combined with risk aversion then implies that the worker is best off if he has a flat age earnings profile for the case where he is revealed to be of low ability. Now suppose he has access to capital markets, although not perfect capital markets. By borrowing in period 1 he can now affect the utility he receives in period 2 if he is revealed to be of high ability. He is therefore best off by having an upward sloping age earnings profile even for the case where he is revealed to be of low ability, because in conjunction with borrowing it allows him to shift utility from high ability states of the world to low ability states of the world. Finally, because the imperfect capital market assumption means the worker pays a penalty when he borrows, the wage increase under a realization of low ability winds up being less than the wage increase which results under a realization of high ability.

One interesting perspective which follows from our analysis concerns the specific role of capital market imperfections in the type of insurance that firms provide to workers. In the Azariadis and Baily settings capital market imperfections served as an incentive for firms to provide insurance, with the result being that firms always provided complete insurance. On the other hand, here there is an incentive for firms to insure workers even in the absence of capital market imperfections. The result is that rather than serving as an incentive for insurance, capital market imperfections in this case serve as a barrier to insurance. That is, the greater the extent of the capital market imperfection, the less complete will be the insurance that firms provide to workers.

III. Labor Market Contracts With an Endogenous Capital Market

In this section we consider an explicit model of the third party sources of funds from whom workers might borrow. We characterize the nature of this endogenous capital market, and then analyze its ramifications for labor market contracts. To begin, we need to consider what factors result in workers facing imperfect capital markets. A primary factor is that a worker cannot use as collateral one of his major assets, namely his human capital. Given the subsequent lack of sufficient collateral, lenders are naturally concerned about the possibility of default. There is a substantial body of literature that has analyzed the nature of capital markets under these circumstances, e.g., Freimer and Gordon (1965), Jaffee and Russell (1976), and Stiglitz and Weiss (1981). One of the findings from this literature is that individuals are likely to face an upward sloping interest rate schedule. As summarized by Stiglitz and Weiss, this occurs because as the amount borrowed increases "the probability of default for any particular borrower increases," and "the mix of borrowers changes adversely." Since we are concerned primarily with deriving an upward sloping interest rate schedule endogenously and then considering the labor market ramifications of this schedule, we will focus on only one of the above explanations. Specifically, we will focus on the first explanation based on moral hazard problems and abstract away from any adverse selection considerations.

Formally, our specification of the credit market is a variant of the model employed by Jaffee and Russell. Each potential borrower is assumed to face a cost of default denoted θ. Following Jaffee and Russell, this penalty for default may be interpreted as a reduction in the earnings capability of an individual after he defaults, and it may reflect "moral costs" of default as well. For each individual θ is a draw from a random variable which has a cumulative distribution function $F(.)$, and probability density function $f(.)$. It is further assumed that $F(0) = 0$, $F(\bar{\theta}) = 1$, $f(\theta) > 0$ for all $\theta \in (0,\bar{\theta})$, and $f'(\theta)$ exists for all $\theta \in (0,\bar{\theta})$. That is, θ always falls somewhere in the interval $(0,\bar{\theta})$, where the density function is positive and differentiable in this interval.[7]

An individual privately observes his realization for θ, but only after the decision concerning how much to borrow has been made. At the time the borrowing decision is made, an individual and the potential lenders to that individual only know the distribution function $F(.)$.

Consider now a borrower's decision concerning whether or not to default. Let X denote the amount borrowed, and r denote the interest rate. An individual will (will not) default whenever the penalty to default is less (greater) than the contracted repayment, i.e., whenever θ <(>) $(1+r)X$. Let $\hat{\theta} = (1+r)X$. Given the above, $\hat{\theta}$ is the critical value for θ such that a borrower will (will not) default whenever θ <(>) $\hat{\theta}$.

The next step is to consider the behavior of lenders. It is assumed that lenders obtain their funds at the constant interest rate r^*, and that they have no other costs (note: in the notation of Section II, $r^* = (1-\beta)/\beta$). Lenders are assumed to be risk neutral and thus maximize expected profits. With a competitive loan market, a zero expected profit condition must hold. This implies that the interest rate r which is charged on a loan of size X must satisfy:

(3) $$(1+r)X(1-F(\hat{\theta})) = (1+r^*)X.$$

Equation (3) simply states that the expected revenue from the loan must equal the cost of providing the loan. Note, for a given X, there may be zero, one, or multiple values for r which satisfy (3). Whenever it exists, we will denote the minimum interest rate which satisfies (3) as $r(X)$. The following proposition characterizes the properties of $r(X)$.

Proposition 4: There exists a value X^*, $0 < X^* \leq \infty$, such that:

i) $r(X)$ does (does not) exist if $X <(>) X^*$

ii) $r(X^1) < r(X^2)$ if $0 < X^1 < X^2 < X^*$

iii) $r'(X)$ exists for a positive neighborhood of zero.

Proposition 4 indicates that individuals face an upward sloping interest rate schedule up to some maximum amount above which lenders refuse to lend. This maximum amount occurs when the amount borrowed is sufficiently large that an increase in the interest rate would actually lower expected profits. This can occur because an increase in the interest rate causes a corresponding increase in the probability of default.

Proposition 4 provides a characterization of the imperfect capital market that workers are likely to face given the described possibility of default. While this interest rate schedule is similar to that employed in Proposition 3 of Section III, the relationship is not exact. The following proposition describes the circumstances under which the endogenously derived capital market will yield an interest rate schedule exactly like that employed in Proposition 3.

Proposition 5: If $(1-F(\theta)) > \theta f(\theta)$ for all $\theta \in (0,\bar{\theta})$, then there exists a value X^*, $0 < X^* \leq \infty$, such that:

i) $r(X)$ does (does not) exist if $X <(>) X^*$

ii) $r'(X) > 0$ if $0 < X < X^*$.

Given that the endogenously derived capital market yields an interest rate schedule similar to that employed in Proposition 3, a reasonable conjecture is that the resulting labor market contract will resemble that characterized in Proposition 3. We now turn our attention to this question. With the assumptions made in Section II which characterize the labor market, i.e., assumptions 1-11, the equilibrium labor contract is now characterized by the following maximization problem.[8,9]

$$(4) \qquad \max_{\substack{W_1, W_2^L, W_2^H \\ c_1, c_2^L(\theta), c_2^H(\theta)}} \mu(c_1) + \beta \int_0^{\bar{\theta}} [p\mu(c_2^H(\theta)) + (1-p)\mu(c_2^L(\theta))]f(\theta)d\theta$$

$$\text{s.t. } p[A^H - W_1 + \beta(A^H - W_2^H)] + (1-p)[A^L - W_1 + \beta(A^L - W_2^L)] \geq 0$$

$$W_2^j \geq A^j \quad \text{for} \quad j = L,H$$

$$(1+r(c_1-W_1))(W_1-c_1) + W_2^j - c_2^j(\theta) \geq 0 \quad \text{for} \quad \theta > \hat{\theta} \quad \text{and} \quad j = L,H$$

$$c_2^j(\theta) \leq W_2^j - \theta \quad \text{for} \quad \theta < \hat{\theta} \quad \text{and} \quad j = L,H$$

$$c_1 - W_1 \leq X^*$$

where $\hat{\theta} = (1+r(c_1-W_1))(c_1-W_1)$. Equation (4) is equivalent to equation (2) except that consumption in period 2 now depends on the realization of θ. This can be seen by examination of the budget constraint when the worker borrows. Previously the budget constraint stated that second period consumption could not exceed the second period wage minus the contracted repayment. In equation (4) this is the case when $\theta > \hat{\theta}$. However, when $\theta < \hat{\theta}$ the worker defaults on his loan, and thus the constraint on period 2 consumption is the second period wage minus the cost of default. We can now proceed to the labor contract which results given this endogenously derived capital market specification.

Proposition 6: The solution to (4) is characterized by,

i) $W_1 < W_2^L < W_2^H = A^H$

ii) $c_1 > W_1$, $c_2^L(\theta) < W_2^L$ and $c_2^H(\theta) < W_2^H$ for all θ.

Proposition 6 tells us that our endogenously derived capital market specification yields qualitatively the same age-earnings profiles as found in Proposition 3. This reinforces our previous argument concerning the introduction of an intermediate capital market assumption. We now see that if workers are mobile so that they cannot bind themselves to firms, then the presumption that imperfections in the capital market completely restrict workers from borrowing is too severe. Even with moral hazard problems associated with the possibility of default, third party lenders are likely to allow at least some borrowing, albeit at rates higher than the default free rate. Further, as argued previously, when one moves away from the severe no borrowing assumption, the type of insurance provided through the labor market contract becomes much more plausible. First, as opposed to the result under the no borrowing assumption, workers are insured against the uncertainty they face concerning their own ability. This insurance taking the form of wage increases even for those workers revealed to be of low ability. Second, as opposed to what occurs under a perfect capital market assumption, this insurance is only partial in that low ability workers receive smaller raises than those received by workers revealed to be of high ability.

IV. Implications for Experience Earnings Profiles

In a widely cited article, Medoff and Abraham (1980) presented evidence concerning the relationship between experience, compensation and productivity among managerial employees. Their conclusion was that for workers in the same job category there seems to be first, a strong positive correlation between experience and compensation, and second, no correlation or a negative correlation between experience and productivity. Similar results have been found by, among others, Dalton and Thompson (1971) and Pascal and Rapping (1972). In particular, Dalton and Thompson found that engineers over the age of thirty five were in general below average in terms of productivity, while at the same time being above average in terms of compensation. On the other hand, Pascal and Rapping found that, even after controlling for productivity differences, there seems to be a positive correlation between experience and compensation for major league baseball players.

The above somewhat paradoxical results have brought forth a host of competing explanations. Examples of explanations which have been put forth to explain these results are those of Salop and Salop (1976), Grossman (1977), and Lazear (1979, 1981). In Salop and Salop workers vary in terms of an innate quit propensity, and firms in turn employ upward sloping age earnings profiles to screen out potential employees who are 'quitters'. Grossman's argument also relies on quitting behavior, but there the crucial factor is that young workers have on average a higher probability of quitting. This tends to lower wages for young workers, because it increases the probability that in the better states of nature the worker will leave the firm. Lazear's argument is one concerned with shirking. That is, by deferring payments firms can increase the penalty associated with being fired, and in this way deter employees from shirking.[10]

A different explanation for the paradox comes out of some of the papers mentioned earlier. Suppose productivity does not depend on experience, and there are low mobility costs. Freeman (1977) and Harris and Holmstrom (1982) demonstrate that, if workers have no access to capital markets, then compensation will be positively related to experience because workers revealed to be of high ability will have their wages bid up over time. More recently Weiss (1984) considered a similar model in the presence of a perfect capital market. The implication of his analysis is that the paradox might occur not only because workers revealed to be of high ability receive raises, but also because workers revealed to be of low ability receive raises. The logic is that the raises for the workers revealed to be of low ability serve as a form of insurance against the uncertainty workers face concerning their own ability.[11] As mentioned earlier, however, the Weiss analysis yields the unappealing property that the raises for the two types of workers are identical.

The analysis of this paper tells us two things concerning wage increases in the absence of productivity increases. First, for workers revealed to be of low ability to receive raises in the absence of productivity increases, it is not necessary that workers face perfect capital markets. Rather, this will be the case as long as workers are not completely restricted from borrowing. Second, the property that workers revealed to be of low ability receive raises can be obtained without having the raises be of the same magnitude as those of workers revealed to be of high ability.

Including the explanation investigated in this paper, there are now a number of explanations which can account for the empirical finding that the correlation between experience and compensation does not seem to be explained solely by a correlation between experience and productivity. This suggests that empirical tests which would help us to discriminate among these competing hypotheses might now be worthwhile. Below we discuss tests which could be used for this purpose. First, empirical analysis could be done on groups of workers all of whom have a very low quit propensity. If results similar to the Medoff and Abraham results were found within such a group, we would have an indication that the phenomenon is not due solely to an argument which depends on differences in quit propensities, e.g., the Grossman, and the Salop and Salop arguments. Note, because of the high rents associated with the job, baseball players rarely quit while they are still productive. They are therefore an example of a group which satisfies the specified condition, which in turn implies that the Pascal and Rapping empirical results already give us an indication that quit propensities are not the sole factor. Second, one could test the strength with which compensation increases in the absence of productivity growth. That is, is it the case, as suggested by Harris and Holmstrom, that workers for whom positive information is revealed receive raises, while other workers simply do not receive pay cuts? Or is it the case, as is suggested by the analysis in this paper, that even workers for whom negative information is revealed receive raises, but raises that are smaller than those for whom positive information is revealed? If the data is consistent with the latter statement, then we would have evidence for the importance of the insurance effect which arises when workers have access to capital markets, but not perfect capital markets.

V. Conclusion

The insurance aspects of employer-employee attachments has been one of the major focuses of the burgeoning literature on labor market contracts. Starting with the work of Azariadis and Baily, the standard capital market assumption employed in this literature has been that workers have no access to capital markets. We have argued that this might have been a reasonable assumption for the initial settings analyzed by Azariadis and Baily, but for many of the more recent applications the assumption is much less reasonable. Our argument is as follows. Azariadis and Baily assume a high degree of specificity between workers and firms, with the result being that workers are completely insured through the labor market contract. Hence, any capital market imperfection would result in exactly the same contract as the one they derived, and thus their analyses suffered no loss of generality because of the simplifying assumption that workers have no access to capital markets. On the other hand, in many of the more recent applications there is no assumption of a high degree of specificity between workers and firms. The result is that firms only provide workers with partial insurance, and hence the extent of the capital market imperfection may very well have a significant effect on the form of the contract offered.

One branch of the literature open to the above criticism is the set of papers which model the idea that, as a worker ages, firms accumulate information concerning the expected productivity of the worker in subsequent periods. Papers in this branch of the literature have considered both what occurs when workers have no access to capital markets, as well as what happens when workers face perfect capital markets. To us the analyses in these papers yield implausible results as regards the type of insurance provided. With workers having no access to capital markets, a very weak form of insurance is provided. In this case it is as though workers faced a lottery in which the winners are promised wage increases, while losers are only promised not to have their wages cut. Alternatively, with perfect capital markets, the insurance provided is implausible in that it involves bad workers receiving the same wage increases as good workers.

The above motivated us to analyze a model consistent with this branch of the literature, but employ an intermediate assumption concerning the capital market. We demonstrated that if workers are allowed access to capital markets, but not perfect capital markets, then the insurance provided is much more plausible. As before, in response to positive news regarding a worker's future productivity, the worker's wage will be increased. In contrast, however, other realizations of the worker's expected future output now also result in a wage increase, but one smaller than the increase provided under a more positive realization. That is, under an intermediate capital market assumption, the insurance takes the form of a wage increase even for the case where the worker loses the lottery.

We then proceeded to a further analysis of the capital market assumption. In particular, we showed how our intermediate assumption concerning the capital market could be justified through explicit modeling of the third party sources of funds from whom workers might borrow. Previous papers have neglected to provide this extra step, and we feel it is important in that without it there is no guarantee that the capital market assumption employed will be the appropriate one for the environment being analyzed.

The obvious direction in which the analysis in this paper could be extended would be to allow for an intermediate capital market assumption in other contexts where perfect insurance is not provided through the labor contract. One example is the recent set of papers which extend the Azariadis and Baily analyses to the asymmetric information case (see e.g., Azariadis 1983, Chari 1983, Grossman and Hart 1981, 1983, and Green and Kahn 1983). Similar to how the extent of the capital market imperfection affected the divergence from full insurance in the environment analyzed in this paper, the extent of the capital market imperfection may very well affect the divergence from full insurance in this recent asymmetric information literature.

A second direction in which our analysis could be extended concerns the notion of moral hazard. The model in this paper, as well as the models of Freeman, Harris and Holmstrom, and Weiss, abstract away from problems concerning moral hazard in the labor market.[12] Consider again the type of environment analyzed in this paper, wherein information concerning a worker's future productivity is revealed through the worker's present output. In the absence of moral hazard, we found that moving to an intermedite capital market assumption decreased the future wage differential between those workers for whom present output is high and those for whom it is low. Once moral hazard is introduced, however, the effect of introducing an intermediate capital market assumption is not quite so clear. The reasoning is as follows. When moral hazard is present, the above mentioned wage differential can be used as a device to punish low levels of effort. Further, allowing workers some access to a capital market will limit the effective punishment associated with any given wage differential, with the possible result being that high levels of effort can only be induced by actually increasing the specified wage differential. This obviously throws some doubt on the robustness of our results to a world where moral hazard is present, and we feel further analysis might be helpful in identifying which of the two effects tend to dominate in such a world.

Appendix

Proof of Proposition 1: The optimality conditions from (1) reduce to:

(A1) $$\mu'(c_1) = p\mu'(c_2^H) + (1-p)\ \mu'(c_2^L) + \lambda_1$$

(A2) $$\lambda_2 = \mu'(c_1) - \mu'(c_2^H)$$

(A3) $$\lambda_3 = \mu'(c_1) - \mu'(c_2^L)$$

(A4) $$\lambda_2[\beta p(W_2^H - A^H)] = 0, \quad \lambda_2 \geq 0$$

(A5) $$\lambda_3[\beta(1-p)\ (W_2^L - A^L)] = 0, \quad \lambda_3 \geq 0$$

(A6) $$\lambda_1\ [W_1 - c_1] = 0, \quad \lambda_1 \geq 0$$

and the constraints in (1), (where λ_1, λ_2 and λ_3 are the Kuhn-Tucker multipliers associated with the constraints $W_1 \geq c_1$, $W_2^H \geq A^H$, and $W_2^L \geq A^L$ respectively).

To prove the proposition, first note that at the optimum both the worker's budget constraint and the firm's non-negative profit constraint must hold as equalities, while (A2) and (A3) imply $c_2^H \geq c_1$ and $c_2^L \geq c_1$. Suppose $W_1 > c_1$. By (A6), this implies $\lambda_1 = 0$, which given (A1), (A2) and (A3) implies $c_1 = c_2^H = c_2^L$. By the budget constraint and (A4) this implies $W_2^H = W_2^L \geq A^H$. By the expected profit constraint this implies $W_1 \leq W_2^H = W_2^L$, which in turn yields the contradiction $c_1 > W_1$. Hence $W_1 = c_1$. Given this, the budget constraint yields $W_2^H = c_2^H$ and $W_2^L = c_2^L$.

Now suppose that $c_2^L > c_1$. The above and (A3) now imply $c_2^L = W_2^L = A^L > W_1$. By the expected profit constraint this implies $W_2^H > A^H$, which given (A2) and (A4) yields $c_1 = c_2^H > c_2^L$. This involves a contradiction, and hence we have $W_1 = W_2^L = c_1 = c_2^L$.

Finally, suppose that $W_1 = W_2^L = A^L$. The expected profit constraint now implies $W_2^H > A^H$, which given the arguments above yields the contradiction $c_1 = c_2^H > c_2^L$. Hence, we have $W_1 = W_2^L > A^L$, which given the expected profit constraint yields $W_2^H = A^H > W_1 = W_2^L > A^L$.

Proof of Proposition 2: The optimality conditions in this case reduce to (A1)-(A5) (where $\lambda_1 = 0$) and the constraints in (1) (excluding $W_1 \geq c_1$). As previously, the worker's budget constraint and the firm's non-negative profit constraint must hold as equalities. Now, to prove the proposition, we will first prove that $c_1 = c_2^H = c_2^L$. By (A1), observe that if $c_2^H \neq c_2^L$, then either $c_2^H > c_1 > c_2^L$ or $c_2^L > c_1 > c_2^H$. Using (A2) and (A3) both of these yield contractions. Hence, $c_2^H = c_2^L$. By (A1), this implies $c_1 = c_2^H = c_2^L$, which, given (A4), (A5) and the budget constraints, yields $W_2^H = W_2^L \geq A^H$. Given this, the zero expected profit constraint implies $W_1 < A^H \leq W_2^H = W_2^L$. Since $c_1 = c_2^H = c_2^L$ and $W_1 < W_2^H = W_2^L$, this implies by the budget constraints that $c_1 > W_1$, $c_2^H < W_2^H$ and $c_2^L < W_2^L$.

Proof of Proposition 3: We only explicitly consider the case $c - W_1 < X^*$. The other case follows similarly. The optimality conditions from (2) reduce to (A2)-(A5),

$$\text{(A7)} \qquad \mu'(c_1) = [p\mu'(c_2^H) + (1-p)\ \mu'(c_2^L)]\ [1 + \beta[I + (c_1 - W_1)I']],$$

and the constraints in (2). As previously, the worker's budget constraint and the firm's non-negative expected profit constraint must hold as equalities. We first prove that $W_2^H > W_2^L > W_1$. Suppose $W_2^L \geq W_2^H$. Given (A3) and $W_2^H \geq A^H > A^L$, this implies $c_1 = c_2^L$. Note, as well, that $W_2^L \geq W_2^H$ implies $c_2^L \geq c_2^H$ by the budget constraints. Since $c_1 = c_2^L \geq c_2^H$ and $c_2^H \geq c_1$, this implies $c_1 = c_2^H = c_2^L$. The zero expected profit constraint implies $W_1 < A^H$ when $W_2^L \geq W_2^H$. Hence, with $c_1 = c_2^H = c_2^L$ and $W_2^L \geq W_2^H > W_1$, by the budget constraints, $c_1 > W_1$. Yet, if $c_1 = c_2^H = c_2^L$ and $c_1 > W_1$, then the optimality condition (A7) is violated. Thus, $W_2^L > W_2^H$ yields a contradiction. It can similarly be shown that $W_2^L < W_1$ yields a contradiction. Hence, we have $W_2^H > W_2^L > W_1$.

Next, we prove that $c_1 = c_2^L < c_2^H$. First, since $W_2^H > W_2^L$, (A2), (A3) and the budget constraints yield $c_2^H > c_2^L > c_1$. Suppose $c_2^L > c_1$. Then by (A3) and (A5), $W_2^L = A^L$. Since $c_2^H > c_1$, we have by (A2) and (A4), $W_2^H = A^H$. By the zero expected profit constraint this implies $W_1 = pA^H + (1-p)A^L > A^L = W_2^L$. This contradicts $W_2^L > W_1$. Hence, $c_2^L = c_1$. Note, as well, that $c_2^H > c_1$ implies by (A2) and (A4) that $W_2^H = A^H$. Given this, by the arguments above, $W_2^L > A^L$, since otherwise we have a contradiction. Taken together, we have $W_1 < W_2^L < W_2^H = A^H$ and $c_1 = c_2^L < c_2^H$. By the budget constraint, this implies $c_1 > W_1$, $c_2^L < W_2^L$ and $c_2^H < W_2^H$.

Proof of Proposition 4: i) Consider an $\tilde{X}$, $\hat{X}$ pair, such that $0 < \tilde{X} < \hat{X}$ and $r(\hat{X})$ exists. By (3), if $X = \tilde{X}$ and $r = r(\hat{X})$, expected profits would be positive. Alternatively, if $X = \tilde{X}$ and $r = r^*$, expected profits would be negative. Since expected profits are continuous in r this implies there exists an $r = r(\hat{X})$ such that expected profits equal zero. Given the above, if $r(X)$ exists for some $X > 0$ then there must exist an X^*, $0 < X^* < \infty$, such that $r(X)$ exists if $X < X^*$ and $r(X)$ does not exist if $X > X^*$. Because $f(\theta)$ is continuously differentiable and $(1-F(\theta)) - \theta f(\theta) > 0$ in a positive neighborhood of zero, (3) yields by the implicit function theorem that $r(X)$ must exist for at least a positive neighborhood of zero. This proves i).

ii) Since $0 < X^1 < X^2 < X^*$, $r(X^1)$ and $r(X^2)$ exist. If $X = X^2$ and $r = r(X^2)$, expected profits are equal to zero by definition. If $X = X^1$ and $r = r(X^2)$, expected profits would be positive. If $X = X^1$ and $r = r^*$, expected profits would be negative. Since expected profits are continuous in

r, there must exist an $r = r(X^1)$, $r^* < r(X^1) < r(X^2)$, such that expected profits are zero.

iii) Since $f(\theta)$ is continuously differentiable and $(1-F(\theta)) > \theta f(\theta)$ in a positive neighborhood of zero, by the implicit function $r(X)$ exists for a positive neighborhood of zero and is differentiable. $r'(X)$ in this neighborhood is given by:

$$r'(X) = \frac{f((1+r)X)}{(1-F((1+r)X)) - (1+r)Xf((1+r)X)} > 0.$$

Proof of Proposition 5: i) follows immediately from Proposition 4. ii) Given that $(1-F(\theta)) > \theta f(\theta)$ for all θ, expected profits are an increasing function of the interest rate for all positive r. By the implicit function theorem, $r(X)$ is differentiable for $0 \leq X < X^*$ with $r'(X)$ given by:

$$r'(X) = \frac{f((1+r)X)}{(1-F((1+r)X)) - (1+r)Xf((1+r)X)} > 0.$$

Proof of Proposition 6: First, it must be the case that $c_1 \geq W_1$. For if the worker lends in period 1 then he faces the competitive interest rate r^*. From Propositions 1 and 2 we know that in such a situation the worker never chooses to lend. Second, it must also be the case that $c_1 > W_1$. If $c_1 = W_1$, then the optimal labor contract would be the no borrowing solution (Proposition 1). In this situation $W_1 = W_2^L = c_1 = c_2^L(\theta) < c_2^H(\theta) = W_2^H$ for all θ. Note that $c_2^L(\theta)$ and $c_2^H(\theta)$ are constant for all θ in this case (given no borrowing, θ is irrelevant). This contract is dominated by one with some borrowing. To see this, consider the expected utility at the no borrowing solution. Denote this solution with a "~". Let $c_1 = \tilde{c}_1 + Z$ and $c_2^j(\theta) = \tilde{c}_2^j(\theta) - ((1+r(Z))Z$ for all θ and $j = L,H$. Holding wages fixed, this transformation satisfies the budget constraints for sufficiently small Z. At $Z = 0$, expected utility under this transformation is equal to the expected utility under the no borrowing solution. The derivative of expected utility with respect to Z evaluated at $Z = 0$ is given by (note that r' exists in a positive neighborhood of zero):

$$\text{(A8)} \qquad \left.\frac{\partial EU}{\partial Z}\right|_{Z=0} = \beta p(1+r)[\mu'(\tilde{W}_1) - \mu'(\tilde{W}_2^H)].$$

Since $\tilde{W}_1 < \tilde{W}_2^H$ and $\mu'' < 0$, (A8) implies $\left.\frac{\partial EU}{\partial Z}\right|_{Z=0} > 0$. Hence, the no borrowing solution is dominated by one with at least some borrowing. This combined with the budget constraint proves ii).

We now need to prove i). Suppose $W_1 > W_2^L, W_2^H$. This is impossible since $W_2^H > A^H$ and $W_2^L > A^L$ implies with the zero expected profit constraint that $W_1 < A^H$. Now suppose $W_1 > W_2^L$. Denote the solution with $W_1 > W_2^L$ by a "~". Consider the following transformation of this solution: $c_1 = \tilde{c}_1 - \beta(1-p)Z$, $W_1 = \tilde{W}_1 - \beta(1-p)Z$, $c_2^L(\theta) = \tilde{c}_2^L(\theta) + Z$ for all θ, $W_2^L = \tilde{W}_2^L + Z$, $c_2^H(\theta) = \tilde{c}_2^H(\theta)$ for all θ and $W_2^H = \tilde{W}_2^H$. This transformation satisfies all the constraints for sufficiently small Z and at $Z = 0$ this transformation yields the expected utility associated with the "~" solution. The derivative of expected utility with respect to Z evaluated at $Z = 0$ is given by (note that since $(c_1 - W_1)$ does not change under this transformation we need not be concerned about the existence of r'):

$$\text{(A9)} \qquad \left.\frac{\partial EU}{\partial Z}\right|_{Z=0} = -\beta(1-p)\mu'(\tilde{c}_1) + \int_0^{\hat{\theta}} \beta(1-p)\mu'(\tilde{W}_2^L-\theta)f(\theta)d\theta$$

$$+ \int_{\hat{\theta}}^{\bar{\theta}} \beta(1-p)\mu'(\tilde{c}_2^L(\theta))f(\theta)d\theta.$$

Since $\tilde{c}_1 > \tilde{W}_1 > \tilde{W}_2^L > \tilde{c}_2^L(\theta)$ for all θ and $\mu'' < 0$, (A9) implies $\left.\frac{\partial EU}{\partial Z}\right|_{Z=0} > 0$. Hence, $W_1 \not> W_2^L$. In what follows, the above technique of using a marginal transformation of the solution in question to demonstrate suboptimality will be used repeatedly. For the sake of brevity, for the remaining cases we will only indicate what particular transformation will yield the suboptimality of the case in question but will not provide the details of the analysis. Note that in each case "~" denotes the solution under consideration.

Suppose $W_2^L > W_2^H$. The transformation $c_1 = \tilde{c}_1$, $W_1 = \tilde{W}_1$, $c_2^L(\theta) = \tilde{c}_2^L(\theta) - Z$ for all θ, $W_2^L = \tilde{W}_2^L - Z$, $c_2^H(\theta) = \tilde{c}_2^H(\theta) + \frac{(1-p)}{p} Z$ for all θ, and $W_2^H = \tilde{W}_2^H + \frac{(1-p)}{p} Z$, satisfies the constraints for sufficiently small Z, and can be used to demonstrate the suboptimality of $W_2^L > W_2^H$.

Thus far, we know that $W_1 < W_2^L \leq W_2^H$. Suppose $W_1 < W_2^L = W_2^H$. This implies by the budget constraints that $c_2^L(\theta) = c_2^H(\theta)$ for all θ. There are three sub-cases of interest: (a) $c_1 < c_2^L(\hat{\theta}) = c_2^H(\hat{\theta})$; (b) $c_1 > c_2^L(\hat{\theta}) = c_2^H(\hat{\theta})$ and (c) $c_1 = c_2^L(\hat{\theta}) = c_2^H(\hat{\theta})$. First, consider (a). In this case, the transformation $c_2^L(\theta) = \tilde{c}_2^L(\theta) - Z$ for all θ, $W_2^L = \tilde{W}_2^L - Z$, $c_1 = \tilde{c}_1 + \beta(1-p)Z$, $W_1 = \tilde{W}_1 + \beta(1-p)Z$, $c_2^H = \tilde{c}_2^H(\theta)$ for all θ, and $W_2^H = \tilde{W}_2^H$ can be used to demonstrate the suboptimality of this solution. Next, consider (b). The suboptimality of this case can be demonstrated with the transformation $c_1 = \tilde{c}_1 - Z$, $W_1 = \tilde{W}_1$, $c_2^j(\theta) = \tilde{c}_2^j(\theta) + (1+r(\tilde{c}_1-\tilde{W}_1-Z))Z$ for $\theta > \hat{\theta}$ and $j = L,H$, $c_2^j(\theta) = \tilde{c}_2^j(\theta)$ for $\theta < \hat{\theta}$ and $j = L,H$, and $W_2^j = \tilde{W}_2^j$ for $j = L,H$. Finally, consider (c). The suboptimality of this case can be demonstrated with the transformation $c_1 = \tilde{c}_1 + \beta(1-p)Z$, $W_1 = \tilde{W}_1 + \beta(1-p)Z$, $W_2^L = \tilde{W}_2^L - Z$, $c_2^L(\theta) = \tilde{c}_2^L - Z$ for all θ, $W_2^H = \tilde{W}_2^H$, and $c_2^H(\theta) = \tilde{c}_2^H(\theta)$ for all θ. Hence, $W_1 < W_2^L = W_2^H$ is suboptimal.

We now have $W_1 < W_2^L < W_2^H$. Suppose $W_2^H > A^H$. This can be demonstrated to be suboptimal with the transformation $W_2^H = \tilde{W}_2^H - Z$, $c_2^H(\theta) = \tilde{c}_2^H(\theta) - Z$ for all θ, $c_2^L(\theta) = \tilde{c}_2^L(\theta) + (\frac{p}{1-p})Z$ for all θ, $W_2^L = \tilde{W}_2^L + (\frac{1}{1-p})Z$, $c_1 = \tilde{c}_1$, and $W_1 = \tilde{W}_1$. Thus, we have $W_1 < W_2^L < W_2^H = A^H$.

Footnotes

[1]Papers which contain a perfect capital market assumption analysis include Topel and Welch (1983), and Weiss (1984).

[2]As indicated earlier, Waldman (1984) is similar in structure to the papers cited. However, the results of that paper are not consistent with the following discussion. The reason is that, as opposed to the other papers, that paper has an asymmetry between firms. Specifically, after a period of employment the initial employer gets to observe a worker's ability, while other firms only get to observe the subsequent task assignment.

[3]It is obvious that one way to get a more plausible contact is by adding the moral hazard/shirking problems frequently associated with worker-firm relationships. However, we want to demonstate that this type of moral hazard problem is not necessary to get a more plausible contract. Note, the Conclusion contains a further discussion of the significance of introducing this type of moral hazard problem.

[4]One insurance/labor contracting paper which does explicitly consider third party sources of funds is Haltiwanger (1983). In that paper productivity fluctuates across sectors over time while mobility costs are low. The result is that rather than firms providing insurance through the labor market contract (as in Azariadis and Baily), insurance is provided through these third party sources of funds.

[5]If for some realization of the worker's ability the second period wage did not satisfy the restriction, then the worker would be bid away and in terms of worker utility and firm profits it would be as if the restriction was satisfied as an equality. Thus, following Harris and Holmstrom, we simply assume that the contract always satisfies the restriction.

[6]There are multiple wage profiles which solve this new maximization problem. In Proposition 2 we simply present properties which all such wage profiles exhibit.

[7]The two polar capital market assumptions already investigated in the literature, i.e., the no borrowing assumption and the perfect capital market assumption, can be thought of as special assumptions on the distribution function $F(.)$. The no borrowing assumption is simply that $\bar{\theta} = 0$. The perfect capital market assumption is that θ falls in the interval $(\underline{\theta},\bar{\theta})$, where $\underline{\theta}$ is prohibitively high.

[8]To somewhat simplify the mathematics we assume $r(X)$ exists at $X = X^*$.

[9]One might think that (4) should contain an additional constraint which states the interest rate the worker faces when he lends. This, however, is already captured in the third constraint. That is, if $c_1 < W_1$, then $\hat{\theta} < 0$ and $r(c_1-W_1) = r^*$. Hence, the third constraint is then always the relevant constraint and it states that the worker faces the default free rate.

[10]In an earlier paper on the economics of law enforcement, Becker and Stigler (1974) make a similar point.

[11]Medoff and Abraham (1980) had previously suggested this explanation, but their discussion contained no reference to the relevance of the capital market assumption.

[12]Of course, we have not completely ignored the problem of moral hazard. One of our main goals was to derive the appropriate capital market assumption by explicitly modeling the interaction between workers and the third party sources of funds from whom they might borrow. In turn, explicitly modeling this interaction entailed specifying the moral hazard problems which arise when borrowing takes place.

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